Draft Initial ToR for the Global Geodetic Observing System

Terms of Reference

Global Geodetic Observing System (GGOS)

2007 – 2009

Preamble

The proposal for the IAG Project "Global Geodetic Observing System" (denoted here as GGOS-P) was developed by the GGOS planning group from 2001 to 2003 according to by-laws of the International Association of Geodesy (IAG). The proposal was accepted by the IAG Executive Committee and the IAG Council at their meetings during the XXIII IUGG General Assembly in Sapporo in July 2003. GGOS-P was endorsed by the IUGG through Resolution No. 3 at the same General Assembly. During the IAG General Assembly held at Cairns in August 2005, the GGOS-P implementation plan was accepted as a draft, the Chair (Prof. Ch. Reigber) retired, and the IAG appointed a new Chair (Prof. M. Rothacher) and two supporting Vice-Chairs (Ms. R. Neilan and Prof. H.-P. Plag) to lead the next phase of GGOS-P through 2009, with the main goal to develop the strategy for the observing system.

At the IUGG/IAG meeting in July 2007 in Perugia, the Global Geodetic Observing System (GGOS) of IAG was established. GGOS works with the IAG Services to provide the geodetic infrastructure necessary for the monitoring of the Earth system and global change research.

1 Vision of GGOS

The GGOS vision is to empower Earth science to extend our knowledge and understanding of the Earth system processes, to monitor ongoing changes, and to increase our capability to predict the future behavior of the Earth system.

2 Mission of GGOS

GGOS is the flagship of IAG. The development of GGOS in order to meet the requirements of scientific and societal applications of geodesy is the overarching theme for the research and science in IAG. GGOS is committed to disseminate geodetic observations and products to users inside and outside of IAG, and to support scientific and non-scientific communities with geodetic expertise. It promotes and improves the visibility of geodetic scientific research in Earth sciences and society.

The mission of GGOS is to facilitate networking among the IAG Services and Commissions and other stakeholders in the Earth science and Earth Observation communities, to provide scientific advice and coordination that will enable the IAG Services to develop products with higher accuracy and consistency meeting the requirements of particularly global change research, and to improve the accessibility of geodetic observations and products for a wide range of users.

The IAG Services, upon which GGOS is built, benefit from GGOS as a framework for

communication, coordination, and scientific advice necessary to develop improved or new products with increased accuracy, consistency, resolution, and stability. IAG benefits from GGOS as an agent to improved visibility of geodesy's contribution to the Earth sciences and to society in general. The users, including the national members of IAG, benefit from GGOS as a single interface to the global geodetic observation system of systems maintained by the IAG Services not only for the access to products but also to voice their needs. Society benefits from GGOS as a utility supporting Earth science and global Earth observation systems as a basis for informed decisions.

3 Objectives of GGOS

In order to realize its vision, GGOS has the objective to ensure the availability of geodetic science, infrastructure, and products as a basis for all global change research in Earth sciences. This implies the objective to ensure the consistent, comprehensive, and continuous monitoring of the 'three pillars of geodesy', namely *geometry and kinematic*, *Earth orientation and rotation*, and the *gravity field and its variability*.

In order to meet the accuracy requirements of a wide range of users, GGOS aims to integrate different techniques, different models, and different approaches and thus to achieve a better consistency, long-term stability, reliability, and the temporal and spatial resolution required for the understanding of geodetic, geodynamic and global change processes. GGOS views the Earth system as a whole by including the solid Earth as well as the fluid components and the interactions of these components, and it aims to improve the geodetic models at the level required by the observations. GGOS has the goal to ensure consistency across the 'three pillars of geodesy', as well as consistency between the different geodetic standards used in the services and the geosciences community, in agreement with the international unions and programs. GGOS targets an overall accuracy and consistency of GGOS products of the order of 10^{-9} or better. In particular, GGOS aims at maintaining the stability of the existing geometric and gravimetric reference frames by ensuring the generation of uninterrupted time series of state-of-the-art global observations related to the three pillars of geodesy.

GGOS integrates the work of IAG and emphasizes the complementarity of the broad spectrum of geodetic research and application fields. GGOS provides geodesy's contribution (products and discoveries) to Earth sciences and it is the bridge to the other disciplines. Thus, GGOS asserts the position of geodesy in geosciences.

GGOS and its related research and services' products will address the relevant science issues related to geodesy and geodynamics in the 21st century, but also issues relevant to society (global risk management, geo-hazards, natural resources, climate change, severe storm forecasting, sea-level estimations and ocean forecasting, space weather, and others). It is an ambitious program of a dimension that goes beyond IAG, requiring a strong cooperation within the geodetic, geodynamic and geophysical communities, and externally, to related endeavors and communities.

4 Tasks of GGOS

On a high level, GGOS has the tasks to:

- Identify a consistent set of geodetic products and establish the requirements concerning the products' accuracy, temporal and spatial resolution, latency, and consistency;
- Develop the strategy for GGOS appropriate to meet these requirements;
- Identify IAG service gaps and develop strategies to close them;
- Ensure the availability, consistency, reliability and accessibility of geodetic observations, products, and models.

The specific product-oriented tasks of GGOS are to encourage, facilitate and promote the following activities:

- define a unique celestial reference system;
- define a unique terrestrial reference system;
- define a unique geodetic reference system;
- define a unique gravity reference system;
- define all the physical and mathematical models needed to analyze GGOS observations;
- provide and maintain an accurate, stable, and homogeneous celestial reference frame;
- provide and maintain an accurate, stable, and homogeneous terrestrial reference frame including its origin;
- provide and maintain the time-dependent Earth orientation parameters that are used to transform coordinates between the terrestrial and celestial reference frames;
- provide and maintain definitions, constants, models, etc. of the geodetic reference systems;
- provide and maintain parameters describing the static and time-dependent components of the Earth's gravity field;
- provide and maintain parameters describing the static and time-dependent components of the shape of the land, ice, and ocean surfaces;
- provide and maintain parameters describing the total electron content of the ionosphere;
- provide and maintain parameters describing the water vapor content of the troposphere;
- provide and maintain parameters describing the transport of mass within and between the atmosphere, oceans, and land.

The above list is not meant to be complete and other product-specific tasks may develop.

5 Products

As a result of the above tasks, the principal products that are determined and provided by the IAG Services and that are available through GGOS include but are not limited to:

- a catalog of celestial radio sources including their coordinates that provides the celestial reference frame;
- a catalog of terrestrial sites defining the reference polyhedron associated with the terrestrial reference frame, including their reference coordinates at a common epoch and time series describing the temporal evolution of the coordinates;

- time series of coordinates of additional terrestrial sites or points including the necessary models and/or observations that are needed to densify the terrestrial reference frame in order to provide access to the frame anywhere on the Earth's surface;
- precise orbits and clocks for GNSS satellites that allow access to the terrestrial reference frame;
- time series of Earth rotation parameters (UT1, polar motion, nutation/precession) including their time rates-of-change that provides the link between the celestial and terrestrial reference frames;
- values of the defining constants and derived physical and geometrical parameters of the geodetic reference system;
- values of parameters describing the static component of the Earth's gravity field;
- time series of parameters describing the time-dependent component of the Earth's gravity field;
- time-dependent maps of the total electron content of the ionosphere;
- time series of zenith path delays that provides the water vapor content of the troposphere;
- time series of angular momenta of the atmosphere, oceans, continental water storage including ice and snow, mantle, and core that provide estimates of the mass transport within the Earth system;
- time series of site displacements caused by loading and unloading effects of atmospheric surface pressure, ocean-bottom pressure, and continental water storage including snow and ice that provide estimates of the changing shape of the land surface;
- time series of sea surface height and sea level measurements that provide estimates of the changing shape of the ocean surface;
- time series of ice sheet and glacier elevations that provide estimates of the changing shape of the ice surface;
- similar time-dependent, body-fixed site coordinates, orientation parameters, and gravity parameters for other planets and celestial bodies in the solar system such as the Moon and Mars.

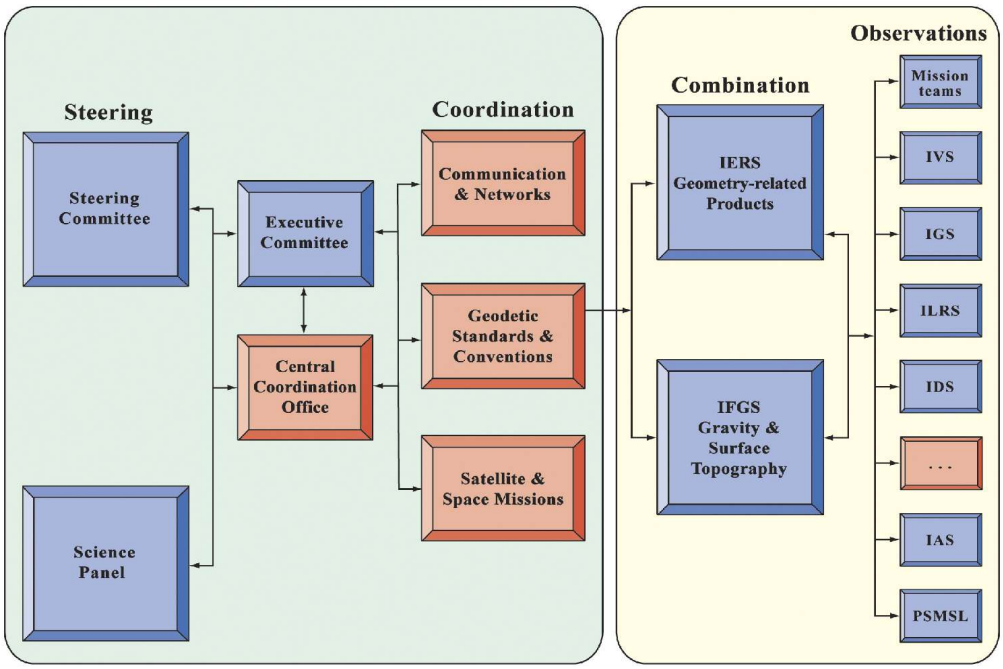
6 Organizational Structure

The organizational structure of GGOS is comprised of two main parts, namely, (1) a steering and advisory part and (2) a coordination part. In the first part, sufficient representation of the stakeholders is the guiding principle, while for the second part, coordination across the 'three pillars of geodesy' and across the IAG Services is the focus.

The first part, steering and advice, has the following key elements:

- **GGOS Steering Committee:** the central oversight entity.
- **Executive Committee:** serves at the direction of the Steering Committee to accomplishes activities of GGOS between the Steering Committee meetings.
- **Science Panel:** advices the Steering Committee and and represents the geodetic and

geophysical community.



- **Working Groups:** address overarching issues common to several or all IAG Services, and are a mechanism to bring the various services' and commission activities together or to link the GGOS to external organizations (especially the Group on Earth Observations (GEO) and related GEO committees and working groups).

The second part, coordination, consists of four entities, namely:

- **Central Coordinating Office**: supports the Executive Committee, Steering Committee and Science Panel administratively and runs the day-to-day business.
- **Coordination and Networks entity:** facilitates the overall planning and coordination of the geodetic networks and the data communication.
- **Geodetic Standards and Conventions entity:** maintains geodetic standards and orchestrates the consistency of conventions across the three pillars of geodesy and across all IAG Services, and ensures that the standards and conventions are in agreement with the similar standards and conventions of relevant organizations.
- **Satellite and Space missions entity:** proposes, plans, and promotes satellite and space missions as required in order to achieve the objectives and goals of GGOS and works closely with relevant organizations, in particular the space agencies, for the implementation of these missions.

7 Steering, Advising and Administration

7-1 Steering Committee

The Steering Committee exercise oversight of all GGOS activities. Changes to the Terms of Reference are made with a 2/3-majority of all voting Steering Committee members. Elections are by vote. All other decisions are based on consensus. In cases, where a consensus cannot be reached, decisions are resolved by vote, if requested so by at least three voting Steering Committee members. Votes are by simple majority. Valid votes require participation of at least half of the voting Steering Committee members. Votes can be held at Steering Committee meetings, or if appropriate, be conducted by e-mails, by fax, or in Steering Committee telecons or videocons.

Roberts Rule of Order shall govern those procedures that are not specified by these Terms of Reference. The Steering Committee shall meet at least twice yearly.

The Steering Committee has the following voting members:

GGOS Chair (votes in case of a tie)	1
Vice-Chairs	2
Chair of GGOS Science Panel	1
Chairs of GGOS Working Groups*	1 or more
IAG President	1 (ex-officio)
IAG Commission Representatives*	4
Service Representatives*	10 or more (1 per service)
Members at Large	4
	24 (or more)

* Each primary representative can designate an alternate person who can assume the responsibilities, including voting, when the primary delegate can not attend.

Observers are invited to the Steering Committee meetings as needed.

Meeting documentation (agenda and minutes) is public. Meeting agendas are made available at least two weeks before a meeting.

The chair of the GGOS Steering Committee (denoted in the following as GGOS Chair) is elected according to the By-Laws of IAG. The two Vice-Chairs of the GGOS Steering Committee are elected by the Steering Committee. The Vice-Chairs are elected for staggered terms of two years. The Vice-Chairs can be reelected.

7-2 Executive Committee

The Executive Committee has six members:

GGOS Chair	1
GGOS Vice-Chairs,	2
Members at Large (Voting Members of the SC)	3
	6

The GGOS Chair appoints an independent Nominating Committee to solicit candidates for the three Members at Large Steering of the Executive Committee (EC). The candidates must be

current voting members of the SC. These candidates for the three (3) positions on the EC are nominated or self-nominated by the current voting members of the Steering Committee. The Nominating Committee presents the list of nominations to the SC for a vote.

The EC meets as needed, usually by teleconference. Observers may be invited to attend EC meetings as needed. The IAG President is permanently invited as observer.

7-3 Science Panel

The GGOS Science Panel is an independent and multi-disciplinary advisory board that provides scientific support to the GGOS steering and coordination entities in the development of GGOS strategy, methods, and conventions. The Science Panel shall has seven to ten (7 to 10) members representing all relevant fields of Earth sciences.

Members are selected through the recommendation from the GGOS community and approved by the Steering Committee. The Science Panel elects its own Chair. The Science Panel will develop the GGOS Science Plan and present it to the Steering Committee; a review of progress accomplished towards the plan will be addressed at least annually at one of the meetings of the Steering Committee.

GGOS is an observing system for *Earth System Dynamics*, focusing on global deformation and mass exchange processes in the System Earth and encompassing virtually all facets of geodesy. The rationale must be scientifically sound, broad and include all the activities that GGOS will aggregate today, and envisage in future. The GGOS Science Plan, defining the GGOS science rationale will guide the Steering Committee tasks. The Science Plan shall provide a logical framework within a broader science and application context, including an analysis of the state-of-art in the science and technology fields, strength and deficiencies, and recommendations of what should be done.

The GGOS Science Plan will serve as the basis for the implementation plan and a derived work plan. Furthermore, the Science Plan is expected to be a compelling document for presentation to potential future partners, sponsors, and clients.

7-5 Working Groups

GGOS Working Groups (WGs) are established by the GGOS Steering Committee as needed. The Steering Committee will designate an interim Chair to begin the organization of the WG and to develop a draft charter. WG members are proposed by the Chair based on recommendations from the GGOS community and approved by the Steering Committee. Once the WG is established, it will elect its own chair. Chair terms will last four years; chairs may be reelected. The WG maintains its mission, which is approved by the Steering Committee.

A permanent WG is responsible for the representation of IAG as a Participating Organization in GEO. This WG on 'GEO Representation' is chaired by the IAG Principal to GEO or his or her delegate. Members of the WG are the IAG delegates to the GEO Plenary, Committees and Working Groups. The head of the GGOS Central Coordinating Office is an ex-officio member of the WG. This WG develops input for GEO activities and solicits support from the GGOS community as needed. A main goal of the WG is to ensure interoperability of GGOS with the other systems contributing to the Global Earth Observation System of Systems

(GEOSS) and to streamline the development of GGOS in accord with the general developments in Earth Observation.

GGOS WGs are generally only established if there is a compelling reason for a new WG and will be disbanded when no longer required. GGOS WGs will not duplicate ongoing work in IAG Services or address issues best dealt with in single IAG Services or Commissions.

8 Coordination

8-1 Central Coordination Office

The Central Coordinating Office performs day-to-day activities in support of GGOS, and ensures coordination of the activities of the various components. It supports the Executive Committee, the Steering Committee and the Science Panel through administration of activities, including the preparation and documentation of meetings. It ensures information flow from these entities to the coordination entities and maintains a documentation of the GGOS activities.

This office will manage specific assistance functions that enhance the coordination across all areas of GGOS, including inter-services coordination and support for workshops.

The Office also maintains an extensive overview of internal and external GGOS users and supports GGOS outreach activities, including those to potential new users. As part of these activities, the Central Coordinating Office lends special support to the GGOS WG on GEO representation and any GGOS outreach and user linkage groups or WGs.

8-2 Communication and Networks

The GGOS Communication and Networks entity is responsible for the design and continuous improvement of the GGOS network, including the geometry, collocation, and communication links. This entity periodically assess the network, identifies gaps, proposes augmentations and technological upgrades, and monitors the impact of network changes on products.

8-3 Geodetic Standards and Conventions

The Geodetic Standards and Convention entity of GGOS provides standards and conventions and strongly encourages compliance to quality assurance (validation, calibration, ensure the 1 part per billion [ppb] level) through increased interaction of the GGOS components, especially the services. The entity maintains definitions of a unique celestial reference system, a unique terrestrial reference system, a unique geodetic reference system, and a unique gravity reference system, as well as definitions of all the physical and mathematical models needed to analyze GGOS observations.

The entity carries out its work in close connection to relevant organizations such as IAG, IAU, FIGS, as well as the national mapping authorities.

8-4 Satellite and Space Missions

The GGOS Satellite and Space Missions entity proposes geodetic (and geodesy related) space missions (including geodetic missions to the Moon and other planets) with the goal to ensure uninterrupted series of geodesy-related space missions to observe the time-varying gravity field, the time-varying sea-, ice-, and land-surface topography, and to maintain the geometric and gravimetric reference frames. The entity works with the GGOS Science Panel to develop the scientific rationale for these missions. The entity works in collaboration with the major space agencies towards implementation of the missions. The entity maintains a web site with information of all upcoming and planned missions.

9 Users

GGOS serves a wide range of users inside and outside of GEO. Inside IAG, the IAG Services, Commissions, Study-Groups, and individual scientists benefit from GGOS. In its development, GGOS provides a general research theme for IAG.

With the products made available through GGOS, it serves Earth scientists in general and supports Earth Observation. These products also support many non-scientific applications in society at large.

10 External relations

GGOS must be recognized by partners outside IAG including governments, inter-governmental organizations and non-governmental organizations (e.g, UNESCO, UNEP, FAO, UNOOSA, IOC, GEO, ICSU, IGOS-P, WCRP, IGBP, GEWEX, GOOS, GTOS, GCOS, CEOS, FIGS, etc.), as geodesy's most important contribution to Earth sciences. For this purpose, contacts have to be established and/or maintained with these organizations. Relations to those institutions and organizations maintaining infrastructure that contributes to GGOS, such as national mapping authorities, space agencies, and CEOS, are of particular importance.

IAG is a Participating Organization of GEO. GGOS acts on behalf of the IAG in GEO and actively contributes to GEOSS.

Approval of the Terms of Reference

To be approved by GGOS EC in June 2007, the GGOS Steering Committee in July 2007, and the and IAG Executive Committee afterwards in 2007.