

Geometric Services of the International Association of Geodesy: *The backbone of global geodesy*

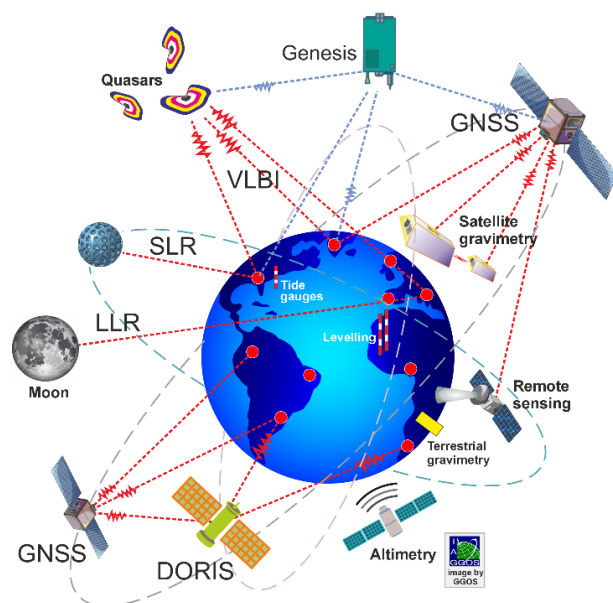
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Observing the Earth from the field of geodesy is the starting point for understanding its shape, orientation, gravity field, and temporal dynamics. From a geometric perspective, geodesy determines the positions and displacements of points on the Earth's surface with millimetric precision, providing the foundation for determining the Earth's shape and monitoring the kinematics of its surface. In this context, the Global Geodetic Observing System (GGOS) integrates the international infrastructures, techniques, and services that ensure a precise, consistent, and sustainable global reference system, supporting scientific, environmental, and technological applications at the planetary scale. The techniques used in space geodesy include VLBI, DORIS, SLR and GNSS, to which can be added the study of the sea surface using satellite altimetry and GNSS reflectometry. Additionally, the long-term monitoring of sea level is done with tide gauges worldwide. The integration of these techniques requires coordinated frameworks to ensure consistency and accuracy. The Services of the International Association of Geodesy that oversee each of these techniques are essential for ensuring operations, data quality and reliable geodetic information supporting Earth system science and societal applications.

IAG Geometry Services

The Services of the International Association of Geodesy (IAG) are a unique organisational feature. The Services are the organisations that oversee all aspects related to individual geodetic techniques, from operational to product generation, data handling, quality control, analysis and so on. The complexities of each technique, the continuous need to maintain and improve the quality of the observations and products generated, and the variety of institutions that own and operate the infrastructure require an organisational structure to ensure the smooth and continuous provision of observations of the highest quality, as well as their development and improvement at a technical level.



Geodetic observation techniques: The toolbox of Geodesy comprises different sensors and instruments on the Earth (land and oceans), in the air, and in space, which together compose one large, comprehensive "geodetic instrument" for monitoring the System Earth in a wide range of spatial and temporal scales.

Thanks to the strong international voluntary commitment of national mapping authorities, space agencies, universities, research institutes, and individuals contributing to the IAG's activities on a best-effort basis, the IAG has established a robust organisational infrastructure. Within this infrastructure, the IAG Services for the Earth's geometry and gravity field form the backbone of global geodesy. The current Geometric Services are:

- *International VLBI Service for Geodesy and Astrometry (IVS)*
- *International Laser Ranging Service (ILRS)*
- *International GNSS Service (IGS)*

- *International DORIS Service (IDS)*
- *Permanent Service for Mean Sea Level (PSMSL)*

The *International Earth Rotation and Reference Systems Service (IERS)* integrates the contributions of the space-technique-specific Geometric Services to provide consistent, reliable, and long-term fundamental geodetic products that serve as the basis for positioning and navigation, Earth Observation, Earth system science, public administration, geomatics, and a wide range of coordinate-based applications.



International Earth Rotation and Reference Systems Service (IERS)

IERS provides the global reference systems, Earth orientation information, standards, and models that are essential for modern geodesy, astronomy, and space science. It maintains the *International Terrestrial Reference System and Frame (ITRS/ITRF)* and the *International Celestial Reference System and Frame (ICRS/ICRF)*, providing the fundamental terrestrial and celestial references needed for precise positioning, navigation and Earth Observation. The IERS determines and disseminates *Earth Orientation Parameters*, describing variations in the Earth's rotation and orientation in space and enabling the consistent transformation between terrestrial and celestial reference frames. It also develops the *IERS Conventions*, which provide internationally accepted models, constants, and standards for high-precision geodetic and astronomical data analysis, and provides *geophysical-fluid information* for interpreting variations in Earth orientation. Through these activities, the IERS provides a fundamental link between Earth geometry, Earth rotation, and celestial reference systems, ensuring the consistency and interoperability of global geodetic observations and products.

Find out more <https://www.iers.org/>





International VLBI Service for Geodesy and Astrometry (IVS)

IVS is an international collaboration of organisations that operate or support *Very Long Baseline Interferometry (VLBI)*. Its primary purpose is to provide products and services that support geodetic, geophysical, and astrometric research and operational activities. IVS coordinates VLBI observing programs, including the scheduling of sessions and the operation of a global network of radio telescopes, correlators, and analysis centres. It establishes standards for data acquisition, processing, and analysis, ensuring consistency and high quality across all products. These products include Earth Orientation Parameters, which describe the Earth's rotation in space, as well as contributions to both the terrestrial and celestial reference frames. Additional outputs include tropospheric parameters and time series of baseline lengths between stations. All IVS products are made publicly available, supporting a wide range of scientific and operational applications. IVS also promotes the development and improvement of VLBI technology and techniques, ensuring its continued role within the essential global geodetic infrastructure and its integration into GGOS.

Find out more <https://ivscc.gsfc.nasa.gov/>



International Laser Ranging Service (ILRS)

The ILRS coordinates global *Satellite Laser Ranging (SLR)* and *Lunar Laser Ranging (LLR)* activities, providing precise distance measurements between ground stations and satellites or lunar retroreflectors. These measurements are based on the accurate timing of laser pulses, enabling the determination of satellite orbits with very high precision. The ILRS plays a fundamental role in defining the origin and scale of the International Terrestrial Reference Frame, as its observations are uniquely sensitive to the Earth's centre of mass. The service operates a global network of laser ranging stations, supported by data and analysis centres that process and distribute the observations and derived products. These products include precise satellite ephemerides, station coordinates, Earth Orientation Parameters, and geocenter motion. The ILRS ensures that all data meet strict standards in terms of accuracy, quantity, and timeliness, supporting both scientific research and operational applications. It also contributes to missions in geodesy, geophysics, and space science, and promotes the continued development of laser ranging technologies.

Find out more <https://ilrs.cddis.eosdis.nasa.gov/>





International GNSS Service (IGS)

The IGS provides freely and openly available high-precision *Global Navigation Satellite Systems (GNSS)* data and products to support a wide range of scientific, engineering, and operational applications. Its global network consists of more than 500 continuously operating GNSS stations that track multiple satellite constellations, forming the observational backbone for precise positioning, navigation, timing and Earth Observation. The IGS generates a variety of high-quality products, including precise satellite orbits, satellite clock corrections, Earth Rotation Parameters, ionospheric and tropospheric parameters, and station position time series and coordinates. These products are essential for the realisation and maintenance of the International Terrestrial Reference Frame and for ensuring consistency across geodetic techniques. The IGS operates through a distributed structure that includes data, analysis, and combination centres, all working under agreed standards, conventions, and guidelines. The IGS also plays an important role in promoting the use of GNSS data, supporting new applications, and contributing to the integration of geodetic observations within GGOS. All data and products are made openly available to the scientific community and other users worldwide.

Find out more <https://igs.org/>



International DORIS Service (IDS)

The IDS provides high-quality data and derived products from the *DORIS (Doppler Orbitography and Radiopositioning Integrated by Satellite)* system, which is used primarily for precise orbit determination of satellites, especially those carrying altimetry instruments. The service relies on a global network of approximately sixty ground beacons distributed worldwide, which transmit signals received by satellites equipped with DORIS receivers. The IDS organises the collection, archiving, and distribution of these data through its data centres, and coordinates their analysis through a network of analysis and combination centres. Its products include station position time series and coordinates, geocenter motion, and Earth Orientation Parameters. These products contribute significantly to the realisation of the International Terrestrial Reference Frame and to the monitoring of geophysical processes. The IDS ensures that all data and products are consistent, validated, and openly accessible, and it operates within an international collaborative framework that supports scientific research and operational applications as part of GGOS.

Find out more <https://ids-doris.org/>





Permanent Service for Mean Sea Level (PSMSL)

PSMSL is responsible for the collection, analysis, and distribution of long-term sea level data obtained from a [global network of tide gauges](#), and more recently, from [GNSS reflectometry sites](#). It maintains a comprehensive database of mean sea level measurements, which are used extensively in studies of climate change, ocean dynamics, and coastal processes. The PSMSL works in close collaboration with other geodetic services, particularly the IGS and IDS, to incorporate information on vertical land motion at tide gauge stations, thereby improving the interpretation of observed sea level changes. It also collaborates with international initiatives such as the Global Sea Level Observing System (GLOSS) to integrate GNSS observations with tide gauge data, ensuring consistency within global reference frames. The service provides standardised datasets that are freely available to the scientific community and other users. These datasets are essential for monitoring long-term sea level trends and variability, and they play a key role in understanding the impacts of climate change on the global ocean and coastal environments within the GGOS framework.

Find out more <https://psmsl.org/>



RECAP

Why the IAG Services Matter

The IAG Services are an essential component of the international geodetic infrastructure. They coordinate observations, standards, analysis, and data from organisations around the world and transform them into consistent, reliable, and openly accessible geodetic products. Without the IAG Services, geodetic activities would become increasingly fragmented. Global reference frames would be harder to maintain and connect, long-term observations could lose continuity, and geodetic products would become less consistent and interoperable. This would directly affect our ability to monitor changes in the Earth system and support applications ranging from climate and sea-level monitoring to geohazards, positioning, satellite missions, and Earth Observation. The joint work of GGOS and the IAG Services ensures that geodesy functions as a global observing system; not simply as a collection of individual observations and isolated, technique-dependent products.

Find out more

Web geodesy.science/ggos/services/
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