Thoughts on Challenges to GGOS and the Road Ahead

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GGOS is a consortium for the advancement of global geodetic measurements that is supported by various funding agencies, IAG services and the scientific community. Geodetic science springs from an arcane but very important technology and science base.

Today geodetic science is the science that measures ocean circulation via satellite altimetry and gravity measurements, ice mass variability via airborne and satellite altimetry and gravity, land deformation via geodetic imaging technologies from InSAR and lidar and weather of the geospace via GNSS sounding technologies. Our global networks transfer time, monitor GNSS satellite systems, provide the fundamental measurements and reference frames for national datums, and the interplanetary navigation of telescopes and interplanetary probes.

Our purpose in supporting GGOS should be to make geodesy a term readily understood as the driving science and technology behind lidar, radar, altimeters, telescopes, Earth satellites, and space probes.

The Role of GGOS:

- GGOS must facilitate the next phase of technological advance in geodetic science that we are now entering.
- GGOS should work to develop consensus amongst the scientific and technical groups and organizations as well as the supporting funding agencies.
- GGOS must be a herald for the wonderful achievements of geodetic science in the forefront of Earth System Science while also acting as a voice for the consensus views and aspirations of the geodetic community.
- GGOS must improve the visibility of Geodetic Science through improved interactions with the other observing systems and in meeting critical societal needs through organizations such as GEOSS and IGOS.

The Challenges Ahead:

From the use of the chronograph to the development of space geodesy, advances in Positioning, Navigation and Timing (PNT) have supported new advances in exploration and understanding of our environment in the New World, Our World or New Worlds. We are entering a very challenging period for space geodesy - a period of great new possibilities.

Climate Change: The grandest and most immediate scientific challenge is the measurement and understanding of sea level change. Addressing this challenge will require a positioning and navigation system and resulting reference frame capable of measuring global sea level change with an accuracy of 0.1mm/yr or better at regional to global spatial scales and seasonal to multi-decadal temporal scales.

Geohazards: GGOS currently provides measurements of accurate topography and its changes due to forces such as volcanic inflation, landslides, or fault motion continued

support for this activity is critical. There is little doubt that improving PNT and terrestrial reference frames will advance new approaches to understanding and forecasting geohazards. just as the improved geodetic support to the understanding and mitigation of geohazards will require rapid positioning, navigation and timing (PNT) with mm positioning and sub nanosecond timing within an accurate reference frame. GNSS atmospheric and ionospheric occultation is but one example of these new and important technologies that address atmospheric and space weather forecasting. InSAR and Lidar coupled with precise PNT have invented geodetic imaging in the mapping of topography and its change.

Our Core Networks: Is the accuracy of our global networks sufficient to measure the changes in the rates of sea level change with 0.1mm accuracy?

There are strong efforts underway to integrate analyses or the four geodetic networks with the goal of eliminating analysis errors and inconsistencies. The GGOS physical infrastructure of the VLBI, GNSS, and SLR geodetic networks is old, badly heterogeneous, and fraying. These geodetic networks (VLBI, GNSS, SLR) developed as independent technologies with their own analysis systems and independently deployed networks. There is little co-location of instruments, and the few sites that are co-located do not continuously control or measure instrument displacements.

The IVS has provided us with an important VLBI2010 report to sets a technological roadmap for VLBI. We have designs for small portable and automated fixed next generation laser ranging systems from the ILRS. GPS, Galileo, and GLONASS will soon triple the number of precision orbiting GNSS sources with a wide variety of new more powerful and precise signals. These technologies require very significant international technological investments. GGOS must facilitate the next phase of technological advance in geodetic science that we are now entering.

GNSS Development: The nations of the world are rapidly expanding the GNSS constellations. GGOS should be an active participant in the design of these systems by recommending minimum standards for the GNSS satellites systems of relevance to GGOS. For example, the IGS in its Berne meeting recommended that retroreflectors should be installed aboard all GNSS satellites. A minimum standard for these retroreflectors should be put forth by GGOS that would insure proper cross calibration between the IGS and the ILRS networks.

Space Exploration: The GGOS networks will continue to play an important role in space exploration, from the definition of the Celestial Reference Frame and the provision of Earth Orientation Parameters to the tracking of lunar and interplanetary probes. GGOS should advance and promote the contribution of GGOS to space exploration where new investments are likely.

GGOS should be a facilitator for the development space geodetic science in the decades ahead by promoting development, services, and collaboration. We need to work to insure that GGOS is an effective organization that brings new recognition and resources to geodetic science.