

A White Paper on Significant Challenges in Earth System Science: Perspectives from the National Geodetic Survey

Introduction

What are key challenges or questions for Earth System Science across the spectrum of basic research, applied research, applications and/or operations in the coming decade? Why are these challenges timely and in particular, why are space-based observations fundamental to addressing these challenges?

Challenge 1.

What geophysical changes are taking place on and within the Earth? What impacts do these changes have on society?

Enhancing the integration of space and ground-based observing systems will continue to support applied research, application development, operational infrastructures and judicious governance of national and international policies. Areas of interest that would see immediate benefits are:

- Improves sea surface topography
- Improves geoid modeling
- Identify gravity changes over time
- Improves spatial resolution of gravity observations
- Supports sea level change monitoring
- Supports spatial and temporal resolutions for land deformation monitoring
- Supports Global Geodetic Observing System (GGOS) initiative
- Improves mass change detection and observations
- Improves measurements to discern geophysical signals

Challenge 2.

How do we accurately monitor geophysical changes over time?

The advent of the Global Positioning System has revolutionized many sectors of society during the last 25 years. Integrating Global Navigation Satellite Systems (GNSS) will further enhance positioning, navigation and timing capabilities that will be an immediate benefit to the scientific, commercial and private sectors. From a scientific and commercial point of view, the integration of GNSS can be used to define a highly stable and accurate terrestrial reference frame. The following areas of interest would benefit:

- Improves sea level change monitoring
- Improves subsidence monitoring locally and regionally
- Improves shoreline delineation and coastal change detection

- Improves sea level observations from global tide gauge network
- Improves tectonic plate motion modeling
- Supports Global Geodetic Observing System (GGOS) initiative
- Improves spatial and temporal resolutions of geospatial observations

Additionally, the integration of global geodetic networks with other observing systems (seismic, ocean buoy, tide gauge, currents, atmospheric conditions) will enhance a number of warning/monitoring systems and will provide additional resources for emergency responders, urban and rural planners/administrators, transportation optimization and tracking as well as enhancing airborne and space-based imaging capabilities. Below are several high-visibility systems that will benefit:

- Improves early warning systems – Tsunamis, Earthquakes, flooding & surges
- Improves emergency response time when natural hazards and events occur
- Improves coastal zone management and resilience initiatives
- Improves 3-D mapping
- Improves change detection
- Enhances feature/species identification

Additional Remarks

Space-based observations such as those from Earth observing systems and GNSS are fundamental to addressing many scientific and operational challenges because they can provide time and position information to datasets that are global, seamless and more valuable. Freely available access to these datasets also supports open source modeling of geophysical phenomena and software products that could be used for many applications including some of the more prominent such as monitoring, forecasting and enhanced decision making.