The Global Geodetic Core Network: Foundation for Monitoring the Earth System

A Project of the Global Geodetic Observing System (GGOS) as a contribution to the Global Earth Observation System of Systems (GEOSS)

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Background

The GEO Task AR-07-03 "Global Geodetic Reference Frames" (now Sub-Task DA-09-02c) carried out a detailed assessment of the requirements that the nine Societal Benefit Areas (SBA) of Earth Observations addressed by the Group on Earth Observations (GEO) have in terms of geodetic observations and products, with special focus on the requirements concerning the geodetic terrestrial reference frame (TRF). The outcome of the assessment is summarized in the "GGOS 2020" Book (Plag and Pearlman, 2009). In brief, two of the most demanding requirements for the TRF are monitoring the water cycle at global to regional scales, and monitoring and modeling sea surface and ocean mass changes in order to detect global change signals in ocean currents, volume, mass, and sea level. Quantitatively, the assessment finds that the terrestrial reference frame should be accurate at a level of 1 mm and be stable at a level of 0.1 mm/yr. Likewise, the static geoid should be accurate at a level of 1 mm and be stable at a level of 0.1 mm/yr, consistent with the accuracy and stability of the terrestrial reference frame (Gross et al., 2009).

A number of satellite missions are currently observing sea and ice surfaces, and mass transport in the water cycle is being determined from satellite gravity missions. Future sea surface topography and satellite gravity missions will add valuable observations for the detection and monitoring of global change signals. SAR missions provide measurements of land surface displacements that help to detect, for example, active volcanoes, unstable slopes, and areas of coastal subsidence, and InSAR provides surface displacements induced by earthquakes, groundwater extraction, volcano eruptions, and melting ice loads as crucial input for science and research. Emerging technologies such as GNSS reflectrometry and LIDAR will increase spatial and temporal coverage of these observations. Full utilization of the potential of these observations for research and practical applications will only be possible if the geodetic terrestrial reference frame meets or exceeds the accuracy and stability levels summarized in Gross et al., (2009). Only then will we be able to close the mass balance in the global water cycle and to constrain with narrow uncertainties changes in ice sheets and glaciers, land water storage, ocean mass and volume, and sea level. Likewise, full utilization of the satellite observations for studies of geohazards, and the prevention and mitigation of disasters depends on a reliable reference frame allowing for the combination and integration of different technologies and data sets.

In order to achieve the required accuracy and stability levels in the terrestrial reference frame, integration of the whole suite of space-geodetic techniques is required. The assessment carried out in the frame of Task AR-07-03 of the required global geodetic infrastructure emphasizes the importance of geodetic core sites for this integration of the techniques and identifies the current large geographical gaps in the global network of core sites as a major limitation for improvements in reference frame accuracy and stability. Core sites are those sites where all four of the space-geodetic techniques are co-located and where the ties between the individual stations (GNSS, SLR, VLBI, DORIS) at the site are known to the same accuracy as the targeted reference frame accuracy.

Based on that, the "GGOS 2020" assessment in Recommendation 9.1 recommends
"*that*
the global geodetic infrastructure not only be maintained at the current level but also be augmented, in order to close major spatial and technological gaps, with: (1) a global network of core sites on all continents, (2) absolute and superconducting gravimeters at a global network of reference sites, in particular the core sites, and (3) two additional dedicated SLR satellites, that
an operational core system be built up and maintained with the necessary infrastructure for an operational geodetic Earth system service providing quantitative information on changes in ice sheets, sea level, water cycle, and climate, as well as for hazards, disasters, and resource management application, and that
the operational core include at least: (i) the global geodetic networks for the determination and monitoring of the geodetic reference frames, including Earth rotation, (ii) continuous gravity satellites missions for the monitoring of mass transport, (iii) continuous satellite missions for the monitoring of ice sheets, sea surface height, and lake level variations, and (iv) continuous satellite missions for the imaging of the solid Earth's surface."

Objectives of the Project

With this project, GGOS aims to close the major geographical and technological gaps in the current global network of geodetic core sites. The project will design a network of core sites that will have the requisite geographical coverage to allow the targeted reference frame accuracy to be achieved. By facilitating an upgrade of the current network to the new core network the geographical gaps will be removed. The development of the new core sites of the Global Geodetic Core Network will address major technological gaps at the current core sites and will lead to a reduction of the operational resources required for the individual sites. In particular, the new core sites will provide well monitored ties between the individual stations at the site. The Global Geodetic Core Network will be a major step in the implementation of Recommendation 9.1, which resulted from GEO Task AR-07-03.

Mode of implementation

GGOS will prepare a Call for Participation to be issued to all GEO Member Countries and Participating Organizations. This call will ask for contributions to the Global Geodetic Core Network in various forms: science and research in support of the development of the individual core sites and of the Global Geodetic Core Network; technological developments of the components of the core sites; establishment and/or operation of core sites; provision of suitable locations for the core sites; data centers for the Global Geodetic Core Network, etc.

Linkage to GEO Committees and Tasks

The GGOS Project is a direct contribution to Sub-Task DA-09-02c. There are several other links to GEO activities that will be further developed. Here we mention initially that a key aspect of this GGOS Project is to facilitate contributions of relevant science and research communities to an activity of direct relevance to GEO SBAs and to the improvement of a crucial component of GEOSS. Therefore, this project can serve as a pilot project for Activity 4 of the Task ST-09-02:
"*4. Specific efforts will be made to contact universities and research laboratories with the goal to involve them in GEOSS activities. Steps towards this goal include:*

- ...

- *Establish proactive collaboration between S&T activities at universities and labs identified under (1) and relevant GEO tasks.*"

It also should be considered how different aspects of this project could be integrated in other activities of the ST-09-02 Task, for example, the "GEO Label", and "GEOSS at Work" activities.

Initial Time Schedule

Up to August 31, 2009: Development of a Call for Participation (CfP); potential with different parts
September 1, 2009: Publication of the CfP (potentially only Part 1)
November 30, 2009: Deadline for submission of Proposals
December 31, 2009: Announcement of selected Proposals.

References

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