

# Precise Geodetic Infrastructure

## National Requirements for a Shared Resource



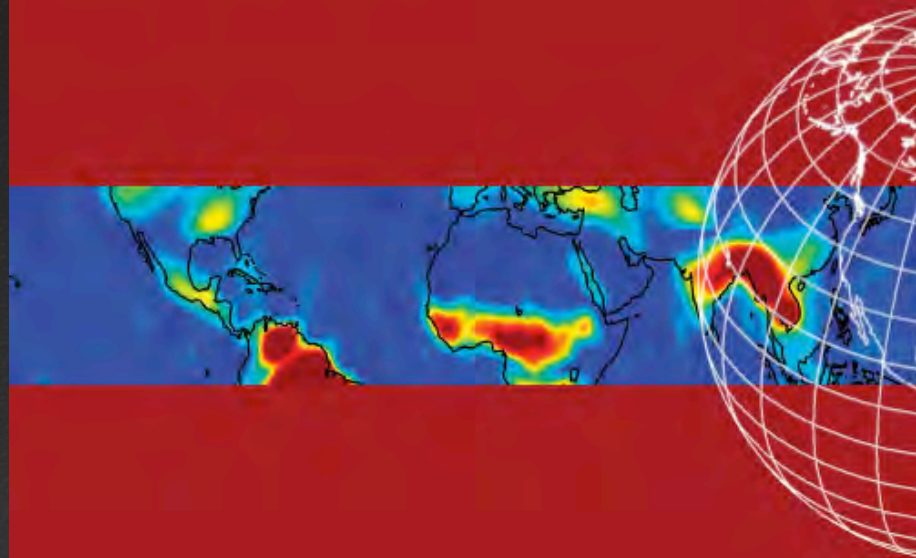
Jean-Bernard Minster

John C. Ries

Thomas A. Herring

October 1, 2010 Briefing

PRECISE GEODETIC INFRASTRUCTURE  
National Requirements for a Shared Resource

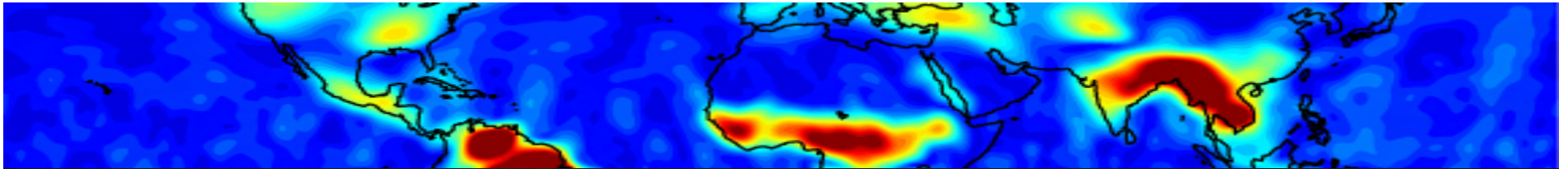


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## Task

- Describe and assess the range of benefits to the nation that are dependent on high precision geodetic network
- Review high priority scientific objectives that are dependent on geodetic networks
- Describe the infrastructure requirements for achieving these objectives and benefits
- Assess the opportunities for technological innovation that will arise from renewed investment in geodetic infrastructure
- Recommend a national plan for the implementation of a precision geodetic infrastructure



## ***Committee members***

**J. Bernard Minster** (Chair), Scripps Institution of Oceanography, La Jolla, California

**Zuheir Altamimi**, Institut Géographique National, Paris France

**Geoffrey Blewitt**, University of Nevada, Reno

**William E. Carter**, University of Florida, Gainesville

**Anny Cazenave**, Centre National d'Études Spatiales, Toulouse, France

**Herb Dragert**, Natural Resources Canada, Sidney, British Columbia

**Tom A. Herring**, Massachusetts Institute of Technology, Cambridge

**Kristine M. Larson**, University of Colorado, Boulder

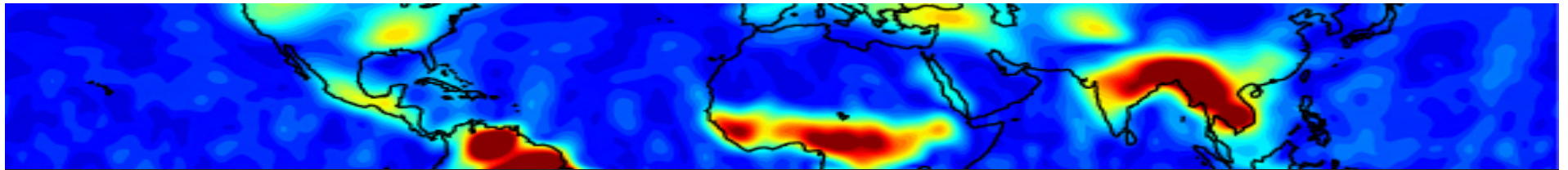
**John C. Ries**, University of Texas at Austin

**David T. Sandwell**, Scripps Institution of Oceanography, La Jolla, California

**John M. Wahr**, University of Colorado, Boulder

*Liaison from the Committee on Seismology and Geodynamics*

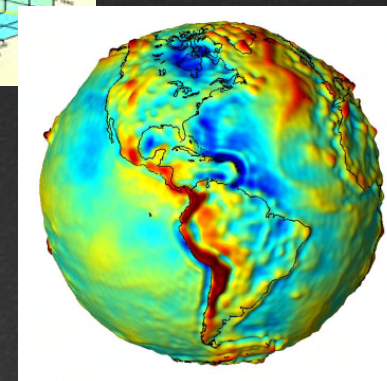
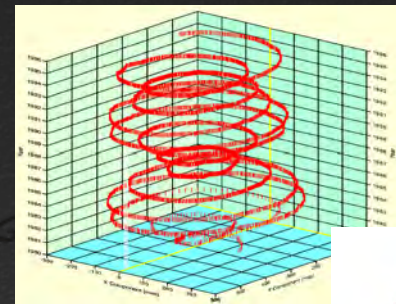
**James L. Davis**, Lamont-Doherty Earth Observatory, Columbia University, New York



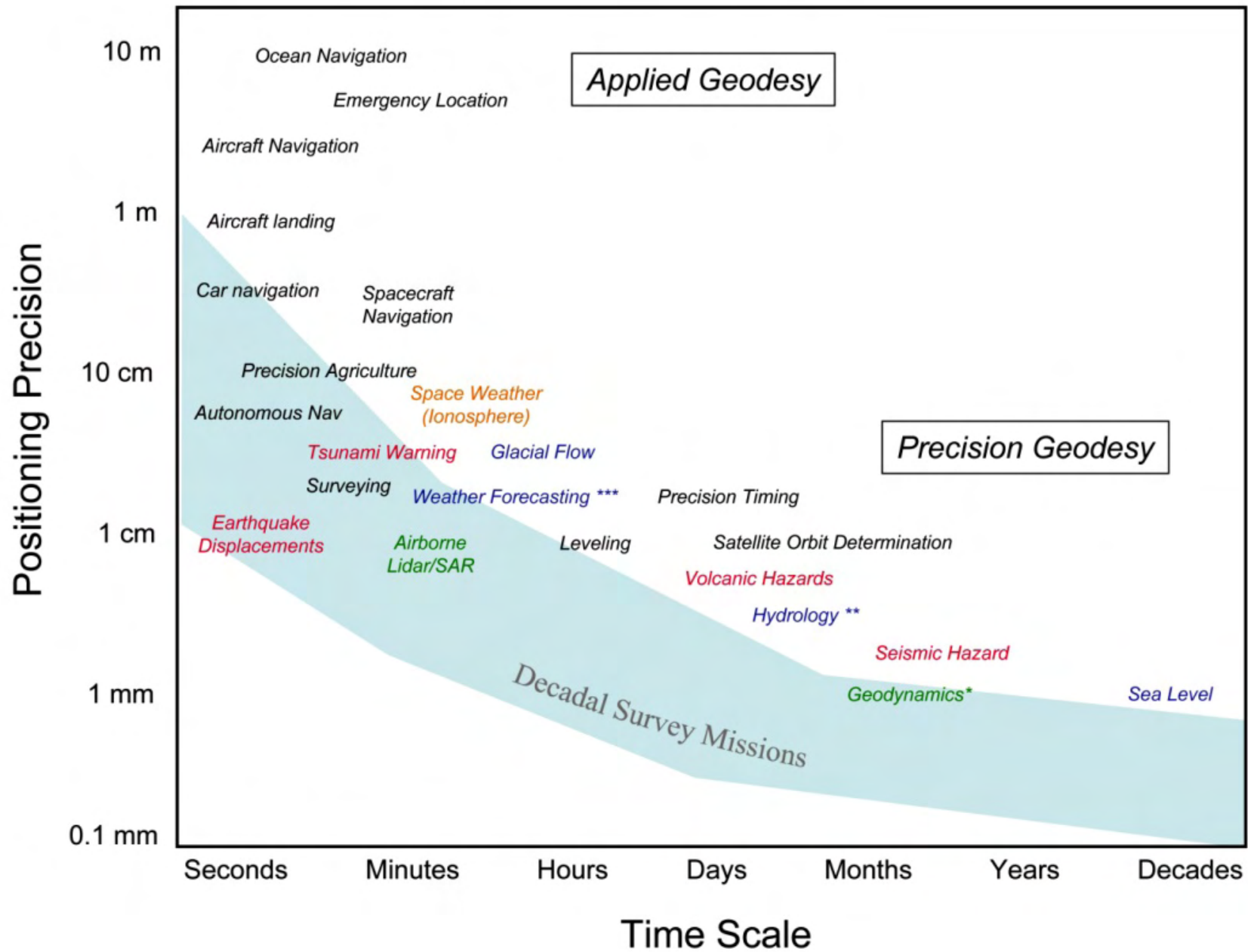
## GEODESY

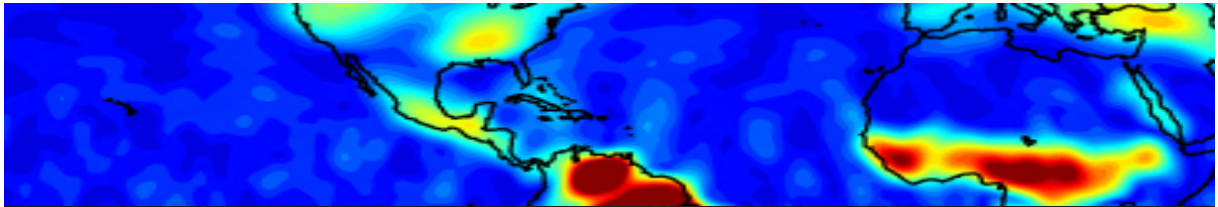
The science of accurately measuring and understanding three fundamental properties of Earth:

- its geometric shape,
- its orientation in space,
- its gravity field,



... and the changes of these properties with time.

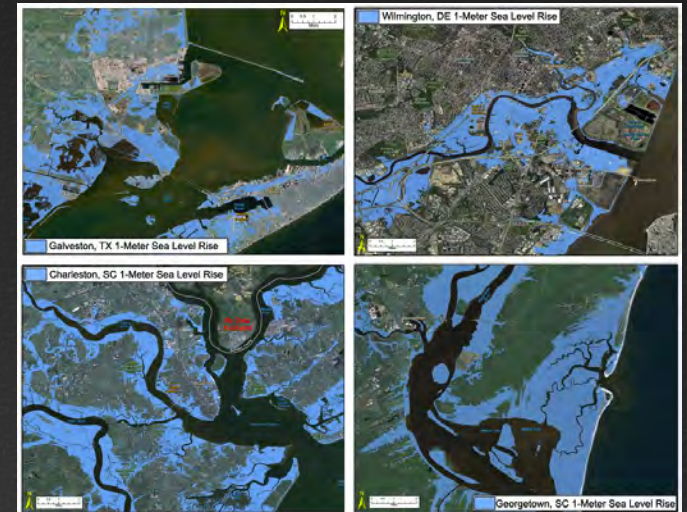
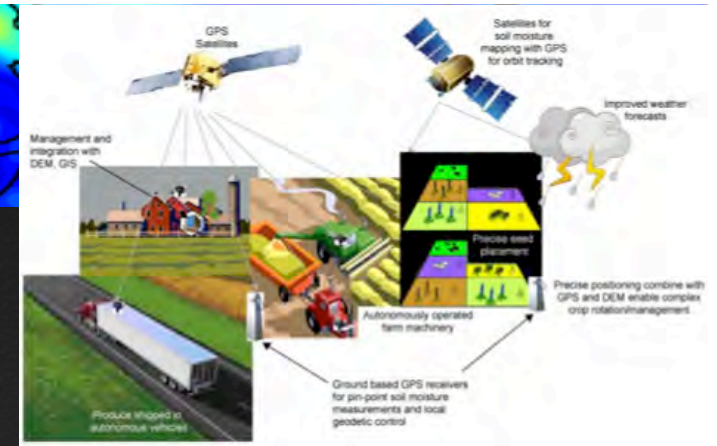




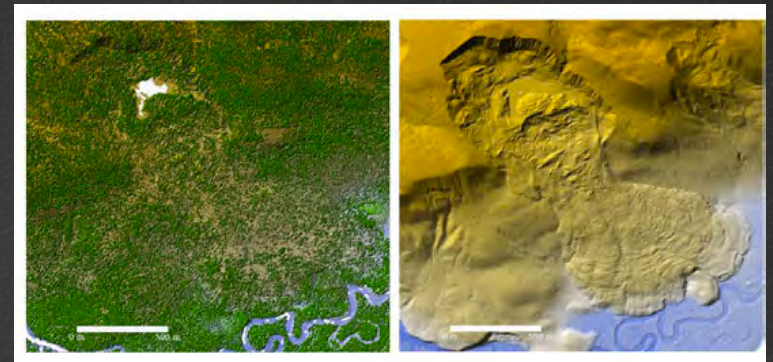
## Geodesy for the benefit of society

Military, research, civil, and commercial areas, e.g.:

- Real time positioning
- Autonomous navigation (roads, sea, air)
- Precision agriculture
- Surveying, floodplain mapping
- Forest mapping, biomass estimation
- Natural hazards monitoring and early warning
- Sea level change



... TIME IS OF THE ESSENCE!



# Earth Science Requirements

## Solid Earth Dynamics

- Geodynamics, PGR, EOP

## Natural Hazards

- Volcano, Earthquake, Landslide, Flood, Tsunami

## Ocean and Cryosphere Dynamics

- Sea Level Rise

## Hydrologic Cycle and Water Resources

- Storage, Subsidence, River and Lake Levels

## Weather .

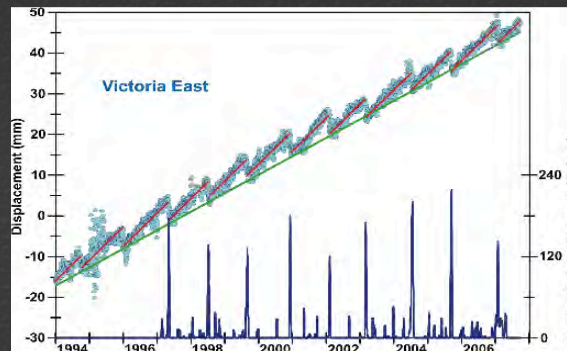
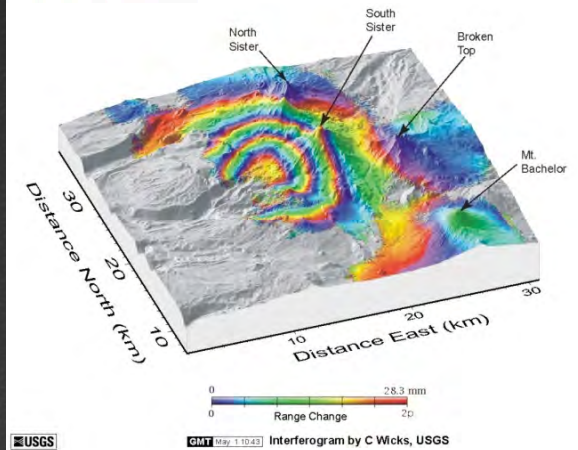
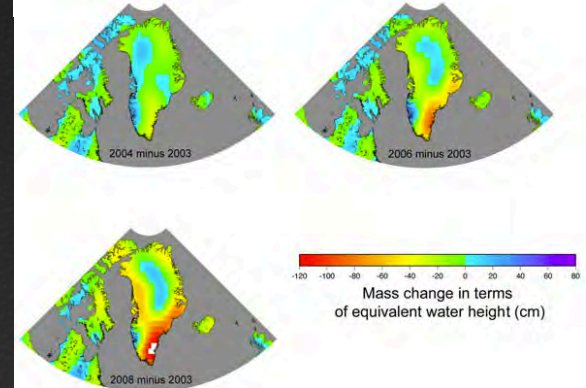
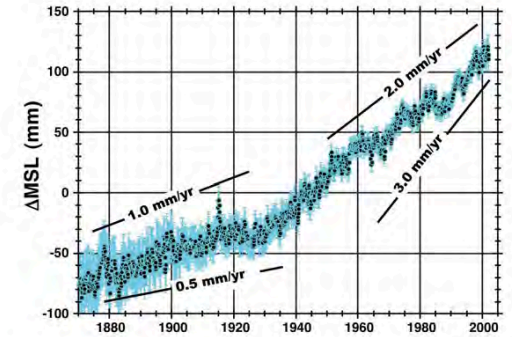
- Ground- and Based, Space Weather

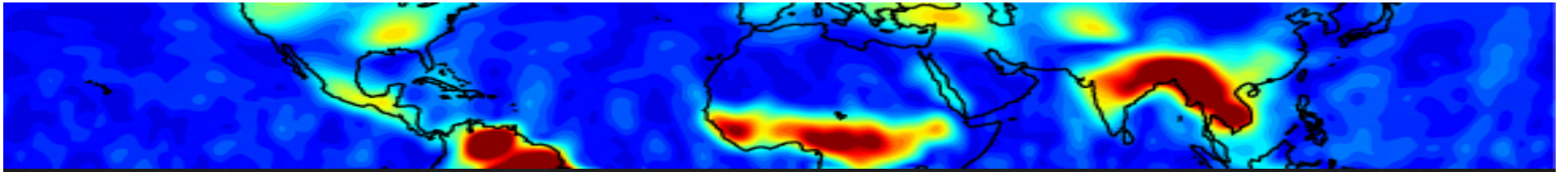
## Precision Spacecraft Navigation

- Precision Orbit Determination, Interplanetary Navigation

## Timing and Time Transfer .

## Decadal Missions

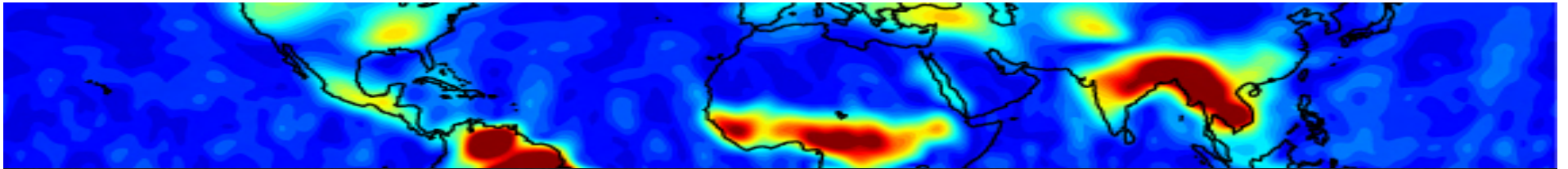




# Geodetic Infrastructure

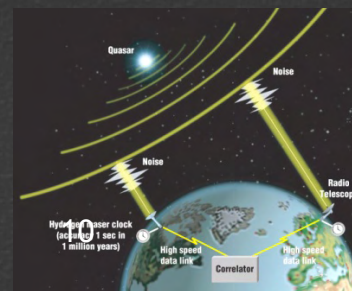
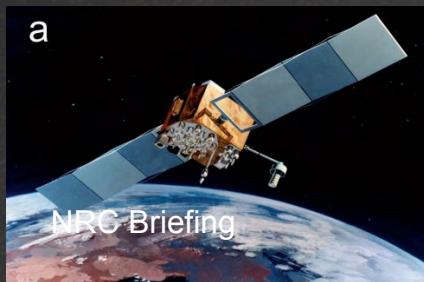
- Ground-based networks (local to global, temporary to permanent)
- Earth observation satellites (precise positioning, altimetry, gravity)
- Data collection, dissemination and stewardship facilities
- National and international services

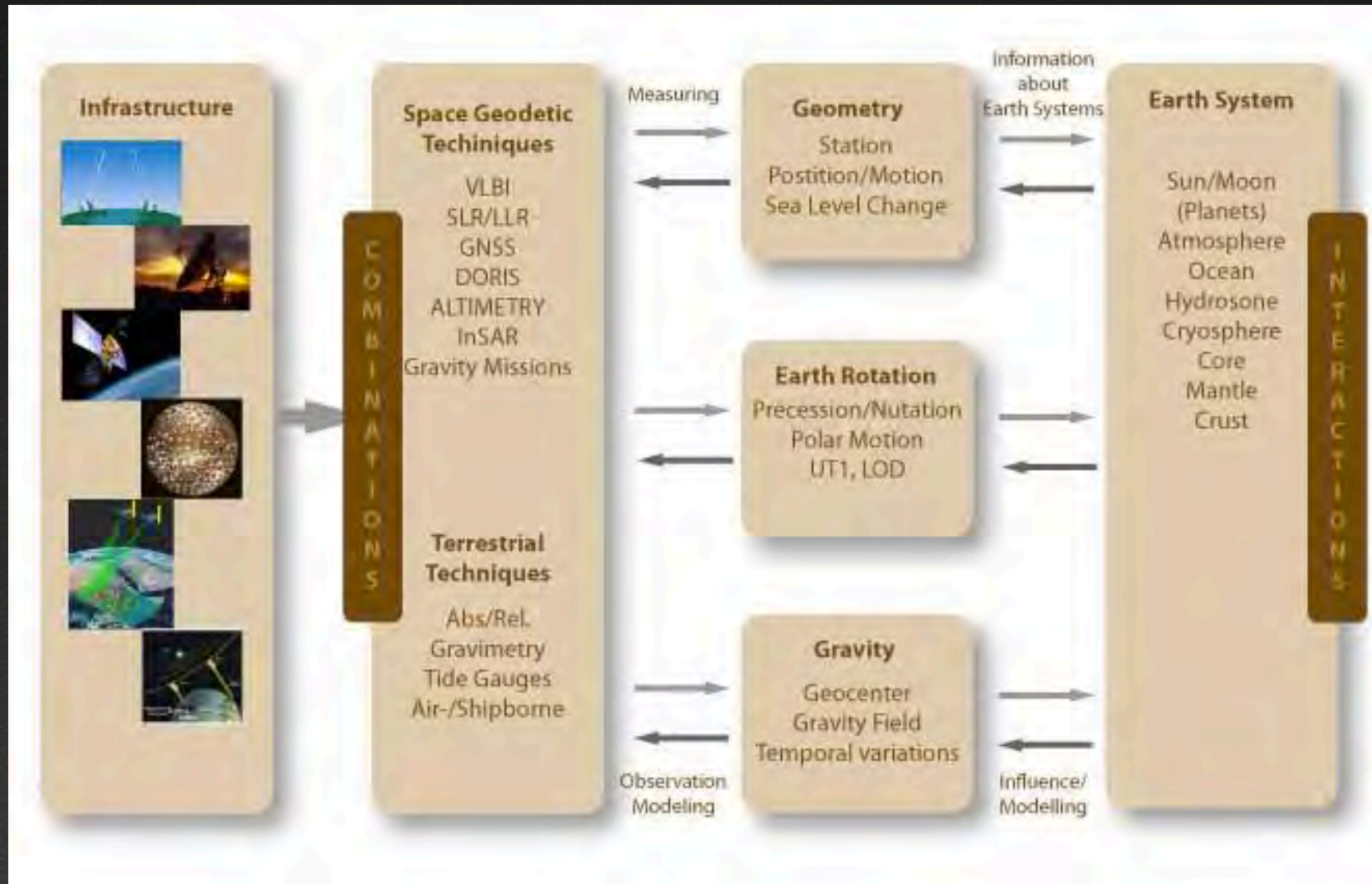
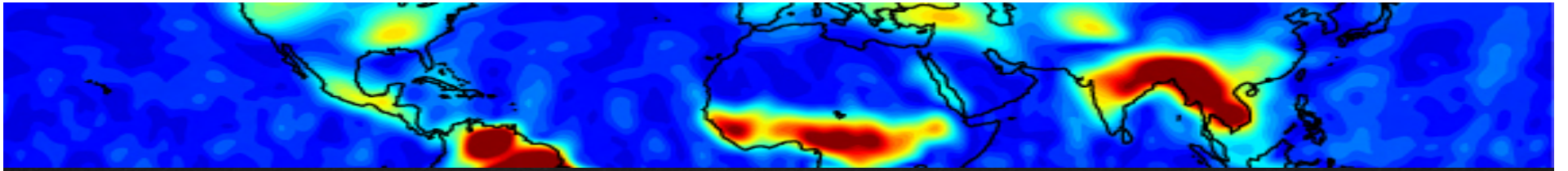


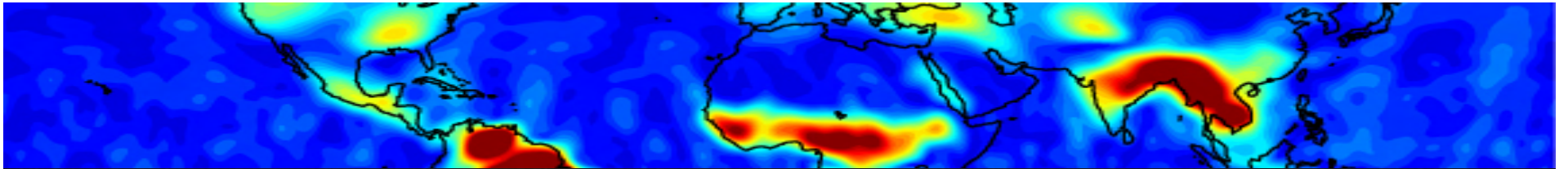


# Geodetic Systems

- Very Long Baseline Interferometry (VLBI)
- GNSS/GPS
- Satellite and Lunar Laser Ranging (SLR and LLR)
- Doppler Orbit Determination and Radiopositioning Integrated by Satellite (DORIS)
- Ground and airborne gravity
- Tide gauges







# Precision geodesy since Sputnik

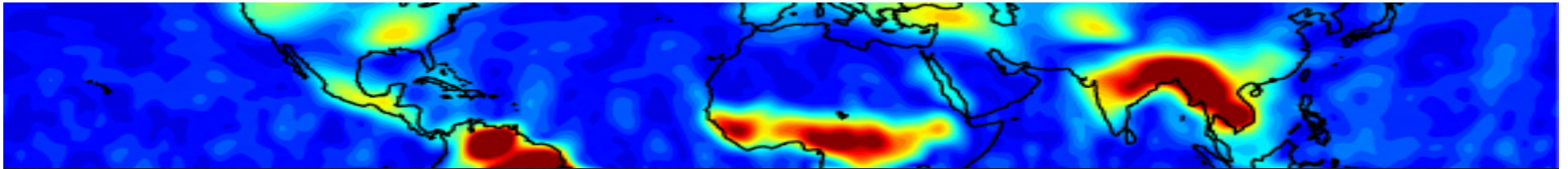
... advanced by about one order of magnitude each decade

... does not show any sign of slowing down!

... is now truly global

... pushed the envelope in spatial and temporal resolution

... is more and more driven by real time applications



# So...what's the problem?

- Critical infrastructure in “danger of collapse”
  - Some critical networks are sparse and ill-balanced
  - Some sites rely on decades-old equipment
  - Cross-system connections are still not resolved satisfactorily
- Aging, small workforce: where are the new geodesists coming from?
- Nobody has overall long-term responsibility

**These combined factors pose a risk of a sudden, drastic loss of geodetic observing capability**

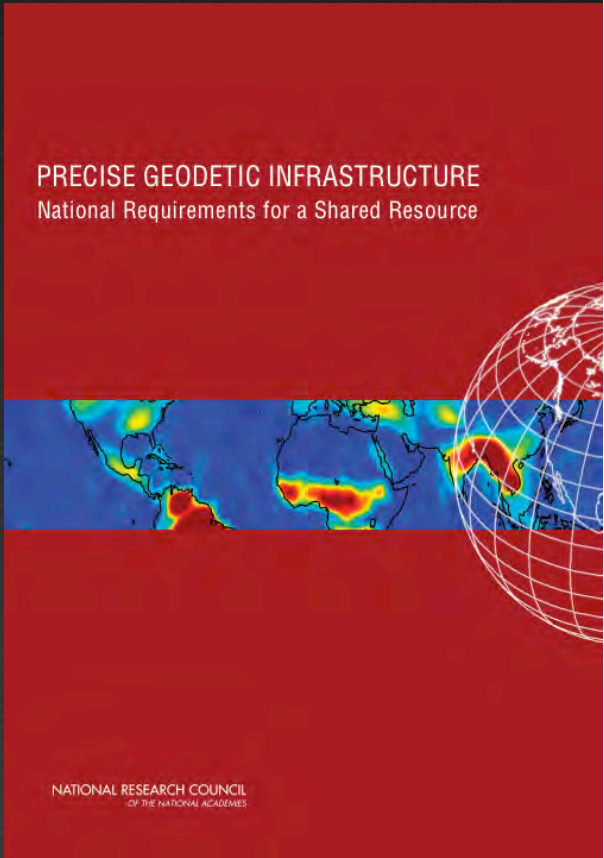
- How does the US support GEO/GEOSS in the long term?



# What we need to do!

**The United States, to maintain leadership in industry and science, and as a matter of national security, should invest in maintaining and improving the geodetic infrastructure, through:**

- **upgrades in network design and construction**
- **modernization of current observing systems**
- **deployment of improved multi-technique observing capabilities, and**
- **funding opportunities for research, analysis, and education in global geodesy.**



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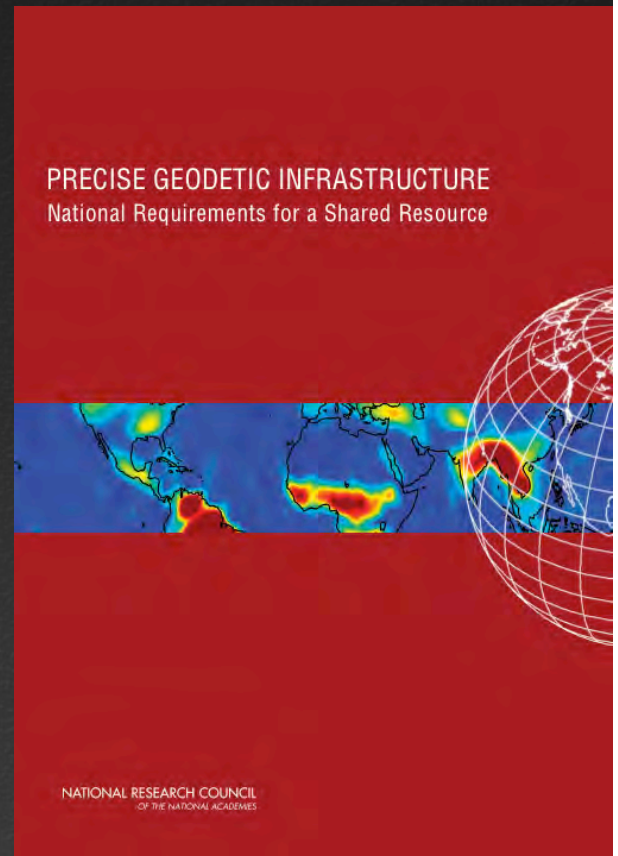
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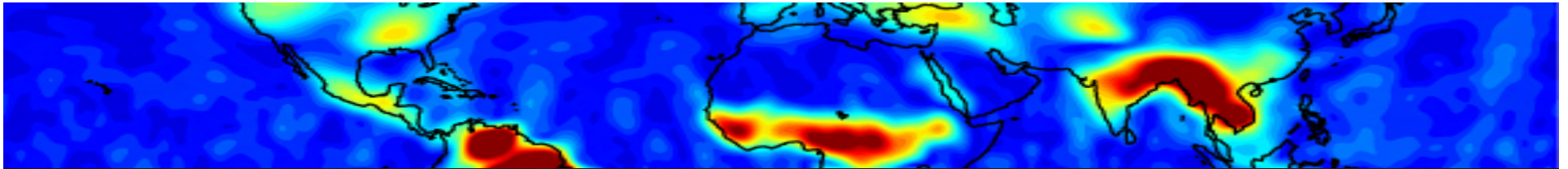


## Specifically, in the near-term..

- **The United States should construct and deploy the next generation of automated high-repetition rate SLR tracking systems at the four current U.S. tracking sites in Hawaii, California, Texas, and Maryland.**
- **It also should install the next-generation VLBI systems at the four U.S. VLBI sites in Maryland, Alaska, Hawaii, and Texas.**

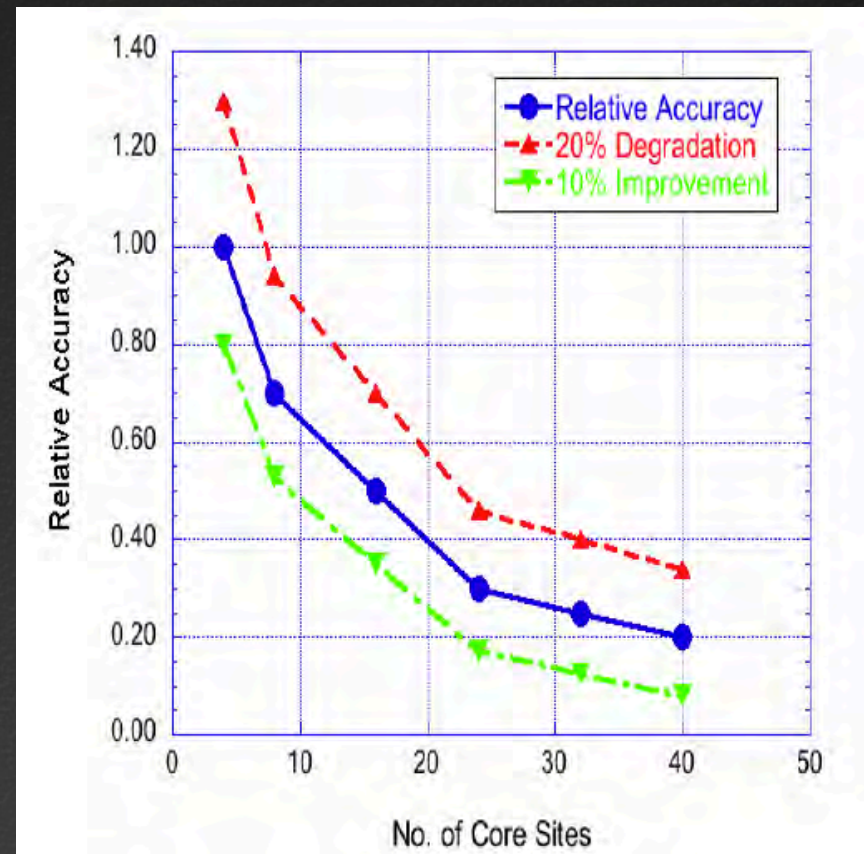
**Maintaining the long history of data provided by these sites is essential for reference frame stability as we transition between ever-evolving geodetic techniques.**

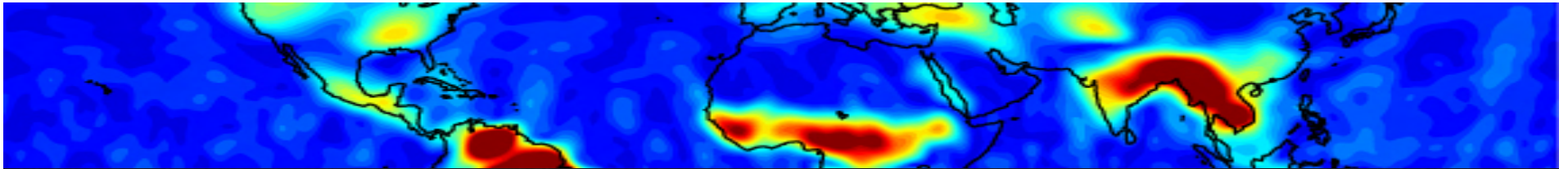




## And in the long-term...

The United States should deploy additional stations to complement and increase the density of the international geodetic network, in a cooperative effort with its international partners, with a goal of reaching a global geodetic network of at least 24 fundamental stations.

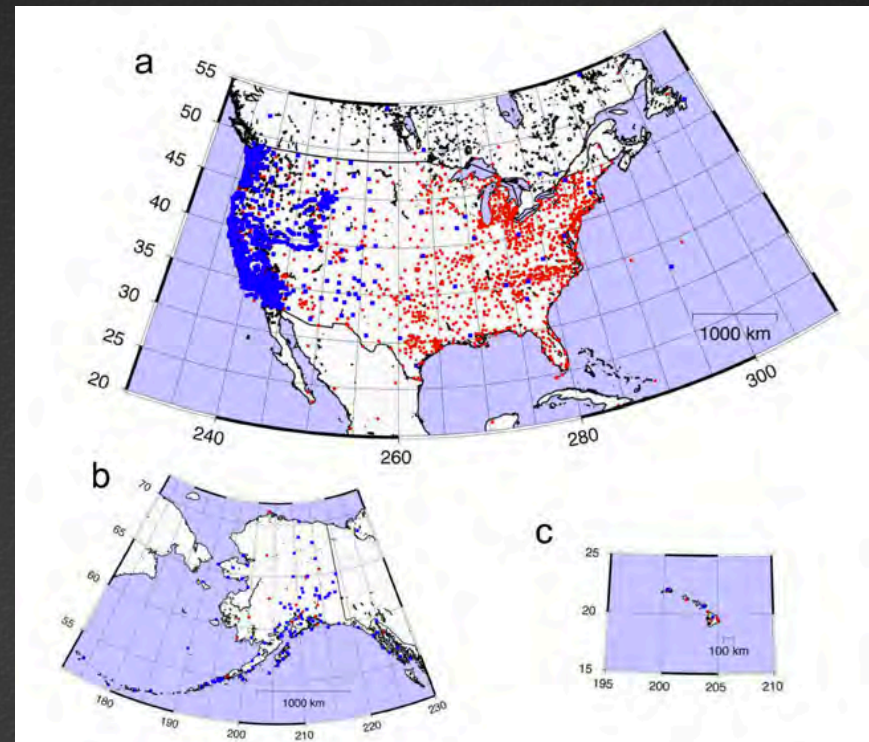


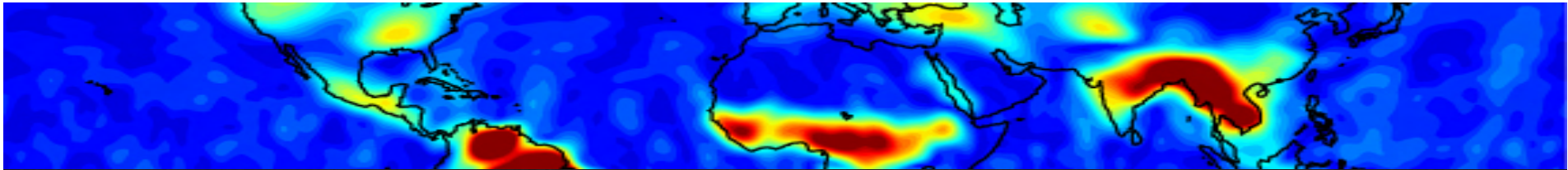


## Meanwhile ...

The United States should establish and maintain a high-precision GNSS/GPS national network constructed to scientific specifications, capable of streaming high-rate data in real-time.

All GNSS/GPS data from this network should be available in real-time without restrictions (and at no cost or a cost not exceeding the marginal cost of distribution), as well as in archived data files.





# Global responsibility, national interest...

The United States should continue to participate in, and support the activities of, the international geodetic services (IGS, ILRS, IVS, IDS, IGFS and IERS) by providing long-term support for the operation of geodetic stations around the world and by supporting the participation of U.S. investigators in the activities of these services.

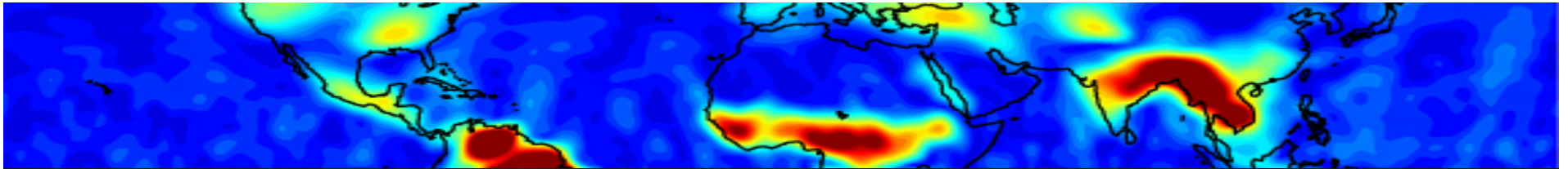


**International GNSS Service**  
Formerly the International GPS Service



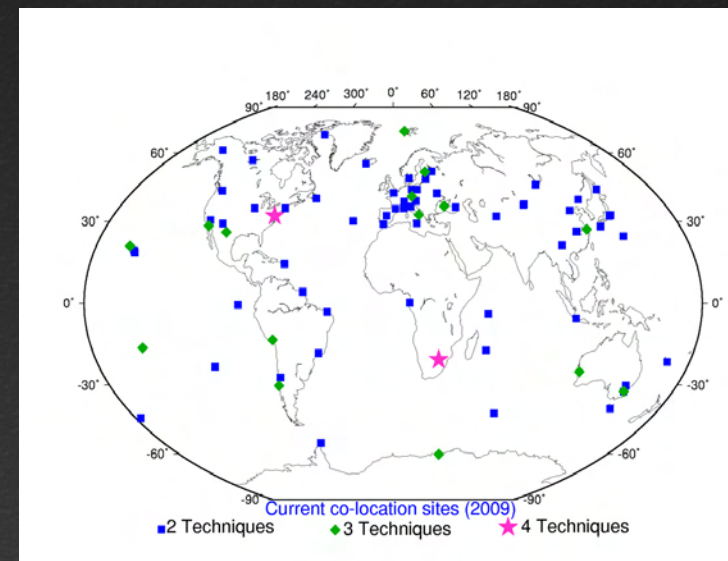
International Earth Rotation and Reference Systems Service

3849 3849803099 5893984112 3890 3478346191  
2788 28 171878 26531486933  
7267276278264236  
46 353193246



## A long-term global reference frame...

The U.S., through the relevant federal agencies, should make a long-term commitment to maintain the International Terrestrial Reference Frame (ITRF) to ensure its continuity and stability. This commitment would provide a foundation for Earth system science, studies of global change, and a variety of societal and commercial applications.

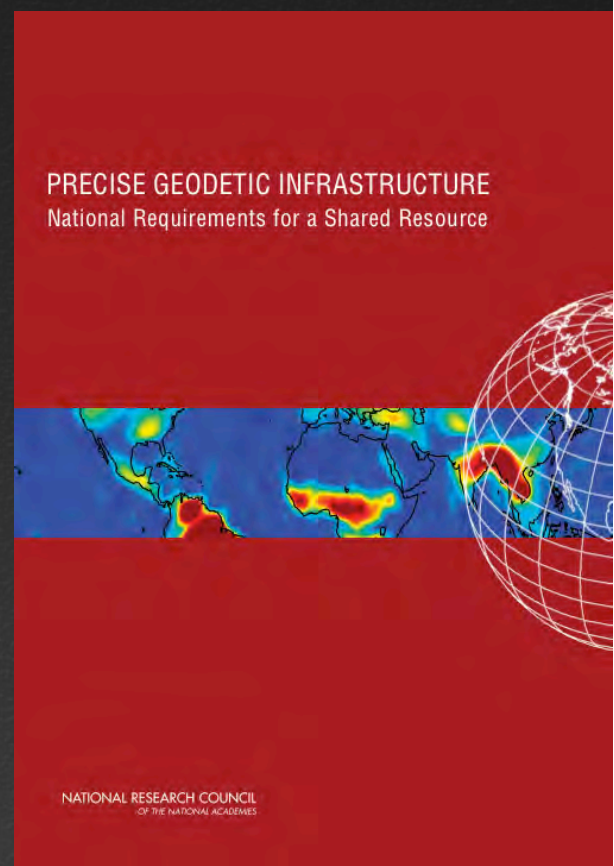


**MORE TIES, please!**



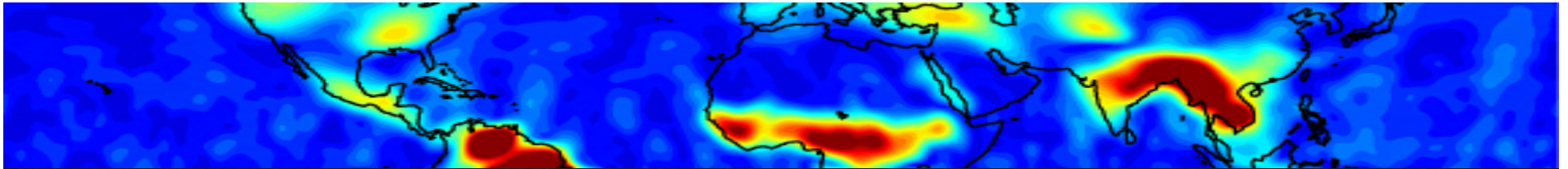
# How do we make this work?

**The United States should establish a federal geodetic service to coordinate and facilitate the modernization and long-term operation of the national and global precise geodetic infrastructure to ensure convenient, rapid, and reliable access to consistent and accurate geodetic data and products by government, academic, commercial, and public users.**



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**... but we'll need trained people!**

**A quantitative assessment of the workforce required to support precise geodesy in the United States and the research and education programs in place at U.S. universities should be undertaken as part of a follow-up study focused on the long-term prospects of geodesy and its applications.**

