El proyecto
“Sistema de Observación Geodésico Global”
[Global Geodetic Observing System (GGOS)]
de la Asociación Internacional de Geodesia (IAG)

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Resumen

La nueva estructura de la Asociación Internacional de Geodesia (IAG) incluye un proyecto central, que sirve como insignia de la asociación. En julio de 2003 se aprobó el proyecto “Global Geodetic Observing System” (GGOS) en esta función. GGOS tiene dos objetivos generales, la coordinación interna de las actividades geodésicas y la representación externa de la geodesia ante los cuerpos científicos, políticos y sociales en el mundo. La coordinación incluye la integración de todas las observaciones geométricas y gravimétricas usando constantes, estandares y parametros compatibles, y la generación de productos consistentes para sistemas de referencia, rotación y campo de la gravedad. La representación externa debe hacer mas conocido la disciplina de la geodesia en la política y en la sociedad. La estructura del proyecto se estableció en los principios del año 2004.
The International Association of Geodesy

The International Association of Geodesy (IAG) is a scientific organization within the International Union of Geodesy and Geophysics (IUGG) under the umbrella of the International Council for Science (ICSU).

The mission of IAG is the advancement of geodesy as an Earth science including the study of the planets and their satellites. It is structured into four **Commissions** and twelve **Services** for fundamental and applied research and the generation of relevant products in support of science and society.

The **Global Geodetic Observing System (GGOS)** serves as a flagship of IAG to coordinate the geodetic research work and to represent geodesy in other sciences and in society.
The International Association of Geodesy

Commissions

1 Reference Frames
Pres.: H. Drewes

2 Gravity Field
Pres.: C. Jekeli

3 Geodynamics
Pres.: V. Dehant

4 Applications
Pres.: C. Rizos

Inter-Commission-Committees

Theory, Pres.: P. Xu

Planetary Geodesy, Pres.: D. Smith

Services

IERS
J. Vondrak

IGS
J. Dow

IVS
W. Schlüter

IGFS
R. Forsberg

IGeS
F. Sanso

PSMSL
P.L. Woodworth

ILRS
W. Gurtner

IDS
G. Tavernier

BGI
J.-P. Barriot

ICET
B. Ducarme

BIPM
E.F. Arias

IBS
A. Korth

Association Project

Global Geodetic Observing System (GGOS), Pres.: C. Reigber
The Vision of GGOS (1)

- GGOS integrates different techniques, different models and different approaches in order to achieve better consistency, long-term reliability and understanding of geodetic, geodynamic and global change processes.

- GGOS provides the scientific and infrastructure basis for all the global change research in Earth sciences.
The Vision of GGOS (2)

Provide products as the basis for science and practice.

Consistent parameter estimation.

Integration of geodetic observation techniques.

Geodynamics, Global Change, Navigation, GIS, Engineering, ...

Geometry
Orientation
Earth gravity field

Geometric
Gravimetric
The Mission of GGOS (1)

- To collect, archive and ensure accessibility of geodetic observations and models;
- To ensure the robustness of the three fields of geodesy:
  - Geometry and kinematics
  - Earth orientation and rotation
  - Gravity field and its variability
The Mission of GGOS (2)

➢ To *identify geodetic products* and to establish the requirements concerning its *accuracy, time resolution, and consistency*;

Product examples:

- **Identify products**: What is needed in geodesy, science and society?
- **Accuracy**: $10^{-9}$ or better for all kinds of GGOS products;
- **Time resolution**: Depending on products from hours to decades;
- **Consistency**: Use of compatible standards, models, parameters.
The Mission of GGOS (3)

➢ To identify service gaps and develop strategies to close them;
➢ To stimulate close cooperation between IAG services;

Examples of IAG service gaps:
• Unified global height reference system (global vertical datum),
• Vertical deformation models (tectonic, isostatic, loading, ... ),
• Global sea level monitoring (satellite altimetry service),
• Free availability of terrestrial gravity data.

Examples of the necessity of close cooperation of services:
• To use identical standards, models and parameters;
• To generate compatible products (time intervals, reliability, ...);
• To coordinate common research in fields of mutual interest.
The Mission of GGOS (4)

- To promote and improve the visibility of geodetic research:
  → Let people know that it’s geodesy that provides the basis for space research, navigation, engineering, cadastre, global spatial data infrastructure, rural and urban development, ...
  → Disseminate information by publishing in popular literature.

- To achieve maximum benefit for the scientific community and for society in general.
  → Exchange data and information with geosciences and other sciences in an easily understandable way;
  → Provide policy makers and publicists with the necessary information for their decisions and reports.
The Objectives of GGOS (1)

1. Coordination within geodesy

- GGOS aims at maintaining the stability of time series of geometric and gravimetric reference frames;
- GGOS ensures the consistency between the different geodetic standards used in the geo-scientific community;
- GGOS aims at improving the geodetic models at the level required by the observations;
- GGOS focuses on all aspects to ensure the consistency of geometric and gravimetric products.
The Objectives of GGOS (1a)

→ Time series of geometric and gravimetric reference frames:
  • Coordinates of extragalactic radio sources: ICRFyy
  • Terrestrial station positions and velocities: ITRFyy
  • Earth rotation parameters: precession, nutation, UT1, polar motion
  • CHAMP, GRACE gravity field models: EIGENii, GGMjj
  • Tide gauge records with vertical control by GPS: PSMSL, TIGA

Arequipa (Peru) earthquake 2001

Buenaventura (Colombia) tide gauge
The Objectives of GGOS (1b)

→ Examples of inconsistencies in *standards, models, products*:

<table>
<thead>
<tr>
<th>geometric</th>
<th>gravimetric</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Definition</strong> of origin:</td>
<td>centre of network</td>
</tr>
<tr>
<td>$X_0, Y_0, Z_0$</td>
<td>centre of mass</td>
</tr>
<tr>
<td>... of orientation:</td>
<td>rotation axis</td>
</tr>
<tr>
<td>$X_P, Y_P, \Delta UT$</td>
<td>axis of inertia</td>
</tr>
<tr>
<td>... of scale:</td>
<td>$C_{10}, C_{11}, S_{11}$</td>
</tr>
<tr>
<td>$c$</td>
<td>$C_{12}, S_{12}$</td>
</tr>
<tr>
<td><strong>Models</strong> for tides:</td>
<td>tide free</td>
</tr>
<tr>
<td>... for deformation:</td>
<td>geometric only</td>
</tr>
<tr>
<td><strong>Product</strong> reference:</td>
<td>ITRF, GRS80</td>
</tr>
<tr>
<td>... update:</td>
<td>regularly</td>
</tr>
<tr>
<td></td>
<td>episodic</td>
</tr>
</tbody>
</table>
The Objectives of GGOS (2a)

2. Representation of geodesy in international bodies

- GGOS shall be established as an official partner in the United Nations‘ Integrated Global Observing Strategy (IGOS).

- IGOS is a strategic planning process that links research, long-term monitoring and operational programmes in a framework for decisions and resource allocation providing governments with information for decision-making.

- IGOS is developed by a partnership including the:
  - Committee on Earth Observation Satellites (CEOS)
  - World Climate Research Programme (WCRP)
  - Int. Group of Funding Agencies for Global Change (IGFA)
  - International agencies sponsoring global observations
  - Global Observing Systems (G3OS): GCOS, GOOS, GTOS
The Objectives of GGOS (2b)

- IAG has become a participating organization in the intergovernmental ad-hoc Group on Earth Observations (GEO).

→ GEO was established by a declaration of 33 nations plus the European Commission during the Earth Observation Summit held in Washington, DC, on July 31, 2003.

→ It signifies the political commitment to move toward the development of a comprehensive, coordinated, and sustained Earth observation system(s).

→ GEO will seek in its work to
  - improve coordination of strategies for Earth observations,
  - to involve and assist developing countries,
  - exchange in situ, aircraft, and satellite observations,
  - prepare a 10-year implementation plan.
The Scientific Rationale of GGOS

GGOS shall have the *central theme*

“Global deformation and mass exchange processes in the System Earth“

which includes all the activities of GGOS in the future:

- Global effects caused by geodynamics; quantification of angular momentum exchange and mass balance in the system Earth;
- Global pattern of all kind of deformation of geodynamic as well as of anthropogenic origin on land, ice covers, and of sea level, in particular due to the mass transfer between solid Earth, atmosphere, and hydrosphere (including ice covers).
Geodesy in Earth System Research (1)

Geodesy is capable of providing information on the mass exchange between all elements (components) of the Earth’s system by observing:

- deformation of the solid Earth (geometry and kinematics);
- water circulation in oceans, ice covers, atmosphere, solid Earth (satellite radar and laser altimetry, atmospheric sounding, gravity);
- mass exchange between the atmosphere, the hydrosphere and the biosphere (variations of Earth rotation and gravity field).
Geodesy in Earth System Research (2)

Geometry (positioning)  Earth rotation  Gravity field

Solid Earth  Atmosphere  Hydrosphere
Variation of Earth Rotation

Effects on the Entire Body of the Earth

Source: Lambeck 1988
Effects on the Solid Earth (Geosphere) (1)

Plate tectonics and crustal deformation
Effects on the Solid Earth (Geosphere) (2)

Plate tectonics and crustal deformation
Effects on the Solid Earth (Geosphere) (3)

Plate tectonics and crustal deformation

[Diagram showing earthquake locations and displacement vectors near Manzanillo with GPS week and cm measurements, and earthquake data such as dates, magnitudes, and distances.]
Effects on the Oceans

Sea Level Changes from Satellite Altimetry (Bosch 2003)
Effects on the Atmosphere

GPS Atmosphere Sounding
(Integrated Water Vapour)

Source: http://www.gfz-potsdam.de
Effects on the Hydrosphere
Geodesy is capable of observing the complete water cycle

Continents: Gravity Field Missions

Atmosphere: GPS Sounding

Oceans: Satellite Altimetry
CHAMP/GRACE Gravity Field Missions

http://www.utexas.edu

http://www.gfz-potsdam.de
The Present Structure of GGOS

- GGOS Project Board and Steering Committee
  - Chair: Ch. Reigber
  - Secretary: H. Drewes

- IAG Services & Commissions

- WG on Services’ Synergies (W. Gurtner)

- WG on Strategy and Funding (Ch. Reigber)

- Working Groups
  - Copyright, Data Access Policy, Publishing, Certification (H.-P. Plag)
  - Data and Info Systems (R. Neilan)
  - Infrastructure: Networks, Communication (M. Pearlman)
  - User Linkage: Science, Industry, Authorities, Outreach (B. Engen)
Conclusion

There are two principal aspects in the mission of GGOS:

1. **“Internally“**
   To guarantee the reliability of geodetic products by ensuring the consistency of standards, parameters, models and reference systems used in the three fields of geodesy: Earth geometry, Earth orientation, and Earth gravity field.

2. **“Externally“**
   To promote and improve the visibility of geodetic research and results, to represent geodesy in international bodies, and to achieve maximum benefit for the scientific community and for society in general.