Building the space segment of GEOSS

Comprehensive observation of the Earth from global to local scales

Overview: Earth observation satellites have been described as the single richest and most important source of information available about the Earth system and its environment.

Data from Earth observation satellites offers unique value. Satellites orbiting the Earth have a unique vantage point for routine observation of the land, oceans, atmosphere, and sub-surface. They are able to take many different measurements over very large areas, regularly, and over long periods of time, day and night and in all weather conditions.

Data from Earth observation satellites also provides the necessary regional and global context to enable other observational data to be understood. For example, a measurement of the air temperature from a single ground-based observatory tells us certain things; but its value is greatly increased when it can be interpreted in the context of global atmospheric dynamics mapped using satellites.

The costs and complexity of Earth observation satellites are significant. It has long been accepted that international cooperation is critical for comprehensive, sustained, and coordinated observations.

Challenges: Through the international Committee on Earth Observation Satellites (CEOS) and the Coordination Group for Meteorological Satellites (CGMS), satellite Earth observation is well coordinated.

CEOS, as the 'space arm' of GEO, has made strong links to the GEO community at many levels. CEOS engages directly with specific initiatives to understand how existing and future assets can be optimized to meet specific user needs. CEOS also develops 'virtual constellations' that promote continuity of observations for a particular variable (e.g., Sea Surface Temperature), coordinating mission development and operations across space agencies. Through its relationship with GCOS (the Global Climate Observing System) and thereby to the United Nations Framework Convention on Climate Change (UNFCCC), CEOS is managing a systematic response to the provision of Essential Climate Variables. CEOS is also starting to implement cross-cutting 'thematic' observing strategies, such as the CEOS strategies for carbon and water observations.

However, despite this significant progress, challenges remain in ensuring that users have the information derived from satellite data they need, and in ensuring that data plays as full a role as possible in supporting the vision of GEO.

Satellites have a finite life, new user needs emerge, and technologies change. Dealing with these broader challenges does not just require coordination, it ultimately requires investment. Justifying that investment requires:

- Validated and prioritized understanding of the long-term observational requirements;
- Evidence that the data is being used and delivering benefit 'in the real world';
- Strong voices from key parts of the community saying 'we need this'.

Other challenges exist in ensuring the data that is collected delivers maximum benefits. Key areas where further attention is needed include:

- Crafting initiatives that key stakeholders, like development banks, non-governmental organizations and UN institutions, see as sufficiently 'concrete' to engage in and support.
- Proactively building the end-to-end partnerships that ensure users, providers, and other key stakeholders are all involved in defining problems, mobilizing resources, and delivering solutions. An approach predicated on 'first we build the GEOSS, then it gets used' will not work.

- Ensuring the required in-situ observations are captured and made available. Most real world applications benefit when satellite and in-situ observations are integrated. Particularly in the terrestrial domain, there is a lack of coordination of in-situ observation.
- Understanding the role that commercial satellite imagery can play in the future of GEO, and how the complementarity with government satellite programmes can be exploited.
- Accelerating efforts to ensure users can reliably 'mash up' data from multiple missions in a way that: enhances the quality of their products; supports reliable large-scale time-series analyses; and mitigates the risks associated with dependence on a specific mission/sensor.

In some domains (such as moderate resolution land imaging) the data availability landscape has shifted significantly. The availability of global scale free and open data is increasing rapidly, and the challenges are increasingly in ensuring the data is available in forms that make it easy for users to exploit it. These challenges affect all users, but are particularly acute for less developed countries.

These challenges make it critical that next generation data architectures are exploited. Technologies likes cloud computing, and improvements in data correction techniques, have great potential to make satellite data more usable. New approaches may also help ensure satellite data can be better integrated with in-situ and socio-economic/statistical data to derive reliable and high quality information. Obstacles to data access and application need to be removed for satellite EO to realise its full potential in an information-rich world.

In addition to these more general challenges, and despite best efforts in space agency coordination, there are still gaps foreseen in the space segment. For example, a recent CEOS study on how to respond to the GEO Water Strategy has flagged potential gaps. Passive microwave for measurement of sea surface temperature at high latitudes is also an area space agencies are watching closely.

How to Help. Key areas where we would appreciate your help are:

- Providing input to the critical User Needs foundational task, which seeks to define observational requirements. This work will guide space agency efforts to provide the observations users need.
- Getting behind efforts to ensure better coordination of terrestrial in-situ observations.
- Generating evidence of the value of satellite EO (alone and in combination with other data sources), sharing it, and communicating it.
- Where possible, sharing results and techniques so that others can benefit from it. Open code and algorithms are highly desirable, and help accelerate progress in the broader community.
- Engaging with efforts to exploit next generation data products and architectures, and encouraging investment in the infrastructure required to fully utilize them.

We would also like the GEO community to work in a more 'challenge-oriented' way.

It is important that we keep thinking about how to leverage the efforts of specific initiatives to 'build the GEOSS', as this means that what we do now can make it easier to do new things in the future.

However, we need to emphasize that our priority is organizing our efforts and communications around how we, through the convening power of GEO, are connecting people together to solve real world challenges that are important to people today. Frameworks like the *Global Goals for Sustainable Development, Sendai Framework for Disaster Risk Reduction,* and *Paris Climate Agreement* have great potential to help us make this shift.

Contact Information. Jonathon Ross (CEOS Executive Officer). Jonathon.Ross@ga.gov.au.