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Update on the Activities of the GGOS Bureau of Networks and Observations

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Abstract: The recently reorganized GGOS Bureau of Networks and Observations has many elements that are associated with building and sustaining the infrastructure that supports the Global Geodetic Observing System (GGOS) through the development and maintenance of the International Terrestrial and Celestial Reference Frames, improved gravity field models and their incorporation into the reference frame, the production of precision orbits for missions of interest to GGOS, and many other applications. The affiliated Service Networks (IVS, ILRS, IGS, IDS, and now the IGFS and the PSMSL) continue to grow geographically and to improve core and co-location site performance with newer technologies. Efforts are underway to expand GGOS participation and outreach. Several groups are undertaking initiatives and seeking partnerships to update existing sites and expand the networks in geographic areas void of coverage. New satellites are being launched by the Space Agencies in disciplines relevant to GGOS. Working groups now constitute an integral part of the Bureau, providing key service to GGOS. Their activities include: projecting future network capability and examining trade-off options for station deployment and technology upgrades, developing metadata collection and online availability strategies; improving coordination and information exchange with the missions for better ground-based network response and space-segment adequacy for the realization of GGOS goals; and standardizing site-tie measurement, archiving, and analysis procedures. This poster will present the progress in the Bureau's activities and its efforts to expand the networks and make them more effective in supporting GGOS.

GGOS Bureau of Networks and Observations: Overview

Role of the Bureau: To advocate and encourage implementation of the Core and Co-location Network to satisfy GGOS requirements, to monitor the status of the network and project its future condition, and to support and advocate for infrastructure critical for the development of data products essential to GGOS.

Objectives: The current objective is the deployment of a globally distributed network of 32, new technology core sites with VLBI, SLR, GNSS and DORIS to achieve reference that will permit mm accuracy at 0.1 mm/year stability over decades. The new role of the Bureau is now being expanded to better integrate the non-geometric Services (Gravity Service, tide gauge networks, etc.) and to strengthen communications with the space missions, the simulation activities to project network capability, and some of the data gathering functions.

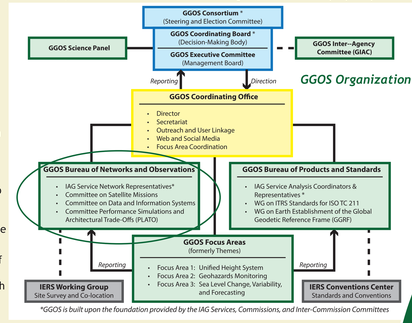
Reality: Site deployment and upgrade will occur over many years, and some sites for economic and political reasons will not be in the ideal locations. Co-location sites (non-core sites) will continue to play a vital role in our data products. The utility of our output will be the product of network Core Sites, Co-location sites, mix of technologies, adherence to proper operational and engineering procedures, and making best use of the data once it leaves the field.

Organizational Elements

- Services networks (IGS, IVS, ILRS, IDS, IGFS, tide gauges, etc.)
- Committees:
  - Missions
  - Performance Simulations and Architectural Trade-Offs (PLATO)
  - Data and Information Systems
  - Ground Survey and Co-location (IERS WG)

GGOS Organization: Elements within Bureau are intended to work as an integrated team whose main focus is to ensure that the networks required to collect the data that will support the GGOS products are in place and produce these data.

Bureau Leadership: Board made up of a Director, Secretary, Analysis Coordinator, a representative from each Network Service and Working Group.



*GGOS is built upon the foundation provided by the IAG Services, Commissions, and Inter-Commission Committees

GGOS Bureau of Networks and Observations: Recent Activities

- Submitted Bureau implementation plan
- Completed and posted second revision of the document "GGOS Requirements for Core Sites", November 01, 2015
- Held first meeting on development of GGOS plan for metadata
- Working with gravity field community and the gravity field service (IGFS) to help integrate gravity field into the Global Geodetic Reference Frame
- Participating in the NASA team discussing possible core site options in Brazil (GGOS perspective)
- Alexander Neidhardt writing book "Applied Computer Science for GGOS Observatories. Communication, Coordination and Automation of Future Geodetic Infrastructures"
- Continue to solicit for new participants in the GGOS Affiliated Network
- Continue developing 5 and 10 year projected network capability based on new facilities being built and planned

GGOS and Bureau Committees and Working Groups: Recent Updates

IERS Working Group on Site Survey and Co-location

- IERS Site Survey and Co-location Working Group (SiSuCo) agreed to terminology accepted by all services
- IDS has upgraded equipment and evaluated monuments and definitions
- VLBI developed a continuous observation-schedule adapted monitoring system (HEIMDALL)
- IGS has completed 83% of robot antenna calibrations

Bureau Committee on Performance simuLations and Architectural TradeOffs (PLATO) (Daniela Thaller/Richard Gross)

- Test solutions and simulations examined the impact of different noise levels on the TRF, variations of the observing scenario for dual antenna sites, and even the tracking of GNSS satellites with VLBI
- Combination TRF solutions with real SLR and GPS data to LEO satellites (e.g., Jason-2) evaluated the possible use of such targets as "space ties" with multiple co-located techniques
- Local tie improvement at fundamental station Wettzell with a multi-technique ground target
- Simulations of the changing network geometry and data quality for globally distributed SLR & VLBI co-located core network, projecting its performance in +5 and +10 years from present

Bureau Committee on Missions (Juergen Mueller/Roland Pail)

- Starting work on updating inventory/repository of current and near-future satellite missions
- Working on Missions Section of the GGOS website
- Committee membership revised to active members; Juergen Mueller is the new Committee Chair with Roland Pail as the deputy
- "Science and User Requirements Document for Future Gravity Field Missions" *(http://www.dgk.badw.de/fileadmin/docs/b-320.pdf)* being finalized for publication (IUGG initiative)

Bureau Committee on Data and Information Systems (Bernd Richter/Carey Noll)

- Technical Interchange Meeting on Metadata held in Boulder CO in August 2015 to discuss strategies for metadata within GGOS (essential to GGOS Portal)
- Metadata will focus on data products and descriptive information and interface to existing standards and related efforts (ISO, NASA EOSDIS, eGeodesy, etc.); workshop recommended establishing a Metadata Working Group (MWG) to help formulate a plan for GGOS metadata and advise on implementation
- Developing a proposal for a "GGOS Metadata Schema", including examples, for review within the MWG and the services
- Plan to utilize efforts underway within the IGS to describe site information (Site Log Schema effort); recommended for use by all IAG services where appropriate

GGOS Bureau of Networks and Observations: Tasks and Plans

All of the Services will focus on their respective network coordination, data acquisition, and data analysis to generate products for science and societal needs articulated by GGOS. The Services will constantly strive to improve the robustness and quality of their data and the results through improved procedures, technologies and modeling. In its role to support the Services and better serve the users, the GGOS Bureau of Networks and Observations will:

- Advocate for implementation of the global space geodesy network of sufficient capability to achieve data products essential for GGOS;
- Provide a forum for the Services and Working Groups to meet, discuss status and plans, and examine common interests and requirements;
- Update Site Requirements Document (with the IAG Services) (July 30, 2015);
- Monitor and project the status and evolution of the GGOS space geodesy network in terms of location and performance (with the IAG Services);
- Project future network capability and examine trade-off options for station deployment and closure, technology upgrades, impact of site ties, etc. (PLATO WG);
- Coordinate the effort of the services to implement procedures to provide test-based estimates of their data quality and report (first discussion at Bureau meeting at EGU 2015);
- Facilitate efforts to integrate other ground networks (gravity field, tide gauges, etc.) into the GGOS Network to support GGOS requirements (Progress report at EGU 2016);
- Support the technical services on the promotion of recommended technologies/configurations and procedures in the establishment of new sites and the upgrading of current sites, and in the evaluation of performance of new stations and new capabilities after they become operational;
- Standardize site-tie measurement, archiving, and analysis procedures, maintain a current site-tie archive, and encourage additional groups to help support the network site-tie task (IERS Survey and Co-location WG and the Data Centers);
- Develop a metadata strategy for all ground-based measurement techniques (WG on Data and Information);
- Improve coordination and information exchange with the Missions for better ground-based network response to mission requirements and space-segment adequacy for the realization of GGOS goals (Missions WG);
- Support GGOS submissions to GEO, CEOS, and other international organizations.

The evolution of the networks will be a long-term endeavor (10 – 20 years), but the evolution in the networks and the associated modeling and analyses will provide steady and very useful improvements in the data products. The evolving data and data products will be a major driver for developing and validating new models and analysis techniques.

Global Networks Supporting GGOS

IAG Services: Recent Updates

International GNSS Service (IGS)

- IGS Multi-GNSS capability continues to be enhanced through MGEX project
- IGS Real-time Service anticipated to achieve full operational capability within the year
- International GNSS Monitoring and Assessment (IGMAS) project is taking form
- GNSS-provider networks to join IGS: NGA, JAXA in progress, others through IGMAS soon
- IGS participation within United Nations Committee of Experts on Global Geospatial Information Management (UN-GGIM) Working Group on Global Geodetic Reference Frame is opening new avenues of international cooperation

International VLBI Service for Geodesy and Astrometry (IVS)

- First time broadband VGOS observations on transoceanic baselines (Feb. 2016): KPGO (Hawaii), Westford (Massachusetts) and GGAO (Maryland)
- 9th IVS General Meeting was held in Johannesburg, South Africa preceded by the 2nd IVS Training School on VLBI for Geodesy and Astrometry at the Hartebeesthoek Radio Astronomy Observatory (March 2016)
- Trial broadband VGOS observations with an intercontinental network including KPGO, Westford, GGAO, Yebes (Spain), Wettzell (Germany) and Ishioka (Japan) in July 2016
- VGOS antennas will be installed in Ny-Ålesund (Norway), Onsala (Sweden) and Shanghai (China) in 2016.
- Re-observation of the VLBA Calibrator Survey for the 3rd realization of the ICRF reduced the errors of ~2400 sources by a factor of 3

International Laser Ranging Service (ILRS)

- Review and update of ILRS Terms of Reference underway
- New stations established at: Brasilia, Wettzell SOS-W, Borowiec, La Plata; new/upgraded stations underway at: Hartebeesthoek, Metsahovi, San Juan (Chinese), Mount Abu and Ponmundi in India, Sejong Korea; new stations planned at McDonald, Haleakala, Ny-Ålesund (NMA), Yebes, Tahiti, Yarragadee, and others
- ILRS list of satellites now includes 81 satellites, LEO, LAGEOS, GNSS, and GEO; several new satellites now require restricted tracking to avoid optical damage the payload. Some stations involved with tracking of space debris
- Evaluation of the SLR components of the ITRF2014 underway
- Official orbital data product on LAGEOS and Etalon satellites now operational
- New Data Quality Board established to address laser ranging data quality issues
- 2015 ILRS Technical Workshop "Network Performance and Future Expectations for ILRS Support of GNSS, Time Transfer and Space Debris Tracking" held Oct. 26-30 in Matera, Italy; proceedings: *http://cddis.gsfc.nasa.gov/2015_Technical_Workshop/*

International DORIS Service (IDS)

- DORIS-equipped Jason-3 and Sentinel-3A satellites launched in early 2016 with the new generation DGXX-S receiver (new software, new features, improved modeling)
- DORIS has provided a reliable service in 2015 with a network availability maintained at over 85% of the operating stations
- Extensive testing performed in Wettzell in preparation for the installation of DORIS by the end of 2016; tests focused on mitigating RF interference between DORIS and VLBI through varying distances, height and RF shielding (terrain, buildings, RF blockers and absorbers; lessons learned can be applied to other sites
- DORIS special issue in Advances in Space Research (co-editors: Frank G. Lemoine and Ernst J.O. Schrama) to be published soon
- First issue of the IDS Newsletter in April 2016 (see *http://ids-doris.org*)
- Next IDS Workshop will be held in La Rochelle (France) from October 31 to November 01, 2016 in conjunction with the 2016 OSTST (*http://www.ostst-altimetry-2016.com/*); call for papers is open (deadline for abstracts: July 15, 2016)

International Gravity Field Service (IGFS)

- Participation in the establishment of the Global Geodetic Reference System/Frame (GGRS/GGRF) and the International Height Reference System/Frame (IHRS/IHRF)
- Cooperation in setting up the new International Digital Elevation Model Service (IDEMS)
- New Central Bureau at the Aristotle University of Thessaloniki (activities started April 4, 2016, *http://igfs.topo.auth.gr/*)

Permanent Service for Mean Sea Level (PSMSL)

- Became member of the International Council for Science - World Data System (ICSU-WDS)
- PSMSL and SONEL working on a system to provide benchmark and datum information of tide gauge stations and GNSS installations
- Improved qualification of long-term trend estimates includes the time series length needed to obtain a trend with uncertainties of 1.0 mm/yr, 0.5 mm/yr, and 0.1 mm/yr

IAG: *http://www.iag-aig.org*
GGOS: *http://www.ggos.org*
IGS: *http://www.igs.org*
IVS: *http://ivscc.gsfc.nasa.gov*
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