IAG Scientific Assembly 2025:
Geodesy for a changing environment

Symposium G05: Advances in GNSS, Positioning Technologies, and Engineering Geodesy

Conveners: Pawel Wielgosz, Heidi Kuusniemi, Fabricio S. Prol, Jianghui Geng, Ningbo Wang, Cuixian Lu, Janis Kaminskis, Artur Fischer

This symposium focuses on both theoretical and practical advancements, as well as innovative applications in positioning, navigation, timing (PNT), geodetic remote sensing, and geodetic engineering. It serves as a platform to bring together scientists conducting research in these areas, as well as a place to encourage scientific discussion. We particularly welcome research on the following topics:

- Multi-signal positioning architectures and emerging technologies: Solutions that address the limitations of location determination and extend capabilities beyond traditional standalone GNSS. This includes applications in Augmented Reality (AR), Indoor Positioning Systems (IPS), and Computer Vision (CV) within buildings or densely populated urban areas, as well as complementary technologies such as LEO-PNT, LiDAR, Radar, 5G, inertial systems, V2X communication, and sensor fusion approaches to enhance accuracy and resilience in positioning.

- Multi-constellation and multi-frequency GNSS applications and advancements: Exploring the use of GNSS in various scenarios, including autonomous driving, instantaneous high-precision positioning, precise time and frequency transfer, precise orbit determination, and meteorological disaster monitoring and early warning systems. These topics emphasize the immense potential of GNSS technology.

- Advancements in GNSS-based tropospheric products: Research focused on the development of reliable real-time and post-processed GNSS tropospheric products for troposphere monitoring, modelling, and precise positioning. This includes the use of machine learning or deep learning methods to develop enhanced global, regional, or local tropospheric delay models, as well as the integration of current water vapor sensing systems for advanced tropospheric models with applications in meteorology and geoscience.

- Engineering Geodesy challenges: Theoretical and practical studies on structural health monitoring, displacement and deformation monitoring, and maintaining local reference frames using satellite and modern multi-sensor technologies such as GNSS, InSAR, LiDAR, UAVs, and others. This includes the development of observation models for these technologies.

We welcome any contributions that address these topics or relate to the broader activities of the IAG Commission 4.

G05-1: Emerging Positioning Technologies and GNSS Augmentations

Conveners: Heidi Kuusniemi, Fabricio S. Prol, Dinesh Manandhar, Mahmoud Elsanhoury

This session welcomes contributions presenting solutions that address the limitations of location determination and extend capabilities beyond traditional standalone GNSS. This includes applications in Augmented Reality (AR), Indoor Positioning Systems (IPS), and Computer Vision (CV) within buildings or densely populated urban areas, as well as complementary technologies such as LEO-PNT, LiDAR, Radar, 5G, inertial systems, V2X communication, and sensor fusion approaches to enhance accuracy and resilience in positioning. Additionally, we have an interest in new techniques for positioning and integrity, perspectives of how the positioning and augmentation technologies should develop in the future, advancements of low-cost solutions, smart wearable systems, and quantum navigation. This session welcomes presentations on

- Development of new positioning techniques;
- Analyzing the integrity levels of geodetic positioning for collaborative positioning;
- Enhancing geodetic positioning for real-time applications;
- Providing perspectives of how the positioning and augmentation technologies should develop utilizing upcoming systems, e.g., LEO systems;
- Advancing solutions for low-cost instruments as well as smart wearable systems;
- Exploring the future opportunities of quantum navigation.

G05-2: Multi-frequency Multi-constellation GNSS

Conveners: Jianghui Geng

The construction of multi-constellations and the utilization of multi-frequency have expanded the spatial coverage, catering to the diverse application requirements across various scenarios and levels. However, these advancements have also introduced new technological and theoretical challenges. Therefore, this session aims at contributions exploring the use of GNSS in various scenarios, including autonomous driving, high-precision positioning, precise time and frequency transfer, precise orbit determination, and meteorological disaster monitoring and early warning systems. These topics emphasize the immense potential of GNSS technology. We invite research from the following areas:

- Theoretical, methodological, and technological problems arising from the development of multi-constellation and multi-frequency GNSS;
- Combining multi-constellation GNSS as well as multi-frequency signals for PPP-AR time /frequency transfer.
- Advances of PPP-AR/PPP-RTK models and methods
- Innovative methods and techniques for mass-market/smartphone GNSS receivers.
- Integrity monitoring algorithms for precise positioning methods using carrier phase measurements such as RTK and PPP.
- Application of modernized GNSS signals for Natural Hazards and Disaster Resiliency.

Other related topics are also welcomed.

G05-3: GNSS for Troposphere

Conveners: Cuixian Lu, Galina Dick, Ningbo Wang, Jonathan Jones

This session welcomes research focused on the development of reliable real-time and post-processed GNSS tropospheric products for troposphere monitoring, modeling, and precise positioning. This includes the use of machine learning or deep learning methods to develop enhanced global, regional, or local tropospheric delay models, as well as the integration of current water vapor sensing systems for advanced tropospheric models with applications in meteorology and geoscience. This session invites contributions focused on:

- Developing and optimizing reliable GNSS tropospheric products in real-time and post-processed modes, including ZTDs, gradients, STDs, water vapor, etc.
- Applications of GNSS tropospheric products in monitoring and forecasting different weather processes and systems (extreme precipitation, convective storms, drought…).
- Evaluation of the current water vapor sensing techniques and the integration of multi-source and multi-scale water vapor information for improved meteorological applications.
- Establishment of global/regional/local tropospheric delay models by using machine learning or deep learning methods serving for applications in both meteorology and geoscience.
- Exploring the full potential of a priori tropospheric delay models in enhancing GNSS precise positioning as well as geological disaster monitoring.

G05-4: Engineering Geodesy

Conveners: Janis Kaminskis, Janina Peplinska

This session welcomes contributions that address theoretical and practical studies on structural health monitoring, displacement and deformation monitoring, and maintaining local reference frames using satellite and modern multi-sensor technologies such as GNSS, InSAR, LiDAR, UAVs, and others, including the development of observation models for these technologies. In particular, we welcome presentations on:

- Establishing the theoretical framework for the transition from the global ITRF coordinate reference frame to the local engineering coordinate reference frame.
- Methods for the maintenance and updating of the local coordinate reference frame.
- Constructing the multi-modal, multi-scale, high-quality engineering geodetic dataset and developing corresponding AI-enabled data mining and prediction methods.
- Novel algorithms and technologies of InSAR geodesy for improving accuracy and robustness in monitoring surface deformation and infrastructure health.
- Ground-based/UAV SAR instruments integrated with spaceborne InSAR measurements for performances and resilience in InSAR engineering geodetic applications and monitoring.
- Evaluation of the mathematical modeling of multisensory observations.
- Developing scenarios for displacement and deformation monitoring utilizing the real-time and non-real-time sources of multisensor data.
- Integration of measurement techniques for monitoring non-linear deformations.
- Systems of Health Monitoring (SHM) - aided life-cycle performance assessment, in particular: lifetime prognosis, predictive maintenance, damage monitoring, repair and strengthening, Interoperability of monitoring system (accessibility of data).

- Digital twins and their role in the process of geodetic investment support at the stage of facility implementation, as well as monitoring and risk assessment during the first loads and operation.
- Field applications: Integrated systems and implementations of SHM, Monitoring of bridges, buildings, dams, tunnels, space structures, heritage structures, and other structures.