

Session: Resilience of IAG Scientific Services

Conveners Richard Gross (President of the International Association of Geodesy)
Hansjörg Kutterer (Chair of GGOS D-A-CH)

Program Friday, 6th March 2026, 10:30 – 12:00
10:30 – 11:15 Panel **Resilient Scientific Data Infrastructures in Geodesy – State, Constraints, and Threats**
10:30 – 10:40 Introductory presentation by Hansjörg Kutterer
10:40 – 11:15 Discussion

11:15 – 12:00 Panel **Improving the Resilience of IAG’s Products**
11:15 – 11:25 Introductory presentation by Richard Gross
11:25 – 12:00 Discussion

Panellists

Resilient Scientific Data Infrastructures in Geodesy – State, Constraints, and Threats

Allison Craddock (UN Global Geodetic Centre of Excellence, Germany)
Martin Lidberg (Chair of EUREF, GGOS-BNO Deputy Director)
Daniela Thaller (Director of the IERS Central Bureau)
Kirsten Elger (Chair of the GGOS Committee on DOIs)
Taylor A. Yates (IGS ACC Representative)
Martin Sehnal (Director of the GGOS Coordinating Office)

Improving the Resilience of IAG’s Products

Robert Heinkelmann (IERS Analysis Coordinator)
Tom Herring (IGS Analysis Coordinator)
Frank Lemoine (ILRS Science Coordinator)
Benedikt Soja (IVS Analysis Coordinator)
Petr Štěpánek (IDS Analysis Coordinator)
Riccardo Barzaghi (IGFS Chair)

Concept Note

The International Association of Geodesy (IAG) is a scientific organization that has been serving scientists since 1862. The data and products provided by the IAG Scientific Services have been used to gain greater understanding of the geodetic properties of the Earth including its shape, gravity, and rotation and how they change in space and time. The IAG’s data and products have also been widely used by other geoscientific disciplines such as seismology, vulcanology, and tectonophysics to further our understanding of the earthquake cycle, volcanic eruptions, and plate tectonic motions. Besides the scientific applications of the IAG’s data and products, they are also being increasingly used by society for positioning and navigation services.

GNSS (Global Navigation Satellite Systems) receivers can be incorporated into cell phones, vehicles, drones, airplanes, and satellites to aid in positioning and navigating those platforms. Commercial companies are operating private networks of GNSS stations to serve the needs of their customers in areas such as farming, mining, and forestry. And surveying techniques are increasingly relying on GNSS for land administration, construction, and monitoring the deformation of structures such as dams. Underlying many of these societal applications of GNSS is a reference frame within which the position of the platform, GNSS station, or survey marker is given. Oftentimes, the reference frame used for this is based on the International Terrestrial

Reference Frame (ITRF) that is determined and maintained by the International Earth Rotation and Reference Systems Service (IERS).

The growth of the reliance of society on the IAG's data and products means that the IAG is no longer serving just scientists but is now also serving society in its needs for geodetic information. This places additional requirements on the IAG's data and products. While scientists are largely concerned with the accuracy and timeliness of the IAG's data and products, many societal applications are more concerned with their continuous and unrestricted availability and their proven reliability. Meeting the needs of society for geodetic information therefore means making the data and products provided by the IAG's Scientific Services as well as the underlying, fundamental observation and data infrastructures more resilient. In addition to the robustness of the established workflows, this also refers to reliable authoritative and institutional commitment in terms of human and material resources.

The geometric Services of the IAG, namely the International GNSS Service (IGS), International VLBI Service (IVS), International Laser Ranging Service (ILRS), and International Doris Service (IDS), already have a number of individual Analysis Centres that provide data and products determined by that individual Analysis Centre. These Services are therefore reasonably resilient in that regard. However, most of these Services, including the IERS, have only one Combination Centre or Analysis Centre Coordinator that takes the data and products from the individual Analysis Centres and combines them. This represents a single source of failure for the combined products. Making the combined products resilient to failure means having additional Combination Centres or Analysis Centre Coordinators that provide consistent combined products from redundant processing chains and IT infrastructures.

The gravity field-related Services play a central role as data repositories. For instance, BGI (Bureau Gravimétrique International) stores, curates and provides gravity values collected by various organisations; ISG (International Service for the Geoid) and ICGEM (International Centre for Global Earth Models) store, curates and provide regional or global gravity field models; IDEMS (International Digital Elevation Model Service) collects and makes available digital terrain models from various sources; and IGETS (International Geodynamics and Earth Tide Service) supports the monitoring of temporal variations in the Earth's gravity field by analysing long-term records from ground gravimeters, tiltmeters, strainmeters, and other geodynamic sensors. Despite their long history of operation and strong connections with data providers and users around the world, their repositories typically depend on a single institution. There is little redundancy or backup centres, which makes their long-term stability vulnerable.

Based on the above, this session will be a forum for exploring the ways and means within the IAG and its Services

- To identify data repositories at risk and evaluate datasets that may no longer be available, either now or in the future.
- To develop strategies to preserve geodetic observations, products, and research results, for example by encouraging the establishment of data repositories located on different continents.
- To discuss ways of improving the availability of geodetic data and products to the research community and to society in general.
- To identify the main challenges relating to storage capacity and personnel resources for the indexing, curation or disciplinary aggregation of data, as well as legal assessment processes and integrating data into cross-regional or worldwide structures.
- To evaluate the suitability of using cloud environments as geodetic data repositories.
- To discuss how the combined products from the IAG's Geometric Services, including the IERS, can be made more resilient.

Outcomes

The panel on *Resilient Data Infrastructure in Geodesy* first described how the resilience of geodetic data infrastructure is currently being addressed and then discussed ways that it could be improved. The panel recommended that the geodetic data infrastructure evolve in such a way that in the future it consists of a globally distributed, cybersecure network of data centers having synchronized, quality controlled holdings operated by dedicated staff with sustainable governance. The panel emphasized the importance of collecting and archiving meta data along with the observations. And the panel noted that the geodetic data infrastructure is just one link in the global geodesy supply chain and that the entire supply chain needs to be made more resilient. Finally, the panel discussed the need to raise the awareness of the importance of geodesy to the public, to decision makers, and especially to students. For geodesy to thrive in the future we must attract students to the field.

The panel on *Improving the Resilience of IAG's Products* first described how the products from IAG's Services are currently being determined, focusing on how combined products are generated. The panel then discussed how the resilience of the products could be improved, particularly the resilience of the combined products. While most Services have multiple Analysis Centers, some of the Analysis Centers have only one analyst. And most Services have only one Combination Center to determine the combined products. Eliminating these single sources of failure would greatly improve the resilience of IAG's products. This entails establishing multiple Combination Centers at each Service having independent processing chains determining combined products that are consistent with each other. The panel also discussed the need for resilient personnel with multiple people being trained in the analysis and determination of the Service's products. Finally, the panel also noted the need to raise the awareness of the importance of geodesy, echoing the concerns of the panel on *Resilient Data Infrastructure in Geodesy*.