GGOS Bureau of Networks and Observations

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Membership

Standing Committees affiliated with this Bureau:

- GGOS Standing Committee on Satellite Missions
- GGOS Standing Committee on Data and Information Systems
- GGOS Standing Committee on Performance Simulations and Architectural Trade-Offs (PLATO)
- IERS Working Group on Survey and Co-location

Associated Members and Representatives:

- Director (Mike Pearlman/CfA USA)
- Secretary (Carey Noll/NASA USA)
- Analysis Specialist (Erricos Pavlis/UMBC USA)
- IERS Representative (Sten Bergstrand/SP Sweden)
- A representative from each of the member Services:
    - IGS (Ruth Neilan/JPL USA, Steve Fisher/JPL USA)
    - ILRS (Giuseppe Bianco/ASI Italy, Wu Bin/SHAO China)
    - IDS (Jérôme Saunier/IGN France, Pascale Ferrage/CNES France)
    - IVS (Hayo Hase/BKG Germany, Chopo Ma/NASA USA)
    - IGFS (Riccardo Barzaghi/PM Italy, George Vergos/UT Greece)
    - PSMSL (Lesley Rickards/BODC UK, Tilo Schone/GFZ Germany)
- A representative from each of the member Standing Committees:
    - PLATO (Daniela Thaller/BKG Germany, Benjamin Maennel/GFZ Germany)
    - Data and Information (Günter Stangl/OEAW Austria, Carey Noll/NASA USA)
    - Satellite Missions (Jürgen Müller/IfE Germany, Roland Pail/TUM Germany)
    - IERS Working Group on Survey Ties and Co-location (Sten Bergstrand/SP Sweden, John Dawson/GA Australia)

Activities, Actions, and Publications during 2015-2017

Activities

The Bureau:

- Continued to provide a forum for the Services and Standing Committees/Working Groups to share and discuss plans, progress, and issues, and to develop and monitor multi-entity efforts to address GGOS requirements; meetings are held in conjunction with AGU and EGU each year; material from the meetings are posted on the GGOS website (http://www.ggos.org/Components/BNC/BNChome.html).
- Continued the Bureau's "Call for Participation in the Global Geodetic Core Network: Foundation for Monitoring the Earth System" and work with new potential groups interested in participating; a total of 19 submissions have been received covering 114 sites that included legacy core sites, legacy/new technology co-location sites, core and co-location sites under development, and sites offered for future participation; a summary of the CfP responses is available on the Bureau's website:

(http://192.106.234.28/Components/BNC/update%20Apr2013/GGOS_CfPResponseSummaries_20150106.pdf). A number of other new stations will join once they are operational.

- Continued to advocate for new and increased network participation, encouraging formation of new partnerships to develop new sites, monitored the status of the networks; held meetings and communications with representatives from Russia, Italy, Brazil, Japan, Spain, France, and Saudi Arabia to discuss implementation of new stations and upgrade of legacy stations.
- Supported efforts for the integration of various ground observation networks within the GGOS affiliated Network; continued to maintain and update the "Site Requirements for GGOS Core Sites" document (with the IAG Services); the next major step will be to include the requirements for the gravity field once it is fully documented by the IGFS and the IGRF working group; Work with the IGFS in the definition of its requirements.
- Continued to promote and advocate for GGOS and the GGOS integrated global geodetic ground-based infrastructure through talks and posters at AGU, EGU, AOGS, APSG (China), JpGU-AGU, IAG, etc. and meetings and special presentations at GSI (Japan), IMPE (Brazil), IAP (Russia) etc.; supported efforts to integrate relevant parameters from other ground networks (gravity field, tide gauges, etc.) into the GGOS network to support GGOS requirements.
- Continued to maintain and update the inventory/repository of current and near-future satellite missions, highlighting those of most interest to GGOS; The current version should be online in mid-2017; continued advocating for new advocating new missions; wrote letters of support for the E-GRASP/Eratosthenes proposals; Need to stress greater cooperation between the PLATO and Missions Standing Committees. More details are provided in the Missions Standing Committee section below .
- Provided simulations and analyses to estimate how the data products will improve over time as the infrastructure improves. The next survey of current and projected network station capabilities will be undertaken in the second half of 2017. The results from the survey will be used to project network data quality capability 5 and 10 years ahead. Simulations on the e-GRASP/Eratosthenes mission and other co-location missions to strengthen the case for support and for network planning. More detail is provided in the Standing Committee on Performance Simulations & Architectural Trade-Offs (PLATO) section below.
- Continued development and implementation of a GGOS metadata system in two stages: a stage-one scheme (hosted by CDDIS) for GGOS and GGOS-relevant data products planned for demonstration by the end of 2017, and a longer term, stage-two implementation, for the full GGOS requirements including site and instrument information, based on an XML metadata scheme under development by the Geoscience Australia, UNAVCO, and the IAG. Additional details are provided in the Data and Information Standing Committee section below.
- Continued working on the establishment of a common terminology for all space geodesy techniques, a terminology which is also valid outside the space geodetic community; the DORIS community has adapted a common terminology, and improved its surveying procedures as well as communication of the results. The IGS

terminology has done the same, but there are differences among the techniques; continued working on outreach to increase local survey participation and standardization. More details are provided in the IERS Working Group on Survey Ties and Co-Location section below.

Related Bureau Documentation

As part of the network activity, the Bureau has facilitated the creation of several key documents:

- "GGOS Site Requirements for Fundamental Stations" document: http://192.106.234.28/Components/BNC/update%20Apr2013/GGOS_SiteReqDoc_1207.pdf
- A guidelines document for site characterization of the GGOS network sites was developed, "The Global Geodetic Core Network: Foundation for Monitoring the Earth System": http://192.106.234.28/Components/BNC/update%20Apr2013/GGOS_sitecategorization.pdf
- A plan to define the process by which GGOS determines the extent of the needed infrastructure, including the scope and specification of the network, conditioned on the existing or plausible technology available, "GGOS Infrastructure Implementation Plan": http://192.106.234.28/Components/BNC/GGOS_Infrastructure_Plan_V3_130321.pdf
- A plan to assess the current and future plans for a GGOS core network, including projections five to ten years in the future, "Space Geodesy Network Model": http://192.106.234.28/Components/BNC/candidatesites_130122.pdf
- Documents developed within the context of NASA's Space Geodesy Project, evaluating several sites as potential core sites; these documents are available from the SGP website at: http://space-geodesy.gsfc.nasa.gov/publications/papers.html
- A summary report issued from the TLS (Terrestrial Laser Scanner) Workshop that was held at NASA GSFC, September 08-10, 2008: http://192.106.234.28/Components/BNC/Summary%20report%20from%20the%20TLS%20(Terrestrial%20Laser%20Scanner).pdf

Websites

http://www.ggos.org/Components/BNC/BNChome.html
http://www.ggos-portal.org/lang_en/GGOS-Portal/EN/Themes/SeaLevel/seaLevel.html

Publications and Presentations

M. Pearlman, C. Ma, C. Noll, E. Pavlis, H. Schuh, T. Schoene, R. Barzaghi, S. Kenyon, "The GGOS Bureau of Networks and Observations and an Update on the Space Geodesy Networks", Abstract EGU2015-7420, presented at EGU 2015 General Assembly, April 13-17, 2015, Vienna, Austria, April 12-17, 2015.

M. Pearlman, E. Pavlis, C. Ma, C. Noll, D. Thaller, B. Richter, R. Gross, R. Neilan, J. Mueller, R. Barzaghi, S. Bergstrand, J. Saunier, M. Tamisiea, "Update on the Activities of the GGOS Bureau of Networks and Observations", Abstract No. 10095. Presented at European Geosciences Union General Assembly, April 17-22, 2016.

C. Noll, “GGOS: Global Geodetic Observing System”, presented at 2016 WDS Members' Forum, Denver, Colorado, September 11, 2016.

G. Stangl, C. Noll, “GGOS: The Global Geodetic Observing System” (poster), presented at 2016 WDS Members' Forum, Denver, Colorado, September 11, 2016.

M. Pearlman, C. Noll, C. Ma, E. Pavlis, R. Neilan, J. Saunier, T. Schoene, R. Barzaghi, D. Thaller, S. Bergstrand, J. Mueller, “The GGOS Bureau of Networks & Observations: An Update on the Space Geodesy Network & the New Implementation Plan for 2017-2018”, Abstract No. EGU2017-10698, presented at European Geosciences Union General Assembly 2017, Vienna, Austria, April 24-28, 2017.

M. Pearlman, H. Schuh, D. Angermann, C. Noll, “The Global Geodetic Observing System (GGOS) – Its Role and Its Activities”. JpGU-AGU Joint Meeting, Chiba, Japan, May 22-26, 2017.

M. Pearlman, C. Ma, R. Neilan, C. Noll, E. Pavlis, J. Saunier, T. Shoene, R. Barzaghi, D. Thaller, S. Bergstrand, J. Mueller, “The GGOS Bureau of Networks and Observations: Activities and Plans”. Presented at IAG-IASPEI, Kobe, Japan, July 30-August 04, 2017.

GGOS Standing Committee on Satellite Missions

Chair: Jürgen Müller (Germany)
Co-Chair: Roland Pail (Germany)

Members

Besides Chair and Co-Chair, CSM has quite an open team of members, associate members and guests to work on the various CSM tasks and to provide material for the website, presentation material, and other documentation.

CSM has 1 or 2 meetings per year. The main work, however, is done via email exchange.

Purpose and Scope

The Committee on Satellite Missions (CSM), formerly GGOS Satellite Mission Working Group, was established in December 2008, under the lead of C.K. Shum. In December 2010, Isabelle Panet was appointed as new Chair, in December 2013 Roland Pail took over the role of the CSM Chair, followed by Jürgen Müller in December 2015.

The purpose and scope of CSM is the information exchange with satellite missions as part of the GGOS space infrastructure, for a better ground-based network response to mission requirements and space-segment adequacy for the realization of the GGOS goals. New space missions shall be advocated and supported, if appropriate.

CSM has been set-up as an international panel of experts, with consultants of national and international space agencies.

Satellite missions are a prerequisite for realizing a global reference for any kind of Earth observation. They are the key for monitoring change processes in the Earth system on a global scale with high temporal and spatial resolution. Therefore, beyond purely scientific objectives they meet a number of societal challenges, and they are an integral part of the GGOS infrastructure and essential to realize the GGOS goals. The role of CSM is to monitor the availability of satellite infrastructure, to propose and to advocate new missions or mission concepts, especially in case that a gap in the infrastructure is

Activities and Actions

- New chair (Jürgen Müller) took over in December 2015.
- In 2016, the number of active committee members has been revised.
- An inventory of the GGOS satellite infrastructure has been collected, including some missions that only touch the GGOS needs. The list will be refined and updated in the 2017/2018 timeframe.
- A preliminary list of satellite contributions to fulfill the GGOS 2020 goals has been prepared. The list will be refined and updated in the 2017/2018 timeframe.
- In 2015 chaired by CSM (Roland Pail), the "Science and user requirements document for future gravity field missions" has been finalized and published, see www.dgk.badw.de/fileadmin/docs/b-320.pdf
- In 2016, CSM has contributed to ESA's Earth Explorer 9 call by providing support letters (from GGOS chair) and by actively acting in the proposers' teams (individual CSM members) of the two planned geodetic missions
    - E-GRASP/Eratosthenes (co-location of geodetic transmitters in space)
    - E.motion2 (gravity field mission)

- Close cooperation exists with the Bureau of Standards and Products, and the Sub-Commissions 2.3 and 2.6 of IAG. Additionally, there are strong interfaces to national and international space agencies.

Objectives and Planned Efforts for 2015-2017 and Beyond

1. Contribute to a CSM section on the GGOS website. A new website is available since early 2017. Here, close exchange with the GGOS Communication Office is planned.
2. Revise and maintain the inventory/repository of current and near-future satellite missions. A reduced list with the most important missions has been prepared in spring 2017 and is revised now by the CSM members. It shall continuously be extended and updated.
3. Evaluate and refine contributions of current and near-future missions to the GGOS 2020 goals. A revised version with the most important contents has been prepared in spring 2017 and is revised now by the CSM members. It shall continuously be extended and updated.
4. Support advocating new missions. New calls are expected in 2017/2018. Currently, the ESA EE9 mission proposal E-GRASP/Eratosthenes is supported.
5. Interface with other GGOS components to identify critical gaps in the satellite infrastructure and advocating new missions. Here, regular exchange is planned with PLATO, e.g., to stimulate dedicated simulations to better understand and overcome shortcomings with respect to the GGOS 2020 goals.
6. Support GGOS positions in preparation to CEOS/GEO meetings.
7. Support the Executive Committee and the Science Committee in the GGOS Interface with space agencies.

Most of the CSM tasks are ongoing activities. These tasks will require interfacing with other components of the Bureau; especially the ground networks component, the simulation activity (PLATO) as well as the Bureau of Standards and Products.

Website

http://www.ggosdays.com/en/bureaus/bno/committee-satellite-missions/

Publications and Presentations

Pail, R.; IUGG, Writing Team: Observing Mass Transport to Understand Global Change and Benefit Society: Science and User Needs, An international multi-disciplinary initiative for IUGG; in: Pail, R. (eds.) Deutsche Geodätische Kommission der Bayerischen Akademie der Wissenschaften, Reihe B, Vol. 2015, Heft 320, Verlag der Bayerischen Akademie der Wissenschaften in Kommission beim Verlag C.H. Beck.

GGOS Standing Committee on Data and Information Systems

Chair: Guenter Stangl (Austria)
Co-Chair: Carey Noll (USA)

Purpose and Scope

Develop a metadata strategy for all ground-based measurement techniques and data products that provides discoverability and interoperability, is easily transferable via web services, and is based on internationally recognized data exchange methods; the plan is to implement a metadata scheme in two stages: a stage-one scheme for GGOS and GGOS relevant data products and a longer term, stage-two scheme for the full GGOS requirements

The current focus of the WG is on developing standards for metadata that can be utilized by the space geodesy community. Metadata typically encompass critical information about the measurements that are required to turn these measurements into usable scientific data. Metadata also includes information that supports data management and provides a foundation for data discovery. Data centers extract metadata from incoming data sources and also augment that metadata with information from other sources. It is typical for data centers to store the metadata in databases in order to manage the data in their archives and to distribute both data and metadata to data users. Metadata can further be utilized by data discovery applications to allow users to find datasets of interest. In order to be effective, metadata need to be simple to generate and maintain. They must be consistent and informative for the archivist and the user.

GGOS is seeking a metadata schema that can be used by all of its elements for standardized metadata communication, archiving, and retrieval. First applications would be automated distribution of up-to-date stations configuration and operational information, data archives and catalogues, and procedures and central bureau communication. Several schemas that show promise have been under development by SOPAC (Scripps), GML (Australia/NZ), etc. The intent is that data need be entered only from an initial source (a station, a Data Center, an Operations Center, data products, etc.) and would then flow to and be integrated into those metadata files where users would have access. The plan is to organize a meeting, probably in early August at UNAVCO in Boulder, for representatives from the Services, the Data Centers, the Science Community, etc. to give each of the schema developers an opportunity to preach his wears and allow discussion on the pros and cons of each.

The objective is to try to come to closure on a schema that we could as a community adopt for general implementation. Groups would not be obligated to a rapid implementation schedule, but would commit to the agreed schema when they are ready to begin the process.

Activities and Actions

- CDDIS continues to construct collection-level metadata records for implementation in NASA EOSDIS (CMR)
- IGS continues development of Site Log XML metadata (lead: Fran Boler/UNAVCO)
    - Geosciences Australia (GA) has released GeodesyML
        - Implements an application schema for the Site Log XML metadata
    - Several IGS data centers and groups have worked with this schema and are implementing/refining

- Use Cases are slowly being assembled
- Software tools for text site log to XML site log conversion are being developed and will be available to all

Objectives and Planned Efforts for 2015-2017 and Beyond

- Adopt and implement a metadata system to provide access to GGOS relevant data products (December 30, 2017)
  - Define the data product requirements for the GGOS relevant metadata (February 15, 2017)
  - Present concept and plan for implementation (EGU 2017 and/or the GGOS CB meeting in April 2017)
  - Status report (IAG Assembly or other venue in July 2017)
  - Prototype of Phase 1 implementation (GGOS Days in October 2017)
  - Implementation of the operational data product metadata scheme (December 31, 2017)
- Adopt and implement a full metadata system including site information and relevant tools and capability (e.g., the Australian GL scheme)
  - Definition of the requirements; definition of Phase 1 (March 1, 2018)
  - Resolve issues and applicability of the Australian GL scheme and recommend schema (EGU 2018)
  - Metadata implementation plan including definition of tasks, roles, and distribution of tasks, and plans for integration of components (June 2018)
  - Demonstration of Phase 1 prototype (GGOS Days, 2018)
  - Demonstration of Phase 1 first operational system (June 2019)

GGOS Standing Committee on Performance Simulations & Architectural Trade-Offs (PLATO)

(Joint WG with IAG Commission 1)

Chair: Daniela Thaller (Germany)
Vice-Chair: Benjamin Männel (Germany)

Contributing Institutions (in alphabetical order):

- AIUB, Switzerland
- BKG, Germany
- CNES/IGN, France
- DGFI-TU Munich, Germany
- ETH Zürich, Switzerland
- GFZ/TU Berlin, Germany
- IfE University Hannover, Germany
- JPL, USA
- NASA GSFC/JCET, USA
- NMA, Norway
- TU Vienna, Austria

Purpose and Scope

- Develop optimal methods of deploying next generation stations, and estimate the dependence of reference frame products on ground station architectures
- Estimate improvement in the reference frame products as co-located and core stations are added to the network
- Estimate the dependence of the reference frame products on the quality and number of the site ties and the space ties
- Estimate the improvement in the reference frame products as other satellites are added, e.g., cannonball satellites, LEO, GNSS constellations
- Estimate the improvement in the reference frame products as co-locations in space are added, e.g., use co-locations on GNSS and LEO satellites, add special co-location satellites (GRASP, E-GRASP/Eratosthenes, NanoX, etc.)

Achievements over the past two years:

- Several projects related to simulation studies became funded (DGFI-TUM, AIUB, TU Vienna, GFZ)
- Simulations for the planned E-GRASP/Eratosthenes mission were carried out by several institutions; E-GRASP/Eratosthenes is a proposal for an ESA Earth-Explorer-9 Mission, with the science team led by Richard Biancale (CNES)
- Several geodetic software packages have been augmented by the capability to carry out realistic simulation scenarios (VieVS, DOGS, Bernese, Geodyn)
- Simulations for improved global SLR station network were carried out
- Simulations for an SLR station in Antarctica (Syowa, co-located with VLBI) were carried out, showing the benefit for geocenter
- The impact of the local ties (LT) on the reference frame products were studied regarding different stochastic models of the LT, selection of the LT, and the impact of systematically wrong LT. It was shown that the LT standard deviations of 1 mm or better

lead to the best datum realization of an SLR+VLBI-TRF. Simulating wrong LT indicate Wettzell, Badary and AGGO as important LT sites in the SLR and VLBI combination.
- Starting simulations for improved SLR tracking of GNSS satellites
- Simulations (and analysis of data as far as available) for new VGOS telescopes by using next generation broadband VLBI technology, showed that the GGOS requirements of 1 mm accuracy and 0.1 mm/year stability will likely be fulfilled for the reference frame.
- Simulations and analysis of VLBI tracking data of GNSS satellites and the Chinese APOD cube-satellite (i.e., using co-locations in space) were carried out using the Australian VLBI antennas for several sessions during 2016.
- Simulations related to more LLR data assuming millimeter ranging accuracies (up to three future single-prism reflectors on the moon and two additional LLR sites on the southern hemisphere) were carried out. The effect on the lunar reflector coordinates, the mass of the Earth-Moon system and two relativistic parameters (temporal variation of the gravitational constant and equivalence principle) was studied. Especially, the measurements to the new type of reflectors would lead to an improved accuracy of the estimated parameters up to a factor of 6 over a decade of new measurements.

Objectives and Planned Efforts for 2017-2019 and Beyond

- Examine trade-off options for station deployment and closure, technology upgrades, impact of site ties, etc. (December 31, 2017)
- Simulation studies “ground” to assess impact on reference frame products of: network configuration, system performance, technique and technology mix, co-location conditions, site ties (December 31, 2017)
- Simulation studies “space” to assess impact on reference frame products of: co-location in space, space ties, available satellites (October 31, 2018)
- Project future network capability over the next 5 and 10 year periods using projected network configuration in new system implementation; (February 28, 2018)
- Develop improved analysis methods for reference frame products by including all existing data and available co-locations (October 31, 2018)
- Analysis campaign with exchanged simulated observations (December 31, 2018)
- Status reports will be given at IAG Scientific Assembly (July 2017), GGOS days (October 2017) and REFAG Meeting (autumn 2018)
- Annual meetings are foreseen in conjunction with EGU General Assembly

Publications:

Ampatzidis D, König R, Glaser S, Schuh H (2016), The Assessment of the Temporal Evolution of Space Geodetic Terrestrial Reference Frames, IAG Symposia Series, DOI 10.1007/1345_2016_251

Glaser S, Ampatzidis D, König R, Nilsson T, Heinkelmann R, Flechner F, Schuh H (2016), Simulation of VLBI Observations to Determine a Global TRF for GGOS, IAG Symposia Series, DOI 10.1007/1345_2016_256

Glaser S, König R, Ampatzidis D, Nilsson T, Heinkelmann R, Flechner F, Schuh H (2017), A Global Terrestrial Reference Frame from simulated VLBI and SLR data in view of GGOS, Journal of Geodesy, DOI 10.1007/s00190-017-1021-2

Plank L, Hellerschmied A, McCallum J, Böhm J, Lovell J (2017), VLBI observations of GNSS satellites: from scheduling to analysis. J Geod, Springer, doi:10.1007/s00190-016-0992-8

Schuh H, König R, Ampatzidis D, Glaser S, Flechtner F, Heinkelmann R, Nilsson T (2016), GGOS-SIM – Simulation of the Reference Frame for the Global Geodetic Observing System, IAG Symposia Series, DOI 10.1007/1345_2015_217

IERS Working Group on Site Survey and Co-location

Chair: Sten Bergstrand (Sweden)
Co-Chair: John Dawson (Australia)

Members:

https://www.iers.org/IERS/EN/Organization/WorkingGroups/SiteSurvey/sitesurvey.html

Purpose and Scope

The working group was established in 2004 as part of the IERS to homogenize local surveying activities at different space geodetic sites. In 2014, it was agreed that the working group would act also for GGOS under the IERS name. The overall goal is to provide a base necessary for rigorous terrestrial reference frame realizations, and to highlight the presence of technique- and/or site-specific biases. The main effort aspires to provide the means of an uncertainty assessment that can be included in the next ITRF.

Activities and Actions

- Recent work has first been to establish a general and common terminology to all techniques, which is also valid outside the space geodetic community, and to fulfill the local tie requirements set out in the GGOS book. The DORIS community has adapted the common terminology, and improved its surveying procedure as well as communication of results.
- IGS terminology has been adapted without alterations; the concepts are there, but the technique specific terminologies vary. The main focus of the IGS component has been a reassessment of existing sites rather than surveying as such.
- The ILRS maintains a list of current and historical sites. A combined effort from several institutes involved a common application to the European EMPIR program. The application fulfilled the acceptance criteria, but was not granted funding due to limited resources.
- The VLBI terminology concerning site surveys has been consolidated, and an automated terrestrial monitoring system for telescopes called Heimdall has been developed, as well as a complete model for telescope deformation.
- A campaign to examine the short-term combination of VLBI, GNSS and automated terrestrial monitoring at two baseline ends has been performed, with some processing left to be finished.

Objectives and Planned Efforts for 2017-2019 and Beyond

- Assess the ground truth uncertainty of different techniques to include in the next ITRF;
- Evaluate the VLBI-GNSS-terrestrial campaign of the Onsala-Metsähovi baseline; additionally, more sites should be surveyed. However, this is an activity that the respective station managers need to allocate funding for. The working group does not have the means to do this, and would appreciate any help to create a pull in this direction.

Website

https://www.iers.org/IERS/EN/Organization/WorkingGroups/SiteSurvey/sitesurvey.html