Inter-Commission Committee on Marine Geodesy (ICCM)

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President: Valérie Ballu (France)
Vice President: Heidrun Kopp (Germany)

ICCM website - https://geodesy.science/iccm/

1 Structure

Joint Working Groups

JWG M.1 Data and tools exchange
Chair: Pierre Sakic (France)
Affiliations: IERS, GGOS

JWG M.2 GNSS-Acoustic technologies and experiments
Chair: James Foster (Germany)
Affiliations: Commissions 1, 3, 4

JWG M.3 Seafloor pressure - an essential variable for monitoring vertical deformation as well as ocean dynamics
Chair: Matt Wei (USA)
Affiliations: Commission 3, ICCC

JWG M.4 Realtime and post-processed kinematic GNSS positioning: status and perspectives for seafloor and sea-surface positioning
Chair: Tianhe Xu (China)
Vice-Chair: Zhiguo Deng (Germany)
Affiliations: Commission 4

JWG M.5 Acoustic Delay Corrections for Submarine Geodesy
Chair: Shuqiang Xue (China)
Affiliations: Commission 4, IERS

JWG M.6 How marine geodesy can better contribute to coastal hazards assessment and mitigation
Chair: Morelia Urlaub (Germany)
Vice-Chair: Lifeng Bao (China)
Affiliations: Commission 3

2 Activities during the reporting period 2023-2025

2.1 General Activities

The objective of the ICCM is to help develop links and mutual knowledge among the international marine geodesy community, with a special focus on Seafloor geodesy. We

have finalized the new Terms of Reference for ICCM in 2024, developed an ICCM webpage and conducted 2 virtual meetings gathering ICCM working groups leaders. Note that virtual meetings with people around the world are particularly challenging due to the time coverage. We also ran an ICCM splinter meeting during EGU 2025 in Vienna. Below are the main achievements and recommendations coming from the Joint Working Groups.

2.2 Reports of Joint Working Groups

JWG M.1 – Data and tools exchange

The JWG presented its activities in poster form at AGU23 last December. It will soon be available at https://hal.science/hal-04803624.

In the near future, we plan to work on three main tasks:

- To make our standardization work known to other international structures, typically the GGOS Bureau of Products and Standards, in order to give it visibility and to obtain a possible support for its diffusion.
- To establish a task-force to standardize pressure (OBP) data, comparable to what has been done for GNSS-A data, in order to design an exchange standard. This should be done in coordination with JWG M.3, led by Matt Wei, and if possible a representative of NOAA, which distributes DART data.
- Continue discussions on a common international nomenclature for geodetic sites/-points at sea, taking into account the need for re-instrumentation, the specificity of the different instruments that can be deployed (acoustic or pressure), and the analogy with GNSS stations on land. E-mail exchanges have already taken place and should continue.

JWG M.3 – Seafloor pressure - an essential variable for monitoring vertical deformation as well as ocean dynamics

The JWG hosted a 3-hour pre-conference event on February 18th, 2024, at the Ocean Sciences Meeting in New Orleans, LA, United States. Sixty-two participants attended this event, which is way more than we expected. For the first ninety minutes, oral presentations were given. After 10 minutes of break, thirty-one people participated in a breakout session in which small groups discussed shared interests, project ideas, and general needs for fostering collaboration between the geodesy and oceanography communities. Each group reported their main points at the end of the event. We have advertised future events and encouraged collaborations between participants.

JWG M.4– Realtime and post-processed kinematic GNSS positioning: status and perspectives for seafloor and sea-surface positioning

Realtime and post-processed kinematic GNSS positioning: status and perspectives for seafloor and sea-surface positioning

The main works are as follows:

- Propose an integrated real-time precise point positioning (InRPPP) system with B2b/B2a/B1C services, which increases the number of redundant observations, making full use of the available augmentation messages, thus improving the positioning performance;
- Propose an integrated BeiDou Satellite-Based Augmentation (InBDSBAS) system with B2a and B1C services where the B1C, B2a, and broadcast ephemeris messages are resiliently utilized, thus improving the number of available satellites and positioning accuracy.

More details on JWG M.4 topic and recommendations can be found on the IAG website, via the link https://geodesy.science/wp-content/uploads/Proposal_1130_Xu.pdf.

JWG M.5 – Acoustic Delay Corrections for Submarine Geodesy

The spatiotemporal variation of sound speed, arising from the intricate marine environment, pose the most challenging issue that restricts seafloor geodetic positioning. Therefore, a reference sound speed profile (RSSP) was conventionally measured to achieve centimeter-level accuracy in seafloor geodetic positioning, but the sound speed variation inverted from GNSS-A observations is based on the RSSP which lacks a global conventional reference. In addition, low-cost GNSS-A technology based on unmanned systems has rapidly advanced in recent years, but these unmanned systems are often unable to be outfitted with requisite equipment for SSP measurement due to the limitation of the capacity and energy availability. Over the past few decades, global ocean observation programs have led to the release of numerous global gridded marine environmental datasets (GGMED) containing temperature and salinity data. As observational data accumulate, observation methods diversify, and data processing technologies advance, the spatiotemporal resolution of GGMED has continually improved, now reaching up to $1/12^\circ \times 1/12^\circ \times 1$ day. This progress enables the replacement of in-field RSSP measurements with GGMED and supports high-precision seafloor geodetic positioning. Additionally, with the integration of observational data and physical models, along with the development of AI large models, global operational ocean forecasting systems, similar to numerical weather prediction, have been established. These systems provide higher-resolution marine forecast datasets in real-time, paving the way for real-time seafloor geodetic positioning without in-field RSSP measurements. Being similar to GNSS, acoustic signals used for underwater positioning face delays caused by using a reference sound speed as a substitution for the real sound speed field (SSF). Drawing on GNSS tropospheric delay correction strategies, it is recommended to define a reference sound speed, develop delay correction models and mapping functions, and utilize GGMED to improve acoustic ranging corrections for seafloor precise positioning.

- To make acoustic delay correction based on a conventional sound speed (CSS) for seafloor geodesy is not insurmountable when learning from GNSS. Although the CSS can be defined arbitrarily for developing GNSS-A ranging, we recommend that the CSS be defined as the sound speed in sea-surface water with a temperature of 4 degrees and a salinity of 35‰. It is noticeable that this definition is not the

best choice when considering only the static acoustic delay correction order, but it is very practical for users to conveniently get the CSS worldwide.

- The static acoustic delay Taylor series expansion needs to be truncated to the second order, and the temperature and salinity profiles from the GLORYS12 reanalysis product are recommended to conduct the Taylor series expansion. Note that forecasting marine environmental products might be more meaningful for developing real-time GNSS-A observation systems.
- The proposed GNSS-A ranging observation model with static delay corrections can achieve centimeter-level precision for seafloor geodetic positioning. The positioning error resulted from adopting the static delay corrections replacing in-field Sound Speed Profile (SSP) is within 4 mm along the horizontal directions, while that along the vertical direction is within 3 cm.

More details on JWG M.5 topic and recommendations can be found on the IAG website, via the link https://geodesy.science/wp-content/uploads/Proposal_1128_xue.pdf.