The GGOS Bureau of Products and Standards

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(3) German Aerospace Centre (DLR), Germany

Joint SIRGAS / GGOS Session, November 12, 2019, Rio de Janeiro, Brazil
Overview

Data
- Point positioning
- Surface scanning
- Gravity measurements

Analysis
- Standards and Models
- Analysis Centres
- Combination Centres

Products
- Geometry & kinematics
- Earth rotation
- Gravity field

Geodetic Reference Frames
IAG‘s Global Geodetic Observing System (GGOS)

Integration of the geodetic observation techniques

[Deutsches Geodätisches Forschungsinstitut (DGFI-TUM) | Technische Universität München]
GGOS Organizational Structure

GGOS is built upon the foundation provided by the IAG Services, Commissions, and Inter-Commission Committees.
GGOS Bureau of Products and Standards (BPS)

The BPS supports GGOS in its key goal to obtain consistent products describing the geometry, rotation and gravity field of the Earth.

Objectives
- contact & coordinating point for homogenization of IAG standards and products
- keep track of the adopted geodetic standards and conventions across all IAG components, and initiate steps to close gaps and deficiencies
- integrate geometric and gravimetric parameters
- develop new geodetic products, needed for Earth sciences and society

Compiled with GMT
BPS Organizational Structure

- The BPS is hosted at Technical University of Munich
- BPS staff:
  - D. Angermann (Director), T. Gruber (Deputy Director), M. Gerstl, R. Heinkelmann (GFZ), U. Hugentobler, L. Sánchez, P. Steigenberger (DLR)
- Entities associated to the BPS
  - Committee “Earth System Modelling” (Chair: M. Thomas)
  - Committee “Essential Geodetic Variables (EGVs)” (Chair: R. Gross)
  - WG “ITRS Standards for ISO TC 211” (Chair: C. Boucher), dissolved because work has been completed
  - JWG “Establishment of the Global Geodetic Reference Frame (GGRF)” (Chair: U. Marti), setup of a continuation WG in progress
- Associated members of the BPS:
  - ~ 25 representatives designated by the IAG Services and other relevant entities involved in standards and geodetic products
## Representatives of IAG Services and other entities

<table>
<thead>
<tr>
<th>Position (IAG Service, other entity)</th>
<th>Representatives</th>
<th>Affiliation, Country</th>
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</thead>
<tbody>
<tr>
<td>IERS Conventions Center</td>
<td>Gérard Petit (until 2016) Br. Stamatakos (since 2017) Thomas Herring R. Heinkelmann (since 2019, BPS) Urs Hugentobler (BPS staff) Erricos Pavlis John Gipson Frank Lemoine, John Ries, Jean-M. Lemoine, H. Capdeville</td>
<td>BIPM (France) USNO (USA) MIT (USA) GFZ (Germany) TUM (Germany) UMBC/NASA (USA) GSFC/NASA (USA) GSFC/CSR (USA) CNES/GRGS (France)</td>
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<td>IERS Analysis Coordinator</td>
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<td>IVS Analysis Coordinator</td>
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<td>IGFS Chair</td>
<td>Riccardo Barzaghi Sylvain Bonvalot Mirko Reguzzoni Franz Barthelmes (until 2017) E. Sinem Ince (since 2018)</td>
<td>Politec. Milano (Italy) IRD (France) Politec. Milano (Italy) GFZ (Germany) GFZ (Germany) ESRI (USA) BKG (Germany)</td>
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<td>BGI Chair</td>
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<td>ISG President</td>
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<td>ICGEM Chair</td>
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<td>IDEMS Director</td>
<td>Kevin M. Kelly Hartmut Wziontek</td>
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<tr>
<td>Gravity Comm. (corresp. Member)</td>
<td>Jürgen Kusche Johannes Ihde (until 2017) Detlef Angermann (since 2018) Josef Ádám Catherine Hohenkerk (until 2018) James L. Hilton (since 2018) Robert Heinkelmann (BPS staff) Michael Craymer (Chair) Larry Hothem (Vice Chair)</td>
<td>Univ. Bonn (Germany) BKG, GFZ (Germany) TUM (Germany) Univ. Budapest (Hungary) United Kingdom USNO (USA) GFZ (Germany) NRCan (Canada) USA</td>
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<td>IAG Representative to ISO</td>
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<td>IAG Communication and Outreach</td>
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<td>IAU Commission A3 Representative</td>
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<td>Control Body for ISO Geodetic Registry</td>
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BPS inventory of standards and conventions

- Inventory of standards and conventions used for the generation of IAG products (published in IAG Geodesists Handbook 2016, see below)
  - Assessment of the present status
  - Identification of gaps
  - Provision of recommendations (interaction with IAG Components)

- 2nd version of the BPS inventory almost finalized, updates on:
  - IAG/GGOS Structure
  - General issues and numerical standards
  - ICRF2 → ICRF3
  - ITRF2008 → ITRF2014
  - EOP08C04 → EOP14C04
  - GNSS orbits, IGFS activities, Height Systems

- 2nd version will be published online at the GGOS Website (Januar 2020)

Numerical standards used within IAG

<table>
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<tr>
<th></th>
<th>semi-major axis $a$ [m]</th>
<th>Geocentric Grav. Constant $GM$ [$10^{12} \text{m}^3\text{s}^{-2}$]</th>
<th>Dyn. form factor $J_2$ [$10^{-6}$]</th>
<th>Earth’s rotation $\omega$ [rad s$^{-1}$]</th>
<th>Normal potential $U_0$ or $W_0$ [m$^2$s$^{-2}$]</th>
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<tbody>
<tr>
<td>GRS80 (1979)</td>
<td>6 378 137</td>
<td>398.600 5</td>
<td>1 082.63</td>
<td>7.292 115</td>
<td>62 636 860.850</td>
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<tr>
<td>EGM2008</td>
<td>6 378 136.3</td>
<td>398.600 4415$^{(1)}$</td>
<td>1 082.635 9</td>
<td>7.292 115</td>
<td>62 636 856.0 (1998)</td>
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</table>

$^{(1)}$TT-compatible value; $^{(2)}$value given in zero-tide system; $^{(3)}$TCG-compatible value

- **GRS80** (still) provides the **conventional values** (IUGG 1979 / IAG 1980)
- The geodetic work is based on **different numerical standards** (e.g., GRS80 values, IERS Conventions, standards used for gravity and altimetry)
- Thus, a unique and consistent set of numerical standards **does not exist within IAG**, moreover different time and tide systems are in use within geodesy

**BPS recommendations on numerical standards**

- **REC 1**: The used numerical standards including time and tide systems must be clearly documented for all geodetic products.
- **REC 2**: The $W_0$ value issued by the IAG resolution No. 1 (2015) should be used as the conventional reference value for geodetic work.
- **REC 3**: The development of a new Geodetic Reference System GRS20XX based on best estimates of the major parameters is desired.
Review of IERS products

- BPS inventory provides 3-4 recommendations for each product
- Three general recommendations for IERS products:
  - Consistency of CRF, TRF and EOP (IUGG Res. 2011, IAG Res. 2019)
  - Processing standards should be consistently applied by all ACs
  - Core networks and co-locations need to be further improved
- Ongoing activities of the technique-specific IAG Services and the IERS
- IAU is involved concerning the celestial reference system and frame
Gravity-related products

- The IGFS Central Bureau (igfs.topo.auth.gr) provides a new updated IGFS webpage, including a dedicated products portal and metadata information (e.g., geoid, GGMs, DEM, SG, tide data)
- Many static and temporal gravity field models are available at the ICGEM website, open access of data products, DOI for data sets
- A conventional GGM (as official IAG product) may be useful, this issue is under discussion within the IGFS
- Combination Service for Time-variable Gravity Field Solutions (COST-G)
- Developments on the unification of height systems (GGOS Focus Area “Unified Height System”, Chair: L. Sánchez)
International Centre for Global Earth Models

Global Gravity Field Models

We kindly ask the authors of the models to check the links to the original websites of the models from time to time. Please let us know if something has changed.

The table can be interactively re-sorted by clicking on the column header fields (Nr, Model, Year, Degree, Data, Reference).

In the data column, the datasets used in the development of the models are summarized, where $S$ is for satellite (e.g., GRACE, GOCE, LAGEOS), $A$ is for altimetry, and $G$ for ground data (e.g., terrestrial, shipborne and airborne measurements).

The links calculate and show in the last columns of the table directly invoke the Calculation Service and Visualization page for the selected model. For models with a registered doi (“digital object identifier”) the last column contains the symbol ✓, which directly opens the page on “http://dx.doi.org”.

If you click on the reference, the complete list of references can be seen.

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<th>Nr</th>
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<th>Year</th>
<th>Degree</th>
<th>Data</th>
<th>References</th>
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<th>Calculate</th>
<th>Show</th>
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<td>300</td>
<td>S</td>
<td>Lemoine et al, 2019</td>
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</table>

The satellite-only gravity field model GOCO06s

Cite as:

Kvas, Andreas; Mayer-Gürr, Torsten; Krauss, Sandro; Brockmann, Jan Martin; Schubert, Till; Schuh, Wolf-Dieter; Pail, Roland; Gruber, Thomas; Jäggi, Adrian; Meyer, Ulrich (2019): The satellite-only gravity field model GOCO06s. GFZ Data Services. http://doi.org/10.5880/ICGEM.2019.002
UN GGIM Subcommittee on Geodesy (SCoG)

Working Group **Data sharing and development of standards**

- **12 members** (Australia, Canada, Germany, Jamaica, Kyrgyzstan, New Zealand, USA)
- Chair: M. Craymer (Canada)
- IAG Representative: D. Angermann (Germany)
- GGRF Road Map Implementation Plan was provided to the UN-GGIM Committee of Experts
- Three **recommendations** were provided:
  1. More open share data, standard operating procedures, expertise, and technology
  2. Resolve concerns that currently limit data sharing
  3. Support common standards and make them openly available
Committee on Essential Geodetic Variables (EGVs)

- The Committee on Essential Geodetic Variables (EGVs) has been established in 2018, associated to the BPS (Chair: R. Gross)
- It comprises the members of the GGOS Science Panel, Representatives of the IAG Services and GGOS
- Within the Group on Earth Observations (GEO), the Global Ocean Observing System (GOOS) and Global Climate Observing System (GCOS) have defined Essential Ocean and Climate Variables (EOVs/ECVs)

Essential Climate Variables (ECV)
- Atmospheric (air temperature, water vapour, pressure, …)
- Oceanic (sea-surface temperature, sea level, sea ice, …)
- Terrestrial (river discharge, ground water, glaciers and ice caps, …)

- Examples of EGVs: position of reference objects (e.g., ground stations, radio sources), EOPs, ground- and space-based gravity observations, …
- Such EGVs could then serve as a basis for a gap analysis to identify requirements concerning observations, networks and products
Committee on Essential Geodetic Variables (EGVs)

GGOS
Detlef Angermann (Germany)
Richard Gross, Chair (USA)
Harald Schuh (Germany)

GGOS Focus Area 1
(Unified Height System)
Bernhard Heck (Germany)

GGOS Focus Area 2
(Geohazards Monitoring)
Diego Melgar (USA)

GGOS Focus Area 3
(Sea Level Change)
Don Chambers (USA)

GGOS Focus Area 4
(Space Weather)
Ehsan Forootan (UK)

IAG Commission 1
Markus Rothacher (Switzerland)
Geoffrey Blewitt (USA)

IAG Commission 2
Kosuke Heki (Japan)
Thomas Gruber (Germany)

IAG Commission 3
Jianli Chen (USA)
Jose Ferrandiz (Spain)

IAG Commission 4
Jens Wickert (Germany)
Pawel Wielgosz (Poland)

IAG ICC Theory
Yoshiyuki Tanaka (Japan)
Mattia Crespi (Italy)

IERS
Tom Herring (USA)

IGS
Tom Herring (USA)
Michael Moore (Australia)

ILRS
Erricos Pavlis (USA)
Jürgen Müller (Germany)

IVS
John Gipson (USA)
Johannes Böhm (Austria)

IDS
Laurent Soudarin (France)
Jean-Michel Lemoine (France)

IGFS
Urs Marti (Switzerland)
Georgios Vergos (Greece)

BGI
Sylvain Bonvalot (France)

ICGEM
E. Sinem Ince (Germany)

ISG
Jianliang Huang (Canada)

IGETS
Hartmut Wziontek (Germany)
Jean-Paul Boy (France)

IDEMS
Christian Hirt (Germany)
Michael Kuhn (Australia)

PSMSL
Svetlana Jevrejeva (UK)

BIPM
none

Total: 35
Ongoing activities and planned actions

- to continue the work regarding standards and conventions, interaction with IAG components, and other entities involved
- to contribute to the re-writing/revising of the IERS Conventions, BPS Director has been nominated as Chapter Expert for Chapter 1 „General definitions and numerical standards“
- to focus on the integration of geometric and gravimetric observations and to support the development of integrated products (e.g., GGRF, IHRF, atmosphere products)
- to interact with external stakeholders (e.g., ISO, IAU, UN-GGIM, …)
- to contribute to the UN GGIM Subcommittee on Geodesy (SCoG), IAG representation in GGRF Working Group Data Sharing and Development of Geodetic Standards
- to contribute to the Committee on Essential Geodetic Variables (EGVs)
- to compile a new BPS Implementation Plan for the next 4 years