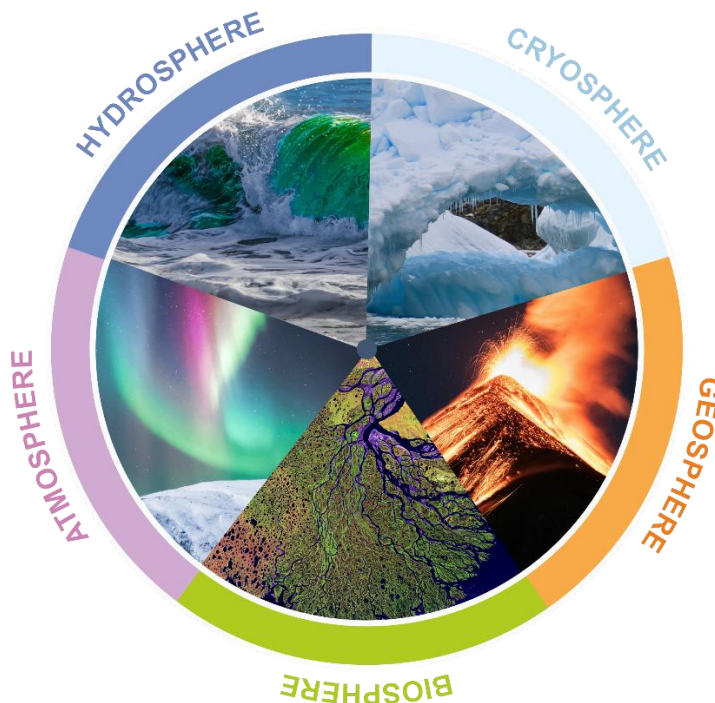
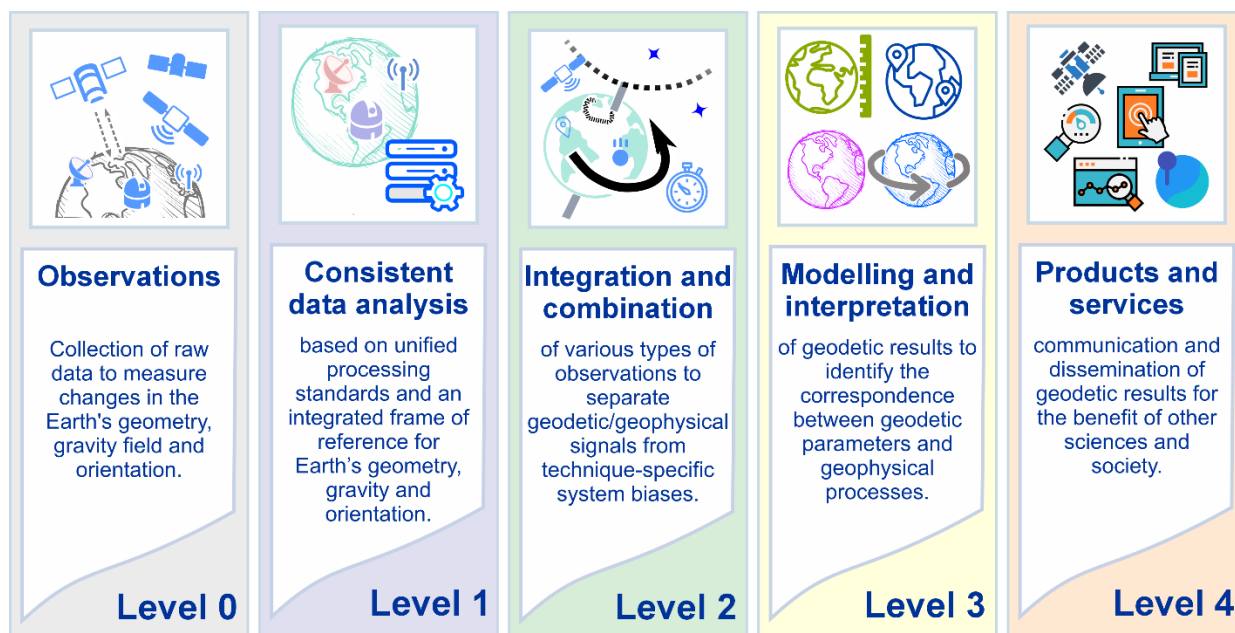


Earth system monitoring with geodesy

The Global Geodetic Observing System (GGOS) is the response of the international geodetic community, organised under the International Association of Geodesy (IAG), to the need to continuously monitor the Earth system. GGOS observes the time-varying shape, rotation and gravity field of the Earth with respect to precise and long-term stable geodetic reference frames. Changes to these characteristics are inherently related to changes occurring within and between the Earth's components: the geosphere, atmosphere, hydrosphere, cryosphere and biosphere. Geodesy is therefore an essential discipline for Earth system monitoring. GGOS aims to raise awareness of this new role of geodesy and to move from the provision of usual geodetic products (station coordinates, geoid, Earth orientation parameters, satellite orbits) to a consistent modelling and interpretation of Earth system processes and interactions, ensuring an integrated observing system.

The Earth is a restless planet. It is subject to a wide range of external and internal processes that change its shape (including continental, oceanic and ice-covered areas), the distribution of mass between and within its components (geosphere, biosphere, cryosphere, hydrosphere and atmosphere), and its rotation and orientation in space. The task of geodesy is to determine the shape, gravity field and rotation of the Earth as a function of space and time. These properties react together, albeit in different ways, to processes in each of the components of the Earth system. Therefore, in order to achieve its primary objective, geodesy is necessarily involved in the detection, analysis and modelling of the signals emitted by the Earth system, in particular those recorded by geodetic observations.





The path from geodetic measurements to Earth system monitoring comprises several stages:

- **Level 0:** Collection of raw data using various techniques to measure changes in the Earth's geometry (kinematic), gravity field, (mass distribution) and orientation (rotation). It is performed by the operation of the observing infrastructure (ground- and space-based techniques).
- **Level 1:** Consistent data analysis based on unified processing standards and an integrated frame of reference for Earth's geometry, gravity and orientation. This is essential to ensure that changes detected after analysis of geodetic data truly represent changes in the Earth system and not inconsistencies in data preparation and analysis.
- **Level 2:** Integration and combination of geodetic measurements collected by different observing techniques to separate

true geodetic/geophysical signals from technique-specific system biases and to improve our understanding of Earth system signals, as different manifestations of the same processes can be detected by different techniques with different sensitivities.

- **Level 3:** Modelling and interpretation of geodetic results to elucidate the relationships between geodetic parameters and geophysical processes.
- **Level 4:** Provision of geodetic products and services for the benefit of other sciences and society.

The last one is of special importance, because if geodetic results are not adequately communicated and disseminated, the state-of-the-art monitoring of the Earth system enabled by geodesy cannot be properly exploited and acknowledged by other sciences and communities.

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