



Long-Range Science Goals for Geodesy Community Workshop Proposal

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Organizing Committee
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Long-Range Science Goals for Geodesy Community Workshop
Salt Lake City, Utah, October 6, 2009

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Project Summary: We seek funding to convene a one-day community workshop in order to identify new and emerging science challenges in geodesy. Over two decades, rapid advances in new and maturing geodetic technologies have fueled the interrogation of the kinematics, structure, and dynamics of the solid Earth and its fluid envelopes. The pace of this change is quickening, and is coupled with the recognition of and investment in technology-driven science as a national asset in a global economy. In response to the need to articulate new and emerging research opportunities in geodesy and its interdisciplinary applications, we propose a workshop to develop a written plan in a Grand Challenges format, identifying the science questions, required workforce development and diversity, and needed instrumentation and facilities. The objectives of this workshop are to build consensus on the most pressing and promising grand challenges that can be addressed with geodesy, focusing on solid earth sciences, hydrology, and cryospheric and atmospheric sciences. The results of this meeting will be distributed to NSF, NASA, USGS and other agencies and organizations, and will inform related science planning efforts. On behalf of the conference organizers, UNAVCO seeks support for 77 U.S. scientists to attend the meeting. Session leaders at the workshop will form the writing committee that will produce a draft white paper to distribute before Fall AGU, 2009, and a final document by end of January 2010.

Intellectual Merit

With the continued development of advanced terrestrial and space geodetic methods, geodesy has grown rapidly and there are now crucial geodetic applications in a wide range of scientific fields, from ground water systems and fault dynamics to mapping the speed of ice flows and the amount of water vapor in the atmosphere. This workshop will provide critical guidance for how to best take advantage of these rapid scientific advances – particularly in interdisciplinary studies and new applications – and recent technological advances (e.g. TLS, LiDAR, InSAR, real-time GPS). It will identify the science questions, required workforce development and diversity, and needed instrumentation and facilities to take advantage of the major new opportunities that have emerged in recent years in the field of geodesy.

Broader Impacts

The long-term science goals articulated at the proposed workshop will guide the infrastructure development and community efforts over the next decade. The workshop will also identify the most pressing needs of the geodetic community, in particular regarding the training of future geodesists and the education of scientists so they can use the rapidly advancing geodetic technology, and rapidly growing geodetic data sets, for their research. The results of this meeting will include a strategic plan for how to train researchers, present and future, in geodetic methods to ensure that the scientific challenges we face can be met. The results of the workshop will be provided to government agencies and to the broader community through publication of a final plan document, distributed at key meetings and posted on the UNAVCO website.

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Summary of Request: We seek funding to convene a one-day community workshop in order to identify new and emerging science challenges in geodesy. The proposed workshop will precede and inform both the EarthScope Science Planning workshop and the National Academy of Sciences' report on broad research opportunities in the Earth Sciences. The goals of this workshop are to build consensus on the most pressing and promising grand challenges that can be addressed with geodesy, focusing on solid earth sciences, hydrology, and cryospheric and atmospheric sciences. The results of this meeting will be distributed to NSF, NASA, USGS and other agencies and organizations, and will inform related science planning efforts. On behalf of the conference organizers, UNAVCO seeks support for 77 U.S. scientists to attend the meeting. Session leaders at the workshop will form the writing committee that will produce a draft white paper to distribute before Fall AGU, 2009, and a final document by end of January 2010.

Rationale for the Workshop

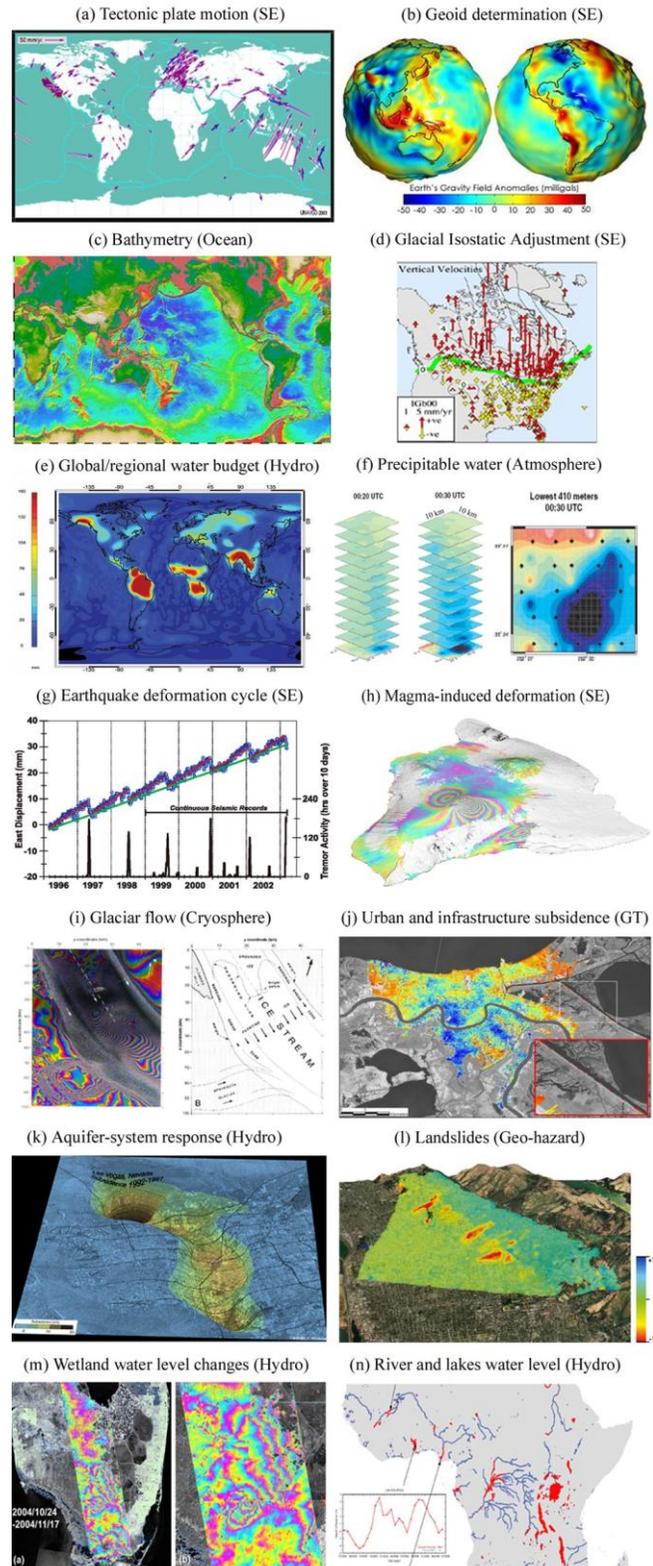
Over two decades, rapid advances in new and maturing geodetic technologies have fueled the interrogation of the kinematics, structure, and dynamics of the solid Earth and its fluid envelopes (Figure 1). The pace of this change is quickening, and is coupled with the recognition of and investment in technology-driven science as a national asset in a global economy. In response to the need to articulate new and emerging research opportunities in geodesy and its interdisciplinary applications, we propose a workshop to develop a written plan in a Grand Challenges format, identifying the science questions, required workforce development and diversity, and needed instrumentation and facilities. This plan will inform a number of other national science planning initiatives scheduled to occur by early in 2010.

The UNAVCO community developed a strategic plan in 2008, providing a roadmap to advance new science directions – many of which were articulated in 2007, and submitted in proposals for the geodesy facility's core support. Because of rapid scientific advances – particularly in interdisciplinary studies and new applications – and the quickening pace of technological change, major new opportunities have emerged, even in the last two or three years. With the continued development of advanced terrestrial and space geodetic methods, geodesy has grown rapidly and there are now crucial geodetic applications in a wide range of scientific fields, from ground water systems and fault dynamics to mapping the speed of ice flows and the amount of water vapor in the atmosphere.

The need for a plan builds on many recent advances: (1) expanded geodetic imaging at regional and global scales, including LiDAR, InSAR, UAVSAR, and global gravity data acquisition; (2) progress towards mm-level global GPS geodesy; (3) availability of research, civic, and commercial real-time GPS networks around the world; (4) a burgeoning demand for TLS technology; (5) improvements in data access and analysis with web services and cyberinfrastructure; (6) the potential for expanded use of autonomous integrated geodetic and geophysical networks to new scientific targets in new geographic settings – including the polar regions – and new science disciplines; (7) new tools for ingestion and analysis of large and complex data sets; (8) new applications in research areas such as atmospheric science and hydrology; (9) the potential to build on continent- and global-scale integrated geodetic data sets such as Plate Boundary Observatory/EarthScope and the planned DESDynI mission; (10) opportunities to advance early warning with integrated geophysical data sets, and (11) community commitment to integrative scientific studies that link massive data sets to physically-based models, with direct relevance to mitigation of natural hazards, through the collection and stewardship of long-term geodetic observations.

A long-range science plan that addresses these opportunities will provide the community with important insight into the most promising research questions that can be addressed by geodetic methods, and for answering fundamental science questions in a variety of fields. Thus, we seek funding to organize a workshop bringing current and future leaders in the relevant scientific disciplines together to define the elements of this plan.

Figure 1. From *Geodesy in the 21st Century*, EOS, May 5, 2009. See the electronic supplement for references.



Proposed Workshop

The workshop will be organized around six scientific themes in areas where geodesy is contributing to fundamental discoveries:

- Natural Hazards

Surface deformation and gravity measurements around active faults and volcanic systems, landslides, regions of active subsidence are critical to understanding both the scientific processes and the societal hazards associated with these systems. Recent advances in geodetic techniques have also brought applications to tsunami warning and extreme weather events.

- Climate Change

One of the great scientific challenges is the understanding of interactions among the cryosphere, oceans, and the solid Earth, particularly in regard to the global redistribution of water and the implication for sea level. Geodetic measurements are also playing an increasingly important role in weather forecasting and for the study of atmospheric dynamics.

- Hydrology

Geodetic imaging is providing important insights into the dynamics of local and regional aquifers, surface water, soil moisture, and snow pack, and is crucial for measuring changes in the ground-water supply and constraining the terrestrial water budget. More than 80 percent of the identified subsidence in the United States is a consequence of the increasing development of land and water resources, which threatens to exacerbate existing land subsidence problems and initiate new ones. Characterizing and monitoring how surface water (lakes, rivers, etc) is naturally and anthropogenically redistributed in space and time is key to resolving the terrestrial water supply component of the water cycle. Resolving the aerial extent, volume, surface velocities and circulation patterns in rivers and water bodies will significantly advance our understanding of the terrestrial water budget.

- Cryosphere

Space geodesy has brought major advances in recent years in what we know about glaciers and the dynamics of ice flow, including the role of land ice (ice sheets, caps and glaciers) in current and future sea level rise and the role of sea ice and associated feedbacks on the global climate system.

- Global Geodynamics

Detailed measurements of surface motion and gravity field on continental and planetary scales are essential for understanding deformation of the tectonic plates and the fluid behaviour of the mantle below. Determination of earth rotation parameters, such as the polar motion and the length of day is also important for constraining geodynamic models and the internal structure of the Earth.

- Geomorphology and Surface Processes

The Earth's land surface is continuously reshaped by catastrophic tectonic and hydrologic events, sea level rise, and collapses; all of which impact the terrestrial water supply, ecosystems, and infrastructure. Measuring and characterizing the changes in the landscape and how the movement of water affects the land surface is key in understanding geologic and hydrologic processes and making links between hydrology, geology and biosphere.

Each of these themes will have a leading scientist in that field chairing the discussion of research opportunities in that topic. There will be a lot of ground to cover in a single day meeting, and so the organizing committee will try to strike a balance between inclusiveness and focused discussion. Our proposed agenda for the workshop is as follows:

Pre-workshop evening

7:00 pm Ice Breaker – welcoming remarks

Proposed Workshop Agenda

8:30 am Introductory Plenary Session

- Introduction from organizing committee (15 min)
- Keynote talks on morning themes emphasizing emerging research areas (15-20 min each)

10:00 am Morning breakout session (3 themes in parallel)

- 1-2 short presentations
- Discussion of scientific challenges and how they can be addressed by geodesy.

12:00 pm Lunch (Org. committee and theme leaders can meet to review results of morning session.)

1:00 pm Afternoon Plenary Session

- Keynote talks on afternoon themes emphasizing emerging research areas (15-20 min each)

2:00 pm Afternoon breakout session (3 themes in parallel)

- 1-2 short presentations
- Discussion of scientific challenges and how they can be addressed by geodesy.

4:00 pm Closing Plenary Session

- Reports from theme leaders
- Discussion with community

Organizing committee and Theme leaders will have working dinner to begin draft of white paper.

The primary goal of the workshop is the identification of key areas where additional research is needed to further our understanding dynamic systems within the Earth, atmosphere, cryosphere, and hydrosphere; this will be achieved through a community workshop, followed by additional forums for community input on the draft white paper. Since we plan to have the first draft of the document by the Fall AGU meeting, we will make the long range science plan a key component of the UNAVCO business meeting, as well as providing an electronic forum for community input.