

Bureau of Products and Standards Implementation Plan 2020-2022

1 IMPLEMENTATION OVERVIEW

1.1 Introduction

The Bureau of Products and Standards (BPS) is a redefinition of the former Bureau for Standards and Conventions, which was established as a GGOS component in 2009. This redefinition is a consequence of a restructure of the GGOS organization in 2014. The work of the BPS is primarily focused on the IAG Services and the products they derive on an operational basis for Earth monitoring making use of various space geodetic observation techniques such as VLBI, SLR/LLR, GNSS, DORIS, altimetry, gravity satellite missions, gravimetry, etc. The Bureau is built upon existing observing and processing systems of the IAG. It supports the IAG in its goal to obtain products of highest possible accuracy, consistency, and temporal and spatial resolution, which should refer to a consistent reference frame, stable over decades in time. To achieve this essential goal, it is a fundamental requirement that common standards and conventions are used by all IAG components for the analysis of the different geometric and gravimetric observations. The BPS also concentrates on the integration of geometric and gravimetric parameters and the development of new products, required to address important geophysical questions and societal needs.

Charter of the Bureau of Products and Standards:

The main purpose of the BPS is to keep track of adopted geodetic standards and conventions across all IAG components as a fundamental basis for the generation of consistent geometric and gravimetric products. The BPS shall act as contact and coordinating point regarding homogenization of standards and IAG products. The IAG Services shall keep their full responsibility.

More specifically the charter of the BPS may be divided into two major topics/activities:

- (1) **Standards:** A key objective is the compilation of an inventory regarding standards and conventions adopted by IAG and its components. This includes an assessment of the present status, the identification of gaps and shortcomings concerning geodetic standards and the generation of the IAG products, as well as the provision of recommendations. It is obvious that such an inventory needs to be regularly updated since the IAG standards and products are continuously evolving. The BPS shall also propose the adoption of new standards where necessary and propagate standards and conventions to the wider scientific community and promote their use. In this context, the BPS recommends the development of a new Geodetic Reference System GRS20XX based on the best estimates of the major parameters related to a geocentric level ellipsoid.
- (2) **Products:** The BPS shall take over a coordinating role regarding the homogenization of standards and geodetic products. The present status regarding IAG Service products shall be evaluated, including analysis and combination procedures, accuracy assessment with respect to GGOS requirements, documentation and metadata information for IAG products. The Bureau shall initiate steps to identify user needs and requirements for geodetic products and shall contribute to develop new and integrated products. The BPS shall also contribute to the development of the GGOS Portal (as central access point for geodetic products), to ensure interoperability with IAG

Service data products and external portals (e.g., GEO, Copernicus, EOSDIS, EPOS, GFZ Data Services).

1.2 Goals and Objectives

The role of the Bureau is to provide a forum for the IAG Services and other entities involved in standards and products. In this context, the BPS shall act as contact and coordinating point to share and discuss plans and progress, and to develop and monitor multi-entity efforts to address GGOS requirements.

Primary objectives:

- (1) The BPS shall ensure that common standards and conventions are implemented and adopted by all IAG components as a fundamental basis for the generation of consistent IAG products.
- (2) The BPS shall act as contact and coordinating point for the IAG Services regarding homogenization of standards and products, whereas the IAG Services shall keep their full responsibility and visibility to manage their supporting data, products and information systems.
- (3) The BPS shall take over a coordinating role and shall define procedures to ensure an overall efficient use of resources. The primary focus of the BPS shall be on existing geodetic products and on the development of new products to meet the needs of scientific users and society in general.

The BPS also contributes to various objectives of the GGOS goals 1 and 2 of the strategic plan (see Table 1.2-1). These objectives are under the major responsibility of other GGOS entities. Thus, they are considered as secondary objectives of the BPS (see implementation plans of the respective GGOS entities).

Table 1.2-1: Bureau of Products and Standards (BPS): Goals and Objectives Mapping (primary (√√) and secondary (√) goals). Please note that this table has been taken from the GGOS strategic plan 2014 and it will be updated according to the next GGOS strategic plan. This holds in particular for the wording of Objective 3.2, which needs to be reformulated.

	Goal 1 – Geodetic Information and Expertise			Goal 2 – Global Geodetic Infrastructure		Goal 3 – Services, Standardization, and Support		Goal 4 – Communication, Education, and Outreach	
	Objective 1-1 – Understand societal and scientific needs and deficiencies	Objective 1-2 – Position GGOS as the primary source for geodetic information and expertise	Objective 1-3 – Connect with the larger scientific community and integrate with other Earth observing	Objective 2-1 – Support and advocacy for infrastructure and associated elements	Objective 2-2 – Lead efforts for the integration of various ground observation networks within the GGOS network	Objective 3-1 – Standardization	Objective 3-2 – Coordination and Development of IAG Services	Objective 4-1 – Establish a Strong Internet/Online Presence	Objective 4-2 – Outreach to the Technical Community and General Society
Coordinating Board	√√	√√	√	√	√	√	√	√	√
Consortium	√	√	√√	√	√	√	√√		√
Coordinating Office	√	√	√	√	√	√	√	√√	√√
Bureau of N&O			√	√√	√√		√		
Bureau of P&S	√	√	√	√		√√	√√		
Science Panel	√√	√	√√				√		√

1.3 BPS Authority, Governance Structure, Management Structure, and Implementation Approach

1.3.1 BPS Authority

The BPS shall take over the responsibility to define the policies and procedures for the management and coordination activities as well as for the other tasks specified in its charter. Besides the BPS staff, the Bureau also includes the chairs of the associated GGOS entities (the two Committees, see Section 1.3.3 and appendix D) as well as the nominated representatives of the IAG Services and other entities involved in standards and conventions (see Tab. 1.3.1) to formulate the tasks and to design the necessary procedures in the field of standards and geodetic products.

The Bureau is authorized to conduct its management and coordination tasks as given in this implementation plan. This includes the specification of tasks and a time schedule for the BPS activities. The BPS is also responsible to setup procedures to measure the progress of the work with respect to the implementation plan and to undertake actions to resolve potential deficiencies. The overall procedures for the operation of the Bureau activities including the interactions with the contributing components shall be managed in an efficient way to avoid an overload of bureaucracy.

Concerning the interactions between the different GGOS components, the authorities and responsibilities should be defined in the overall GGOS framework and coordinated by the GGOS Coordinating Office. The GGOS Coordinating Board acts as central oversight and decision-making body. If actions and decisions have to be taken that involve entities outside GGOS such as the IAG Services, their respective governing bodies and for general issues also the IAG Executive Committee should be consulted prior to execution.

1.3.2 Governance Structure

The governance structure is specified in the GGOS Coordinating Office Implementation Plan.

1.3.3 Management Structure

ALLOCATION AND DISTRIBUTION OF RESOURCES

The basic configuration of resources (man-power) for the BPS is composed by the staff members of Deutsches Geodätisches Forschungsinstitut, Technische Universität München (DGFI-TUM), and the Ingenieurinstitut für Astronomische und Physikalische Geodäsie (IAPG), Technical University Munich, within the Forschungsgruppe Satellitengeodäsie (FGS). This consortium includes in addition the Bundesamt für Kartographie und Geodäsie (BKG), Frankfurt am Main, and the Institut für Geodäsie und Geoinformation (IGG) of the University Bonn.

The present BPS staff members are Detlef Angermann (director), Thomas Gruber (deputy director), Michael Gerstl, Urs Hugentobler and Laura Sánchez (all from Technical University Munich), as well as Robert Heinkelmann (GFZ German Research Centre for Geosciences Potsdam) and Peter Steigenberger (German Aerospace Centre (DLR), Oberpfaffenhofen).

In its current structure, the following GGOS entities are associated with the BPS:

- Committee “Contributions to Earth System Modelling” (Chair: Maik Thomas)
- Committee “Definition of Essential Geodetic Variables (EGVs)” (Chair: Richard Gross)
- Working Group “Towards a consistent set of parameters for the definition of a new GRS establishment of the GGRF” (Chair: Urs Marti)

According to its charter, the work of the BPS requires a close interaction with the IAG Analysis and Combination Centers regarding the homogenization of standards and products. The IAG Services and the other entities involved in standards and geodetic products nominate their representatives to the BPS and they are associated members of the BPS.

The Bureau comprises the staff members, the chairs of the associated GGOS components (the two committees and the working group as listed above) as well as the representatives of the IAG Services and other entities involved in standards (see Tab. 1.3-1). Regarding the development of standards, there is a direct link with the IERS Conventions Center, the IAU, BIPM, CODATA, ISO, and the UN-GGIM Subcommittee on Geodesy.

The GGOS Committees “Contributions to Earth System Modelling” and “Definition of Essential Geodetic Variables (EGVs)” as well as the Working Group “Towards a consistent set of parameters for the definition of a new GRS” have formulated a charter and work plan, which are included in this implementation plan (see Appendix D).

OVERSEEING AND COORDINATING THE DAY-TO-DAY OPERATIONS

Together with the associated GGOS entities, the BPS will develop a task plan and define/setup procedures to oversee and coordinate day-to-day operations. The staff members of the BPS will arrange face-to-face meetings on a very flexible basis due to short distances. Other communication tools are telecons, e-mails and phone calls to coordinate the day-to-day operations, the monitoring of the schedule as well as a redefinition of tasks and responsibilities in case of need.

REPORTING OF TECHNICAL AND/OR SCIENTIFIC PROGRESS AND CONFIGURATION MANAGEMENT

The reporting of technical and/or scientific progress against schedule, as well as alignment of this progress is part of the communication plan (see Table 1.3-2). The coordination and management among all GGOS entities is given in the implementation plan of the GGOS Coordinating Office.

Table 1.3-1: Resources of the BPS.

Position	Resource	Entity Contributing
BPS Director, Co-Director	Detlef Angermann, Thomas Gruber	DGFI, IAPG (both TUM)
BPS Team Geometry, TRF, satellite orbits Earth rotation, CRF Gravity, height systems	Detlef Angermann, Urs Hugentobler, Peter Steigenberger Michael Gerstl, Robert Heinkelmann Thomas Gruber, Laura Sánchez	TUM + GFZ, DLR/GSOC
Committee “Contributions to Earth System Modeling“	Chair: Maik Thomas	GFZ (Germany)
Committee “Definition of Essential Geodetic Variables (EGVs)“	Chair: Richard Gross	NASA/JPL (USA)
JWG “Towards a consistent set of parameters for the definition of a new GRS”	Chair: Urs Marti	Swisstopo (Switzerland)
IERS Conventions Centre	Director: Nick Stamatakos	USNO (USA)
IERS Analysis Coordinator	Tom Herring (former IERS AC)	MIT (USA)
IGS Representative	Urs Hugentobler (BPS staff member)	FESG/TUM (Germany)
ILRS Analysis Coordinator	Erricos Pavlis	UMBC/NASA (USA)
IVS Analysis Coordinator	John Gipson	GSFC/NASA (USA)
IDS Representatives	Frank Lemoine, John Ries, Jean-Michel Lemoine, Hugues Capdeville	GSFC, CSR (USA), CNES (France)
IGFS Chair	Riccardo Barzaghi	Politecnico, Milano (Italy)
BGI Chair	Sylvain Bonvalot	IRD (France)
ISG Chair	Mirko Reguzzoni	Politecnico, Milano (Italy)
ICGEM Chair	Franz Barthelmes	GFZ (Germany)
IDEMS Chair	Kevin M. Kelly	ESRI (USA)
IGETS Chair	Hartmut Wziontek	BKG (Germany)
Gravity community representative	Jürgen Kusche	Univ. Bonn (Germany)
IAG Representative to ISO/TC 211	Detlef Angermann (BPS staff)	DGFI-TUM (Germany)
IAU Commission A3	James L. Hilton	USNO (USA)
Chair of Control Body for ISO Geodetic Registry	Chair: Mike Craymer Vice-Chair: Larry Hothem	NRCan (Canada) USA

Table 1.3-2: BPS Communications Plan. The table identifies the communications requirements of the BPS

Communication Type	Purpose	Medium	Frequency	Audience	Owner	Deliverables
GGOS Consortium meeting	Interactions GGOS/IAG	Face-to-face or Online	Annually	Consortium members, invitees	GGOS President	Presentations, report of GGOS entities, minutes
GGOS CB meeting	Review status, strategic issues	Face-to-face or Online	Twice per year (EGU, GGOS Days)	CB members, invitees	GGOS President	Reports of GGOS entities, minutes
GGOS EC telecons	Discussion of day-to-day business	Telecons	Monthly	GGOS EC members	GGOS President	Minutes, action items
BPS staff member meetings (internal)	Management of BPS day-to-day business	Face-to-Face in Munich or Online	Every 2-3 months	BPS staff members	BPS Director	Minutes, action items
Reports of BPS and associated entities	Monitoring progress	n/a	Twice per year	Bureau Board members and invitees	BPS Director	Progress reports, minutes, action items
BPS meetings	Manage BPS business	Face-to-face or telecons	Varying	Entity members and invitees	BPS Director	Reports, minutes, action items

1.3.4 Implementation Approach

The Bureau comprises the BPS staff members, the chairs of the associated GGOS entities and the representatives of the IAG Services as well as other entities involved in standards. This configuration of the BPS ensures a close interaction among GGOS entities and IAG Services. A communication plan (see Tab. 1.3-2) has been defined and setup for a regular exchange of information. Regarding the development of standards, there is a direct link with the IERS Conventions Centre, the IAU, BIPM, CODATA, ISO, and the UN-GGIM Subcommittee on Geodesy. A link to the newly established UN-GGIM Global Geodetic Centre of Excellence (GGCE) will be established. The implementation approach of the BPS also considers user needs and requirements for geodetic products as well as the development of new products, which will require novel combination approaches. For these activities the BPS will bring together the existing resources of IAG Services, and should also involve other GGOS entities (e.g., the Focus Areas and the Science Panel). Concerning the requirements regarding infrastructure (e.g., space geodetic networks) there will be a close cooperation with the GGOS Bureau of Networks and Observations (BNO).

At present, we do not see any dependency on outside resources or approvals and also make-or-buy decisions and trade studies are not relevant for the BPS.

1.4 Stakeholder Definition

The stakeholder definition and advocacy strategies are overall tasks of GGOS (see implementation plans of the GGOS Coordinating Board and the GGOS Coordinating Office).

Table 1.4-1: BPS Stakeholders and Advocacy Strategies

STAKEHOLDERS	ADVOCACY STRATEGIES
INTERNAL STAKEHOLDERS	
GGOS Coordinating Board GGOS Coordinating Office GGOS Science Panel IAG Services	The advocacy strategies are specified in the implementation plan of the GGOS Coordinating Office (see also the communication plan given in Table 1.3-2).
EXTERNAL STAKEHOLDERS	
CEOS GEO Space Agencies United Nations Universities National Mapping and Geodetic Agencies IAU ISO CODATA UN-GGIM SCoG GGCE	The advocacy strategies are specified in the implementation plan of the GGOS Coordinating Office.

2 GGOS Bureau of Products and Standards Baselines

PROJECT BASELINES CONSIST OF A SET OF REQUIREMENTS:

The work of the BPS fundamentally depends on a long-term stable and adequate geodetic infrastructure, comprising, e.g., global terrestrial networks of observatories, Earth observing satellites, data infrastructure, analysis and combination centers of the IAG Services, as well as the GGOS Portal as central access point to IAG products. Regarding the infrastructural issues there is a close interaction with the GGOS Bureau of Networks and Observations.

TECHNICAL OR SCIENTIFIC CONTENT THAT FORMS THE BPS:

The major contribution of the BPS is to support IAG in its goal to provide highly accurate and consistent geodetic products based on unified standards and conventions. The Bureau should address the user needs and requirements for geodetic products and should contribute to develop new products from an integration of geometric and gravimetric observations.

EXECUTION AND REPORTING:

The BPS will regularly measure the progress of the work with respect to the activities and the schedule defined in the implementation plan and will report to the other GGOS entities and to IAG as specified in the GGOS communications plan.

2.1 Requirements Baseline

The requirements addressed in this baseline are those requirements of a technical nature that will require a technical verification and validation. They represent *“the high level activities that GGOS together with the IAG must ensure”* (GGOS 2020, p. 224). Other activities pursued in support of meeting objectives and their overarching goals are presented as part of Section 2.2 (Schedule Baseline). Table 2.1-1 shows only those requirements whose oversight has been allocated to the BPS—the totality of functional and operational requirements can be found in the Coordinating Board implementation plan. It also shows the allocation of those requirements to an IAG service or other entity. These requirements may be rewritten at a later stage to ensure they meet requirement definition standards.

There are the following general requirements:

- The BPS activities strongly depend on a stable geodetic infrastructure, including global terrestrial networks of observatories (Bureau of Networks and Observations), data infrastructure, analyses and combination centers providing IAG Service products.
- The Science Panel should support the BPS to assess the user requirements regarding existing products and the need for new products.

Table 2.1-1: BPS Requirement Allocation (Source: GGOS2020 Book, Chapter 7.7).

REQUIREMENT REFERENCE	REQUIREMENT AND INTERPRETATION	GGOS ALLOCATION	IAG SERVICE (OR OTHER ENTITY) ALLOCATION
Functional Specifications for GGOS			
Determination, maintenance, and access to the global terrestrial reference frame			
ITRF-001- DER	Provision of the reference frame through a dynamic Earth reference model — The terrestrial reference frame will be provided by an operational dynamical Earth reference model which will assimilate observations of variations in the Earth’s geometry (in particular, for a reference polyhedron), the shape of the ice and ocean surfaces, the gravity field, and Earth rotation. Moreover, the reference model will also assimilate auxiliary observations, in particular meteorological observations. This dynamic Earth reference model will allow the prediction of reference trajectories for any point on Earth with temporal resolution of 1 hour and a sub-kilometer spatial resolution. The stability of the model in terms of geokinematics will be that of the reference polyhedron, i.e., sub-millimeter per year.	BPS	IERS
ITRF-002- ORI	Tie between RFO and CM — The deviation between the reference frame origin of the terrestrial reference frame and the center of mass of the Earth system will be smaller than 1 mm at any time.	BPS	IERS
ITRF-003- PRE	Precision of reference coordinates — The precision of coordinates of the points of the reference polyhedron of the ITRF will be better than 1 mm in the horizontal and 3 mm in the vertical component at any time.	BPS	IERS
ITRF-004- SCA	Scale of the reference frame — The scale of the reference frame will be accurate to 0.1 ppb and stable to 0.01 ppb/yr.	BPS	IERS
Earth rotation			
ERP-001- EOP	Earth Orientation Parameters — Earth Orientation Parameters will be determined with an accuracy of 1 mm, a temporal resolution of 1 hour, and a latency of 1 week; near real-time determinations of the Earth Orientation Parameters will be determined with an accuracy of 3 mm.	BPS	IERS
Earth’s gravity field			
GRAV-001- GEOID	Accuracy of the static geoid — The static geoid will be provided with an accuracy of 1 mm, a long-term stability of 0.1 mm/yr and a spatial resolution of 10 km.	BPS	ISG

GRAV-002-VAR	Accuracy of the time variable gravity field — The time variable geoid will be provided with an accuracy of 1 mm, a long-term stability of 0.1 mm/yr, a spatial resolution of 50 km, a temporal resolution of 10 days, and a latency of 0.5 months.	BPS	IGFS
Earth system monitoring: mass transport and mass redistribution			
ESM-001-SSH	Sea surface height variations — The sea surface height variations will be determined globally with an instantaneous local accuracy of 10 mm, a temporal resolution of 10 days, a spatial resolution of 10 km, a latency of 5 days, and a local secular accuracy of 0.5 mm/yr.	BPS	PSMSL
ESM-001-GSL	Global sea surface changes — The globally average sea surface height changes will be determined with an instantaneous accuracy of 1 mm, a temporal resolution of 10 days, a latency of 10 days, and a secular accuracy of 0.1 mm/yr.	BPS	PSMSL
ESM-002-CRY	Cryosphere mass balance — The variations in the surface elevation for the large ice sheets will be determined with an instantaneous local accuracy of 20 mm, a temporal resolution of 10 days, a spatial resolution of 10 km, a latency of 20 days, and a local secular accuracy of 0.2 mm/yr.	BPS	PSMSL
ESM-003-WCY	Mass transport in the global water cycle — The mass transport in atmosphere, ocean, cryosphere, and terrestrial hydrosphere will be determined to an accuracy of an equivalent of 10 mm water cover with a temporal resolution of 10 days, a spatial resolution of 400 km, and a latency of 0.5 months.	BPS	PSMSL
Determination, maintenance, and access to the celestial reference frame			
ICRF-001-DET	Determination of the Celestial Reference Frame — The ICRF will be defined by the coordinates of a number of extragalactic radio sources distributed throughout the sky. The coordinates of the ICRF sources will be accurate to 25 microarcseconds and stable to 3 microarcseconds/yr.	BPS	IERS
Operational Specifications for GGOS			
GGOS-Ops-5	Operate a dynamic Earth reference model assimilating comprehensive observations of variations in Earth's geometry, gravity field and rotation.	BPS	TBD
GGOS-Ops-6	Document the procedures, standards, and conventions used to generate the products.	BPS	None
GGOS-Ops-8	Ensure continuity, accuracy, and consistency of observations and products as the networks and data reduction procedures evolve.	BPS	GGCE, IAG Services

2.2 Schedule Baseline

The scheduled activities of the Bureau of Products and Standards are shown in Fig. 2.2-1. The activities are divided into three main categories: Coordination activities, specific tasks of the BPS and outreach activities.

	2020												2021												2022												
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	
Strategic Planning Phases	for 2020-2022												for 2023-2024																								
Development Implementation Plan																																					
New Implementation Plan																																					
Communication & Coordination Activities																																					
EC Monthly Telecon	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
CB Semiannual Meetings (EGU, GGOS Days)				x												x												x									
Consortium Annual Meeting																																					
BPS Meetings (external)					x												x																				
BPS Meetings (internal)	x				x								x				x								x												
Specific Tasks - Products and Standards																																					
2nd version BPS inventory	←→																																				
Revision BPS inventory	←→																																				
Publication BPS inventory in Geodesist's HB																																					
Resolving deficiencies (with IAG Services)	←→																																				
Updating and extending BPS inventory	←→																																				
Classification and description of products	←→																																				
Gap analysis regarding products	←→																																				
Interaction with IAG Services	←→																																				
Interaction with IAU, UN-GGIM, GGCE, ISO, ...	←→																																				
Rewriting IERS Conventions (Chapter 1)	←→																																				
Submission revised Chapter 1 (to IERS CC)																																					
Outreach Activities																																					
BPS input for new GGOS website	←→																																				
Geodetic products for new GGOS website	←→																																				
BPS input for GGOS outreach material	←→																																				
Preparation UAW and GGOS Days 2021	←→																																				
Co-convenor of GGOS sessions	←→																																				
Publications and presentations	←→																																				

Fig. 2.2-1: Overview and schedule of BPS activities.

2.2.1 Coordination of BPS activities

Beside the coordination of the Bureau activities in the field of standards and geodetic products, the BPS also contributes to some general GGOS coordination activities (performed under the responsibility of the GGOS Coordination Office, see CO Implementation Plan). The coordination activities comprise the organization of internal Bureau meetings of the BPS staff members and (external) BPS meetings with the Board members and invitees. Furthermore, the work of the BPS requires a close interaction with the IAG Analysis and Combination Centers regarding the homogenization of geodetic products as well as with other entities involved in standards and conventions. Tab. 1.3-1 shows the associated members of the BPS, representing the IAG Services, IAU and other entities. The link to the IERS Conventions Center is strengthened by the nomination of the BPS director as Chapter Expert for Chapter 1 of the IERS Conventions “General definitions and numerical standards”. Furthermore, the nomination of the BPS director as the IAG representative to ISO/TC 211 and to the UN-GGIM GGRF Working Group “Data Sharing and Development of Geodetic Standards” ensures a link to ISO and UN-GGIM. Fig. 2.2-1 displays the schedule of the coordination activities.

2.2.2 Specific tasks of the BPS

The tasks of the BPS are to

- act as contact and coordinating point for homogenization of IAG standards and products;
- keep track of adopted geodetic standards and conventions across all IAG components, and initiate steps to close gaps and deficiencies;
- interact with external stakeholders in the field of standards and conventions (e.g., IAU, ISO, BIPM, CODATA, UN-GGIM, GGCE, ...);
- act as IAG representative to ISO/TC 211 and to the UN-GGIM GGRF Working Group “Data Sharing and Development of Geodetic Standards”;
- contribute to the UN GGIM Subcommittee on Geodesy (SCoG) and its newly established Global Geodetic Centre of Excellence (GGCE), mainly to the Working Group "Data Sharing and Development of Geodetic Standards";
- regularly update the inventory on standards and conventions used for the generation of IAG products to incorporate the latest developments in these fields;
- contribute to the re-writing/revising of the IERS Conventions, mainly in the function as Chapter Expert for Chapter 1 “General definitions and numerical standards“;
- focus on the integration of geometric and gravimetric observations, and to support the development of integrated products (e.g., GGRF, IHRF, atmosphere products);
- contribute to the Committee on the Definition of Essential Geodetic Variables (EGV), such EGVs could then serve as a basis for a gap analysis to identify requirements concerning observational properties and networks, accuracy, spatial and temporal resolution and latency;
- contribute to the newly established Working Group "Towards a consistent set of parameters for the definition of a new GRS";
- contribute to the GGOS DOI Working Group, focusing on Digital Object Identifier (DOI) for geodetic data and products to improve discoverability of data sets and to ensure that data providers receive proper credit for their published data.

Please note that most of these specific BPS tasks are long-term activities. Some of them are divided into sub-tasks (see Fig. 2.2-1).

The activities of the two associated GGOS Committees “Contributions to Earth System Modeling” and “Definition of Essential Geodetic Variables”, as well of the GGOS Working Group “Towards a consistent set of parameters for the definition of a new GRS” are provided in Appendix D.

2.2.3 Outreach activities

The BPS supports the outreach activities of the GGOS Coordinating Office (see CO Implementation Plan). This holds in particular for the design of the BPS contents and the products part as input for the new GGOS website as well as for contributions to other GGOS outreach material such as the GGOS brochure. Furthermore, the work of the BPS is presented at scientific conferences (e.g., IAG Symposia, EGU, AGU) and workshops (e.g. UAW, GGOS Days), and published in scientific journals. The BPS also supports the organization of GGOS sessions at scientific conferences.

2.3 Resources

The work force requirement for the activities of the BPS is estimated to be in the order of about one full-time position per calendar year, composed by the seven BPS staff members of DGFI-TUM, IAPG, FESG, GFZ and GSOC/DLR (see sect. 1.3.3) and by other representatives of the BPS (e.g., Committee and WG chairs, associated members).

Infrastructure requirements, including computer servers and other supporting technologies (e.g., for tele- or videoconferences) are provided by the host institutions.

3 CHANGE LOG

Table 3-1: GGOS Bureau of Products and Standards Implementation Plan Change Log

VERSION	RELEASE DATE	SYNOPSIS OF RELEASE
X.Y	[YYMMDD]	[Synopsis goes here]
1.0	140801	First draft version
2.0	150326	Second draft version for review of GGOS CB in Vienna (April 2015)
3.0	150528	Revised version (May 2015)
4.0	161019	Implementation Plan 2017-2018, first draft version, discussed during GGOS days 2016
5.0	170315	Implementation Plan 2017-2018, revised version
6.0	200918	Implementation Plan 2020-2022, first draft
7.0	210118	Implementation Plan 2020-2022, revised version

4 APPENDICES

Appendix A Abbreviation

BIPM	Bureau International de Poids et Mesures
BKG	Bundesamt für Kartographie und Geodäsie, Frankfurt/Main
BNO	Bureau of Networks and Observations
BPS	Bureau of Products and Standards
CB	Coordinating Board
CEOS	Committee on Earth Observations Satellites
CO	Coordinating Office
CODATA	Committee on Data for Science and Technology
CNES	Center National d'Etudes Spatiales
CRF	Celestial Reference Frame
DGFI-TUM	Deutsches Geodätisches Forschungsinstitut der Technischen Universität München
DLR	Deutsches Zentrum für Luft- und Raumfahrt
DOI	Digital Object Identifier
DORIS	Doppler Orbitography and Radiopositioning Integrated by Satellite
EC	Executive Committee
EGV	Essential Geodetic Variables
EOP	Earth Orientation Parameter
FESG	Forschungseinrichtung Satellitengeodäsie, Technische Universität München
FGS	Forschungsgruppe Satellitengeodäsie
GEO	Group on Earth Observation
GEOSS	Global Earth Observation System of Systems
GFZ	Helmholtz Centre Potsdam, German Research Centre for Geosciences
GGCE	Global Geodetic Centre of Excellence
GIAC	GGOS Interagency Committee
GGIM	Global Spatial Information Management
GGOS	Global Geodetic Observing System
GGRF	Global Geodetic Reference Frame
GNSS	Global Navigation Satellite System
IAG	International Association of Geodesy
IAPG	Institut für Astronomische und Physikalische Geodäsie, TU München
IAU	International Astronomical Union
ICRF	International Celestial Reference Frame
IDS	International DORIS Service
IERS	International Earth Rotation and Reference Systems Service
IGFS	International Gravity Field Service

IGG	Institut für Geodäsie und Geoinformation, Universität Bonn
IGS	International GNSS Service
ILRS	International Laser Ranging Service
ISO	International Organization for Standardization
ITRF	International Terrestrial Reference Frame
IVS	International VLBI Service for Geodesy and Astrometry
LLR	Lunar Laser Ranging
SCoG	Subcommittee on Geodesy (UN-GGIM)
SLR	Satellite Laser Ranging
TRF	Terrestrial Reference Frame
UN	United Nations
UN-GGIM	UN Committee on Experts on Global Geospatial Information Management
VLBI	Very Long Baseline Interferometry
WG	Working Group

Appendix B Glossary

Table B-1: Terms and Definitions

TERM	DEFINITION
[Term goes here]	[Definition goes here]

Appendix C References

ANGERMANN D., GRUBER T., GERSTL M., HEINKELMANN R., HUGENTOBLER, U., SÁNCHEZ L., STEIGENBERGER P.: GGOS BUREAU OF PRODUCTS AND STANDARDS: INVENTORY OF STANDARDS AND CONVENTIONS USED FOR THE GENERATION OF IAG PRODUCTS. THE IAG GEODESIST'S HANDBOOK 2016, J GEOD 90(10): 1095-1156, DOI:10.1007/s00190-016-0948-z, 2016.

PLAG, H.P AND M. PEARLMAN (EDITORS): GLOBAL GEODETIC OBSERVING SYSTEM – MEETING REQUIREMENTS OF A GLOBAL GEODETIC SOCIETY ON A CHANGING PLANET IN 2020, SPRINGER 2009, DOI: 10.1007/s10291-007-0067-7.

Appendix D GGOS Entities associated with the BPS

D.1. GGOS Committee "Contributions to Earth System Modelling"

(Maik Thomas)

Purpose

The GGOS Committee on "Earth System Modeling" tends to promote the development of physically consistent modular Earth system modeling tools that are simultaneously applicable to all geodetic parameter types (i.e., Earth rotation, gravity field and surface geometry) and observation techniques. Hereby, the committee contributes to:

- the interpretation of geodetic monitoring data and, thus, to a deeper understanding of dynamical and complex interacting processes in the Earth system responsible for the observed variations;
- the establishment of a link between the geodetic products delivered by GGOS and numerical process models;
- a consistent combination and integration of observed geodetic parameters derived from various monitoring systems and techniques;
- the utilization of geodetic products for the interdisciplinary scientific community.

Objectives

The overall long-term goal is the development of a physically consistent modular numerical Earth system model for homogeneous processing, interpretation and prediction of geodetic parameters with interfaces allowing the introduction of constraints provided by geodetic time series of global surface processes, rotation parameters and gravity variations. This ultimate goal implicates the following objectives:

- development of Earth system model components considering interactions and relationships between surface deformation, Earth rotation and gravity field variations as well as interactions and physical fluxes between relevant compartments of the Earth system;
- promotion of homogeneous processing of geodetic monitoring data (de-aliasing, reduction) by process modeling to improve analyses of geodetic parameter sets;
- contributions to the interpretation of geodetic parameters derived from different observation techniques by developing strategies to separate underlying physical processes;
- contributions to the integration of geodetic observations based on different techniques in order to promote validation and consistency tests of various geodetic products.

Activities

Major current activities focus on:

- the implementation of generalized modules for the realistic consideration of interactions of near-surface fluids with the geosphere arising, e.g., from surface-loading and self-attraction;
- implementation of interfaces to geodetic monitoring data based on Kalman and particle filter approaches in order to constrain and improve stand-alone model approaches and to prove consistency of various geodetic monitoring products;
- feasibility studies for the provision of error and uncertainty estimates of model predictions of geodetic parameters (Earth rotation, gravity field, surface deformation) due to imperfect model physics, initialization, and external forcing.

Important in-progress activities and future efforts focus on:

- evaluation of opportunities to constrain dynamically coupled model systems with geodetic data products by applying Kalman filter and inversion techniques;
- application of forward modeling and inversion methods in order to improve model-based predictions of geodetic quantities and to invert geodetic observations for the underlying causative processes.

D.2. GGOS Committee "Definition of Essential Geodetic Variables"

(Richard Gross)

Objectives

The GGOS BPS Committee on Essential Geodetic Variables was established in 2018 in order to define a list of Essential Geodetic Variables and to assign requirements to them. Essential Geodetic Variables (EGVs) are observed variables that are crucial (essential) to characterizing the geodetic properties of the Earth and that are key to sustainable geodetic observations. Examples of EGVs might be the positions of reference objects (ground stations, radio sources), Earth orientation parameters, ground- and space-based gravity measurements, etc. Once a list of EGVs has been determined, requirements can be assigned to them. Examples of requirements might be accuracy, spatial and temporal resolution, latency, etc. These requirements on the EGVs can then be used to assign requirements to EGV-dependent products like the terrestrial and celestial reference frames. The EGV requirements can also be used to derive requirements on the observing systems that are used to observe the EGVs. And the list of EGVs can serve as the basis for a gap analysis to identify observations needed to fully characterize the geodetic properties of the Earth. During GGOS Days 2017 it was agreed that a Committee within the GGOS Bureau of Products and Standards should be established in order to define the list of Essential Geodetic Variables and to assign requirements to them. This Committee was subsequently established in 2018 and consists of representatives of the IAG Services, Commissions, Inter-Commission Committees, and GGOS Focus Areas.

Tasks

The tasks of the Committee on Essential Geodetic Variables are to:

- Develop criteria for choosing from the set of all geodetic variables those that are considered essential
- Develop a scheme for classifying EGVs
- Within each class, define a list of EGVs
- Assign requirements to each EGV
- Document each EGV including its requirements, techniques by which it is observed, and point-of-contact for further information about the EGV
- Perform a gap analysis to identify potential new EGVs
- Define a list of geodetic products that depend on each EGV
- Assign requirements to the EGV-dependent products
- Hold workshops to engage the geodetic community in the process of defining EGVs, determining their dependent products, and assigning requirements to them

Members

GGOS

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

GGOS Focus Area 1

(Unified Height System)
Laura Sanchez (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)
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Kosuke Heki (Japan)
Thomas Gruber (Germany)

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Jianli Chen (USA)
Jose Ferrandiz (Spain)

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Jens Wickert (Germany)
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IAG ICC Theory

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Mattia Crespi (Italy)

IAG ICC Climate

Annette Eicker (Germany)

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Tom Herring (USA)

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Tom Herring (USA)
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Hartmut Wziontek (Germany)
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Christian Hirt (Germany)
Michael Kuhn (Australia)

PSMSL

Svetlana Jevrejeva (UK)

Other

Srinivas Bettadpur (UTCSR)
Johannes Bouman (BKG)

Total: 38

D.3. Working Group "Towards a consistent set of parameters for the definition of a new GRS"

(Urs Marti)

Terms of Reference

The Geodetic Reference System 1980 GRS80 is still the conventional system for most applications in Geodesy and other Earth sciences. It was defined through the four parameters a (semi-major axis), J_2 (Dynamical Form Factor), GM (geocentric Gravitational Constant) and ω (Angular Rotation Velocity). It represents the scientific status of the 1970ies and in its concept, the tidal systems and relativistic theories are not considered. Since its adaptation, various inconsistencies have been introduced into geodetic standards and applications, such as new values for GM or a in the IERS conventions. In 2015, a conventional value for the gravitational potential at sea level W_0 was adopted in an IAG resolution, which is in contradiction to the definition of GRS80.

This WG will publish a new set of defining parameters for a modern GRS based on today's knowledge and calculate all the necessary derived parameters in a consistent way. It will study the necessity to work towards an IAG resolution to replace GRS80 as the conventional system and provide transformation procedures between the two systems. It will study as well the necessity to define and adopt a conventional global gravity field model for standard applications in geodesy, navigation and related topics.

This JWG is assigned to the GGOS Bureau of Products and Standards (BPS) and works together with representatives of IAG Commissions 1 and 2, the Inter-Commission-Committee on Theory (ICCT), the International Gravity Field Service (IGFS), the International Earth Rotation and Reference Systems Service (IERS) and the Committee on Essential Geodetic Variables (EGV).

This JWG will focus its activities on the coordination of the geometric reference frame, the global height system, the global gravity network and their temporal changes. The application of Earth orientation parameters and tidal models and the underlying standard and reference models has to be brought into consistency.

Objectives and activities

The main objectives and activities of this working group are:

- Calculate consistent parameters of a new mean Earth ellipsoid and derived quantities
- Study the necessity to replace the global reference system GRS80 as the conventional system
- Advance the realization of a conventional global reference gravity field model (combined and satellite only)
- Assist the working group for establishing the International Height Reference System (IHR) in the realization
- Integrating and combining the global gravity network with other techniques
- Study the influence of earth orientation parameters, tidal models and relativistic effects on the realization of a consistent global reference frame in geometry, height and gravity
- Foster the free exchange of geodetic data and products

Members

Urs Marti (Switzerland), Chair

Detlef Angermann (Germany), Chair of GGOS BPS, IERS

Richard Gross (USA) IAG Vice President, Committee on EGV

Ilya Oshchepkov (Russia), GRS, Gravity Networks and Height Systems

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