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The Geodesist's Handbook 2008

International Association of Geodesy

A constituent Association of the

International Union of Geodesy and Geophysics (IUGG)

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GEODESIST'S HANDBOOK 2008

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Foreword

The Geodesist's Handbook of the International Association of Geodesy (IAG) has been published since 1980 always in the year after the IUGG/IAG General Assembly. The objective is to present the Association and its current structure to the broader geodetic community. New association entities and officers are introduced, and the planned activities for the next legislature period are presented.

The first part of the Handbook 2008 gives a review of the latest historical developments and the current status of IAG. Tribute to past leading IAG officers is traditionally given by a resigning Secretary General for the full period of his activity. Carl Christian Tscherning was the IAG Secretary General for twelve years from 1995 to 2007. He summarizes the curricula vitae and main activities of the IAG Presidents Wolfgang Torge, Klaus-Peter Schwarz, Fernando Sansò, and Gerhard Beutler as well as the IAG Secretaries General Claude Boucher and Carl Christian Tscherning. The IAG Statutes, Bylaws and Rules are also published in their current versions.

The second part summarizes the official outcome of the 24th IUGG General Assembly, which was likewise the 42nd IAG General Assembly, held in Perugia, Italy, in July 2007. An overview of most important IAG events from 2003 to 2007 is given in the presidential address. The laudation and acceptance speech of two scientists decorated with the highest IAG awards (Levallois Medal and Bomford Prize) are published. Reports of the Secretary General, the IAG Council and Executive Committee meetings, and the resolutions conclude this section.

The third part of the Handbook gives the detailed structures for the period 2007-2011. All IAG components (Commissions, Services, the Global Geodetic Observing System, and the Communication and Outreach Branch) are described along with their sub-components (Inter-commission Committee, Sub-commissions, Projects, Study Groups and Working Groups). This forms the major section of the scientific work of IAG.

The fourth part completes the Handbook with some general information useful for the geodetic community. Geodetic standards and conventions relevant for geodesy are summarized, the IAG Internet representation is highlighted, and the IAG national representatives and main IAG publication series are listed. There used to be lists of geodetic data centres, educational establishments, publication series, and directory in the Geodesist's Handbook. It arose that nowadays these lists are outdated very soon. Therefore, and to avoid a waste of paper, these lists are no longer published as paper copies. They are published in the IAG Homepage and are available as paper copies on request.

We'd like to thank all the contributors to the Geodesist's Handbook 2008. These are in particular all the IAG officers listed in the structures, but also the uncounted secretaries and technicians in the institutions affiliated with IAG or one of its components or sub-components. The engaged and authentic cooperation in geodesy is one of the most effective means for the great success of our science. We hope that this collaboration will be continued or even extended in the current period 2007 – 2011.

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Secretary General

Helmut Hornik
Assistant Secretary General

József Ádám
COB President

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The International Association of Geodesy (IAG)

Update of the History of the International Association of Geodesy

József Ádám

President of IAG Communication and Outreach Branch

In 1828, *J.J. Baeyer* published a paper with *C.F. Bessel* proposing collaboration between East Prussia and Russia on long arc measurements. The life's work of General Baeyer to promote international geodesy was finally realized following an initiative "Über die Größe und Figur der Erde" submitted to the King of Prussia in April 1861. In his memorandum J. J. Baeyer suggested that the states of Europe should work together to measure the size and shape of the Earth and proposed methods to achieve this aim. The origin of the International Association of Geodesy (IAG) goes back to 1862, the year, in which the "Mitteleuropäische Gradmessung", predecessor of the IAG, was established. The first "General Conference of the Representatives to the Mitteleuropäische Gradmessung" (Central European Arc Measurement) took place in Berlin in 1864, which might be considered as the forerunner of the General Assemblies of the IAG.

The IAG has a long history which is well documented by a number of papers, see e.g. *Angus-Leppan (1984 a, b, 1992), Beutler (2004), Beutler et al. (2004), Mueller (1990, 1992, 1997), Levallois (1980), Louis (1992), Schwarz (2000), Torge (1996, 2005), Whitten (1988)*. My interest is to collect some main information connected to the IAG history in tables and to make a few related tables complete, cf. Levallois (1980).

1. Assemblies of the IAG

1.1 General Conferences and Assemblies

The first General Conference of the "Mitteleuropäische Gradmessung", being the forerunner of IAG, took place in Berlin in 1864, where also a Central Bureau (CB) was established. By 1867 the name of the organization had changed to "Europäische Gradmessung". Since this organization developed well, therefore in 1886 it was extended to the "Internationale Erdmessung", or International Geodetic Association (or in French: Association Internationale de Géodésie). In 1919, the Association was a founding member of a larger scientific group and became the Section of Geodesy of the International Union of Geodesy and Geophysics (IUGG). Due to the changes of the IUGG's statutes, the name of the organization changed first to the Association of Geodesy, then in 1946 to the current name, International Association of Geodesy.

The General Assembly (earlier General Conference) is a very important date and event in the administrative and scientific life of the Association. Since 1922 the General Assembly (GA) of the IAG is held concurrently with the IUGG's GA at the same time and same place. (The first IUGG's GA was in 1922.) Since 1963, the IUGG/IAG GAs are held every four years. The IUGG GAs are numbered with Roman numerals, thus the next GA will be number XXV (25th) in Melbourne, Australia in 2011. This will be the 43rd GA of the IAG from the very beginning General Conference in Berlin, in 1864. Table 1 lists the years and locations of IAG's GAs as well as the previous names of the IAG.

1.2 Scientific Assemblies

The IAG Scientific Assemblies (SAs) are generally held mid-way during the period between two meetings of the IUGG/IAG GA. An SA usually consists of a group of scientific symposia and a group of component meetings, held at the same time and place. The first SA (which was called that time as General Meeting) was held in Japan in

1982 and the next one will be in Argentina in 2009 (see Table 2).

2. Officers and Office of the IAG

2.1 Past IAG Presidents and Secretaries General

Based on the publications of *Levallois (1980), Kukkamäki (1980)* and *Joselyn (2007),* Table 3 and 4 list the past IAG Presidents and Secretaries General. Brief biographical memoirs of former Presidents and Secretaries General are in The Geodesist's Handbooks and available in the new IAG website.

2.2 Hosts of the IAG Central Bureau

By the new IAG By-Laws (§37) the Secretary General is assisted by an IAG Office established by the Association in the country in which the Secretary General resides. Currently this Office is hosted by the Deutsches Geodätisches Forschungsinstitut (DGFI) in Munich, Germany. The name of this office before the last GA in Perugia in 2007 was called as Central Bureau (CB), or as Secretariat in the early of last century. The IAG Office is (earlier CB or Secretariat was) the secretariat of the Bureau and the Executive Committee (EC, which was earlier called as Permanent Commission). It maintains organization and liaison for the Association and is responsible for financial management, organizing and running of GAs, etc. The IAG Office (or CB) is directed by the Secretary General, who has one or more Assistant Secretaries. In the first period of IAG, the CB was headed by nominated directors, as *J.J. Baeyer* between 1864 and 1885, and *F.R. Helmert* between 1886 and 1917. Table 5 lists the hosts of the IAG's Central Bureau.

3. Editors-in-Chief of the IAG Official Journals

3.1 Editors-in-Chief of the Journal of Geodesy

At the GA in Rome in May of 1922, the delegates made a decision for the publication of *Bulletin Géodésique* (BG). For 74 years, BG has been the official journal of the Section of Geodesy of the IUGG and subsequently of the IAG. Published by the IAG Central Bureau in Paris until 1990, it was taken over the Springer publishing house.

In 1975 the m*anuscripta geodaetica* (MG) was launched by Kremers Verlag under a spiritual leadership of Professor *Erik W. Grafarend,* to provide a place to publish longer manuscripts and for the fast publication of author produced manuscripts. The MG was also established for the international publication of contributions from the field of geodesy. From 1988 the MG was also published by the Springer-Verlag.

As of the beginning of 1991, i.e. Vol. 65, No. 1. BG and MG had a joint editorial board. On the basis of a common interest of the IAG Executive Committee (EC) and Springer-Verlag expressed in merging the two journals, beginning from January 1, 1996 the new official organ of the IAG, *Journal of Geodesy* (JoG) replaced the BG and MG. Therefore, the JoG is the continuation and merger of the BG and MG. The volume numbering of the BG is carried on. For the list of the Editors-in-Chief see Table 6.

3.2 Editors of the Geodesist's Handbook

On the basis of a decision of the IAG EC, from 1980 the BG (and currently the JoG) publishes, after every GA, a special issue called *The Geodesist's Handbook* which is devoted to a detailed description of the Association. It provides the actual information on the Association, including the reports of the President and Secretary General presented at the previous IAG GA meeting, the resolutions taken at that meeting, and the Association structure listing components and sub-components for the running period, rules for the IAG Fund, IAG Awards and for the conduct of scientific meetings as well as relevant scientific information. The Editors (see Table 7) were nominated by the IAG EC. This issue is the eighth one in a series appeared up to now.

4. Awards Established by the IAG

The IAG EC established prestigious awards for outstanding contributions to geodesy and distinguished service to the Association. The rules for the awards are published in The Geodesist's Handbooks. These awards and their winners are as follows.

4.1 The Guy Bomford Prize

The Guy Bomford Prize is awarded by the IAG for outstanding contribution to Geodesy. It was established by the British National Committee for Geodesy and Geophysics to mark the contributions to geodesy of Brigadier G. Bomford, formerly of the University of Oxford and an IAG Past President. It has been inaugurated by the IAG in 1975. The Prize is normally awarded at intervals of four years on the occasion of the IAG's GA.

The Guy Bomford Prize is awarded to a young scientist or a team of young scientists for outstanding theoretical or applied contributions to geodetic studies, particularly in the four year period preceding the GA at which the award is made. Scientists who are under 40 years of age on December 31, of the year preceding the GA at which the award is made, are eligible for the award. Nominations will be invited by the IAG Bureau from all National Committees of IUGG member countries at least one year

ahead of the GA. The Prize is presented to the successful candidate at the opening Plenary Session of the IAG Assembly. He or she shall be invited to deliver a lecture during the course of the IAG Assembly. Table 8 lists the winners of the Bomford Prize. A few speeches of the Bomford Prize winners are published in The Geodesist's Handbook (see Vol. 1980, 1988, 1996, 2000, 2004, and this issue).

4.2 The Levallois Medal

The Levallois Medal was established in 1979 to honour Jean-Jacques Levallois, and to recognize his outstanding contribution to the IAG, particularly his long service as Secretary General between 1960 and 1975. The award of the Medal is made in recognition of distinguished service to the Association, and/or to the science of geodesy in general.

The Medal is normally awarded at four year intervals, on the occasion of the GA of the IAG and IUGG; but the award may be omitted if it is considered that there is no candidature of sufficient merit, and an additional award may be made at any time if justified by exceptional circumstances. A nomination for the award shall be made by an ad hoc committee consisting of the IAG Honorary Presidents and must be confirmed by the IAG Executive Committee. Table 9 lists the winners of the Levallois Medal. Some laudations for Levallois Medal winners are in the Geodesist's Handbook (see Vol. 1996, 2000, 2004, and this issue).

4.3 The IAG Young Author Award

The purpose of the IAG Young Author Award is to draw attention to important contributions by young scientists in the Journal of Geodesy and to foster excellence in scientific writing. The applicant must be 35 years of age or younger when submitting the paper for publication. The paper must present the applicant's own research, and must have been published in the two annual volumes of the Journal of Geodesy (JoG) preceding either the IAG GA or the IAG SA. Although multiple author papers are considered, single author papers are given more weight in the selection process. Presentation of the awards will be made at each IAG GA and each IAG SA.

For each two-year period the Editor-in-Chief of the Journal of Geodesy will propose a minimum of three candidates for the award. In addition, proposals made by at least three IAG Fellows or Associates will be considered for the competition. The voting members of the IAG Executive Committee will make the final selection. It will be based on the importance of the scientific contribution, which may be either theoretical or practical, and on the quality of the presentation. The name and picture of the award winner and a short biography are published in the IAG Newsletter part of the Journal of Geodesy. The winners of the Young Author Award are listed in Table 10.

5. The Science Services Hosted by the IAG

The IAG is the home of a number of science services whose goals include providing the user community with various geodetic products and/or information and to foster international cooperation. There are four types of services, one related to *(a)* geometry, one to *(b)* gravity, one to *(c)* both geometry and gravity and one to *(d)* documentation and information. Table 11 contains the IAG science services (in consistent with the new IAG By-Laws) with the address of their webpages, which are listed in alphabetical order. There are two services among them acting as „umbrella" service, that is the IERS over the geometry related services and the IGFS over the gravity related services.

The history of the IAG services is well documented, see e.g. *Mueller (1998), Beutler et al. (2004),* and web-pages of the services (see Table 11).

6. Fellows of the IAG

Past officers of the IAG shall be eligible for appointment as Fellows and shall be invited to become such. In recognition for esteemed services rendered in different IAG entities (EC, Commissions, Services, JoG, etc), these types of „memberships" of the *„Fellows of the International Association of Geodesy"* were established in 1991. The EC makes these appointments by which scientists become affiliates of the IAG.

Table 12 lists the Fellows of the IAG appointed at the IUGG/IAG GAs beginning in Vienna in 1991.

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Table 1: General Assemblies of the International Association of Geodesy

No	Meeting Location	Year
I. General Conferences		
I.a. "Mitteleuropäische Gradmessung" (1862-1867)		
1	Berlin, Prussia	1864
2	Berlin, Prussia	1867
I.b. "Europäische Gradmessung" (1867-1886)		
3	Vienna, Austria-Hungary	1871
4	Dresden, Saxony	1874
5	Stuttgart, Württemberg	1877
6	Munich, Bavaria	1880
7	Rome, Italy	1883
8	Berlin, Prussia	1886
I.c. International Geodetic Association (Internationale Erdmessung) (1886-1919)		
9	Paris, France	1889
10	Brussels, Belgium	1892
11	Berlin, Germany	1895
12	Stuttgart, Germany	1898
13	Paris, France	1900
14	Copenhagen, Denmark	1903
15	Budapest, Austria-Hungary	1906
16	Cambridge, United Kingdom	1909
17	Hamburg, Germany	1912

No	Meeting Location	Year
II. General Assemblies of the Section and the Association of Geodesy as part of the General Assemblies of the IUGG		
II.a. Section of Geodesy of the IUGG (1920-1933)		
18	Belgium (Constitutive Assembly)	1919
19	Rome, Italy	1922
20	Madrid, Spain	1924
21	Prague, Czechoslovakia	1927
22	Stockholm, Sweden	1930
23	Lisbon, Portugal	1933
II.b. Association of Geodesy (1933-1946)		
24	Edinburgh, United Kingdom	1936
25	Washington, United States	1939
II.c. International Association of Geodesy (IAG; 1946-....)		
26	Oslo, Norway	1948
27	Brussels, Belgium	1951
28	Rome, Italy	1954
29	Toronto, Canada	1957
30	Helsinki, Finland	1960
31	Berkeley, United States	1963
32	Zurich-Lucerne, Switzerland	1967
33	Moscow, USSR	1971
34	Grenoble, France	1975
35	Canberra, Australia	1979
36	Hamburg, Germany	1983
37	Vancouver, Canada	1987
38	Vienna, Austria	1991
39	Boulder, USA	1995
40	Birmingham, United Kingdom	1999
41	Sapporo, Japan	2003
42	Perugia, Italy	2007
43	Melbourne, Australia	2011

Table 2: Scientific Assemblies of the IAG

No	Meeting Location	Date	Number of participants
1	Tokio, Japan	May 7-15,1982	200
2	Edinburgh, Scotland	August 3-12,1989	NA
3	Beijing, China	August 8-13,1993	350
4	Rio de Janeiro, Brasil	September 3-9,1997	350
5	Budapest, Hungary	September 2-7, 2001	461
6	Cairns, Australia (*)	August 22-26, 2005	724 (IAG:145)
7	Buenos Aires, Argentina	August 31- Sept. 4, 2009	

(*) together with IAPSO and IABO

Table 3: IAG Presidents

No	Period	Name	Place of Homestead
1	1864 – 1885	Johann J. Baeyer	Potsdam, Prussia
2	1886 – 1891	Carlos Ibanez de Ibero	Madrid, Spain
3	1892 – 1902	Hervé E. A. A. Faye	Paris, France
4	1903 – 1918	Léon J. A. Bassot	Paris, France
5	1919 – 1933	William Bowie	Washington, USA
6	1933 – 1945	Felix A. Vening-Meinesz	Amersfoort, The Netherlands
7	1945 – 1951	Walter D. Lambert	Washington, USA
8	1951 – 1954	Carl F. Baeschlin	Zürich, Switzerland
9	1954 – 1957	James de Graaf Hunter	London, United Kingdom
10	1957 – 1960	Gino Cassinis	Milan, Italy
11	1960 – 1963	Charles A. Whitten	Washington, USA
12	1963 – 1967	Guy Bomford	London, United Kingdom
13	1967 – 1971	Antonio Marussi	Trieste, Italy
14	1971 – 1975	Youri D. Boulanger	Moscow, USSR
15	1975 – 1979	Tauno J. Kukkamäki	Helsinki, Finland
16	1979 – 1983	Helmut Moritz	Graz, Austria
17	1983 – 1987	Peter V. Angus-Leppan	Kensington, Australia
18	1987 – 1991	Ivan I. Mueller	Columbus, USA
19	1991 – 1995	Wolfgang Torge	Hannover, Germany
20	1995 – 1999	Klaus-Peter Schwarz	Calgary, Canada
21	1999 – 2003	Fernandó Sansó	Milan, Italy
22	2003 – 2007	Gerhard Beutler	Berne, Switzerland
23	2007 – 2011	Michael G. Sideris	Calgary, Canada

Table 4: IAG General Secretaries

No	Period	Name	Place of Homestead
1	1886 – 1900	Adolf Hirsch	Neuchatel, Switzerland
2	1900 – 1918	Hendricus G. van de Sande-Bakhuysen	Leiden, The Netherlands
3	1919 – 1945	Georges Perrier	Paris, France
4	1946 – 1960	Pierre Tardi	Paris, France
5	1960 – 1975	Jean-Jacques Levallois	Paris, France
6	1975 – 1991	Michel Louis	Paris, France
7	1991 – 1995	Claude Boucher	Paris, France
8	1995 – 2007	Carl C. Tscherning	Copenhagen, Denmark
9	2007 –	Hermann Drewes	Munich, Germany

Table 5: Hosts of the IAG Central Bureau

No	Period	Name	Place of Homestead
1	1864 – 1919	Royal Prussian Geodetic Institute	Potsdam, Prussia/Germany
2	1919 – 1995	Institut Géographique National (IGN)	Paris, France
3	1995 – 2007	Niels Bohr Institute, Department of Geophysics, University of Copenhagen	Copenhagen, Denmark
4	2007 –	Deutsches Geodätisches Forschungsinstitut (DGFI)	Munich, Germany

Table 6: Editors-in-Chief of Official Journals of the IAG (BG = Bulletin Géodésique, MG = manuscripta geodaetica and JoG = Journal of Geodesy)

No	Journal	Period	Name of Editor-in-Chief	Place of homestead
1	BG	1922 – 1945	Georges Perrier	Paris, France
2	BG	1946 – 1951	Pierre Tardi	Paris, France
3	BG	1952 – 1964	Jean-Jacques Levallois	Paris, France
4	BG	1965 – 1975	Michel Louis	Paris, France
5	BG MG	1975 – 1986 1976 – 1980	Ivan I. Mueller	Columbus, USA
6	MG	1980 – 1982	Peter Meissl	Graz, Austria
7	MG	1982 – 1988	Erwin Groten	Darmstdt, Germany
8	MG	1989 – 1991	Clyde C. Goad Erik W. Grafarend	Columbus, USA Stuttgart, Germany
9	BG	1987 – 1991	Carl Christian Tscherning	Copenhagen, Denmark
10	BG MG	1991 – 1995	Carl Christian Tscherning Petr Vaníček	Copenhagen, Denmark New Brunswick, Canada
11	JoG	1995 – 2003	Peter J. G. Teunissen	Delft, The Netherlands
12	JoG	2003 – 2007	William Featherstone	Perth, Australia
13	JoG	2007 –	Roland Klees	Delft, The Netherlands

Table 7: Editors of the Geodesist's Handbook

No	Year	Editor	Place of homestead
1	1980	Ivan I. Mueller	Columbus, USA
2	1984	Carl Christian Tscherning	Copenhagen, Denmark
3	1988	Carl Christian Tscherning	Copenhagen, Denmark
4	1992	Carl Christian Tscherning	Copenhagen, Denmark
5	1996	Pascal Willis	Paris, France
6	2000	Ole B. Andersen	Copenhagen, Denmark
7	2004	Ole B. Andersen	Copenhagen, Denmark
8	2008	Hermann Drewes, Helmut Hornik József Ádám, Szabolcs Rózsa	Munich, Germany Budapest, Hungary

Table 8: Bomford Prize Awardees of the IAG

No	Year	Name of Scientist	Place of homestead
1	1975	Erik W. Grafarend	Munich, Germany
2	1979	Fernandó Sansó	Milan, Italy
3	1983	John Wahr	Boulder, USA
4	1987	Peter J. G. Teunissen	Delft, The Netherlands
5	1991	Shuhei Okubo	Tokyo, Japan
6	1995	Thomas A. Herring	Cambridge, USA
7	1999	Véronique Dehant	Brussels, Belgium
8	2003	Ramon Hanssen	Delft, The Netherlands
9	2007	Masato Furuya	Tokyo, Japan

Table 9: Levallois Medal Awardees of the IAG

No	Year	Name of Scientist	Place of homestead
1	1983	Charles A. Whitten	Washington, USA
2	1983	Rudolf Sigl	Munich, Germany
3	1987	Arne Bjerhammar	Stockholm, Sweden
4	1991	Paul Melchior	Brussels, Belgium
5	1995	Willem Baarda	Delft, The Netherlands
6	1999	Torben Krarup	Copenhagen, Denmark
7	2003	George Veis	Athen, Greece
8	2007	Carl Christian Tscherning	Copenhagen, Denmark

Table 10: IAG Best Young Author Awardees

No	Year	Author's name	Country	Title of the publication
1	1993	Hussein Abou-Elsoaad Abd-Elmotaal	Egypt	Vening-Meinesz Moho dephts: traditional, exact and approximated. *Manuscripta Geodaetica*, 18 (1993), 4 (171-181)
2	1994	Jean-Pierre Barriot	France	Line of sight operators in planetary Geodesy *Manuscripta Geodaetica*, 19 (1994), 5 (269-283).
3	1995	Srinivas V. Bettadpur	India	Hotine's geopotential formulation: revisited. *Bulletin Géodésique*, 69 (1995), 3 (135-142).
4	1996	Giovanna Sona	Italy	Numerical problems in the computation of ellipsoidal harmonics. *Journal of Geodesy*, 70 (1995), 1-2 (117-126).
5	1997	none		
6	1998	Cheinway Hwang	Taiwan	Inverse Vening-Meinesz formula and deflection geoid formula: applications to the predictions of gravity and geoid over the South China Sea. *Journal of Geodesy*, 72 (1998), 5 (304-312).
7	1999	Peiliang Xu	China	Biases and accuracy of, and an alternative to, discrete nonlinear filters. *Journal of Geodesy*, 73 (1999), 1 (35-46).
8	2000	Christopher Kotsakis Rüdiger Lehmann	Canada Germany	The multiresolution character of colloction. *Journal of Geodesy*, 74 (2000), 3-4 (275-290). Altimetry-gravimetry problems with free vertical datum. *Journal of Geodesy*, 74 (2000), 3-4 (327-334).
9	2001	Susan Skone	Canada	The impact of magnetic stourms on GPS receiver performance. *Journal of Geodesy*, 75 (2001), 9-10 (457-468).
10	2002	none		
11	2003	Michael Kern	Germany	A study on the combination of satellite, airborne and terrestrial gravity data (with K.-P. Schwarz and N. Sneeuw). *Journal of Geodesy*, 77 (2003), 3-4 (217-225).
12	2004	Shfaqat Abbas Khan	Pakistan	Shallow water loading tides in Japan from superconducting gravity (with J.L. Hoyer). *Journal of Geodesy*, 78 (2004), 4-5 (245-250).
13	2005	Roland Pail	Austria	A parametric study ont he impact of satellite attitude errors on GOCE gravity field recovery. *Journal of Geodesy*, 79 (2005), 4-5 (231-241).
14	2006	Steffen Schön	Germany	Uncertainty in GPS networks due to remaining systematic errors: the internal approach (with H. Kutterer). *Journal of Geodesy*, 80 (2006), 3 (150 -162).

Table 11: IAG Services

No	Name of the IAG Service / Address of the Homepage	Accronym	Year of Establishment
1	Bureau Gravimétrique International – *http://bgi.cnes.fr*	BGI	1951
2	Bureau International de Poids et Measures – Section Time, Frequency and Gravimetry – *http://www.bipm.org*	BIPM	1920
3	International Altimetry Service – *http://ias.dgfi.badw.de/*	IAS	2008
4	IAG Bibliographic Service – http://www.bkg.bund.de/nn_159384/DE/Bundesamt/Informationsdienste/iag__node.html__nnn=true	IBS	1984
5	International Center for Earth Tides – *http://www.astro.oma.be/ICET*	ICET	1958
6	International Center for Global Earth Models – *http://icgem.gfz-potsdam.de/ICGEM*	ICGEM	2003
7	International DEM Service – *http://www.cse.dmu.ac.uk/EAPRS/iag/*	IDEMS	2003
8	International DORIS Service – *http://ids.cls.fr*	IDS	2003
9	International Earth Rotation and Reference Systems Service – *http://www.iers.org*	IERS	1987 (1895)
10	International Geoid Service – *http://www.iges.polimi.it*	IGeS	1991
11	International Gravity Field Service – *http://www.igfs.net*	IGFS	2003
12	International GNSS Service – *http://igscb.jpl.nasa.gov*	IGS	1994
13	International Laser Ranging Service – *http://ilrs.gsfc.nasa.gov*	ILRS	1997
14	International VLBI Service for Geodesy and Astrometry – *http://ivscc.gsfc.nasa.gov*	IVS	1999
15	Permanent Service for Mean Sea Level – *http://www.pol.ac.uk/psmsl*	PSMSL	1933

Table 12: Fellows of the IAG

No.	Last name	First name	Country
– awarded in 1991 –			
1	Adebekun	O.A.	Nigeria
2	Ajakaiye	Deborah-Enilo	USA
3	Ashkenazi	Vidal	UK
4	Augath	Wolfgang	Germany
5	Baker	Trevor F.	UK
6	Balmino	Georges	France
7	Baran	Lubomir W.	Poland
8	Birardi	Giuseppe	Italy
9	Bjerhammar	Arne	Sweden
10	Blitzkow	Denisar	Brazil
11	Bock	Yehuda	USA
12	Boedecker	Gerd	Germany
13	Bossler	John D.	USA
14	Boucher	Claude	France
15	Brosche	Peter	Germany
16	Brunner	Fritz K.	Austria
17	Bursa	Milan	Czech Republic
18	Campbell	James	Germany
19	Carrera	Galo	Canada
20	Charfi	Mohamed	Tunisia
21	Chen	Junyoung Y.	China
22	Chovitz	Bernard H.	USA
23	Coker	Oluwole	Nigeria
24	Colombo	Oscar L.	USA
25	Comolet-Tirman	André	France
26	Cook	Alan H.	UK
27	Cross	Paul A.	UK
28	Daugherty	Kenneth I.	USA
29	de Jonge	Paul	USA
30	Dermanis	Athanasios	Greece
31	Dickey	Jean O.	USA
32	Dodson	Alan H.	UK
33	Douglas	Bruce C.	USA
34	Drozyner	Andrzej	Poland
35	Dufour	Henri	France
36	Eckhardt	Donald	USA

No.	Last name	First name	Country
– awarded in 1991 (cont'd) –			
37	Fadahunsi	Olagoke	Nigeria
38	Fajemirokun	Francis	Nigeria
39	Feissel-Vernier	Martine	France
40	Fejes	István	Hungary
41	Fischer	Irene K.	USA
42	Forsberg	Rene	Denmark
43	Forsyth	P.	Canada
44	Fritsch	Dieter	Germany
45	Gaignebet	J.	France
46	Gaposchkin	Edward M.	USA
47	Gemael	Camil	Brazil
48	Goad	Clyde C.	USA
49	Grafarend	Erik W.	Germany
50	Groten	Erwin	Germany
51	Gubler	Erich	Switzerland
52	Guinot	Bernard	France
53	Heck	Bernhard	Germany
54	Hein	Günter	Germany
55	Henneberg	Heinz	Venezuela
56	Henriksen	Soren	USA
57	Holota	Petr	Czech Republic
58	Hora	L.	Czech Republic
59	Hsu	Hou Tse	China
60	Huddle	James R.	USA
61	Jekeli	Christopher	USA
62	Jentzsch	Gerhard	Germany
63	Joó	István	Hungary
64	Joshi	C.S.	India
65	Kahle	Hans-Gert	Switzerland
66	Kahmen	Heribert P.	Austria
67	Kakkuri	Juhani	Finland
68	Kasahara	K.	Japan
69	Kausel	Edgar	Chile
70	Kautzleben	Heinz	Germany
71	Kearsley	A. H. William	Australia
72	King	Robert W.	USA

Table 12 cont'd: Fellows of the IAG

No.	Last name	First name	Country
– awarded in 1991 (cont'd) –			
73	Kiviniemi	Aimo	Finland
74	Klees	Roland	The Netherlands
75	Koch	Karl Rudolf	Germany
76	Kolaczek	Barbara	Poland
77	Konan	K.	Ivory Coast
78	Kovalevsky	Jean	France
79	Kozai	Yoshihide	Japan
80	Krynski	Jan	Poland
81	Kumar	Muneendra	USA
82	Kuo	John T.	USA
83	Lefebvre	Michael P.M.	France
84	Lelgemann	Dieter	Germany
85	Lennon	Geoff W.	Australia
86	Lensen	G.	New Zealand
87	Levallois	Jean-Jacques	France
88	Livieratos	E.	Greece
89	Louis	Michel	France
90	Mader	Gerald R.	USA
91	Makris	Janis	Germany
92	Mancini	Armando	USA
93	Marson	Iginio	Italy
94	Mc Nutt	Marcia	USA
95	McCarthy	Dennis D.	USA
96	Melbourne	William G.	USA
97	Melchior	Paul	Belgium
98	Morelli	Carlo	Italy
99	Moritz	Helmut	Austria
100	Mueller	Ivan I.	USA
101	Nakagawa	Ichiro	Japan
102	Nobili	Anna	Italy
103	Obel	J.D.	Kenya
104	Odlanicki-Poczobut	M.	Poland
105	Pertsev	B.P.	Russia
106	Poder	Knud	Denmark
107	Poitevin	Christian	Belgium
108	Prilepin	Mikhail T.	Russia

No.	Last name	First name	Country
– awarded in 1991 (cont'd) –			
109	Rais	Jacub	Indonesia
110	Rapp	Richard H.	USA
111	Reigber	Christoph	Germany
112	Robbins	A.R.	UK
113	Rostom	R.S.	Kenya
114	Rummel	Reiner	Germany
115	Sacerdote	Fausto	Italy
116	Sansó	Fernando	Italy
117	Saxena	Narendra K.	USA
118	Schaffrin	Burkhard	USA
119	Schmitt	Günter	Germany
120	Schutz	Bob E.	USA
121	Schwarz	Klaus-Peter	Canada
122	Seeber	Günter	Germany
123	Sevilla	Miguel J.	Spain
124	Shelus	Peter J.	USA
125	Sideris	Michael G.	Canada
126	Sjöberg	Lars E.	Sweden
127	Snay	Richard A.	USA
128	Sünkel	Hans	Austria
129	Tanaka	Torao	Japan
130	Teunissen	Peter J.G.	The Netherlands
131	Torge	Wolfgang	Germany
132	Tscherning	Carl Christian	Denmark
133	Vanicek	Petr	Canada
134	Veillet	Christian	France
135	Vyskocil	Pavel	Czech Republic
136	Wahr	John	USA
137	Wells	David E.	Canada
138	Welsch	Walter M.	Germany
139	White	Lawry A.	Australia
140	Wilson	Peter	Germany
141	Woodworth	Philip L.	UK
142	Waalewijn	A.	The Netherlands
143	Yatskiv	Yaroslav Y.	Ukraine
144	Yokoyama	Koichi	Japan

Table 12 cont'd: Fellows of the IAG

No.	Last name	First name	Country
– awarded in 1991 (cont'd) –			
145	Zilkoski	David B.	USA
146	Zund	Joseph David	USA
– awarded in 1995 –			
147	Ádám	József	Hungary
148	Barzaghi	Riccardo	Italy
149	Becker	Matthias	Germany
150	Beutler	Gerhard	Switzerland
151	Bosch	Wolfgang	Germany
152	Chao	Benjamin Fong	USA
153	Denker	Heiner	Germany
154	Dow	John	Germany
155	Elgered	Gunnar K.	Sweden
156	Engen	Bjørn	Norway
157	Geiger	Alain	Switzerland
158	Kato	Teruyuki	Japan
159	Kleusberg	Alfred	Germany
160	Kouba	Jan	Canada
161	Landau	Herbert	Germany
162	Langley	Richard B.	Canada
163	Linkwitz	Klaus	Germany
164	Molodensky	Serguei	Russia
165	Neilan	Ruth	USA
166	Noll	Carey	USA
167	Okubo	Shuhei	Japan
168	Pâquet	Paul	Belgium
169	Ries	John C.	USA
170	Rueger	Jean M.	Australia
171	Schrama	Ernst J.O.	Netherlands
172	Shum	Che-Kwan	USA
173	Spoelstra	T.A.Th.	Netherlands
174	Takemoto	Seyuzo	Japan
175	Thomas	Claudine	France
176	Weightman	Jack A.	UK
177	Willis	Pascal	France
178	Yunck	Thomas	USA

No.	Last name	First name	Country
– awarded in 1999 –			
179	Andersen	Ole Baltazar	Denmark
180	Andersen	Niels	Denmark
181	Arabelos	Dimitris	Greece
182	Arur	M.G.	India
183	Ballani	Ludwig	Germany
184	Benciolini	G. Battista	Italy
185	Bevis	Michael G.	USA
186	Blewitt	Geoffrey	UK
187	Bosworth	John M.	USA
188	Cazenave	Anny	France
189	Clark	Thomas A.	USA
190	Degnan	John	USA
191	Dehant	Veronique	Belgium
192	Drewes	Hermann	Germany
193	Ducarme	Bernard	Belgium
194	Featherstone	William	Australia
195	Freeden	Willi	Germany
196	Herring	Thomas	USA
197	Ilk	Karl-Heinz	Germany
198	Johanssen	Jan	Sweden
199	Jonge	P. de	The Netherlands
200	Knudsen	Per	Denmark
201	Li	Zheng-Xin	China
202	Manning	John	Australia
203	Pavlis	Nicos	USA
204	Rizos	Chris	Australia
205	Rocken	Christian	USA
206	Tziavos	Ilias N.	Greece
207	Vermeer	Martin	Finland
208	Wei	M.	Canada
209	Wolf	Detlef	Germany
210	Zerbini	Suzanna	Italy
– awarded in 2003 –			
211	Arias	Elisa Flicitas	Argentina
212	Barriot	Jean-Pierre	France
213	Berry	Philippa Anne	UK

Table 12 cont'd: Fellows of the IAG

No.	Last name	First name	Country
– awarded in 2003 (cont'd) –			
214	Brunini	Claudio A.	Argentina
215	Bruyninx	Carine	Belgium
216	Gambis	Daniel	France
217	Gendt	Gerd	Germany
218	Gross	Richard S.	USA
219	Gurtner	Werner	Switzerland
220	Han	Shaowei	Australia
221	Hanssen	Ramon	The Netherlands
222	Harsson	Bjørn Geirr	Norway
223	Hwang	Cheinway	Taiwan
224	Keller	Wolfgang	Germany
225	Kenyon	Steve C.	USA
226	Kursinski	Robert	USA
227	Kutterer	Hansjorg	Germany
228	Lehmann	Rüdiger	Germany
229	Marchenko	Alexander	Ukraine
230	Scharroo	Remko	The Netherlands
231	Schlüter	Wolfgang	Germany
232	Schöne	Tilo	Germany
233	Skone	Susan	Canada
234	Sneeuw	Nico	Canada
235	Stewart	Mike	Australia
236	Strykowski	Gabriel	Denmark
237	Tiberius	Christian	The Netherlands
238	van der Marel	Hans	The Netherlands
239	Vandenberg	Nancy	USA
240	Visser	Pieter	The Netherlands
241	Vitushkin	Leonid	France
242	Vondrak	Jan	Czech Republic
243	Weber	Robert	Austria
244	Yuanxi	Yang	China
– awarded in 2007 –			
245	Altamimi	Zuheir	France
246	Biancale	Richard	France
247	Craymer	Michael	Canada
248	Crossley	David	USA

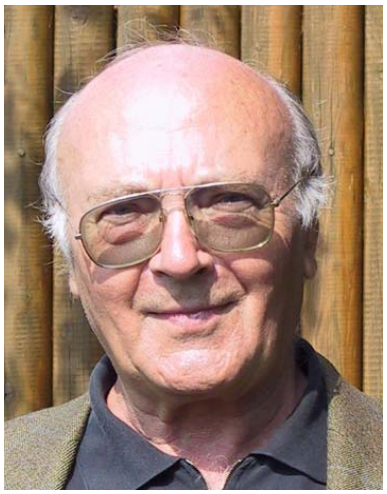
No.	Last name	First name	Country
– awarded in 2007 (cont'd) –			
249	Dietrich	Reinhard	Germany
250	Ding	Xiaoli	Hong Kong
251	Fortes	Luiz Paulo Sonto	Brazil
252	Gao	Yang	Hong Kong
253	Grejner-Brzezinska	Dorota	USA
254	Heki	Kosuke	Japan
255	Hothem	Larry	USA
256	Huang	Jianliang	China
257	Ihde	Johannes	Germany
258	Kuhn	Michael	Australia
259	Kusche	Jürgen	The Netherlands
260	Marti	Urs	Switzerland
261	Merry	Charles	South Africa
262	Moore	Angelyn W.	USA
263	Noll	Carey	USA
264	Novák	Pavel	Czech Republic
265	Pacino	Maria Christina	Argentina
266	Pearlman	Michael R.	USA
267	Plag	Hans-Peter	USA
268	Poutanen	Markku	Finland
269	Richter	Bernd	Germany
270	Rothacher	Markus	Germany
271	Rózsa	Szabolcs	Hungary
272	Scheinert	Mirko	Germany
273	Schuh	Harald	Austria
274	Sun	He-Ping	China
275	Torres	Joao Agria	Portugal
276	Tóth	Gyula	Hungary
277	Verroneau	Mark	Canada
278	Vitushkin	Leonid	France
279	Wang	Jinling	Australia
280	Wonnacott	Richard	South Africa
281	Xu	Peiliang	Japan
282	Yu	Jinhai	China
283	Zhu	Shen Yuan	Germany

Past officers of the International Association of Geodesy (1991 – 2007)[1]

Compiled by **Carl Christian Tscherning**
Honorary Secretary General

1. Presidents

Wolfgang Torge
President 1991 – 1995



Wolfgang Reinhold Julius **TORGE** was born on June 4, 1931, in Laubusch, Germany. He studied surveying engineering and geodesy at the Technical University of Hannover, Germany, where he received a Dipl.-Ing. Degree in 1955, and promoted to a Dr.-Ing. in 1966, with a thesis on long-range gravity measurements. In his professional and scientific career, he held positions in exploration geophysics, state survey agencies, and at the Hannover Geodetic Institute, and he served as a technical expert in a Central American surveying and cadastral project. In 1968, he was appointed full professor for geodesy at the University of Hannover, where he directed the "Institut für Erdmessung" until his retirement in 1996. His teaching and research activities covered geometric and physical geodesy with special emphasis on gravimetry and gravity field modeling, and he gave lecture courses at numerous universities and research institutes in Europe, Africa, Latin America, and China. Research projects on the establishment of fundamental gravity networks and the detection and interpretation of gravity variations with time, employing relative and absolute techniques, led to a collaboration with many institutes and agencies in several parts of the world, including Iceland, South America, and China, while local and regional geoid computations concentrated on Europe. During the last few years, Torge concentrated on the history of geodesy, including that of the IAG, one outcome being a monograph on the history of geodesy in Germany published in 2007.

He engaged himself early in IAG, and served as Secretary (1976 – 1983) and President (1983 – 1987) of the "Gravimetry" respectively "Gravity Field Determination" Section. After the IAG-Vice-Presidency (1987-1991) he was elected as IAG President, and appointed Honorary President in 1995. In his position as the Chairman of the National Committee of Geodesy and Geophysics (1979 – 1983), Torge was responsible for the organisation of the IUGG General Assembly in Hamburg 1983. As the IAG representative to the Instituto Panamericano de Geografia y Historia (1991 – 2003), he succeeded in activating a number of IAG related projects and scientific conferences in Latin America, including the IAG Scientific Assembly in Rio de Janeiro (1997).

Torge has published about 180 scientific papers mainly on gravimetry, determination of the geoid and of deflections of the vertical, and gravity variations with time, and he is the author of a textbook on "Geodesy". This started in German language in 1975, with a second edition in 2003, and includes three editions (1980-2001) in English, as well as translations into Spanish, Chinese, and Greek. His monograph on "Gravimetry" (1989) was translated

[1] This text continues the article "History of the International Association of Geodesy" by Michel Louis in the Geodesists Handbook 1992, covering the period 1983-1991. Bulletin Géodésique (66), 1992, 79-81.

into Chinese and Russian. Torge is member of the German Geodetic Commission at the Bavarian Academy of Sciences, and honorary resp. corresponding member of the Hungarian Academy of Sciences and the Academia Nacional de Ingenieria, Argentina. He has been the scientific editor of the "Zeitschrift für Vermessungswesen" (1971 – 2002), and he received (1991) the "Helmert medal" being the highest award of the "Deutscher Verein für Vermessungswesen (DVW)".

Klaus-Peter Schwarz
President 1995 – 1999

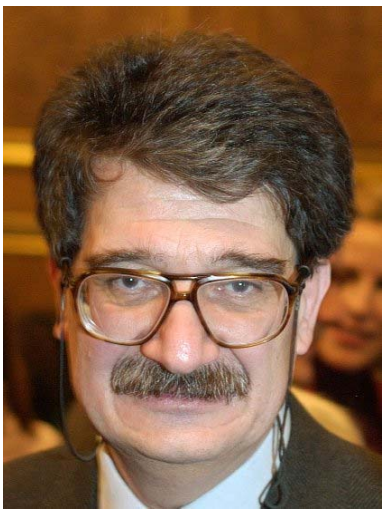
Klaus-Peter Schwarz is professor emeritus and former Head of the Department of Geomatics Engineering at the University of Calgary, Canada.

He was born on February 1, 1938 in Königsberg, Germany. After working for three years in mining surveying, he enrolled in the geodetic program at the University of Bonn, Germany, from which he graduated with a Dipl.-Ing. degree in 1965. He continued his studies and received degrees from universities in Canada (M.Sc. New Brunswick, 1967), Germany (Dr.-Ing. summa cum laude, Berlin, 1971), and Austria (habilitation, Graz, 1975). After returning to Canada in 1977, he worked at the University of New Brunswick before joining the newly established program at the University of Calgary in 1979. The program soon received international recognition and he stayed with it for the next twenty-three years. He had the privilege to serve as Head of the Department during the period 1990 – 1995.

His research and teaching was focused on the use of inertial and satellite techniques in geodesy, with special emphasis on the combination of GPS and strap-down inertial systems (SINS). Major progress was made in two areas, airborne digital mapping and airborne gravimetry. The first required the optimization of GPS/SINS integration with respect to position and orientation accuracy. The second required the optimization of the GPS-SINS difference with respect to the accuracy of the gravity disturbance vector. As a by-product the simultaneous determination of position and gravity is feasible because all measurements are obtained from the same sensors. To further explore this area of research, a series of symposia on kinematic geodesy were held between 1981 and 2001 in Banff, Canada. The contributions of K.P. Schwarz to geodesy have been recognized by honorary degrees from the Wuhan Technical University, China and the University of Hannover, Germany; he also was elected to full membership in the Russian Academy of Navigation and Motion Control and is a corresponding member of the German Geodetic Commission.

K.P. Schwarz has been active in the IAG for about 30 years, starting in 1973, when he was asked to participate in organizing the First IAG International Summer School in Ramsau, Austria - at that time a novel way of teaching advanced research subjects. About ten years later, he was asked to be the program director of the Beijing International Summer School on Local Gravity Field Approximation – the first IAG-sponsored event in China. After serving as president of a number of Special Study Groups and as a member of the first Cassini Committee, he was elected as President of Section IV in 1987. Four years later he became First Vice-President of the IAG and in 1995 IAG President. During his tenure the need for change in the IAG structure was identified as a high priority. The scope of geodetic science had enormously expanded, technological change was rapid, and the need for more flexibility in the organizational structure was urgent. First steps towards resolving these issues were initiated before 2000, but the bulk of the work was done during the next period.

Fernando Sansò
President 1999 – 2003



Born in 1945 he got a degree (cum laude) in theoretical physics in 1967.

After a 2 years fellowship at the Institute of Mathematics of Politecnico di Milano, he became assistant professor of Surveying at the Institute of Surveying, Photogrammetry and Geophysics where he taught statistical methods for surveying and geodetic applications up to present years.

After full professorship in 1981, he became director of the Institute till 1992.

His interest in physical and mathematical geodesy was strongly stirred after a 6 months stage at the Graz University, with Prof. H. Moritz in 1978. During this stage the first researches on geodetic boundary value problems were started, leading to many new results and a systematization of this tool for the gravity field analysis.

Bomford Prize awarded in 1979. He entered into the IAG Executive Committee in 1983, as secretary of Section IV on theory and methodology of which he was elected President in 1991. He became Vice-President of IAG in 1995 and then President for the period 1999-2003.

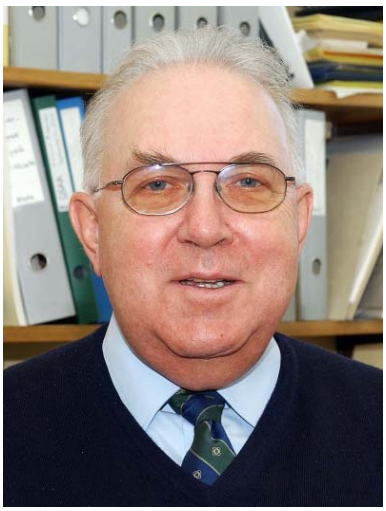
Meanwhile he has organized international schools of theoretical geodesy as well as a series of formerly so-called Hotine, then Hotine-Marussi Symposia.

Furthermore he founded already in 1992 the IAG International Geoid Service on account of which also another series of Geoid-schools was initiated, which still continues with one course every couple of years.

He has been editor of various international journals, awarded the Doctor Scientiarum honoris causa degree in Geodetic Science by the University of Copenhagen, the full membership of the Accademia Nazionale dei Lincei and the fellowship of the Royal Astronomical Society.

He is presently chair of the PhD doctorate in Geodesy and geomatics of Politecnico di Milano. He has been author or co-author of about 300 scientific publications.

Gerhard Beutler
President 2003 – 2007



Gerhard Beutler was born in 1946 and is married to Ruth M. Schweizer since 1979. Daughter Marianne was born in 1981. Gerhard Beutler received his elementary and secondary school education in Kirchberg (Canton Bern, Switzerland), and high school education in the city of Berne (Gymnasium Humboldtianum). The high school studies were completed by acquiring the "Eidgenössischer Maturitätsausweis" (type C, Mathematics / Natural Sciences)" in 1964. In the years 1964 – 1971 he studied physics, mathematics, and astronomy at the Phil.-nat. Faculty of the University of Berne. In 1971 he received the diploma in astronomy. Between 1971 and 1983 he was research assistant at the Astronomical Institute of the University of Berne (AIUB). In this period he completed his Ph.D. thesis entitled *Integrale Auswertung von Satellitenbeobachtungen* (1976) as well as his second doctorate (Habilitation) entitled *Lösung von Parameterbestimmungsproblemen in Himmelsmechanik und Satellitengeodäsie mit modernen Hilfsmitteln* (1983).

In the years 1983 – 1984 Gerhard Beutler was a research assistant at the University of New Brunswick (UNB) in Fredericton, Canada, where he gained first experience in the scientific exploitation of the Global Positioning System (GPS). From 1984 to 1991 he was research associate and lecturer (with courses in astronomy, celestial mechanics, numerical analysis) at the AIUB. The foundations of the Bernese GPS Software were laid in this time period.

In 1991 Gerhard Beutler was elected Associate Professor and Director of the AIUB as successor of Prof. Paul Wild. In 1996 he was promoted to the position of a full professor. The two-volume work "Celestial Mechanics, Theory and Applications", published in the Springer Astronomy & Astrophysics Library, was compiled in the years from 2000 to 2005 together with Prof. Leos Mervart (Technical University of Prague) and Dr. Andreas Verdun (AIUB).

Between 1991 and 1993 Gerhard Beutler chaired the IGS (International GPS Service) Oversight Committee. Between 1994 and 1997 he served as the first Chairman of the IGS (now called International GNSS Service). He is still member of the IGS Governing Board.

Gerhard Beutler is fellow of the IAG (International Association of Geodesy) since 1995, fellow of the AGU (American Geophysical Union) since 1996. In addition to the chairmanship/membership of the IGS Governing Board, Gerhard Beutler held a series of offices in the IAG, in particular President of CSTG (committee on the coordination of space techniques) between 1995 and 1999, IAG Vice President between 1999 and 2003, IAG President between 2003 and 2007. In this time span the IAG accomplished a profound review of its structure.

In 2006 Gerhard Beutler received the Vening-Meinesz Medal of the EGU (European Geophysical Union) and the honourable degree of "Dr.-Ing. Ehren halber" of the Technical University of Munich (TUM).

Since 2007 he is member of the US Presidential Committee on Positioning, Navigation, and Timing (PNT). He also became Hans Fischer fellow of TUM's Institute for Advanced Study (IAS), where he conducts, together with Prof. Reinhard Rummel, the three-year project "satellite geodesy".

2. Secretaries General

Claude Boucher
Secretary General 1991 – 1995

Né le 8 juillet 1949 à Troyes (France), C Boucher est ancien élève de l'Ecole Polytechnique (X 69) et Ingénieur Général des Ponts et Chaussées (canal géographique).

Diplômé d'Etudes Approfondies de l'Université Pierre et Marie Curie Paris VI (Astronomie Fondamentale et Mécanique Céleste) (1973 – 1974), il a été ingénieur à l'Institut Géographique National (IGN) de 1974 – 1999, exerçant les fonctions successives suivantes: chercheur au Service de Géodésie et Nivellement (SGN) puis chef de ce service, directeur Technique de l'IGN et termina sa carrière à l'IGN comme chargé de mission auprès du Directeur Général.

En 1999, il est nommé chargé de mission au Département Espace et Aéronautique du Ministère de la Recherche et des Nouvelles Technologies, et devient en 2004 membre permanent du Conseil Général des Ponts et Chaussées (3e section)..

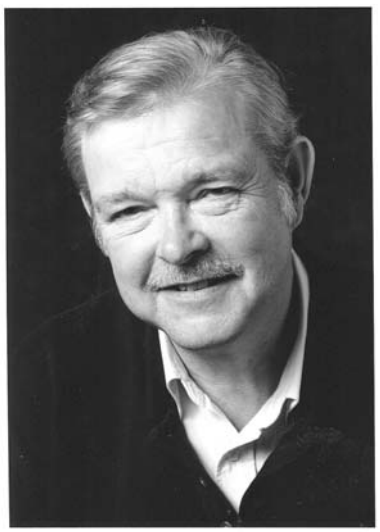
Il a été Directeur Exécutif du Groupe de Recherche de Géodésie Spatiale (1985-1991) ainsi que Secrétaire de la Section de Géodésie du Comité National Français de Géodésie et de Géophysique (CNFGG) puis Président de cette Section (1997 – 2003)

Membre correspondant du Bureau des Longitudes, il est également Fellow de la Royal Institution of Chartered Surveyors (FRICS)

Dans le cadre international, il a exercé les fonctions de secrétaire adjoint de l'Association Internationale de Géodésie (IAG) de 1975 à 1991,en soutien à Jean-Jacques Levallois, puis Michel Louis, de Secrétaire de la Fédération des Services de données Astronomiques et Géophysiques (FAGS) (1980 – 1986) et enfin de Secrétaire Général de l'IAG (1991 – 1995) avec Pascal Willis comme secrétaire adjoint.

Il a par exercé de multiples activités, notamment président de la Commission X de l'IAG Réseaux Géodésiques Globaux et Régionaux (1995 – 2003) et responsable de la réalisation de l'ITRF (International Terrestrial Reference Frame) dans le cadre du Service International de Rotation et des Références Terrestres (IERS), depuis sa création en 1988, et ceci jusqu'en 2004.

Carl Christian Tscherning
Secretary General 1995 – 2007



Born May 21, 1942. Mag. Scient. in geodesy, May 1970, University of Copenhagen. During military service 1960 – 1962 trained as Field Artillery survey group leader. Worked 1964 – 1988 at the Geodetic Institute of Denmark initially as a student assistant. Lecturer (part time) in physical geodesy at the University of Copenhagen 1977-1988. From 1988 professor of geodesy.

He has stayed several periods at the Ohio State University and at the German Geodetic Research Institute (Munich) and been a visiting senior scientist, U.S. National Geodetic Survey in 1981.

Carl Christian Tscherning was secretary of the International Association of Geodesy (IAG) Section III (Gravity Field) 1983 – 1987; Associate Editor Reviews of Geophysics 1984 – 1987; Editor-in-Chief Bulletin Géodesique 1986 – 1995 and Manuscripta Geodaetica 1992 – 1995. Moreover Secretary International Geoid Commission, 1987; Member Directing Board International Gravity Bureau 1986 – 1994; IUGG representative to CODATA, 1987 – 1995; Secretary General IAG 1995 – 2007; Associate Editor Studia Geophysica et Geodaetica from 2005. Has hold many offices in professional organizations such as President of the Geo-Section of the Danish Union of Masters and Ph.D.'s in Science and Humanities (Dansk Magister-forening) 1985 – 1987 and president the Science Faculty section 1989 – 1995; Vice President Danish Geophysical Society 1984 – 1989 and President 1990 – 1991, Secretary, 1985 of Danish National Committee for the International Union of Geodesy and Geophysics, President 1992 – 1999.

His research has primarily been in physical geodesy and in the geodetic use of space methods (satellite radar altimetry, GPS), resulting in more than 240 publications in national and international scientific journals, symposium proceedings and report series. Received Ole Rømer award (Danish), 1971, and W. A. Heiskanen Senior Award (Ohio State University), 1976. Fellow American Geophysical Union, 1991, Foreign Associate Royal Astronomical Society (UK), 1999, IAG Levallois Medal, 2007.

IAG Statutes

adopted by the IAG Council

on July 9, 2007 at the XXIV IUGG General Assembly in Perugia, Italy

1. Definition of Terms

(a) Geodesy is the discipline that deals with the measurement and representation (geometry, physics, temporal variations) of the Earth and other celestial bodies.

(b) IUGG means the International Union of Geodesy & Geophysics.

(c) IAG or Association means the International Association of Geodesy.

(d) Adhering Body has the same meaning as in the Statutes of the IUGG.

(e) General Assembly means an assembly for scientific and/or administrative purposes of:

(i) the delegates appointed by the adhering bodies; and

(ii) individual members as defined by Statute 6(b)

(f) Period means the interval of time between the closures of two successive ordinary General Assemblies.

2. International Association of Geodesy

(a) The International Association of Geodesy:

(i) is a constituent Association of the IUGG; and

(ii) is subject to the Statutes and Bylaws of the IUGG.

(b) In the event of the dissolution of the IAG, its assets shall be ceded to the IUGG.

3. Mission

The Mission of the Association is the advancement of geodesy. The IAG implements its mission by furthering geodetic theory through research and teaching, by collecting, analyzing, modelling and interpreting observational data, by stimulating technological development and by providing a consistent representation of the figure, rotation, and gravity field of the Earth and planets, and their temporal variations.

4. Objectives

The IAG shall pursue the following objectives to achieve its mission:

(a) Study, at the highest possible level of accuracy, all geodetic problems related to Earth observation and global change, including:

i) Definition, establishment, and maintenance of global and regional reference systems for interdisciplinary use.

ii) Rotation of the Earth and planets.

iii) Positioning and deformation studies.

iv) Gravity field determination.

v) Ocean, ice and sea level.

vi) Time transfer.

vii) Signal propagation through the planets' atmospheres.

(b) Support the maintenance of geodetic reference systems for continuous, long-term observations and archival of results.

(c) Provide observational and processed data, standards, methodologies, and models in a form that ensures the broadest possible range of research and application.

(d) Stimulate development and take advantage of emerging space and other technologies to increase the resolution and accuracy of geodetic data and products in order to advance geodetic and interdisciplinary research.

(e) Initiate, coordinate, and promote international cooperation and knowledge exchange through symposia, workshops, summer schools, training courses, publications, and other means of communication.

(f) Foster the development of geodetic activities and infrastructure in all regions of the world, taking into consideration the specific situation of developing countries.

(g) Collaborate with the international science and engineering community in supporting the application of geodetic theory and techniques and the interpretation of results.

(h) Cooperate with national and international agencies in establishing research goals, missions, and projects.

5. Structure and Administration

(a) The Association's structure shall comprise a small number of components: Commissions, Services, the Global Geodetic Observing System (GGOS) and the Communication and Outreach Branch (COB).

(b) Subcomponents, such as IAG Projects, Sub-commissions, Commission Projects, Inter-commission Committees, and Study and Working Groups, may be formed as provided for in the Bylaws.

(c) The administration of the IAG is carried out by the General Assembly, the Council, the Bureau and the Executive Committee. The COB is the office responsible for the promotional activities of the IAG and the communication with its members.

6. Current Commissions

The membership of the IAG shall comprise:

(a) Adhering Bodies; and

(b) individual members in accordance with the Bylaws.

7. Commission Sub-components and Joint Sub-components

IAG Council

(a) The Council is responsible for governance, strategic policy and direction.

(b) The membership of the Council consists of delegates appointed by adhering bodies.

(c) Each adhering body may appoint one delegate subject to the conditions in (d) (e) and (f) below.

(d) A delegate may only represent one adhering body.

(e) The delegate appointed by an adhering body must have previously participated in IAG activities.

(f) The President, Vice President and Secretary General may not serve as delegates.

(g) The delegate nominated by the adhering body will also perform the function of correspondent for the adhering body except where the adhering body has expressly advised that the delegate and the correspondent are different people.

8. Bureau

(a) The Bureau of the Association shall consist of the President, the Vice-President and the Secretary General.

(b) The duties of the Bureau shall be to administer the affairs of the Association in accordance with these Statutes and Bylaws and with the decisions of the Council and the Executive Committee.

9. President

(a) The President shall be elected by the Council.

(b) The President shall provide general leadership for the Association.

(c) The President presides over the meetings of the General Assembly, the Council, the Executive Committee, and the Bureau, without vote, except in the case of a tie as provided in 14(f).

(d) The President, on completion of his or her term of office of one period, shall serve for the next period in the position of Immediate Past President.

10. Vice President

(a) The Vice President shall be elected by the Council.

(b) The Vice President shall perform such tasks as may be assigned by the President, the Executive Committee or the Council.

(c) The Vice President assumes the functions, duties and powers of the President when the latter is absent or otherwise unable to assume office.

11. Secretary General

(a) The Secretary General shall be elected by the Council

(b) The Secretary General shall serve as secretary of the General Assembly, the Council, the Executive Committee, and the Bureau and arrange for meetings of these bodies in accordance with the Bylaws.

12. Executive Committee

(a) The Executive Committee shall consist of the following voting members: the Bureau, the immediate Past President, the Presidents of the Commissions, the Chair of GGOS, the President of the COB, the three representatives of the Services, and two Members-at-Large to improve geographical and organizational balance.

(b) Presidents of the Inter-commission Committees, Chairs of the IAG Projects, and the Assistant Secretaries shall attend any meeting of the Executive Committee, with voice but without vote. The Past Presidents, and past Secretaries General may attend any meeting of the Executive Committee, with voice but without vote, (except for the immediate past president, who does have a vote).

(c) The election of Executive Committee members shall be in accordance with the Bylaws.

(d) The duties of the Executive Committee shall be to further the objectives of the Association through effective coordination and through the formulation of general policies.

13. Council Meetings

(a) The Council will meet at the time of a General Assembly.

(b) The Council may hold extraordinary meetings at times other than a General Assembly. Such meetings must be proposed by the Executive Committee and need the support of one third of the delegates before they can be called.

(c) The Council may also deliberate and decide matters at other times by correspondence and mail ballot.

(d) If the delegate and the correspondent are not the same person, the mail ballot must be cast by the correspondent.

(e) The members of the Executive Committee may attend meetings of the Council, with voice but without vote, except for those who are also delegates.

14. Voting in Council Meeting

Voting in Council shall follow the following rules:

(a) An Adhering Body which is not represented at a Council meeting may vote by correspondence on any specific question, provided that the matter has been clearly defined on the final agenda distributed in advance, and that the discussion thereon has not produced any significant new considerations or change in its substance, and that the said vote has been received by the President prior to the voting. In such a case the vote will be cast in accordance with 13(d).

(b) In order that the deliberations of the Council shall be valid, the number of Delegates present must be at least half of the Adhering Bodies represented at the General Assembly of the IUGG. If the meeting is not held at the same time as an IUGG General Assembly, the number present at the most recent IUGG Assembly is used.

(c) On questions not involving matters of finance, each delegate from an Adhering Body, with its IUGG subscriptions paid up to the end of the calendar year preceding the voting, shall have one vote.

(d) On questions involving finance, each delegate from an Adhering Body, which has paid its IUGG subscriptions up to the end of the calendar year preceding the voting, shall have the right to vote. The number of votes allotted to each delegate of an Adhering Body shall then be equal to the number of its category of membership, as defined by the IUGG.

(e) Before a vote in a Council meeting, the President shall decide whether or not the matter under consideration is financial in character and whether the procedure of voting by correspondence applies.

(f) Decisions of the Council shall be taken by a simple majority, except as otherwise specified in these Statutes. If a tie should occur in a Council vote, the President shall cast the decisive vote. This procedure also applies if the vote is taken by mail ballot. Simple and two-thirds majorities are determined by the proportion of affirmative votes to the sum of all votes (affirmative, negative and abstention). Blank and invalid ballots

and votes not cast by delegates present are counted as abstentions.

(g) Except as otherwise provided in the Statutes or Bylaws, meetings of the Council, as well as those of other IAG administrative bodies, shall be conducted according to Robert's Rules of Order.

15. Decision of Council

(a) Decisions of the Council shall be reported to the individual membership in a meeting of the IAG General Assembly.

(b) If the majority of those present at this meeting disagree with the decisions of the Council, the Council shall reconsider the question, and make a decision, which shall be final.

16. Changes to Statutes and Bylaws

Changes in the Statutes and Bylaws shall be made as follows:

(a) The Association shall review the Statutes and Bylaws to ensure an up-to-date structure of its scientific organization every eight years. To achieve this goal a Review Committee will be appointed by the Executive Committee at its first meeting after the General Assembly in periods where a review must be performed. Proposals for a change of any article of these Statutes and Bylaws must reach the Secretary General at least six months before the announced date of the Council meeting at which it is to be considered. The Secretary General shall notify all adhering bodies of any proposed change at least four months before the announced date of the Council meeting.

(b) The Statutes may not be modified except by the approval of a two-thirds majority of votes cast at a Council meeting, and shall come into force at the close of that meeting.

(c) The Council shall have the power to adopt Bylaws within the framework of the Statutes.

(d) The Bylaws may be modified by a simple majority of votes cast at a Council meeting, and shall come into force at the close of the meeting.

IAG Bylaws adopted by the IAG-Council
on July 9, 2007 at the XXIV IUGG General Assembly in Perugia, Italy

1. Definition of Terms

(a) **Association Components** or **Components** means Commissions, Services, the Global Geodetic Observing System (GGOS), and the Communication and Outreach Branch (COB).

(b) **Commissions** represent major fields of activity in the IAG which, together, cover the whole of geodesy.

(c) **Services** collect and analyze observations to generate products relevant to geodesy and other sciences and applications.

(d) The **Global Geodetic Observing System (GGOS)** works with the IAG Services to provide the geodetic expertise and infrastructure necessary for the monitoring of the Earth system and global change research.

(e) **Association subcomponents** or **sub-components** means long term sub-components and short term sub-components and includes joint sub-components.

(f) **Long term sub-components** means IAG Projects (broad in scope and of high interest for the entire field of geodesy), Inter-commission Committees, Sub-commissions and Commission Projects which may remain established for several periods.

(g) **Short term sub-components** means Study Groups and Working Groups which are established for a maximum term of one period

(h) **Steering Committee** means a group of elected and appointed IAG officers who review the work of Commissions, Inter-commission Committees (see 17), IAG Projects (see 16), and the Communication and Outreach Branch (see 18).

(i) **Period** means the interval of time (approximately 4 years) between the closure of two successive IAG General Assembly meetings.

2. Responsibilities of Association Components

(a) The scientific work of the Association is performed by Commissions, Services and the GGOS.

(b) The responsibilities of the Association components are determined by the Council on the recommendation of the Executive Committee.

(c) Components shall interact with each other where their activities are inter-related.

(d) Each component may set up sub-components and is responsible for the activities of those sub-components.

3. General Responsibilities of Component Presidents or Chairs, and Steering Committees

(a) Each component shall have a President or Chair who will lead a Steering Committee.

(b) The component president or chair is responsible for the scientific development within the component's field of interest. The component president or chair shall:

(i) coordinate the work of the Sub-components;

(ii) keep the officers of the Component as well as the Bureau informed of the component's activities, on an annual basis;

(iii) collect reports of the sub-components two months before each IAG General Assembly meeting (except where the IAG Executive has agreed otherwise) for publication in the "Travaux de l'Association Internationale de Géodésie";

(iv) receive suggestions for new sub-components, and suggestions for continuation of existing ones; and

(v) recommend changes to sub-components to the IAG Executive Committee for approval.

(c) The component steering committee shall meet at least once per year and at least once during each meeting of the IAG General Assembly.

(d) The component steering committee shall review at one of its meetings (usually the IAG General Assembly meeting, or the IAG Scientific meeting):

(i) the activities of the sub-components over the past period;

(ii) the subcomponent structure; and

(iii) the programs for the forthcoming period for those subcomponents that will be recommended for continuation.

(e) The component steering committee shall forward copies of all relevant correspondence of components and subcomponents of the Association to the IAG Secretary General.

(f) The component steering committee may organise scientific and organizational meetings and workshops provided that they are readily distinguished as being of a more limited scope than IAG Scientific symposia or IAG Sponsored Symposia as described in Bylaws 27 and 28.

4. Commission Responsibilities

Commissions shall promote the advancement of science, technology and international cooperation in their field. They establish the necessary links with sister disciplines and with the relevant Services. Commissions shall represent the Association in all scientific domains related to their field of geodesy.

5. Commission Steering Committee

(a) The Commission Steering Committee shall be set up at each meeting of the IAG General Assembly, following the election of the Association officers

(b) The Steering Committee shall have the following voting members:

i. Commission President.

ii. Commission Vice-president.

iii. Chairs of the Sub-commissions and Commission Projects.

iv. Up to three representatives of the Services relevant to the work of the Commission.

v. Up to two Members-at-Large to balance geographical and member country representation.

6. Appointment of Commission Officers

(a) The Commission President shall be elected by the Council for one period without reappointment except where exceptional circumstances justify reappointment.

(b) The Commission Vice President shall be appointed by the IAG Executive Committee for one period without reappointment except where exceptional circumstances justify reappointment.

(c) Chairs of the Sub-commissions and Commission Projects shall be appointed by the Commission President and Vice-President within two months following the General Assembly.

(d) The representatives of the Services shall be appointed by the Commission President and Vice-president upon proposal of the Services.

(e) The Members-at-Large and the chairs of the Sub-commissions and Commission Projects shall be nominated by the Commission President and Vice-President within two months following the IAG General Assembly meeting.

(f) The appointments of Members at Large and Chairs of Sub-commissions and Commission Projects take effect on approval of the nominations by the IAG Executive Committee.

(g) Members-at-Large are appointed for one period without reappointment

7. Duties of Commission Steering Committee

The Commission Steering Committee is subject to the general responsibilities of component steering committees in Bylaw 3(c), 3(d), 3(e), and 3(f) above. In particular, its duties are to:

(a) Review the Commission's field of interests and objectives.

(b) Liaise with the other IAG commissions, the Inter-commission Committees, and with similar organizations outside the IAG, as appropriate.

(c) Foster active participation of young geodesists and geodesists from under-represented countries.

(d) Coordinate and review the work of its components and report at the time of the Scientific Assembly to the IAG Executive Committee on the progress and performance of the components.

(e) Encourage and organize Commission and inter-disciplinary symposia and/or sessions at major geodesy related international meetings.

(f) Maintain a commission web page and e-mail service.

(g) Nominate up to three editors for the Journal of Geodesy.

8. Current Commissions

On the coming into effect of these bylaws, there shall be four Commissions with areas of scientific responsibility as outlined below:

(1) Commission 1: Reference Frames

(a) Establishment, maintenance, improvement of the geodetic reference frames.

(b) Advanced terrestrial and space observation technique development for the above purposes.

(c) International collaboration for the definition and deployment of networks of terrestrially-based space geodetic observatories.

(d) Theory and coordination of astrometric observation for reference frame purposes.

(e) Collaboration with space geodesy/reference frame related international services, agencies and organizations.

(2) Commission 2: Gravity Field

(a) Terrestrial, marine, and airborne gravimetry.

(b) Satellite gravity field observations.

(c) Gravity field modelling.

(d) Time-variable gravity field.

(e) Geoid determination.

(f) Satellite orbit modeling and determination.

(3) Commission 3: Earth Rotation and Geodynamics

(a) Earth Orientation (Earth rotation, polar motion, nutation and precession).

(b) Earth tides.

(c) Tectonics and Crustal Deformation.

(d) Sea surface topography and sea level changes.

(e) Planetary and lunar dynamics.

(f) Effects of the Earth's fluid layers (e.g., post glacial rebound, loading).

(4) Commission 4: Positioning and Applications

(a) Terrestrial and satellite-based positioning systems development, including sensor and information fusion.

(b) Navigation and guidance of platforms.

(c) Interferometric laser and radar applications (e.g., Synthetic Aperture Radar).

(d) Applications of geodetic positioning using three dimensional geodetic networks (passive and active networks), including monitoring of deformations.

(e) Applications of geodesy to engineering.

(f) Atmospheric investigations using space geodetic techniques.

9. Commission Sub-components and Joint Sub-components

(a) Commission Sub-components are Sub-commissions, Commission Projects, Study Groups, and Working Groups, which all belong to one commission.

(b) If more than one commission is involved in a Sub-component, the term Joint Sub-component will be used, e.g. Joint Sub-commission, Joint Commission Project, Joint Study Group, Joint Working Group.

10. Sub-commissions and Joint Sub-commissions

(a) A Sub-commission may be set up for topics where the Commission plays a leading or coordinating role.

(b) Where a topic relates to the scientific responsibilities of more than one Commission, a Joint Sub-commission shall be established under the lead of one Commission.

(c) A Sub-commission is expected to be established for several periods.

(d) Sub-commissions are established and terminated by the IAG Executive Committee upon recommendation from the Commission President.

(e) A proposal to the Executive Committee for a Joint Sub-commission requires the recommendation of the Presidents of all contributing Components.

(f) Guidelines for the establishment of Sub- commissions are established by the Executive Committee and published in the Geodesist's Handbook.

11. Commission Projects and Joint Projects

(a) A Commission project may be established when a new scientific method or a new technique is being developed, or when it seems appropriate to apply an existing technique to a specific geographic area where international collaboration is required.

(b) Where a topic for a Commission Project relates to the scientific responsibilities of more than one Commission, or a Commission and a Service, a Joint Commission Project shall be established under the lead of one Commission.

(c) A Commission Project is established for one period and may be extended for another period subject to a positive review.

(d) Commission Projects are established and terminated by the IAG Executive Committee upon recommendation from the Commission President.

(e) A proposal to the Executive Committee for a Joint Commission Project requires the recommendation of the Presidents of all contributing Components.

(f) Guidelines for the establishment of Commission Projects are established by the Executive Committee and published in the Geodesist's Handbook.

12. Study Groups, Working Groups, Joint Study Groups and Joint Working Groups

(a) A Study Group or Working Group may be established at any time to address clearly defined well-focused scientific topics of limited scope within the field of the Commission.

(b) Where a topic for a Study Group or Working Group relates to the scientific responsibilities of more than one Commission, or a Commission and a Service, a Joint Study Group shall be established under the lead of one Commission.

(c) A Study Group or Working Group is established for one period or less.

(d) Study Groups and Working Groups, including the position of Group chair, are established and terminated by the IAG Executive Committee upon recommendation from the Commission President.

(e) A proposal to the Executive Committee for a Joint Study Group or Joint Working Group requires the recommendation of the Presidents of all contributing Components.

(f) Guidelines for the establishment of Study Groups and Working Groups are established by the Executive Committee and published in the Geodesist's Handbook.

(g) The Chair of a Study Group or Working Group is responsible for initiating and directing its work and appointing its members.

(h) Study Group and Working Group membership should be balanced so as to reflect international cooperation in its subject.

(i) A Study Group or Working Group may have not more than 20 full members and an unlimited number of correspondent members.

(j) The Chair of each Study Group or Working Group shall issue a brief description of the work to be performed and a list of members, to be published in the Geodesist's Handbook after each General Assembly.

(k) The Chair of each Study Group or Working Group shall report annually to its members and the commission steering committee, on results achieved and outstanding problems.

(l) Guidelines for proposing candidates for the Study Group Chair or Working Group Chair will be established by the Executive Committee.

13. Services

(a) IAG Services generate products, using their own observations and/or observations of other services, relevant for geodesy and for other sciences and applications. Accuracy and robustness of products, quality control, timeliness, and state of the art quality are the essential aspects of the Services.

(b) Each Service shall define its Terms of Reference as appropriate to accomplish its mission and shall submit the Terms of Reference to the IAG Executive Committee for approval.

(c) Each Service shall have an IAG representative, appointed by the IAG Executive Committee, as a voting member of its directing/governing board.

(d) Services are linked to at least one of the Commissions and may be also linked to other scientific organizations, such as the International Astronomical Union (IAU) or the Federation of Astronomical and Geophysical data analysis Services (FAGS).

(e) Services shall collaborate on a scientific basis with the Commissions, establish Joint Commission Projects, and Joint Study Groups and help compile the Commissions' list of themes for Study Groups.

(f) Three representatives shall be elected in accordance with Bylaw 39 to the IAG Executive Committee to serve the interests of all Services.

(g) On any matter relating to the products of a Service, the Service shall represent the IAG.

14. Current Services

On the coming into effect of these bylaws, there shall be fifteen Services as outlined below:

(a) International GNSS Service

(b) International VLBI Service for Geodesy and Astrometry.

(c) International Laser Ranging Service

(d) International Gravimetric Bureau

(e) International Geoid Service

(f) International Centre for Earth Tides

(g) International Earth Rotation and Reference Systems Service

(h) International DORIS Service

(i) International Gravity Field Service

(j) International Centre for Global Earth Models

(k) International DEM Service – to be confirmed

(l) Permanent Service for Mean Sea Level

(m) Time Section of the International Bureau of Weights and Measures

(n) International Altimetry Service (IAS) – to be confirmed

(o) IAG Bibliographic Service.

15. The Global Geodetic Observing System (GGOS)

(a) The GGOS is IAG's observing system to monitor the geodetic and the global geodynamic properties of the Earth as a system.

(b) GGOS works with other IAG components, such as the IAG Services and the IAG Commissions, as well as the Inter-Commission Committees, to provide unique, mutually consistent, and easily accessible geodetic products (including the geometric reference frames and the gravity field) and the relevant geodetic constants for science and society.

(c) GGOS operates on its own Terms of Reference, defined by the GGOS Steering Committee and approved by the IAG Executive Committee. GGOS nomination and election procedures are specified in its Terms of Reference. Changes in the GGOS Terms of Reference may be proposed by the GGOS Steering Committee and approved by the IAG Executive Committee.

(d) The GGOS Chair is appointed by the IAG Executive Committee in consultation with the GGOS Steering Committee for one four-year period, which may be renewed once.

16. IAG Projects

(a) IAG Projects are flagship projects of a broad scope and of highest interest and importance for the entire field of geodesy and are expected to be established for a decade or longer.

(b) Planning for the creation of an IAG Project shall be carried out by a planning group established by the Executive Committee.

(c) The Project Steering Committee shall have the following voting members:

(i) The project chair appointed by the IAG Executive Committee

(ii) One member from each Commission appointed by the Commissions' Steering Committee

(iii) Two Members-at-Large proposed by the members of the Project Steering Committee identified in clause (i) and (ii) above and approved by the IAG Executive Committee.

(iv) Chairs of the IAG Project Working Groups (if any).

(v) Representatives of other IAG components, as appropriate.

(d) Guidelines for the establishment of Commission Projects are established by the Executive Committee and published in the Geodesist's Handbook.

(e) IAG Project Sub-components are Working Groups but not Study Groups.

17. Inter-commission Committees

(a) Inter-Commission Committees shall handle well defined, important and permanent tasks involving all Commissions.

(b) Each Inter-commission Committee shall have a steering committee, which shall include the following members:

(i) President appointed by the IAG Executive Committee.

(ii) Vice-president appointed by the IAG Executive Committee on the recommendation of the president.

(iii) One representative appointed by each Commission.

(c) The terms of reference for each Inter-commission Committee shall be developed by a planning group appointed by the IAG Executive Committee for approval by the Executive Committee.

(d) Inter-Commission Committees will be established for at least 2 periods (eight years) and shall be reviewed by the Executive Committee every eight years.

(e) The Inter-commission Committees shall report to the IAG Executive Committee.

18. Communication and Outreach Branch (COB)

(a) The function of the Communication and Outreach Branch is to provide the Association with communication, educational/public information and outreach links to the membership, to other scientific Associations and to the world as a whole.

(b) The responsibilities of the Communication and Outreach Branch shall include the following tasks:

(i) Promote the recognition and usefulness of geodesy in general and IAG in particular.

(ii) Publications (newsletters).

(iii) Membership development.

(iv) General information service and outreach.

(c) The Communication and Outreach Branch shall also assist the IAG General Secretary, in the following tasks as required:

(i) Maintenance of the IAG Web page.

(ii) Setting up Association schools.

(iii) Setting up meetings and conferences

(iv) Maintaining the Bibliographic Service.

(d) The IAG Executive Committee establishes the Branch on a long-term basis by issuing a Call for Participation. The responding organization(s) and the IAG Executive Committee shall then negotiate the Terms of Reference and other conditions.

(e) The President of the Communication and Outreach Branch shall be elected by Council.

(f) Major decisions related to the operations of the COB shall be made by a Steering Committee consisting of the following voting members:

(i) Communications and Outreach Branch President.

(ii) IAG Secretary General.

(iii) Editor-in-Chief of the Journal of Geodesy.

(iv) Up to 5 other members appointed by the Executive Committee on the recommendation of the President of the Communications and Outreach Branch.

19. Editor-in-Chief and Editorial Board

(a) There shall be one Editor-in-Chief for the journal, hereinafter referred to as the Editor. An Assistant Editor-in-Chief may assist the Editor. The Editor shall be advised and assisted by a Board of Editors, hereinafter referred to as the Board. To ensure broad expertise, each of the Commissions may nominate up to three members of the journal’s editorial board.

(b) The Editor shall be responsible for the scientific content of the journal. The Editor shall make the final decision on whether a refereed scientific manuscript is accepted for publication. The Editor shall keep the Executive Committee informed of the activities and status of operations of the journal.

(c) A few months before each meeting of the General Assembly, the current Editor, in consultation with the Bureau, shall recommend a preliminary list of candidates for the new Board of Editors. This list shall be published on the IAG website at least two months in advance of the General Assembly to solicit additional nominations for the Editorial Board from the geodetic community. The additional candidates will be added to the list.

(d) At the meeting of the General Assembly, the current Board shall appoint the members of the new Board from those recommended. After taking office, the new Board shall nominate the new Editor and the new Assistant Editor for the next period. After approval of these nominations by the Executive Committee, the Editor and the Assistant Editor will be considered as elected. Concurrence with the Publisher will be sought.

(e) The Editor, the Assistant Editor, and the members of the Editorial Board shall each hold office for one period, but may be eligible to be re-elected for one further period.

20. IAG Publications

(a) The IAG publications include the Journal of Geodesy, the IAG Newsletter, the Geodesist's Handbook, the "Travaux de l'Association Internationale de Géodésie,", IAG Special Publications, and the IAG Symposia series.

(b) The Association's journal is the Journal of Geodesy, hereinafter referred to as the journal. The journal is published monthly through an agreement between the Association and a publishing company, or by other arrangement approved by the Executive Committee. The terms of any agreement for publication of the journal shall be negotiated by the President of the Communications and Outreach Branch and ratified by the Executive Committee.

(c) The journal publishes peer-reviewed papers, covering the whole range of geodesy, including geodetic applications.

(d) The IAG Newsletter is under the editorial responsibility of the Communication and Outreach Branch. It should be published on the IAG web site and distributed to members electronically.

(e) After each IAG General Assembly meeting, a special issue of the Journal of Geodesy shall be published under the name of "The Geodesist's Handbook". This issue provides the actual information on the Association, including the reports of the President and Secretary General presented at the previous IAG General Assembly meeting, the resolutions taken at that meeting, and the Association structure listing all components and sub-components for the running period, rules for the IAG Fund, IAG Awards and for the conduct of scientific meetings as well as relevant scientific information.

(f) After each IAG General Assembly meeting, a collection of the reports by the Association components shall be published in the "Travaux de l'Association Internationale de Géodésie". This publication is supplied free of charge to the officers of the Association and to the adhering body of each member country.

(g) Proceedings of IAG symposia may be published in the IAG Symposia Series. The series editor is the President of the Association, with the symposia convenors acting as volume editors. All manuscripts are peer reviewed, and the volume editor shall make the final decision on whether a manuscript is accepted for publication.

(h) At every IAG General Assembly meeting each member country is encouraged to supply either an adequate number of copies of its National Report on geodetic work done since the previous General Assembly meeting in hard copy or a digital copy of its national report to be placed on the IAG web site. These National Reports, as far as available, are distributed by the IAG Office in the same manner as the "Travaux de l'Association Internationale de Géodésie".

21. Individual Membership

(a) Individuals engaged in geodesy, can become individual members of the Association on application and payment of the membership fee.

(b) Applications for individual membership are submitted to the Secretary General.

(c) The decision on the membership application shall be made by the Bureau.

(d) Benefits of membership include

(i) Substantial reduction on the individual subscription rate to the Journal of Geodesy.

(ii) The right to participate in the IAG election process both as a nominator and a nominee (provided IUGG laws are observed).

(iii) Upon application, correspondent membership in a sub-commission or study group of choice.

(iv) Reduction of the registration fee for IAG meetings as set under Bylaws 25(i), 26(d) and 27(c).

(e) The membership fee per annum is set by the Executive Committee. In setting the fee the Executive Committee will consider a recommendation from the Secretary General.

(f) In individual cases, the Secretary General may consider a discount or full remission of membership fees on application by the member.

(g) Where a member provides a donation in excess of the membership fee, the excess shall be assigned to the IAG Fund in support of young scientists.

(h) Membership is terminated if the membership fee is not paid or if an application for discount or full remission has not been received one year after the fee was due.

22. Fellows

The Executive Committee may invite past officers of the Association to be Fellows. Where the invitation is accepted, the Executive Committee shall confirm the appointment.

23. IAG Fund

The Executive Committee may establish a fund (IAG Fund) for supporting specific IAG activities as defined in the IAG Fund Rules, to be published in the Geodesist's Handbook in accordance with Bylaw 20(e). The fund is under the direct responsibility of the President; the fund's resources are administered by the Secretary General.

24. IAG Awards

The Executive Committee may establish awards for outstanding contributions to geodesy and distinguished service to the Association. The rules for the awards are published in the Geodesist's Handbook in accordance with Bylaw 20(e).

25. Administration of the IAG General Assembly meetings

(a) The IAG General Assembly shall meet at the same time and the same place as the IUGG General Assembly meeting.

(b) Before any meeting of the IAG General Assembly, the Bureau of the Association shall prepare detailed agendas for the Council meetings, Executive Committee meetings, the opening and the closing sessions.

(c) The Executive Committee shall draw up the agenda for the scientific program. Joint Symposia covering topics of interest to two or more Associations within the Union may be arranged.

(d) The agendas developed according to (b) and (c) above are sent to the member countries and to all the officers of the Association so as to reach them at least two months prior to the IAG General Assembly meeting. In principle, only matters on the agenda may be considered during the sessions, unless a decision to do otherwise is passed by a two-thirds majority in the Council concerning the agenda of the Council meeting, or in the Executive Committee concerning the scientific program.

(e) At each meeting of the IAG General Assembly, the President shall present a detailed report on the scientific work of the Association during his/her tenure. The Secretary General shall present a detailed report on the administrative work and on the finances of the Association for the same period. The President and Secretary General should include in their reports, proposals for work to be undertaken during the coming period, within the limits of expected resources. These reports shall be published in "The Geodesist's Handbook".

(f) At each meeting of the IAG General Assembly, the work of each Commission, each Service, the Communication and Outreach Branch, and each IAG Project shall be reported by its President / Chair. IAG Representatives to other scientific bodies report to the Executive Committee.

(g) Individual authors are responsible for the reproduction of their scientific papers. prior to the meeting. Where the IAG office receives sufficient copies of papers at the meeting, it shall distribute these to the delegates.

(h) Assembly Secretaries shall be appointed by the Council on the recommendation of the adhering body of the country in which the next IAG General Assembly meeting or Scientific Assembly will take place. In cooperation with the Bureau, the Assembly Secretary has responsibility for liaison with the organizers working on the preparation of the Assembly.

(i) The Executive Committee may set a reduced registration fee for Individual members in accordance with 20(d) (iv).

26. Scientific Meetings

(a) Scientific meetings of the IAG are:

(i) the Scientific Symposia held during a General Assembly;

(ii) Scientific Assemblies, including Scientific Symposia; and

(iii) IAG sponsored Symposia.

(b) The IAG Newsletter shall include on a regular basis, a Calendar of IAG Symposia and other scientific meetings organized or sponsored by the IAG or its components.

(c) The Executive Committee shall appoint an official IAG Scientific Meeting Representative for each of the scientific meetings to be governed by these Bylaws. The representative is obliged to remind the organizers to obey the Bylaws for scientific meetings and to report back to the Executive Committee.

(d) The Executive Committee may set a reduced registration fee for Individual members in accordance with 21(d) (iv).

27. Scientific Assemblies

(a) Scientific assemblies are generally held mid-way during the period between two meetings of the IAG General Assembly and shall consist of a group of component meetings and/or a group of Scientific Symposia, held at the same time and place.

(b) The Executive Committee shall appoint an Assembly Secretary in accordance with Bylaw 25(h).

(c) The Executive Committee may set a reduced registration fee for Individual members in accordance with 21(d)(iv).

28. Scientific Symposia

(a) Scientific symposia take place at meetings of the IAG General Assembly and Scientific Assembly. In general, they shall be organized by Association components and sub-components, and be led by their respective chairs.

(b) The study of some questions may require joint meetings of several components under a chair, appointed by the Executive Committee. A committee consisting of the component Chairs shall decide on the agenda and on the inclusion of scientific presentations.

(c) At each meeting of the IUGG General Assembly Joint Scientific Symposia covering topics of interest to two or more Associations within the IUGG and/or other international scientific organizations may be arranged. Though the IAG may be asked to act as convenor or co-convenor, these symposia shall follow the rules issued by the IUGG. The IAG may participate also in joint symposia at any other time outside of meetings of the IAG General Assembly obeying the same procedures.

(d) The arrangement of a scientific symposium shall be subject to the usual approval procedure provided by in the Geodesist's Handbook in accordance with Bylaw 20(e).

29. IAG Sponsored Symposia

(a) The IAG may sponsor a symposium covering broad parts of geodesy and having large attendance at any suitable time outside the IAG General Assembly meeting or Scientific Assemblies, and shall call it an IAG Sponsored Symposium, provided the following conditions are fulfilled:

(i) One or more Association component or subcomponent shall sponsor it or at least two Study Groups.

(ii) Host organization of the symposium shall accept a Scientific Organizing Committee (SOC) appointed by the IAG Executive Committee.

(iii) The symposium shall be open to all bona-fide scientists in accordance with the ICSU rules.

(iv) The symposium proceedings shall be published within 6-8 months.

(b) The SOC appointed under 29(a)(ii) above shall be responsible for the quality of science of the symposium being at a high level. A Local Organizing Committee (LOC) shall take care of the organization and logistics.

(c) Applications for approval of an IAG Symposium should be submitted to the Secretary General at least two years before the intended date of the meeting. Detailed guidelines for such applications, and the expectations from the SOC and LOC, may be found in the Geodesist's Handbook in accordance with Bylaw 20(e).

30. International Cooperation

(a) The Association may participate in joint bodies of the IUGG and other scientific organizations, especially those belonging to the International Council for Science (ICSU). These bodies shall be administered according to their specific rules.

(b) The Association shall initiate international cooperation in scientific work of international and interdisciplinary character. This includes the adequate participation in international programs and projects and the representation at scientific congresses, symposia etc. of organizations with related activities.

(c) The President of the Association shall decide on the proper participation or representation. Representatives to international programs and projects shall be appointed by the Executive Committee and shall keep the President informed on the activities, on a biannual basis. The representatives shall also prepare a report to be presented at the IAG General Assembly meeting.

31. Duties of the Council

(a) In addition to any other functions, powers and duties provided in other Statutes and Bylaws, the Council shall:

(i) Examine questions of general scientific policy or administration, and propose actions deemed necessary.

(ii) Elect the voting members of the Executive Committee, with exception of the GGOS Chair; see 15(c).

(iii) Receive reports from the Secretary General and consider for approval the decisions or actions taken by the Bureau and the Executive Committee since the last Council meeting.

(iv) Set up and dissolve Association components.

(v) Appoint the three members of the ad hoc committee created for examining the finances of the Association, consider its recommendations and adopt the final budget.

(vi) Consider proposals for changes in the Statutes and Bylaws.

(vii) Decide on the venue of IAG Scientific Assembly meetings.

(viii) Approve the establishment of Inter-Commission Committees and IAG Projects.

(b) Council meetings shall be convened by the President of the Association. It shall meet at least once during each IAG General Assembly meeting, and may be convened at other times, normally coinciding with a meeting of the IAG Scientific Assembly.

32. Duties of the Executive Committee

(a) In addition to any other functions, powers and duties provided in other Statutes and Bylaws, the Executive Committee shall:

(i) Initiate actions and issue guidelines, as required, to guide the Association towards the achievement of its scientific objectives.

(ii) Fill vacancies occurring between IAG General Assembly meetings, in accordance with the present Statutes and Bylaws.

(iii) Approve the internal structure of Association components.

(iv) Make recommendations to the Council on matters of general policy of the Association and on the implementation of its objectives.

(v) Appoint Fellows of the Association, upon the recommendation of the Bureau..

(vi) Appoint planning groups for Inter-commission Committees and IAG Projects.

(vii) Establish Inter-commission Committees and IAG Projects.

(viii) Appoint an IAG Review Committee every eight years.

(ix) Appoint the Assistant Secretaries of the Association.

(x) Confirm the links between Commissions and Services.

(xi) Adopt the suggested membership fee

(xii) Appoint the Vice-president of Commissions.

(xiii) Appoint representatives to external bodies.

(xiv) Establish an IAG Fund.

(b) Executive Committee meetings shall be convened by the President of the Association. It shall meet at IAG General Assembly meetings and its members are expected to attend the meetings of the Council, with voice but without vote. It shall also meet normally at least once a year, especially one year before the IAG General Assembly meeting, in order to prepare the scientific agenda and the timetable of the next IAG General Assembly meeting.

(c) At a meeting of the Executive Committee, no member may be represented by any other person, except a President of Commission who may be represented by the Vice-President. In order that the deliberations of the Executive Committee shall be valid, at least half of its members must be present or represented.

(d) The agenda for each meeting of the Executive Committee shall be prepared by the Bureau and sent to the members at least three months prior to the meeting.

33. Duties of the Bureau

(a) In addition to any other functions, powers and duties provided in other Statutes and Bylaws, the Bureau shall:

(i) Draw up the agenda of the meetings of the Council and Executive Committee and send these to the members at least three months prior to the meeting.

(ii) Ensure the adequate administration of the Association.

(iii) Receive applications for individual memberships and accept individuals as Members of the Association.

(iv) Recommend Fellows to the Executive Committee.

(b) The Bureau shall normally meet before each meeting of the Executive Committee.

34. Duties of the President

In addition to any other functions, powers and duties provided in other Statutes and Bylaws, the President shall:

(a) Provide general leadership for the Association in all matters.

(b) Convene and preside over the IAG General Assembly meeting and over all meetings of the Council, Executive Committee and Bureau.

(c) Represent the Association in its dealing with national or international organizations or institutions.

(d) Submit a report to the IAG General Assembly meeting on the scientific work of the Association during his/her tenure.

35. Duties of the Vice President

In addition to any other functions, powers and duties provided in other Statutes and Bylaws, the Vice President shall act as the President whenever the President is not present or is unable to perform any of the President's duties, and shall perform such tasks as may be assigned by the President, the Executive Committee or the Council.

36. Duties of the Secretary General

In addition to any other functions, powers and duties provided in other Statutes and Bylaws, the Secretary General shall:

(a) Serve as secretary of the General Assembly, the Council, the Executive Committee and the Bureau; arrange for meetings of these bodies, distribute promptly the agenda and prepare and distribute the minutes of all their meetings.

(b) Act as Director of the IAG Office.

(c) Manage the affairs of the Association, attend to correspondence, and preserve the records.

(d) Circulate all appropriate information related to the Association.

(e) Prepare the reports of the Association's activities.

(f) Perform such other duties as may be assigned by the Bureau.

(g) The function of the Secretary General is unpaid and only expenses incurred in connection with the functions and duties are repayable.

37. Assistant Secretaries

(a) The Secretary General is assisted by a small number of assistant secretaries, one of whom is located in the same office as the Secretary General.

(b) The position of Assistant Secretary is unpaid and only expenses incurred in connection with the functions and duties are repayable.

38. IAG Office

To assist the Secretary General, the Association establishes the IAG Office in the country in which the Secretary General resides. The Executive Committee negotiates logistical and financial support with the host country.

39. Procedure for Nominations and Elections of Officers

(a) Elections shall take place by mail vote before each IAG General Assembly meeting and should be completed one month before the assembly.

(b) The President of the Association, after taking advice from the Executive Committee, shall appoint a Nominating Committee consisting of a Chair and three other members.

(c) The Nominating Committee, after taking advice from the Delegates of the Adhering Bodies, the officers, fellows, and members of the Association, shall normally propose at least two candidates for each position to be filled by election in the Council. Candidates shall be asked to signify their acceptance of nomination and to prepare a resume, maximum 150 words, outlining their position, research interests and activities relating to the Association.

(d) The Adhering Bodies and the individual membership (i.e. the General Assembly membership) shall be informed of these nominations three months before the IAG General Assembly meeting.

(e) During the following month further nominations can be submitted by the Delegates of the Adhering Bodies. Such additional nominations shall be in writing, shall be supported by at least two members of the Council, and shall be submitted with resumes as described above to the Chair of the Nominating Committee.

(f) Nominations shall be checked against the eligibility criteria in Bylaw 40 by the Nominating Committee. Ineligible nominations will not be accepted and the members of Council who supported the nomination will be advised of the reason for its rejection.

(g) Delegates shall be informed of these further eligible nominations and resumes and of their supporters.

(h) The Chair of the Nominating Committee shall write to all services asking them for one nomination from each service for the Service representatives on the Executive Committee. The Nominating Committee shall recommend normally two nominees for each of the Services' three positions, considering appropriate scientific and national distribution. The procedure for seeking additional nominations in sub clause (e) above does not apply to these positions.

(i) If candidates have been nominated for more than one position, they will be asked to make a decision for which position they will allow their name to stand.

(j) Elections shall be by mail ballot and by majority vote. In this case, the delegates of the Adhering Bodies form the Council.

40. Eligibility & Terms of Office

(a) No person may hold more than one of the following offices at the same time: President of the Association, Vice-President, President of a Commission, President of a Service, Chair of GGOS, President of the Communication and Outreach Branch, Chair of an IAG Project.

(b) A member of the IUGG Bureau or of the IUGG Finance Committee may not occupy the post of President, of Vice-President or of Secretary General of the Association.

(c) The President of the Association is elected for one Period and may not be immediately re-elected to the same office.

(d) The Vice-President is elected for one period and may not be re-elected to the same office.

(e) The Secretary General is elected for one period initially. He/she may be re-elected for two additional periods.

41. Extraordinary Vacancies

(a) Should the position of President become vacant during the Period between two IAG General Assembly meetings, his duties devolve to the Vice-President until the closure of the next IAG General Assembly meeting.

(b) Should the post of Secretary General become vacant, the President shall arrange without delay for the Executive Committee to propose a replacement and for the Council to appoint a new Secretary General so as to ensure the continuity of the work of the IAG Office. This appointment has effect until the closure of the next IAG General Assembly meeting and shall not be counted in the restriction of eligibility for re-election of the Secretary General under Bylaw 40(e).

42. Finance

(a) The Finances of the Association derive from the following sources:

(i) Contributions of IUGG Adhering Bodies of which a portion, determined by the IUGG Council on recommendation of its Finance Committee, is paid to the Association by the Treasurer of the Union.

(ii) Sale of publications.

(iii) IAG Fund collected from individual contributions for specific purposes.

(iv) Membership fees.

(v) A portion of the registration fee charged at IAG symposia.

(vi) Other sources e.g., grants, interests, and funds remaining after a symposium.

(b) The Secretary General is responsible to the Bureau and to the Council for managing the funds in accordance with the Statutes and Bylaws, with the decisions of the Council. The Secretary General alone shall be responsible for control of the financial operations of the Association.

(c) At each IAG General Assembly meeting the budget proposal for the next period shall be presented by the Secretary General and submitted for approval to the Council. The budget as approved by the Council shall be implemented by the Secretary General.

(d) During each IAG General Assembly meeting, the Council shall examine all expenditures during the preceding period to ensure that they were in accordance with the proposed budget previously approved. The Council shall appoint an ad hoc committee for carrying out this examination in detail.

(e) In addition, the accounts shall be audited by a qualified accountant and shall then be reported to the IUGG Treasurer, as prescribed in Article 20 of the IUGG Bylaws.

Rules for the Guy Bomford Prize and Levallois Medal

Guy Bomford Prize

Purpose

The Guy Bomford Prize is awarded by the International Association of Geodesy for outstanding contribution to Geodesy. It was established by the British National Committee for Geodesy and Geophysics to mark the contributions to geodesy of Brigadier G. Bomford, formerly of the University of Oxford and a Past President of the International Association of Geodesy. It has been inaugurated by the IAG in 1975. The Prize is normally awarded at intervals of fours years on the occasion of the General Assembly of the IAG held concurrently with the General Assembly of the International Union for Geodesy and Geophysics. The following rules for the award of the Guy Bomford Prize may be altered by the IAG Executive Committee if a majority of its voting members sees a necessity to do so.

Eligibility

The Guy Bomford Prize is awarded to a young scientist or to a team of young scientists for outstanding theoretical or applied contributions to geodetic studies, particularly in the four year period preceding the General Assembly at which the award is made. Scientists who are under 40 years of age on December, 31, of the year preceding the Assembly at which the award is made, are eligible for the award.

Nominations

Nominations will be invited by the IAG Bureau from all National Committees of IUGG member countries at least one year ahead of the General Assembly. Each committee can make one nomination which has not necessarily to be from its own country. The deadline for nominations will normally be six months before the next General Assembly and will be explicitly started in the letter of invitation. Nominations must be accompanied by:

- The full name, address, age, academic and/or professional qualifications and position of the candidates and the name of the National Committee making the nomination.
- An outline of the reasons for the nomination including a general summary of the career and scientific achievement of the candidate.
- A review of the recent achievements of the candidates which would merit the award, including references to key papers, published, alone or jointly, during the preceding four-year period.
- A curriculum vitae, publication list, and copies of up to two key papers which are considered to justify candidature.
- The name and address of two referees who could be consulted.

Selection procedure

A selection committee will be appointed consisting of the presidents of the IAG commissions and two other members to be appointed by the IAG Bureau. Based on the material submitted by the National committees each member of the selection committee will rank the nominations and select the candidate to be awarded the Guy Bomford prize. The decision (not the detailed ranking) will be communicated to all National Committees and to the selected candidate. The prize may be withheld if, in the opinion of the selection committee, there is no sufficiently qualified candidate available.

Presentation of award

The Prize shall be presented to the successful candidate at the opening at the opening Plenary Session of the IAG Assembly. He or she shall be invited to deliver a lecture during the course of the IAG Assembly.

Levallois Medal

Purpose

The Levallois Medal was established by the International Association of Geodesy in 1979 to honour Jean-Jacques Levallois, and to recognize his outstanding contribution to the IAG, particularly his long service as Secretary General, 1960-1975.

The award of the Medal will be made in recognition of distinguished service to the Association, and/or to the science of geodesy in general.

The Medal is normally awarded at four year intervals, on the occasion of the General Assemblies of the International Association of Geodesy and International Union of Geodesy and Geophysics; but the award may be omitted if it is considered that there is no candidature of sufficient merit, and an additional award may be made at any time if justified by exceptional circumstances.

Nomination and Election

A nomination for the award shall be made by an ad hoc committee consisting of the Honorary Presidents and must be confirmed by the IAG Executive Committee. The ad hoc committee shall prepare a citation, suitable for publication, setting out the grounds for the proposed award before the General Assembly.

Rules for IAG Scientific Meetings

1. IAG Scientific Meetings are organized by IAG Components (Commissions, Services, Global Geodetic Observing System) or Sub-components (Inter-commission Committees, Sub-commissions, Projects, Study Groups, Working Groups). They may take place:
   a) during IAG General Assemblies, held in conjunction with the IUGG General Assemblies,
   b) during IAG Scientific Assemblies, held in-between successive General Assemblies, or
   c) at any time and place apart from the General or Scientific Assemblies of the IAG.

2. During the General or Scientific Assemblies the scientific meetings are organized under the chairmanship of the Presidents of the IAG Components. For specific topics there may be joint meetings of several Components under a chair appointed by the IAG Executive Committee. The inclusion of scientific papers for presentation at a General or Scientific Assembly is decided by a Scientific Committee established by the IAG Executive Committee.

3. At General Assemblies joint symposia covering topics of two or more Associations within the Union and/or other international scientific organizations may be organized. Though the IAG may be asked to act as convenor or co-convenor, these symposia follow the IUGG rules for such activities.

4. The IAG may participate also in joint symposia with other Associations at any other time outside of the General Assemblies, following the same procedures.

5. The IAG may sponsor scientific symposia covering appropriate topics of Geodesy at any time outside of the General or Scientific Assemblies, and may call them IAG-Symposium if the following conditions are fulfilled:
   - The Symposium has to be organized by at least one Component or two Sub-components of the IAG.
   - The host organization of the Symposium must accept a Scientific Committee appointed by the IAG Executive Committee with the advice of the proposer of the Symposium.
   - The Symposium must be open to all scientists in accordance with the ICSU Rules.
   - The proceedings of the Symposium should be published within 6-8 months after the end of the Symposium in the series of IAG Symposia.

   IAG expects that immediately after the end of the Symposium the chairperson of the Scientific Committee will prepare a short summary to be published in the Journal of Geodesy and in the IAG Newsletter.

6. Applications for approval to be designated IAG-Symposium should be submitted to the Secretary General of the IAG at least twelve months before the proposed date of the Symposium. The following information must be provided in the application for approval:
   a) Title,
   b) Date and duration,
   c) Location,
   d) Sponsoring and co-sponsoring (Sub-) Components of IAG,
   e) Other co-sponsoring scientific organizations with letters enclosed,
   f) Suggested composition of the Scientific Committee,
   g) Local Organizing Committee, host organization, name and address of contact, etc
   h) Estimated number of participants,
   i) Financial support expected from sources other than the IAG,
   j) Names of the proposed editors of proceedings,
   k) Draft scientific programme,
   l) A detailed account of why the proposed Symposium is useful and necessary at the time proposed, and its relationship with other meetings.

7. Guidelines for the organization of the Symposium:
   a) The Scientific Committee is responsible for ensuring a high standard of scientific value of the Symposium. The chair of the Scientific Committee:
      - invites participants after the Symposium is approved by the IAG Executive Committee,
      - invites contributions and sets a deadline for submissions of abstracts, and
      - informs the IAG Secretary General of all important matters pertaining to the Symposium.

b) The Local Organizing Committee is responsible for the smooth running of the Symposium. It does not receive financial assistance from the IAG, with all the necessary expenses being met by local funds or by contributions from the participants. The requirements of local organizations are generally as follows:

- providing meeting rooms suitable for the expected number of participants,
- providing the facilities for oral and visual presentations,
- provide adequate space and logistical support for poster sessions (if any),
- reproduction of participants' document (if necessary), organize publication of proceedings or production of CD version,
- sufficient secretarial and technical assistance,
- undertake full responsibility for registration of participants, maintaining a web page, printing of brochures and programmes, etc.
- information on accommodation (hostels, hotels, etc...), sent to the IAG Executive Committee for acceptance, and to prospective participants, and
- organizing receptions and excursions during a free period within the meeting, or just before or after the meeting.

8. The IAG Executive Committee shall recognize scientific meetings other than symposia (workshops, etc.) organized by IAG (Sub-) Components, alone or jointly with other international and national groups and bodies, at any time outside of the General Assemblies, if they have been approved by the Executive Committee. The Meeting may be announced as "International Meeting, organized by the ..... of IAG". It is not permitted to use the term "IAG-Symposium".

9. The IAG may recognize scientific meetings, organized by national bodies as important scientific events with benefit for the international geodetic community and to sponsor them if the meeting is open to all scientists according to the ICSU Rules, and will be sponsored by at least one IAG (Sub-) Component, and if the organizer undertakes to maintain the expected standard for IAG-Symposia.

   These Meetings may be announced as "International Meeting, organized by ....., sponsored by IAG". It is not permitted to use the term "IAG-Symposium". Sponsorship by the IAG means only official recognition and does not imply financial support by the IAG. The IAG may appoint an official representative to that meeting. The IAG expects that, in the event that proceedings are published, the Proceedings will be prepared by the local organizers and published within 6-8 months after the end of the meeting.

   Applications for sponsorship should be submitted to the IAG Secretary General not later than 18 months before the intended date of the meeting.

10. In its decision whether to approve and/or sponsor a scientific meeting, the IAG Executive Committee takes into account the need for a balanced selection of meetings, a representative coverage of subjects, and a good geographical distribution. The IAG wishes to avoid duplication of symposia or meetings, and to discourage symposia or meetings with overlapping themes that are held with too high a frequency.

    The IAG Secretary General shall publish a calendar of IAG-Symposia and other scientific meetings organized by IAG-bodies or sponsored by IAG in the Journal of Geodesy, in the IAG Newsletter and on the IAG Website.

IAG Young Authors Award

Purpose

To draw attention to important contributions by young scientists in the Journal of Geodesy and to foster excellence in scientific writing.

Eligibility

The applicant must be 35 years of age or younger when submitting the paper for the competition. The paper must present his or her own research, and must have been published in the two annual volumes of the Journal of Geodesy (J of G) preceding either the IAG General Assembly or the Scientific Assembly. Although multiple author papers will be considered, single author papers will be given more weight in the selection process.

Award

The award consists of a certificate and a cheque of US $ 1000. Presentation of the awards will be made at each IAG General Assembly and each Scientific Assembly. Up to two awards will be presented on each occasion for the two-year period corresponding to the annual volumes specified above.

Nomination and Selection

For each two-year period the Editor-in-Chief of the Journal of Geodesy will propose a minimum of three candidates for the award. In addition, proposals made by at least three Fellows or Associates will be considered for the competition. The voting members of the IAG Executive Committee will make the final selection. It will be based on the importance of the scientific contribution, which may be either theoretical or practical, and on the quality of the presentation. The name and picture of the award winner and a short biography will be published in the Journal of Geodesy.

Procedure

Each year the conditions for the award will be announced in the Journal of Geodesy. Nominations should be sent to the Secretary General of the IAG, giving name, address, and age of the author (at date of submission), the title of the paper on which nomination is based, and a brief justification. Nominations must be received by March 1 of the year in which either an IAG General Assembly or an IAG Scientific Assembly takes place.

IAG Travel Award

Purpose

To assist young scientists from member countries to present results of their research at IAG meetings (general meetings, workshops, etc.).

Eligibility

The applicant must present results of his or her research at the meeting and must be 35 years of age or less at the date of the application. The application must be supported by at least one IAG Fellow or two Associates.

Type of awards

There are two awards, one for meetings in the applicant's own country, and the other for meetings outside the applicant's country. The first group is called *IAG National Travel Award* and has a maximum financial value of US $ 400. It is available for meetings in developing countries. The second award is called the *IAG International Travel Award* and has a maximum financial support of US $ 800. The amounts can occasionally be adjusted by the IAG Executive Committee. Normally, the total number of awards are limited to 10 in any given year.

Application procedure

Applicants are asked to send their application at least three months before the meeting to the IAG Office. As a minimum, the application should contain: title, authors, and abstract of the paper to be presented, acceptance by the organising committee (if available), travel budget and sources of additional funding. The letter(s) of support (one IAG Fellow or two Associates) should be sent separately.

Selection procedure and criteria

Selection of applicants will be done by the IAG Bureau. It will be based on the letter(s) of support and the applicant's ability to actually attend the meeting. Priority will be given to candidates from developing countries.

Additional benefits

The IAG will encourage organizers of meetings to waive registration fees for all IAG Travel award winners.

IAG Fund

The IAG Fund aims at supporting specific IAG activities. Its primary goals are:

- to provide travel support for young scientists to attend IAG Symposia and workshops,
- to assist in the organisation of IAG workshops in developing countries, and
- to provide an annual IAG Best Publication Award for young scientists.

The fund was established by the IAG Executive Committee at its meeting in Columbus, Ohio, 1992, see Bulletin Géodésique, Vol. 68, pp. 41-42, 1994.

Contributors are divided in 3 groups:

- Presidents Club (cumulative contributions of USD 1000 and more or equivalent in EUR)
- Special contributors (annual contributors of USD 100 … USD 1000 or equivalent in EUR)
- Contributors (annual contributions of less than USD 100 or equivalent in EUR)

The rules for the IAG Young Authors Award and for the IAG Travel Award for young scientists are given in a separate section of the Geodesist's Handbook.

I wish to contribute to the IAG fund

Annual basis ☐ One-and-for-all ☐

Amount ...…… USD or .. …… EUR

Payment

Please charge my credit card

☐ Master Card, ☐ VISA Card

Card number: .....

Expiry date: ..... Security code: .....

Or bank transfer

Remittee: Staatsoberkasse
Bank: Bayerische Landesbank, Brienner Strasse 18,
D − 80333 Muenchen, Germany
Bank No.: 70050000, Account No.: 24592,
SWIFT code/BIC: BYLADEMM,
IBAN: DE36 7005 0000 0000 024592,

Note to payee: DGFI PK 2504.2100.0078, your name

Title: _____

Name: _____

Institution/Department: _____

_____

_____

Address: _____

Country: _____

Phone: _____

Fax: _____

E-Mail: _____

Date: _____

Signature: _____

The XXIV IUGG General Assembly Perugia, Italy, 2007

Presidential Address

Gerhard Beutler

Distinguished Guests,
Friends and Colleagues,
Ladies and Gentlemen,

It is my pleasure and privilege to welcome you to the opening session of the IAG General Assembly 2007 in Perugia, Italy. It is the 24th General Assembly of IUGG and the 42nd of IAG since its foundation in 1864. The General Assembly is the last event organized by the Executive Committee of a four-year period, in IAG language simply called "the Period". This report thus covers the Period from the IUGG/IAG General Assembly in Sapporo, Japan in 2003 to that of 2007 in Perugia, Italy. In order to ensure a smooth transition from the old to the new Executive, the new IAG Executive Committee was elected by mail ballot prior to the General Assembly. The names and affiliations of the new IAG Executive members are listed in this Geodesist's handbook, which is why I am confining myself in this written report to congratulating the esteemed colleagues of the new IAG Executive for their election and to wish them success and good luck for the next Period.

Since the 2003 IUGG General Assembly in Sapporo a number of IAG officers passed away. The names reported to the IAG Secretariat are:

- William Baarda (Netherlands)
- B.R. Bowring (UK)
- Karel Hamal, (Czech Republic)
- Torben Krarup (Denmark)
- Ludmila Kubackova, (Czech Republic)
- Madhav N. Kulkarni (India)
- Buford K. Meade (USA)
- Paul Melchior (Belgium)
- Hans Pelzer (Germany),
- Milos Pick (Czech Republic)
- Muzafer Serbetci (Turkey)
- Peter Schwintzer (Germany)
- Pavel Vyskocil (Czech Republic)
- Urho A. K. Uotila (Finland/USA)

We pay our respect to these colleagues and bear their contributions to IAG in mind.

The IAG Structure 2003-2007

The IAG went through a major review process between 1999 and 2003. In September 2001 the review process was formally concluded by the adoption of new IAG Statutes and Bylaws, which provide basis for the IAG structure and work since 2003. Implementing the, and working in, the new environment was one of the major challenges of the Period 2003-2007. In retrospective it can be said that the new IAG structure provides a satisfactory vessel for the Association's work and that it gave the Association a significant new thrust. The essential IAG elements of the Period 2003-2007 were:

- Four Commissions
- Fourteen Services
- Communication and Outreach Branch
- Inter-Commission Committees
- Study and Working Groups
- Bureau
- Executive Committee
- Journal of Geodesy

The IAG statutes and Bylaws list Commissions, Services and the Communication and Outreach Branch as components on the same level of the IAG hierarchy – an essential change w.r.t. the previous structure. IAG Projects, Inter-commission Committees and IAG Study and Working Groups are sub-components. The administration of the association is carried by the General Assembly, the Council (normally meeting at General Assemblies), the Bureau and the Executive Committee, where the IAG Secretary General serves as secretary for these bodies. The Journal of Geodesy is the Association's journal.

The four Commissions are continuations of four out of the five Sections of the previous IAG structure. The IAG Section on Theory and Methodology was succeeded by the Inter-Commission Committee on Theory (ICCT), an entity set up with the intention to interact with all IAG Commissions and Services and with the GGOS (see next paragraph). As opposed to the original intention, it remained the only operating Inter-commission Committee of the 2003-2007 period.

The new IAG structure allowed (and allows) it to create IAG Projects. They are meant to create a focal point of the Association's work. The Global Geodetic Observing System (GGOS) was created as the one and only IAG Project of the past period.

The Communication and Outreach Branch (COB) is intended to provide the Association with communication, educational/public information and outreach links to the membership, to other scientific associations and to the world as a whole. József Ádám is the President, Szabolcs Rósza the Secretary of the COB, which is hosted by the Department of Geodesy and Surveying, Budapest University of Technology and Economics. The COB undoubtedly increased IAG's public visibility.

The IAG Central Bureau and the Journal of Geodesy already were key elements in the previous structure. They continued their work essentially with the same mission and the same leadership as in the previous Period. The administration of the association was carried, as in the previous periods by the General Assembly, the Council, the Bureau, and the Executive.

The IAG Statutes and Bylaws are reviewed at eight-year intervals by a Review Committee. In view of the important structural changes implemented in 2003 it seemed advisable that the first review should take place already in 2007 (the next one is planned for 2015). Prof. Klaus-Peter Schwarz, IAG President 1995-1999, was leading this effort. The result of this work, the revised Statues and Bylaws approved by the Council at the General Assembly 2007, is contained in this Handbook. We will mention one substantial structural change later in this report.

Geodesy is based on three pillars, namely (1) the geometric shape of the Earth, (2) the orientation and the (rotational) motion of our planet in space, and (3) the Earth's gravity field. Towards the end of the 20th century geodesists could proudly state that the first two pillars are monitored at a level of 10^{-9} (few mm in mean station coordinates, sub-milli-arcseconds in the Earth rotation parameters polar motion, precession, nutation and fractions of microseconds in the length of the day). We owe these proud achievements to a great extent to the IAG services, in particular the IERS and the technique-specific geometry-related services IVS, ILRS, IGS, and IDS. Their reports may be found elsewhere in this Handbook. At the end of the 20th century we had, however, also to admit that we were far from such accuracies where the third pillar of geodesy, the Earth's global gravity field, was concerned.

This situation improved dramatically with the launch of the first gravity field satellite CHAMP (CHAllenging Minisatellite Payload) in the year 2000 (where, admittedly, CHAMP also carried other fascinating experiments related to atmosphere sounding and to the monitoring of the magnetic field). CHAMP's recovery of the Earth's gravity field mainly relied on the monitoring of the orbital motion using a space-borne GPS (Global Positioning System) receiver. With "only" about one year of CHAMP's GPS data it is possible to recover the Earth's static gravity field up to terms of about 60 (in degree and order of the spherical harmonics expansion) with an accuracy, which is generally better by one or more orders of magnitude compared to what was known before (except for the low degree terms).

With the launch of the satellite constellation GRACE-A and -B, orbiting the Earth in the same orbital plane and separated in along track direction by about 250 km, the resolution of the gravity field was once more considerably improved (terms up to degree and order 100 may now be determined) and the accuracy was again significantly improved (by at least one order of magnitude, at least for terms of higher degrees) from the CHAMP-only to the GRACE- and CHAMP-based gravity fields. Moreover, it is now feasible to study not only the static, but also the time varying gravity field – GRACE-based gravity fields are routinely generated with a monthly resolution). This allows the study of many aspects of highest interest in geophysics, like, e.g., the annual water cycle between oceans, atmosphere, and solid Earth. Technically, this new quantum jump in gravity field determination was enabled by the microwave-link (K-Band) between the twin satellites, allowing it to monitor distance changes between the satellites continuously with an accuracy of only few microns (the "absolute" orbits are monitored with GPS, like in the case of CHAMP). With the CHAMP and GRACE missions in

orbit and with ESA's GOCE mission to be launched in 2008 our knowledge of the gravity field (expressed in the geoidal height) approaches the 10^{-9} level, which is comparable to the accuracy achieved by the products related to the first two pillars of geodesy.

IAG has neither launched these fascinating missions, nor has it the responsibility for the operational aspects of them. IAG was and is, however, heavily involved in the planning phases and the scientific exploitation of these fascinating experiments through individuals and geodetic research institutions heavily engaged in IAG work.

This rapidly changing geodetic environment of course stimulated the scientific work in IAG in the past Period. Let me address a few highlights and important developments as reported by individual IAG entities.

IAG Commission 1 on Reference Frames (President Hermann Drewes, Vice-president C. K. Shum) organized the International IAG / FIG Symposium GRF2006 on Geodetic Reference Frames in Munich. The ITRF2005, published a few days prior to the symposium by the IERS, based as its predecessors on the space geodetic techniques VLBI (Very Long Baseline Interferometry), SLR/LLR (Satellite and Lunar Laser Ranging), and GNSS (Global Navigation Satellite Systems), was discussed in detail (and at times emotionally) at the symposium. It became clear on one hand that great progress was achieved in the understanding of the combination techniques in space geodesy and that the number of experts and institutions working in this domain could be substantially increased in the previous ten years, but also that, on the other hand, the problem of defining and maintaining our planet's global reference frame is delicate and still needs continued attention and research. The commission also did its best to initiate an International Altimetry Service (IAS). This initiative, led by Dr. Wolfgang Bosch, could not be concluded as planned in the past Period. The IAS is, however, a necessity from the scientific perspective and may hopefully be launched in the period 2007-2011.

IAG Commission 2 on the Gravity Field (President Chris Jekeli, Vice-President Ilias Tziavos) was of course at the forefront of analysing data and results emerging continuously from the space missions mentioned above. The commission also made considerable progress in the establishment the International Gravity Field Service (IGFS). It is in particular noteworthy that the "First International Symposium of the IGFS" was organized by the Commission in Istanbul, Turkey in 2006.

IAG Commission 3 on Earth Rotation and Geodynamics (President Véronique Dehant, Vice-President Michael Bevis) established three sub-commissions on Earth tides, crustal deformation, and geophysical fluids) and initiated common activities in this field, which also take profit out of the IAG services' work.

IAG Commission 4 on Positioning and Applications (President Chris Rizos, Vice-president Pascal Willis) was very active in establishing and improving the links to our sister society FIG (Fédération Internationale des Géomètres). The collaboration with FIG is a logical task for this application-oriented commission and was undoubtedly favoured by the fact that Matt Higgins from FIG and Chris Rizos from IAG are countrymen and engaged on similar levels with a similar portfolio in their organizations.

The IAG Services are working according to their own terms of reference and have clearly defined missions, objectives, and products. Their work is very much appreciated by IAG, a fact, which is reflected by the new IAG structure with Commissions and Services on the same level of the hierarchy. Their achievements are documented in detail elsewhere in this Handbook. Let me mention here that the IGS (International GNSS Service) celebrated its first ten years as an official IAG service at the University of Bern in 2004 and that the IVS laid down its views on the future in a document called VLBI2010. It also is worth mentioning that the Journal of Geodesy currently is publishing special issues devoted to the IAG services. The volumes on DORIS and VLBI already have been completed, the work for the volumes of the other services has been initiated.

The GGOS Project, IAG's flagship since 2003, evolved in two steps in Period 2003-2007; The definition phase, between 2003 and 2005, was led by Christoph Reigber (Chair) and Hermann Drewes (Secretary). This phase was concluded at the IAG Scientific Assembly 2005 in Cairns, Australia. The final report recommended to start the implementation of GGOS as an IAG entity without delay. The implementation phase, lasting from 2005 to 2007 was led by Markus Rothacher (GGOS Chair), Ruth E. Neilan and Hans-Peter Plag (GGOS Vice-Chairs).

The GGOS Chair and the Vice-chairs get input and directions from the broad-based GGOS Steering Committee. The daily work was performed by a small executive committee. The results of the GGOS project in the 2003-2007 are remarkable. A first draft of the GGOS2020 document was available to IAG before the General Assembly in Perugia – for this purpose the GGOS Retreat and Writing Team Meeting was organized in February 2007 in Oxnard, California. Thanks to the team effort IAG is today a recognized and respected so-called participating organization of GEO, the Group on Earth Observation. The GGOS project delivered many presenta-

tions at International scientific symposia, organized sessions, etc. It was in particular responsible for organizing the GGOS Symposium and it represented IAG at the IUGG Union Symposium on Global Observing Systems in Perugia. These developments led the IAG Council to accept a substantial change in the IAG structure at its recent General Assembly in Perugia: In the IAG Statutes the GGOS is now listed together with the Commissions, Services, and the COB as an IAG component. Its definition for the period 2007-2011 is contained in the IAG Bylaws:

(a) The GGOS is IAG's observing system to monitor the geodetic and the global geodynamic properties of the Earth as a system.

(b) GGOS works with other IAG components, such as the IAG Services and the IAG Commissions, as well as the Inter-Commission Committees, to provide unique, mutually consistent, and easily accessible geodetic products (including the geometric reference frames and the gravity field) and the relevant geodetic constants for science and society.

(c) GGOS operates on its own Terms of Reference, defined by the GGOS Steering Committee and approved by the IAG Executive Committee. […].

(d) The GGOS Chair is appointed by the IAG Executive Committee […].

The **Inter-commission Committee on Theory (ICCT)** was led by Peiliang Xu in the past Period. The ICCT organized in particular the VIth Hotine-Marussi Symposium in Wuhan (China) in 2006. This event united theorists, practitioners, generalists, specialists from IAG Commissions, Services, the GGOS, and – of course – the members of ICCT. The symposium was a full success and indicated how the work of the ICCT might develop in future. Problems concerning the visibility of the ICCT at IAG Scientific Assemblies and General Assemblies should be avoided in future (to the extent possible). It is in any case the firm wish of the old and new IAG Executive Committees to keep the ICCT on board the IAG ship and to let it provide a bridge between the IAG components using the language of mathematics and methodology.

Christian Tscherning served as the Association's **Secretary General** from 1995 to 2007. His work to the benefit of the Association and geodesy in general was honoured with the Levallois medal 2007 (Laudatio reproduced in this Handbook).

Will Featherstone was Editor in Chief of the **Journal of Geodesy (JoG)** between 2003 and 2007. Under his leadership the JoG significantly improved its position on the scientific "market" (the impact factor was almost doubled in his era). The IAG is grateful for Will Featherstone's outstanding work. We all should follow his recommendation and publish our key results in the Association's journal. A highly ranked Journal of Geodesy is in the interest of the entire Association.

Schools and Meetings

The organization and sponsoring of educational meetings and the organization of schools is an important activity in IAG. Four such events were organized by IAG in the Period (for a detailed list consult the report of the IAG Secretary General contained in this Handbook). IAG organized or sponsored more than twenty workshops, symposia or other meetings in this Period (the detailed list is provided in the Secretary General's report). The list gives an impression of the work done by the IAG commissions, the services, and IAG officers. The main events convened by IAG were the IAG Scientific Assembly in August 2005 in Cairns, Australia and the symposia on the occasion of the General Assembly in Perugia.

The results of the IAG Scientific Assembly have been published by Paul Tregoning and Chris Rizos (eds.) in Volume 130 of the IAG Symposia Series. The contributions are arranged in nine parts (following the structure of the symposium). Part 1 contains joint papers of IAG and IAPSO, part 2 deals with the frontiers in the analysis of space geodetic measurements, Part 3 with gravity field determination, Part 4 with Earth processes, Part 5 with reference frames, Part 6 with the GGOS, Part 7 with airborne mapping etc, Part 8 with atmospheric sounding using space geodetic techniques, and Part 9 with "geodesy of the planets". The volume contains more than 900 pages and documents the rich scientific harvest of the symposium. Paul Tregoning, Chris Rizos and the reviewers of the contributions must be congratulated for the very efficient editing process.

In Perugia IAG was convening the IUGG symposium on global Earth observing systems, co-convening four joint symposia (two with IAPSO, one with IASPEI and IACVEI, and one with IAMAS, IAPSO, IAHS). Four IAG symposia were related (as usual) to the work performed in the four commissions, one was devoted to GGOS. All IAG symposia were co-convened by the ICCT.

Relationships to other Scientific Organizations

IAG is one of seven (from 2007 onwards eight) Associations of the IUGG. The associations are: IAG, IAGA (Geomagnetism and Aeronomy), IAHS (Hydrological Sciences), IAMAS (Meteorology and Atmosphere Sciences), IAPSO (Physical Sciences of the Ocean), IASPEI (Seismology and Physics of the Earth Interior), IAVCEI (Volcanology and Chemistry of the Earth‘s Interior). The new association, approved by the IUGG Council at the 2007 General Assembly is the IACS (International Association of Cryospheric Sciences).

Inter-Association Symposia, common projects, etc., are frequent and mutually beneficial. Let me repeat in particular that the IAG/IAPSO Scientific Assembly 2005 “Dynamic Planet 2005” was a highlight for both associations. IAG is a member of the Joint Board of the Geospatial Information Societies (JB-GIS) together with FIG, ISPRS (International Society of Photogrammetry and Remote Sensing), ICA (International Cartographic Organization), IHO (International Hydrological Organization), and IMTA (International Map Trade Organization).

The JB-GIS normally meets on an annual basis, where the meeting places and dates coincide with one of the member organizations’ major assemblies. The relationship represented by the JB-GIS is important for IAG and should be continued on the level of the presidents or the secretaries general in future, as well.

From the point of view of the Association the relationship with FIG and ISPRS are of particular importance. The relations between FIG and IAG are defined in the document “Liaison between the FIG and the IAG”, where the latest update stems from 2006.IAG was officially represented at all major FIG conferences and working weeks in the time period 2003-2006 (the joint IAG / FIG Symposium in October 2006 in Munich was already mentioned). I am personally indebted to Prof. Holger Magel (FIG President 2003-2006) and Matt Higgins (FIG Vice-President 2007-2010) for their personal engagement to further the good relationship between our organizations from the FIG side.

GEO was established by a declaration of 33 nations plus the European Commission during the Earth Observation Summit held in Washington, DC, on July 31, 2003. Since May 2004 IAG is a so-called participating organization of GEO. The IAG Executive Committee decided that GGOS should act on behalf of IAG in GEO. The IAG plays a very active role to help developing the GEOSS (GEO System of Systems) and the GEO 10-Year Implementation plan. More information about this issue and the link to IGOS, UNESCO‘s Integrated Global Observing Strategy may be found in the GGOS report.

Developing Countries

The IAG Committee of Developing Countries was co-chaired by Charles Merry and Luiz Fortes, where Charles Merry mainly focused on activities in Africa, Luiz Fortes on activities in South America.

The activities initiated by the AFREF (African Geodetic Reference Frame) are recognized as important and they are supported by IAG to the extent possible. The AFREF was conceived as a unified geodetic reference frame for Africa to be the fundamental basis for the national and regional three-dimensional reference networks fully consistent and homogeneous with the International Terrestrial Reference Frame (ITRF). When fully implemented, AFREF will consist of a network of continuous permanent GPS stations such that a user anywhere in Africa would have free access to GPS data and products and would be at most 1000 km from such stations. IAG and FIG are strong supporters of AFREF.

SIRGAS (Sistema de Referencia Geocentrico para Las Americas) is of vital importance for the wider region of Latin America. A concentrated effort was made in the 2003-2007 period to integrate Central America and the Caribbean into the SIRGAS activities. IAG is giving continued support to SIRGAS activities, e.g., by sponsoring meetings.

Whereas IAG is pleased with the encouraging developments in Africa and South America, it is also aware of the fact that similar activities should be extended to other parts of the world. Much remains to be done in this field.

Congratulation

Dr. Irene K. Fischer (USA), a pioneer in geoid studies for application to defence and space programs in connection with the development of a unified world geodetic system celebrated her hundredth birthday in 2007. The IAG General Assembly wishes to thank Irene K. Fisher for significant contributions to the field of geodesy and congratulates her for having completed hundred revolutions around the Sun in 2007! The first session of the Symposium GS001 was devoted to Irene K. Fisher. Hermann Drewes, chairing this session, briefly reviewed her achievements when opening the session.

Concluding Remarks

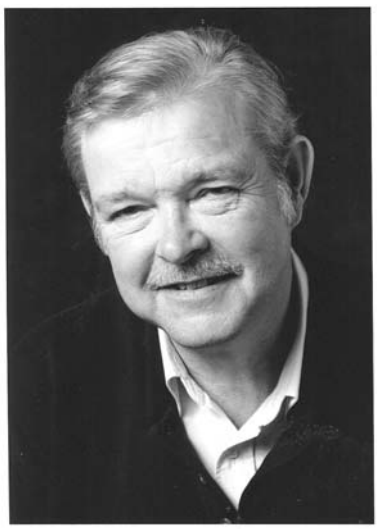
I would like to thank the IAG General Secretary Christian Tscherning, the IAG Vice-President Michael Sideris, the IAG Executive Committee, all IAG officers and the entire IAG community for their never ending work (at times hard labour) for IAG and for me personally in the past Period. It would be impossible to keep an Association like IAG running without the invaluable contributions of so many dedicated individuals and the support of so many institutions contributing, e.g., to the IAG services. We should never forget that IAG is based to a great extent on voluntary contributions and we should be grateful that with these contributions to geodesy could be established under the IAG flag as a modern branch of science. Speaking of the IAG "flag": A few days ago the new IAG logo was approved by the IAG Executive Committee. It would be a pleasure to see it in future on many presentations and on the occasion of many scientific conferences.

Let me conclude on a personal note: I had the honour of being deeply involved in IAG affairs since the IUGG General Assembly 1991 in Vienna, when I was appointed as Chairman of the IGS Campaign Oversight Committee – a rather rough start of my life in the Association. It was probably the most important decision in my IAG career to let IGS operations continue after the IGS Test Campaign in fall 2002, The decision to continue was, by the way, a clear case of insubordination, ignoring the directives of the IAG Executive. This bad behaviour did, however, not help me to escape the administrative work in IAG. After many years of service I intend to spend the last part of my professional life (hopefully mainly) with scientific issues – with one exception: I offered to continue serving as representative of the IAG President on the IGS Governing Board for a few more years. I am thus going "back to the roots". Let me finally thank you all, friends, colleagues, and favourite enemies (to quote my wife Ruth), for a most enjoyable chapter of my life!

Levallois Medal Citation for Carl Christian Tscherning

Laudatio

Fernando Sansò, Honorary President



Carl Christian Tscherning

Jean Jacques Levallois was a great geodesist; both a great scientist (just remember his book and the European height datum ED50) and a great organizer (he had been IAG Secretary General for sixteen years). To honour him, IAG has been awarding a medal in his name, either for outstanding scientific merit or for exemplary service to the Association. This year, one can hardly find any colleague meeting these qualifications better than Carl Christian Tscherning. Christian has been working for decades on the scientific side, making it possible to apply in practice a difficult theoretical idea of Moritz and Krarup in gravity field estimation. He expanded the theoretical basis of least-squares collocation and implemented it into a piece of software (GEOCOL), which has been enormously influential and widely used by the geodetic community. At the same time, he has served the Association as Editor-in-Chief of Bulletin Géodésique for eight years and then as the Secretary General for another twelve years.

We are therefore fully convinced that IAG's choice for the Levallois medal this year will not only honour J.J. Levallois but also inspire the younger generation of geodesists to follow his example, just as Carl Christian Tscherning has done so well.

Answer by the recipient of the Levallois Medal 2007, C. C. Tscherning, to the Laudatio by F. Sansò

I am very pleased to receive the Levallois Medal, and I want to use this opportunity to describe an incident related to J. J. Levallois and myself during the General Assembly in Grenoble in 1975. At that time copies of papers were delivered by hand or mailed to the Secretary General, i.e. Levallois, with address at the General Assembly. The many stacks of papers were stored in the office of the Secretary General and distributed after the paper had been presented.

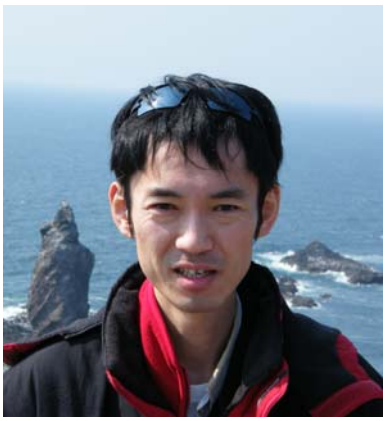
This procedure made me (at that time 33 years old) very angry, because I wanted to read the papers before the presentation, so that I could comment (criticize) on the presentation. I complained, and said youthfully to Levallois that this was very badly organized. He got mad at me and said: "When you one day become Secretary General, you can try to do better".

Now, today I must say that nobody could have done better than Levallois neither administratively as Secretary General nor as a geodetic scientist. It is therefore a special pleasure for me to receive the medal which carries his name.

C. C. Tscherning

Guy Bomford Prize Acceptance Speech

Masato Furuya



Masato Furuya

IAG President Beutler, Ladies and Gentlemen:

It is a great honour to receive the 2007 Guy Bomford Prize. I express my sincere gratitude to the Central Bureau of IAG, Shuzo Takemoto, John Wahr, and all others not only in Japan but also in the world who took the time to present this prize to me. My research has been focused on the geodetic measurements of geodynamic phenomena and their geophysical interpretations. I was really fortunate to have been in the right place at the right time to take advantage of both ground-based and space-borne modern geodetic techniques. Nonetheless, it is only the numerous suggestions, criticisms, and the inspirations, I received from my mentors and colleagues along with dedicated efforts, that have enabled me to conduct exciting research and to be worthy of this prestigious prize today.

I understand that this prize has been awarded in recognition of my contributions during the previous four years. But I think I should begin with mentioning my days as a graduate student. I enrolled in geodesy, owing to my interests in the variations in the Earth's rotation. This interest was sparked by a hypothesis proposed by Yozo Hamano, my mentor at the Department of Geophysics, University of Tokyo, in early 90s. According to his hypothesis, the length-of-day changes resulting from climate change could perturb the fluid motion in the outer core, and thereby alter the geomagnetic field. Although this idea was in contrast with what had been generally believed, I was very much impressed with the theory, and the interdisciplinary nature of the Earth's rotation. Although Prof. Hamano is known to be a specialist for paleomagnetism, I am aware of his dislike of such a reference to himself, and instead of pushing me toward geomagnetism, he generously introduced me to Isao Naito, another empathetic teacher at the National Astronomical Observatory, Mizusawa. I was even more fortunate to meet and collaborate with Ben Chao at NASA/Goddard (now at National Central University, Taiwan), which was a fantastic experience for me. Both Prof. Hamano and Prof. Naito have been constantly insisting on the Earth system science, that does not belong to any traditional disciplines but instead should be tackled from a broader perspective. I am sympathetic to this philosophy. I believe that modern geodesy has been increasingly extending the spatial and temporal scope of its application, thereby enlarging our perspectives on the state and evolution of the Earth system.

In 1999, I was appointed as a member of Shuhei Okubo's group at the Earthquake Research Institute, University of Tokyo. I have been expected to perform InSAR as well as some ground-based gravity measurements for earthquake and volcano studies. Due to the generous supports of Prof. Okubo, I was soon able to generate interferograms. However, a pivotal event in my career took place in 2000 – the caldera collapse and associated eruptions and earthquakes on and around the Miyakejima volcano island. Due to the persistent efforts and leadership of Prof. Okubo and the participation of Wenke Sun, we were able to exploit both the FG5 absolute gravimeter and LaCoste & Romberg G-type gravimeters, and detect spatial-temporal gravity changes associated with the magma movement. The gravity change data provided compelling evidence of significant density changes associated with the caldera collapse. Although we were unable to apply InSAR during the eruption event due to problems related to vegetation, the Geographical Survey Institute in Tsukuba – which operates nationwide GPS network – had four of them working at Miyakejima at the time. GSI also extensively carried out airborne photogrammetry to monitor the rapid changes in topography. We are greatly indebted to those data in our geophysical modeling.

Another turning point was my two years' stay at the University of Colorado at Boulder. In parallel with InSAR data analysis and the modeling of volcano deformation, I collaborated with John Wahr, Karl Mueller, Roger Bilham and another visitor – Sripati Satyabala – who was from India. John and his collaborators have been conducting GPS and gravity measurement in Greenland, but there were only a couple of continuous GPS receivers. Although both John and I understood that it would be challenging to detect a long-wavelength signal using InSAR, which was indeed the case, a lucky chance helped us to find unloading ground deformation due to an ice-burst flood episode at one lake. Karl is an expert in structural geology, and Karl and John suggested that I apply InSAR to Canyonlands National Park, Utah, where no continuous GPS measurements are conducted. Fortunately we were able to detect the active salt tectonic motion in the park, although its amplitude is only a couple of millimetres per year. Nevertheless, we confirmed that the precision of the InSAR measurements would be in sub-millimetre per year, depending on the prevailing conditions.

Roger and Satyabala have been researching crustal deformation in central Asia for years, and a chance meeting with them opened my eyes to the possibilities in that area. The interdisciplinary collaboration definitely helped me to further expand my perspectives regarding the Earth system. I would like to thank my collaborators at CU Boulder for providing me with excellent opportunities and making my years in the US fabulous and productive.

The Earth system is not as simple as a so-called "complex system" that is tackled by some modern physicists. It has infinite degrees' of freedom with multiple phases and chemical components, and is appallingly complicated. In order to better understand the state of the Earth system, we should not remain confined to any specific phenomenon and/or techniques. However, it appears to be impossible for one individual to carry out such studies. Therefore, interdisciplinary collaborative efforts will be crucial for the advancement of Earth system science, and in this regard modern geodesy will undoubtedly play an indispensable role owing to its multidisciplinary nature. There still remains plenty of scope for improvement in modern geodesy, not only in terms of measurement techniques but also in terms of modeling the data produced by these techniques. However, I am certain that geodesy will continue to provide us with breakthroughs and discoveries for many years to come.

In addition to the people I mentioned earlier, I would like to thank Taizo Yoshino, Tetsuro Kondo, and friends at the former Communications Research Lab; Urs Wegmuller and Charles Werner at Gamma Remote Sensing; Tim Niebauer and colleagues at Micro-G-LaCoste. I also thank ESA, CSA, and JAXA for their acquisition of excellent SAR data, and I appreciate NASA/JPL for making the excellent digital elevation model publicly available. I have acknowledged all of those I wish to share credit with. Last but not least, I would like to thank my family.

Thank you very much.

Report of the IAG Secretary General

C. C. Tscherning

The Secretary General of the International Association of Geodesy is pleased to submit to the XXIVth General Assembly his report on the activities of the Association for the period between the XXIIIrd and the XXIVth General assemblies.

1. Administrative Activities of the Association

1.1 Central Bureau Activities

Since the adoption of the new statutes and by-laws at the Sapporo General Assembly, IAG has both National Members and individual (personal) members. A main function of the Central Bureau is now related to the contact with these personal members. The Central Bureau maintains and updates a database of addresses of individual members and it keeps track of their membership fees. It maintains the accounts related to the IUGG allocation.

The function of the Central Bureau has changed due to the establishment of a Communication and Outreach Branch which since November 2003 publishes a monthly Newsletter, maintains the IAG home-page (*http://www.iag-aig.org*) and promotes IAG and geodesy as such.

The Geodesists Handbook, 2004, edited by Dr. O.B. Andersen was published. (Journal of Geodesy, Vol. 77, no. 10 – 11 April 2004).

1.2 The Executive Committee (EC)

The EC met 2004 in Nice, in 2005 in Cairns, Australia, in connection with the IAG Scientific Assembly, 2006 and 2007 in Vienna, Austria, in connection with the EGU General Assembly.

1.3 IUGG/IAG General Assembly, July 2003, Sapporo, Japan

The IAG General Assembly 2003 in Sapporo was considered to be too long, which is why IAG reduced its own program to only 4 + 4 weekdays. This program covered presentations of reports and scientific papers for the five IAG Sections in the seven first days; the last day was devoted to a symposium on IGGOS. The section symposia were reviewed and have been published in the IAG Symposium Series by the Springer Verlag. All the national reports had been published before the General Assembly in the "Travaux de l'Association Internationale de Géodésie", on a CD-ROM.

The national reports were distributed at the IAG general assembly. Many of them were available in electronic form. They are now available through links on the IAG homepage.

1.4 Individual Membership

With the new statutes and by-laws individual membership has been introduced. The individual members receive a newsletter and they have various other benefits. The membership fee is USD 50, with a discount of 1 year, if the membership fee is paid for 3 (4) years. Institutions may pay the institutional membership fee for a number of co-workers. Students and retired colleagues do not have to pay the membership fee, provided that they were able to receive the IAG newsletter by e-mail. By the end of the year 2006 260 scientists had signed up as IAG members, of which about 150 paid the regular membership fee.

1.5 Communication and Outreach.

Based on two responses to a call for participation the EC decided to establish the new COB under the leadership of Prof. Joseph Adam at the Budapest University of Technology and Economics. The COB has established a modern web-page: *http://www.iag-aig.org* and prepares material for the promotion of IAG activities. Part of the information is password-protected and only available to the individual members.

1.6 Scientific Meetings

The list of meetings sponsored or organized by IAG is given in Appendix A.

2. Finance

The financial report for the period 2003-2007 is presented in Appendix B. The following comments may be added:

2.1 Receipts

The receipts were stable from the subvention point of view. The contribution from the membership fee is important, as is the income from the "head charge" per participant (at both the Sapporo and Cairns meetings). It has been possible to spend more on travel grants than budgeted due to savings on the administration.

2.2 Expenditures

The expenditures were close to what was predicted with minor differences. A significant increase of travel support for scientists (primarily young and from a developing country) was possible due to the income from the membership fee and the head charge.

2.3 Budget 2007-2010.

The budget for the following period was approved by the Council 9 July 2007 and is found in Appendix C.

3. Educational Activities

A number of workshops and schools have been organized:

- IAG-IASPEI Joint Capacity Building Workshop, 17 – 23 January 2005, Miramare-Trieste, Italy.
- The "School on the determination and use of the geoid", was conducted first in Budapest, Hungary in February 2005 and then in June 2006 in Copenhagen, Denmark.
- A Geoid School for our colleagues of French tongue took place 27 June – 1 July in France.
- "Summer School on Microgravimetric methods: static and dynamic aspects", 23 – 28 October 2005 in Lanzarote, Canary Islands, Spain.

4. Conclusion and Outlook

This report is the third and last prepared by the current Secretary General, now having functioned in three periods as Secretary General of IAG.

The IAG is in a healthy state with respect to its economy and organization. The establishment of the Communication and Outreach Branch has been successful and the number of individual members has reached a satisfactory number. However more funds will needed in order to support e.g. the GGOS activities and travel grants for young scientists.

Sincere thanks to the Presidents and EC members I have worked with and to all active in IAG. Also thanks to the Central Bureau secretaries, Mrs. Henriette Hansen, Mrs. Christina Schneider Petersen and Mr. Emil Enemærke as well as to the Niels Bohr Institute, University of Copenhagen.

Appendix A

IAG organized or sponsored Meetings:

- 10 Years IGS Workshop and Symposium, 1 – 5 March, 2004, Berne, Switzerland.
- Second International GOCE User Workshop, "GOCE, the Geoid and Oceanography", ESA-ESRIN, Frascati (Rome), Italy, 8 – 10 March 2004. (IAG Sponsored).
- 14th EUREF Symposium of the IAG Sub-commission for Europe, 2 – 5 June 2004, Bratislava, Slovakia and the 15th EUREF Symposium, 1 – 4 June 2005 in Vienna, Austria. The 16th EUREF Symposium, 14 – 17 June 2006, Riga, Latvia.
- 1st FIG International Symposium on Engineering Surveys for Construction Works and Structural Engineering, Nottingham 28 June – 1 July 2004. (IAG Sponsored).
- 15th International Symposium on Earth Tides, 2 – 6 August 2004, Ottawa, Canada.
- Gravity, Geoid and Space Missions – GGSM2004, 30 August – 3 September 2004, Porto, Portugal
- XII General Assembly of the WEGENER Project, 21 – 23 September 2004, Tangier, Morocco and
- XIII Assembly, 4 – 7 September 2006, Nice, France.
- International Workshop on "Deformation and Gravity Change: Indicators of Isostacy, Tectonics, Volcanism and Climate Change", Lanzarote, Canary Islands, Spain. 2004.
- International Symposium on Geodetic Deformation Monitoring, from geophysical to engineering roles, 17 – 19 March 2005 in Jaen, Spain.
- IAG/IAPSO Scientific Assembly "Dynamic Planet 2005", 22 – 26 August 2005 in Cairns, Australia.
- 7th Conference on optical 3-D measurements took place 3 – 5 October 2005 in Vienna, Austria.
- 3rd IAG Symposium for Geodetical and Structural Engineering and 12th FIG Symposium on Deformation Measurements, 22 – 14 May 2006, Baden, Austria.
- VI Hotine-Marussi Symposium of Theoretical and Computational geodesy: Challenge and role of modern geodesy. 29 May – 2 June 2006, Wuhan, PR China.
- Int. Workshop "Height Systems, Geoid and Gravity of the Asia-Pacific", 6 – 8 June 2006, Ulaanbaatar, Mongolia.

- Understanding Sea-level rise and variability WCRP Workshop, 6 – 9 June 2006, Paris, France (IAG Sponsored).
- AFREF Technical Workshop, 9 – 13 July 2006, Cape Town, South Africa.
- International Workshop on quality improvement and coastal-land applications of satellite altimetry, 21 – 22 July 2006, Beijing, PR China. "Gravity Field of the Earth".
- 1st Int. Symposium of the IGFS, 28 August – 1 September 2006, Istanbul, Turkey.
- Symposium "Geodetic Reference Frames", GRF2006, 9 – 13 October 2006, Munich, Germany.

Appendix B:

International Association of Geodesy
Financial Report for the period: 1.1.2003-31.12.2006

11.8	Administration, Meetings (EC, Bureau)	5.418,28	6.2	Interest	80,81
11.9	Administration, Representation	1.069,90	6.3	Others	57.424,61
11	**Administration:**	2.731,12	15	IUGG Allocation	132.761,07
13	Assemblies	33.996,29	6.7	Payments for EGG-97 CD	2.310,20
18.2	Bank charges	1.671,53	7	Total receipts	**192.576,69**
16.2	Best Paper Award	3.064,32	12.1	Proceeding Assemblies	4296,45
16.1	Bomford prize	2.000,00	14.1	Refund of grants not spend 2005	15179,09
11.4	Communication	6784,15	5	Sale of Publications	0,00
	Results for	**the period of 1.1 2003-31.12.2006**			
	Expenditures			**Receipts**	
18.5	Expenses IAG Fund	-			
18.4	Geoid School	3.473,85			
16	Grants (Permanent Services, etc.)		6.14	Geoid School	**3.501,52**
18.3	Loss on exhange	340,99			
11.6	Micellaneous	11.868,89	6.1	Gains on exchange	8.388,58
18.6	PBS Internatinal (fee)	2.878,51			
12	Publications	24.544,46	6.6	Rio fees and Rio Proceedings	178,11
11.2	Quaters	3.003,00	3	Other Grants	4.977,33
14	Symposia & Scientific meetings:		6.8	Sale of IGeS Lecture Notes and CD	185,10
14.1	Symposia & Scientific meetings: organi	80.545,14	6.9	Michellaneous, Membership Fee	24.597,40
14.2	Symposia &Scientific meetings: travel	11.083,08	6.12	Receipt of IAG Fund	6.886,00
	Total	**91.628,22**		**Total**	**1.502,58**
19	Total Expenditures	**279.613,55**			
11.5	Travel	8.514,42	6	Miscellaneous receipts:	
				Surplus	-8.329,32

	Balance 2006				
	Assets			**Liabilities**	
20	Bank 31.12.2006	88.138,93		Net Capital	83.161,60
				Deposit IGS	4.977,33
22	**Total**	**88.138,93**	**10**	**Total**	**88.138,93**

	Net Capital 2006			
			Open 1.1.2003	30.360,59
	Balance 31.12.2002	30.360,59	Surplus 31.12.2006	0,00
		30.360,59		**30.360,59**

Appendix C:

International Association of Geodesy
Budget for the period: 1.1.2007-31.12.2010

	Budget for the period			1.1.2007-31.12.2010	
	Expenditures			**Receipts**	
11	**Administration:**	40000	15	IUGG Allocation	100000
12	Publications	39000	3	Other Grants	5000
13	Organization	30000	5	Sale of Publications	25000
14	Symposia & Scientific meetings (Grants, etc.	80000	6	Miscellaneous receipts:	14000
16	Grants (Prizes, Permanent services ect.)	8000	6.11	Membership fees	25000
18	Miscellaneous (inc. IGS 4977)	10000	6.12	Receipt of IAG Fund	4000
19	Total Expenditures	207000	7	Total receipts	173000
				Deficit	34000
	Total	207000		**Total**	207000

	Balance 2010			
	Assets			**Liabilities**
20	Bank 2010.12.31	54000		Net Capital	54000
22	**Total**	**54000**		**Total**	**54000**

	Net Capital 2010			
				Open 1.1.2006	88000
	Balance 31.12.2010	54000		Deficit 31.13.2010	34000
		54000			**54000**

All amounts in USD

Summary of the IAG Council and Executive Committee Meetings during the XXIV IUGG General Assembly in Perugia, Italy, July 2007

Compiled by **Hermann Drewes**, IAG Secretary General

There were two IAG Council Meetings and three IAG Executive Committee Meetings held during the XXIV IUGG General Assembly in Perugia, Italy. The minutes of these meetings were published in the IAG Newsletter July 2007 in the IAG Homepage and in the Journal of Geodesy. In the following we give a short summary of the meetings.

The IAG Council Meetings took place on July 2 and July 9, 2007. The following member countries were represented:

- Argentina (Maria Cristina Pacino),
- Australia (Will Featherstone),
- Austria (Harald Schuh, Christoph Twaroch),
- Belgium (Véronique Dehant),
- Bosnia Herzegovina (Medzida Mulic),
- Brazil (Denizar Blitzkow),
- Canada (Spiros Pagiatakis),
- Chile (Rodrigo Maturana),
- China (Yamin Dang),
- Colombia (William Martinez),
- Czech Republic (Petr Holota),
- Denmark (Niels Andersen),
- Germany (Jürgen Müller),
- Estonia (Artu Ellmann),
- Finland (Markku Poutanen),
- France (Claude Boucher, Pascal Willis),
- Hungary (József Ádám),
- India (V. M. Tiwari),
- Indonesia (Hasanuddin Z. Abidin),
- Israel (Gilad Even-Tzur),
- Japan (Shuhei Okubo),
- Luxembourg (Niw Schares),
- Mongolia (guest: Mijiddorj Saandar),
- New Zealand (Donald Grant),
- Nigeria (C. U. Ezeigbo),
- Norway (Bente Lilja Bye),
- Poland (Jan Krynski),
- Portugal (Joao Agria Torrres),
- Romania (Lucian Besutiu),
- Russian Federation (Michail Prilepin),
- Slovak Republic (Ladislar Brimich),
- South Africa (Aslam Parker),
- Spain (Miguel Sevilla),
- Sweden (Lars Sjöberg),
- Switzerland (Beat Bürki, Adrian Wiget),
- Turkey (Ali Kilicoglu, Bahadir Aktug),
- UK (Alan Dodson),
- USA (Jeff Freymueller, C K Shum).

In addition, several members of the IAG Executive Committee assisted the meetings:

- Ole B. Andersen, Gerhard Beutler, Veronique Dehant, Hermann Drewes, Chris Jekeli, Steve Kenyon, Charles Merry, Chris Rizos, Markus Rothacher, Fernando Sansó, Michael Sideris, Carl Christian Tscherning.

Main topics of the agenda were:

- Organization of the IAG Symposia and meetings during the XXIV General Assembly,
- Appointment and report of the Audit Committee (see annex 1),
- Appointment of the Resolution Committee and adoption of Resolutions (see report in this volume),
- Proposal and approval of the IAG Budget 2007 – 2011 (see Report of the Secretary General, Appendix C, this volume),
- IAG Awards: Levallois Medal and Bomford Price (see reports in this volume),
- Review of election procedures and new IAG EC members,
- Change of Statutes and Bylaws (see annex 2),
- Venue of the Scientific Assembly 2009,
- Approval of continuation or establishment of new Inter-Commission Committees and Association Projects,
- Election of Honorary Secretary General.

The IAG Executive Committee for the period 2003-2007 met on July 2, July 4, and July 6, 2007. The following members were present:

- Gerhard Beutler (President), Carl Christian Tscherning (Secretary General), Michael Sideris (Vice-president), Hermann Drewes (President of Commission 1), Chris Jekeli (President of Commission 2), Veronique Dehant (President of Commission 3), Chris Rizos (President of Commission 4), Luiz Paulo Fortes and Charles Merry (Members at Large), Ruth Neilan, Markus Rothacher and Harald Schuh (Services Representatives), József Ádám (President of the COB), Fernando Sansó (Immediate Past President), Klaus-Peter Schwarz (Past President), Steve Kenyon (without vote), Ole B. Anderson (Assistant Secretary General).

Main topics of the agenda were:

- Organization of the IAG Symposia and meetings during the XXIV General Assembly,
- Proposal for members of the Audit Committee,
- Nomination of members of the Resolution Committee,
- New IAG Fellows,
- Result of the IAG elections 2007 and the handling of ties,
- Venue of IAG Scientific Assembly 2009,
- Appointment of IAG representatives,
- Sponsorship of Symposia,
- GGOS Status and Terms of Reference,
- New Statutes and Bylaws (see annex 2),
- New IAG logo,
- Collaboration with FIG and ION,
- IAG Budget,
- Status of Handbook and Travaux,
- Revision of rules for Bomford Prize and Levallois Medal,
- Report of the Committee of Developing Countries,
- Appointment of Commission Vice-Presidents and President of ICCT,
- Journal of Geodesy Editorial Board proposal,
- Audit Committee report (see annex 1),
- Resolution Committee Report,
- ICET proposal.

Annex 1

Audit Report

The Audit Committee performed the following functions

1.1 Examined a random selection of receipt and bank statements of the IAG account for the period January 2003 to December 2006. The final quadrennial report and interim annual reports had been checked by Hans Borge Nielsen, a firm of authorized public accountants.

1.2 Checked the balances appearing in the annual and quadrennial IAG reports.

1.3 Examined expenditure to ensure conformity with the 2003-2007 budget as approved at the IUGG General Assembly in Sapporo in July 2003.

1.4 Made some enquiries that were clarified by C. C. Tscherning (IAG Secretary General) and Emil Enemærke (Niels Bohr Institute).

1.5 Examined the budget for the period 2007-2011.

The Audit Committee makes the following observations and comments on the IAG accounts

2.1 The accounts were generally well presented and all expenditure was supported by receipts and bank statements.

2.2 The two earlier accounts of IAG are now combined into one (in DKK) as recommended by the Audit Committee appointed by the IAG Council in Sapporo 2003.

2.3 The Secretary General has negotiated the bank services as recommended by the former Audit Committee. By choosing an electronic banking service the costs are now considerably reduced. In addition, this solution saves time and thus administrative costs.

2.4 During the review period, the IAG made an operating surplus of approximately USD 53.000. This amount is added to the IAG reserve, leaving reserves of approximately USD 83.000.

2.5 The Audit Committee found that the IAG had a surplus on the average over the 4 year period on approximately USD 13.000 per year. This amounts to less than 10% of the budget which is generally acceptable. The Audit Committee concludes that the budget estimates are being based on the experience accumulated over the years.

2.6 The Audit Committee note that the surplus of 2006 consists of net capital USD 46.732,66 and Other Grants (deposit from IGS) USD 4.977,33 amounting to USD 51.707,99.

2.7 The total net capital is USD 83.161,60 and in the official account is USD 88.138,94. This is due to a deposit from IGS that asked the IAG to solve a practical problem on money transfer.

2.8 The Administrative expenditures were significantly less than budgeted and the expenditures on Symposia and Scientific Meetings were significantly larger than the budget. The expenditure allocated to this last item was devoted to support the attendance of young scientists to symposia and scientific meetings. The Audit Committee finds this priority in line with the general policy of IAG and IUGG.

2.9 There is a significant difference between the budget and the expenditure on Publications that is explained by the change of contract conditions between the IAG and Springer Verlag.

2.10 The Audit Committee noted that no discount was given to IAG members at the IAG Scientific Assembly in Cairns in 2005.

2.11 The inclusion of the proceedings in the registration fee of the Sapporo IUGG General Assembly led to less registered participants directly under IAG. Several IAG members chose to register as IUGG or other associations in order to save money. The consequence of this is the decrease of the IUGG allocation to IAG since it is based on the number of attendees registered as IAG affiliates.

The Audit Committee makes the following recommendations

3.1 In order to ensure compliance with international standards of accounting and auditing, it is recommended to continue with a solution similar to the existing one, namely an official auditing company. The costs of the present services are considered a fair price in the market and must be kept at the present cost level whenever possible.

3.2 The budget for grants to young scientists must increase. Further the IAG should make this focus area more visible also in its accounting system and thus make the necessary administrative changes by adding a new post 14.3 Grants to Young Scientists.

3.3 The IAG should not include the price of the proceedings in the registration fees of meetings in order to keep the number of IAG members registered at the IUGG General Assemblies as high as possible.

3.4 The organizers of the IAG meetings should be encouraged to publish their proceedings by Springer Verlag (ref. 2.9) in order to maintain a series of publications with the IAG label and ensuring a high standard as well.

3.5 In order to save both money and administrative costs the IAG should seize to offer the possibility to use payment by checks.

On behalf of the IAG Council, the Audit Committee has the following acknowledgements and thanks

4.1 Carl Christian Tscherning, IAG Secretary General, for his efficient and cautious administration and management of the IAG Central Bureau.

4.2 The Niels Bohr Institute, University of Copenhagen for administrative and other support, notably the secretariat staff.

4.3 The International Geoid Service (Polytechnic of Milano, Italy) and the University of Hannover for providing the International Geoid School notes and the EGG97 CD-ROM, respectively.

Perugia, July 6, 2007

Bente Lilja Bye, Jan Krynski, Joao Torres

Annex 2

Report of the IAG Review Committee for the Period 2003-2007

In May 2004, the IAG President Gerhard Beutler established the IAG Review Committee by appointing Klaus-Peter Schwarz (Canada) as chairman and Luiz Fortes (Brazil), Don Grant (New Zealand), and Pascal Willis (France) as members of the Committee. Work of the Committee commenced in January 2005 on the following subjects:

- a letter by JoAnn Joselyn, the IUGG Secretary General, pointing out discrepancies between the Statutes and Bylaws of the IUGG and the IAG,
- questions concerning individual membership in the IAG, and
- the question whether the COB director should be appointed or elected.

Discussion of these topics was done by e-mail. By the middle of the year good progress had been made on all three topics, and it was decided that a meeting of the Committee at the IAG Scientific Assembly meeting in Cairns would be useful. Marcelo Santos, who had circulated a discussion paper on the topic of individual membership, was invited to attend the Committee meeting. After some stimulating discussion, it was agreed that

- the concerns expressed by the IUGG Secretary General had been answered,
- direct involvement of individual IAG members was possible in sub- commissions and study groups but not in commissions,
- the procedure for the COB director should closely follow that for the IAG Secretary General, i.e. the director should be elected.

After including these changes into the existing IAG Statutes and Bylaws, a letter was sent to all IAG officers in August 2005 inviting their input into the work of the Committee. With one exception, there was no response to this letter in either 2005 or 2006.

In December 2006 Don Grant proposed that the Committee should consider a major restructuring of the Statutes and Bylaws in order to improve functionality and detect inconsistencies. The members of the Committee were unanimous in supporting the proposal. Don Grant offered to provide a first draft. After a period of intense e-mail interaction, the restructuring was completed in time for the deadline (end of February 2007). The new Statutes and Bylaws were sent to the IAG Secretary General with the request to forward them to the Council members. The document was structured in such a way that the

- proposed new Statutes and Bylaws,
- Statutes and Bylaws as published in the Geodesist's Handbook 2004, and
- reasons for making changes to the 2004 version

were shown side by side in three columns to facilitate comparisons.

This document was also presented to the IAG Executive at its meeting in Vienna on April 16, 2007. Detailed discussions took place and some significant changes were made to the version mailed out in February. The changes recommended by the EC were incorporated as corrections to the February 2007 copy and were forwarded to the Secretary General on June 18, 2007 for distribution to the Council members. This version was presented to the IAG Council at its meetings on July 2 and 9, 2007 during the IAG General Assembly meeting in Perugia, Italy. It was adopted as the July 9 version with a few additional changes made at that meeting and in the final editing. The latter was necessary because of changes adopted on July 9, 2007.

Compared to the 2004 version of the Statutes and Bylaws, the following changes were made to the Statutes:

- Statute 1: Definition of geodesy
- Statute 5: Roles of GGOS and COB
- Statute 6: Membership
- Statutes 6, 7, 12: Roles of Council, Bureau, and Executive Committee
- Statutes 8 to 11: Responsibilities of Bureau members
- Statute 13: Roles of delegates and correspondents

Similarly, significant changes we made to the Bylaws. They are as follows:

- Bylaw 1: GGOS and COB defined as components
- Bylaw 3 to 5: Composition of Component and Commission Steering Committees
- Bylaws 13 & 14: Clarification of the role of the Services
- Bylaw 15: Definition and role of GGOS
- Bylaw 16: Composition of IAG Project Steering Committee
- Bylaw 21: IAG Individual Membership

In addition to the significant changes listed above, a large numbers of minor corrections were made to improve the clarity of the documents and eliminate typing and referencing errors. After the new Statutes and Bylaws had been accepted, a team consisting of P. Willis, F. Barlier, and S. Durand translated the documents into French. Their efficient work is greatly appreciated. A special note of thanks goes to the members of the Review Committee, who put so much time and energy into this task.

October 4, 2007

K. P. Schwarz

IUGG Resolutions

Adopted by the IUGG Council at the XXIV IUGG General Assembly, Perugia, Italy, July 2 – 13, 2007

Resolution 1

Precession, nomenclature, and definition of TDB (Temps Dynamique Barycentrique)

The International Union of Geodesy and Geophysics,

Considering,

That the IUGG adopted in 2003 the International Astronomical Union (IAU) 2000 resolutions related to reference systems; and That the IAU adopted three resolutions in 2006 which are complimentary to the previous IAU2000/IUGG2003 resolutions;

Recognizing,

The importance of reference frame, Earth orientation, and time systems used by the geosciences community;

Endorses,

The 2006 IAU resolution, Resolution B1, which notes that the IAU2000 precession model was not dynamically consistent and recommends that it should be replaced by the P03 precession model; The 2006 IAU resolution, Resolution B2, which, in the first part, deals with the nomenclature related to the intermediate reference systems, while the second part fixes the orientation of the axes of the celestial reference system Barycentric Celestial Reference System (BCRS) and Geocentric Celestial Reference System (GCRS); and The 2006 IAU resolution, Resolution B3, which recommends the use of a fixed linear relation between Temps Dynamique Barycentrique (TDB) and Temps-Coordonnée Barycentrique (TCB), and solves the ambiguity between these time systems.

Resolution 2

Geocentric and International Terrestrial Reference Systems (GTRS and ITRS)

The International Union of Geodesy and Geophysics,

Considering,

The increasing importance of geodetic reference systems in geosciences, and more generally in numerous scientific and technical activities, such as satellite navigation systems and geospatial information;

Noting,

The IUGG Resolution 2 and International Association of Geodesy (IAG) Resolution 1, both adopted in 1991 at the Vienna IUGG General Assembly, which defined the Conventional Terrestrial Reference System (CTRS);

Recognizing,

The quality of the work done by several IAG services (IERS, IGS, ILRS, IVS, IDS) to realize these systems and provide access for numerous users within and beyond the geosciences community;

Endorses

The definition of a Geocentric Terrestrial Reference System (GTRS) in agreement with the 2003 IAU resolution B1.3; The definition of the International Terrestrial Reference System (ITRS) as the specific GTRS for which the orientation is operationally maintained in continuity with past international agreements (BIH orientation); and

Adopts

The ITRS as the preferred GTRS for scientific and technical applications; and

Urges

Other communities, such as the geo-spatial information and navigation communities, to do the same.

Resolution 3

Global Geodetic Observing System (GGOS) of the International Association of Geodesy (IAG)

The International Union of Geodesy and Geophysics,

Recognising,

The great progress made during the last decades in the use of space and ground-based techniques for monitoring the Earth System, and the efforts made towards the integration of geodetic observation techniques, data processing, and evaluation and process modelling; The significant progress of Ian's project Integrated Global Geodetic Observing System (IGGOS) since 2003, which was renamed Global Geodetic Observing System (GGOS) in 2005; That the IAG is represented on the Group on Earth Observation (GEO) by GGOS,; The urgent need to further develop and strengthen the scientific and organizational collaboration of geodesy within geosciences; and The necessity of generation and accessibility of consistent products for users in Earth observation, Earth sciences, neighbouring disciplines and society in general;

Considering,

That, due to the progress of GGOS, the IAG decided to elevate its status from a project to a full component of IAG in order to further realize the IUGG Resolution No. 1 adopted at the 22nd General Assembly in Birmingham and the IUGG Resolution No. 3 at the 23rd General Assembly in Sapporo;

Noting,

The new structure of IAG reflected by the designation of GGOS as a permanent component;

Urges,

Sponsoring organizations and institutions to continue their support of the elements of GGOS, which is crucial for sustaining long-term monitoring and understanding of the Earth System; and

Encourages,

The Associations to support further development of GGOS through participation and cooperation by sharing/providing data, models, products, and expertise useful for GGOS, and to establish close links with GGOS through the relevant components in their structure, and to assist in symposia, meetings, and joint activities.

Resolution 4

Electronic Geophysical Year, 2007-2008 (edgy) and Data Rescue

The International Union of Geodesy and Geophysics,

Noting,

The ability of modern information and communications technologies to revolutionize the science and management of data and information; The growing recognition of the need for, and the benefits of a science information commons; The urgent need to rescue and store data at risk of being lost; and That 2007-2008 is the 50-year anniversary of the International Geophysical Year, which pioneered the concept of international cooperation and sharing of data and information about the Earth for the common good;

Urges,

The funding agencies to support the effort to rescue valuable historical data; and

Encourages,

Scientists and their scientific bodies worldwide to use the occasion of the Electronic Geophysical Year, 2007-2008 to undertake activities to improve data access, data preservation, data discovery, data release, education and outreach, to reduce the digital divide, and to sign the edgy Declaration for an Earth and Space Science Information Commons[1].

Resolution 5

Ionosphere Satellites

The International Union of Geodesy and Geophysics,

Noting,

The ability of low Earth orbiting satellites to provide spatial and temporal monitoring of the topside ionosphere and to define the near-Earth environment;

Recognizing,

That an extended time series of satellite observations of magnetic/electric fields and of plasmas in the Earth's ionosphere

are crucial for a wide spectrum of geoscience and space science studies;

The unique equatorial orbiting Italian Space Agency satellite ESPERIA; and

[1] http://www.egy.org/declaration.html

Understanding,

That the DEMETER mission will end in 2008;

Welcomes,

The plans by several nations to launch Ionospheric monitoring satellite missions.

Resolution 6

The Urgency of Addressing Climate Change

The International Union of Geodesy and Geophysics,

Considering,

The advances in scientific understanding of the Earth system generated by collaborative international, regional, and national observations and research programs; and The comprehensive and widely accepted and endorsed scientific assessments carried out by the Intergovernmental Panel on Climate Change and regional and national bodies, which have firmly established, on the basis of scientific evidence, that human activities are the primary cause of recent climate change;

Realizing,

Continuing reliance on combustion of fossil fuels as the world's primary source of energy will lead to much higher atmospheric concentrations of greenhouse gases, which will, in turn, cause significant increases in surface temperature, sea level, ocean acidification, and their related consequences to the environment and society; Stabilization of climate to avoid "dangerous anthropogenic interference with the climate system", as called for in the UN Framework Convention on Climate Change, will require significant cutbacks in greenhouse gas emissions during the 21st century; and Mitigation of and adaptation to climate change can be made more effective by reducing uncertainties regarding feedbacks and the associated mechanisms;

Urges,

Nations collectively to begin to reduce sharply global atmospheric emissions of greenhouse gases and absorbing aerosols, with the goal of urgently halting their accumulation in the atmosphere and holding atmospheric levels at their lowest practicable value; National and international agencies to adequately support comprehensive observation and research programs that can clarify the urgency and extent of needed mitigation and promote adaptation to the consequences of climate change; Resource managers, planners, and leaders of public and private organizations to incorporate information on ongoing and projected changes in climate and its ramifications into their decision-making,

with goals of limiting emissions, reducing the negative consequences of climate change, and enhancing adaptation, public well-being, safety, and economic vitality; and

Organizations around the world to join with IUGG and its member Associations to encourage scientists to communicate freely and widely with public and private decision-makers about the consequences and risks of on-going climate change and actions that can be taken to limit climate change and promote adaptation; and

Resolves,

To act with its member Associations to develop and implement an integrated communication and outreach plan to increase public understanding of the nature and implications of human-induced impacts on the Earth system, with the aim of reducing detrimental consequences.

Resolution 7

Intensified Study of Aerosol Pollution Effects on Precipitation

The International Union of Geodesy and Geophysics,

Welcoming,

The comprehensive and peer reviewed report "Aerosol Pollution Impact on Precipitation, A scientific Review" that provides an indepth study of the relationship between aerosol pollution and precipitation, called for by the IUGG XXII General Assembly in Sapporo and the WMO Congress CgXIV in Geneva, and prepared by the International Aerosol-Precipitation Scientific Assessment Group (IAPSAG);

Considering,

That aerosol pollution resulting from biomass burning, fossil-fuel burning, and wild fires can significantly alter precipitation and its distribution; That the changes in precipitation that can occur depend on the characteristics of aerosol pollution and the geographic and meteorological situations; and That changes and re-distribution in precipitation have significant societal and economic impacts; and

Noting,

That the recommendations of the review mentioned above call for actions by international bodies, individual governments, and the scientific community at large;

Invites,

WMO to join with IUGG and form an Aerosol-Precipitation Project Group charged with converting the recommendations of the Review into an international action plan; WMO to join with IUGG in approaching the Food and Agricultural Organization (FAO) and other international organizations to join the IUGG/WMO efforts and participate in the planning;

Encourages,

IAMAS, IAHS, and other IUGG Associations, in collaboration with WMO, to continue their efforts to improve understanding of aerosol pollution with the goal of moderating adverse effects; and

The scientific community to study the direct impacts of aerosol pollution on precipitation and global and regional precipitation climate.

Resolution 8

Reduction of Risk from Natural Hazards

The International Union of Geodesy and Geophysics,

Considering,

Global, regional, and local increases of vulnerability and all changes of environmental conditions including climate; and The continuous increase of fatalities, the number of people affected, and property damage caused by natural events;

Realizing,

That climate changes will continue into the future even with decreasing greenhouse gas emissions; That disaster reduction, management, and preparedness as well as warning systems need long term planning; and That reducing the impact of disasters should be carried out mainly at the local level;

Urges,

The international science community to quantify natural hazards and extreme events at all scales; To adopt integrative and comprehensive interdisciplinary approaches towards developing adaptation in order to decrease vulnerability; and To produce planning tools for disaster risk reduction at all scales.

Resolution 9

Thanks

The International Union of Geodesy and Geophysics,

Gratefully records its appreciation for the organization, arrangements, and hospitality at the XXIV General Assembly. On behalf of all participants, the Council expresses its warm thanks to the Italian National Committee for IUGG, the University of Perugia, the Local Organizing Committee, the Program Committee, and all others for their efforts to make the XXIV General Assembly a scientific success in the beautiful city of Perugia.

IAG Resolutions

Adopted by the IAG Council at the XXIV IUGG General Assembly, Perugia, Italy, July 2 – 13, 2007

Resolution 1

Gratitude to the Host Institution of the Central Bureau

The International Association of Geodesy,

acknowledging

the hosting of its Central Bureau at the Niels Bohr Institute (NBI) of the University of Copenhagen from 1996 to 2007,

thanks

(i) the NBI for the excellent support it provided, as well as

(ii) the Assistant Secretary General, Ole Andersen, and

(iii) the secretaries Mrs. Henriette Hansen, Mrs. C.S. Petersen, Mrs. Anni Pallesen and Mr. E. Enemærke for their outstanding work over the years.

Resolution 2

Placing Laser Retro-reflectors on Satellites of the Global Navigation Satellite System

The International Association of Geodesy,

noting

(i) the extensive and accelerating use over the past 15 years of the Global Navigation Satellite System, GNSS, (i.e., United States' Global Positioning System (GPS) and the Russian GLONASS) and the anticipated future use of new GNSS (i.e., European Galileo and China's COMPASS);

(ii) the societal benefits increasingly derived from the integration of the space-geodetic observations within the Global Geodetic Observing System (GGOS), including GNSS, Satellite Laser Ranging (SLR), Very Long Baseline Interferometry (VLBI), Doppler Orbitography Radiopositioning Integration by Satellite (DORIS); and

(iii) the essential contribution of the integration of the techniques to the multidisciplinary scientific advances, including the establishment and maintenance of an accurate and stable terrestrial reference frame,

recognizes

(i) the improved inter-technique calibrations and validation needed for the demanding geodetic accuracy to achieve a high-accuracy reference frame to support positioning, navigation, and timing; and

(ii) the resulting improvement in our understanding of the Earth system dynamics, including geohazards, ice and ocean mass transport, atmospheric processes, and sea-level variations; and

recommends

(i) that all future GNSS satellites carry precision laser retro-reflector arrays; and

(ii) that a careful pre-launch ground calibration/measurement of the centre of mass offset of the array be provided.

Structures for the Period 2007– 2011

International Union of Geodesy and Geophysics (IUGG)

Executive Committee

President
Tom Beer (Australia)

Vice-President
Harsh K. Gupta (India)

Immediate Past-President
Uri Shamir (Israel)

Treasurer
Aksel W. Hansen (Denmark)

Secretary General
Alik Ismail-Zadeh (Germany)

Bureau Members
1. *Yun-Tai Chen* (China)
2. *Ali Tealeb* (Egypt)
3. *David Jackson* (U.S.A.)

The **IUGG Bureau** is composed by the
- President,
- Vice-President,
- Treasurer,
- Secretary General, and
- Bureau Members

The **IUGG Executive Committee** is composed of the
- full Bureau as listed above,
- the Past President of IUGG, and
- the Presidents of the Associations (see below).

The Secretary General of each Association generally attends all of the EC meetings, but is not a voting member.

Finance Committee
1. *Jan Krynski* (Poland)
2. *Kyoshi Suyehiro* (Japan)
3. *Juan Francisco Vilas* (Argentina)
4. *David Collins* (UK)

Associations

International Association of Cryospheric Sciences
President: *Georg Kaser* (Austria)
President-elected: *Ian Allison* (Australia)
Secretary General: *Manfred Lange* (Germany)

International Association of Geodesy
President: *Michael Sideris* (Canada)
Secretary General: *Hermann Drewes* (Germany)

International Association of Geomagnetism and Aeronomy
President: *Eigil Friis-Christensen* (Denmark)
Secretary General: *Bengt Hultqvist* (Sweden)

International Association of Hydrological Sciences
President: *Arthur Askew* (Switzerland/Australia)
President-Elect: *Gordon Young* (Canada)
Secretary General: *Pierre Hubert* (France)

International Association of Meteorology and Atmospheric Sciences
President: *Wu Guixiong* (China)
Secretary General: *Hans Volkert* (Germany)

International Association for the Physical Sciences of the Oceans
President: *Lawrence Mysak* (Canada)
Secretary General: *Johan Rodhe* (Sweden)

International Association of Seismology and Physics of the Earth's Interior

President: *Wu Zhongliang* (China)

Secretary General: *Peter Suhadolc* (Italy)

International Association of Volcanology and Chemistry of the Earth's Interior

President: *Setsuya Nakada* (Japan)

Secretary General: *Joan Marti* (Spain)

Union Commission Officers for 2007-2011

Union Commission on Geophysical Risk and Sustainability (GeoRisk)

President: *Kuniyoshi Takeuchi* (Japan)

Secretary General: *Gerd Tetzlaff* (Germany)

Union Commission on Mathematical Geophysics (CMG)

President: *Dan Rothman* (USA)

Secretary General: *Claudia Pasquero* (USA)

Union Commission on Studies of Earth's Deep Interior (SEDI)

President: *Gauthier Hulo*t (France)

Secretary General: *Michael Bergman* (USA)

International Association of Geodesy (IAG)

1. IAG Executive Committee

1.1 IAG Bureau

President: *Michael G. Sideris* (Canada)
Vice President: *Chris Rizos* (Australia)
Secretary General: *Hermann Drewes* (Germany)

1.2 IAG Immediate Past President

President 2003-2007: *Gerhard Beutler* (Switzerland)

1.3 IAG Commissions

Commission 1: Reference Frames
President: *Zuheir Altamimi* (France)

Commission 2: Gravity Field
President: *Yoichi Fukuda* (Japan)

Commission 3: Earth Rotation and Geodynamics
President: *Michael Bevis* (USA)

Commission 4: Positioning and Applications
President: *Sandra Verhagen* (Netherlands)

1.4 Global Geodetic Observing System

GGOS Chair: *Markus Rothacher* (Germany)

1.5 Communication and Outreach Branch

COB President: *József Ádám* (Hungary)

1.6 Representatives of the Services

Representatives:
- *Steve Kenyon* (USA)
- *Ruth Neilan* (USA)
- *Harald Schuh* (Austria)

1.7 Members at Large

Members:
- *Kosuke Heki* (Japan)
- *Richard Wonnacott* (S. Africa)

1.8 Non-voting Members

Inter-Commission Committee on Theory
President: *Nico Sneeuw* (Germany)

Assistant Secretary General: *Helmut Hornik* (Germany)

IAG Past Presidents:
- *Helmut Moritz* (Austria)
- *Ivan I. Mueller* (USA)
- *Wolfgang Torge* (Germany)
- *Klaus-Peter Schwarz* (Canada)
- *Fernando Sansò* (Italy)

IAG Past Secretaries General:
- *Michel Louis* (France)
- *Claude Boucher* (France)
- *Christian C. Tscherning* (Denmark)

2. IAG Office

Deutsches Geodätisches Forschungsinstitut (DGFI)
Secretary General: *Hermann Drewes* (Germany)
Assistant Secretary General: *Helmut Hornik* (Germany)

3. IAG Communication and Outreach Branch

Hungarian Academy of Sciences (HAS) / Budapest University of Technology and Economics (BUTE)
- President: *József Ádám* (Hungary)
- Secretary: *Szabolcs Rózsa* (Hungary)

4. Journal of Geodesy

Editor in Chief : *Roland Klees* (Netherlands)

5. Detailed Structure of the Commissions

5.1 Commission 1: Reference Frames

President: *Zuheir Altamimi* (France)

Sub-Commissions

SC1.1: Coordination of Space Techniques
President: *Markus Rothacher* (Germany)

SC1.2: Global Reference Frames
President: *Claude Boucher* (France)

SC1.3: Regional Reference Frames
President: *João Torres* (Portugal)

SC1.3 a: Europe
Chair: *Johannes Ihde* (Germany)

SC1.3 b: South and Central America
Chair: *Claudio Bruyninx* (Argentina)

SC1.3 c: North America
Chairs: *Richard Snay* (USA), *Michael Craymer* (Canada)

SC1.3 d: Africa
Chair: *Richard Wonnacott* (South Africa)

SC1.3 e: Asia-Pacific
Chair: *Shigeru Matsuzaka* (Japan)

SC1.3 f: Antarctica
Chair: *Reinhard Dietrich* (Germany)

SC1.4: Interaction of Celestial and Terrestrial Reference Frames
President: *Harald Schuh* (Austria)

Inter-Commission Project

IC-P1.1: Vertical Reference Frames (joint with Commission 2 and IGFS)
Chair: *Johannes Ihde* (Germany)

Inter-Commission Study Groups

IC-SG1.1: Theory, Implementation and Quality Assessment of Geodetic Reference Frames (joint with ICCT, IERS)
Chair: *Athanasios Dermanis* (Greece)

IC-SG1.2: Quality of Sensor Networks (joint with ICCT, Commission 4)
Chair: *Hansjörg Kutterer* (Germany)

IC-SG1.3: Configuration Analysis of Earth Oriented Space Techniques (joint with ICCT, Commissions 3, 2)
Chair: *F. Seitz* (Germany)

Inter-Commission Working Groups

IC-WG1.1: Environment Loading: Modelling for Reference Frame and positioning applications (joint with Commission 4 and IERS)
Chairs: *Tonie van Dam* (Luxembourg), *Jim Ray* (USA)

IC-WG1.2: Precise Orbit Determination and Reference Frame Definition (joint with Commission 2)
Chair: *Frank Lemoine* (USA)

IC-WG1.3: Concepts and Terminology related to Geodetic Reference Systems
Chair: *Claude Boucher* (France)

IC-WG1.4: Site Survey and Co-locations (joint with IERS)
Chair: *Gary Johnston* (Australia)

5.2 Commission 2: Gravity Field

President: *Y. Fukuda* (Japan)

Sub-Commissions

SC2.1: Gravimetry and Gravity Networks
President: *Leonid. F. Vitushkin* (BIPM)

SC2.2: Spatial and Temporal Gravity Field and Geoid Modelling
President: *Martin Vermeer* (Finland)

SC2.3: Dedicated Satellite Gravity Mapping Missions
President: *Roland Pail* (Austria)

SC2.4: Regional Geoid Determination
President: *Urs Marti* (Switzerland)

SC2.5: Satellite Altimetry
President: *Cheinway Hwang* (Taiwan)

Commission Projects

CP2.1: European Gravity and Geoid
Chair: *Heiner Denker* (Germany)

CP2.2: North American Geoid
Chair: *Dan Roman* (USA)

CP2.3: African Geoid
Chair: *Hussein Abd-Elmotaal* (Egypt)

CP2.4: Antarctic Geoid
Chair: *Mirko Scheinert* (Germany)

CP2.5: Gravity and Geoid in South America
Chair: *Maria Cristina Pacino* (Argentina)

CP2.6: South Asian and Australian Geoid
Chair: *Bill Kersley* (Australia)

Study Groups

SG2.1: Comparisons of Absolute Gravimeters
Chair: *Leonid F. Vitushkin* (BIPM)

SG2.2: High-Resolution Forward Gravity Modelling for Improved Satellite Gravity Missions Results
Chair: *Michael Kuhn* (Australia)

Inter-Commission Projects

IC-P3.1: GGP Global Geodynamics Project (joint with Commission 3)
Chair: *David Crossley* (USA)

Inter-Commission Study Groups

IC-SG4: Inverse Problems and Global Optimization (joint with ICCT)
Chair: *Christopher Kotsakis* (Greece)

IC-SG5 Satellite Gravity Theory (joint with ICCT)
Chair: *Torsten Mayer-Gürr* (Germany)

Inter-Commission Working Groups

IC-WG 2.1: Absolute Gravimetry (joint with IGFS)
Chair: *Herbert Wilmes* (Germany)

IC-WG 2.2: Evaluation of Global Earth Gravity Models (joint with IGFS)
Chair: *Jianliang Huang* (Canada)

5.3 Commission 3: Earth Rotation and Geodynamics

President: *Michael Bevis* (USA)
Vice-President: *Richard Gross* (USA)

Sub-Commissions

SC 3.1: Earth Rotation and Earth Tides
President: *Gerhard Jentzsch* (Germany)

SC 3.2: Tectonic Deformation
President: *Markku Poutanen* (Finland)

SC 3.3 Geophysical Fluids
President: *Aleksander Brzezinski* (Poland)

SC 3.4: Cryospheric Change and Earth Deformation
President*: James Davis* (USA)

Inter-Commission Project

IC-P3.1: Global Geodynamics Project (GGP) (joint with Commission 2)
Chair: *David Crossley* (USA)

IC-P3.2: Working Group of European Geoscientists for the Establishment of Networks for Earth Science Research (WEGENER) (joint with Commission 3)
Chair: *Susanna Zerbini* (Italy)

Inter-Commission Study Group

IC-SG7: Temporal Variations of Deformation and Gravity (joint with ICCT)
Chair: *Detlef Wolf* (Germany)

5.4 Commission 4: Positioning and Applications

President: *Sandra Verhagen* (Netherlands)
Vice-President: *Dorota Grejner-Brzezinska* (USA)

Sub-Commissions

SC 4.1: Multi-Sensor Systems
President: *Dorota Grejner-Brzezinska* (USA)

SC 4.2: Applications of Geodesy in Engineering
President: *Günther Retscher* (Austria)

SC 4.3: Remote Sensing and Modelling of the Atmosphere
President: *Marcelo Santos* (Canada)

SC 4.4: Applications of Satellite and Airborne Imaging systems
President: *Xiaoli Ding* (Hong Kong)

SC 4.5: High-precision GNSS (note: name change)
President: *Yang Gao* (Canada)

Study Groups

SG 4.1: GNSS Remote Sensing and Applications
Chair: *Shuanggen Jin* (South Korea)

SG 4.2 IGS Products for Network RTK and Atmosphere Monitoring
Chair: *Robert Weber* (Austria)

(more detailed information cf. the special article on Commission 4)

Inter-Commission Working Groups

IC-WG 1.1: Environment Loading: Modelling for Reference Frame and Positioning Applications (joint with Commission 1)
Chair: *Tonie van Dam* (Luxembourg)

Inter-Commission Study Groups

IC-SG 2: Quality of Sensor Networks (joint with ICCT)
Chair*: Hansjörg Kutterer* (Germany)

IC-SG 6: InSAR for Tectonophysics (joint with ICCT)
Chair: *Masato Furuya* (Japan)

6. InterCommission Committee on Theory (ICCT)

President: *Nico Sneeuw* (Germany)
Vice President: *Pavel Novák* (Czech Republic)

Inter-Commission Study Groups

IC-SG1: Theory, Implementation and Quality Assessment of Geodetic Reference Frames
(joint with Commission 1, IERS)
Chair: *Athanasios Dermanis* (Greece)

IC-SG2: Quality of Geodetic Multi-Sensor Systems and Networks
(joint with Commissions 4, 1)
Chair: *Hansjörg Kutterer* (Germany)

IC-SG3: Configuration analysis of Earth Oriented Space Techniques
(joint with Commissions 3, 2, 1)
Chair: *Florian Seitz (*Germany)

IC-SG4: Inverse Theory and Global Optimization
(joint with Commission 2)
Chair: *Christopher Kotsakis* (Greece)

IC-SG5: Satellite Gravity Theory
(joint with Commission 2)
Torsten Mayer-Gürr (Germany)

IC-SG6: InSAR for Tectonophysics
(joint with Commissions 3, 4)
Chair: *Masato Furuya* (Japan)

IC-SG7: Temporal Variations of Deformation and Gravity
(joint with Commissions 3, 2)
Chair: *Detlef Wolf* (Germany)

IC-SG8: Towards cm-accurate Geoid – Theories, Computational Methods and Validation
(joint with Comm. 2)
Chair: *Y. M. Wang* (USA)

7. IAG Services

Bureau International des Poids et Mesures (BIPM), Section Time, Frequency and Gravimetry
Head of Section: *Elisa Felicitas Arias* (France)

IAG Bibliographic Service (IBS)
Chair: *Annekathrin Michlenz* (Germany)

International Altimeter Service (IAS)
Chairman of the Steering Committee: *Wolfgang Bosch* (Germany)

International Centre for Earth Tides (ICET)
Chair: *Jean-Pierre Barriot* (France)

International Centre for Global Earth Models (ICGEM)
Director: *Jürgen Kusche* (Germany)

International Digital Elevation Models Service (IDEMS)
Director: *Philippa Berry (UK)*

International DORIS Service (IDS)
Chair of Governing Board: *Gilles Tavernier* (France)
Director of Central Bureau: *Laurent Soudarin* (France)

International Earth Rotation and Reference Systems Service (IERS)
Chair of Directing Board: *Chopo Ma* USA)
Director of Central Bureau: *Bernd Richter* (Germany)

International Geoid Service (IGeS)
President/Director: *Riccardo Barzaghi* (Italy)

International GNSS Service (IGS)
Chair of Governing Board: *John Dow* (Germany)
Director Central Bureau: *Ruth Neilan* (USA)

International Gravimetric Bureau (Bureau Gravimetrique International (BGI)
Director : *Sylvain Bonvalot* (France)

International Gravity Field Service (IGFS)
Chair: *Rene Forsberg* (Denmark)

International Laser Ranging Service (ILRS)
Chair of Gov. Board: *Werner Gurtner* (Switzerland)
Director Central Bureau: *Michael Pearlman* (USA)

International VLBI Service for Geodesy and Astrometry (IVS)
Chair of Directing Board: *Harald Schuh* (Austria)
Director Coordinating Centre: *Dirk Behrend* (USA)

Permanent Service for Mean Sea Level (PSMSL)
Director: *Lesley J. Rickards* (UK)

8. Global Geodetic Observing System (GGOS)

Chair: *Markus Rothacher* (Germany)

Vice-Chairs: *Ruth Neilan* (USA), *Hans-Peter Plag* (USA)

Steering Committee

- GGOS Chair (votes in case of a tie)
- Vice-Chairs (2)
- Chair of GGOS Science Panel
- Chairs of GGOS Working Groups* (1 or more)
- Head Coordinating Office (ex-officio)
- IAG EC Representative (ex-officio)
- IAG Commission Representatives* (4)
- Service Representatives* (1 per service – 10 or more)
- Members-at-Large (4 or more)

Executive Committee

- *Markus Rothacher* (Germany)
- *Ruth Neilan* (USA)
- *Hans-Peter Plag* (USA)
- *Chopo Ma* (USA)
- *Michael Pearlman* (USA)
- *Susanna Zerbini* (Italy)

GGOS Science Panel
Chair: *Richard Gross* (USA)

Working Groups

Ground Networks and Communications
Chair: *Michael Pearlman* (USA)

Satellite Missions
Chair: *Srinivas Bettadpur* (USA)

User Linkage and Outreach
Chair: *Bente Lilja Bye* (Norway)

Data and Information Systems
Chair: *Bernd Richter* (Germany), *Carey Noll* (USA)

Conventions, Modelling, Analysis
Chair: *Hermann Drewes* (Germany)

GEO Representation
Chair: *Hans-Peter Plag* (USA)

* Each primary representative can designate an alternate person who can assume the responsibilities, i.e., vote, when the primary delegate can not attend.

Structure of Commissions

Commission 1 - Reference Frames

web: http://iag.ensg.ign.fr

President: **Zuheir Altamimi** (France)
Vice President: **Mike Craymer** (Canada)

Terms of Reference

Reference systems and frames are of primary importance for many Earth science researches and applications, satellite navigation as well as for practical applications in geo-information. A precisely defined reference frame is needed for the quantification of, e.g. Earth rotation and its gravity field, sea level variation, tectonic motion and deformation, post-glacial rebound, geocentre motion, large scale deformation due to Earthquakes, local subsidence and other ruptures and crustal dislocations. Commission 1 activities and objectives are to deal with theoretical aspects of reference systems and the practical applications for their realizations as well as applied researches. Commissions 1 will closely interact with the 3 other IAG Commissions, ICCT, Services and GGOS components where reference system aspects are of concern. A close cooperation will be enforced with international entities that operate and finance space geodesy observatories in order to take all possible measure allowing improving the quality and distribution of the current co-location sites (Figure 1), which constitute the main foundation of the International Terrestrial Reference Frame (ITRF)

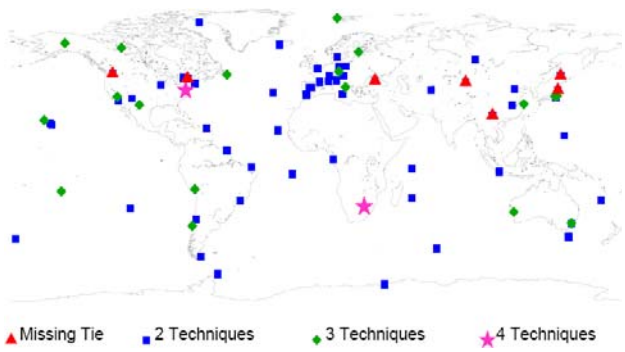


Figure 1. Currently operating co-location sites (September, 2007)

Commission 1 is identical with the Sub-commission B2 of the Scientific Commission B of the ICSU Committee on Space Research (COSPAR).

Objectives

The main objectives of Commission 1 are:

- Definition, establishment, maintenance and improvement of the geodetic reference frames.
- Advanced terrestrial and space observation technique development for the above purposes.
- International collaboration for the definition and deployment of networks of terrestrially-based space geodetic observatories.
- Theory and coordination of astrometric observation for reference frame purposes.
- Collaboration with space geodesy/reference frame related international services, agencies and organizations.
- Promote the definition and establishment of vertical reference systems at global level, considering the advances in the regional sub-commissions.

Structure

Sub-Commissions

- SC1.1: Coordination of Space Techniques
  President: Markus Rothacher (Germany)
- SC1.2: Global Reference Frames
  President: Claude Boucher (France)
- SC1.3: Regional Reference Frames
  President: João Torres (Portugal)
- SC1.3 a: Europe
  Chair: Johannes Ihde (Germany)
- SC1.3 b: South and Central America
  Chair: Claudio Brunini (Argentina)

- SC1.3 c: North America
  Chairs: Richard Snay (USA), M. Craymer (Canada)
- SC1.3 d: Africa
  Chair: Richard Wonnacott (South Africa)
- SC1.3 e: Asia-Pacific
  Chair: Shigeru Matsuzaka (Japan)
- SC1.3 f: Antarctica
  Chair: Reinhard Dietrich (Germany)
- SC1.4: Interaction of Celestial and Terrestrial Reference Frames
  President: Harald Schuh (Austria)

Inter-Commission Project:

- IC-P1.2: Vertical Reference Frames
  (Joint with Commission 2 and IGFS)
  Chair: Johannes Ihde (Germany))
- IC-P3.2: Working Group of European Geoscientists for the Establishment of Networks for Earth Science Research (WEGENER)
  (Joint with Commission 3)
  Chair: Susanna Zerbini (Italy)
  (Description see Commission 3)

Inter-Commission Study Groups:

- IC-SG1: Theory, Implementation and Quality Assessment of Geodetic Reference Frames
  (Joint with ICCT, IERS)
  Chair: Athanasios Dermanis (Greece)
  (Description see ICCT)
- IC-SG2: Quality of Geodetic Multi-Sensor Systems and Networks
  (Joint with ICCT, Commission 4)
  Chair: Hansjörg Kutterer (Germany)
  (Description see ICCT)
- IC-SG3: Configuration Analysis of Earth Oriented Space Techniques
  (Joint with ICCT, Commissions 3,2)
  Chair: Florian Seitz (Germany)
  (Description see ICCT)

Inter-Commission Working Groups:

- IC-WG1.1: Environment Loading: Modelling for Reference Frame and Positioning Applications
  (Joint with Commission 4 and IERS)
  Chairs: Tonie van Dam (Luxembourg), Jim Ray (USA)
- IC-WG1.2: Precise Orbit Determination and Reference Frame Definition
  (Joint with Commission 2)
  Chair: Frank Lemoine (USA)
- IC-WG1.3: Concepts and Terminology Related to Geodetic Reference Systems
  Chair: Claude Boucher (France)
- IC-WG1.4: Site Survey and Co-locations
  (Joint with IERS)
  Chair: Gary Johnston (Australia)

Programme of Activities

The Commission 1 program of activities will include, mainly:

- Encourage, initiate and support theoretical and applied research activities related to reference frames;
- Enforce Research and Development activities that impact the reference frame determination and its accuracy as well as the best and optimal usage of reference frame in Earth Science applications;
- Closely interact with all established IAG Services: IVS, IGS, ILRS, IDS and the IERS, including their Combination Centres and Working Groups;
- Theory and application of the transformation between Celestial and Terrestrial Reference Systems and application to the consistency between ICRF, ITRF and EOPs, in cooperation with IVS and IERS;
- Explore advanced combination methodologies of products and raw observations of space geodesy techniques;
- Investigate all systematic error sources and limitation factors of space geodesy techniques and their combination;
- Encourage and assist, within each regional sub commission, countries to re-define and modernize their national geodetic systems, compatible with the ITRF
- Establish a dedicated Web site relating all Commission 1 activities;

Steering Committee

- President: Zuheir Altamimi (France)
- Vice President: Mike Craymer (Canada)
- President SC1.1: Markus Rothacher (Germany)
- President SC1.2: Claude Boucher (France)
- President SC1.3: João Torres (Portugal)
- President SC1.4: Harald Schuh (Austria)
- Representatives of IERS/IDS/IGS/ILRS/IVS: Werner Gurtner (Switzerland), Chopo Ma (USA), John Ries (USA)
- Members at large: Shigeru Matsuzaka (Japan), Caudio Brunini (Argentina)

Sub-Commissions

SC 1.1 Coordination of Space Techniques

President: Markus Rothacher (Germany)

Terms of Reference

The space geodetic observation techniques, including Very Long Baseline Interferometry (VLBI), Satellite and Lunar Laser Ranging (SLR/LLR), Global Navigation Satellite Systems (GNSS) such as GPS, GLONASS, and in future GALILEO, the French DORIS, as well as altimetry, InSAR, and the gravity missions, contribute significantly to the knowledge about and the understanding of the three major pillars of geodesy: the Earth's geometry (point coordinates and deformation), Earth orientation and rotation, and the gravity field as well as its time variations. These three fields interact in various ways and they all contribute to the description of processes in the Earth System. Each of the space geodetic techniques contributes in a different and unique way to these three pillars and, therefore, their contributions should be combined into a consistent Global Geodetic Observing System (GGOS), the project of the IAG.

Sub-Commission 1.1 coordinates efforts that are common to more than one space geodetic technique, such as models, standards and formats. It shall study combination methods and approaches concerning links between techniques co-located at fundamental sites, links between techniques co-located onboard satellites, common modelling and parameterisation standards, and perform analyses from the combination of a single parameter type up to a rigorous combination on the normal equation (or variance covariance matrices) and even the observation level. The list of interesting parameters includes site coordinates (e.g. time series of combined solutions), Earth orientation parameters, satellite orbits (combined orbits from SLR, GPS, DORIS, altimetry), atmospheric refraction (troposphere and ionosphere), gravity field coefficients, geocentre coordinates, etc. One important goal of SC1.1 will be the development of a much better understanding of the interactions between the parameters describing geometry, Earth rotation, and the gravity field as well as the study of methods to validate the combination results, e.g., by comparing them with independent geophysical information.

To the extent possible SC1.1 should also encourage research groups to develop new observation techniques connecting or complementing the existing set of measurements.

Sub-Commission 1.1 has the task to coordinate the activities in the field of the space geodetic techniques in close cooperation with all the IAG Services, especially with the IERS and its Working Group on Combination, and with COSPAR.

Objectives

The principal objectives of the scientific work of Sub-Commission 1.1 are the following:

- Study systematic effects of or between space geodetic techniques.
- Develop common modelling standards and processing strategies.
- Comparison and combination of orbits derived from different space geodetic techniques together with the IGS LEO Working Group.
- Explore and develop innovative combination aspects such as, e.g., GPS and VLBI measurements based on the same high-accuracy clock, VLBI observations to GNSS satellites, combination of atmospheric information (troposphere and ionosphere) of more than one technique, etc.
- Establish methods to validate the combination results (e.g., with global geophysical fluids data).
- Explore, theoretically and practically, the interactions between the gravity field parameters, EOPs, and reference frames (site coordinates and velocities), improve the consistency between these parameter groups, and assess, how a correct combination could be performed.
- Study combination aspects of GPS and InSAR.

Additional objectives of Sub-Commission 1.1 are:

- Promotion of international scientific cooperation.
- Coordination of common efforts of the space geodetic techniques concerning standards and formats (together with the IERS).
- Organization of workshops and sessions at meetings to promote research.
- Establish bridges and common activities between SC1.1 and the IAG Services.

Links to Services

Sub-Commission 1.1 will establish close links to the relevant services for reference frames, namely International Earth Rotation and Reference Systems Service (IERS), International GPS Service (IGS), International Laser Ranging Service (ILRS), International VLBI Service for Geodesy and Astrometry (IVS), and International DORIS Service (IDS).

Working Groups

WG 1.1.1: Comparison and Combination of Precise Orbits Derived from Different Space Geodetic Techniques

(joint with the IGS LEO WG)

This working group is taking over the role of the former CSTG Sub-commission on Precise Orbit Determination (POD) of Low Earth Orbiting (LEO) Satellites. It will work closely together with the IGS LEO Working Group, but will have a broader research field not focussing on GPS, but on the interplay between different tracking techniques. The main topics of the WG will be:

- Comparison and combination of satellite orbits derived from various tracking techniques, including SLR, DORIS, GPS, altimetry, K-band links, CCD, and possible future observation techniques. Satellite orbits ranging from LEOs up to geostationary satellites (GEOs) should be considered.
- Assessment of systematic errors between different orbit types and observation techniques.
- Study of improved force models and POD strategies based on the combination of techniques.

WG 1.1.2: Interaction and Consistency between Terrestrial Reference Frame, Earth Rotation, and Gravity Field

(joint with Commission 2, Commission 3, and GGOS)

This working group has to be a joint working group together with Commission 2, Commission 3, and GGOS.

Its main research topics are:

- Study the theoretical and practical interactions/ relationships between parameters and models describing the Terrestrial Reference Frame (TRF), Earth rotation, and the gravity field (e.g., low degree harmonics of the gravity field, Love numbers...).
- Assess and study the consistency between products of these three fields.
- Investigate methods and techniques to combine geometry, Earth rotation, and gravity field parameters (e.g., by including LEO satellites into global solutions).

WG 1.1.3: Comparison and Combination of Atmospheric Information Derived from Different Space Geodetic Techniques

(Joint with IGS Troposphere WG, IGS Ionosphere WG, and IVS)

The task of this working group shall be the comparison and the combination of information about the atmosphere derived from different space geodetic techniques such as GPS, VLBI, InSAR, altimetry, etc. A very close cooperation with the IAG services, especially the IGS and the IVS are essential. Major research topics are:

- Investigate differences between tropospheric delay parameters estimated by different techniques; assess systematic biases between techniques and the accuracy of each individual technique; consider ways to combine and validate the information of different techniques.
- Study the accuracy of global or regional ionosphere maps or simple delays derived from different techniques; assess systematic biases; compare, combine, and validate results.

SC 1.2 Global Reference Frames

President: Claude Boucher (France)

Terms of Reference

Sub-Commission 1.2 is engaged in scientific research and practical aspects of the global reference frames. It investigates the requirements for the definition and realization of the terrestrial reference systems (TRS) and frames (TRF), addresses fundamental issues closely related to TRS, such as multi-technique global geodetic observatories (local ties, site effects, interdisciplinary use…) or methods for the combined processing of heterogeneous observation data. The work will be done in close cooperation with the International Earth Rotation and Reference Systems Service (IERS), in particular with the ITRS Product Centre, the other relevant IAG services (IGS, ILRS, IVS, IDS), and the IAG Global Geodetic Observing System (GGOS). Theoretical aspects (e.g., quality measures, relativistic modelling) will be investigated in cooperation with the Inter-Commission Committee on Theory.

Objectives

The following research topics will form the fundamental objectives during the next period:

- Basic concepts and related terminology
- Improvement of relativistic modelling
- Fundamentals of the realization of the global terrestrial reference frames: co-location problems, local ties, datum problems (origin, scale and orientation, time evolution), coordinates origin, geo-centre, time series approach, long-term consistency with EOPs and ICRF…
- Analysis of strengths, weaknesses and systematic differences (biases) of individual techniques (VLBI, SLR, GPS, DORIS) related to their contribution to global combined TRF
- Combination methodologies of individual techniques' solutions and analysis of the underlying models, parameters, datum definitions etc.
- TRF by multi-technique data analysis
- Global Geodetic Observatories, concepts and practical implementation

Links to Services

Sub-Commission 1.2 will closely be linked to the relevant services, in particular to the International Earth Rotation and Reference Systems Service (IERS), but also to the International GPS Service (IGS), International Laser Ranging Service (ILRS), International VLBI Service for Geodesy and Astrometry (IVS), and International DORIS Service (IDS).

Structure

The sub-commission has an open membership. Details about its activities will be given in its web page accessible through the IAG links.

Project, Study and Working Groups linked to SC1.2

- **IC-P 1.2: Vertical Reference Frames**
  Chair: Johannes Ihde (Germany)
- **IC-SG 1: Theory, Implementation and Quality Assessment of Geodetic Reference Frames**
  (jointly with ICCT)
  Chair: Athanasios Dermanis (Greece)
- **IC-WG 1.3: Concepts and Terminology related to Geodetic Reference Systems**
  Chair: Claude Boucher (France)
- **IC-WG 1.4: Site Survey and Co-location**
  (jointly with IERS)
  Chair: Gary Johnston (Australia)

SC 1.3 Regional Reference Frames

President: João Torres (Portugal)

Terms of Reference

Sub-Commission 1.3 deals with the definitions and realizations of regional reference frames and their connection to the global International Terrestrial Reference Frame (ITRF). It offers a home for service-like activities addressing theoretical and technical key common issues of interest to regional organisations.

Objectives

In addition to specific objectives of each regional sub-commission, the main objectives of SC1.3 as a whole are:

- Develop specifications for the definition and realization of regional reference frames, including the vertical component with special consideration of gravity data and other data.
- Coordinate activities of the regional sub-commissions focusing on exchange and share of competences and results.
- Develop and promote operation of GNSS permanent stations, in connection with IGS whenever appropriate, to be the basis for the long-term maintenance of regional reference frames.
- Promote the actions for the densification of regional velocity fields.
- Encourage and stimulate the development of the AFREF project in close cooperation with IGS and other interested organizations.
- Encourage and assist, within each regional sub-commission, countries to re-define and modernize their national geodetic systems, compatible with the ITRF.

Structure

Regional Sub-commissions

- **SC1.3a Europe (EUREF)**
  Chair: Johannes Ihde (Germany)
  Chair of the Technical Working Group (TWG): Carine Bruyninx (Belgium)
  Secretary: Helmut Hornik (Germany)
- **SC1.3b South and Central America (SIRGAS)**
  Chair: Claudio Brunini (Argentina)
  Vice-President: Laura Sanchez (Colombia/Germany)
- **SC1.3c North America (NAREF)**
  Co-Chairs: Richard Snay (USA), Michael Craymer (Canada)
- **SC1.3d Africa (AFREF)**
  Chair: Richard Wonnacott (South Africa)
- **SC1.3e South-East Asia and Pacific**
  Chair: Shigeru Matsuzaka (Japan)
- **SC1.3f Antarctica (SCAR)**
  Chair: Reinhard Dietrich (Germany)

Working Group

- **SC1.3-WG1: Regional Dense Velocity Fields**
  Chair: Carine Bruyninx (Belgium)

Programme of Activities

- Organize inter-regional workshops addressing activities, results and key issues of common interest to the regional sub-commissions.
- Develop analysis strategies and compare methods for the implementation of the regional reference frames and their expression in the ITRF, with full interaction with the IGS.
- Consider establishing regional dense velocity fields for, primarily, the long-term maintenance of the regional reference frames.
- Contribute at regional levels to the realization and improvement of local surveys in the collocation sites, with full cooperation with the Sub-commission 1.2 Global Reference Frames.
- SC1.3-WG1: The main task of this WG is to develop harmonized and possibly common specifications for the densification of the regional velocity fields.

SC1.3a Regional Reference Frame for Europe (EUREF)

Chair: Johannes Ihde (Germany)

Chair of the Technical Working Group (TWG): Carine Bruyninx (Belgium)

Secretary: Helmut Hornik (Germany)

Terms of Reference

EUREF, the Regional Reference Frame Sub-commission for Europe, deals with the definition, realization and maintenance of the European Reference Frame. EUREF is focusing on both the spatial and the vertical components in close cooperation with the pertinent IAG components (Services, Commissions, and Inter-commission projects) and EuroGeographics, the consortium of the National Mapping and Cadastral Agencies (NMCA) in Europe.

Structure

- EUREF is composed by representatives from European IAG member countries.
- The TWG (Technical Working Group) is composed by members elected by the plenary, members in charge of special projects and ex-officio members.

Programme of Activities

- Continue to develop the EUREF Permanent Network (EPN) in close cooperation with IGS, for the maintenance of the European Reference Frame, as a contribution to the ITRF and as infrastructure to support other relevant projects, namely the European initiatives related with GALILEO
- Extend the Unified European Levelling Network (UELN) and prepare it to be computed under a geo-kinematic approach
- Implement the project European Combined Geodetic Network (ECGN) and investigate the discrepancies already identified in the combination of the EUVN (European United Vertical Network) results and the gravimetric geoid *(*project EUVN_DA), in close co-operation with IAG Commission 2
- Establish a dense velocity field model for the long-term maintenance of the European reference frame
- Consider the contribution to the IAG Program GGOS (Global Geodetic Observing System) using the installed infra-structures managed by the EUREF members
- Promote the adoption of the reference systems defined by EUREF (ETRS89 - European Terrestrial Reference System 1989 and EVRS -European Vertical Reference System) in the European countries and European-wide organizations involved in geo-referencing activities
- Organize annual symposia addressing activities carried out at national and European-wide level related with the global work and objectives of EUREF

SC1.3b Regional Reference Frame for South and Central America (SIRGAS)

Chair: Claudio Brunini (Argentina)

Vice-chair: Laura Sánchez (Colombia / Germany)

Terms of Reference

Sub-commission 1.3b (South and Central America) encompasses the activities developed by the “Geocentric Reference System for the Americas” (SIRGAS). As such, it is concerned with the definition and realization of a unified reference frame for South and Central America, consistent with ITRS/ITRF, and promoting the definition and establishment of a unified vertical reference system in the region.

Objectives

The main purpose of the Sub-commission 1.3 is the definition, realization, and maintenance of the 3D geocentric reference system for the Americas, including a gravity field-related vertical reference system. This objective comprises:

- Determination and maintenance of a geocentric reference frame (a set of stations with high-precise geocentric coordinates [X, Y, Z] and their variation with time [Vx, Vy, Vz]), as a regional densification of the global ITRF.
- Establishment of the geocentric datum in the member countries defined by the origin, orientation and scale of SIRGAS (i.e. IERS).

- Definition and realization of a unified vertical reference system composed by consistent physical and geometrical heights, as well as, their variations with time, i.e. [h, V_h, H, V_H, N, V_N].
- To promote and coordinate the efforts of the Latin American countries to achieve the defined objectives.

Structure

The structure of the sub-commission is based on the functioning bodies of the SIRGAS project. There are currently three Working Groups:

- SC1.3b-WG1: Reference System
  Chair: Sonia Costa (Brazil)
- SC1.3b-WG2: Geocentric Datum
  Chair: Tomas Marino (Costa Rica)
- SC1.3b-WG3: Vertical Datum
  Chair: William Martinez (Colombia)

The SIRGAS steering committee (or *council*, as it is named in the SIRGAS statutes) is composed by:

- SC1.3b Chair
- SC1.3b Vice-Chair
- SC1.3b-WG1 Chair
- SC1.3b-WG2 Chair
- SC1.3b-WG3 Chair

Programme of Activities

- To improve the coverage and functioning of the SIRGAS Continuously Operating Network (SIRGAS-CON) following the IAG recommendations related with the monumentation, maintenance, and analysis strategies (WG1).
- To improve the determination of the velocity field for Latin America, based on independent computations using collocation and finite elements (WG 1);
- To derive ionosphere models (WG 1);
- To assist the countries in establishing the geocentric datum (WG 2);
- To assist the countries in establishing national reference frames (WG 2);
- To carry out spirit levelling of the SIRGAS 2000 and SIRGAS-CON stations (WG 2, WG 3);
- To connect the classical vertical networks between neighbouring countries (WG 2, WG 3);
- To adjust the geopotential numbers of the national vertical networks in a continental frame (WG 3);
- To collaborate with the determination of the sea surface topography at the reference tide gauges (WG 3);
- To establish a unified height system in the frame of a global vertical reference system (WG 3).

SC1.3c Regional Reference Frame for North America (NAREF)

Co-Chairs: Richard Snay (USA), Michael Craymer (Canada)

Terms of Reference

To provide international focus and cooperation for issues involving the horizontal, vertical, and three-dimensional geodetic control networks of North America, including Central America, the Caribbean and Greenland (Denmark). For more information, see www.naref.org.

Objectives

In collaboration with the IAG community, its service organisations and the national geodetic organizations of North America, the aims and objectives of this regional sub-commission are to provide international focus and cooperation for issues involving the horizontal, vertical and three dimensional geodetic control networks of North America. Some of these issues include:

- Densification of the ITRF reference frame in North America and the promotion of its use;
- Maintenance and future evolution of vertical datums (ellipsoidal and orthometric), including the North American Vertical Datum of 1888 (NAVD88) and the International Great Lakes Datum (IGLD);
- Collocation of different measurement techniques, such as GPS, VLBI, SLR, DORIS, tide gauges, etc.;
- Effects of crustal motion, including post-glacial rebound and tectonic motions along, e.g., the western coast of North America and in the Caribbean;
- Standards for the accuracy of geodetic positions;
- Outreach to the general public through focused symposia, articles, workshops and lectures, and technology transfer to other groups.

Structure

- Co-Chairs
- WG organizing committee

  Members: Michael Craymer (Canada), Per Knudsen (Denmark), Richard Snay (USA)

Working Groups

- SC1.3c-WG1: North American Reference Frame (NAREF)

  Chair: Michael Craymer (Canada)

- SC1.3c-WG2: Stable North American Reference Frame (SNARF)

  Chair: Geoff Blewitt (USA)

- SC1.3c-WG3: Reference Frame Transformations

  Chair: Michael Craymer (Canada)

Programme of Activities

- **SC1.3c-WG1:** To densify the ITRF reference frame in the North American region by organizing the computation of weekly coordinate solutions and associated accuracy information for continuously operating GPS stations that are not part of the current IGS global network. A cumulative solution of coordinate and velocities will also be determined on a weekly basis. The working group will organize, collect, analyse and combine solutions from individual agencies, and archive and disseminate the weekly and cumulative solutions.
- **SC1.3c-WG2:** To establish a high-accuracy standard reference frame, including velocity models, procedures and transformations, tied to a "stable North America" which would serve the broad scientific and geomatics communities by providing a consistent, mm-accuracy, stable reference with which scientific and geomatics results (e.g., positioning in tectonically active areas) can be produced and compared.
- **SC1.3c-WG3:** To determine consistent relationships between international, regional and national reference frames/datums, to maintain (update) these relationships as needed and to provide tools for implementing these relationships.

SC1.3d Regional Reference Frame for Africa (AFREF)

Chair: Richard Wonnacott (South Africa)

Terms of Reference

Sub-commission 1.3d (Africa) is concerned with definition and realization of a unified continental reference frame (AFREF) for Africa which will be consistent and homogeneous with the global International Terrestrial Reference Frame (ITRF).

Objectives

In collaboration with the IAG community and its services organisations and the National and Regional Mapping Organisations of Africa, the aims and objectives of Sub-commission 1.3d (Africa) are:

- To define the continental reference system of Africa. Establish and maintain a unified geodetic reference network as the fundamental basis for the national 3-d reference networks fully consistent and homogeneous with the global reference frame of the ITRF;
- To realize a unified vertical datum and support efforts to establish a precise African geoid, in concert with the African Geoid project activities;
- To establish continuous, permanent GPS stations such that each nation or each user has free access to, and is at most 500 km from, such stations;
- To provide a sustainable development environment for technology transfer, so that these activities will enhance the national networks, and numerous applications, with readily available technology;
- To understand the necessary geodetic requirements of participating national and international agencies and;
- To assist in establishing in-country expertise for implementation, operations, processing and analyses of modern geodetic techniques, primarily GPS.

Structure

- Chair
- Members of African countries

Programme of Activities

It is envisaged that regionalization of AFREF will follow an approach that consists of three major phases:

1. The establishment of a framework of permanent or semi-permanent GPS base stations throughout the region that will become part of the worldwide IGS network of stations.
2. The densification of the network of permanent or semi-permanent base stations, largely on a country-by-country basis, to determine the relationship between the national geodetic system and the ITRS, and to refine the transformation parameters necessary to relate the national systems to a common ITRF.
3. The third and equally important phase of the project will be to address the development of a more refined geoid model for Africa and the definition of a common vertical datum for the continent. This will be done in collaboration with the IAG Africa Geoid Project (Project 2.3 Commission 2).

It is further planned to hold workshops and seminars to strengthen the science and knowledge of geodesy and GNSS within Africa and their application to the development of reference frames.

SC1.3e Regional Reference Frame for South-East Asia and Pacific

Chair: Shigeru Matsuzaka (Japan)

Terms of Reference

To provide a regional focus for cooperation in the definition, realisation and densification of the International Terrestrial Reference frame (ITRF). This activity will be carried out in close collaboration with the Regional Geodesy Working Group of the Permanent Committee for GIS Infrastructure in Asia and the Pacific which operates under the purview of the United Nations Regional Cartographic Conference for Asia and the Pacific (UNRCC-AP).

Objectives

The objectives of the Sub-commission 1.3e are:

- The densification of the ITRF and promotion of its use in the connection and enhancement of national networks;
- To promote the development of a regional vertical reference datum system
- To develop a better understanding of tectonic motions

and plate boundaries within the region

- The development of an improved geoid by enhancement of the data from the regional gravity network and global gravity models
- Collocation of different measurement techniques, such as GPS, VLBI, SLR, DORIS, tide gauges, and maintenance of precise local geodetic ties at these sites.
- To outreach to developing countries through symposia, workshops, training courses, and technology transfer.
- Encourage the establishment of further continuous GPS base stations, (accurately) positioned within ITRF, with data available both locally and to IGS.

Program of Activities

The activities of this sub commission will principally be carried out by the members of national surveying and mapping organisations through the PCGIAP Regional Geodesy Working Group and through the scientific members of the Asia Pacific Space Geodynamics Project (APSG**).**

In order to densify the ITRF reference frame in the Asia Pacific Region an annual geodetic observation campaign will be held each year to provide an opportunity to connect to national geodetic networks and to determine site velocities. These campaigns include several geodetic techniques:

- SLR, through cooperation with ILRS and WPLTN,
- VLBI, through APSG,
- GPS through PCGIAP.

Computations are undertaken in several countries from a common data set, which includes data from weekly epoch occupations, and continuously operation GPS which are not contributing to the IGS network. Only selected stations from the massive Japanese network are included. The combination of results is being developed in the region and a PCGIAP workshop on Regional Geodesy will be held each year to strengthen regional cooperation, to discuss and analyse results of the geodetic campaigns, and to promote technology transfer.

External Links

- Regional Geodesy Working Group of the Permanent Committee for GIS Infrastructure in Asia and the Pacific (PCGIAP)
- Asia Pacific Space Geodynamics project (APSG)

SC1.3f Regional Reference Frame for Antarctica (SCAR)

Chair: Reinhard Dietrich (Germany)

Terms of Reference

Sub-commission 1.3f (Antarctica) is focusing on the definition and realization of an unified reference frame for Antarctica which will be consistent with the global International Terrestrial Reference Frame (ITRF). It will establish close links to corresponding activities within the Scientific Committee on Antarctic Research (SCAR).

Objectives

- Maintenance and densification of the precise geodetic reference network in Antarctica by permanent observations and GPS campaigns;
- Realization of an unified vertical datum including GPS ties of tide gauges;
- Providing unified reference for other GPS applications like airborne gravimetry, ground truthing for satellite missions, geodynamics and glaciology;
- Develop technologies for remote geodetic observatories.

Programme of Activities

1. Organization of GPS campaigns in Antarctica, maintenance of the data archive.
2. Data analysis and determination of the Antarctic GPS network as a regional densification of ITRF.
3. Support airborne surveys and satellite missions with precise terrestrial reference.

Organize meetings and workshops on Antarctic geodesy jointly with related SCAR activities in order to strengthen the international cooperation and to make optimum use of field logistics and infrastructure.

SC 1.4 Interaction of Celestial and Terrestrial Reference Frames

President: Harald Schuh (Austria)

Terms of Reference

The main objective of the IAG Sub-Commission 1.4 is the study of the interaction of the celestial and the terrestrial reference frames. In particular, SC 1.4 is focusing on the consistency between the frames.

WG 1.4.1: Theoretical Aspects of the Celestial Reference System and Systematic Effects in the CRF Determination

The celestial and the terrestrial ephemeris origin replaced in 2003 the vernal equinox and the traditional first axis of the terrestrial intermediate frame. Consequently, the Earth rotation angle replaced the apparent sidereal time. The Earth orientation parameters consisting of the difference between UTC and UT, the polar motion parameters, and the nutation residuals, connect the CRF and the TRF. Some effects or modelling errors which can be expressed in both frames, e.g. atmospheric gradients, can systematically affect each of the frames. Other effects affect only one frame directly but – if not modelled there correctly - can still be transcribed as deformation of the other frame or change of the Earth orientation parameters.

In 2006 new IAU definitions were adopted with relevance for WG 1.4.1

- IAU Resolution B1 (*http://www.iau.org/fileadmin/content/pdfs/IAU2006_Resol1.pdf*) deals with the adoption of the P03 Precession Theory and Definition of the Ecliptic.
- IAU Resolution B2 (*http://www.iau.org/fileadmin/content/pdfs/IAU2006_Resol2.pdf*) is a supplement to the IAU 2000 Resolutions on reference systems.

W.r.t. theory the effects of the new IAU definitions, the relation between the barycentric system (as realized by VLBI) and the geocentric system shall be studied.

Additionally, effects which systematically affect source positions are to be identified as well as an inconsistent handling of such effects in different software packages. It is well-known that the accuracy achieved today is also limited by technique- and/or solution-related systematic biases, which are often poorly characterized or quantified.

Concerning systematic effects, the following activities are planned:

- Comparison of various CRF realizations
- Study of effects of geodetic datum definition on VLBI-determined CRF
- Study of effects of meteorological data on VLBI-determined CRF
- Study of effects of various analysis options on VLBI-determined CRF

WG 1.4.2: Realization of Celestial Reference Frames (CRF and Transformations)

To achieve further progress regarding the realization of celestial reference frames it is essential to review the current status, to identify deficiencies and to make proposals for improvements. This task is closely related to various components of the IERS and the techniques analysis coordinators (in particular of the IVS), and requires a close cooperation between the different groups. The activities include the survey of the current status of CRF realization, a review regarding the implementation of IERS Conventions and IAG Fundamental Parameters and different space techniques for CRF realization.

The International Celestial Reference Frame (ICRF) realized by VLBI is currently defined by the radio positions of 212 extragalactic objects (Ma et al. 1998). Since its inception there have been two extensions to the ICRF: ICRF-Ext.1 (IERS, 1999) and ICRF-Ext.2 (Fey et al. 2004). Planning for a second realization of the ICRF is currently underway with a projected completion date concurrent with the XXVIIth IAU General Assembly in 2009. Two Working Groups (WG) were established on the second realization of the ICRF (ICRF2) as a joint project of the *International Astronomical Union* (IAU), the *International Earth Rotation and Reference Systems Service* (IERS) and the *International VLBI Service for Geodesy and Astrometry* (IVS).

Goal of the IAU WG: Oversee generation, validation and utility of ICRF2; engage in formulation of resolutions of adoption by IAU (*http://rorf.usno.navy.mil/ICRF2/IAU/*).

Goal of the IVS/IERS WG: Produce ICRF2 for IERS / IVS consideration and for submission to the IAU Working Group (*http://www.iers.org/MainDisp.csl?pid=198-1100160*).

This WG (1.4.2) will survey the current status of CRF realization in close touch with the two WGs mentioned above and it will review the implementation of the IERS Conventions and IAG Fundamental Parameters concerning CRF relevant aspects.

Concerning highly precise optical celestial reference frames, the state of the art optical catalogue is the FK6 (Wielen et al. 1999). It includes the FK5 and the Hipparcos-Catalogue. Upcoming optical astrometry space missions such as GAIA (Global Astrometry Interferometer for Astrophysics) and SIM (Space Interferometer Mission) will significantly enhance the quality of the optical catalogues in terms of position precision and number of stars.

WG 1.4.3: Interaction Between Celestial and Terrestrial Reference Frames

A major goal of this WG is to investigate the interaction between the celestial and terrestrial reference frame and the transformation between both (by precession, nutation, Earth rotation angle, polar motion), and to improve the consistency between celestial reference frames, a terrestrial reference frame and EOP. This includes the effect of errors in the CRF on the terrestrial reference frame and vice versa, the realization of the NNR-condition for the ITRF (e.g. the influence of deformations). The interaction between the frames and the EOP determination, the effect of various geophysical models, and the interaction with the gravity field will also be investigated.

Transformations between corresponding reference frames can be improved connecting co-located reference points of different techniques using e.g. terrestrial local tie measurements. As it is common practice to attach GNSS receivers on LEO or other satellites used for SLR to tie the different techniques' reference frames, such connections will also be considered by the WG.

The scheduled activities of the WG are:

- Identify effects of errors in the CRF on the TRF and related products (e.g. EOP) and vice versa.
- Compare the EOP with geophysical models and identify the effect of Earth deformation on the EOP determination.
- Investigate GPS satellite orbits used as quasi celestial reference frame for satellites in Low Earth Orbit.
- Investigate satellite and receiver antenna phase centre variations and their implications to reference frame determination.

Inter-Commission Projects

IC-P1.2 Vertical Reference Frames

Chair: Johannes Ihde (Germany)
(Joint with Commission 2 and IGFS)

Terms of Reference

The IAG Inter-commission Project 1.2 studied during the period 2003 – 2007 the possibilities of the definition and realization of a global vertical reference system (GVRS) based on the classical and modern observations and a consistent modelling of both, geometric and gravimetric parameters.

The results of the work of the Inter-commission Project 1.2 are documented in **Conventions for the Definition and Realization of a Conventional Vertical Reference System (CVRS)**. In the CVRS conventions a general concept for the definition and realization of a unified, global vertical reference system is described. The CVRS conventions are aligned to the IERS 2003 Conventions.

Parts of the IERS 2003 conventions are the basis for the CVRS conventions.

Open topics are the establishment of an information system describing the various regional vertical reference frames and their relation to a GVRS, the determination of transformation parameters between regional vertical reference frames and the unified global height system as well as the relationships between an GVRS and the International Terrestrial Reference System.

Objectives

- Further development of the CVRS conventions
- Preparation of decision about numerical standards as task in cooperation with International Astronomical Union (IAU) and international hydrological associations.
- Initiation of a pilot project for an IVRS realization on the basis of the IGS TIGA-PP, GGP and IGFS for AG and a CGGM

Program of Activities

- Study of information on regional vertical systems and their relations to a global vertical reference system for practical applications;
- Study of combination procedures of height data sets from different techniques;
- Development of the basic relationships between ITRS and IVRS conventions, parameters, realization, models
- Unification of regional (continental) height systems
- Preparation of a pilot project for the realization of a GVRS.

Membership

- Zuheir Altamimi (France)
- Matt Amos (New Zealand)
- Alireza A. Ardalan (Iran)
- Wolfgang Bosch (Germany)
- Claude Boucher (France)
- Carine Bruyninx (Belgium)
- Milan Bursa (Czech Republic)
- Gleb Demianov (Russia)
- Will Featherstone (Australia)
- Rene Forsberg (Denmark)
- Satoru Fukuda (Japan)
- Bernhard Heck (Germany)
- Johannes Ihde (Germany)
- Bill Kearsley (Australia)
- Gunter Liebsch (Germany)
- Teixeira Luz (Brazil)
- Markku Poutanen (Finland)
- Laura Sanchez (Colombia)
- Steve Shipman (UK)
- Marc Véronneau (Canada)
- Viliam Vatrt (Czech Republic)

Inter-Commission Working Groups

IC-WG 1.1 Environment Loading: Modelling for Reference Frame and positioning applications

(Joint with Commission 4 and IERS)

Chairs: Tonie van Dam (Luxembourg), Jim Ray (USA)

Terms of Reference

The accuracy and precision of current space geodetic techniques are such that displacements due to non-tidal surface mass loading are now measurable in many cases. So data analysts have increasing interest in applying displacement corrections to their geodetic results in order to remove the geophysical loading effects. Unfortunately, doing so can introduce undesirable errors into coordinate times series and thus into the ITRF itself if the corrections are not computed or applied with utmost care. Problems that are sometimes encountered include: a proliferation of different (and sometimes erroneous) loading models; use of various different reference frames not always well suited to the geodetic reductions; applying corrections at the observation level versus longer-period a-posteriori average corrections; attributes of the geophysical loading models such as a lack of mass conservation or other errors. The goal of this working group is to investigate procedures to ensure that suitable environmental corrections are available to users and that the optimal usage is made.

Objectives

The principle objectives of the scientific work are the basic research on:

- Investigate optimal methods to mitigate loading effects in ITRF frame parameters and site coordinates

Additional Objectives and Program of Activities

- Accuracy assessment of the different loading models
- Assessment of the propagation of errors into the site coordinates and the ITRF
- Define which models should be applied at the observation level and which should be applied in the post-processing
- Tie results/findings to IERS conventions

Membership

- Tonie van Dam (Luxembourg)
- Jim Ray (USA)
- David Lavallee (UK)
- Xavier Collilieux (France)
- Zuheir Altamimi (France)
- Pascal Gegout (France)
- Ernst Schrama (Netherlands)
- Frank Wu (USA)

IC-WG1.2 Precise Orbit Determination and reference frame definition

(Joint with Commission 2)

Chair: Frank Lemoine (USA)

Terms of Reference

The accuracy of the terrestrial reference frame terrestrial realizations is heavily dependent on the quality of the precision orbit determination (POD) to the satellites that are used for the station coordinate and EOP determinations. The POD in turn is dependent on the quality of the force and measurement models for each of the individual techniques (SLR, DORIS, GNSS) and satellites the contribute to the ITRF solutions (Lageos1, Lageos2 in the case of SLR; TOPEX/Poseidon, Jason-1, ENVISAT, The SPOT satellites in the case of DORIS, and GPS and Galileo in the case of GNSS). The activities of this working group encompass the POD issues in precision orbit determination that will affect reference frame determination, and important related applications that depend on accurate reference frame such as the determination of the change in global mean sea level from space borne ocean altimeter data.

Objectives

The principle objectives of the scientific work are the basic research on:

- Investigation of POD issues that will have a direct impact on the quality of the derived IERS products for each of the services, and assess how improvements might be made.

Additional Objectives and Program of Activities

- Accuracy assessment of the different ITRF realizations with respect to different POD parameterizations or satellite constellations.
- Assessment of the impact of how improved POD might map into IERS products such as station coordinate time series and EOP determination.
- Define which models should be applied at in the POD processing for each of the space geodetic techniques (SLR, DORIS, GNSS) .
- Tie results/findings to IERS conventions

Membership

- Frank Lemoine (USA)
- Bruce Haines (USA)
- John Ries (USA)
- Pascal Willis (France)
- Marek Ziebart (UK)
- Anthony Sibthorpe (UK)
- Gerd Gendt (Germany)
- Jean Paul Berthias (France)

IC-WG1.3 Concepts and terminology related to Geodetic Reference Systems

Chair: Claude Boucher (France)

Terms of Reference

Several recent events has underlined the need to have an agreement on basic concepts related to Geodetic Reference Systems within the geodetic scientific community. This refer in particular to the work performed by IAU, presently accepted by IUGG, as well as the redaction of a new edition of the IERS Conventions. An associated terminological effort is needed, both within the geodetic community and outside, referring to various communities of practice, such as geo-information or GNSS community (providers or users).

The working group will consider all needs or concerns within IAG, as well as some external structure closely connected, such as IAU or ISO.

Objectives

The global objective of the WG is to establish a report accepted by its members and describing basically a recommended nomenclature, together with all useful comments for a better reader's understanding. An ad hoc summary will be written to be published under the IAG stamp, nominally in the Journal of Geodesy.

The field covered are all those connected to Geodetic Reference Systems (tri-dimensional, vertical, horizontal, gravimetric, astrometric…)

Specific steps will be followed by the WG activities:

- Identification of topics of interest within all IAG components (commissions, services, GGOS, outreach…)
- Selection of external bodies with relevant topic (e.g. IAU, ISO, International GNSS Committee…)
- Effective link between the WG and the previous list
- Selection of the rubriques of the recommended nomenclature
- Agreement of the text of the nomenclature
- Redaction of the final report
- Redaction of the executive summary for the JoG

Membership (provisional)

- Zuheir Altamimi (France)
- Geoff Blewitt (USA)
- Claude Boucher (France) President
- Nicole Capitaine (France)
- Athanasios Dermanis (Greece)
- Herman Drewes (Germany)
- Johannes Ihde (Germany)
- Sergei Klioner (Russia)
- Erricos Pavlis (USA)
- Gerard Petit (France)
- Hans-Peter Plag (USA)
- Jim Ray (USA)
- Pascal Willis (France)

IC-WG1.4 Site Survey and Co-locations

(Joint with IERS)

Chair: Gary Johnston (Australia)

Goals and Objectives

The major goals and objectives of the WG are:

1. Site Survey and Standards

- Develop, test, compare and set standards on site survey methods, including observational techniques, network design, classical adjustment, geometrical modelling and/or direct measurement techniques for invariant point determination, reference frame alignment, software implementation and SINEX generation. This will include the development of a standards document for undertaking site surveys;
- Preparation and coordination of a Pilot Project (PP) on site survey. The PP will include a test campaign(s) to be used for the comparison of different approaches to local tie surveys addressing each of the technical elements;
- Develop standards for the documentation of site surveys, including survey report content and format;
- Suggest a pool of expertise to provide advice to survey teams, as required, on standards for site surveys.

2. Coordination

- Liaise with local and international survey teams undertaking site surveys at important co-location sites.
- Liaise with the technique combination groups to ensure WG site survey products meet user requirements;
- Coordinate as required and make recommendations to observatories as to survey scheduling and re-survey frequency;
- Develop and distribute software tools to the community to assist in the generation of site survey products, including SINEX generation software
- Provide a forum to raise the profile of site survey as a critically important independent geodetic technique.

3. Site Survey Research

- Investigate new site survey methodologies, including observational techniques, observational modelling, invariant point definition, geometrical modelling and/or direct measurement techniques for invariant point determination, reference frame alignment and structural deformation analysis.

4. Future Planning

- The WG will make recommendations and prepare for the future in respect to the ongoing site survey needs of the community and how these needs will be met in the long term (to address issues outside of the scope of this WG);
- Develop recommendations as to how the community can provide the IERS database with all information relevant to inter-technique combination issues and to the maintenance of the ITRF: collect and archive SINEX files of local surveys with correct variance-covariance information, survey reports, site documentation and log files, maps, types of co-located instruments, list of site events (technique independent), etc.

Commission 2 – Gravity Field

web: http://www-geod.kugi.kyoto-u.ac.jp/iag-commission2/

President: **Yoichi Fukuda** (Japan)
Vice President: **Pieter Visser** (The Netherlands)

Terms of Reference

Accurate determination of the gravity field and its temporal variations is a prime target of modern geodesy. It is closely related to geophysics, geodynamics, navigation, metrology and other related disciplines including the Earth's environmental issues as well. To this end, Commission 2 was established at the IUGG in Sapporo in summer 2003 for promoting, supporting, and stimulating the advancement of knowledge, technology, and international cooperation in the geodetic domain associated with Earth's gravity field. In the last period of 2003-2007, Commission 2 has achieved its primary goals and has been ready for the next quadrennium. Moreover the major part of the associated scientific themes is of long-term interest so that the structure of Commission 2 essentially continues the one in the last period.

Commission 2, at the start of the new period, consists of four sub-commissions, six projects, two study group and several inter-commission projects, working groups, study groups. The sub-commissions cover following science themes; terrestrial, airborne, ship borne gravimetry and relative/absolute gravity networks; spatial and temporal gravity field and geoid modelling; dedicated satellite gravity missions; and regional geoid determination. The projects are established to organize work on unique and exceptional areas of interest or particular problems requiring specific international cooperation.

Commission 2 has strong links to sister commissions, ICCT, IGFS and other components of IAG. Connections to these components are created with inter-commission projects, working groups, study groups that provide a cross-disciplinary stimulus for work in several topics of interest to the commission.

Commission 2 has been expected to involve important problems in the next four years; for instance, analysis of a new type of data from new satellite gravity mission (GOCE); more accurate modelling of the temporal gravity field variation to understand mass transports; new observation technologies. A new Study Group (SG2.2) has been established to look at forward gravity modelling techniques for high-resolution gravity field recovery to assist in processing data from current and future satellite gravity missions. Other Study Groups/ Working Groups focused on well-defined subjects will be established as the need arises.

Objectives

The main objectives of Commission 2 are:

- terrestrial, airborne, ship borne, and satellite gravimetry.
- precise regional and global geoid determination and geopotential modelling.
- regional and global temporal variations in the gravity field.
- dedicated satellite gravity mapping missions.
- gravity determination from satellite altimetry.

Structure

Sub-Commissions

- SC2.1: Gravimetry and Gravity Networks
  President: Leonid F. Vitushkin (BIPM)
- SC2.2: Spatial and Temporal Gravity Field and Geoid Modelling
  President: Martin Vermeer (Finland)
- SC2.3: Dedicated Satellite Gravity Mapping Missions
  President: Roland Pail (Austria)
- SC2.4: Regional Geoid Determination
  President: Urs Marti (Switzerland)
- SC2.5: Satellite Altimetry
  President: Cheinway Hwang (Taiwan)

Commission Projects

- CP2.1: European Gravity and Geoid
  Chair: Heiner Denker (Germany)
- CP2.2: North American Geoid
  Chair: Dan Roman (USA)
- CP2.3: African Geoid
  Chair: Hussein Abd-Elmotaal (Egypt)
- CP2.4: Antarctic Geoid
  Chair: Mirko Scheinert (Germany)
- CP2.5: Gravity and Geoid in South America
  Chair: Maria Cristina Pacino (Argentina)
- CP2.6: South Asian and Australian Geoid
  Chair: Bill Kearsley (Australia)

Study Groups

- SG2.1: Comparisons of Absolute Gravimeters
  Chair: Leonid F. Vitushkin (BIPM)
- SG2.2: High-Resolution Forward Gravity Modelling for Improved Satellite Gravity Missions Results
  Chair: Michael Kuhn (Australia)

Inter-Commission Projects

- IC-P1.2: Vertical Reference Frames
  (Joint with Commission 1 and IGFS)
  Chair: Johannes Ihde (Germany)
  (Description see Commission 1)
- IC-P3.1: Global Geodynamics Project (GGP)
  (Joint with Commission 3)
  Chair: David Crossley (USA)
  (Description see Commission 3)

Inter-Commission Study Groups

- IC-P1.2: Vertical Reference Frames
  (Joint with Commission 1 and IGFS)
  Chair: Johannes Ihde (Germany))
  (Description see Commission 1)
- IC-SG4: Inverse Problems and Global Optimization
  Chair: Christopher Kotsakis (Greece)
  (Description see ICCT)
- IC-SG5: Satellite gravity theory
  Chair: Torsten Mayer-Gürr (Germany)
  (Description see ICCT)
- IC-SG8: Towards cm-accurate Geoid – Theories, Computational Methods and Validation
  Chair: Yan Ming Wang (USA)
  (Description see ICCT)

Inter-Commission Working Groups

- IC-WG2.1: Absolute Gravimetry
  (joint with IGFS)
  Chair: Herbert Wilmes (Germany)
- IC-WG2.2: Evaluation of Global Earth Gravity Models
  Chair: Jianliang Huang (Canada)
  (Description see IGFS)
- IC-WG1.2: Precise Orbit Determination and Reference Frame Definition
  Chair: Frank Lemoine (USA)
  (Description see Commission 1)
- IC-P3.1: Global Geodynamics Project (GGP)
  (Joint with Commission 3)
  Chair: David Crossley (USA)

Program of Activities

The Gravity Field Commission fosters and encourages research in the areas of its sub-entities by facilitating the exchange of information and organizing Symposia, either independently or at major conferences in geodesy. The activities of its sub-entities, as described below, constitute the activities of the Commission, which will be coordinated by the Commission and summarized in annual reports to the IAG Bureau.

The status of Commission 2, including its structure and membership, as well as links to the internet sites of its sub-entities and parent and sister organizations and services, will be updated regularly and can be viewed on the web site:

http://www-kugi.kyoto-u.ac.jp/iag-commission2/

Steering Committee

- President: Yoichi Fukuda (Japan)
- Vice President: Pieter Visser (The Netherlands)
- President SC2.1: Leonid F. Vitushkin (BIPM)
- President SC2.2: Martin Vermeer (Finland)
- President SC2.3: Roland Pail (Austria)
- President SC2.4: Urs Marti (Switzerland)
- President SC2.5: Cheinway Hwang (Taiwan)
- Representative of the IGFS: Rene Forsberg
- Representative of the International Centre of Global Earth Models: Jürgen Kusche
- Representative of GGP: Jacques Hinderer

Sub-Commissions

SC 2.1 Gravimetry and Gravity Networks

President: Leonid F. Vitushkin (BIPM)

Vice-President: Gerd Boedecker (Germany)

Terms of Reference and Objectives

Sub-commission 2.1 promotes scientific investigations of gravimetry, gravity measurements and gravity networks. It promotes the growth of the number of absolute gravity determination and of the number of the sites for such determinations. It provides the gravity community with the means to access the confidence in gravity measurements at the well-defined level of accuracy through organizing, in cooperation with metrology community, the international comparisons of absolute gravimeters. The sub-commission proceeds from such point-wise gravimetry to precise gravimetry/gradiometry which should cover, in particular, the land-sea border areas to resolve still existing problem of significant biases and errors in determination. The Sub-commission promotes such research and development by stimulating airborne and shipboard gravimetry and gradiometry. It encourages and promotes special absolute/relative gravity campaigns, techniques and procedures for the adjustment of the results of gravity surveys on a regional scale. Sub-commission encourages development of the Global Gravity Reference Network for GGOS. Through the inter-commission WG on Absolute Gravimetry the Sub-commission works on the standardization of absolute gravity data, software for absolute gravity measurement and appropriate information. The Sub-commission will encourage regional meetings or workshops dedicated to specific problems, where appropriate.

Program of Activities

To meet these goals, the Sub-commission sets up Special Study Group 2.1 on Comparisons of Absolute Gravimeters, inter-commission Working Group on Absolute Gravimetry (inter SC 2.1 and IGFS) and Commission Projects CP2.1-2.7

Structure

- Gravity Networks in Polar Regions (Rene Forsberg)
- Relative Gravimetry (Matthias Becker)
- Absolute Gravimetry (Herbert Wilmes)
- Superconductive Gravimetry (David Crossley)
- Aerogravimetry and Gradiometry (Uwe Meyer)
- East Asia and Western Pacific Gravity Networks (Yoichi Fukuda)
- Gravity in South America (Maria Cristina Pacino)

SC 2.2 Spatial and Temporal Gravity Field and Geoid Modelling

President: Martin Vermeer (Finland)

Terms of Reference

The subjects of study that the Sub-commission supports and promotes can be summarized, without claim to completeness, as follows. Research work in the spatial domain concentrates on:

- Global and regional gravity modelling
- Topographic/isostatic modelling
- Downward and upward continuation problems
- Boundary value problem approaches
- Spectral techniques like (but not limited to) spherical harmonics
- Height theory and height systems
- Geodetic aspects of satellite radar altimetry

Studies in the temporal domain of the gravity field include, among others, the following:

- Tides
- The effect of postglacial land uplift
- Time derivatives of the J_n
- Short/medium term gravity change due to movements of air and water
- Anthropogenic gravity changes.

Program of Activities

To meet these goals, the Sub-commission invites the establishment of Special Study Groups (SSG's) on relevant topics, promotes and organizes special sessions at IAG Symposia and other conferences, and reports on the research work in these areas of interest.

SC 2.3 Dedicated Satellite Gravity Mapping Missions

President: Roland Pail (Austria)

Terms of Reference

The successful launches of the German CHAMP (2000) and US/German GRACE (2002) missions have led to a revolution in global gravity field mapping by space-borne observation techniques, and provided valuable contributions to many geoscientific fields of application, such as geodesy, hydrology, oceanography/altimetry, glaciology, and solid Earth physics. These two missions have proven new concepts and technologies, such as space-borne accelerometry and low-low Satellite-to-Satellite Tracking (SST), in combination with more conventional observation techniques, like GPS SST and Satellite Laser Ranging (SLR). CHAMP and GRACE have already produced consistent long- to medium-wavelength global gravity field models and its temporal changes, and have supported the preparation for the European Space Agency (ESA) GOCE dedicated gravity field mission, which will further revolutionize high-accuracy and high-resolution gravity field mapping employing for the first time in history the satellite gravity gradiometry (SGG) observations.

Program of Activities

The focus of this sub-commission will be to promote and stimulate the following activities:

- generation of static and temporal global gravity field models based on observations by the satellite gravity missions CHAMP, GRACE, and GOCE, as well as optimum combination with complementary data types (SLR, terrestrial and air-borne data, altimetry, etc.), both on a global and a regional/local scale
- investigation of alternative methods and new approaches for gravity field modelling, with special emphasis on functional and stochastic models and optimum data combination
- identification, investigation and definition of enabling technologies for future gravity field missions: observation types, technology, formation flights, etc.
- communication/interfacing with gravity field model user communities (climatology, oceanography/altimetry, glaciology, solid Earth physics, geodesy, ...).

SC 2.4 Regional Geoid Determination

President: Urs Marti (Switzerland)

Terms of Reference and Objectives

Sub-Commission 2.4 is concerned with the following areas of investigation: regional geoid projects: data sets, involved institutions, comparison of methods and results, data exchange, comparison with global models, connection of regional models gravimetric geoid modelling techniques and methods, available software GPS/levelling geoid determination: methods, comparisons, treating and interpretation of residuals common treatment of gravity and GPS/levelling for geoid determination geoid applications: GPS heights, sea surface topography, integration of geoid models in GPS receivers, vertical datums. other topics: topographic effects, downward and upward continuation of terrestrial, airborne, satellite data specifically as applied to geoid modelling.

SC 2.5 Satellite Altimetry

President: Cheinway Hwang (Taiwan)

Terms of Reference

Over the past two decades, satellite altimetry has contributed to our understanding of the ocean, marine geodesy and geophysics, cryosphere, orbital science and solid earth geophysics. Recent technological advances in altimetry will further these understandings and applications, and foster new discoveries in earth sciences. This IAG sub-commission will serve as an interface between altimeter data and their users and promote the visibility of IAG in altimetric science . Selected highlights are:

- Establish a close link between this sub-commission and International Altimeter Service (IAS) to facilitate data distribution, problem solving and application.
- Promote new applications of satellite altimetry in solid earth science and environmental geodesy, e.g., studies of postglacial rebound, vertical displacements at major tectonic-active zone, melting of permafrost zones.
- Promote applications and evaluations of interferometric altimetry
- Promote interdisciplinary applications of altimetry in geodesy, geophysics and oceanography.
- Develop techniques to improve altimeter data quality in coastal zones and land

Program of activities

This sub-commission will help to organize independent workshops or special sessions in major meetings to promote altimetric applications in earth sciences, and to increase the visibility of IAG in altimetric science. Special study groups will be established to investigate important issues.

Commission Projects

CP 2.1 European Gravity and Geoid Project (EGGP)

Chair: Heiner Denker (Germany)

Terms of Reference and Objectives

Within the first 4-year term of this project from 2003 – 2007, a new geoid and quasigeoid model EGG07 was developed. The EGG07 model is a complete update compared to the previous computation from 1997 (EGG97), employing all high-resolution gravity and terrain data available for Europe in mid-2007 as well as a GRACE based global geopotential model (EIGENGL04C). The computation procedure was based on the remove-restore technique, residual terrain model reductions and the spectral combination approach. The evaluation of the EGG07 model by independent GPS and levelling data proved significant improvements as compared to the previous EGG97 model, indicating an accuracy potential of 0.03 – 0.05 m at continental scales and 0.01 – 0.02 m over shorter distances up to a few 100 km, provided that high quality and resolution input data are available.

The aim of this project for the time frame 2007 – 2011 is to further refine the geoid and quasigeoid modelling in Europe, continuing and extending the present contacts and successful cooperation with the respective national and international agencies.

The main topics of interest in the project include:

- improvement of a few land areas with insufficient gravity and terrain data (e.g., East Europe),
- improvement of the marine gravity data,
- utilization of improved satellite altimetry results,
- inclusion of GPS and levelling data,
- use of GOCE geopotential models,
- test of other modelling techniques,
- refinement of the mathematical modelling,
- development of location-dependent error estimates.

The project reports to Sub-Commission 2.4. It is organised by a steering committee and has national delegates (project members) from most of the countries in Europe.

Steering Committee

- Heiner Denker (Chair) (Germany)
- Riccardo Barzaghi (Italy)
- Rene Forsberg (Denmark)
- Johannes Ihde (Germany)
- Ambrus Kenyeres (Hungary)
- Urs Marti (Switzerland)
- Michel Sarrailh (France)
- Ilias Tziavos (Greece)

CP 2.2 North American Geoid

Chair: Dan Roman (USA)

Terms of Reference and Objectives

The primary objective of the Project is the development of a regional gravity field and geoid model for North America in order to achieve a common vertical datum. “North America" will encompass Iceland, Greenland, Canada, the U.S.A. (including Alaska and Hawaii), and Mexico as well as countries forming Central America, the Caribbean Sea, and the northern portions of South America.

Both Canada and the U.S.A. are moving towards the definition of new vertical datums based on gravimetric geoids, and other countries may adopt similar approaches if a suitable model is developed that meets their respective national interests. The intent here is to ensure a suitable North American Geoid is developed to serve as a common datum for everyone as well as the basis for a forthcoming International Great Lakes Datum model in 2015 (IGLD 15). Likewise, all countries in the region would be served by having access to a common model for translating oceanographic effects to terrestrial datums for various scientific, commercial, engineering, a disaster preparedness applications.

The achievement of a geoid model for North America will be accomplished by coordinating activities between agencies and universities with interest in geoid theory, gravity, gravity collection, gravity field change, geo-

physical modelling, digital elevation models (DEM), digital density model (DDM), altimetry, dynamic ocean topography, levelling and vertical datums. Of particular interest will be relating geoid and ocean topography models to ocean topography and tidal bench marks.

The determination of a geoid model for North America is not limited to a single agency, which will collect all necessary data from all countries. The Project encourages theoretical diversity in the determination of a geoid model between the agencies. Each agency takes responsibility or works in collaboration with neighbouring countries in the development of a geoid model for their respective country with an overlap (as large as possible) over adjacent countries. Each solution will be compared, the discrepancies will be analyzed, and the conclusions will be used to improve on the next model.

Program of Activities

The Project will support geoid activities in countries where geoid expertise is limited by encouraging more advanced members to contribute their own expertise and software. The Project will encourage training and education initiative of its members (e.g., International Geoid Service (IGeS geoid school and graduate studies).

The chair of the Project will meet with the equivalent European and South American projects to discuss overlap regions and to work towards agreements to exchange data. Finally, the members of the Project will keep close contact with all related Study Groups of the IAG. The Project is open to all geodetic agencies and universities across North America with an interest in the development of a geoid model for North America. The meetings of the Commission Project 2.2 are open to everyone with interests in geodesy, geophysics, oceanography and other related topics.

Members will communicate primarily using e-mails. However, members of the Project plan to arrange annual meetings. Preferably, these meetings will be held during international conferences where most members will be present; however, some meetings will be held in North America to minimize travel costs. Minutes of meeting will be prepared and sent to all members of the Project.

Membership

- Daniel R. Roman (chair, NGS/U.S.A.)
- Marc Veronneau (GSD/Canada)
- Rene Forsberg (KMS/Greenland)
- Per Lyster Pedersen (ASIAQ/Greenland)
- Antonio Hernandez Navarro (INEGI/Mexico)

CP 2.3 African Geoid

Chair: Hussein Abd-Elmotaal (Egypt)

Terms of Reference

The African Geoid Project (AGP) is a project of Commission 2 of the International Association of Geodesy (IAG). The main goal of the African Geoid Project is to determine the most complete and precise geoid model for Africa that can be obtained from the available data sets. Secondary goals are to foster cooperation between African geodesists and to provide high-level training in geoid computation to African geodesists.

Objectives

The objectives of the project are summarized as follows:

- Identifying and acquiring data sets - gravity anomalies, DTM's, GPS/levelling.
- Training of African geodesists in geoid computation.
- Merging and validating gravity data sets, producing homogenous gravity anomalies data set ready for geoid computation.
- Computing African geoid.
- Evaluating the computed geoid using GPS/levelling data.

Full Members

- Hussein Abd-Elmotaal (Chair) (Egypt) (abdelmotaal@lycos.com)
- Charles Merry (South Africa) (cmerry1@gmail.com)
- Benahmed Daho (Algeria) (d_benahmed@hotmail.com)
- Hassan Fashir (Sudan) (fashir@lycos.com)
- Saburi John (Tanzania) (saburi@uclas.ac.tz)
- Peter Nsombo (Zambia) (pnsombo@eng.unza.zm)
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- Solofo Rakotondraompiana (Madagascar) (sorako@syfed.refer.mg).

CP 2.4 Antarctic Geoid

Chair: Mirko Scheinert (Germany)

Terms of Reference and Objectives

The main goal of AntGP is to work towards a continent-wide determination of the Antarctic geoid on basis of a completed Antarctic terrestrial gravity dataset. However, Antarctica remains the continent with the largest gaps in terrestrial gravity data coverage. A complete gravity dataset of the Antarctic will be needed in order to facilitate the regional geoid determination, to contribute to the determination of the global gravity field in combination with data of the new gravity satellite missions GRACE and GOCE, but also to densify the satellite data. Therefore, the compilation of existing gravity data should be pursued and new observation campaigns should be promoted. The Antarctic Geoid Project (AntGP) should be a focus group for geodesists and geophysicists interested in gravity and geoid in Antarctica.

Activities

- Initiating and facilitating the exchange of Antarctic gravity field data
- Collecting and evaluating existing gravity data (surface, airborne and satellite) and GNSS data at tide gauges to compute best possible gravity anomaly and geoid grids for Antarctica
- Promoting new terrestrial and airborne gravity survey activities
- Promoting new precise gravity ties to older and new traverses and airborne surveys
- Promoting the measurement of reference gravity stations, especially using absolute gravity meters
- Liasing with similar data initiatives in solid-earth geophysics, especially the Scientific Committee on Antarctic Research (SCAR), and the International Polar Year 2007/2008 (IPY).

Membership

- Mirko Scheinert (chair), TU Dresden, Germany
- Martine Amalvict, Université Strasbourg, France
- Alessandro Capra, Università di Modena a Reggio Emilia, Italy
- Detlef Damaske, BGR Hannover, Germany
- Reinhard Dietrich, TU Dresden, Germany
- Fausto Ferraccioli, British Antarctic Survey
- Rene Forsberg, Danish National Space Centre
- Larry Hothem, USGS, USA
- Cheinway Hwang, National Chiao Tung University, Taiwan
- Wilfried Jokat, AWI Bremerhaven, Germany
- Gary Johnston, Geoscience Australia
- A.H. William Kearsley, University of New South Wales, Australia
- Steve Kenyon, NIMA, USA
- German L. Leitchenkov, VNIIOkeangeologia, Russia
- Jaakko Mäkinen, FGI, Finland
- Kazuo Shibuya, NIPR, Japan
- C.K. Shum, OSU Columbus, USA
- Dag Solheim, Statens Kartverk, Norway
- Michael Studinger, Lamont-Doherty Earth Observatory, USA

Corresponding Members

- Graeme Blick, LINZ, New Zealand
- Dave McAdoo, National Oceanic and Atmospheric Administration, USA

CP 2.5 Gravity and Geoid in South America (GGSA)

Chair: Maria Cristina Pacino (Argentina)

Terms of Reference and Objectives:

The project entitled Gravity and Geoid in South America, as part of the Commission II of IAG, was established as an attempt to coordinate efforts to establish a new Absolute Gravity Network in South America, to carry out gravity densification surveys, to derive a geoid model for the continent as a height reference and to support local organizations in the computation of detailed geoid models in different countries.

Besides, a strong effort is being carried out in several countries in order to improve the distribution of gravity information, to organize the gravity measurements in the continent and to validate the available gravity measurements.

The main objectives of the project are:

a) To re-measure the existent absolute gravity stations and to encourage the establishment of new stations.

b) To validate fundamental gravity network from different countries in order to establish a single and common gravity network for South America.

c) To adjust national gravity networks and to link them together.

d) To obtain and to maintain files with data necessary for the geoid computation like gravity anomalies, digital terrain models, geopotential models and satellite observations (GPS) on the levelling network of different countries.

e) To provide a link between the different countries and the International Geoid Service in order to assure access to proper software and geopotential models for local geoid computation.

f) To compute a global geoid model for South America with a resolution of 5´ x 5´ using the available data. To encourage countries to cooperate by releasing data for this purpose.

g) To encourage and eventually support local organizations in different countries endeavouring to increase the gravity data coverage, to improve the existing digital terrain models, to carry out GPS observations on the levelling network and to compute a high resolution geoid.

h) To organize and/or encourage the organization of workshops, symposia or seminars on gravity and geoid determination in South America.

i) To test and to use future geopotential models derived from the modern missions (GRACE and GOCE) as well as any new combined model (e.g. GGM2007).

Links to be established in the Project

- Bureau Gravimétrique International (BGI)
- International Geoid Service I – Milan
- International Geoid Service II – Saint Louis
- University of Leeds – GETECH
- SIRGAS

Coordinator

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Membership

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- Mauro Andrade de Sousa (Brazil)
- Eduardo Andrés Lauría (Argentina)
- Rodrigo Maturana Nadal (Chile)
- Jose Napoleon Hernandez (Venezuela)
- Alfonso R. Tierra C. (Ecuador)
- Corresponding Members
- Roberta P. Rodino (Uruguay)
- Fabian Barbato (Uruguay)
- Melvin Jesus Hoyer Romero (Venezuela)
- Graciela Font (Argentina)
- Rodrigo Barriga Vargas (Chile)
- Lorenzo A. Centurion (Paraguay)

CP 2.6 South Asian and Australian Geoid

Chair: Bill Kearsley (Australia)

1. Charter

To promote cooperation in and knowledge of the geoid and related studies in the region of South East Asia.

2. Organisation

2.1 Target Membership

Countries in and associated with ASEAN and countries in the region including The Philippines, Papua New Guinea, Indonesia, Malaysia, Singapore, Brunei, Thailand, Vietnam, Cambodia, Laos, Myanmar, and Australia and New Zealand. Because of the synergy which exists between the objectives of this Committee and those of the Geodesy Working Group of the UN Permanent Committee For GIS Infrastructure for Asia and the Pacific (PCGIAP), it seems logical to extend the borders of the subject region to those covered by this UN Committee which have geographical connections with the above countries.

2.2 Sub-Commission Structure

I feel that the executive should be small to ensure efficiency, and that the Committee should comprise one member from each participating country. Because of the need to carry national authority, the national member is logically the officer in the country's National Geodetic Authority responsible for the National Geoid and/or National Height Datum matters.

3. Topics of Interest

3.1. Gravity and Related Data

Explore ways in which we may

a) share available gravity data (e.g. via International Gravity Bureau; GETECH, University of Leeds; USGS Data Centre)
b) share available DEM's along common borders (National Geodetic Authorities)
c) combine resources for terrestrial gravity surveys along common borders
d) combine resources for airborne gravity surveys in the region.

Clearly an important phase of this study is to identify and catalogue the gravity that exists – including the recently observed airborne campaigns. It is also important to establish a protocol for sharing the data. National authorities may be reluctant to give all the data available and at the precision available. It should be possible for geoid evaluation purposes, however, to decrease the resolution and accuracy of data shared along common borders without either comprising the precision of the geoid significantly, or the security of the national data shared.

3.2 Geoid Control

Explore ways in which countries of the region may cooperate by

a) sharing geometric (GPS/levelling) geoid control data
b) combining efforts in global GPS campaigns (e. g., IGS'92)
c) undertaking joint campaign for the inter-connection of National Height Datums.

In such campaigns as these the activities of the PCGIAP group would be most relevant.

3.3 Education and Research

Encourage and sponsor, for the region,

a) meetings and workshops, in co-operation with the International Geoid Service, (such as the IAG Workshop on Height Systems, Geoid & Gravity of the Asia Pacific held in Ulan Bataar, Mongolia in June, 2006) to foster understanding in the evaluation and use of gravimetric geoids, and in their application to heighting with GPS.
b) technical sessions in scientific and professional conferences
c) research into matters of common concern/interest.

Study Groups

SG 2.1 Comparisons of Absolute Gravimeters

Chair: Leonid F. Vitushkin (BIPM)

Terms of Reference

Absolute ballistic gravimeters have become the primary measurement standards in gravimetry in the field of the measurement of free-fall acceleration. Currently the only way to determine the level of accuracy of the absolute ballistic gravimeters and provide the uniformity in absolute measurements of free-fall acceleration is by a comparison of the results of their measurements.

The principal task of the Special Study Group consists of organization (in collaboration with the BIPM (*http://www.bipm.org*), Working Group on Gravimetry of Consultative Committee on Mass and Related Quantities – CCM WGG) of the four-year period International Comparisons of Absolute Gravimeters (ICAGs) at the BIPM and Regional International Comparisons of Absolute Gravimeters (RICAGs) at the sites selected on a continental scale. The next Eighth ICAG should be held in 2009.

The increasing demand for reliability and confidence in absolute gravity measurements requires further improvement of a technical protocol, developed for the first time for the Seventh ICAG in 2005, for the future ICAGs and RICAGs. Such a protocol should be developed according the rules of the international Mutual Recognition Arrangement for national measurement standards and for calibration and measurement certificates issued by National Metrology Institutes.

The relevance to the SG is that its members are the specialists from geodetic and geophysical communities, as well as the metrological community and this study group is more to participation than more official CCM WGG where the membership is related to the institutes responsible for the traceability in gravimetry. Such intercommunications within the Study Group as well as a linkage between this group and CCM WGG will make it possible to develop the ICAGs and RICAGs technical protocol accepted by both communities.

The sites for regional comparisons of absolute gravimeters (in America, Asia, Europe, and Africa) should be recommended by the geodetic-geophysical community and related to regional structures of metrology community (Regional Metrology Organization, for example, EURAMET – European Metrology Organization, SIM – Inter-American Metrology System, etc.).

Objectives

- The organization (in collaboration with the Bureau International des Poids et Mesures (BIPM) and Working Group on Gravimetry of Consultative Committee on Mass and Related Quantities (CCM WGG) of the four-year period International Comparisons of Absolute Gravimeters (ICAGs) at the BIPM and Regional International Comparisons of Absolute Gravimeters (RICAGs) at the sites selected on a continental scale.
- The selection of the sites for regional (on a continental scale) comparisons of absolute gravimeters in collaboration with other working groups of Sub-Commission 2.1, CCM WGG and inter-commission SC 2.1 – IGFS Working Group on Absolute Gravimetry.

Membership

- Matthias Becker (Germany)
- Gleb Demianov (Russian Federation)
- James Faller (USA)
- Olivier Francis (Luxembourg)
- Alessandro Germak (Italy)
- Jacques Hinderer (France)
- Alexandr Kopaev (Russian Federation)
- Jaakko Mäkinen (Finland)
- Shigeki Mizushima (Japan)
- Jan Mrlina (Czech Republic)
- Andrzej Pachuta (Poland)
- Vojtech Palinkas (Czech Republic)
- Enrique Rodriguez Pujol (Spain)
- Ian Robinson (United Kingdom)
- Diethard Ruess (Austria)
- Yury Stus (Russian Federation)
- Michel Van Camp (Belgium)
- Simon Williams (United Kingdom)

SG 2.2 High-Resolution Forward Gravity Modelling for Improved Satellite Gravity Missions Results

Chair: Michael Kuhn (Australia)

Terms of Reference and Objectives

With the launch of the new satellite gravity missions CHAMP, GRACE and in future GOCE a new era of modelling the static as well as time-variable Earth's gravity field has begun. Currently, GRACE time-variable gravity observations attract enormous interest across all geo-sciences, which is due to the unprecedented spatial and temporal resolution and precision on a global and regional scale. However, local gravity field modelling still requires additional high-resolution information such as from terrestrial gravity observations or local topography data. Especially, for the latter high-resolution global, regional and local digital elevation models (DEMs) are available with resolutions down to about 100 m by 100 m on a global scale (e.g. 3-arc-sec by 3-arc-sec SRTM-derived terrain models) or well below the 100 meter-level for regional and local DEMs. Furthermore, the DEM data are complemented with an increasing number of geological and geophysical information describing mass-density variations within the Earth's interior. Today these data allow for the use of forward gravity modelling techniques (direct application of Newton's integral) in order to recover high-resolution gravity field information on a local, regional and global scale.

This IAG Study Group (SG) focuses on the application of forward gravity modelling techniques for high-resolution gravity field recovery with the specific aim to assist in processing data from current and future satellite gravity missions. This can be two-fold either introducing the high-resolution gravity information to results of the gravity missions or the removal of the same from satellite gravity observations. The SG will mostly focus on the following topics:

- Derivation and analysis of the Earth's gravity field's high-resolution content on a local, regional and global scale. This involves the use and analysis of high-resolution DEMs and mass-density information of mostly the topographic masses.
- Provision of high-resolution gravity field corrections/ reductions and anomalies to the geodetic and wider research community. In a longer-term this could result into a special gravity field service.
- Review of forward gravity modelling techniques in the space domain with particular view on fast algorithms not requiring the introducing of considerable approximations. Such algorithms are vital for the derivation and provision of global forward gravity modelling results.
- As an application the SG will also focus on the construction of high-resolution synthetic Earth gravity models (SEGMs) partly or completely based on forward gravity modelling.

The SG can be seen as a logical continuation of IAG SSG 3.117 and IAG SG 2.2. While the former mostly looked into the construction of SEGMs the latter had a broad view on forward gravity modelling. The proposed SG will build on the experience of these study groups and focuses on a rather narrow application of forward gravity modelling, which is of great importance to the processing and analyzing of observations and results from current and future satellite gravity missions.

The SG is open to researchers of any discipline who feel that are able to actively contribute to its aims. Furthermore, members should be prepared to participate in special focus groups looking into particular aspects within the SG. It is aimed that the SG meets on a regular basis (e.g. once a year) during major conferences of the IAG or other related societies. Apart from these formal meetings communication within the SG will be mostly by e-mail and the setup of a designated webpage.

Membership

- Michael Kuhn (Chair) (Australia), m.kuhn@curtin.edu.au
- Hussein Abd-Elmotaal (Egypt)
- Heiner Denker (Germany)
- William Featherstone (Australia)
- Jakob Flurry (Germany)
- Thomas Gruber (Germany)
- Michael Kern (Austria)
- Atef Makhaloof (Germany)
- Pavel Novak (Czech Republic)
- Spiros Pagiatakis (Canada)
- Roland Pail (Austria)
- Nikolaos Pavlis (USA)
- Gabor Papp (Hungary)
- Dan Roman (USA)
- Gabriel Strykowski (Denmark)
- Gyula Toth (Hungary)
- Dimitris Tsoulis (Greece)
- Yan Wang (USA)
- Insa Wolf (Germany)

Inter-Commission Working Groups

IC-WG 2.1 Absolute Gravimetry

(Joint with IGFS)
Chair: Herbert Wilmes (Germany)

Terms of Reference and Objectives

The Sub-Commission 2.1 "Gravimetry and Gravity Networks", promotes scientific investigations of gravimetry and gravity networks, terrestrial, airborne, shipboard and planetary gravity measurements. One of the outputs of the SC 2.1 activities is the result of gravity measurements, i.e. the gravity data.

The International Gravity Field Service IGFS coordinates the servicing of the geodetic and geophysical community with gravity field-related data, software and information.

The scientific community of IAG demands more detailed information about the Earth gravity field by precise terrestrial absolute gravity (AG) observations in an evenly distributed station network and with an improved timely coverage by repeated AG measurements and/or additional superconducting gravity (SG) observations. This is accentuated by the Global Geodetic Observing System GGOS. For consistent evaluation and combination of gravimetric and geometric observations, the applied correction models, parameters and constants need to be compared and standardized.

Currently the role of absolute gravimetry increases which is related to a growing number of absolute ballistic gravimeters (ABG) and the rising number of AG measurements worldwide. The philosophy of gravity measurements is changing from the rare AG determinations at a few principal network stations to repeated absolute observations at hundreds of sites accompanied in some cases by measurements of temporal gravity variations using superconductive (relative) gravimeters.

Absolute ballistic gravimetry is based on the primary method of measurement of free-fall acceleration. The accuracy of ABGs is determined in the international comparisons. The set of ABG with the determined uncertainty in the measurements provides the can we use valuable means to establish a gravity network of global scale with well-maintained stations where the gravity field variations can be monitored. Several ABGs with the determined metrological characteristics may be used for monitoring the gravity variations related, in particular, to changes of the solid Earth's geometry and mass distribution, hydrology or atmosphere variations, etc.

Considering the role of absolute gravity measurements for the knowledge of the gravity field and its temporal variations, the requests from IGFS and the results of the discussions at the round table during the IGFS Symposium in Istanbul (2006) and at the 2nd (2006) and 3rd (2007) Joint Meetings of CCM Working Group on Gravimetry and SC 2.1 Study Group 2.1.1 on Comparisons of Absolute Gravimeters the President of Sub-Commission 2.1 "Gravimetry and Gravity Networks" lead to the decision to establish a new "Working Group on Absolute Gravimetry".

This group will be the inter Sub-Commission 2.1 and IGFS working group which will report to SC 2.1 and IGFS. In reality, this WG 2.1.1 should be even more integrating because of the wide requests for the absolute gravity data from other sub-commissions and projects of Commission 2.

The proposed Working Group on Absolute Gravimetry will have following objectives and tasks:

1. Design and promotion of a worldwide network of AG stations, repeated absolute observations and improved measurement procedures:

   The group should

   - encourage station providers to repeat their observations (and even help to enable repeated occupations),
   - establish a worldwide network of AG stations, which should partly coincide with the regional sites for the comparisons of AGs.
   - encourage the combined AG and SG measurements and determination of precise gravity time series. This should be carried out in close cooperation with the Global Geodynamics Project GGP.

2. Enable the combination of AG measurements with geometric measurements (GNSS, SLR, VLBI) and the development of the methods for the identification of mass changes and the methods for specific investigations.

3. Work with already observed data, advance and test a database tool in close cooperation with BGI, work on standardization of absolute gravity data presentation, establish and promote the AG meta-database for storage and worldwide distribution of AG data, compile and fix parameters and models for the homogeneous evaluation of AG measurements. This database should improve the visibility of AG measure-

ments and support cooperation of partners working in gravity and other disciplines.

This document was prepared by Leonid Vitushkin and Herbert Wilmes (BKG, Germany). Herbert Wilmes' candidacy to chair a new WG 2.1.1 is proposed by L. Vitushkin and R. Forsberg.

IC-WG 2.2 Evaluation of Global Earth Gravity Models

(Joint with IGFS)

Chair: Jianliang Huang (Canada)

Terms of Reference and Objectives

The US/German GRACE satellite gravity mission, launched in 2002, has succeeded in determining the Earth's gravity field with an average accuracy of tens microGals, equivalent to a few centimetres in the geoid height signal, at a spatial resolution of about 250 km. In the meantime, the coverage and quality of surface gravity and elevation data over land and ocean areas has been also improving significantly with a number of airborne gravity campaigns in Arctic and Asia, several ongoing terrestrial gravity surveys worldwide, and a US space shuttle mission for the past decade. Due to these advances, the National Geospatial-Intelligence Agency, US, has been undertaking a revolutionary project to upgrade its benchmark Earth Gravity Model (EGM96) to a new improved version EGM07, with an expected average geoid accuracy of better than 20 cm and a spatial resolution of 10 km, in order to meet the requirements from various scientific and industrial sectors.

The upcoming European GOCE mission will be mapping the Earth's gravity field with the same level of accuracy and a spatial resolution of about 100 km. A series of GOCE-based global gravity models are expected to be available in the next few years, contributing additional and valuable knowledge to global gravity field mapping. The evaluation of such EGMs is commonly based on comparisons with other "external" data sets that depend on the same gravity field. The EGM07 development team and various other centres responsible for the development of global gravity field models routinely perform such comparisons using a variety of validation data sets, such as geoid heights from GPS and spirit levelled heights, airborne and surface gravity measurements, marine geoid heights from mean oceanographic sea surface topography models and altimetry observations, orbits from other geodetic and altimetry satellites etc.

In response to the call of having an independent, coordinated and inclusive team for the evaluation of the new EGMs, a Joint Working Group (JWG) was established between IGFS and the IAG Commission 2 in 2005. The main objective of the JWG is to develop standard validation/calibration procedures, and to perform the quality assessment of GRACE-, CHAMP- and GOCE-based satellite-only and combined solutions for the static Earth's gravity field, especially EGM07. For the past three years, many members of this group had conducted intensive evaluations for the CHAMP- and GRACE-based released models. Their contribution to the quality analysis and improvement of these models has been well recognized in the international geodetic community. Significant progress has been made in developing new validation/calibration methods as well. Due to the ongoing demand for most of its objectives, the group will continue to work during the next four years towards the evaluation of global Earth gravity models, using existing and new validation procedures.

Another equally important EGM evaluation topic is with respect to the temporal variation of the Earth's gravity field features derived from GRACE monthly solutions. The repeated absolute/relative gravity measurements and super-conducting gravity observations provide the most accurate temporal variation on the ground level. As part of the initiative, validation/calibration methods for temporal gravity variation will be explored.

Program of Activities

1. The JWG creates opportunities through communication and workshops/conferences for international cooperation to develop and propose standard methods for evaluating global EGMs using external geodetic and oceanographic data. A specific research area of interest will be the issue of how to handle the different spectral content of satellite-based global gravity field models and terrestrial gravity data.
2. The JWG conducts evaluation of new global EGMs, especially EGM07.
3. The JWG compiles a global set of high-quality GPS-levelling data.
4. The JWG explores evaluation methods for temporal gravity variation.
5. The WG encourages active participation and contribution from its members through email contact, conferences/meetings, scientific presentations and publications.

6. A WWW site will be maintained to facilitate communication, information and data exchanges.

The Joint Working Group reports to IGFS and the Commission 2.

Membership

- Jianliang Huang (Chair) (Canada)
- Christopher Kotsakis (Vice-Chair) (Greece)
- Hussein Abd-Elmotaal (Egypt)
- Benahmed Daho Sid Ahmed (Algeria)
- Jonas Ågren (Sweden)
- Denizar Blitzkow (Brazil)
- Minkang Cheng (USA)
- Heiner Denker (Germany)
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- Will Featherstone (Australia)
- Thomas Gruber (Germany)
- Cheinway Hwang (Taiwan)
- Ali Kilicoglu (Turkey)
- Roland Klees (The Netherlands)
- Jaroslav Klokocnik (Czech)
- Yuki Kuroishi (Japan)
- Jiancheng Li (China)
- Charles Merry (South Africa)
- Pavel Novak (Czech)
- Joe Olliver (UK)
- Maria Pacino (Argentina)
- Erricos C. Pavlis (USA)
- Dan Roman (USA)
- Marcelo Santos (Canada)
- Nico Sneeuw (Germany)
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Commission 3 - Geodynamics and Earth Rotation

web: http://www.earthsciences.osu.edu/IAG-C3

President: **Michael Bevis** (USA)
Vice President: **Richard Gross** (USA)

Terms of Reference

Geodynamics in the broader and most traditional sense addresses the forces that act on the earth, whether they derive from outside or inside of our planet, and the way in which the earth moves and deforms in response to these forces. This includes the entire range of phenomena associated with earth rotation and earth orientation such as polar motion, length of day variation, precession and nutation, the observation and understanding of which are critical to the transformation between terrestrial and celestial reference frames. It also includes tidal processes such as solid earth tides and ocean loading tides.

During the last few decades many geophysicists have come to use geodynamics in a more restricted sense to address processes such as plate tectonics and postglacial rebound that are dominantly endogenic processes. Because the earth as a mechanical system responds to both endogenic and exogenic forces, and these responses are sometimes coupled, Commission 3 studies the entire range of physical processes associated with the motion and the deformation of the solid earth. The purpose of Commission 3 is to promote, disseminate, and, where appropriate, to help coordinate research in this broad arena.

Sub-commission 3.1 (Earth Rotation and Earth Tides) addresses the entire range earth rotation phenomena including tidal deformation. Sub-commission 3.2 (Tectonic Deformation) addresses the entire range of tectonic phenomena including plate tectonics, intraplate deformation, the earthquake deformation cycle, a-seismic phenomena such as episodic tremor and slip, and volcanic deformation. Sub-commission 3.3 (Geophysical Fluids) addresses the space-time variation of atmospheric pressure, seafloor pressure and the surface loads associated with the hydrological cycle, and earth's (mainly elastic) responses to these mass redistributions. Sub-commission 3.4 (Cryospheric Change and Earth Deformation) addresses the earth's instantaneous and delayed responses to ice mass changes, including seasonal (cyclical) mass changes and progressive changes associated with climate change. This group will study postglacial rebound at all spatial scales, and also the elastic deformation taking place in the near-field of existing ice sheets and glaciers.

The areas addressed by the various sub-commissions sometimes overlap. Commission 3 also has overlapping interests with other entities within the IAG, and with Commissions in other Associations such as the International Astronomical Union (IAU). The recent space mission GRACE has expanded our common interests with IAG Commission 2 (Gravity) since temporal changes in gravity are associated with both with the drivers of earth deformation (e.g. changing ice and loads) and with earth's response to these and other forcing.

Objectives

To develop cooperation and collaboration the theory, modelling and observation of Earth rotation and geodynamics, and to ensure development of research in these areas by organizing meetings, symposia, and general assemblies, by creating working groups on specific topics, and by encouraging exchange of ideas and data, comparisons of methods and results improving the accuracies, content, methods, theories, and understanding of Earth rotation and geodynamics. To serve the geophysical community by linking them to the official organization providing the International Reference Systems/Frames and Earth orientation parameters (IERS and related bodies), and organizations providing all the other data on which geodynamics and Earth rotation studies can be performed.

Structure

Sub-Commissions

- SC 3.1: Earth Rotation and Earth Tides
  President: Gerhard Jentzsch (Germany)
- SC 3.2: Tectonic Deformation
  President: Markku Poutanen (Finland)

- SC 3.3: Geophysical Fluids
  President: Aleksander Brzezinski (Poland)
- SC 3.4: Cryospheric Change and Earth Deformation
  President: James Davis (USA)

Inter-Commission Project

- IC-P3.1: Global Geodynamics Project (GGP)
  (Joint with Commission 2)
  Chair: David Crossley (USA)
- IC-P3.2: Working Group of European Geoscientists for the Establishment of Networks for Earth science Research (WEGENER)
  (Joint with Commission 1)
  Chair: Susanna Zerbini (Italy)

Inter-Commission Study Groups

- IC-SG6: InSAR for Tectonophysics
  Chair: Masato Furuya (Japan)
  (see ICCT)
- IC-SG7: Temporal Variations of Deformation and Gravity
  Chair: Detlef Wolf (Germany)
  (see ICCT)

Program of Activities

Commission 3 fosters and encourages research in the areas of its sub-entities by facilitating the exchange of information and organizing Symposia, either independently or at major conferences in geodesy or geophysics. Some events will be focused narrowly on the interests of the sub-commissions and other entities listed above, and others will have a broader commission-wide focus. Our activities will be announced on our main website *www.earthsciences.osu.edu/IAG-C3*.

Steering Committee

- President: Michael Bevis (USA)
- Vice President: Richard Gross (USA)
- President SC3.1: Gerhard Jentzsch (Germany)
- President SC3.2: Markku Poutanen (Finland)
- President SC3.3: Aleksander Brzezinski (Poland)
- President SC3.4: James Davis (USA)
- President IC-P3: David Crossley (USA)
- President IC-SG7: Detlef Wolf (Germany)
- Representative of IGFS: Srinivas Bettadpur (USA)

Sub-Commissions

SC 3.1 Earth Rotation and Earth Tides

President: Gerhard Jentzsch (Germany)
http://www.geo.uni-jena.de/geophysik/etc/

Terms of Reference

Sub-commission 3.1 (Earth Rotation and Earth Tides) addresses the entire range of earth rotation phenomena including tidal deformation, both on the experimental as well as on the theoretical level.

Earth tides and Earth rotation observations have a very long tradition. These observations led to the discovery of the Earth's elastic properties which cause tidal deformation and variations in Earth orientation and rotation parameters. The phenomena responsible for these variations include the full range of periodic and non-periodic phenomena like Earth tides and ocean tidal loading, atmospheric dynamics as well as plate tectonics and intraplate deformation. The periods range from seismic normal modes over Earth tides until the Chandler Wobble and beyond. Thus, the time scales range from seconds to years and for the spatial scales from millimetres to continental dimension.

As tidal friction is affecting Earth rotation, all the geophysical properties of the Earth contribute to the explanation of this phenomenon. Therefore, the research on tidal deformation due to tidal potential and ocean loading are a prerequisite to answer such questions.

Further, Earth tides and loading tides are affecting the position of fiducial sites and have to be corrected for providing stable references. Such references are needed for the observation and monitoring of changes at the Earth's surface at global, regional and local scales. Therefore, there is a considerable contribution to global geodynamics as well as to climate changes by supplying primary constraints for the correction of other observations, and also for modelling processes of the planet as a whole as well as for understanding geophysical phenomena occurring at smaller scales.

Tidal gravimetry has helped to improve the knowledge about Earth's dynamics, as well as about Earth's global structure. It is a powerful tool providing information to global terrestrial gravity field and its temporal variations. Especially superconducting gravimeters allow continuous monitoring of the gravity signal at a given site with a pre-

cision of better than 10^{-10}. These geophysical observation together with other geodetic observations and geological sources of information provide the means to understanding the structure, dynamics and evolution of the Earth system.

Last but not least SC3.1 is also responsible for the International Centre of Earth Tides (ICET), which is to be moved from the Royal Observatory of Brussels, Belgium, to the French University of Polynesia, Tahiti.

Objectives

General objectives of the Sub-Commission 3.1 include:

- to study new observation techniques;
- to study the relation between Earth tides and ocean tides;
- to study the effects of meteorologic parameters on the observations;
- to study the dynamics of the Earth at tidal and non-tidal frequencies;
- to study the interplay of tides and Earth rotation;
- to study tides on the planets;
- to study the effects of ocean loading and global water distribution;
- to organize working groups on specific topics;
- to promote, develop and coordinate international conferences and programs related to observations, analysis and data interpretation for the fields mentioned above;
- to contribute reference frame related work in order to better understand deformations and improve global, regional and local reference frames and their dynamical modelling;
- to promote the development of appropriate models;
- to advice the International Centre of Earth Tides (ICET).

The sub-commission is aware that the objectives of the IAG Global Geodetic Observing System (GGOS) including e.g.

- the integral effect on Earth rotation of all angular momentum exchange inside the Earth, between land, ice, hydrosphere and atmosphere, and between the Earth, Sun, Moon, and planets,
- the geometric shape of the Earth's surface (solid earth, ice and oceans), globally or regionally, and its temporal variations, whether they are horizontal or vertical, secular, periodical or sudden, and
- by adding the Earth's gravity field-stationary and time-variable-mass balance, fluxes and circulation

are in close relation to our objectives. Therefore, SC3.1 also touches the topic ‘Tidal effects in the framework of GGOS’.

Structure and Forms of Activities

The Sub-Commission 3.1 on Earth rotation and Earth tides has a President and a Vice-President. National representatives are involved into preparations of conferences as well as into the considerations concerning the award of the **Earth Tide Medal**.

Further, SC3.1 comprises working groups to work for different sub-topic s like:

- Earth Tides in Geodetic Space Techniques, co-chaired by H. Schuh and Wu Bin;
- Analysis of Environmental Data for the Interpretation of Gravity Measurements, co-chaired by C. Kroner and G. Jentzsch, and
- Gravitational Physics, chaired by L. Mansinha, as well as
- Precise Tidal Prediction, chaired by Y. Tamura.

Beside the organization of special sessions at international meetings, the SC3.1 will continue to organize a symposium every four years (next in Jena in September, 2008: *www.ets2008.de*). In between these symposia, a comprehensive working group meeting together with the GGP-project was and will be organized again. We will continue to publish the outcome of these meetings in proceedings, either separate ones or as special issues of scientific journals.

Related Working Groups

First, SC3.1 is linked to the sub-commissions SC3.2 and SC3.3, and the next Earth Tide Symposium will be organized as a joint meeting covering a broader range of topics.

The inter-commission project GGP (Global Geodynamics Project) was promoted by the previous sub-commission, and future cooperation is one main focus. Other inter-commission study groups can be included if possible.

SC3.1 will also cooperate with GGOS, as mentioned above.

SC 3.2 Tectonic Deformation

President: Markku Poutanen (Finland)
Vice President: Jeffrey Freymueller (USA)
http://iagsc32.fgi.fi/

Terms of Reference

There are many geodetic signals that can be observed and are representative of the deformation mechanisms of the Earth's crust at different spatial and temporal scales. This include the entire range of tectonic phenomena including plate tectonics, intraplate deformation, the earthquake deformation cycle, a-seismic phenomena such as episodic tremor and slip, and volcanic deformation. The time scales range from seconds to years and from millimetres to continental dimension for the spatial scales.

Space geodetic measurements provide nowadays the means to observe deformation and movements of the Earth's crust at global, regional and local scales. This is a considerable contribution to global geodynamics by supplying primary constraints for modelling the planet as a whole, but also for understanding geophysical phenomena occurring at smaller scales.

Gravimetry, absolute, relative and nowadays also spaceborne, is a powerful tool providing information to the global terrestrial gravity field and its temporal variations. Superconducting gravimeters allow a continuous acquisition of the gravity signal at a given site with a precision of 10^{-10}. This is important in order to be able to detect and model environmental perturbing effects as well as the weak gravity signals associated with vertical crustal movements of the order of mm/yr. These geodetic observations together with other geophysical and geological sources of information provide the means to understanding the structure, dynamics and evolution of the Earth system.

One of the key issues nowadays is the definition and stability of global and regional reference frames. Tectonic deformations in all time and spatial scales as well as mass transfer will affect reference frames. The work done in SC3.2 will deal in information essential to the reference frames.

Objectives

General objectives of the Sub-commission 3.2 will include:

- to study tectonic motions, including plate deformation;
- to study local crustal movements, some of which could be potentially hazardous
- to contribute reference frame related work in order to better understand deformations and improve global, regional and local reference frames and their dynamical modelling;
- to study sea-level fluctuations and changes in relation to vertical tectonics along many parts of the coastlines and in relation to environmental fluctuations/changes affecting the geodetic observations;
- to co-operate with SC3.4 in studies of postglacial rebound;
- to promote, develop and coordinate international programs related to observations, analysis and data interpretation for the fields of investigation mentioned above;
- to promote the development of appropriate models.

One should also notice that the objectives of the IAG Global Geodetic Observing System (GGOS) include e.g.

- the integral effect on Earth rotation of all angular momentum exchange inside the Earth, between land, ice, hydrosphere and atmosphere, and between the Earth, Sun, Moon, and planets,
- the geometric shape of the Earth's surface (solid earth, ice and oceans), globally or regionally, and its temporal variations, whether they are horizontal or vertical, secular, periodical or sudden, and
- by adding the Earth's gravity field-stationary and time-variable-mass balance, fluxes and circulation.

According to these objectives, SC3.2 should have close contacts to the GGOS activities, because many of the items are shared in the plans of GGOS and SC3.2. Focus on SC3.2 will be on understanding and modelling tectonic motions so that their effect on reference frames can be better applied.

Structure and Forms of Activities

The Sub-Commission 3.2 on Tectonic Deformation comprises sub-entities or working groups corresponding either to different geographical regions or different important and actual topics involved in the field of the Sub-Commission studies. These sub-entities are dealing with main scientific objectives having common general aspects and, in parallel to these objectives, follow the development of technology and measurement techniques capable to best fulfil the scientific objectives.

The SC3.2 will promote itself, but also encourage its working groups and other related groups or institutions to organize meetings or larger scientific conferences for selected scientific or technological subjects. Outcome of these meetings will be published in Proceedings, either separate one or as special issues of scientific journals.

Our meetings will be announced at *http://iagsc32.fgi.fi/* and *www.earthsciences.osu.edu/IAG-C3*.

Links

- SC 3.4 Cryospheric Change and Earth Deformation: James Davis (USA)
- Asia-Pacific Space Geosynamics (APSG): Kosuke Heki (Japan)
- Central Europe Regional Geodynamics Project (CERGOP): Janusz Sledzinski (Poland)
- IC-P3.2: Working Group of European Geoscientists for the Establishment of Networks for Earth science Research (WEGENER): Susanna Zerbini (Italy)

The list will be updated later with representatives of respective fields. The SC is open to everyone interested in the tectonic deformation and related topics. An e-mail list will be updated continuously.

Related Working Groups

During the period 2003-2007, there existed a sub-group Geodynamics of the Central Europe, chaired by Janusz Sledzinski (Poland). Co-operation with this group will be continued.

Close contacts with the “Working group of European Geoscientists for the Establishment of Networks for Earth science Research” (WEGENER) will be continued.

An ILP (International Lithosphere Program) Regional Co-ordination Committee CC 1/5 DynaQlim (Upper Mantle Dynamics and Quaternary Climate in Cratonic Areas, chaired by Markku Poutanen) established in 2007 will link SC3.2 geodetic studies in other disciplines like geology, geophysics and seismology. The ILP is charged with promoting multidisciplinary research projects of interest to both the geological (IUGS) and geophysical (IUGG) communities.

SC 3.3 Geophysical Fluids

President: Aleksander Brzezinski (Poland)

Terms of Reference

Mass transport in the atmosphere-ocean-cryosphere-mantle-core system, or the 'global geophysical fluids', cause observable geodynamic effects on broad time scales. Although relatively small, these global geodynamic effects have been measured by space geodetic techniques to increasing, unprecedented accuracy, opening up important new avenues of research that will lead to a better understanding of global mass transport processes and of the Earth’s dynamic response. Angular momenta and the related torques, gravitational field coefficients, and geocentre shift for all geophysical fluids are the relevant quantities. They are studied theoretically and are observed using global-scale measurements and/or products from state-of-the-art models, some of which assimilate such measurements.

Objectives

The objective of the Sub-Commission is to serve the scientific community by supporting research and data analysis in areas related to variations in Earth rotation, gravitational field and geocentre caused by mass transport in the geophysical fluids, which include the atmosphere, ocean, continental water, mantle, and core along with geophysical processes associated with ocean tides and the hydrological cycle.

The Sub-Commission is aware that its objectives overlap with the objectives of the IAG Global Geodetic Observing System with its central theme "Global deformation and mass exchange processes in the Earth system" and the following areas of activities

- deformation due to the mass transfer between solid Earth, atmosphere, and hydrosphere including ice;
- quantification of angular momentum exchange and mass transfer.

Program of Activities

Sub-Commission 3.3 follows the Program of Activities defined by Commission 3. In addition, SC 3.3 interacts with the sister organizations and services, particularly with the IERS Global Geophysical Fluids Centre and its eight Special Bureaus: for the Atmosphere, Oceans, Tides, Hydrology, Mantle, Core, Gravity/Geocentre, Loading. Due to the overlapping of the tasks, SC 3.3 should also have close contacts to the GGOS activities.

Our meetings will be announced at *www.earthsciences.osu.edu/IAG-C3*.

Structure

- Atmosphere (David Salstein)
- Oceans (Rui Ponte)
- Tides (Jim Ray)
- Hydrology (Ben Chao)
- Mantle (Richard Peltier)
- Core (Tim Van Hoolst)
- Gravity/Geocentre (Erricos Pavlis)
- Loading (Pascal Gegout)

SC 3.4 Cryospheric Change and Earth Deformation

President: James Davis (USA)
Vice-President : Detlef Wolf (Germany)

Terms of Reference

Past and present changes in the mass balance of the earth's glaciers and ice complexes induce present-day deformation of the solid earth on a range of spatial scales, from the very local to global. The earth's deformational response to cryospheric change is complex due to a number of factors, including: complexities in the visco-elastic structure of the earth; the spatial and temporal variability of the mass changes; and the interaction between the cryosphere and the ocean, which lead to a redistribution of cryospheric mass in a highly dynamic system. These complexities pose both observational and modelling challenges. The purpose of Sub-commission 3.4 is to promote, and where appropriate, to help coordinate research involving geodetic observation and modelling of earth deformation due to past and ongoing cryospheric changes, with emphasis on present-day deformation taking place in the near field of existing ice sheets and glaciers and the extent to which this deformation is a response to climate change.

Program of Activities

Our meetings will be announced at *www.earthsciences.osu.edu/IAG-C3*.

Inter-Commission Projects

IC-P 3.1 Global Geodynamics Project (GGP)

(Joint with Commission 2)

Chair: David Crossley (USA)

Terms of Reference

The purpose of the Global Geodynamics Project (GGP) is to maintain a network of superconducting gravimeters (SG) to monitor all changes in the Earth's gravity field at periods of seconds and longer. GGP started on July 1, 1997, and since then 1 minute data has been archived in the GGP database at the International Centre of Earth Tides (ICET, Commission 3). Due to the strong overlap between Earth Rotation, Earth Tides, and The Gravity Field, GGP became an IAG Inter-Commission Project in 2003, and reports to both Commissions 2 and 3.

The SG is currently the most sensitive and stable instrument for the measurement of the vertical component of the Earth's gravity field, with a time domain error of <0.1 microgal and a frequency domain accuracy of 1 nGal. When combined with absolute gravimetry at the same station, the instruments together are able to measure long term changes in gravity with an error of 1-2 microgal per year. Each SG is the focus of a national effort to provide a continuous gravity record for geodetic and geophysical research. The GGP is an opportunity for the various SG groups to participate in a global campaign to monitor the gravity field and to exchange the raw data. GGP does not have a mandate to establish or fund new stations.

Objectives

The objective of GGP is to maintain standards for the collection of SG data, and provide an accessible database for global use. Precise measurements of the Earth's gravity field are essential to answer a number of important questions in geodesy and geophysics: (a) the gravity effect of the global atmospheric loading and mass redistribution on the solid Earth, (b) the use of precise tidal analysis to refine estimates of the nearly diurnal free wobble of the Earth and models of oceanic loading, (c) observation of changes in gravity associated with slow and silent earthquakes, tectonic motions, sea-level changes and post-glacial rebound, (d) monitoring the rotation pole of the Earth on a time scale of minutes, (e) accurate observations of seismic normal modes, especially in the long-period band below 1 mHz and to determine precise amplitudes, (f) monitor gravity changes associated with hydrology (soil moisture and groundwater) at fiducial sites, (g) provide ground truth for gravity satellite missions where a sufficient density of SGs are located on the surface, and (h) provide data and information on gravity effects associated with motions of the inner core and in the outer fluid core.

Program of Activities

GGP meets at least once a year, either at a national conference to hold business meetings, or to hold a GGP Workshop where scientific papers are presented. A GGP Newsletter is circulated at about 6 month intervals, and we maintain a webpage for general information.

SG groups send data to ICET once a month, and the data is archived through an arrangement with ISDC/GFZ in Potsdam. Within 1 year of collection, the data is released to the scientific community.

Membership

- Secretary: J. Hinderer
- Representative to GGOS: J. Hinderer
- SG group leaders:
- Y. Fukuda (Kyoto U., Japan)
- J. Hinderer (IPG Strasbourg, France)
- C. Hwang (National CTU Taiwan)
- Y. Imanishi (Tokyo U., Japan)
- J.-W. Kim (Sejong U., S. Korea)
- J. Liard (GSC Ottawa, Canada)
- B. Meurers (U. Vienna, Austria)
- J. Neumeyer (GFZ, Potsdam)
- K. Shibuya (NIPR, Tokyo, Japan)
- H.-P. Sun (IGG, Wuhan, China)
- Y. Tamura (NAO Mizusawa, Japan)
- M. van Camp (ROB, Brussels)
- H. Virtanen (FGI, Masala, Finland)
- H. Wilmes (BKG, Germany)

The GGP mailing list comprises about 100 names.

IC-P 3.2 Working Group of European Geoscientists for the Establishment of Networks for Earth Science Research (WEGENER)

(joint with Commission 1)

Chair: Susanna Zerbini (Italy)

Terms of Reference

The evolution of geodetic techniques in the past decade, with unprecedented achievements in the precise detection and monitoring of 3D movements at the millimetre level has opened new prospects for the study of Earth kinematics and hence dynamics. However, those achievements also raised new issues that have to be properly taken into account in the processing and analysis of the data, demanding a careful inter-disciplinary approach.

Areas in Europe, primarily in the broad collision zone between Europe, Africa and Arabia, provide natural laboratories to study crucial and poorly understood geodynamic processes. These have been systematically monitored in the last decade by different research groups using a variety of space geodetic and other techniques. However, in general data analysis has been done from the perspective of one discipline and processing procedures have not always followed a standard approach.

The existence of these data (geodata) never completely explored, justifies a new insight by using a really integrated approach that combines data from different observational techniques and input from other disciplines in the Earth Sciences. This should lead to the development of interdisciplinary work in the integration of space and terrestrial techniques for the study of the Eurasian/African/Arabian plate boundary deformation zone (and adjacent areas), and contribute to the establishment of a European Velocity Field.

With that purpose it is important to promote stronger international cooperation between Earth-Scientists interested in the that plate boundary zone. Towards that goal the WEGENER project aims to:

- Actively encourage the cooperation of all geoscientists studying the Eurasian/African/Arabian plate boundary deformation zone, by promoting the exploitation of synergies;
- Be a reference group for the integration of the most advanced geodetic and geophysical techniques by developing the adequate methodologies for a correct data integration and interpretation;
- Act as a forum for discussion and scientific support for geoscientists from all over the world interested in unraveling the kinematics and mechanics of the Eurasian/African/Arabian plate boundary deformation zone;
- Promote the use of standard procedures for geodetic data, in particular GPS data, quality evaluation and processing.

The need to involve different research areas demands for collaboration with different IAG Commissions and in particular Commission 1 and Commission 3. Commission 1 is responsible for regional and global reference frames, for the coordination of space techniques and for satellite dynamics. WEGENER can contribute significantly to each one of these areas and, in particular, to regional and global reference frames by making available, in its study area, quality-tested regional data sets acquired with different space and terrestrial techniques, as well as relevant quality-tested solutions. Additionally WEGENER can contribute by carrying out studies, already being developed by WEGENER member groups, on the definition of effective integrated observational strategies.

Objectives

The primary goals of the WEGENER project are:

- Continue as a framework for geodetic/geophysical/geological cooperation in the study of the Eurasian/African/Arabian plate boundary zone;
- Foster the use of space-borne, airborne and terrestrial hybrid techniques for earth observation;
- Define effective integrated observational strategies for these techniques to reliably identify and monitor crustal movements and gravity field variations over all time-scales;
- Facilitate and stimulate the integrated exploitation of data from different techniques in the analysis and interpretation of geo-processes;
- Organize periodic meetings with special emphasis on interdisciplinary research and interpretation and modelling issues;
- Reinforce cooperation with African and Arabian countries and colleagues, which can both contribute to understanding the kinematics and dynamics of the Eurasian/African/Arabian plate boundary zone and promote the growth of such research in these countries.

Planned Activities

- Build up a web-portal and an associated geo-data-base that enables access to metadata, for the WEGENER geographical area, with results and when possible historical data from episodic campaigns, including geodetic, geophysical and geological data, and results for strain rates, velocity fields, focal mechanisms, etc.;
- Define standards for GNSS network establishment, data acquisition and guidelines for data processing and reliability checks.
- Define strategies for a full exploitation of different geodata (GNSS, gravimetry, InSAR, seismic, etc.);
- Establish a GPS analysis centre specially dedicated to process permanent and episodic campaign data, not analyzed by other GPS centres, which will contribute to the development of a joint velocity field (EUROVEL) that can support kinematic and geodynamic modelling in the WEGENER area of interest;
- Organize bi-annual conferences to serve as high-level international forum, in which scientists from all over the world can look at a multidisciplinary interpretation of geodynamics, and strengthen the collaboration between countries (North-South collaboration);

Link to Services

The WEGENER Inter-Commission project will establish links to different relevant services, such as:

- EUREF;
- International Earth Rotation and Reference Systems Service (IERS);
- International GNSS and Reference Frame Service (IGS);
- International Laser Ranging Service (ILRS);
- International VLBI Service for Geodesy and Astrometry (IVS);
- International DORIS Service (IDS);
- Regional Reference Frame Northern Africa (AFREF);
- Global Geodetic Observing System (GGOS).

Membership

- Chair: Susanna Zerbini (Italy)
- Board Members
  - Boudewijn Ambrosius, The Netherlands, B.A.C. Ambrosius@lr.tudelft.nl
  - Luisa Bastos, Portugal, lcbastos@fc.up.pt
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  - Karim Yelles, Algeria, kyelles@yahoo.fr
  - Salah M. Mahmoud, Egypt, alahm@nriag.sci.eg
  - Abdullah ArRajehi, Saudi Arabia, arrajehi@kacst.edu.sa
- Representative of Commission 1: A. Caporali
- Representative of Commission 3: T. van Dam

Commission 4 – Positioning and Applications

web: http://enterprise.lr.tudelft.nl/iag/iag_comm4.htm

President: **Sandra Verhagen** (The Netherlands)
Vice President: **Dorota Grejner-Brzezinska** (USA)

Terms of Reference

To promote research into the development of a number of geodetic tools that have practical applications to engineering and mapping. The Commission will carry out its work in close cooperation with the IAG Services and other IAG Entities, as well as via linkages with relevant Entities within Scientific and Professional Sister Organisations.

Recognising the central role that Global Navigation Satellite Systems (GNSS) plays in many of these applications, the Commission's work will focus on several Global Positioning System (GPS)-based techniques, also taking into account the expansion of GNSS with Glonass, Galileo and Beidoe. These techniques include precise positioning, but extending beyond the applications of reference frame densification and geodynamics, to address the demands of precise, real-time positioning of moving platforms.

Several Sub-Commissions will deal with precise kinematic GNSS positioning technology itself (alone or in combination with other positioning sensors) as well as its applications in surveying and engineering. Recognising the role of continuously operating GPS reference station network, research into non-positioning applications of such geodetic infrastructure will also be pursued, such as atmospheric sounding. Thereby, other geodetic techniques such as VLBI will be considered as well.

The commission will also deal with geodetic remote sensing, using (differential) InSAR, and GNSS as a remote sensor with land, ocean and atmosphere applications.

Objectives

The main objectives of Commission 4 are:

- Research into (integration of) new navigation and deformation measurement / sensor technologies, and their applications.
- Encourage research and development into new applications in e.g. "precise navigation", "geodetic remote sensing", "engineering geodesy".
- Collaboration with geodetic organizations and services to promote and enable the use of GNSS and geodetic infrastructure for positioning as well as non-positioning applications.

Structure

Sub-Commissions

- SC 4.1: Multi-Sensor Systems
  President: Dorota Grejner-Brzezinska (USA)
- SC 4.2: Applications of Geodesy in Engineering
  President: Günther Retscher (Austria)
- SC 4.3: Remote Sensing and Modelling of the Atmosphere
  President: Marcelo Santos (Canada)
- SC 4.4: Applications of Satellite and Airborne Imaging Systems
  President: Xiaoli Ding (Hong Kong)
- SC 4.5: High-Precision GNSS
  President: Yang Gao (Canada)

Study Groups

- SG 4.2: GNSS Remote Sensing and Applications
  Chair: Shuanggen Jin (South Korea)
- SG 4.3: IGS Products for Network RTK and Atmosphere Monitoring
  Chair: Robert Weber (Austria)

Inter-Commission Working Groups

- IC-WG1.1: Environment Loading – Modelling for Reference Frame and Positioning Applications
  Chair: Tonie van Dam (Luxembourg)
  (Description see Commission 1)

Inter-Commission Study Groups

- IC-SG2: Quality of Geodetic Multi-Sensor Systems and Networks
  (Joint with Commission 1, ICCT)
  Chair: Hansjörg Kutterer (Germany)
  (Description see ICCT)
- IC-SG6: InSAR for Tectonophysics
  Chair: Masato Furuya (Japan)
  (Description see ICCT)

Program of Activities

- Interface with IAG sister organisations and other organizations – e.g. FIG, ISPRS, IEEE, ION
- Promote Geodesy and GGOS to a wide (professional) community
- Offer outreach opportunity through its conferences and seminars (jointly organised with other organisations)

Steering Committee

- President: Sandra Verhagen (The Netherlands)
- Vice-president: Dorota Grejner-Brzezinska (USA)
- President SC 4.1: Dorota Grejner-Brzezinska (USA)
- President SC 4.2: Günther Retscher (Austria)
- President SC 4.3: Marcelo Santos (Canada)
- President SC 4.4: Xiaoli Ding (Hong Kong)
- President SC 4.5: Yang Gao (Canada)
- Member-at-large: Pawel Wielgosz (Poland)
- Representative of IAG Services: Ruth Neilan (USA)

Sub-Commissions

SC 4.1 Multi-Sensor Systems

President: Dorota Grejner-Brzezinska (USA)
Vice-President: Naser El-Sheimy (Canada)
Secretary: Jinling Wang (Australia)

Terms of Reference

To coordinate research and other activities that address broader areas of multi-sensor system theory and applications, with a special emphasis on integrated guidance, navigation, positioning and orientation of airborne and land-based platforms. The primary sensors of interest will be GNSS and inertial navigation systems; however the important role of other techniques used for indoor and pedestrian navigation environmental monitoring is also recognized. The Sub-commission will carry out its work in close cooperation with other IAG Entities, as well as via linkages with relevant scientific and professional organizations, such as ISPRS, FIG, IEEE, ION.

Objectives

- To follow the technical advances in navigation sensors and algorithms, including autonomous vehicle navigation, based on
  - positioning sensors and techniques such as GPS (and pseudoliltes), INS, including MEMS IMU, wheel sensors, ultrasonic and magnetic sensors, and
  - positioning methods based on cellular networks and their hybrid with GPS
- To follow the technical advances in mapping sensors, such as CCD cameras, laser range finders, laser scanners and radar devices
- To standardize definitions and measurements of sensor related parameters
- To study and report on the performance of stand alone and integrated navigation systems
- To report on the development, possibilities and limitations of new multi-sensor system technologies.
- To explore non-linear estimation and information fusion methods including artificial intelligence (AI), spectral estimation, parallel cascade identifiers, hybrid AI/KF modules and particle filters.
- To facilitate extending the mobile mapping concept to environmental monitoring applications.

- To stimulate new ideas and innovation in:
  - navigation algorithms, sensor calibration, synchronization and inter-calibration
  - real-time sensor information processing and georeferencing
  - sensor and data fusion
  - automation techniques for information extraction from multi-sensor systems using expert systems
- To study and monitor the progress in new applications (not limited to conventional mapping) of multi-sensor systems (transportation, engineering, car navigation, environmental monitoring personal navigation, indoor navigation, etc.)
- To promote research collaboration and to organize and to participate in professional workshops, seminars, meetings
- To promote research and collaboration with countries with no or limited access to modern multi-sensor technology

To establish a web page providing information on the SC 4.1 activities, technology updates, and professional meeting calendar.

Working Groups

WG 4.1.1 Alternative Integration Algorithms

Chair: Aboelmagd Noureldin (Canada)

Terms of Reference

This working group will focus on developing new methods to replace traditional Kalman filtering (KF) techniques and improves positioning accuracy, especially when using low cost inertial sensors. The "Alterative Integration Algorithms" WG will explore non-linear estimation and information fusion methods including artificial intelligence (AI), spectral estimation, parallel cascade identifiers, hybrid AI/KF modules and particle filters. We will target applications related to land vehicles and airborne navigation.

WG 4.1.2 Indoor Navigation Systems

Chair: Günther Retscher (Austria)

Terms of Reference

To promote research and development in the area of indoor navigation using systems, such as WiFi (Wireless Fidelity), UWB (Ultra-wide Band) and RFID (Radio Frequency Identification) in combination with dead reckoning (DR) sensors including micro-electro-mechanical systems (MEMS) inertial systems and other low cost positioning sensors; and to integrate these location technologies with GNSS. To report progress on multi-sensor integration and fusion technologies for an optimal estimation of a current users' location and to develop new self calibration techniques for DR based on fuzzy logic and artificial intelligence.

WG 4.1.3 Multi-Sensor Systems for Environmental Monitoring Applications

Chair: Jan Skaloud (Switzerland)

Terms of Reference

This working group investigates several topics that facilitate extending the mobile mapping concept to environmental monitoring applications. The primary goals are:

- Adaptation of mobile mapping platforms for optimal monitoring on highly inclined terrain (e.g. cliffs, avalanches, landslides debris flow, etc.)
- Introduction of rigorous quality measures into digital terrain models (DTM) derived from multi-sensor mobile platforms.
- Revision of integrity measures used in direct georeferencing of multi-sensor platforms.

SC 4.2 Applications of Geodesy in Engineering

President: Günther Retscher (Austria)
Vice-President: Gethin Roberts (UK)
Secretary: Michaela Haberler-Weber (Austria)

Terms of Reference

Rapid developments in engineering, microelectronics and the computer sciences have greatly changed both instrumentation and methodology in engineering geodesy. To build higher and longer, on the other hand, have been key challenges for engineers and scientists since ancient times. Now, and for the foreseeable future, engineers confront the limits of size, not merely to set records, but to meet the real needs of society minimising negative environmental impact. Highly developed engineering geodesy techniques are needed to meet these challenges. The SC will therefore endeavour to coordinate research and other activities that address the broad areas of the theory and applications of engineering geodesy tools. The tools range from conventional terrestrial measurement and alignment technology (optical, RF, etc.), Global Navigation Satellite Systems (GNSS), geotechnical instrumentation, to software systems such as GIS, decision support systems, etc. The applications range from construction engineering and structural monitoring, to natural phenomena such as landslides and ground subsidence that have a local effect on structures and community infrastructure. The SC will carry out its work in close cooperation with other IAG Entities, as well as via linkages with relevant scientific and professional organisations such as ISPRS, FIG, IEEE, ION.

Objectives

- To monitor research and development into new technologies that are applicable to the general field of "engineering geodesy", including hardware, software and analysis techniques.
- To study advances in dynamic monitoring and data evaluation systems for buildings and other manmade structures.
- To study advances in monitoring and alert systems for local geodynamic processes, such as landslides, ground subsidence, etc.
- To study advances in geodetic methods used on large construction sites.
- To study advances in the application of artificial intelligence techniques in engineering geodesy.
- To document the body of knowledge in this field, and to present this knowledge in a consistent frame work at symposia and workshops.
- To promote research into several new technology areas or applications through the SC4.2 Working Groups.

Program of Activities

- To study the technology and applications of engineering geodesy in order to address the objectives for SC4.2 (Description see above).
- To organize and to participate in professional workshops, seminars, meetings, etc.
- To establish a web page providing information on SC4.2 activities, professional meeting calendar, etc.

Working Groups

WG 4.2.1 Measurement Systems for the Navigation of Construction Processes

Chair: Wolfgang Niemeier (Germany)

Terms of Reference

To study and report the performance of the currently used navigation/guidance systems for construction machinery, and to promote the development of new methods and techniques for controlling construction processes.

WG 4.2.2 Dynamic Monitoring of Buildings

Chair: Gethin Roberts (UK)

Terms of Reference

To study and report the performance of currently used building monitoring systems, including techniques based on satellite and terrestrial measurements, and to promote the application of new sensor technology.

WG 4.2.3 Application of Artificial Intelligence in Engineering Geodesy

Chair: Alexander Reiterer (Austria)

Terms of Reference

To study and report on topics such as control of measurement- and guidance-systems, deformation analysis, control of alert systems, and the evaluation of their

complex data stream through the use of Artificial Intelligence (AI) techniques (e.g. knowledge-based systems, genetic algorithms, artificial neural networks, etc.).

WG 4.2.4 Investigation of Kinematic and Dynamic Behaviour of Landslides and System Analysis

Chair: Gyula Mentes (Hungary)

Terms of Reference

Worldwide landslides are one of the major types of natural hazards killing or injuring a large number of individuals and creating very high costs every year. There has already been done a wide range of research work on landslides. Most of this work had a bias towards one discipline, like remote sensing or geology. The new idea of the working group is to promote multidisciplinary integration of different methods. The main goal is to set up an integrated workflow for landslide hazard management.

SC 4.3 Remote Sensing and Modelling of the Atmosphere

President: Marcelo Santos (Canada)
Vice-President: Jens Wickert (Germany)
Secretary: Catherine Mitchel (Bath, UK)

Terms of Reference

The objective of Sub-Commission 4.3 (SC 4.3) is to coordinate research dealing with the treatment, interpretation and modelling of measurements collected in the atmosphere for the purpose of improvements in geodetic positioning as well as for better understanding the atmosphere itself. Even though GNSS techniques are seen here as the primary research tools, other sensors also bring important information on the atmosphere and as such should be considered in the context of this Sub-Commission. Dedicated satellites, having on-board GNSS receivers, can also contribute to atmospheric studies by exploring the atmosphere-induced bending of GNSS signals while propagating through the atmosphere, to furnish round-the-clock weather data, monitor climate change, and improve space weather forecasts. Geodetic positioning can benefit and contribute to atmospheric models, such as Numerical Weather Prediction (NWP) models. Novel advancements in modelling the atmosphere as applied to positioning, error sources, instrumentation, dedicated missions, and real- or near real-time data access should also be contemplated. SC4.3 will foster linkages with sister scientific and professional organizations, such as IAG, ISPRS, FIG, IEEE and ION.

Objectives

- To explore the synergy that exists between Geodesy, meteorology and ionospheric sciences.
- To encourage the processing of more and more LEO and also ground based data more and more also in near-real and/or real time.
- To study the application of readily available data from numerical weather prediction models (data provision, assimilation techniques).
- To study and suggest ways for homogenization of long term data set (e.g., some IGS stations since 1993) for climatologic investigations
- To investigate the development and enhancement of the relatively new GNSS-based sounding techniques, e.g. neutral atmosphere / ionosphere tomography, GNSS reflectometry / scatterometry for altimetry, meteorology, soil moisture.

- To exploit the potential of new signals' structures (GPS-M, GALILEO, reactivated GLONASS) for GNSS based atmospheric remote sensing.
- To suggest additional platforms for GNSS based atmospheric remote sensing (buoys, aircrafts, balloons, more dense ground networks, LEO constellations).
- To follow, study and contribute towards the technical and scientific advances in atmospheric research.
- To suggest standard definitions and terminology as per appropriate in the context of Geodesy and atmospheric sciences.

Program of Activities

- To promote research collaboration among research groups worldwide.
- To organize and/or participate in scientific and professional meetings
- To maintain a web page concatenating the Sub-Commission activities and reports.
- To encourage special issues of the Journal of Geodesy on atmospheric applications to Geodesy.

Study Group

SG 4.3.1 Ionosphere Modelling and Analysis

Chair: Michael Schmidt (Germany)

Co-Chair: Mahmut O. Karslioglu (Turkey)

Terms of Reference

The general objective of this study group is the development of strategies for establishing ionosphere models which can be used for both, the correction of electromagnetic measurements and the study of ionospheric features and their spatial-temporal evolution. Thus, our overall intention is the combination of physics, mathematics and statistics to derive a high-resolution multi-dimensional ionosphere model.

Working Groups

WG 4.3.1 Ionospheric Scintillation

Chair: Lucilla Alfonsi (Italy)

Terms of Reference

To coordinate the study of ionospheric scintillation by providing the scientific community with a statistical dataset about scintillation morphology, at high and low latitudes, as observed by means of GNSS satellites and encouraging discussions in dedicated forums, and to support current efforts taking place around the world to set up dedicated monitoring networks.

WG 4.3.2 GNSS-Based Sounding of the Atmosphere

Chair: Juha Luntama (Finland)

Terms of Reference

The objective of this Working Group is to explore and evaluate GNSS-based atmospheric sounding techniques establishing common international standards for model performance as well as investigate the potential contributions of new GNSS signal structures to atmospheric studies.

WG 4.3.3 Numerical Weather Predictions for Positioning

Chair: Thomas Hobiger (Japan)

Terms of Reference

To study various technical aspects of using Numerical Weather Prediction (NWP) model data to map the effect of troposphere on space geodetic signals. To concatenate the terminology used by both meteorological and geodetic communities. To test and sediment procedures related to ray-tracing through NWP data layers. To suggest quality control criteria to be used for assessing the quality of tropospheric data and results obtained from them. To evaluate state of the art and report the progress achieved during the time-life of the WG on the use of NWP for positioning.

SC 4.4 Applications of Satellite and Airborne Imaging Systems

President: Xiaoli Ding (Hong Kong)
Vice-President: Linlin Ge (Australia)
Secretary: Makoto Omura (Japan)

Terms of Reference

The main objectives of the Sub-Commission are to promote collaborative research in the development of satellite and airborne imaging systems, primarily including Synthetic Aperture Radar (SAR) and Light Detection And Ranging (LiDAR) systems, for geodetic applications, and to facilitate communications and exchange of data, information and research results through coordinated efforts.

Objectives

- Development of methods, models, algorithms and software for geodetic applications of satellite and airborne imaging systems;
- Study of effects of field and atmospheric conditions on satellite and airborne imaging systems;
- Integration of satellite and airborne imaging systems with other geodetic/geospatial technologies such as GPS and GIS;
- Development and promotion of new geodetic applications of satellite and airborne imaging systems; and
- Development of collaboration with sister organisations such as FIG and ISPRS, and liaison with image data providers.

Program of Activities

- Produce a special issue on geodetic remote sensing in Journal of Geodesy;
- Organise collaborative research activities among members of the Sub-Commission;
- Sponsor and participate in various international conferences in geodetic remote sensing; and
- Discuss collaborations with sister organisations.

Working Groups

WG 4.4.1 Quality Control Framework for InSAR Measurements

Chair: Xiaoli Ding (Hong Kong)

Terms of Reference

To study quality measures and quality control procedures and formulate a quality control framework for InSAR measurements.

WG 4.4.2: Imaging Systems for Monitoring Local Area Surface Deformation

Chair: Makoto Omura (Japan)

Terms of Reference

To study satellite and airborne imaging systems such as InSAR and LiDAR for monitoring local area ground surface deformations such as volcanic and seismic activities, and ground subsidence associated with city development, mining activities, ground liquid withdrawal, and land reclamation.

SC 4.5 High-precision GNSS

President: Yang Gao (Canada)
Vice-President: Sunil Bisnath (Canada)
Secretary: Wu Chen (Hong Kong)

Terms of Reference

High-precision GPS has been applied to support numerous applications in the past decade. At least three other Global Navigation Satellite Systems (GNSS) are in different phases of development and are expected to be full operational within the next five years. Novel technologies are needed to address the opportunities and challenges to enhance the accuracy, availability and integrity of high precision GNSS applications. SC4.5 will coordinate research efforts to identify important research problems in high-precision GNSS and develop methods and technologies to support high-precision GNSS applications. The research subjects include optimal use of signals from multiple GNSS systems, improved error modelling and mitigation methodologies, quality control and integrity monitoring, differential GNSS RTK and precise point positioning, novel use of precise orbit/clock products and GNSS network infrastructures, cost-effective high-precision GNSS applications. SC4.5 will also stimulate strong collaborations among international organizations and with the industry.

Objectives

The major objective of SC4.5 is to promote collective research efforts on the development of high precision GNSS methods and technologies and their applications, to facilitate timely dissemination of scientific findings, and to stimulate strong collaborations among international organizations and with the industry.

Program of Activities

- Identify and investigate important technical issues and problems in high-precision GNSS
- Promote research collaboration among researchers
- Publish white papers
- Collaborate with other international organizations
- Develop linkage with the industry sector
- Participate and organize international conferences and workshops

Working Groups

WG 4.5.1 Quality Measures for Network Based GNSS Positioning

Chair: Xiaolin Meng (UK)

Terms of Reference

To address quality control issues and develop quality measures for precise network-based RTK GNSS positioning. Quality measures for emerging network based differential GNSS positioning for a variety of location-based service applications will also be investigated.

WG 4.5.2 Precise Point Positioning and Applications

Chair: Sunil Bisnath (Canada)

Terms of Reference

To address and investigate issues and problems related to the development of GNSS-based precise point positioning technology and its integration with other positioning methods such as network RTK. The WG will promote novel applications of PPP.

WG 4.5.3 Correction Models for Ultrahigh-Precision GNSS Positioning

Chair: Wu Chen (Hong Kong)

Term of Reference

To promote research and development of precise correction models such as atmospheric and geophysical corrections to further improve GNSS positioning accuracy and reliability.

WG 4.5.4 Multiple Carrier Ambiguity Resolution (MCAR)

Chair: Yanming Feng (Australia)

Terms of Reference

To study efficient approaches to carrier phase ambiguity resolutions with multiple GNSS signals from modernized GPS, GLONASS and Galileo systems and assess their benefits to GNSS technological advancements and applications.

Study Groups

SG 4.2 GNSS Remote Sensing and Applications

President: Shuanggen Jin (South Korea)

Vice-President: James Garrison (USA)

Terms of Reference

Nowadays, the Global Positioning System (GPS), which is a very powerful and important contributor to all scientific questions related to high precision positioning on Earth's surface, has been widely used as a mature technique in geodesy and geodynamics. Recently, the versatility and availability of reflected and refracted signals from GPS gave birth to many new GPS applications for various environmental remote-sensing in atmosphere, ocean and land. Many countries have initiated efforts in this area of researches and applications. The focus of this study group is to facilitate collaboration and communication, and to support joint researches with GNSS remote sensing. A Steering Committee will work closely with members and other IAG Commissions/Sub-Commissions, specifically SC 4.3, to obtain mutual goals. Close collaboration with the International GPS Service (IGS), and IEEE Geoscience and Remote Sensing Society (IGARSS) will be promoted, such as joint sponsorship of international professional workshops and conferences.

Objectives

- To promote developments of current GPS reflected signal sensor and applications
- To improve the existing estimation algorithms and data processing for GPS reflected signals.
- To coordinate data collection campaigns and to compare with terrestrial and satellite observations, in order to encourage research and development into the crucial measurement and applications.
- To investigate applications in atmosphere, ocean and land as well as space sciences.

Membership

- Chair: Shuanggen Jin (Korea Astronomy and Space Science Institute, South Korea)
- Co-chair: James L. Garrison (Purdue University, USA)
- Vice-Chair: Attila Komjathy (JPL, NASA, USA)
- Member-at-large: Isaac Ramos (Universitat Politecnica De Catalunya, Spain)

SG 4.3 IGS Products for Network RTK and Atmosphere Monitoring

President: Robert Weber (Austria)

Terms of Reference

The International GNSS Service (IGS) provides GPS & GLONASS station data and derived products like satellite orbits, clock corrections, electron content models and tropospheric delays of superior quality and within different time frames in support of Earth science research and multidisciplinary applications. Special applications like Network RTK in order to allow for fast access of a globally consistent reference frame for all position applications and near/real-time atmospheric monitoring for weather prediction require GNSS products with greatly reduced delays. Soon these products will be made available to the user community by means of the IGS RT Project in near-real time via Internet and other available streaming technologies.

This Study Group shall identify the needs of near real-time atmospheric monitoring in terms of orbit and clock-correction quality and investigate if the suite of IGS real-time products match the requested quality and spatial resolution necessary for correction data within regional RTK networks. Another topic deals with the coding of IGS products and models to be useful as a state space representation of error sources within the real-time standard formats RTCM and RTCA.

This Study Group is directly linked to IAG Sub-Commissions 4.3 and 4.5 as well as to the International GNSS Service (IGS).

Objectives

- To promote the use of IGS products for Network RTK and Atmosphere Monitoring
- To identify the current needs of near real-time atmospheric monitoring and Network-RTK in terms of IGS product quality, delivery time and spatial resolution
- To investigate options how to provide IGS products in standard real-time formats

InterCommission Committee on Theory (ICCT)

web: http://icct.kma.zcu.cz

President: **Nico Sneeuw** (Germany)
Vice President: **Pavel Novák** (Czech Republic)

Terms of Reference

The InterCommission Committee on Theory (ICCT) was formally approved and established after the IUGG XXI Assembly in Sapporo, 2003, to succeed the former IAG Section IV on General Theory and Methodology and, more importantly, to interact actively and directly with other IAG entities. As a result of this restructuring, and recognizing that geodetic observing systems have advanced to such an extent that geodetic measurements (i) are now of unprecedented accuracy and quality, can readily cover a region of any scale up to tens of thousands of kilometres, yield non-conventional data types, and can be provided continuously; and (ii) consequently, demand advanced mathematical modelling in order to obtain the maximum benefit of such technological advance, the ICCT (1) strongly encourages frontier mathematical and physical research, directly motivated by geodetic need/ practice, as a contribution to science/engineering in general and the foundations of geodesy in particular;

(2) provides the channel of communication amongst the different IAG entities of commissions/services/projects on the ground of theory and methodology, and directly cooperates with and supports these entities in the topic-oriented work;

(3) helps the IAG in articulating mathematical and physical challenges of geodesy as a subject of science and in attracting young talents to geodesy. The ICCT should strive to attract and serve as home to mathematically motivated/oriented geodesists and to applied mathematicians; and

(4) encourages closer research ties with and gets directly involved in relevant areas of the Earth sciences, bearing in mind that geodesy has been always playing an important role in understanding the physics of the Earth.

Objectives

The main objectives of the ICCT are

- to be the international focal point of theoretical geodesy,
- to encourage and initiate activities to further geodetic theory,
- to monitor research developments in geodetic modelling.

To achieve these objectives, the ICCT interacts and collaborates with the IAG Commissions and other IAG related entities (services, projects).

Structure

The structure of InterCommission Committees is specified in the IAG by-laws. The ICCT steering committee consists of the President, the Vice-President and a representative from each of the Commissions.

ICCT activities are undertaken by study groups. By the inter-commission nature of the ICCT, these study groups are joint study groups, affiliated to one or more of the Commissions.

Inter-Commission Study Groups

The following list names the Inter-Commission Study Groups. Their chairpersons are indicated in boldface. The numbers behind the names denote the affiliation to the individual Commissions in order of precedence.

IC-SG1: Theory, Implementation and Quality Assessment of Geodetic Reference Frames
(joint with Commission 1, IERS)
Athanasios Dermanis (Greece)

IC-SG2: Quality of Geodetic Multi-Sensor Systems and Networks
(joint with Commissions 4, 1)
Hansjörg Kutterer (Germany)

IC-SG3: Configuration Analysis of Earth Oriented Space Techniques
(joint with Commissions 3, 2, 1)
Florian Seitz (Germany)

IC-SG4:Inverse Theory and Global Optimization
(joint with Commission 2)
Christopher Kotsakis (Greece)

IC-SG5:Satellite Gravity Theory
(joint with Commission 2)
Torsten Mayer-Gürr (Germany)

IC-SG6:InSAR for Tectonophysics
(joint with Commissions 3, 4)
Masato Furuya (Japan)

IC-SG7: Temporal Variations of Deformation and Gravity
(joint with Commissions 3, 2)
Detlef Wolf (Germany)

IC-SG8: Towards cm-accurate Geoid – Theories, Computational Methods and Validation
(joint with Commission 2)
Y. M. Wang (USA)

Program of Activities

The ICCT's program of activities will include

- participation as (co-)convener of geodesy sessions at major conferences (IAG, EGU, AGU, …),
- organization of a Hotine-Marussi symposium,
- initiation of a summer school on theoretical geodesy,
- maintaining a website for dissemination of ICCT related information.

Steering Committee

President Nico Sneeuw, Germany

Vice-President Pavel Novák, Czech Republic

Representatives:

- Commission 1 Zuheir Altamimi, France
- Commission 2 Pieter Visser, The Netherlands
- Commission 3 Richard Gross, USA
- Commission 4 Sandra Verhagen, The Netherlands
- GGOS TBD

Intercommission Study Groups

IC-SG1 Theory, Implementation and Quality Assessment of Geodetic Reference Frames

Chair: A. Dermanis (Greece)

Affiliation: Commission 1, IERS

Introduction

The realization of a reference system by means of a reference frame, in the form of coordinate time series or coordinate functions for a global set of control stations is a complicated procedure. It involves input data from various space techniques each one based on its own advanced modelling and observation analysis techniques, as well as, criteria for the optimal selection of the time evolution of the reference frame among all data compatible possibilities. The relevant "observed" coordinate time series demonstrate significant signals of periodic, non- periodic variations and discontinuities, which pose the challenge of departing from the current ITRF model of linear time evolution, realized by reference epoch coordinates and constant velocities. The final product needs proper quality measures, which take also into account the possible modelling discrepancies, systematic errors and noise level of each particular space technique. The connection with a celestial frame by means of earth orientation parameters (EOPs) and current geophysical plate motion hypotheses necessitate the study of the compatibility of the geodetically established reference system with reference systems introduced in theoretical studies of the earth rotation and in theoretical geophysics. The working group is primarily aiming in problem identification, outlining of possible solution directions and motivation of relevant scientific research.

Objectives

- Study of models for time-continuous definitions of reference systems for discrete networks with a non-permanent set of points and their realization through discrete time series of station coordinate functions and related earth rotation parameters.
- Understanding the relation between such systems and reference systems implicitly introduced in theories of earth rotation and deformation.
- Extension of ITRF establishment procedures beyond the current linear (constant velocity) model, treatment of periodic and discontinuous station position variations, understanding of their geophysical origins and related models.

- Understanding the models used for data treatment within each particular technique, identification of possible biases and systematic effects and study of their influence on the combined ITRF solution. Study and improvement of current procedures for the merging of data from various space techniques.
- Statistical aspects of reference frames, introduction and assessment of appropriate quality measures.
- Problems of mathematical compatibility within current celestial-to-terrestrial datum transformations and proposal of new conventions which are data-based and theoretically compatible.

Program of Activities

- Launching of a web-page for dissemination of information, presentation, communication, outreach purposes, and providing a bibliography.
- Working meetings at international symposia and presentation of research results in appropriate sessions.
- Organization of workshops dedicated mainly to problem identification and motivation of relevant scientific research.
- A special issue of the Journal of Geodesy on reference frames with papers from working group workshops and invited review papers.

Membership

- Athanasios Dermanis, Chair (Greece)
- Zuheir Altamimi (France)
- Hermann Drewes (Germany)
- Fernando Sansò (Italy)
- Claude Boucher (France)
- Gerard Petit (France)
- Xavier Collilieux (France)
- Axel Nothnagel (Germany)
- Erricos Pavlis (USA)
- Jim Ray (USA)
- Frank Lemoine (USA)
- Geoff Blewitt (USA)

(some members to be confirmed still)

IC-SG2 Quality of Geodetic Multi-Sensor Systems and Networks

Chair: H. Kutterer (Germany)

Affiliation: Commissions 4, 1

Introduction

Modern geodetic observations are usually embedded in an integrated approach based on multi-sensor systems and networks. The fields of application are as manifold as the sensors in use. For example, total stations, GPS receivers and terrestrial laser scanners are applied in engineering geodesy for structural monitoring purposes together with permanently installed equipment. Geometric and physical space-geodetic sensors may serve as a second example since they are used for the determination of global reference frames.

It is good geodetic tradition to assess the quality of the obtained results for further use and interpretation. However, each field of application provides its own quality standards which are to some extent incomplete regarding the immanent processes. At present, there is no general methodology available for the theoretically founded quality assessment of geodetic multi-sensor systems and networks and of the induced processes.

The main focus of the SG is on the methodological foundation of quality in the context of close-range applications in engineering geodesy. Typical properties of the systems and networks considered here are on the one hand their readiness for real-time application and their adaptivity to observed system and process variations. On the other hand the systems and networks as well as their input are uncertain which limits analysis, interpretation and control. The IC SG2's work will cover at least three main fields in this context:

(1) Identification and mathematical definition of the relevant process-related uncertainty and quality properties and models, propagation and inference,

(2) revision, quality-related extension, and comparison of different approaches for the state space prediction and filtering (e.g., Kalman and shape filters, Bayesian filters, particle filters, fuzzy filters),

(3) validation studies using applications of broader geodetic interest such as geodetic monitoring, mobile mapping, machine control.

Comparable work outside geodesy both in the engineering and mathematical communities and in international standardization will be taken into account.

Objectives

The main objectives of the IC SG2 are

- to derive and promote a terminology and methodology for the quality assessment of geodetic multi-sensor systems and networks,
- to provide a unique platform for quality-related issues in geodesy and neighbouring fields,
- to initiate extended studies on related probabilistic and non-probabilistic methods for interpretation and decision,
- to monitor parallel developments in other communities.

To achieve these objectives, the IC SG 2 interacts and collaborates with the ICCT and its entities as well as the IAG Commissions 4 and 1.

The SG's work will be distributed to IAG sister organizations through respective members.

Members

TBC

Program of Activities

The IC SG2s program of activities will include

- organization of SG meetings and of a scientific workshop on quality issues
- participation in respective symposia,
- maintaining a website for quality-related information,
- supporting contributions to the ICCT activities.

IC-SG3 Configuration Analysis of Earth Oriented Space Techniques

Chair: F. Seitz (Germany)

Affiliation: Commissions 3, 2, 1

Introduction

Activities of the study group are focussed on modern methods of Earth observation from space. Today a multitude of simultaneously operating satellite systems with different objectives are available. They offer a broad spectrum of information on global and regional-scale processes within and/or between individual components of the Earth system in different temporal resolutions.

The general objective of this study group is the development of strategies how complementary and redundant information from heterogeneous observation types can be combined and analysed with respect to physical processes in the Earth system.

Most of the measurement techniques are restricted to the observation of integral effects of a multitude of underlying geophysical processes. It shall be investigated in which way the combination of heterogeneous data sets allows for the separation of processes and the identification of individual contributors.

In particular the studies span geometrical observation techniques (e.g. point positioning systems, imaging radar systems), gravimetrical observation techniques (e.g. GRACE, GOCE) and sensors which allow for the direct observation of individual physical processes (e.g., IceSat, SMOS).

The combination of complementary and redundant observation types fosters and improves the understanding of the Earth system. This implies more reliable information on processes and interactions in the subsystems of the Earth which is especially necessary with regard to studies of global change.

Among the most important steps are compilation and assessment of background information for individual systems and sensors (mode of operation, sensitivity, accuracy, deficiencies) as well as theoretical studies which (new) information on the Earth system can be gained from a combination of different observation methods.

Objectives

- which processes in the Earth system are insufficiently known and which parameters are imprecisely determined?
- can the understanding of individual processes be improved by common analysis of different observations types?
- which are the target parameters and how are the connections with other variables?
- which sensors are available and sensitive for the target parameters?
- which sensors can be used to reduce unwanted signals?
- which are the accuracies, temporal and spatial resolutions of the different data sets and which regions and time spans are covered?
- are the data publicly available or is their access restricted?

- which pre-processing steps are necessary in order to extract the proper information from the raw observation data?
- have the data already been pre-processed? Which methods, models and conventions have been applied? Are there possible error sources or inconsistencies?
- which methods can be applied in order to enhance the information content (e.g. filters)?
- how can the heterogeneous observation types can be combined expediently?
- how do the observation equations look like?
- which methods for parameter estimation can be applied? How can linear dependencies between parameters and rank deficiency problems be solved?
- how can balance equations be regarded in the combination process (e.g. mass and energy balance)?
- are there additional information (models and terrestrial data) which can/must be considered?
- which of the desired parameters can be assessed with the available observation techniques?
- which further parameters are desired and how could appropriate missions for the future look like?

The research activities shall be coordinated between the participating scientists and shall be conducted in interdisciplinary collaboration. At all times the group is open for new contacts and members in order to embed the activities in a wide context.

IC-SG4 Inverse Theory and Global Optimization

Chair: C. Kotsakis (Greece)

Affiliation: Commission 2

Introduction

At the Sapporo IUGG General Assembly (June 30 - July 11, 2003), the International Association of Geodesy (IAG) has approved the establishment of an 'inter-commission' working group (WG) on Inverse Problems and Global Optimization, with the aim of supporting and promoting theoretical and applied research work in various areas of modern geodetic data analysis and inversion. This WG has successfully operated during the last four years under the umbrella of the Intercommission Committee on Theory (ICCT) and the chairmanship of Dr. Jürgen Kusche. During the IAG-EC meeting at the Perugia IUGG General Assembly (July 2 – 13, 2007) the new structure of the ICCT and its associated WG's was discussed, and a decision was made that the ICCT/WG on Inverse Problems and Global Optimization will continue its operation for another 4-year period. The purpose of this document is to give an (updated) description of the WG's potential study areas and research objectives, and its associated terms of reference for the upcoming research period 2007 - 2011.

Terms of Reference

It is well recognized that many, if not most, geodetic problems are in fact inverse problems: we know to a certain level of approximation the mathematical and physical models that project an Earth-related parameter space and/or signal onto some data space of finite discrete vectors; given discrete noisy data we then want to recover the governing parameter set or the continuous field (signal) of the underlying model that describes certain geometrical and/or physical characteristics of the Earth. The situation is further complicated by the fact that these problems are often ill-posed in the sense that only generalized solutions can be retrieved (due to the existence of non-trivial null-spaces) and/or that the solutions do not depend continuously on the given data thus giving rise to dangerous unstable solution algorithms. In order to deal successfully with geodetic data inversion and parameter/signal estimation problems, it is natural that we have to keep track with ongoing developments in inverse problem theory, global optimization theory, multi-parameter regularization techniques, stochastic modelling, Bayesian inversion methods, statistical estimation theory, data assimilation, and other related fields of applied mathematics. In modern geodesy we also have to develop special inversion techniques that can be used for large-scale problems, involving high degree and order gravity field models from space gravity missions and high-resolution discretizations of the density field or the dynamic ocean topography.

Earth's gravity field modelling from space gravity missions has been (and will surely continue to be in the future) a key study area where existing and newly developed tools from Inverse Problem Theory need to be implemented (including the study of regularization methods and smoothing techniques and the quality assessment of Earth Gravity Models, EGMs). With the cutting-edge applications of the latest and upcoming gravity missions (recovery of monthly surface mass variations from GRACE, constraining viscosity/lithospheric/postglacial rebound models from GRACE time-variable gravity and from GOCE static geoid pattern analysis), it can be expected that Inverse Problem Theory will increase its importance for the space gravity community.

Furthermore, there still exist other, more classical geodetic problems that have been identified as inverse and ill-posed and have traditionally attracted the interest of many researchers: the inverse gravitational problem where we are interested in modelling the earth's interior density from gravity observations, various types of downward continuation problems in airborne/satellite gravimetry and geoid determination, certain problems in the context of satellite altimetry and marine gravity modelling, the problem of separating geoid and dynamic ocean topography, the problem of inferring excitations/earth structure parameters from observed polar motion, the determination of stress/strain tensors from observational surface monitoring data, or certain datum definition problems in the realization of global geodetic reference systems. Another, relatively recent, geodetic problem of ill-posed type is the orbit differentiation problem: non-conventional gravity recovery methods like the energy conservation approach and the acceleration approach require GPS-derived kinematic satellite orbits to be differentiated in time, while counteracting noise amplification at the same time. The above non-exhaustive list of inverse problems provides a rich collection of study topics with attractive theoretical/practical aspects, which (in conjunction with the increasing data accuracy, coverage and resolution level) contain several open issues that remain to be resolved.

Objectives

The aim of the WG is to bring together people working on inverse problem theory and its applications in geodetic problems. Besides a thorough theoretical understanding of inverse problems in geodesy, the WG's central research issue is the extraction of maximum information from noisy data by properly developing mathematical/statistical methods in a well defined sense of optimality, and applying them to specific geodetic problems. In particular, the following key objectives are identified:

- Identification and theoretical understanding of inverse and/or ill-posed problems in modern geodesy
- Development and comparison of mathematical and statistical methods for the proper treatment of geodetic inverse problems
- Recommendations and communication of new inversion strategies

More specific research will focus, for example, on global optimization methods and theory, on the mathematical structure of null-spaces, on the treatment of prior information, on nonlinear inversion in geodetic problems and on the use of techniques for treating inverse problems locally. It is also necessary to investigate the quality assessment and numerical implementation of existing regularization methods in practical geodetic problems (e.g. dealing with coloured noise and/or heterogeneous data, using partially over- and underdetermined models, dealing with different causes of ill-pose like data gaps and downward continuation, coping with data sets that have entirely unknown noise characteristics, etc.).

Membership

The following is a proposed (tentative) membership list for the IAG/ICCT WG on Inverse Problems and Global Optimization. The final list will be confirmed within 2007.

- C. Kotsakis (Greece, chair)
- J. Kusche (Germany)
- S. Baselga Moreno (Spain)
- J. Bouman (The Netherlands)
- P. Ditmar (The Netherlands)
- B. Gundlich (Germany)
- P. Holota (Czech Republic)
- M. Kern (The Netherlands)
- T. Mayer-Gürr (Germany)
- V. Michel (Germany)
- P. Novak (Czech Republic)
- S. Pereverzev (Austria)
- B. Schaffrin (USA)
- M. Schmidt (Germany)
- Y. Shen (China)
- N. Sneeuw (Germany)
- S. Tikhotsky (Germany)
- C. Xu (Russia)

Program of Activities

The WG's activities will include the launching of a webpage for dissemination of information, for presentation, communication and monitoring of research results and related activities, and for providing an updated bibliographic list of references for relevant papers and reports in the general area of geodetic inverse problems. This would also provide WG's members (and other interested individuals) with a common platform to communicate individual views and results, and stimulate discussions. Although the discussion will be in general based on e-mail, it is planned to have splinter meetings during international conferences and, if possible, a workshop or a special conference session.

IC-SG5 Satellite Gravity Theory

Chair: T. Mayer-Gürr (Germany)

Affiliation: Commission 2

Members

- Torsten Mayer-Gürr, University of Bonn, Germany – tmg@geod.uni-bonn.de
- Oliver Baur, University Stuttgart, Germany – baur@gis.uni-stuttgart.de
- Wolfgang Bosch, DGFI, Germany – bosch@dgfi.badw.de
- Pavel Ditmar, TU Delft, Netherlands – ditmar@geo.tudelft.nl
- Thomas Gruber, TU Munich, Germany – thomas.gruber@bv.tu-muenchen.de
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- Michael Kern, ESTEC, Netherlands – michael.kern@esa.int
- Jürgen Kusche, GFZ Potsdam, Germany – jkusche@gfz-potsdam.de
- Michael Schmidt, DGFI, Germany – schmidt@dgfi.badw.de
- Roland Schmidt, GFZ Potsdam, Germany – rschmidt@gfz-potsdam.de
- Roland Pail, TU Graz, Austria – pail@geomatics.tu-graz.ac.at
- Insa Wolf, University of Hannover, Germany – wolf@ife.uni-hannover.de

Objectives

- Gravity field estimation
- Perturbation techniques versus in-situ measurements and new approaches like short-arc integration, energy balance and so on.
- Computational problems related to the huge quantities of data. Algorithms to divide the computational tasks to run on massive parallel systems.
- Noise and error treatment
- Estimating the variance-covariance matrices of the observations, filtering techniques.
- Integrated analysis of different sensors featuring individual noise characteristics (like Accelerometer and K-band sensor in case of GRACE), calibration of instruments (internal and external).
- A-posteriori variance-covariance matrices, error propagation, validation.
- Space-time resolution, de-aliasing. Which signals can be estimated and which must be modelled?
- Gravity field modelling
- Choice of basis functions in time and space (with respect to applications in hydrology, oceanography).
- Global and regional modelling, modelling in terms of gravity sources (mass variations).
- Reference systems and datum problems (origin, orientation, static and temporal datum systems for gravity field changes).
- Aspects of data combination
- Combination of the satellite gravity missions (CHAMP, GRACE and GOCE) with terrestrial and aerial gravity information.
- Combination at the data level versus combination of results.
- A-priori information from non-gravity data such as changes in the geometry of the Earth and its rotation.
- Unified approaches: Joint analysis of gravity field observations, Earth rotation, and geometry changes.
- Future satellite missions
- Theory of new observation types and instruments.
- Formation flights. Investigation into stability of satellite formations and their sensitivity to aliasing errors.
- Follow-on gravity field missions.
- Orbit determination: theory, perturbation techniques, stability problems.
- Challenges caused by the increasing accuracy of the observations: integration techniques, numerical problems due to limited digits in computation.

Activities

- Email: Internal email discussions
- Meeting: Organization of working group meeting at larger meetings.
- Website: Launch of a website for communications, information and links to data sources
- Simulation data: Assemble of a simulated data set with orbits, background models and artificial noise. This data set serves to test new algorithms and make different approaches comparable.

IC-SG6 InSAR for Tectonophysics

Chair: M. Furuya (Japan)

Affiliation: Commissions 3, 4

Members (tentative)

- Masato Furuya (chair), Hokkaido University, Japan, furuya@mail.sci.hokudai.ac.jp
- Falk Amelung, University of Miami, USA,
- Roland Bürgmann, UC Berkeley, USA
- Andrea Donnellan, JPL, USA
- Yuri Fialko, SIO/UCSD, USA
- Yo Fukushima, Kyoto University, Japan, yofukushima@rcep.dpri.kyoto-u.ac.jp
- Sigrujon Jónsson, ETH, Switzerland, sj@erdw.ethz.ch
- Zhenhong Li, University College London, UK
- Zhong Lu, USGS, USA
- Taku Ozawa, NIED, Japan
- Matthew Pritchard, Cornell University, USA
- David Sandwell, SIO/UCSD, USA
- Masanobu Shimada, EORC/JAXA, Japan
- Mark Simons, Caltech, USA
- Tim Wright, Leeds University, UK

Introduction

Against a backdrop of a series of SAR satellite missions, ERS1/2, JERS, Envisat/ASAR, ALOS/PALSAR, Radarsat-1/2, TerraSAR/X, planned future missions (e.g. Centinel-1 and Desdyni), the overall objective of this working group is to be a focus of activities in the following research areas, related to geodetic measurement and analysis of SAR/InSAR data and their application to tectonophysical problems.

Objectives

- SAR/InSAR data analysis for tectonophysics: Development of new analysis techniques: e.g., ScanSAR interferometry, PS-InSAR, SBAS approach, Polarimetric InSAR etc..
- Retrieval and separation of atmospheric and crustal deformation signal: Improvement of conventional approaches (stacking or calibration), and development of a brand-new approach
- Modelling and interpretation of SAR/InSAR data: Development, application and assessment of geophysical modelling of InSAR data: e.g., efforts to go beyond over-simplified static solutions.
- Combination of InSAR data with other measurement sources: Development of novel and useful combination of InSAR data with other measurement techniques, such as GPS, gravity, seismogram etc.

Activities

- Email: Internal email discussions
- Meeting: Organization of working group meeting and organization of sessions at larger meetings. Potential candidate venues are the Joint AGU/CGU meeting, IAG workshops, FRINGE workshop, etc.
- Website: Launch of a website for communications, information dissemination and links to data sources
- Monitoring: Monitoring and presentation of activities—either by WG members or external—that are going on in these areas.

IC-SG7 Temporal Variations of Deformation and Gravity

Chair: D. Wolf (Germany)

Affiliation: Commissions 3, 2

Introduction

Recent advances in ground-, satellite- and space-geodetic techniques have detected temporal variations of deformation and gravity with unprecedented accuracy over a wide period range. These variations are related to various surficial and internal earth processes. The new types of observational data require the development of 2-D/3-D earth models and novel interpretational techniques.

Program of Activities

- Development of 2D/3-D elastic/viscoelastic earth models for simulating processes responsible for deformation and gravity variations.
- Forward modelling of deformation and gravity variations caused by atmospheric, cryospheric, hydrospheric or internal forcing functions.
- Inverse modelling of observed deformation and gravity variations in terms of forcing functions or in terms of elastic/viscoelastic earth parameters.

Membership

- H. Abd-Elmotaal (Egypt) abdelmotaal@lycos.com
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IC-SG8 Towards cm-accurate Geoid – Theories, Computational Methods and Validation

Chair: Y. M. Wang (USA)

Affiliation: Commission 2

Introduction

In today's satellite age, the ellipsoidal height can be determined up to 2 cm-accuracy geometrically by the global positioning system (GPS). If geoid models reach the same accuracy, national or global vertical systems can be established in a quick and economical way with cm-accuracy everywhere.

Geoid modelling has been based on Stokes and Molodensky's theories. In both theories, including the theories of gravity and topographic reductions which are fundamentally important for precise geoid computation, approximations and assumptions are made. The evaluation and verification of the effects of assumptions and approximations in the theories are urgently called for. Due to the massive effort on data collection that has improved our knowledge of the Earth's physical surface and its interior, fixed-boundary value problems become practical and useful. Theoretical and numerical studies along this line are not only important in practice, but also may be a fundamental change in physical geodesy.

The working group aims at bringing together scientists concerned with all aspects of the diverse areas of geodetically relevant theory and its applications. Its goal is to provide a framework consisting of theories and computational methods to ensure that cm-accurate geoid is achievable.

Objectives

Theoretical research related to precise geoid computations; studies of geodetic boundary values problems (free and fixed boundary value problems); development and refinement of gravity/topographic reduction theories; exploration and implementation of numerical methods of partial differential equations for Earth's gravity field determination (e.g., domain decomposition, spectral combination and others).

In more details, this includes:

- Studies of the effect of topographic density variations on the Earth's gravity field, especially the geoid.
- Rigorous yet efficient calculation of the topographic effects, refinement of the topographic and gravity reductions.

- Studies on harmonic downward continuations.
- Non-linear effects of the geodetic boundary value problems on the geoid determinations.
- Optimal combination of global gravity models with local gravity data.
- Exploration of numerical methods in solving the geodetic boundary value problems (domain decomposition, finite elements, and others)
- Studies on data requirements, data quality, distribution and sample rate, for a cm- accurate geoid.
- Studies on the time variations of the geoid caused by geodynamics.
- Studies on the interdisciplinary approach for marine geoid determination, e.g., research on realization of a global geoid consistent with the global mean sea surface observed by satellites.

Program of Activities

- Organization of meetings and conferences.
- Organizing WG meetings or sessions, in coincidence with a larger event, if the presence of working group members appears sufficiently large.
- Email discussion and electronic exchange.
- Launching a web page for dissemination of information, expressing aims, objectives, and discussions.
- Monitoring and reporting activities of working group members and interested external individuals.

Membership

- Y.M. Wang, USA (chair)
- W. Featherstone, Australia
- N. Kühtreiber, Austria
- H. Moritz, Austria
- M.G. Sideris, Canada
- M. Véronneau, Canada
- J. Huang, Canada
- M. Santos, Canada
- J.C. Li, China
- D.B. Cao, China
- W.B. Shen, China
- F. Mao, China
- Z. Martinec, Czech Republic
- R. Forsberg, Denmark
- O. Anderson, Denmark
- H. Abd-Elmotaal, Egypt
- H. Denker, Germany
- B. Heck, Germany
- W. Freeden, Germany
- J. H. Kwon, Korea
- L. Sjöberg, Sweden
- D. Roman, USA
- J. Saleh, USA
- D. Smith (USA)

Structure of Services

Bureau International des Poids et Mesures (BIPM)

– Time, Frequency and Gravimetry Section –

web: http://www.bipm.org/en/scientific/tfg/

Elisa Felicitas Arias
Head, BIPM Time, Frequency and Gravimetry Section

Since 1 January 2006, the traditional *BIPM time section* has been transformed into the *BIPM time, frequency and gravimetry (TFG) section*. This new section gathers the staff working on the formation of the international reference time scales and the members of the former length section, with activities in laser work, frequency combs and gravimetry. The TFG section is headed by Dr Elisa Felicitas Arias, head of the former time section.

The impact of the section on fields related to Earth sciences relevant to the IAG is concentrated on two activities of the section, (a) the formation of time scales and (b) the gravimetry.

The frequency combs, which served until the end of 2006 to the key comparison of primary wavelength standards in national laboratories, and the reference lasers are maintained and used for in-house applications only. The section also disposes of a service for filling and testing of iodine cells at the request of national laboratories and other customers.

International Time Scales at the BIPM

International Atomic Time TAI is a continuous, uniform atomic time scale with its second equivalent to the second of ephemeris time. The first time measurements with atomic standards became possible in 1955 after the construction of the caesium standard of the National Physical Laboratory (NPL) in the United Kingdom. The 13th Conférence Générale des Poids et Mesures (1967/1968) adopted a definition of the SI second, based on a caesium transition, and opened the way towards the formal definition of TAI.

Coordinated Universal Time UTC is currently defined as an atomic time scale adjusted to be close to the time of the Earth's rotation (namely UT1). The UTC system as defined today is a stepped atomic time scale and was adopted in 1972 on recommendation of the International Telecommunication Union, Radiocommunication Sector (ITU-R). A one-second step (leap second) is introduced in UTC whenever the International Earth Rotation and Reference Systems Service (IERS) determines that an adjustment is necessary based on space technique observations of the Earth's rotation. As of December 2007, the difference between the continuous TAI and UTC amounts to 33 s. UTC has been adopted by the ITU-R as the international time scale for time dissemination. It is derived from TAI by applying a correction of an integer number of seconds. Like TAI, UTC is a "paper" time scale, but it is approximated by local physical representations UTC(k) through clocks in national metrology laboratories and observatories that contribute to the formation of the international time scales at the BIPM.

The BIPM is responsible for realizing, maintaining and disseminating TAI and UTC. These activities result from the cooperation of 62 laboratories in 47 member states of the Metre Convention and associates. These laboratories are equipped of industrial atomic clocks and of devices to allow the comparison of the local UTC(k) which are necessary to the calculation of the time scales at the BIPM. Some ten of these laboratories have developed and maintain primary frequency standards – the best are the caesium fountains – that provide the primary definition of the time unit of the SI.

TAI and UTC are obtained from a combination of data from about 350 atomic clocks kept by the contributing laboratories. The data are in the form of time differences [*UTC*(*k*) - *Clock*] taken at 5 day intervals.

Local UTC(k) comparisons can presently be made by three techniques: (a) observations based on C/A code measurements from GPS single frequency receivers; (b) data obtained with dual-frequency, multi-channel GPS geodetic type receivers (P3); and (c) two-way satellite time and frequency transfer through geostationary telecommunications satellites (TWSTFT). Significant improvement is being made with the growing number of time links with P3 receivers (20% of the official links in October 2007) and with the increase of the frequency of TWSTFT observations (up to twelve per day). The classical GPS single-channel single-frequency receivers that today represent only 25 % of the time transfer equipment are being replaced to allow multi-channel, single or dual frequency observations. As a result, there has been an improvement in the accuracy for time transfer, and the whole system of time links becomes more reliable.

The algorithm used for the calculation of time scales is an iterative process that starts by producing a free atomic scale (*Échelle atomique libre* or EAL) from which TAI and UTC are derived. Research into time scale algorithms is conducted in the section with the aim of improving the long-term stability of EAL and the accuracy of TAI.

Since 2003, it is estimated that the stability of EAL, expressed in terms of an Allan deviation, has been at or below 0.4×10^{-15} for averaging times of one month. Slowly varying long-term drifts limit the stability to around 2×10^{-15} for averaging times of six months.

To characterize the accuracy of TAI, estimates are made of the relative departure, and its uncertainty, of the duration of the TAI scale interval from the SI second, as produced on the rotating geoid, by primary frequency standards. Since July 2006, individual measurements of the TAI frequency have been provided by eleven primary frequency standards, including seven caesium fountains. Since then, the global treatment of individual measurements has led to a relative departure of the duration of the TAI scale unit from the SI second on the geoid ranging from $+0.7 \times 10^{-15}$ to $+3.7 \times 10^{-15}$, with a standard uncertainty of about 1×10^{-15}.

Because TAI is computed for fast publication and has operational constraints, it does not provide an optimal realization of Terrestrial Time TT, the time coordinate of the geocentric reference system. The BIPM therefore computes TT(BIPM) in post-processing, which is based on a weighted average of the evaluation of the TAI frequency by all available data of the primary frequency standards.

The computation of TAI is carried out every month and the results are published monthly in *BIPM Circular T*. When preparing the *Annual Report*, the results shown in *Circular T* may be revised taking into account any subsequent improvements made to the data. Results are also available from the BIPM website (*www.bipm.org*), as well as all data used for the calculation.

The broad real-time dissemination of UTC through broadcast and satellite time signals is a responsibility of the national metrology laboratories and some observatories, following the recommendations of the ITU.

Gravimetry at the BIPM

The BIPM makes a regular monitoring of the gravity field at the site. Improvement on gravimeter design and performances allows having in our laboratories equipment with high metrological quality.

Together with the IAG the Commission 2 "Gravity Field" and the working group on gravimetry of the Consultative Committee for the Mass and Related Quantities (CCM), the BIPM organizes every four years the *International Campaign of Absolute Gravimeters* (ICAG). About 20 absolute gravimeters from 16 countries, the BIPM and the ECGS participated to the last ICAG in September 2005. In July 2005, relative gravimeters carried out supportive measurements of the gravity gradients and the links between the sites of the BIPM gravity micro-network. The next campaign is scheduled for 2009.

At each campaign, the BIPM provides the calibration of the lasers in gravimeters (at 633 nm and 532 nm), measurements of the laser beam shape, verification of the frequency of the rubidium clocks and continues atmospheric pressure measurements.

Part of the work of the group is devoted to the investigation of the sources of uncertainty in absolute measurements.

Support to the BIPM special projects is given with the characterization of the gravity field for the watt balance.

Relationship with other Organizations

The BIPM time, frequency and gravimetry section is a service of the IAG. The section interacts with many other international organizations related to time metrology. This interaction is fundamental to our activities, since many fields of the physical sciences contribute to the formation and maintenance of time scales. This is the case of Earth sciences, astronomy, satellite navigation, telecommunications, informatics, electronics, etc. Some examples of links with international organizations are the International Astronomical Union (IAU), the ITU, the IERS, the International GNSS Service (IGS), the International Committee for GNSS (ICG).

IAG Bibliographic Service (IBS)

web: http://www.bkg.bund.de/ – Dienste – IAG

Chair: **Annekathrin Michlenz** (Germany)

Development

The service is based on the literature database geodesy, photogrammetry and cartography (GEOPHOKA), which is maintained by the Federal Agency for Cartography and Geodesy, Branch Office Leipzig. Since 1984 there are stored literature entries. They cover the whole subject of geodesy, cartography and photogrammetry and the neighbouring files. Every year 1500 new entries are included into the database. In September 2007 the database comprises about 59700 entries.

Objectives

In addition to the Fast Bibliography within the IAG Newsletter of the Journal of Geodesy the IAG Bibliographic Service serves mainly to inform the geodesists who are associated in the IAG about current geodetic literature from all over the world.

For the IAG Bibliographic Service geodetic journals and other periodicals, publications of research institutes, manuals und text books as well as congress papers are analyzed. The documentalists choose such sources for the service which are relevant to the activities of the Sections, Commissions, Special Commissions und Special Study Groups.

These literature sources are available in the library of the Bundesamt für Kartographie und Geodäsie (BKG) (library symbol F128 or L191).

The topicality of the sources recorded in the IAG Bibliographic Service is dependent on the date of their arriving at the library of the BKG. German-language literature und conference proceedings on geodesy are processes as a rule within 3 weeks after receipt.

Each literature record contains:

- The bibliographic description of the source according to the commonly known rules.
- The descriptors in German. They inform about the content of the recorded source.
- In most cases an abstract, if possible in English. The abstracts are often taken from the source or are processes by the documentalist on the basis of the summary, the conclusions, or the list of contents of the source.

Point of Contact

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International Altimetry Service (IAS)

web: http://ias.dgfi.badw.de/

Chairman of the Steering Committee: **Wolfgang Bosch** (Germany)

Preamble

Satellite Altimetry has evolved to an operational remote sensing technique with important interdisciplinary applications to many geosciences. For geodesy, the potential operational, precise and near global mapping and monitoring of the Earth surface is of particular importance. The construction of high-resolution global mean sea surface and potentially its variability will help to globally unify height reference systems. Altimetry contributes to essential improvements of the Earth gravity field. Even with the new dedicated gravity field missions CHAMP, GRACE and GOCE, satellite altimetry will be needed for the determination of the high resolution gravity field. Mapping and monitoring of seasonal and secular changes of the mean sea level helps to understand fundamental processes of the System Earth: the ocean water mass redistribution, one component of the global hydrological cycle, has impact to the Earth centre-of-gravity, to Earth rotation by the ocean angular momentum functions, the temporal variations of the Earth gravity field, as well as studies of sea level rise and its impact on environment.

Many organisations already provide altimetry data and products suggesting that a service fulfilling these requirements can only be realised as integrated effort: a distributed approach with close collaboration between data providers, archive and product centres, and research laboratories. Such an International Altimetry Service should act mission and agency independent and provide all user groups an improved access and better information on which to build scientifically sound decision making. With respect to endorsements by GLOSS, IAPSO and IAG an Integrating Office for the envisaged International Altimetry Service is established to identify and pool together international resources in altimetry, to propose a design plan for the establishment of an International Altimetry Service and to suggest projects gradually improving existing services for the benefit of the altimetry community at large.

IAS Integrating Office

The general objectives of this IAS-Integrating Office shall be:

- to provide a platform (and single point of contact) for general information on satellite altimetry and its applications;
- to communicate with, and interface to, altimeter mission data providers, centres which process, archive, and analyse altimeter data, and other related services and organizations;
- to promote satellite altimetry as a core element of Global Earth Observing Systems; and
- to help compile and analyse data, and respond to altimeter user requirements.

The IAS Integrating Office accomplishes its mission by:

- collaborating as appropriate with space agencies, processing centres, research institutes and altimetry experts;
- establishing a collaborative web site (a Wiki or Content Management System) that is able to compile basic information on satellite altimetry, its data, products and applications as given by data providers, archive and product centres, research laboratories and experienced users;
- directing user requests for altimetry data, services, models, etc., to the appropriate organization;
- establishing pilot projects which will enhance and expand its activities; these will target various needs of the altimetry community, and may become permanent components of the International Altimetry Service; and
- reporting to IAG, IAPSO, GLOSS, GOOS, GGOS, GEOSS and other bodies related to satellite altimetry on the status, achievements and plans of the altimetry service.

IAS-IO initial tasks and added–value activities:

- Improve information and documentation on altimetry mission data and related products. Provide users with information on where to get altimetry data and

products by compiling and providing associated metadata, setting links to existing data providers and giving advice how to read, transform, and apply data and products. Enable users to assess data and product quality and to com-pare similar products generated by different organisations.

- Develop tools, interfaces or systems to provide GDR/ level2 data or derived higher level products which have been upgraded by improved geophysical corrections, reprocessed orbit ephemeris or re-tracked sensor data. Strengthen the future upgrade capability for GDR/level 2 data by distributed processing mechanisms.
- Provide interfaces to allow user–defined data extracts where experienced user can decide what record parameter they want to get and inexperienced users are given recommended extract formats for specific applications. This requires to setup and maintain electronic version of data element dictionaries for GDR/level 2 data or higher level products.

Steering Committee

- Ole Anderson (representative for IGFS)
- Wolfgang Bosch (chair)
- Alexander Braun (ice applications)
- Yoshi Fukuda (president of IAG Commission 2)
- Richard Gross (for Geophysical Fluids, Vice-President of Commission 3)
- Cheinway Hwang (president Sub-Commission SC2.5 on Satellite Altimetry)
- Phil Woodworth (for PSMSL and GLOSS Experts)

International Centre for Earth Tides (ICET)

web: http://www.astro.oma.be/ICET/

Director: **Jean-Pierre Barriot** (France, French Polynesia)

Activities

- Summary of Data Held: data from about 360 world-wide tidal gravity stations including GGP stations (hourly values, main tidal waves obtained by least squares analyses, residual vectors, oceanic attraction and loading vectors). The Data Bank contains also data from tiltmeters and extensometers.
- Data Products, Publications, Catalogues: a "Bulletin d'Informations des Marées Terrestres" is published electronically once per year with a large number of translations of Russian and Chinese papers.
- A General Bibliography is also regularly kept up to date and published online.
- User Services: the Center provides assistance for the setup of new stations, calibrations of the instruments, data processing as well as for tidal analysis. The assistance is accomplished either by a stay at the Centre or by providing computers programs.
- ICET makes also available tidal predictions for any place and time, which are needed for field gravimetry, absolute gravity measurements and for tilt measurements. These predictions can be computed either on the basis of elastic Earth models and oceanic co-tidal maps, or on basis of the results of direct measurements.

International Centre for Global Earth Models (ICGEM)

web: http://icgem.gfz-potsdam.de

Director: **Jürgen Kusche** (Germany)

Terms of Reference

The determination of the Earth's global gravity field is one of the main tasks of Geodesy: it serves as a reference for geodesy itself, and it provides important information about the Earth, its interior and its fluid envelope for all geosciences. Thus, it is important to make the models of the global gravity field available to the public as products of geodesy. This becomes increasingly important as time variations of the global gravity field can be measured with better and better spatial and temporal resolution.

The calculation of the different functionals of the geopotential (e.g.: geoid, gravity anomaly, gravity disturbance, equivalent water height) from a defined global model, on a specified grid and with respect to a defined reference system, is far from being trivial and a responsibility of geodesy too.

Additionally, it is important to make the spatial structure and temporal variability of the global gravity field available to the general public in a graphic vivid manner.

In particular for temporal gravity models, aspects of consistency in processing, reference frame, and parameterization are becoming more and more important.

ICGEM has been established in 2003 as a new service under the umbrella of the new International Gravity Field Service (IGFS) as one of six centres.

Objectives

- collecting and long-term archiving of existing global gravity field models
- making them available on the web
- use of standardised format (self-explanatory)
- interactive visualisation of the models
- monthly solutions from GRACE included
- web-interface to calculate gravity functionals from the spherical harmonic models on freely selectable grids (filtering)
- evaluation of the models
- monitor consistency of models
- contribution to IGeS schools

Services

The Models

Currently, 98 models are listed with their references and 79 of them are available in form of spherical harmonic coefficients. If available, the link to the original model web site has been added. Models from dedicated time periods (e.g. monthly solutions from GRACE) of CSR, JPL, CNES/GRGS and GFZ are also available.

The Format

The spherical harmonic coefficients are available in a standardised self-explanatory format which has been accepted by ESA as the official format for the GOCE project.

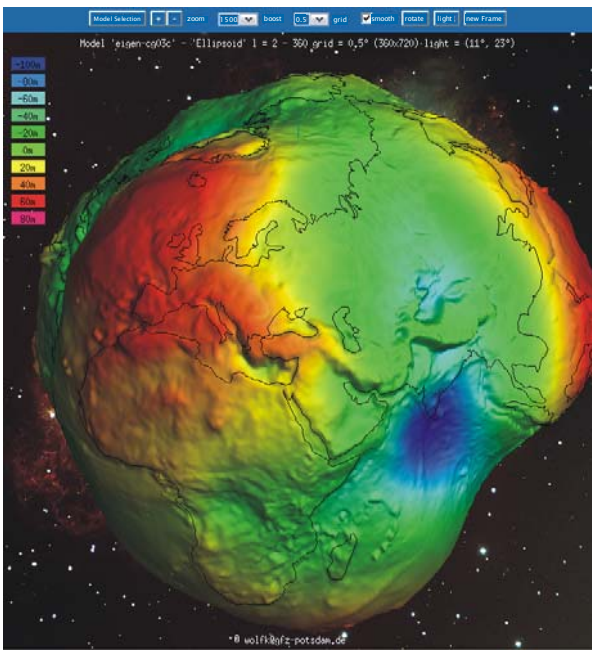


Fig. 1: Visualisation (geoid) of a global gravity field model

The Visualisation

An online interactive visualisation of the models (height anomalies and gravity anomalies) as illuminated projection on a freely rotatable sphere is available. Monthly solutions from GRACE are included. Differences of two models, arbitrary degree windows, zooming in and out, are possible. The visualisation of single spherical harmonics is possible for tutorial purposes.

The Calculation Service

A web-interface to calculate gravity functionals from the spherical harmonic models on freely selectable grids, with respect to a reference system of the user's choice, is provided. The following functionals are available:

- height anomaly
- geoid height
- gravity disturbance
- gravity disturbance in spherical approximation
- gravity anomaly (classical and modern definition)
- gravity anomaly (in spherical approximation)
- equivalent water height (water column)

Filtering is possible by selecting the range of used coefficients or the filter length of a Gaussian averaging filter. The calculated grids (self-explanatory format) and corresponding plots (postscript) are available for download after some seconds.

Fig. 2: Input mask of the calculation service

Evaluation

For a concise evaluation of the models, comparisons with GPS-levelling data and with the most recent combination model in the spectral domain are provided.

Root mean square (rms) about mean of GPS / levelling minus gravity field model derived geoid heights [m]

Model	Nmax	USA 6169 points	Canada 1930 points	Europe 186 points	Australia 201 points
ITG-GRACE02S	170	0.638	0.513	0.638	0.499
EIGEN-GL04S1	150	0.642	0.579	0.703	0.473
EIGEN-GL04C	360	0.363	0.261	0.332	0.262
EIGEN-CG03C	360	0.367	0.311	0.397	0.277
GGM02C	200	0.491	0.381	0.492	0.390
GGM02S	160	0.986	1.120	1.282	1.362
EIGEN-CG01C	360	0.374	0.277	0.412	0.281

Fig. 3: Table (truncated) of comparison of the models with GPS-levelling

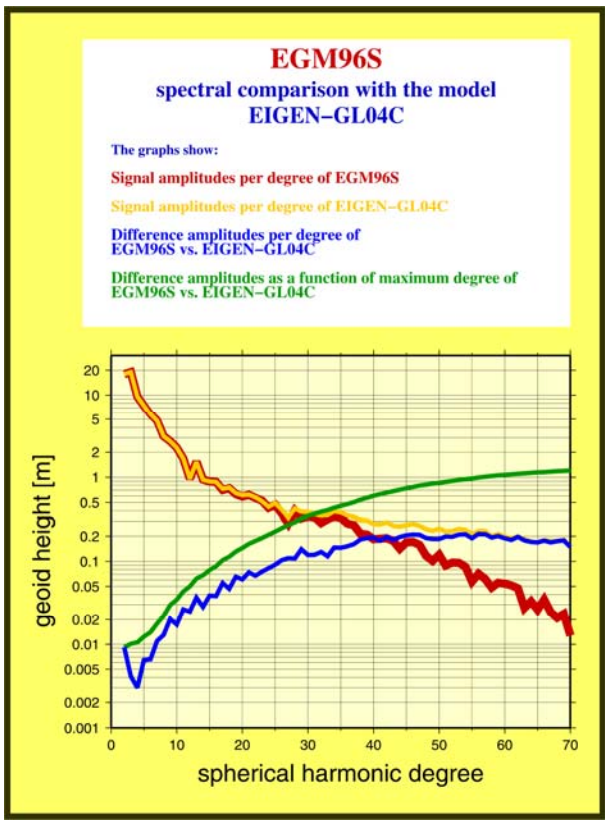


Fig. 4: Comparison of the models (e.g.: EGM96) with the most recent combination model in the spectral domain (e.g. EIGEN-GL04C)

Data Policy

Access to global gravity models, derived products and tutorials, once offered by the centre, shall be unrestricted for any external user.

Staff

ICGEM is hosted by GFZ Potsdam. Its staff consists of

- Jürgen Kusche (Director)
- Franz Barthelmes
- Wolfgang Köhler
- Hartmut Pflug

Point of Contact

Franz Barthelmes
GeoForschungsZentrum Potsdam
Telegrafenberg
D-14473 Potsdam
Germany
E-mail: *bar@gfz-potsdam.de*

International Digital Elevation Model Service (IDEMS)

web: http://www.cse.dmu.ac.uk/EAPRS/iag/

Director: **Philippa Berry** (UK)

The centre for International Digital Elevation Models is one of six centres of the International Gravity Field Service (IGFS) of the International Association of Geodesy (IAG).

Terms of Reference

- To collect digital elevation model datasets and meta-data and provide links to distributed sources in order to facilitate access to DEM data and analysis tools
- To provide an information hub for other relevant information
- To acquire software and link to existing software archives with an emphasis on open source code
- To provide information on relevant space missions
- To provide tutorial information to facilitate access both to data and to relevant analysis techniques
- To ensure effective dissemination of research outputs and information to laboratories and research institutes worldwide

The requirements for topographic mapping are continually escalating as increased computing power and the enhanced interest in planet-wide data mean that studies once performed at a regional level are increasingly being performed at continental or even global scales. The need for access both to DEM data and to data manipulation software, coupled with rapid dissemination of relevant research results is ever more urgent. There is a requirement for support of small groups working in this field and to assist networking of geographically distributed researchers.

Accordingly, the IDEMS centre aims to facilitate access to data sources and associated meta-data, providing a central reference point and, crucially, to create a nexus for networking; particularly for individual researchers and small groups working with these data.

The IDEMS centre places a particular emphasis on water representation in DEMS. The representation of inland surface water within DEMS and its temporal variation is increasingly required both by research groups and to inform water resource management: accordingly information on this topic, together with links to existing data sources and research programmes is included on the IDEMS website.

International DORIS Service (IDS)

─ Terms of Reference ─

web: http://ids.cls.fr/

Chair: **Gilles Tavernier** (France)

Introduction

DORIS (Doppler Orbit determination and Radio Positioning Integrated on Satellite) has been developed by the Centre National d'Etudes Spatiales (CNES) in conjunction with the Institut Géographique National (IGN) and the Groupe de Recherche de Géodésie Spatiale (GRGS).

A proof of concept for the International DORIS Service (IDS) was conducted through a Pilot phase until the establishment of the International DORIS Experiment in 1999 by the International Association of Geodesy (IAG). The IDS has begun formally on July 1, 2003 after the IAG official approval at the IUGG General Assembly in Sapporo. The IDS is an IAG Service and operates in close cooperation with the International Earth rotation and Reference frames Service (IERS).

The IDS mission

The primary objective of the IDS is to provide a service to support, through DORIS data and data products, geodetic and geophysical research activities.

The IDS collects, archives and distributes DORIS observation data sets of sufficient accuracy to satisfy the objectives of a wide range of applications and experimentations. From these data sets the following products are derived :

- Coordinates and velocities of the IDS tracking stations
- Geocentre and scale of the Terrestrial Reference Frame
- Ionospheric information
- High accuracy ephemerides of DORIS satellites
- Earth rotation parameters

The accuracies of these products are sufficient to support current scientific objectives including:

- Realization of global accessibility to and the improvement of the International Terrestrial Reference Frame (ITRF)
- Monitoring deformations of the solid earth
- Monitoring crustal deformation at tide gauges
- Monitoring variations in the hydrosphere (sea level, ice-sheets, etc.)
- Orbit determination for scientific satellites
- Ionosphere monitoring

The IDS organization

The IDS accomplishes its mission through the following components:

- Satellites carrying a DORIS receiver
- Network of tracking stations
- Data Centres
- Analysis Centres - Analysis Coordinator
- Working Groups
- Central Bureau
- Governing Board

Satellites carrying a DORIS receiver

In July 2003, DORIS data are provided by CNES (SPOT-2, SPOT-3, SPOT-4, SPOT-5, TOPEX/ Poseidon, Jason) and the European Space Agency (Envisat). Additional DORIS satellites, such as Cryosat, Jason-2 and Pleïades constellation are also foreseen.

Network of Tracking Stations

The IDS network is composed of DORIS permanent tracking stations located at several host institutions and maintained by the IGN (56 in total in July 2003).

The network can also include additional DORIS stations observing during specific campaigns of scientific interest and selected by the Station Selection Working Group.

Data Centres

The Data Centres are in direct contact with the CNES, which provides the DORIS data. They archive the DORIS data as well as any ancillary information required to process these data.

Analysis Centres and Analysis Coordinator

The Analysis Centres are committed to provide at least one of the above IDS products on a regular basis. Their expertise in DORIS data analysis is a key factor of the product accuracy.

The Analysis Coordinator assists the Analysis Centres. The Analysis Coordinator monitors the Analysis Centres activities to ensure that the IDS objectives are carried out.

Specific expectations include quality control, performance evaluation, and continued development of appropriate analysis standards. The Analysis Coordinator, with the assistance of the Central Bureau, is also responsible for the appropriate combination of the Analysis Centres products into a single set of products.

Through the existing reciprocity agreement between IDS and IERS, the Analysis Coordinator serves as the DORIS Technique Centre representative for IERS, and as such, subject to Governing Board approval, is a member of the IERS Directing Board (together with another person selected by the IDS Governing Board). In turn, the IERS Directing Board designates a representative to the IDS Governing Board. This arrangement ensures full cooperation between the two services.

Working Groups

IDS Working Groups provide expertise on particular topics related to the IDS components or aims at the development of particular IDS product(s) or service(s) relying on the IDS infrastructure.

All Working Groups are created and dismissed by the IDS Governing Board on the approval of the Working Group's charter, which must include a mandate, a schedule, and a chairman.

The Chairpersons of the Working Groups are non-voting members of the IDS Governing Board (see below).

Central Bureau

The Central Bureau (CB) is the executive arm of the IDS Governing Board and as such is responsible for the general management of the IDS consistent with the directives, policies and priorities set by the Governing Board.

In this role the CB, within available resources, coordinates IDS activities, facilitates communications, maintains documentation, and organizes reports, meetings and workshops.

The CB actively coordinates with the Working Groups and committees and ensures the compatibility of IDS and IERS by interfacing with the IERS. The CB acts as the outreach office and promotes use of IDS data and products, maintaining and expanding the visibility of the IDS. To accomplish these tasks the CB works closely with the independent Analysis Coordinator described above.

The CB supports the Analysis Coordinator in combining the various Analysis Centres products and providing him with all information necessary to validate the final combined products.

The CB operates the information system for the IDS and produces the IDS Annual Reports and directory. The CB coordinates the publication of other documents required for the satisfactory planning and day-to-day operation of the Service, including standards and specifications regarding the performance, functionality and configuration requirements of all elements of the Service.

Although the Chairperson of the Governing Board is the official representative of the IDS to external organizations, the CB, consonant with the directives established by the Governing Board, is responsible for the day-to-day liaison with such organizations.

The long term function of IDS is assured through redundancy and emergency contingency for all of its components except for the CB. For this reason the performance of the Central Bureau is to be formally reviewed by the GB at least every five years. On these occasions the Central Bureau will either reconfirm its commitment to the IDS for the next period of five years or announce the termination of operations after a transition phase of at least one year. The GB will formally approve the Central Bureau's proposal, or, alternatively issue a Call for Proposal for a new IDS Central Bureau to take over responsibilities after the transition phase.

In summary, the Central Bureau performs primarily a long-term coordination role to ensure that IDS participants contribute to the Service in a consistent and continuous manner and adhere to IDS standards.

Governing Board

The principal roles of the Governing Board (GB) are to set policy and to exercise broad oversight of all IDS functions and components. It also controls general activities of the Service, including restructuring, that would be appropriate to maintain efficiency and reliability, while taking full advantage of the advances in technology and theory.

The Governing Board (GB) consists of nine voting members and a number of non-voting members. They are distributed as follows:

Elected by IDS Associates (see below)	
Analysis Centres' representative:	1
Data Centres' representative	1
Elected by the Governing Board	
Analysis Coordinator	1
Networks representative	1
Members at large	2
Appointed members	
Director of the Central Bureau	1
Representative of the IERS	1
IAG representative	1
Total voting members	9

The Working Group chairpersons are GB members with voice but without vote.

The appointed members are considered ex officio and are not subject to institutional restrictions. The elected six persons must be members of different organizations. All six candidates have staggered four-year terms, which are renewable twice. The GB membership should be properly balanced with regard to supporting organizations as well as geographically.

For the first two of the above positions representing components of the IDS, the nominating committee conducts the elections. The nominating committee consists of three members, the chair of which is appointed by the Chair of the GB and who is a member of the GB not currently up for re-election. The nominating committee presents to the Associate Members, for each position to be filled, a list of at least two candidates for election. The election will be by the number of votes received by the Associate Members. In the case of a tie the election is by the members of the Governing Board.

For the next four elected positions, four weeks prior to the election by the Governing Board, the Central Bureau presents its candidate(s) to the Governing Board. Based on the reactions of the GB members, or on the outcome of the elected positions, the CB may present a revised list at the GB meeting where the election of the new Board members takes place.

In case of a resignation from the Board, after consulting with the appropriate IDS components, the CB will nominate replacement candidates for election by the GB. The replacement will serve until the end of the term of the resigned Board member.

The Chairperson is one of the members of the GB elected by the Board for a term of four years with the possibility of re-election for one additional term. The Chairperson does not vote, except in case of a tie. He/she is the official representative of IDS to external organizations.

The IAG and IERS representatives are appointed respectively by the IAG Bureau and by IERS Governing Board for a maximum of two four-year terms.

Members of the GB become IAG Fellows with the appropriate rights and privileges after an initial two- year period.

Most GB decisions are to be made by consensus or by a simple majority vote of the members present, provided that there is a quorum consisting of at least six members of the GB. In case of lack of a quorum the voting is by e-mail. Changes in the IDS Terms of Reference and Chairperson of the GB can only be made by a 2/3 majority of the members of the GB, i.e., by six or more votes.

The Board shall meet at least annually and at such other times as shall be considered appropriate by the Chairperson or at the request of three members. The Central Bureau provides the secretariat of the GB.

Associate Members

Associate Members are persons representing organizations, which participate in any of the IDS components. The Central Bureau maintains the list of Associate Members, which is revised annually and is subject to the approval of the Governing Board. The starting list of the IDS Associate Members is a subset of the complete distribution list of the DORIS-Mails.

Associate Members vote for the incoming members of the GB (except for those nominated by the CB). The list of Associate Members eligible for voting in the elections must be approved by the GB at least three months prior to the election process. For the purposes of the election current and former GB members are also considered Associate Members.

IDS Associate Members are considered IAG Affiliates with the appropriate rights and privileges.

International Earth Rotation and Reference Systems Service (IERS)

web: http://www.iers.org

Chair of the Directing Board: **Chopo Ma** USA)
Director of the Central Bureau: **Bernd Richter** (Germany)

Development

The IERS was established as the International Earth Rotation Service in 1987 by the International Astronomical Union and the International Union of Geodesy and Geophysics, and it began operation on 1 January 1988. Since 2001, the IERS works in a new organizational structure; in 2003, the new name of the Service, without changing its abbreviation, was adopted. The IERS is a member of the Federation of Astronomical and Geophysical Data Analysis Services (FAGS).

Objectives

The primary objectives of the IERS are to serve the astronomical, geodetic and geophysical communities by providing the following:

- The International Celestial Reference System (ICRS) and its realization, the International Celestial Reference Frame (ICRF)
- The International Terrestrial Reference System (ITRS) and its realization, the International Terrestrial Reference Frame (ITRF)
- Earth orientation parameters required to study earth orientation variations and to transform between the ICRF and the ITRF
- Geophysical data to interpret time/space variations in the ICRF, ITRF or earth orientation parameters, and model such variations
- Standards, constants and models (i.e., conventions) encouraging international adherence

Products

IERS collects, archives and distributes products to satisfy the objectives of a wide range of applications, research and experimentation. These products include the following:

- International Celestial Reference Frame
- International Terrestrial Reference Frame
- Monthly earth orientation data
- Daily rapid service estimates of near real-time earth orientation data and their predictions
- Announcements of the differences between astronomical and civil time for time distribution by radio stations
- Leap second announcements
- Products related to global geophysical fluids such as mass and angular momentum distribution
- Annual report and technical notes on conventions and other topics
- Long-term earth orientation information

The accuracies of these products are sufficient to support current scientific and technical objectives including the following:

- Fundamental astronomical and geodetic reference systems
- Monitoring and modelling earth rotation/orientation
- Monitoring and modelling deformations of the solid earth
- Monitoring mass variations in the geophysical fluids, including the atmosphere and the hydrosphere
- Artificial satellite orbit determination
- Geophysical and atmospheric research, studies of dynamical interactions between geophysical fluids and the solid earth
- Space navigation.

Structure

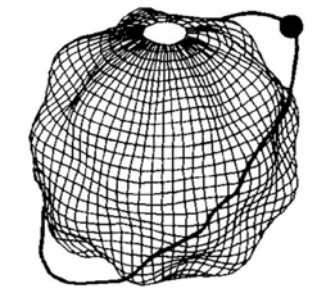
The IERS accomplishes its mission through the following components:

- Technique Centers: International GNSS Service, International Laser Ranging Service, International VLBI Service, and International DORIS Service
- Product Centers: Earth Orientation Center, Rapid Service/Prediction Center, Conventions Center, ICRS Center, ITRS Center, and Global Geophysical Fluids Center with Special Bureaus for the Atmosphere, for the Oceans, for Tides, for Hydrology, for Mantle, for the Core, for Gravity/Geocentre, and for Loading
- ITRS Combination Centers at Deutsches Geodätisches Forschungsinstitut (DGFI), Geomatics Canada/Geodetic Survey Division, Institut Géographique National (IGN)
- Combination Research Centers at Agenzia Spaziale Italiana (ASI), Astronomical Institute, Academy of Sciences of the Czech Republic, and Department of Geodesy, Czech Technical University, Prague, Deutsches Geodätisches Forschungsinstitut (DGFI), Forsvarets forskningsinstitutt (FFI, Norwegian Defence Research Establishment), GeoForschungsZentrum Potsdam (GFZ), Geodätisches Institut der Universität Bonn (GIUB), Groupe de Recherches de Géodésie Spatiale (GRGS), Institut Géographique National (IGN), Ecole Nationale des Sciences Géographiques (ENSG), Laboratoire de Recherche en Géodésie (LAREG), Jet Propulsion Laboratory (JPL)
- Analysis Coordinator
- Central Bureau
- Directing Board
- Working Groups: WG on Combination, WG on Prediction, IERS/IVS WG on the Second Realization of the ICRF.

Some of these components (e.g., Technique Centers) may be autonomous operations, structurally independent from IERS, but which cooperate with the IERS. A participating organization may also function as one or several of these components (except as a Directing Board).

IERS Directing Board 2007

- Zuheir Altamimi (France), *ITRS Center Representative*
- Nicole Capitaine (France), *IAU and FAGS Representative*
- Hervé Fagard (France), *IDS Representative*
- Daniel Gambis (France), *Earth Orientation Center Representative*
- Ralph A. Gaume (USA), *ICRS Center Representative*
- Gerd Gendt (Germany), *IGS Representative*
- Frank Lemoine (USA), *IDS Representative*
- Brian J. Luzum (USA), *Conventions Center Representative*
- Chopo Ma (USA), *IVS Representative, Chair*
- Angelyn W. Moore (USA), *IGS Representative*
- Jürgen Müller (Germany), *ILRS Representative*
- Axel Nothnagel (Germany), *IVS Representative*
- Erricos C. Pavlis (USA), *ILRS Representative*
- Bernd Richter (Germany), *Director of the Central Bureau*
- Markus Rothacher (Germany), *Analysis Coordinator*
- Tonie van Dam (Luxembourg), *GGFC Representative*
- Clark R. Wilson (USA), *IAG / IUGG Representative*
- William H. Wooden (USA), *Rapid Service/Prediction Center Representative*



International Geoid Service (IGeS)

web: http://www.iges.polimi.it

President and Director: **Riccardo Barzaghi** (Italy)

Mission / Objectives

The main tasks of IGeS are

- to collect geoid estimates worldwide, when possible to validate them and to disseminate them upon request among the scientific community: other auxiliary data can also be collected by IGeS, when useful for the geoid determination, and might be made available with the sharp exclusion of gravity anomalies data,
- to collect, test and, when allowed, to distribute software for the geoid determination,
- to conduct researches on methods for the geoid determination, particularly trying to define optimal procedures for merging all the available data,
- to organize schools on geoid determination where both theoretical and practical aspects are illustrated. During the schools students are trained in the use of the relevant software used for geoid computation,
- to issue, at least once per year, the Newton's Bulletin, collecting papers on gravity and geoid. Also, news and results from the other IGFS Centers are welcome,
- to disseminate special publications on geoid computations, e.g. lecture notes of the schools,
- to establish and update a web page and a forum for discussing practical and theoretical aspects on geoid
- to support Agencies or scientists in computing regional geoids.

The Newton's Bulletin has a technical and applied nature and will not accept papers that could be published on the International Journal of Geodesy.

Data and software given to IGeS remain property of the source, which can dictate the conditions of use and restrict their distribution. IGeS itself can indeed perform geoid computations within different projects, but not in economic competition with Firms or Public Organizations institutionally devoted to that.

Products

- SW for handling global models
- SW for the local geoid estimation
- SW for the evaluation of different functionals of the Gravity Field
- Grids, for specified areas, of local and regional geoid estimates
- Documentation of the SW and of the data sources
- Newtons's Bulletin
- Lecture notes and special publications
- International Schools

Future Programs/Development

Beyond institutional activities of IGeS, the following programs are worth of specific mention:

- participation to the International ESA Gradiometric Mission (GOCE);
- computation of improved geoids for Italy and the Mediterranean area;
- participation to the European geoid Project;
- study and possibly first computations for the solution of the problem of the unification of height datums;
- study of improved methodologies for the determination of the geoid at global and local level;
- organization of International Geoid School, possibly one school every two years.

Structure

The Service is for the moment provided by two Centres, one at the Politecnico of Milano, and the other at NIMA (contact person S. Kenyon, steve.c.kenyon@nga.mil) and by individual scientists, called advisors.

IGeS is an official IAG Service which is related to IAG through the International Gravity Field Service and is one of the operative arms of the International Commis-

sion for the Gravity Field. The IGeS Milano Centre is supported by Italian authorities, which nominate upon recommendation of the IGFS, a President, for its international representation and a Director for the operative management.

Its structure, tools and activities are illustrated in the IGeS reports to the Advisory Board of IGFS. In addition the IGeS advisors are individual members of IGeS, which have had an outstanding activity in the field of geoid determination and also can represent IGeS in both research and teaching activities.

At present the following distinguished scientists are IGeS advisors:

- R. Forsberg (Denmark)
- C.C. Tscherning (Denmark)
- M. Sideris (Canada)
- C. Kotsakis (Canada)
- W. Kearsley (Australia)
- W. Featherstone (Australia)
- D. Milbert (USA)
- S. Kenyon (USA)
- N. Pavlis (USA)
- H. Denker (Germany)
- U. Marti (Switzerland)
- H. Duquenne (France)
- D. Arabelos (Greece)
- E. Tziavos (Greece)
- A. Jill (Spain)
- D. Blitzkow (Brazil)

Finally, within the structure of IGeS, Working Groups can be established for specific purposes, limited in time. In 2007, a WG has been established to compare different geoid estimation m using a validated data sample over the Alvernia area (data are supplied by H. Duquenne).

The work will be performed in 2008.

International GNSS Service (IGS)

─ Terms of Reference ─

web: http://igscb.jpl.nasa.gov/

President: **John Dow** (Germany)
Director of the Central Bureau: **Ruth Neilan** (USA)

Preamble

A proof of concept for the International Global Positioning System (GPS) Service for Geodynamics (IGS) was conducted with a three-month campaign during June through September 1992, and continued until December 1993 as a Pilot-Service until the establishment of the IGS as a service of the International Association of Geodesy (IAG). The IGS formally began on 1 January 1994. IGS is a member of the Federation of Astronomical and Geophysical Data Analysis Services (FAGS) and it operates in close cooperation with the International Earth Rotation and Reference Systems Service (IERS). Due to the expansion of IGS objectives, the name of the service was changed to International GPS Service (IGS) on 1 January 1999. Following further expansion of IGS, integrating data from the Russian GLONASS system and planning for the deployment of the European Galileo system, the name was changed to 'International Global Navigation Satellite System (GNSS) Service' on 14 March 2005. The organization retains the acronym 'IGS'.

Mission

The International GNSS Service is committed to providing the highest quality data and products as the standard for Global Navigation Satellite Systems (GNSS) in support of Earth science research, multidisciplinary applications, and education. These activities endeavour to advance scientific understanding of the Earth system components and their interactions, as well as to facilitate other applications benefiting society. The Service also develops the necessary standards and specifications and encourages international adherence to its conventions.

Goals and Objectives

The IGS strives to:

- Provide the highest quality, reliable GNSS data and products, openly and readily available to all.
- Promote universal acceptance of IGS products, standards and conventions.
- Continuously innovate by attracting leading-edge expertise and pursuing challenging projects and ideas.
- Seek and pursue new growth opportunities while responding to changing user needs.
- Sustain and nurture the IGS culture of collegiality, openness, inclusiveness, and cooperation.
- Maintain a voluntary organization with effective leadership, governance, and management.

The IGS collects, archives and distributes GNSS observational data sets of sufficient accuracy to satisfy the objectives of a wide range of applications and experimentation. These data sets are used by the IGS to generate the following data products:

- High accuracy GPS satellite ephemerides and related information
- Earth rotation parameters
- Coordinates and velocities of the IGS tracking stations
- GPS satellite and tracking station clock information, timescale products
- Ionospheric information
- Tropospheric information

The accuracies of these products are sufficient to support c satellite orbit determination

- Ionosphere monitoring
- Climatological scientific objectives including:

- Realization of global accessibility to, and the improvement of, the International Terrestrial Reference Frame (ITRF)
- Monitoring deformation of the solid Earth
- Monitoring earth rotation
- Monitoring variations in the hydrosphere (sea level, ice sheets, etc.)
- Scientific research, eventually weather prediction models
- Time and frequency transfer

The IGS accomplishes its mission through the following components:

- Networks of tracking stations
- Data Centers (DCs)
- Analysis and Associate Analysis Centers (AACs)
- Analysis Center Coordinator (ACC)
- Working Groups, Pilot Projects, Pilot Services (WG, PP, PS)
- Coordinators for special products or components: e.g. Reference Frame, Network, Timing
- Central Bureau (CB)
- Governing Board (GB)

Networks of Tracking Stations

IGS Stations provide continuous tracking using high-accuracy receivers and have data transmission facilities allowing for rapid (minimally daily) data transmission to the data centres (see below). The stations must meet physical and operational requirements as defined in the *'IGS Site Guidelines'* document available from the Central Bureau.

The ensemble of the IGS stations is the IGS network.

Data Centers

IGS data centres fall into three categories: Operational, Regional, and Global Data Centers. Each has varied duties which must be carried out continually and with a minimum of delay or downtime, although the multiplicity of DCs provides a measure of redundancy. The description and responsibilities of each type of DC are detailed in the separate policy document *'IGS Data Centers Charter'* and include duties such as collecting data from GPS tracking stations and ancillary equipment, data validation, permanent archival, providing online availability, and transmittal to and equalization with other DCs. The set of DCs provides for open access to IGS data and products by IGS participants and all external users. DCs are approved by the IGS GB following demonstration of qualifications and commitment.

Analysis Centers

The analysis centres fall into two categories: Analysis Centers (ACs) and Associate Analysis Centers (AACs). The Analysis Centers receive and process tracking data from one or more data centres for the purpose of producing IGS products. The Analysis Centers are committed to submit products for combination into IGS products, without interruption, using designated standards and conventions, and within a specified time delay to meet IGS requirements.

The Analysis Centers generally provide the core products of ephemerides, Earth rotation parameters, station coordinates, and clock information, as well as other recommended products, such as rapid, predicted or real-time orbit and Earth rotation solutions.

Associate Analysis Centers produce specialized products recognized by the Governing Board, e.g., ionospheric information, tropospheric parameters, or station coordinates and velocities for a global or regional sub-network.

The '*Charter for Analysis Centers and Associate Analysis Centers'* is a policy statement of the Governing Board and is available from the Central Bureau.

Analysis Center Coordinator

The Analysis Center Coordinator (ACC, also referred to as the Analysis Coordinator) assists the Analysis Centers. The Analysis Center Coordinator monitors the activities of the Analysis Centers to ensure that the IGS objectives are carried out.

Specific expectations include quality control, performance evaluation, and continued development of appropriate analysis standards. The Analysis Coordinator is also responsible for the appropriate combination of the Analysis Centers' products into a single set of orbit and clock products, which are official IGS products delivered to the Global Data Centers.

The Analysis Center Coordinator is a voting member of the IGS Governing Board (see below) and interacts regularly with the Central Bureau and the IERS. The Analysis Coordinator (or designee as approved by the Governing Board) is one of the two IGS representatives to the IERS Directing Board.

Generally the responsibilities for the Analysis Coordinator shall rotate among the Analysis Centers with appointments and terms specified by the Governing Board.

Working Groups, Pilot Projects, and Product Coordinators

A Working Group works on a particular topic related to the IGS mission according to goals and schedule specified in the Working Group's charter. A Pilot Project aims at the development of particular new IGS product(s) or service(s) relying on the IGS infrastructure. A Product Coordinator is responsible for a specialized product related to the IGS missions and components, as specified in its charter. Each Product Coordinator is supported by a Working Group, whose members take responsibility for providing routine contributions to a combined product, and/or make expertise available to the Working Group.

The Governing Board establishes and terminates Working Groups and Pilot Projects, and appoints the Working Group Chairs and Product Coordinators. A minimum initial commitment for any Product Coordinator is four years. The '*IGS Policy to Establish Working Groups, Projects, and Product Coordinators*' is a policy statement of the Governing Board and is available from the Central Bureau.

Chairs of Working Groups and Pilot Projects are non-voting members of the IGS Governing Board (see below). The Coordinators of the fundamental products shall be voting members of the Board (Analysis Coordinator, Reference Frame Coordinator, Timing Coordinator). Coordinators of derived products are non-voting members.

In the case of products requiring significant joint expertise, the GB may approve GB membership of a representative of a partner organization, in order to ensure appropriate representation and communication. Such a representative is designated by the partner organization and is a non-voting member of the GB. It will normally be expected that the GB will in turn be invited to appoint an IGS representative to the Directing Board, or equivalent body, of the partner organization.

Central Bureau

The Central Bureau (CB) is the executive arm of the IGS Governing Board, responsible for the general management, coordination and day-to-day operations of the IGS consistent with the directives, policies and priorities set by the Governing Board.

In this role the CB, within available resources, coordinates IGS activities, facilitates communications, coordinates general aspects of the IGS network operations, promotes compliance to IGS standards, monitors network operations and quality assurance of data, maintains documentation, organizes meetings and workshops, and coordinates and publishes reports.

The CB actively coordinates with the IGS Pilot Projects and Services, Working Groups, Product Coordinators, and committees and ensures the compatibility of IGS and IERS by interfacing with the IERS. The CB acts as the outreach office and promotes use of IGS data and products, maintaining and expanding the visibility of the IGS. To accomplish these tasks the CB works closely with the Analysis Center Coordinator and the Product Coordinators.

The CB operates the information system for the IGS and produces the IGS Annual Reports and Directory. The CB coordinates the publication of other documents required for the satisfactory planning and day-to-day operation of the Service, including standards and specifications regarding the performance, functionality and configuration requirements of all elements of the Service.

Although the Chair of the Governing Board is the official representative of the IGS to external organizations, the CB, consonant with the directives established by the Governing Board, is responsible for the day-to-day liaison with such organizations.

Through the existing reciprocity agreement between IGS and IERS, the CB serves as the GPS Technique Center for IERS; as such, its designated representative (subject to Governing Board approval) is a member of the IERS Directing Board (together with the Analysis Coordinator). This representative is a member of the IGS Governing Board. In turn, the IERS Directing Board designates a representative to the IGS Governing Board. This arrangement is to assure full cooperation between the two services.

The long term functioning of IGS is assured through redundancy of most of its components, though this does not apply to the CB. For this reason the performance of the Central Bureau is to be formally reviewed by the GB at least every five years. On these occasions the Central Bureau will either reconfirm its commitment to the IGS for the next period of five years or announce that it will terminate operations after a transition phase of at least one year. The GB will formally approve the Central Bureau's proposal, or, alternatively issue a Call for Proposal for a new IGS Central Bureau to take over responsibilities after the transition phase.

In summary, the Central Bureau performs primarily a long-term coordination role to ensure that IGS participants contribute to the Service in a consistent and continuous manner and adhere to IGS standards.

Governing Board

The principal roles of the Governing Board (GB) are to set policy and to exercise broad oversight of all IGS functions and components. It also controls general activities of the Service, including restructuring, that would be appropriate to maintain efficiency and reliability, while taking full advantage of the advances in technology and theory.

The Governing Board (GB) consists of up to eighteen voting members and a number of non-voting members. They are distributed as follows:

• Elected by IGS Associates (see below):	
• Analysis Centers' representatives	3
• Data Centers' representative	1
• Networks' representatives	2
• Elected by the Governing Board upon recommendations from the Central Bureau, for the next term:	
• Representatives of Analysis, Data Centers or Networks	2
• Members at large (up to)	3
• Appointed members	
• Director of the Central Bureau	1
• Analysis Coordinator	1
• Reference Frame Coordinator	1
• Timing Coordinator	1
• Representative of the IERS	1
• IAG representative	1
• President of IAG or designee from the IAG Executive Committee	1
• Total voting members (up to)	18

Working Group and Pilot Project chairpersons, the Network Coordinator, and Product Coordinators, as well as the FAGS representative, are GB members with voice but without vote. A representative of the BIPM, appointed by the BIPM/CCTF with agreement of the IGS GB, is a non-voting member of the Board. In turn, the IGS appoints a representative point of contact to the BIPM/CCTF. The IERS appoints a representative to the IGS GB. In turn, the IGS GB appoints two IGS representatives to the IERS Directing Board: the IGS Analysis Center Coordinator (or designee) and the IGS/CB representative.

The elected persons (up to eleven) must be members of different organizations. The appointed members are considered ex-officio and are not subject to such restrictions. All elected persons have staggered four-year terms, which are renewable once. The GB membership should be properly balanced with regard to supporting organizations as well as geographically.

For the first six positions, which represent components of the IGS that are elected by the IGS Associates, the nominating committee conducts the elections. The nominating committee consists of three members, the chair of which is appointed by the Chair of the GB and who is a member of the GB not currently up for re-election. For elections, the nominating committee presents to the Associate Members a list of at least two candidates for each position to be filled. The election will be determined by the number of votes received from the Associate Members. In the case of a tie, the election is by the members of the Governing Board.

For the four positions elected by the Governing Board, four weeks prior to the election by the Governing Board, the Central Bureau presents its proposed candidate(s) to the Governing Board. Based on recommendations of the GB members, or on the outcome of the elections by the IGS Associates, the CB may present a revised list at the GB meeting where the election of the new Board members takes place.

In case of a resignation from the Board, after consulting with the appropriate IGS components, the CB will nominate replacement candidates for election by the GB. The replacement will serve until the end of the term of the resigned Board member.

The Chairperson is one of the members of the GB elected by the Board for a term of four years with the possibility of re-election for one additional term. The Chairperson does not vote, except in case of a tie. He/she is the official representative of IGS to external organizations. The immediate past Chairperson, if no longer a voting member of the Board, will be invited to continue as a non-voting member of the Board for a period of one year after completion of the term(s) as Chair.

The IAG and FAGS representatives are appointed respectively by the IAG Bureau and by FAGS for a maximum of two four-year terms.

Members of the GB are eligible to be considered for IAG Fellowship with the appropriate rights and privileges after an initial two-year period.

Most GB decisions are to be made by consensus or by a simple majority vote of the members present, provided that there is a quorum consisting of a simple majority of voting members of the GB. In case of lack of a quorum

the voting may be by mail. Voting by e-mail, fax, or mail on any issue is permitted by these Terms of Reference, and the number of mail or email responses must be sufficient to constitute a quorum. Changes in Terms of Reference can be made by a 2/3 majority of all voting members of the GB. At any time the GB can ask for the resignation of the Chair, or any member of the Board, if a majority vote of all voting members of the Board so requests.

The Board shall meet at least annually and at such other times as shall be considered appropriate by the Chairperson or at the request of five members. The Central Bureau provides the secretariat of the GB.

For the GB to effectively assess the value of IGS services to the user communities, and to ensure that the service remains up to date and responsive to changing user needs, the GB will organize reviews of the IGS components at appropriate intervals. The Governing Board will decide, on an annual basis, those groups (Analysis Centers, Data Centers, Network Stations, and the Central Bureau) that are to be reviewed and from time to time may select other activities for review as it deems appropriate.

Executive Committee

The Executive Committee (EC) of the IGS Governing Board is established as a committee that has specific responsibilities allowing it to act on behalf of the GB for the following purposes: 1) to codify and organize issues that are brought to the Board for action, 2) to act for the Board when a quorum of the Board is not present, 3) to act for the Board when a full Board meeting is not possible or necessary. The EC is responsible for exercising the powers of GB in the management of the business and affairs only to the extent set forth in these Terms of Reference. Any actions are communicated to the GB as soon as possible and reported and validated at the next Board meeting. The Executive Committee shall consist of five voting members of the GB:

- Chair of the GB
- Immediate Past Chair (non-voting)
- Director of the CB and
- Three additional voting members of the GB proposed by the Chair of the GB and approved annually by the GB.

Except for the power to amend these Terms of Reference, the Executive Committee shall have all of the powers and authority of the Board in the intervals between meetings of the GB, and subject to the direction and control of the GB. Three votes of EC members are needed for any decision. EC meetings are open to any GB member.

IGS Associate Members

Associate Members are persons representing organizations that participate in any of the IGS components. The membership is balanced with respect to IGS components, organizational representation and geography, and is meant to represent institutions which contribute significantly to the IGS on a continuous basis. Each organization that meets the above criteria shall have a minimum of one and not more than ten Associate Members. The Central Bureau maintains the list of Associate Members, which is revised annually and is subject to the approval of the Governing Board.

Associate Members elect the six members of the GB representing Analysis Centers, Data Centers and Networks (except for those nominated by the CB). The list of Associate Members eligible to vote in elections must be approved by the GB at least three months prior to the election process. Current and former GB members are considered Associate Members.

IGS Correspondents

Correspondents are persons on a mailing list maintained by the Central Bureau, who do not actively participate in the IGS but express interest in receiving IGS publications, wish to participate in workshops or scientific meetings organized by the IGS, or generally are interested in IGS activities. Ex officio IGS Correspondents are the following persons:

- IAG Secretary General
- President of IAG Commission 1: Reference Frames
- President of IAG Commission 4: Positioning and Applications
- Chairs and Directors of affiliated IAG Services
- International VLBI Service (IVS),
- International Laser Ranging Service (ILRS),
- International Earth Rotation and Reference Systems Service (IERS),
- International Doris Service (IDS), etc.,
- Chair of the Global Geodetic Observing System (GGOS), an IAG Project
- IUGG Secretary General
- Former Governing Board Members.

International Gravimetric Bureau
(Bureau Gravimétrique International – BGI)

web: http://bgi.cnes.fr

Director: **Sylvain Bonvalot** (France)

Objectives and Terms of Reference

The main task of BGI is to collect, on a world-wide basis, all gravity measurements and pertinent information about the gravity field of the Earth, to compile them and store them in a computerized data base in order to redistribute them on request to a large variety of users for scientific purposes. The data consists of relative and absolute gravity measurements (mainly 3-D coordinates of station, gravity value, corrections, anomalies...), mean free air or Bouguer anomaly values, gravity maps, reference station descriptions, publications dealing with the Earth's gravity field. Other data types are sometimes used for data validation and geophysical analysis, such as satellite altimetry derived geoid height and gravity anomalies, digital terrain models, spherical harmonic coefficients of current global geopotential models.

BGI has been developing various algorithms and software for data validation and analysis, as well as its own data management system. A large number of services are offered to the users (see below).

All kinds of gravity data can be sent to BGI, with or without restrictions of redistribution to be specified by the contributors, sometimes in the form of a protocol of usage.

Program of Activities

The main orientations consist (i) to consolidate the terrestrial gravity databases (relative and absolute) and (ii) to ease the consultation and diffusion of gravity data and products for end-users. BGI will also continue operating with its supporting organizations, in educational, research and development activities with the aim to maintain a high level of competence and to improve the efficiency and the quality of its services.

- Activities related to gravity database: The main achievements consist in the relative gravity database and in the database of reference gravity stations. Collection of new dataset as well as existing dataset will be encouraged in order to improve the global data coverage and accuracy. Incoming datasets are carefully evaluated and validated using protocols and software already developed at BGI. Global data and products derived from satellite altimetry and gravity missions are to be more and more frequently used to validate land and sea measurements. The achievement of a worldwide Absolute gravity database will be top prioritized in the next few years.
- Activities of diffusion of gravity data and products: New functionalities will be implemented in relation with the database management to perform direct downloads of open-file data or products from the BGI webpage and allow inter-operability between other sites hosting gravity-related databases. BGI will also contribute to the release of updated digital gravity data products (maps, grids …) at global and regional for educational and research purposes. The bibliography database will be also continued.
- Other activities: Link with the commission for the Geoid in data preparation in view of geoid computations and evaluations to be performed by the International Service for the Geoid. Link with other research groups in the validation of satellite derived gravity data and products to improve our global knowledge of the Earth's gravity field. Contribution to the dissemination of educative materials related to gravimetry. Continuation of the publication of the Newton's Bulletin jointly with IGeS.

Structure and membership

BGI depends of the International Association of Geodesy (IAG) of the International Union of Geodesy and Geophysics (IUGG). It is one of the offices of the Federation of Astronomical and Geophysical Services (FAGS). Since 2001, it is one of the "Centres" of the International Gravity Field Service (IGFS) which coordinates within the IAG, the servicing of the geodetic and geophysical community with gravity field-related data, software and information.

The BGI central office (management, secretariat and technical staff) is located in Toulouse, France, in the premises of the Observatoire Midi-Pyrénées. Since 1998, BGI is supported by French Organizations (see below) whose contributions to BGI over four year renewable periods are defined by a covenant. The supporting French organizations are:

- the Bureau de Recherches Géologiques et Minières (BRGM),
- the Centre National de la Recherche Scientifique (CNRS) and the Institut National des Sciences de l'Univers (INSU),
- the Centre National d'Etudes Spatiales (CNES),
- the Ecole et Observatoire des Sciences de la Terre (EOST)
- the Ecole Supérieure des Géomètres et Topographes (ESGT),
- the Institut de Physique du Globe de Paris (IPGP),
- the Institut de Recherche pour le Développement (IRD),
- the Institut Géographique National (IGN),
- the Service Hydrographique et Océanographique de la Marine (SHOM),
- the Université de Montpellier 2 (UM2)

Each supporting organization has a representative member in the BGI Coordinating Committee. The Coordinating Committee contributes twice a year to the orientation and evaluation of the BGI activities.

Providing data to BGI

Essential quantities and information for gravity data submission are (see BGI website for more details):

(1) Position of the site:

- Latitude, longitude (and related accuracy).
- Elevation or depth (and related accuracy).
- For land data: elevation of the site (on the physical surface of the Earth).
- For water stations: water depth.

(2) Measured (observed) gravity, corrected to eliminate the periodic gravitational effects of the Sun and Moon, ocean loading, and the instrument drift.

(3) Reference (base) station (s) used. For each reference station (a site occupied in the survey where a previously determined gravity value is available and used to help establish datum and scale for the survey), give name, reference station number (if known), brief description of location of site, and the reference gravity value used for that station. Give the datum of the reference value; example: IGSN 71.

(4) Give supplementary elevation data for measurements made on towers, on upper floor of buildings, inside of mines or tunnels, atop glacial ice. When applicable, specify whether gravity value applied to actual measurement site or it has been reduced to the Earth's physical surface (surface topography or water surface). Also give depth of actual measurement site below the water surface for underwater measurements.

(5) For marine gravity stations, gravity value should be corrected to eliminate effects of ship motion, or this effect should be provided and clearly explained.

(6) For absolute gravity measurements, station coordinates and description, average gravity value and all related corrections are required.

Services

The most frequent service BGI can provide is data retrieval over a limited area. Data are sent on digital form or transferred electronically. Data coverage plots may also be provided, usually over 20° * 20° areas. Cases of massive data retrieval requests may be considered; they are studied and may be processed in a specific way. The simplest way for users is to acquire the open files of the BGI database, which are on two CDs. Consultation of Absolute gravity database will be soon available.

Other services include: Data screening; Supply of reference base station information; Data evaluation and gridding; Computation of mean values; Supply of information on existing maps.

The costs of the services have been established in view of the categories of users-mostly contributors of measurements and scientists, and also considering the large amount of our host organizations. The charging policy is explained in detail in the BGI website.

Some of the services may be provided free of charge upon request, to data contributors, individuals working in universities, such as students, and generally to any person who can contribute to the BGI activities on a data or documentation exchange basis.

BGI address

Bureau Gravimétrique International
18, Avenue Edouard Belin
31401 Toulouse Cedex 4, France
Phone: 33-5 61 33 29 80
E-mail: bonvalot@ird.fr, bgi@cnes.fr

International Gravity Field Service (IGFS)

web: www.igfs.net

Chairman: Rene Forsberg, Denmark
Director of Central Bureau: Steve C. Kenyon, USA

Objectives

IGFS is a unified "umbrella" IAG service, which will

- Coordinate collection, validation, archiving and dissemination of gravity field related data
- Coordinate courses, information materials and general public outreach relating to the earth's gravity field
- Unify gravity products for the needs of GGOS – the Global Geodetic Observing System

The IGFS coordinates the following "Level-1" IAG services and service centres

- BGI (Bureau Gravimetrique International), Toulouse, France
- IGeS (International Geoid Service), Milano, Italy
- ICET (International Center for Earth Tides), Papeete, French Polynesia
- ICGEM (International Center for Global Earth Models), Potsdam, Germany
- IDEMS (International Digital Elevation Model Service), Leicester, UK

The overall goal of IGFS is to coordinate the servicing of the geodetic and geophysical community with gravity field-related data, software and information. The combined data of the IGFS entities data will include both satellite-derived global models, terrestrial, airborne, satellite and marine gravity observations, earth tide data, GPS leveling data, digital models of terrain and bathymetry, as well as ocean gravity field and geoid from satellite altimetry. Both the static and the temporal variations of the gravity field will be covered by the IGFS.

IGFS will – in cooperation with the services - make a special effort in trying to secure release of data from national and international institutions holding data on the spatial and temporal gravity variations, geoid and the surface heights of the Earth, to make them widely available to the scientific community.

IGFS will coordinate regional conferences, tutorials and schools to train young scientists and members of national institutions in the various aspects of the gravity field science, computations, and data collection. IGFS will maintain a publication activity related to the gravity field, especially through "Newtons Bulletin".

Structure

The Service is organized by means of the following structure:

- Advisory Board
- Central Bureau
- Services and Centres

The Advisory Board is composed of:

- Directors (or their delegates) of each of the Centres of IGFS
- Chairmen of the IGFS working groups
- Presidents (or their delegates) of the IAG Commissions related to the Service work
- A representative of the IAG Executive Committee (IAG-EC)
- Two members appointed among the affiliates.

The Advisory Board

- Coordinate the scientific strategy
- Coordinates the joint activity of the Centres
- Oversees the participation of the Service in international projects
- Presents to the IAG-EC proposals for associating new centres to the Service
- Elects the IGFS affiliates upon nomination by the Centres or affiliates.

The Advisory Board is appointed for four years between IUGG General Assemblies. The existing Advisory Board selects new members as required, and nominates a president for the IGFS. The election is to be confirmed by the IAG Executive Committee. The Advisory Board makes decisions by majority vote; it can also vote by email. The Advisory Board decides the Terms of Reference for IGFS.

IGFS Services and Centres

The IGFS Services and Centres are the "operating arms" of IGFS. The Centres are committed to produce services and products related to the gravity field of the Earth and/or the planets. The Centres within IGFS are approved by the IAG EC. Centres can include bodies of structures external to the IAG (e.g., the BGI which is reporting to FAGS). The Centres will have their own governing bodies, nominated according to internal rules, also taking into account the interests of the supporting entities. In particular, each governing body will have a Director, elected according to internal rules.

Centres will maintain a list of data and products, providing them to the general public according to their policy of dissemination; they will deliver services in the form of data archiving, data analysis, dissemation, software, training, initiation of measurement and data compilation campaigns etc. The activities of each Centre will be reviewed annually by the IAG-EC.

IGFS Central Bureau

The IGFS Central Bureau will act as the IGFS Technical Centre, and handle the daily communications of the IGFS. The Central Bureau will handle the practical collection and homogenization of gravity field data, including the construction of unified gravity field models, e.g. high-resolution spherical harmonic models, and the practical advice and implementation on definitions on gravity field standards such as tidal correction principles, vertical datums, etc. The Central Bureau will also be responsible for the IGFS web site (to be implemented). The IGFS Central Bureau is presently hosted by the National Geospatial-Intelligence Agency, USA.

IGFS Advisory Board

- S. C. Kenyon (USA)
- J. P. Barriot (French Polynesia)
- S. Bonvalot (France)
- R. Barzaghi (Italy)
- J. Kusche (Germany)
- P. Berry (UK)
- Y. Fukuda (Japan)
- S. Bettadpur (USA)
- H. Denker (Germany)
- J. Huang (Canada)
- H. Wilmes (Germany)
- M. G. Sideris (Canada)

International Laser Ranging Service (ILRS)

web: http://ilrs.gsfc.nasa.gov/

Chairman of the Governing Board: **Werner Gurtner** (Switzerland)
Director of the Central Bureau: **Michael Pearlman** (USA)
Secretary: **Carey Noll** (USA)

Development

For many years, international SLR activities had been organized under the Satellite and Lunar Laser Ranging (SLR/LLR) Subcommission of the CSTG. The Subcommission provided a venue for organizing tracking campaigns, adopting data formats, reporting on network status, and sharing technology. However, membership and commitment to the Subcommission were informal, and the main focus was on systems and data acquisition rather than on the production of the most meaningful data products for end users. With strong encouragement from the President of the CSTG, the CSTG SLR/LLR Subcommission Steering Committee undertook the formation of the International Laser Ranging Service, ILRS. A draft Terms of Reference, detailing the mission and the organization of the new service was written and accepted by the CSTG Executive Board in May 1997. A joint CSTG/ IERS Call for Participation in the new ILRS was issued on 24 January 1998. Institution proposals in response to the Call were evaluated at a special meeting of the CSTG SLR/LLR Subcommission Steering Committee and subsequently approved by both the CSTG Executive Board and the IERS Directing Board on 18 April 1998. ILRS approval was granted to 46 tracking stations, 4 Operations Centres, 3 Analysis Centres, 4 Lunar Analysis Centres, 18 Associate Analysis Centres, 2 Global Data Centres and 1 Regional Data Centre. The Central Bureau was established at the NASA Goddard Space Flight Centre. Appointments and elections of Governing Board members were carried out during the summer of 1998. On 22 September 1998, the CSTG SLR/LLR Subcommission was officially disbanded, and replaced by the First ILRS General Assembly, held in conjunction with the 11th International Workshop on Laser Ranging in Deggendorf, Germany. The first ILRS Governing Board meeting was held on 25 September 1998.

Mission

The ILRS collects, merges, analyzes, archives and distributes Satellite Laser Ranging (SLR) and Lunar Laser Ranging (LLR) observation data sets of sufficient accuracy to satisfy the objectives of a wide range of scientific, engineering, and operational applications and experimentation. The basic observable is the precise time-of-flight of an ultra short laser pulse to and from a retro reflector-equipped satellite, corrected for atmospheric delays and satellite centre of mass. These data sets are used by the ILRS to generate a number of fundamental data products, including but not limited to:

- Centimetre accuracy satellite ephemerides
- Earth orientation parameters (polar motion and length of day)
- Three-dimensional coordinates and velocities of the ILRS tracking stations
- Time-varying geocentre coordinates
- Static and time-varying coefficients of the Earth's gravity field
- Fundamental physical constants
- Lunar ephemerides and librations
- Lunar orientation parameters

Structure

The ILRS accomplishes its mission through the following

- Tracking Stations and Subnetworks
- Operations Centres
- Global and Regional Data Centres
- Analysis, Lunar Analysis, and Associate Analysis Centres

- Central Bureau
- Governing Board and Working Groups

Information on these permanent components can be found in the ILRS Web site.

Governing Board (2006)

- Michael Pearlman, Ex-Officio, Director, Central Bureau
- Carey Noll, Ex-Officio, Secretary, Central Bureau
- Zuheir Altamimi, Ex-Officio, President, IAG Commission 1
- Bob Schutz, Appointed, IERS representative to ILRS
- Werner Gurtner, Appointed, Eurolas Network Representative, Chair of the Governing Board
- Giuseppe Bianco, Appointed, Eurolas Network Representative
- Yang Fumin, Appointed, WPLTN Network Representative
- Hiroo Kunimori, Appointed, WPLTN Network Representative
- David Carter, Appointed, NASA Network Representative
- Jan McGarry, Appointed, NASA Network Representative
- Vincenzia Luceri, Elected, Analysis Centre Representative
- Erricos Pavlis, Elected, Analysis Centre Representative
- Wolfgang Seemüller, Elected, Data Centre Representative
- Jürgen Müller, Elected, LLR Representative
- Georg Kirchner, Elected, At Large Representative
- Graham Appleby, Elected, At Large Representative

Products

The most important aspects of the SLR and LLR observations are absolute accuracy and long, stable time histories. Accuracy approaches the level of a few mm for modern stations; time histories can be 25-30 years, or even longer in the case of some satellites. Since the inception of the service, the ILRS has put the generation of official analysis products high on its agenda. Official submissions to the IERS include weekly solutions for station coordinates and Earth Orientation Parameters (EOPs). Additionally, some of the ILRS Analysis Centres (ACs) submit estimates of GM and time-varying geocentre motion to the IERS Global Geophysical Fluids Centre. Other user products include static and time-varying coefficients of the Earth's gravity field, accurate satellite ephemerides for POD and validation of altimetry, relativity, and satellite dynamics, backup POD for other missions, and Lunar ephemeris for relativity studies and lunar libration for lunar interior studies.

The products of the Analysis, Lunar Analysis, and Associate Analysis Centres are made available to the scientific community through the two Global Data Centres:

- Crustal Dynamics Data Information System (CDDIS) at the NASA Goddard Space Flight Centre, Greenbelt, MD, USA,
- European Data Centre (EDC), Munich, Germany, and one Regional Data Centre
- Shanghai Observatory, Shanghai, PRC.

The high accuracy of SLR/LLR data products supports a variety of scientific, engineering, and operational applications including:

- Realization and maintenance of the International Terrestrial Reference Frame (ITRF)
- Access to the centre of mass of the Earth relative to the global network and its time variations
- Monitoring three-dimensional deformations of the solid Earth
- Monitoring Earth rotation variations and polar motion
- Monitoring the long wavelength static and dynamic components of the Earth's gravity field and geoid.
- Supporting, via precise ranging to altimetric satellites, the monitoring of variations in the topography of the liquid and solid Earth (ocean circulation, mean sea level, ice sheet thickness, wave heights, vegetation canopies, etc.)
- Calibration and validation of microwave tracking techniques (e.g., GPS, GLONASS, Galileo, DORIS, and PRARE)
- Picosecond global time transfer experiments
- Determination of non-conservative forces acting on the satellite
- Astrometric observations including determination of the dynamic equinox, obliquity of the ecliptic, and the precession constant
- Gravitational and general relativistic tests, including Einstein's Equivalence Principle, the Robertson-Walker b parameter, and time rate of change of the gravitational constant, G
- Lunar physics including the dissipation of rotational energy, shape of the core-mantle boundary (Love

Number k2), and free librations and stimulating mechanisms
- Solar System ties to the International Celestial Reference Frame (ICRF)

Contacts

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- Carey Noll, Secretary, ILRS Central Bureau: *Carey.Noll@nasa.gov*
- Werner Gurtner, Chair, ILRS Governing Board: *werner.gurtner@aiub.unibe.ch*

Publications

The ILRS Central Bureau maintains a comprehensive Web site as the primary vehicle for the distribution of information within the ILRS community. This site can be accessed at *http://ilrs.gsfc.nasa.gov*. Many ILRS and related publications and reports can now be accessed online through the ILRS Web site including:

- ILRS Terms of Reference and Working Group Charters
- ILRS Annual Reports (first volume published covers year 1999)
- ILRS General Assembly Minutes and Reports
- ILRS Governing Board Minutes
- ILRS Working Group Minutes and Reports
- ILRS Associates Telephone and Email Directory
- ILRS Organizations and Technical Contacts
- Science and Engineering References and Reports

International VLBI Service for Geodesy and Astrometry (IVS)

http://ivscc.gsfc.nasa.gov

Chair of Directing Board: **Harald Schuh** (Austria)
Coordinating Centre Director: **Dirk Behrend (**USA)

Development

The International VLBI Service for Geodesy and Astrometry (IVS) is an international collaboration of organizations, which operate or support Very Long Baseline Interferometry (VLBI) components. IVS was established in 1999 and became a service of IAG that year. In 2000, IVS was recognized as a service of the International Astronomical Union (IAU). In 2002, IVS became a member of the Federation of Astronomical and Geophysical Data Analysis Services (FAGS). IVS interacts closely with the International Earth Rotation and Reference Systems Service (IERS), which is tasked by IAU and IUGG with maintaining the international celestial and terrestrial reference frames (ICRF and ITRF).

Mission/Objectives

The objectives of IVS are:

- To provide a service to support geodetic, geophysical, and astrometric research and operational activities.
- To promote research and development activities in all aspects of the geodetic and astrometric VLBI technique.
- To interact with the community of users of VLBI products and to integrate VLBI into a global Earth observing system.

To meet these objectives, IVS coordinates VLBI observing programs, sets performance standards for VLBI stations, establishes conventions for VLBI data formats and data products, issues recommendations for VLBI data analysis software, sets standards for VLBI analysis documentation, and institutes appropriate VLBI product delivery methods to ensure suitable product quality and timeliness. IVS closely coordinates its activities with the astronomical community because of the dual use of many VLBI facilities and technologies for both astronomy and astrometry/geodesy.

Products

VLBI data products currently available are

- All components of Earth orientation
- Terrestrial reference frame
- Celestial reference frame
- Tropospheric parameters

All VLBI data products are archived in IVS Data Centres and are publicly available.

Structure/Board / Members

IVS accomplishes its goals through Permanent Components. As of 2007 the IVS has:

- 30 Network Stations, acquiring high performance VLBI data.
- 3 Operation Centres, coordinating activities of Network Stations.
- 6 Correlators, processing acquired data, providing feedback to stations and providing processed data to analysts.
- 6 Data Centres, distributing products to users, providing storage and archiving functions.
- 21 Analysis Centres, analyzing the data and producing results and products.
- 7 Technology Development Centres, developing new VLBI technology.
- 1 Coordinating Centre, coordinating daily and long-term activities of IVS.

All together there are 74 Permanent Components, representing 37 organizations in 17 countries, and ~280 individuals who are Associate Members. The 37 organizations that support IVS components are IVS Member Organizations. There are also 9 Affiliated Organizations that cooperate with IVS on issues of common interest but do not support an IVS component.

In addition the IVS has a Directing Board to determine policies, standards, and goals. The current IVS Directing Board consists of the following members (alphabetical):

1. Dirk Behrend (USA) *Coordinating Centre Director*
2. Patrick Charlot (France) *IAU representative*
3. Andrey Finkelstein (Russia) *At Large member*
4. Hayo Hase (Germany/Chile) *Network Stations representative*
5. Ed Himwich (USA) *Network Coordinator*
6. Kerry Kingham (USA) *Operation Centres and Correlators representative*
7. Chopo Ma (USA) *IERS representative*
8. Yoshihiro Fukuzaki (Japan) *Network Stations representative*
9. Arthur Niell (USA) *Analysis and Data Centres representative*
10. Ray Norris (Australia) *FAGS representative*
11. Axel Nothnagel (Germany) *Analysis Coordinator*
12. William Petrachenko (Canada) *Technology Development Centres representative*
13. Harald Schuh (Austria) *IAG representative*
14. Oleg Titov (Australia) *At Large member*
15. Alan Whitney (USA) *Technology Coordinator*
16. Xiuzhong Zhang (China) *At Large member*

Publications and Meetings

IVS publishes an Annual Report, a thrice-annual Newsletter, and Proceedings from its bi-annual General Meeting. All publications are available from the Coordinating Centre and also published on the Web site. IVS holds a General Meeting every two years, a Technical Operations Workshop every two years, and an Analysis Workshop every year. Information about all IVS activities is available at the IVS Web site under the URL *http://ivscc.gsfc.nasa.gov*.

The Permanent Service for Mean Sea Level (PSMSL)

web: http://www.pol.ac.uk/psmsl

Director: **Lesley J. Rickards** (UK)

Development

Since 1933, the Permanent Service for Mean Sea Level (PSMSL) has been responsible for the collection, publication, analysis and interpretation of sea level data from the global network of tide gauges. It is based in Liverpool at the Proudman Oceanographic Laboratory (POL) which is a component of the UK Natural Environment Research Council (NERC). The PSMSL is a member of the Federation of Astronomical and Geophysical Data Analysis Services (FAGS) established by the International Council for Science (ICSU). It is supported by FAGS, the Intergovernmental Oceanographic Commission (IOC) and NERC.

Mission/Objectives

The mission of the PSMSL is to provide the community with a full Service for the acquisition, analysis and interpretation of sea level data. Aside from its central role of operation of the global sea level data bank, the PSMSL provides advice to tide gauge operators and analysts. It occupies a central management role in the development of the Global Sea Level Observing System (GLOSS) and hosts important international study groups and meetings on relevant themes. Several such meetings are planned for 2008 to mark the 75th Anniversary of the PSMSL.

Products

The database of the PSMSL contains over 55000 station-years of monthly and annual values of mean sea level (MSL) from almost 2000 tide gauge stations around the world received from almost 200 national authorities. On average, approximately 2000 station-years of data are entered into the database each year. This database is used extensively throughout the sciences of climate change, oceanography, geodesy and geology, and is the main source of information for international study groups such as the Intergovernmental Panel on Climate Change (IPCC).

Data for all stations are included in the PSMSL METRIC (or total) data set. The METRIC monthly and annual means for any one station-year are necessarily required to be measured to a common datum, although, at this stage, datum continuity between years is not essential. The year-to-year datum checks become essential, however, if the data are subsequently to be included in the PSMSL 'Revised Local Reference (RLR)' component of the data set.

The 'Revised Local Reference (RLR)' dataset of the PSMSL contains records for which time series analysis of sea level changes can be performed. Long records from this dataset have been the basis of all analyses of secular changes in global sea level during the last century. The geographical distribution of longer RLR records contains significant geographical bias towards the northern hemisphere, a situation which is being rectified by the establishment of the GLOSS global sea level network.

The PSMSL is also responsible for the Higher Frequency Delayed Mode (HF DM) data set of sea level information from the GLOSS Core Network. This consists of the original sea level measurements from each sites (typically hourly values) which provide a strategic backup to the MSL information of the main PSMSL data set.

In addition, the PSMSL provides a range of sea level products (e.g. anomaly maps, tables of sea level trends) for its users. These findings are input to national and international scientific study groups regularly. A range of training materials and software products are also made available via its web site which can be consulted for more information.

Structure/Governing Board Members

The PSMSL reports formally to the IAPSO Commission on Mean Sea Level and Tides (President Prof. P. L. Woodworth, UK). It is also served by an Advisory Group which at present consists of Dr. R. Neilan (JPL, USA), Prof. G. Mitchum (University of South Florida, USA), Prof. B. Douglas (University of Maryland, USA), Prof. D. Pugh (Liverpool University, UK), Dr. P. Knudsen (Danish National Space Center), Dr. J. Church (CSIRO, Australia), Dr. R. Bingley (Nottingham University, UK), Dr. T. Aarup (IOC, UNESCO) and Dr. J. Fierro (SHOA, Chile). Suggestions for improvements in PSMSL activities may be sent directly to the PSMSL or via the IAPSO Commission or via any member of the Advisory Group.

Points of Contact

Permanent Service for Mean Sea Level
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Staff members

- Dr. L. J. Rickards (Director)
- Prof. P. L. Woodworth
- Dr. S. Jevrejeva
- Dr. S. Holgate
- Mrs. K. Gordon (Data Base Manager)
- Miss E. Bradshaw (for GLOSS DM HF data set)

Global Geodetic Observing System (GGOS)

– Terms of Reference 2007 –

web: http://www.ggos.org

Chair: **Markus Rothacher** (Germany)
Vice-Chairs: **Ruth Neilan** (USA), **Hans-Peter Plag** (USA)

Preamble

The proposal for the Global Geodetic Observing System (GGOS) was developed by the GGOS planning group from 2001 to 2003 according to bylaws of the International Association of Geodesy (IAG). The proposal was accepted by the IAG Executive Committee and the IAG Council at their meetings during the XXIII IUGG General Assembly in Sapporo in July 2003. GGOS was endorsed by the IUGG through Resolution No. 3 at the same General Assembly. During the IAG General Assembly held at Cairns in August 2005, the GGOS implementation plan was accepted as a draft, the Chair (Prof. Ch. Reigber) retired, and the IAG appointed a new Chair (Prof. M. Rothacher) and two supporting Vice-Chairs (Ms. R. Neilan and Prof. H.-P. Plag) to lead the next phase of GGOS development through 2009.

Changes in the IAG bylaws in 2007 result in GGOS being recognized as an integral component of IAG along with Services and Commissions. As a historical note, this transforms the status of GGOS from that of an IAG Project to an IAG component. Specific to the GGOS is IAG bylaw number 15.

These revised GGOS Terms of Reference have been approved by the IAG Executive Committee at the IUGG General Assembly in Perugia, Italy July 2 – 13, 2007.

GGOS provides the basis on which future advances in geosciences can be built. By considering the Earth system as a whole (including the geosphere, hydrosphere, cryosphere, atmosphere and biosphere), monitoring Earth system components and their interactions by geodetic techniques and studying them from the geodetic point of view, the geodetic community provides the global geosciences community with a powerful tool consisting mainly of high quality services, standards and references, theoretical and observational innovations.

According to the IAG bylaws:

"The Global Geodetic Observing System works with the IAG components to provide the geodetic infrastructure necessary for monitoring the Earth system and global change research."

Vision, Mission and Objectives of GGOS

The **vision** of GGOS is to:

- Integrate different techniques, different models, and different approaches in order to achieve a better consistency, long-term reliability and understanding of geodetic, geodynamic and global change processes;
- Provide the scientific and infrastructure basis as geodesy's significant contribution to global change research in Earth sciences;
- View the Earth system as a whole by including the solid Earth as well as the fluid components, and the static and time-varying gravity field;
- Provide geodesy's contribution (products and discoveries) to Earth sciences and to the other scientific and application disciplines, and thus to assert the position of geodesy in geosciences;
- Integrate the work of IAG and to emphasize the complementarities of the broad spectrum of geodetic research and application fields.

The **mission** of GGOS is to:

- To become the *collective voice for IAG*;
- Promote the data and products of the Services;
- Ensure the stability and monitoring of the three fundamental fields of geodesy, namely *geometry and kinematics, Earth orientation and rotation*, and the *gravity field and its variability*;
- Work through the Services, Commission and their participating organizations to collect and archive geodetic observations, products and models, and to ensure their reliability, consistency and availability;
- Identify a consistent set of geodetic products and establish the requirements concerning the products' accuracy, time resolution, and consistency;

- Identify IAG service gaps and develop strategies to close them;
- Stimulate close cooperation between existing and new IAG Services;
- Promote and improve the visibility of the scientific research in geodesy;
- Achieve maximum benefit for the scientific community and society in general.

The key components of GGOS to accomplish this mission are the IAG Services and Commissions. The Services provide the infrastructure and products on which all contributions of GGOS will be based. The IAG Commissions provide expertise and support for the scientific development within GGOS. In summary, GGOS is geodesy's central interface to the scientific community and to society in general.

In order to fulfil its mission, the **objectives** of GGOS are to:

- Aim at maintaining the stability of and provide open access to the geometric and gravimetric reference frames as well as time series of data and products, by ensuring the generation of uninterrupted state-of-the-art global observations related to the three fundamental aspects of geodesy;
- Focus *in the first phase* on all aspects relevant to ensure the *consistency of geometric and gravimetric products,* which includes space-borne and terrestrial aspects;
- Target an overall accuracy and consistency of GGOS products of the order of 10^{-9} or better;
- Work to ensure the consistency between the different geodetic standards used in the Services and the geosciences community, in agreement with the international unions;
- Aim at improving the geodetic models at the level required by the observations.

IAG is a participating organization of the Group on Earth Observations (GEO) – GGOS acts on behalf of the IAG in GEO and actively contributes to the Global Earth Observation System of Systems (GEOSS).

GGOS is established as an official partner in the United Nation's Integrated Global Observing Strategy Partnership – IGOS-P (effective May 25, 2006).

Science Theme and Rationale

The theme of GGOS is *Earth System Dynamics*, focusing on global deformation and mass exchange processes in the System Earth. The theme and rationale must be scientifically sound, broad and include all the activities that GGOS will aggregate today, and envisage in future. The GGOS Science Plan, defining the GGOS science rationale, is prepared by the Science Panel and approved by the GGOS Steering Committee; the plan will guide the Steering Committee tasks. The Science Plan shall provide a logical framework within a broader science and application context, including an analysis of the state-of-art in the science and technology fields, strength and deficiencies, and recommendations of what should be done.

Under the GGOS umbrella of *geometry, Earth rotation,* and *gravity field* this theme of *Earth System Dynamics* coordinates virtually all facets of geodesy. In addition, it may easily be translated and understood through tangible, individual sub-themes and a wide variety of service products. GGOS will bring together the following scientific questions and focus areas:

- Global patterns of tectonic deformation (with densification realized at regional scales) including inter-plate and intra-plate deformation,
- Global patterns of height changes (in one datum, on all time scales, of geodynamic as well as of anthropogenic origin) on land, of ice covers (including glaciers), and of sea level,
- Deformation (loading as well as expansion) due to the mass transfer between atmosphere, hydrosphere including ice and solid Earth,
- Separation of effects of mass changes from motion and from thermal expansion,
- Separation of ocean effects from solid earth effects (e.g., sea-level estimation),
- Quantification of angular momentum exchange and mass transfer,
- Assessment of the angular momentum and mass balances in the Earth system model, and
- Quantification of mass exchange between the components of the system Earth.

The above list is not meant to be final and can be further developed.

GGOS and its related research and Services' products will address the relevant science issues related to geodesy and geodynamics in the 21st century, but also issues relevant to society (global risk management, geo-hazards, natural resources, climate change, severe storm forecasting, sea-level estimations and ocean forecasting, space weather, and others). It is an ambitious program of a dimension that goes beyond IAG, requiring a strong cooperation within the geodetic, geodynamic and geophysical communities, and externally, to related endeavours and communities.

The GGOS Science Plan will serve as the basis for the implementation of GGOS with a derived work plan. Furthermore, the Plan should become an attractive document for presentation to potential future partners, sponsors, and clients.

Overview of GGOS Structural Elements

The organizational structure of GGOS is comprised of the following key elements:

1. GGOS Steering Committee – is the central oversight entity.

2. GGOS Executive Committee – serves at the direction of the Steering Committee to accomplish day-to-day activities of GGOS tasks.

3. GGOS Science Panel – advises the Steering Committee and represents the geodetic and geoscience community.

4. Services, Commissions and relevant Inter-Commission Committees – are the building blocks upon which GGOS is built.

5. Working Groups and Committees – address overarching issues common to several or all IAG components, and are a mechanism to bring the various Services' and Commission activities together, or to link GGOS to external organizations (especially the Group on Earth Observations (GEO) and its related committees and working groups).

The following entities are proposed and will be defined in the coming period.

6. GGOS Coordination Office – will be established to provide support to GGOS, the GGOS Chair(s) and Executive Committee. This office will coordinate the work within GGOS, support the Chairs, the Executive Committee and the Steering Committee to represent GGOS externally, and foster participation of regional geodetic programs to augment the GGOS global coverage. Funding for this entity must be secured on a long term basis.

7. Bureau of Standards & Conventions - will be created in cooperation with the IERS and IGFS to ensure consistency of the GGOS products on the 10^{-9} level or better, to keep track and make available a detailed and concise list of geodetic conventions, constants, and procedures.

8. Communications & Networks Entity – will be established through cooperation with the IAG Services operating the technique-specific networks and in cooperation with the IERS and IGFS*)*. The multi-technique network design as a whole will be considered including communication and data flow.

9. Satellite and Space Missions Entity – will develop scenarios for uninterrupted series of geodesy-related space missions based on scientific and societal needs, working in close partnership with the space agencies.

Details of the Structure of GGOS

1. GGOS Steering Committee

The Steering Committee is a consensus body with 2/3-majority vote required for changes to the Terms of Reference. Other decisions requiring a vote are decided by simple majority of the votes cast. The quorum for a valid vote is participation of one half of the voting members of the Steering Committee. Votes may be held at meetings or by appropriate electronic means at the discretion of the GGOS EC. *Robert's Rules of Order* shall govern procedures, when not specified by these terms of reference. The Steering Committee shall meet at least once yearly.

Steering Committee (all voting members):	
GGOS Chair (votes in case of a tie)	1
Vice-Chairs	2
Chair of GGOS Science Panel	1
Chairs of GGOS Working Groups*	1 or more
Head, Coordinating Office	1 (ex-officio)
IAG EC Representative	1 (ex-officio)
IAG Commission Representatives*	4
Service Representatives* (1 per service)	10 or more
Members-at-Large	4 (or more)
Total	25 (or more)

* Each primary representative can designate an alternate person who can assume the responsibilities, i.e., vote, when the primary delegate can not attend.

The chair of the GGOS Steering Committee is determined according to IAG bylaws. The Chair of the GGOS Steering Committee is also known as the GGOS Chair. The two Vice-Chairs of the GGOS Steering Committee are elected by the Steering Committee (see Executive Committee below). The Chair appoints an independent Nominations Committee to solicit candidates for election to the Members-at-Large positions. These are to balance the SC with regard to geographical region or unique capability. These candidates for the four (4 or more) positions on the SC are nominated by the Steering Committee in consultation with the GGOS community. The Nomina-

tions Committee presents the list of nominations to the SC for a vote.

2. GGOS Executive Committee

The executive committee is composed of the following members:

GGOS Chair	1
Vice-Chairs	2
EC Members-at-Large	3
Total	6

The Chair appoints an independent Nominations Committee to solicit candidates for the Vice Chairs and three (3) Executive Committee (EC) Members-at-Large. The candidates must be current voting members of the SC. These candidates for the five (5) positions on the EC are nominated or self-nominated by the current voting members of the Steering Committee. The Nominations Committee presents the list of nominations to the SC for a vote. The Vice-Chairs and EC Members-at-Large are elected for four-year terms (staggered by two years for the Vice-Chairs) and can be elected for a second term.

Other observers may be invited to attend EC meetings, usually teleconferences, as needed.

3. GGOS Science Panel

The GGOS Science Panel is an independent and multi-disciplinary advisory board that provides scientific support to the GGOS steering and coordination entities.

The GGOS Science Panel is composed of:

Independent and multi-disciplinary Science Panel members	7-12 members

Members are based on recommendations from the GGOS community and candidates are approved by the Steering Committee. The Science Panel shall elect its own Chair to be approved by the Steering Committee. The Science Panel contributes to the science plan.

4. Services, Commissions and Inter-Commission Committees

GGOS works with these IAG components to provide the geodetic infrastructure necessary for monitoring the Earth system and global change research. GGOS respects the bylaws and terms of reference for these essential components. GGOS is built on the existing IAG Services and their products. GGOS is not taking over tasks of the existing, and well working IAG Services. GGOS will provide a framework for existing or future Services and strive to ensure their long-term stability.

5. Working Groups and Committees

Working Groups or committees are established by the Steering Committee as needed. The chair of a WG or committee is appointed by the Steering Committee. A charter for each WG will be prepared and approved by the GGOS SC. The members of WGs are nominated by the WG Chair and confirmed by the SC. Committees will generally be tasked by the SC for a specific function and committee members are approved by the SC.

It is envisioned that there will be a specific working group for interfacing with the Group of Earth Observations (GEO) and its System of Systems (GEOSS).

6. – 9. Future Structural Elements of GGOS

The following proposed elements of GGOS – the Coordinating Office, Bureau of Standards and Conventions, Communications and Network Entity, and Satellite and Space Missions Entity are to be defined with a detail of the individual structures, charters and organizations to be approved by the GGOS SC not later than in 2009. The GGOS elements are to be filled through a call for participation (CfP).

Communication and Outreach Branch (COB)

web: http://www.iag-aig.org

President: **József Ádám** (Hungary)
Secretary: **Szabolcs Rózsa** (Hungary)

Development

The Communication and Outreach Branch (COB) was created by the IAG Council at its special meeting in Budapest, 7 September 2001. A *Call for Participation* was issued by the IAG Central Bureau (CB) to fill this position. Two offers were received to host the COB. The offer of the Hungarian Academy of Sciences (HAS)/ Budapest University of Technology and Economics (BME) was elected by the Executive Committee (EC) at its meeting in Nice, 11 April, 2003. The IAG Council at the 23rd IUGG/IAG General Assembly (Sapporo, Japan, 30 June-11 July, 2003) has confirmed this election. Thus the COB started its activities in July 2003, and in the period of 2007-2011 will be the second term in the operation of the COB by the HAS/BME.

The Communication and Outreach Branch is one of the components of the Association. According to the new Statutes (§5) of the IAG, the COB is the office responsible for the promotional activities of the IAG and the communication with its members.

Terms of Reference

According to §18 of the new By-laws of the IAG:

(a) The function of the Communication and Outreach Branch is to provide the Association with communication, educational/public information and outreach links to the membership, to other scientific Associations and to the world as a whole.

(b) The responsibilities of the Communication and Outreach Branch shall include the following tasks:
   (i) Promote the recognition and usefulness of geodesy in general and IAG in particular.
   (ii) Publications (newsletters).
   (iii) Membership development.
   (iv) General information service and outreach.

c) The Communication and Outreach Branch shall also assist the IAG General Secretary, in the following tasks as required:
   (i) Maintenance of the IAG Web page.
   (ii) Setting up Association schools.
   (iii) Setting up meetings and conferences
   (iv) Maintaining the Bibliographic Service

d) Major decisions related to the operations of the COB shall be made by a Steering Committee consisting of the following voting members:
   (i) Communications and Outreach Branch President.
   (ii) IAG Secretary General.
   (iii) Editor-in-Chief of the Journal of Geodesy.
   (iv) Up to 5 other members appointed by the Executive Committee on the recommendation of the President of the Communications and Outreach Branch.

Program of Activities

According to the new modernised structure of the IAG, the individual membership has been introduced in addition to the traditional National Members. However the individual membership requires a more commercial, member oriented operation of the Association. The main purpose of the COB is to promote communication and interaction among all of its members and to facilitate the work of IAG in general. Therefore the COB will be a permanent IAG office for publication, publicity and visibility of the Association.

The planned activities of the COB will be split into two main groups:

a) communicational activities, and

b) membership developments and promotional activities

which enable the growth of the IAG itself.

One of the major tasks of the COB is to create the channels of the communication within the Association. Our intention is to make a simple, structured way of communication using various Information technologies (IT). The ***communication of the IAG*** will be done using the following channels:

- the official IAG website (see the chapter IAG on the Internet in this issue),
- publication of the IAG Newsletters and Geodesist's Handbook in cooperation with the IAG Office.

The official *IAG website* acts on one hand as the most important interface to the outside community, and on the other hand it is the first pillar of the communicational infrastructure of the Association. Therefore the content of the website is defined to support both roles.

The server operating in the IAG COB, handles *mailing lists,* which will be the major source of information for the members. The members get all of the announcements and Newsletters via e-mail. Our intention is to operate many mailing lists. Issues for creating/maintaining user database/lists for advertising, circular e-mails, surveys, etc are as follows:

- users can already register themselves by giving contact information and topics of interest (e.g. GPS, Gravity Field, Reference Frames, etc.) for notification;
- registration should be entirely web-based using confirmation e-mails;
- users can access/update/delete their personal contact information with username and password;
- privacy statement is necessary for keeping personal data confident;
- several statistics for geographical user distribution can be shown in simple charts on the IAG website;
- benefits should be clearly stated to be on the user list.

The electronic version of the *IAG Newsletter* is published monthly. It has a unique logo which is *a)* unmistakable and unambiguous, *b)* easy to read and perceive even when printed in black/white, and *c)* simply designed and reproduces to any size. It is available in different formats for distribution: *(i)* plain text for e-mail, *(ii)* HTML for e-mail and website, and *(iii)* PDF for downloading from website. Visitors have following options regarding the distribution of the IAG Newsletter:

- view the Newsletter online or download it directly;
- browse/view/download past issues in the Newsletter archive;
- sign-up for e-mail notification of availability of current issue of the Newsletter with short summary of content;
- each user can freely modify his account or remove himself from the Newsletter distribution list.

A selection of the Newsletter articles is published in the Journal of Geodesy.

The ***membership developments and promotional activities*** are further our most important tasks. The COB focuses not only on increasing the number of members in the IAG, but also on providing science information service to the members. For the *membership developments* a Membership Application Form (MAF) was designed and it is put on the IAG website. The user can click into the Form and fill his/her data electronically in Adobe Reader. There is a separate room in the MAF for members who wish to make a contribution to the IAG Fund, too. In the front-page of our website, there is an indication to download the Membership Application Form.

The major channels of *promotional activities* are the IAG website, and the mailing lists. Some brochures and leaflets are printed, which

- introduce the IAG to the global community,
- emphasize the mission statement of IAG, and
- describe the advantages of being an IAG member.

Our intention is that these brochures should be available at every conference organized and/or sponsored by IAG. Therefore the COB should also represent IAG at all major meeting (including not only IUGG General Assemblies, IAG Scientific Assemblies, AGU and EGS meetings, but also at IAG-sponsored meetings) with different IAG materials (brochures, etc).

Steering Committee

The COB has a Steering Committee (SC) with the following members:

- József Ádám, President (Hungary)
- Szabolcs Rózsa, Secretary (Hungary)
- Gyula Tóth (Hungary)
- Chris Rizos (Australia)
- Markku Poutanen (Finland)
- Ruth Neilan (USA)
- Helmut Hornik (Germany)

Ex officio:

- Herman Drewes (Germany)
- Roland Klees (Netherlands)

Address

The COB operates an office of which address is as follows:

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IAG Representatives to Scientific Bodies

IAG Representatives to the Services

- BGI: delegated to Commission 2
- BIPM: *Claude Boucher* (France)
- IAS: *Wolfgang Bosch* (Germany)
- IBS: *Johannes Ihde* (Germany)
- ICET: *Harald Schuh* (Austria)
- ICGEM: *Markus Rothacher* (Germany)
- IDS: *Michael Often* (Germany)
- IERS: *Clark Wilson* (USA)
- IGeS: *Heiner Denker* (Germany)
- IGFS: *Steve Kenyon* (USA)
- IGS: *Geoff Blewitt* (USA)
- ILRS: *Zuheir Altamimi* (France)
- IVS: *Harald Schuh* (Austria)
- PSMSL: *Per Knudsen* (Denmark)

IAG Representatives to External Bodies

IUGG Commissions

- Gerick (Geophysical Risk and Sustainability): Delegated to GGOS
- CMG (Committee on Mathematical Geophysics): Delegated to ICCT
- SEDI (Study of Earth's Deep Interior): *Véronique Dehant* (Belgium)
- Commission for Data and Information: *Bernd Richter* (Germany), *Ruth Neilan* (USA)

Other Bodies

- ABLOS (IHO-IAG Advisory Board on the Law of the Sea): *Sunil Bisnath* (Canada), *Graeme Blick* (New Zealand), *Chris Rizos* (Australia), *Lars Sjöberg* (Sweden)
- GEO (Group on Earth Observation: Plenary and Committees): *Markus Rothacher* (Germany) / representatives to Committees nominated by GGOS
- ISO TC211 (International Standards Organization, Geographic Information/Geomatics): *Hermann Drewes* (Germany), *Johannes Ihde* (Germany)
- JBGIS (Joint Board of Geospatial Information Societies, WG on Risk and Disaster management): delegated to GGOS
- SIRGAS (Geocentric Reference System for the Americas): *Hermann Drewes* (Germany)
- UNOOSA (United Nations Offices for Outer Space Affairs, UNOOSA): ad-hoc members in various Committees, e.g.,
  - Committee on the Peaceful Use of Outer Space (COPUOS),
  - United Nations Platform for Space-based Information for Disaster Management and Emergency Response (UN-SPIDER)
  - International Committee on Global Navigation Satellite Systems (ICG)

General Information

Standards and Conventions relevant for Geodesy

Hermann Drewes (Germany)

1. Introduction and Nomenclature

Standards and conventions are the basis for all geodetic products. In order to generate unambiguous and consistent results, identical standards and conventions have to be used for parameter estimation and representation in all fields of geodesy, namely for point positions, surface shape, orientation in space, and gravity field. The denomination of standards and conventions is widely used in a broad sense. We shall distinguish standards, standardized units, fundamental physical constants, resolutions, and conventions.

1.1 Standards

Standards are generally accepted specifications and measures for quantitative or qualitative values and their comparisons; they establish assessment, classification, and quality criteria.

A standard defines, represents, or records under specified conditions the magnitude of a unit. A *technical standard* is an established norm or requirement. It is usually a formal document that establishes uniform engineering or technical criteria, methods, processes and practices.

The primary types of technical standards are:

- A **standard specification** is an explicit set of requirements for an item, material, component, system or service. It is often used to formalize technical performance. In geodesy there are standard specifications, e.g., for performance of measurements, installation of monuments, quality and contents of data, accuracy requirements of networks and reference frames, etc.
- A **standard test method** describes a definitive procedure which produces a test result. It may involve making a careful personal observation or a highly technical measurement. Standard methods are defined in geodesy for parameter estimation, statistical tests, quality control and integrity, error analysis, etc. It also includes the models used in data reduction and parameter realization in data processing.
- A **standard procedure** gives a set of instructions for performing operations or functions. Standards procedures in geodesy describe, e.g., the formal performance of measurements, collection and archiving of data, pre-processing of data, routine derivation of geodetic products, etc.
- A **standard definition** is a formally established terminology. Definitions in geodesy include primarily the geodetic datums (origin, orientation and scale of coordinate systems, reference ellipsoid, reference potential, etc.) and reference systems (GRS80, WGS84, ITRS, IGSN71, Tide Gauge Network, etc.).

International, regional and national organizations develop, coordinate, promulgate, revise, amend, reissue, interpret, or otherwise maintain standards of interests for a wide base of users. Most important for geodesy are the **International Organization for Standardization** (ISO, *http://www.iso.org/*), an international standard-setting body composed of representatives from various national standards organizations, and the **Open Geospatial Consortium**, Inc.® (OGC, *http://www.opengeospatial.org/*), an international, voluntary consensus standards organization that is leading the development of standards for geospatial and location-based services.

1.2 Standardized units

The value of a quantity is generally expressed as the product of a number and a unit. The unit is simply a particular example of the quantity concerned which is used as a reference, and the number is the ratio of the value of the quantity to the unit. For a particular quantity, different units may be used. For example, the speed v of a particle may be expressed in the form v = 25 m/s = 90 km/h, where metre per second and kilometre per hour are alternative units for expressing the same value of the quantity *speed*. Because of the importance of a set of well defined and easily accessible units universally agreed for the multitude of measurements that support today's complex society, units should be chosen so that they are readily

available to all, constant throughout time and space, and easy to be realized with high accuracy.

A system of units most relevant for geodesy is established by the **International System of Units** (SI, *www.bipm.org/en/si/si_brochure/*). It was adopted by the 11th General Conference on Weights and Measures (1960) and is hosted by the **International Bureau of Weights and Measures** (Bureau International des Poids et Mesures, BIPM). It establishes at first a system of quantities, including a set of equations defining the relations between them. This is necessary because the equations between the quantities determine the equations relating the units. Then, definitions for a small number of units are given (*base units*), and units for all other quantities are defined as products of powers of the base units (*derived units*). In a similar way the corresponding quantities are described as base *quantities* and *derived quantities*, and the equations giving the derived quantities in terms of the base quantities are used to determine the expression for the derived units in terms of the base units.

Physical quantities are organized in a system of dimensions by convention. There are seven base quantities used in the SI, regarded as having their own dimensions. Three of them are most relevant for geodesy:

- Length (standardized unit metre, [m]),
- Mass (standardized unit kilogram, [kg]), and
- Time, duration (standardized unit second, [s]).

All other quantities are derived quantities, which may be written in terms of the base quantities.

1.3 Fundamental Physical Constants

A physical constant is a physical quantity that is generally believed to be both universal in nature and constant in time. It can be contrasted with a mathematical constant, which is a fixed numerical value but does not directly involve any physical measurement. Among the many physical constants in science, the most widely recognized and important for geodesy are

- the gravitational constant *(G)* and
- the speed of light in vacuum (c_0).

Other constants with relevance to geodesy are

- the standard acceleration of gravity (g) and
- the standard pressure of the atmosphere (p).

The **Committee on Data for Science and Technology** (CODATA, http://www.codata.org) of the **International Council for Science** (ICSU, *http://www.icsu.org*) has the mission to strengthen international science for the benefit of society by promoting improved scientific and technical data management and use. It recommends regularly a set of constants, which are published in *http://www.physics-today.org/guide/fundconst.pdf.*

1.4 Resolutions

A resolution is a written motion adopted by a deliberating body. The substance of the resolution can be anything that can normally be proposed as a motion; in the present context we refer to the motion for adopting standards, constants or any parameters to be used by institutions and persons affiliated with the adopting body. Important resolutions are normally published. Most important resolutions for geodesy are those adopted by the Councils of the **International Union of Geodesy and Geophysics** (IUGG, http://www.iugg.org) and the **International Association of Geodesy** (IAG, http://www.iag-aig.org). They are regularly published in the IUGG Yearbook and the Geodesist's Handbook, respectively.

In a house of a legislature, the term *non-binding resolution* refers to measures that do not become laws. The resolution is often used to express the body's approval of something which they cannot otherwise vote on, due to the matter being handled by another jurisdiction, or being protected by a constitution. Resolutions are not binding like laws of a legislature, but more binding than recommendations. In non-legal bodies, such as IUGG and IAG, which cannot pass laws, they form the highest level of commitment. Resolutions shall be respected by all institutions and persons affiliated with the adopting body.

Important resolutions of IUGG/IAG with respect to standards and conventions refer to, e.g.,

- the Geodetic Reference System 1980 (GRS80),
- the tide system (permanent tides), 1983,
- the group refraction index N for microwaves and refractive index of light, 1999,
- the Celestial Reference System (IAU2000), 2003.

1.5 Conventions

A convention is a set of agreed, stipulated or generally accepted norms, standards or criteria. Certain types of rules or customs may become law, and regulatory legislation may be introduced to formalize or enforce the convention. In physical sciences, numerical values (such as constants, quantities, or scales of measurement) are called conventional if they do not represent a measured property of nature, but originate in a convention, for example an average of many measurements, agreed by the scientists working with these values.

In IAG, conventions may be adopted by its components (Services, Commissions, and GGOS). Most established and common are the Conventions of the **International Earth Rotation and Reference Systems Service** (IERS, *http://www.iers.org/MainDisp.csl?pid=46-25776).* Equivalent conventions will have to be released by the **International Gravity Field Service** (IGFS). The conventions

shall be respected in all applications dealing with topics referred to.

2. Standards and Conventions for Geodesy

Standards and Conventions with general relevance for geodesy are regularly discussed and published in the Geodesist's Handbook (e.g., Groten, 2004, Moritz 2000). They are based primarily on the decisions made by the

- International Bureau of Weights and Measures (BIPM),
- Committee on Data for Science and Technology (CODATA),
- International Association of Geodesy (IAG),
- International Earth Rotation and Reference Systems Service (IERS).

Standardized units are released by the BIPM. The Time, Frequency and Gravimetry Section of BIPM is a Service of IAG. Fundamental physical constants are adopted by CODATA. Resolutions with respect to geodetic standards are adopted by the IAG Council. Specific conventions are published by the IERS. In the following we give an extract of these values.

International Standards (SI) important for geodesy released by BIPM:

- The second is the duration of 9 192 631 770 periods of the radiation corresponding to the transition between the two hyperfine levels of the ground state of the caesium 133 atom.
- The metre is the length of the path travelled by light in vacuum during a time interval of 1/299 792 458 of a second. It follows that the speed of light in vacuum is 299 792 458 metres per second (geocentric, TCG):c_0 = 299 792 458 [m/s].
- The kilogram is the unit of mass; it is equal to the mass of the international prototype of the kilogram.

Fundamental physical constants important for geodesy recommended by CODATA (2006):

- Constant of gravitation (G [m^3 kg^{-1} s^{-2}])
  $6.674\ 28 \cdot 10^{-11} \pm 0.67 \cdot 10^{-14}$
- Speed of light in vacuum (c_0 [m s^{-1}])
  299 792 458 (exact)
- Standard pressure of the atmosphere (p [Pa])
  101 325 (exact)

Geodetic Reference System 1980 (GRS80, Moritz 2000)

- Geocentric gravitational constant (GM [m^3 s^{-2}])
  $3.986\ 05 \cdot 10^{14}$
- Equatorial radius, semi-major axis (a [m])
  6 378 137
- Dynamic form factor (J_2, free of tides)
  $1.082\ 63 \cdot 10^{-3}$
- Angular velocity of rotation (ω [rad s^{-1}])
  $7.292\ 115 \cdot 10^{-5}$

Derived numerical values

- Reciprocal flattening ($1/f$)
  298.257 222 101
- Polar radius, semi-minor axis (b [m])
  6 356 752.3141
- Normal potential at the ellipsoid (U_0 [m^2 s^{-2}])
  62 636 860.850
- Normal gravity at the equator (γ_e [m s^{-2}])
  9.780 326 7715
- Normal gravity at the pole (γ_p [m s^{-2}])
  9.832 186 3685

IERS Conventions 2003 (McCarthy 2004)

- Constant of gravitation (G [m^3 kg^{-1} s^{-2}])
  $6.673 \cdot 10^{-11} \pm 0.01 \cdot 10^{-11}$
- Geocentric gravitational constant (GM [m^3 s^{-2}])
  $3.986\ 004\ 418 \cdot 10^{14} \pm 8 \cdot 10^5$
- Equatorial radius (a [m])
  6 378 136.6 ± 0.10
- Flattening factor ($1/f$)
  298.256 42 ± 0.000 01
- Dynamical form factor (J_2)
  $1.082\ 6359 \cdot 10^{-3} \pm 1 \cdot 10^{-10}$
- Nominal mean angular velocity (ω [rad s^{-1}])
  $7.292\ 115 \cdot 10^{-5}$
- Mean equatorial gravity (g_e [m s^{-2}])
  $9.780\ 327\ 8 \pm 1 \cdot 10^{-6}$
- Potential of the geoid (W_0 [m^2 s^{-2}])
  62 636 856.0 ± 0.5

References

McCarthy, D.D. (2004). IERS Conventions (2003*). IERS Technical Note*, 32, BKG, Frankfurt.

Groten, E. (2004). Fundamental parameters and current (2004) best estimates of the parameters of common relevance to astronomy, geodesy, and geodynamics. *J. Geodesy* (77) 724-731, 2004.

Moritz, H. (2000). Geodetic Reference System 1980. *J. Geodesy* (74) 128-133, 2000.

IAG on the Internet

web: http://www.iag-aig.org

Szabolcs Rózsa, IAG Communication and Outreach Branch

The IAG maintains an Internet site, which is a valuable source of information not only about the Association itself, but also about its scientific disciplines. The primary goal of the website is to communicate with the IAG members, and make information available to the wider Geosciences community in the world as a whole.

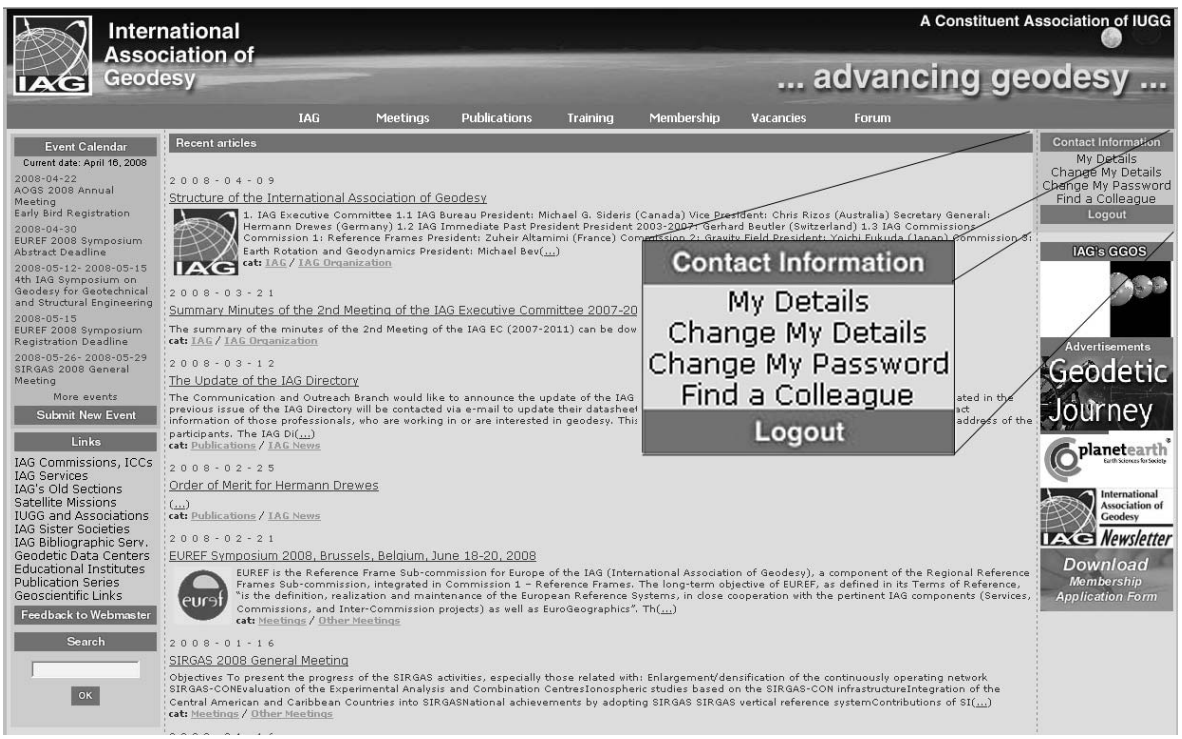
Since the maintenance of the IAG website belongs to the activities of the Communication and Outreach Branch (COB) it is still hosted at the Department of Geodesy and Surveying of the Budapest University of Technology and Economics (BME) with the HAS-BME Research Group for Physical Geodesy and Geodynamics of the Hungarian Academy of Sciences (HAS), Budapest, Hungary.

During the past four years, the website has been continuously improved. Some new features have been added to it, which are discussed here.

Members' Area

Each IAG Individual Member gets automatically a login name and a password after processing his/her Membership Application Form. The login name is always the e-mail address specified in the form, while the password is generated automatically. The login section to the Members' Area can be found on the right side of the IAG opening page.

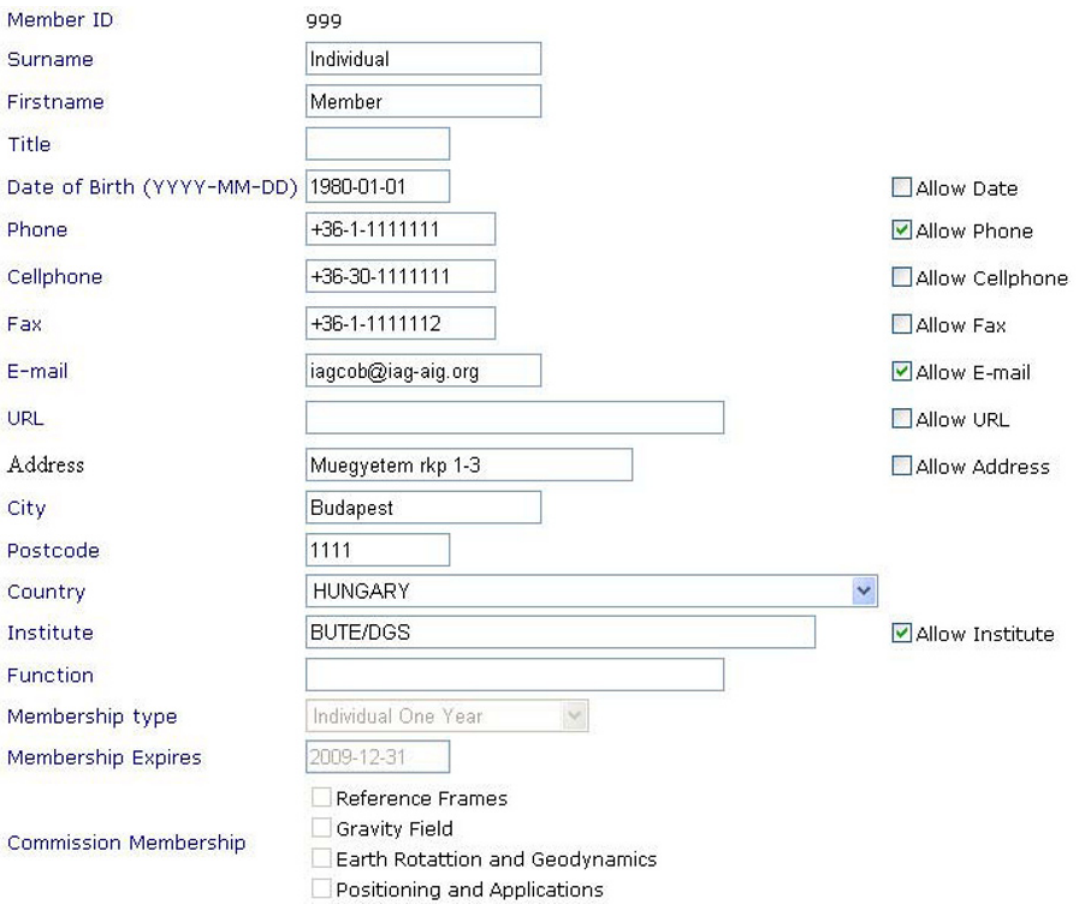
After logging in, one can access the IAG Contact Database as well as some publications available only for the members of the IAG.



The IAG Website with the access to the Contact Database

IAG Contact Database

The contact information of each IAG Member has been stored in a relational database. Every member has the privilege to update his/her own contact information. The information is generally classified (except the name and the country of origin). However one can decide to make some contact details (phone, e-mail, postal address) public. In this case all the other IAG Members can see the selected contact details.



Individual Members may update their contact information, and make the data public.

The Individual Members can specify as well their fields of interest in Geodesy. This may enable the COB to send announcements, publications or other information directly to the appropriate members.

Individual Members can query the database, too. Using the Find a Colleague option, one can select IAG Members according to Name, Institution, Country and Fields of interest.

The IAG COB has recently started a campaign to gather contact data from anyone, who is working in, or interested in Geodesy. These data sets will be stored in the IAG Contact Database in the future, in order to add more international contacts and ease the building of international contacts and help to create international co-operations. Those Colleagues, who are not Individual Members of the IAG, will be able to update their own contact information on the web, but the privilege of querying the database will be limited to IAG Members only.

The IAG Forum

The IAG Forum is a billboard service of the IAG Website. It was established in 2004, but had only marginal number of visits in the last 3 years. During these years the Forum was public, anyone could post articles to it. However due to the large number of spam, the COB decided to create a private Forum for the IAG Individual Members only. In the near future each IAG Individual Member will get a username and password to be able to login to the private IAG Forum. More information on the Forum will be available on the IAG Website and in the IAG Newsletters.

The opening page of the IAG Forum

The IAG Office

The IAG Office maintains an own website, mainly for internal IAG users, at *http//:iag.dgfi.badw.de*.

Publications of the International Association of Geodesy

I. Journal of Geodesy

Twelve issues per year:

annual subscription, sale by unit (Springer-Verlag)

contact:

Springer Verlag
Tiergartenstrasse 17
D – 69121 Heidelberg
www.springeronline.com / www.springer.com

II. Travaux de l'Association Internationale de Géodésie (IAG Central Bureau)

The IAG Reports (Travaux de l'Association Internationale de Géodésie) contain the reports of all IAG components and sub-components. They were published as printed volumes and presented at the IAG General and Scientific Assemblies every two years until 2003. Since 1995 the IAG Reports are also available in digital form, and since 2003 exclusively online (http://www.iag.aig.org).

1. International Association of Geodesy - Travaux 2005
   Internet: http://www.iag-aig.org/index.php?tpl=text&id_c=18&id_t=269
2. International Association of Geodesy - Travaux 2007
   Internet: http://www.iag-aig.org/index.php?tpl=print_doc&id_t=269&id_c=18

III. IAG-Symposia Proceedings

Vol. 125: Adam J., Schwarz K.-P. (Eds.): Vistas for Geodesy in the New Millennium (2001)

Vol. 126: Hwang C., Shum C., Li J. (Eds.): Satellite Altimetry for Geodesy, Geophysics and Oceanography (2004)

Vol. 127: Sansò, F. (Ed.): V Hotine-Marussi Symposium on Mathematical Geodesy (2004)

Vol. 128: Sansò, F. (Ed.): A Window on the Future of Geodesy. IAG Sapporo, 2003 (2005)

Vol. 129: Gravity, Geoid and Space Missions, IAG International Symposium, Porto, 2004 (2005)

Vol. 130: Tregoning P., Rizos C. (Eds.): Dynamic Planet. Monitoring and Understanding a Dynamic Planet with Geodetic and Oceanographic Tools (2007)

Vol. 131: Sansò F., Gil A. J. (Eds.): Geodetic Deformation Monitoring: From Geophysical to Engineering Roles (2006)

These publications are available from::

Springer Verlag
Tiergartenstrasse 17
D – 69121 Heidelberg
www.springeronline.com / www.springer.com

IV. IAG Bibliographic Service

The IAG Bibliographic Service for Geodesy is maintained by the Bundesamt für Kartographie und Geodäsie (BKG)

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Access via internet: http://www.bkg.bund.de/nn_147094/DE/Bundesamt/Informationsdienste/Informationsdienste__node.html__nnn=true

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The IAG Directory comprises a list of addresses of geodesists who are in direct contact with the IAG by having attended an IUGG General Assembly, IAG Scientific Meeting, IAG Symposium in the recent years or maintain any other kind of contact. The addresses comprises the name, title, affiliation, postal address as well as phone/fax number and e-mail address of the respective persons.

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Considering the rules of the protection of personal rights this list is not generally open to everybody. The directory is accessible by password for all individual IAG-members via the IAG homepage <*http://www.iag-aig.org/*> and the <*login for members*> as well as on direct request to the IAG Office <*iag@dgfi.badw.de*>

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