NASA

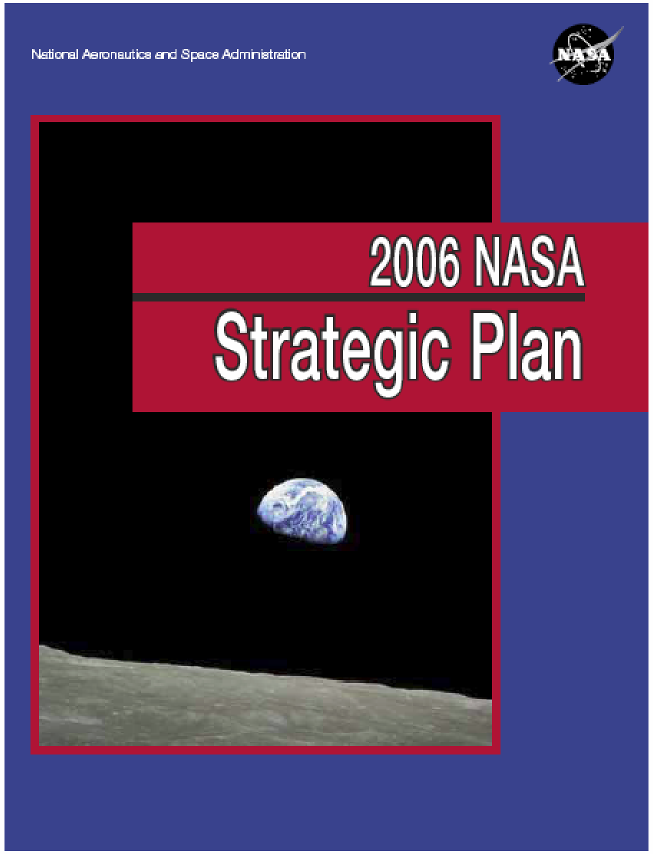
Topics

Outline

- NASA Earth Science
- The US National Research Council's *Decadal Survey*
- The Role of GGOS in These Endeavours

NASA's Strategic Goals: 2006 Through 2016

NASA is a research and development agency formed in 1958 with responsibility for all US government, non-military aeronautic and space activities



Strategic Goal 1: Fly the Shuttle as safely as possible until its retirement, not later than 2010.

Strategic Goal 2: Complete the International Space Station in a manner consistent with NASA's International Partner commitments and the needs of human exploration.

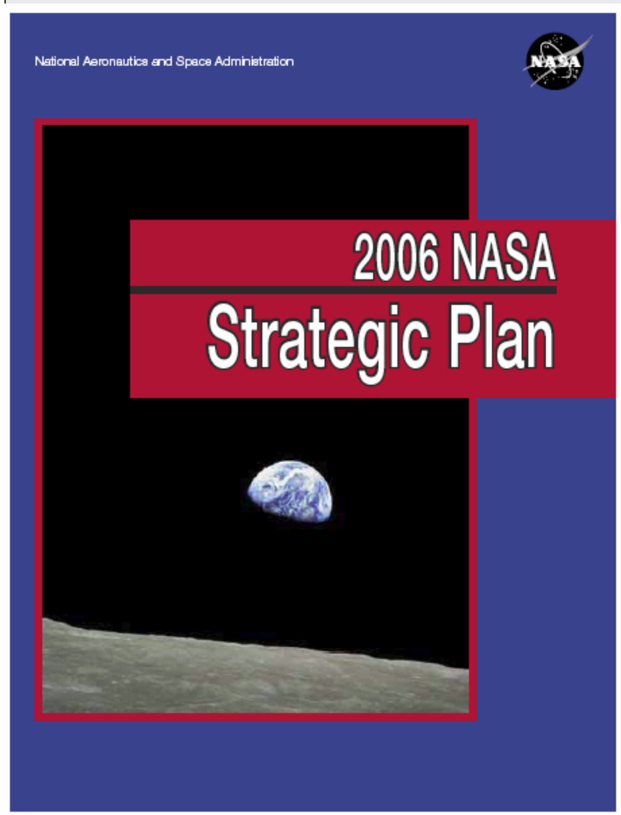
Strategic Goal 3: Develop a balanced overall program of science, exploration, and aeronautics consistent with the redirection of the human spaceflight program to focus on exploration.

Strategic Goal 4: Bring a new Crew Exploration Vehicle into service as soon as possible after Shuttle retirement.

Strategic Goal 5: Encourage the pursuit of appropriate partnerships with the emerging commercial space sector.

Strategic Goal 6: Establish a lunar return program having the maximum possible utility for later missions to Mars and other destinations.

NASA’s Science Goals



- ***Study Earth from space to advance scientific understanding and meet societal needs. (Earth Science)***
- Understand the Sun and its effects on Earth and the solar system. (Heliophysics)
- Advance scientific knowledge of the origin and history of the solar system, the potential for life elsewhere, and the hazards and resources present as humans explore space. (Planetary Science)
- Discover the origin, structure, evolution, and destiny of the universe, and search for Earth-like planets. (Astrophysics)

NASA Earth Science Questions

How is the Earth changing, and what are the consequences for life on Earth?

- How is the global Earth system changing?
- What are the primary causes of change in the Earth system?
- How does the Earth system respond to natural and human-induced changes?
- What are the consequences for human civilization?
- How will the Earth system change in the future?

6 Focus Areas

1. *Atmospheric Composition*
2. *Weather*
3. *Carbon Cycle & Ecosystems*
4. *Water & Energy Cycle*
5. *Climate Variability & Change*
6. *Earth Surface & Interior*

Earth Science Division (cont.)

Five major activities:

- Conducting selected Earth observing satellite missions
- Making high-quality data products available to the broad science community
- Conducting and sponsoring cutting-edge research in the 6 focus areas
- **Applied Science: accelerating the discovery of new and novel uses of NASA Earth science results for societal benefit**
- Developing technologies to improve Earth observation capabilities

Tools: 14 Major Satellites in Orbit

2006 and beyond

Earth Science and Applications from Space
National Imperatives for the Next Decade and Beyond

January, 2007

National Research Council

National Academy of Sciences

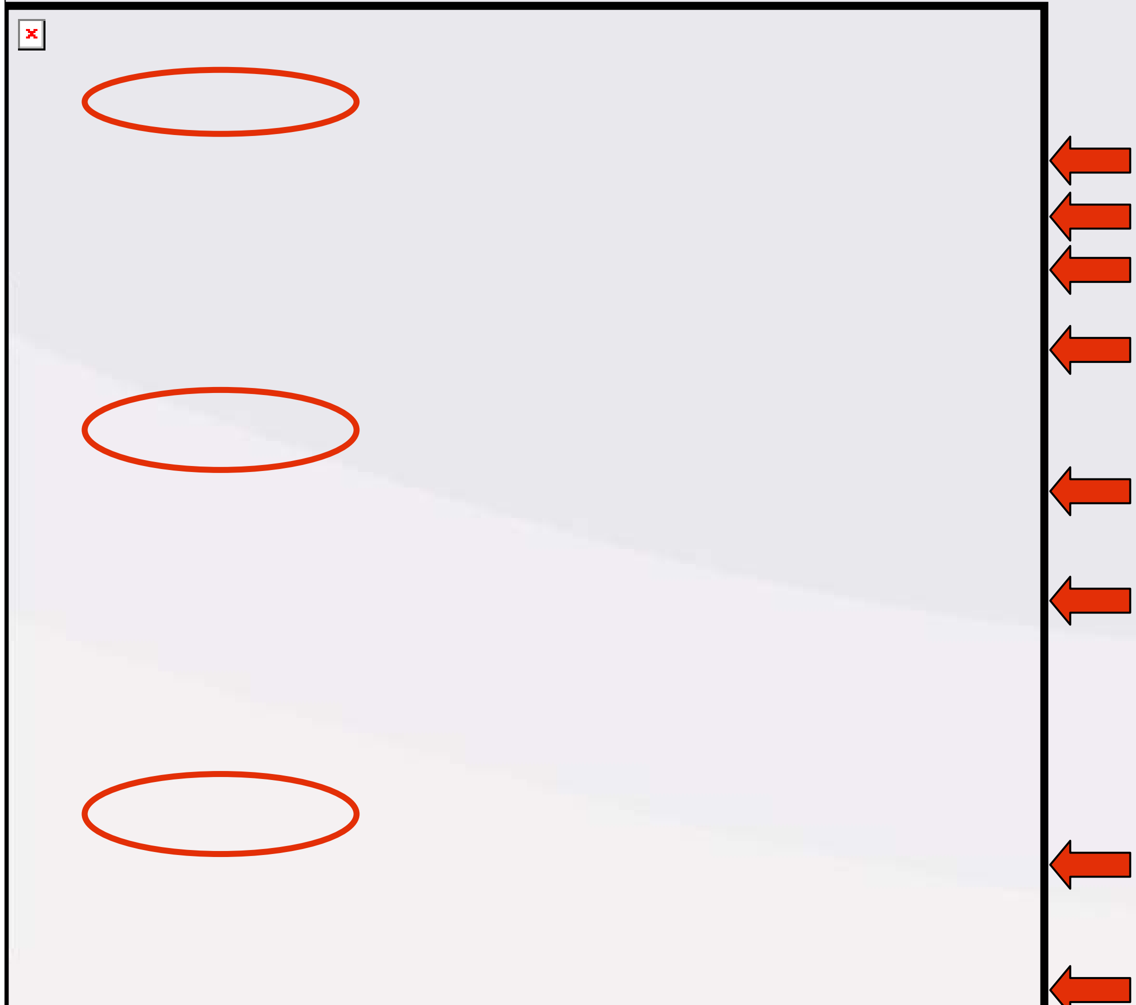
Prepublication: http://www.nap.edu/catalog/11820.html

MAIN RECOMMENDATION
(for next decade)

- NOAA and NASA should undertake a set of 17 recommended missions, phased over the next decade

Decadal Survey

Investing resources to assure the improvement and the continued operation of this geodetic infrastructure is a requirement of virtually all the missions for every Panel in this study



Decadal Study Mission Recommendations Will Depend upon The Global Geodetic Observing System

The Requirement for Precise Measurement and Maintenance of the Terrestrial Reference Frame: (*Earth Science and Applications from Space: National Imperatives for the Next Decade and Beyond, NRC,2007)*

"The geodetic infrastructure needed to enhance, or even to maintain the terrestrial reference frame is in danger of collapse (cf. Chapter 1). Improvements in both accuracy and economic efficiency are needed. Investing resources to assure the improvement and the continued operation of this geodetic infrastructure is a requirement of virtually all the missions for every Panel in this study.

The terrestrial reference frame is realized through integration of the high precision networks of the Global Positioning System (GPS), Very Long Baseline Interferometry (VLBI), and Satellite Laser Ranging (SLR). It provides the foundation for virtually all space-based and ground-based observations in Earth science and global change, including remote monitoring of sea level, sea surface topography, plate motions, crustal deformation, the geoid, and time-varying gravity from space. It is through this reference frame that all measurements can be inter-related for robust, long-term monitoring of global change. A precise reference frame is also essential to interplanetary navigation and diverse national strategic needs."

Scientific and Societal Imperatives

Climate change and impacts

Ice sheets, sea level, and ocean circulation

Shifts in precipitation and water availability

Transcontinental Air Pollution

Shifts in ecosystems response to climate change

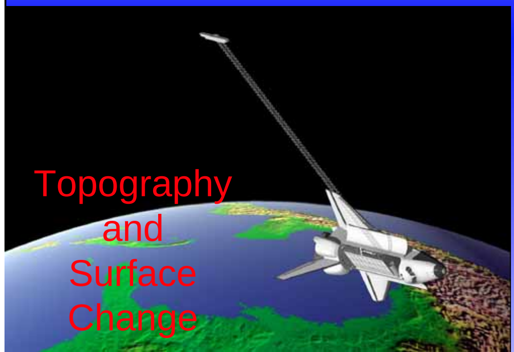
Human health and climate change

Extreme events, including severe storms, heat waves, earthquakes and volcanoes

The Williamstown Report (1970) Recommended the Development of Space Geodesy for Solid Earth and Ocean Physics
Applications of Space Geodesy Have Blossomed

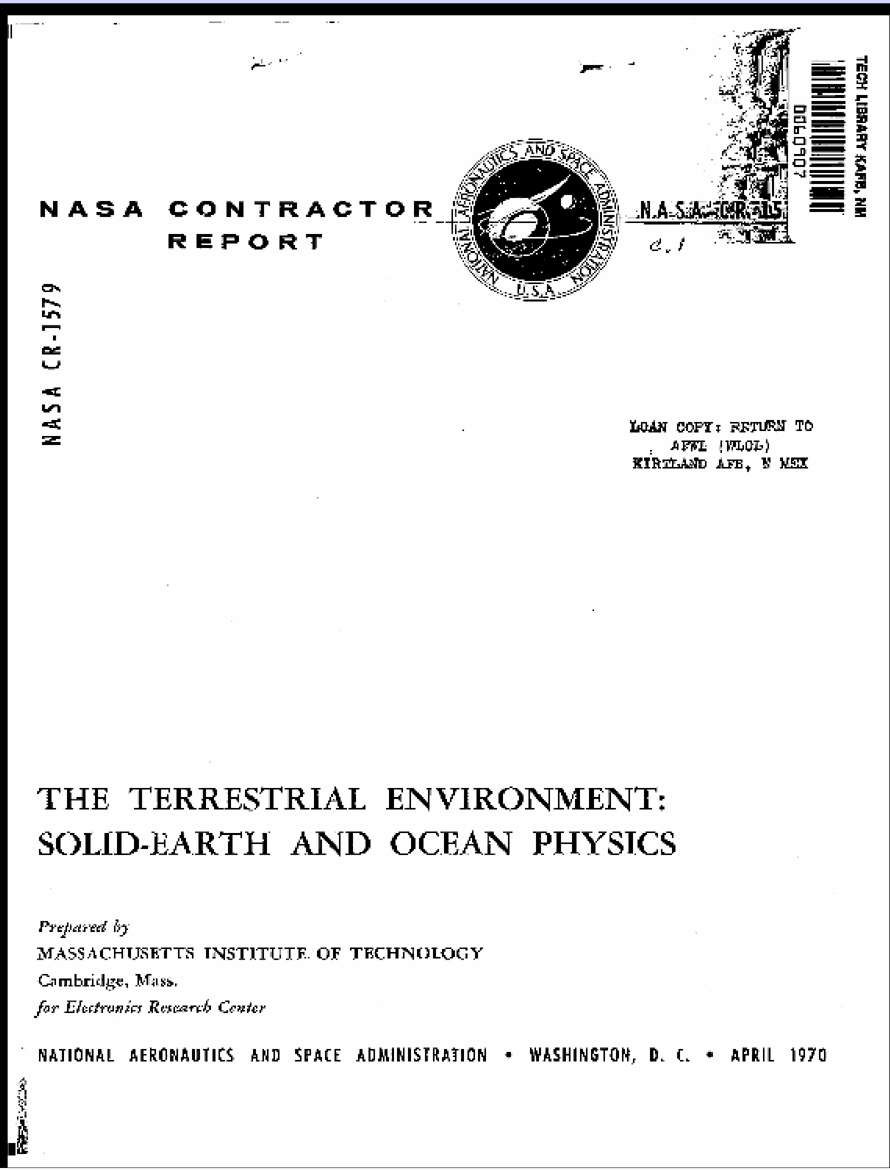
Cryospheric Science

ICESAT



SRTM

Sea Level Change



NASA CONTRACTOR REPORT

NASA CR-1579

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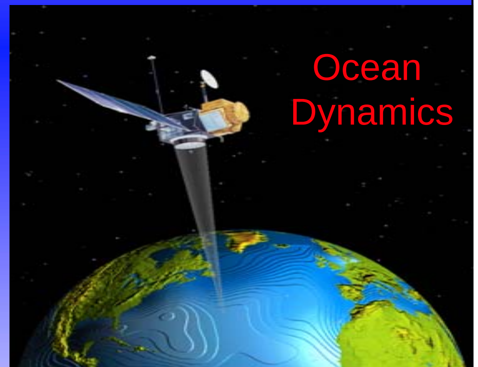
THE TERRESTRIAL ENVIRONMENT: SOLID-EARTH AND OCEAN PHYSICS

Prepared by
MASSACHUSETTS INSTITUTE OF TECHNOLOGY
Cambridge, Mass.
for Electronics Research Center

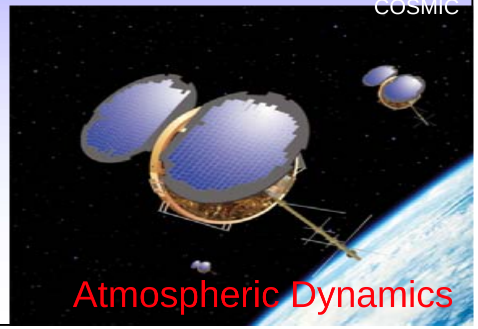
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION • WASHINGTON, D. C. • APRIL 1970

GRACE



Topex/Poseidon

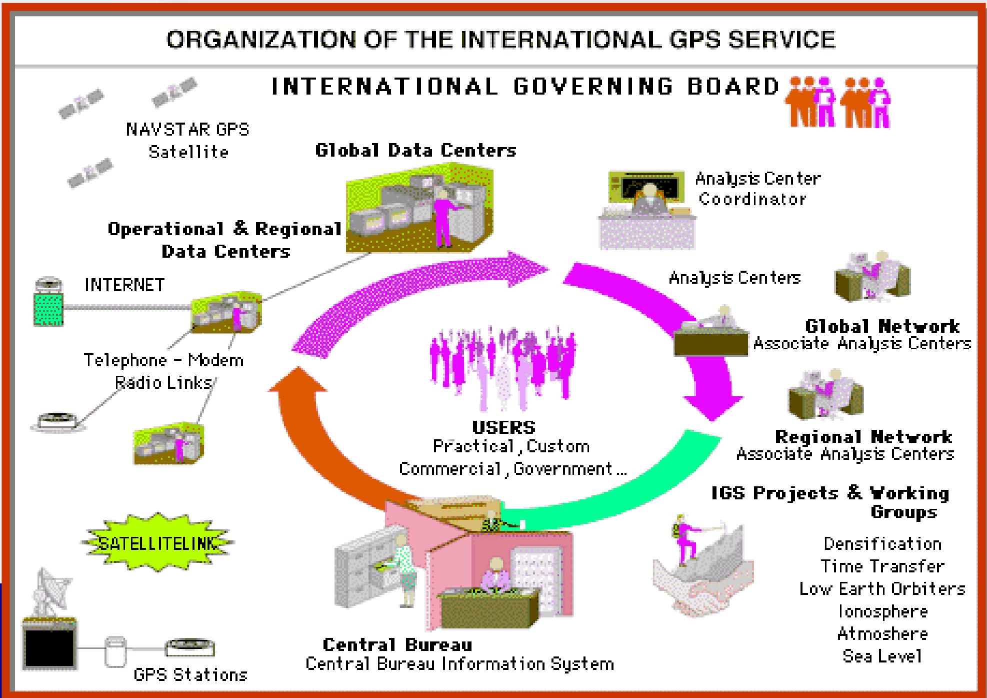
COSMIC



Global Geodetic Network Organization
The Community Management Model

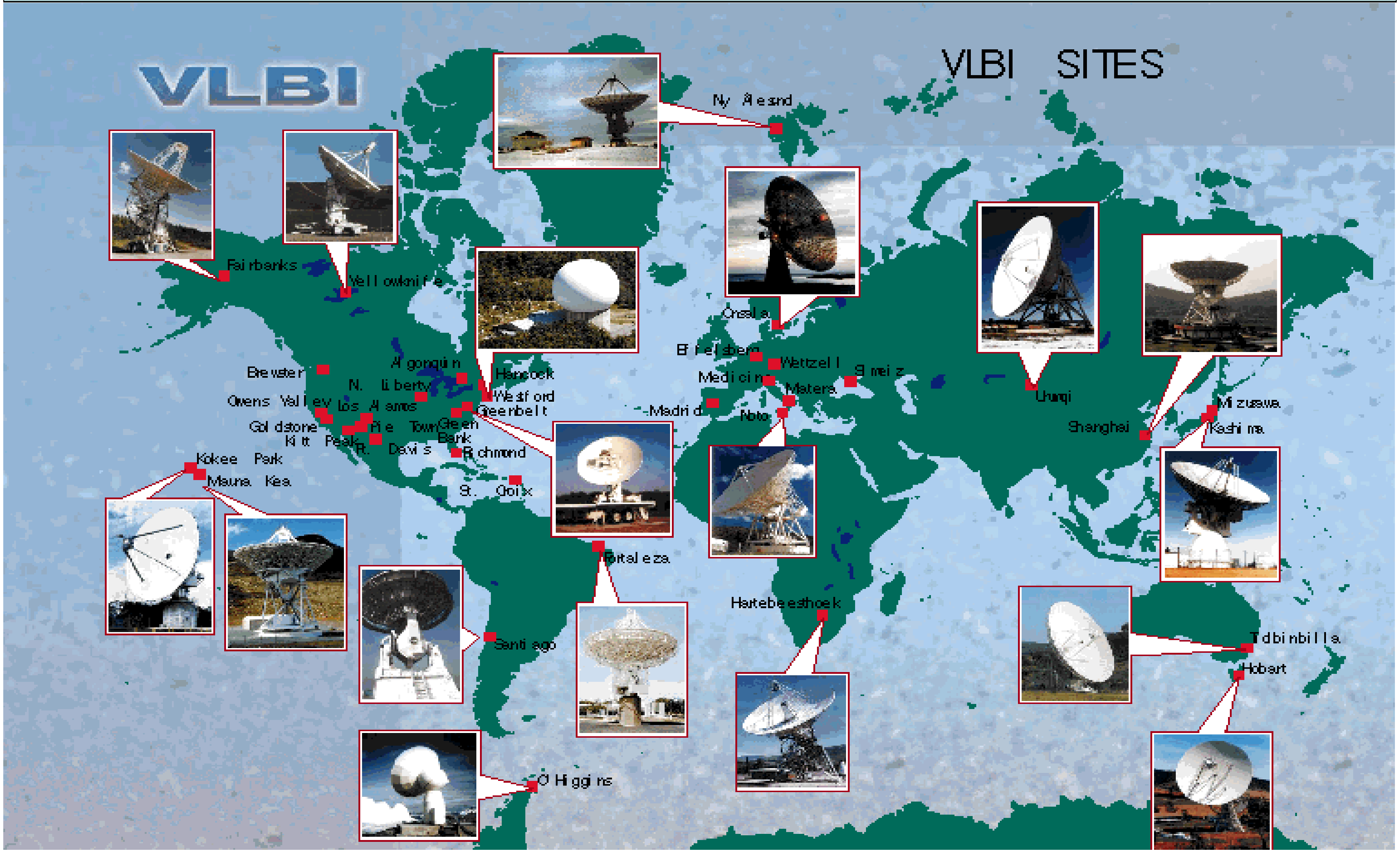
NASA Contributes:

- IGS Central Bureau
- Analysis Center at JPL
- CDDIS Global Data Center at GSFC
- ~70 Global Network Stations

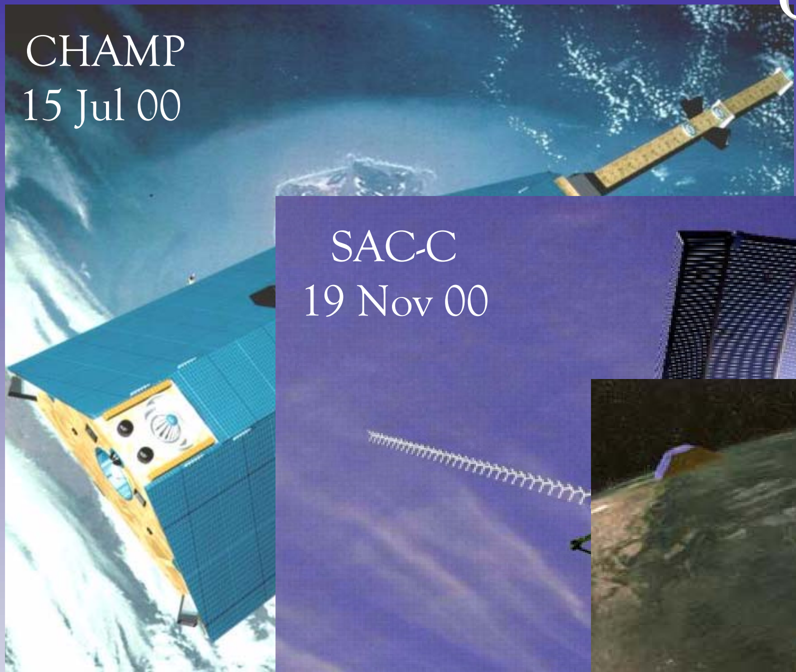


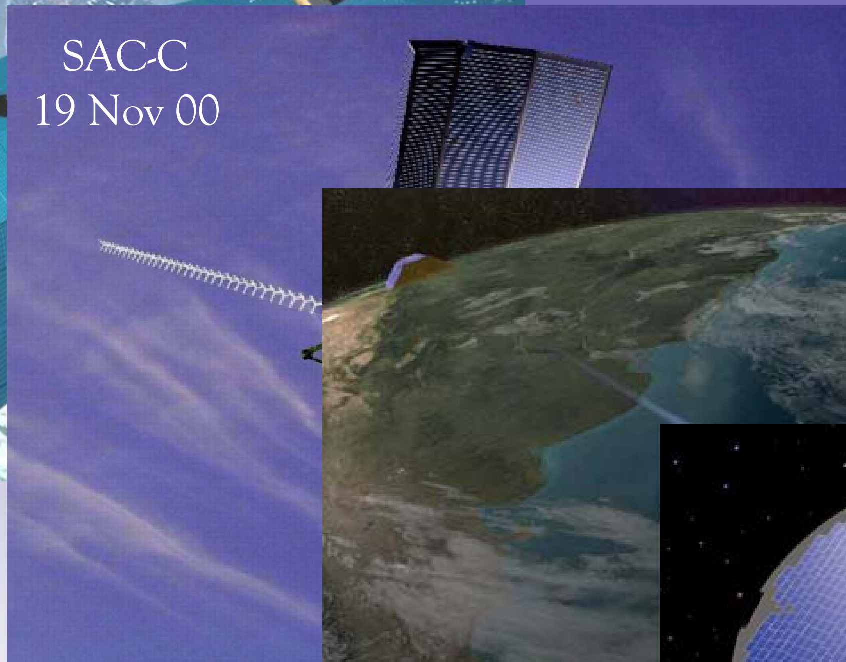
International Satellite Laser Ranging Network

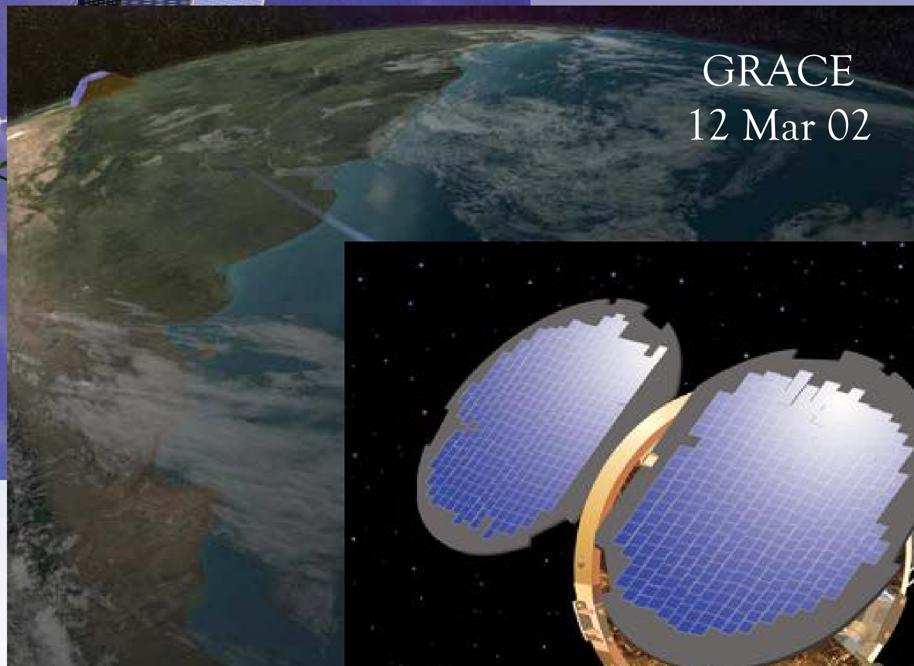
International VLBI Network

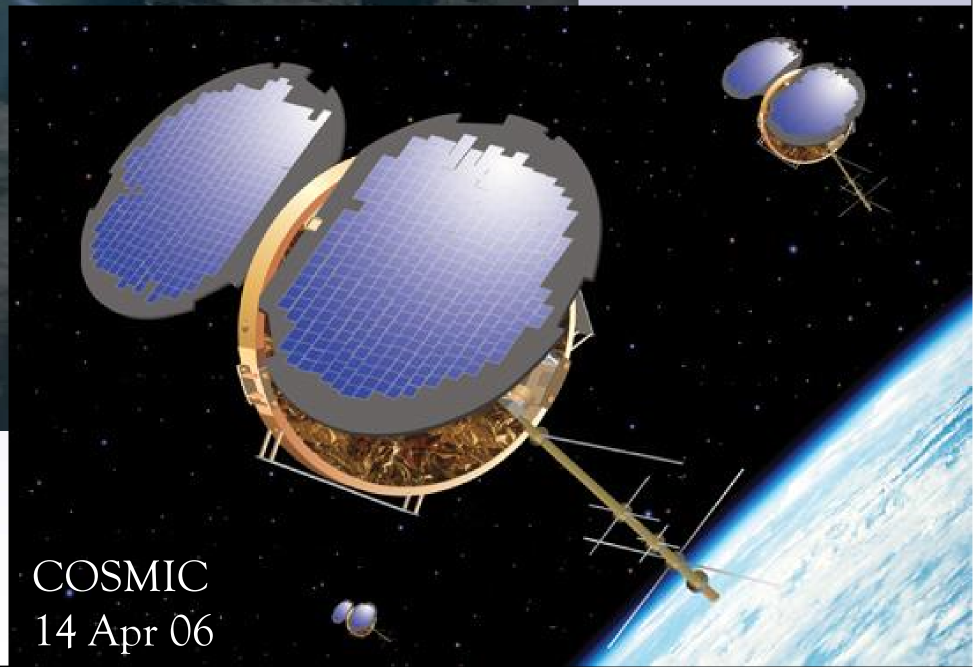


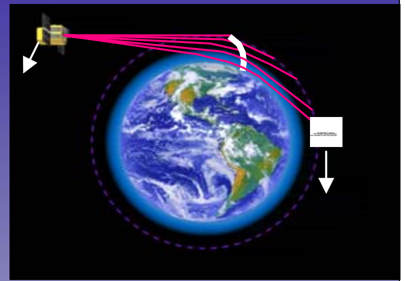
The International GPS Remote Sensing Constellation

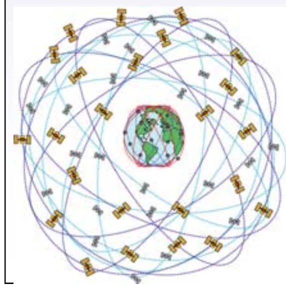




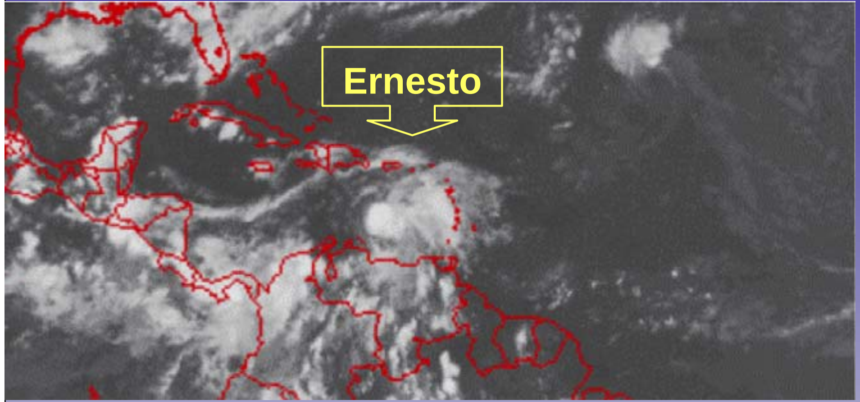




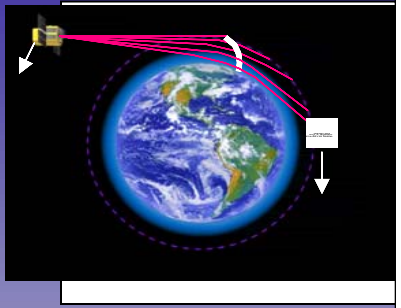




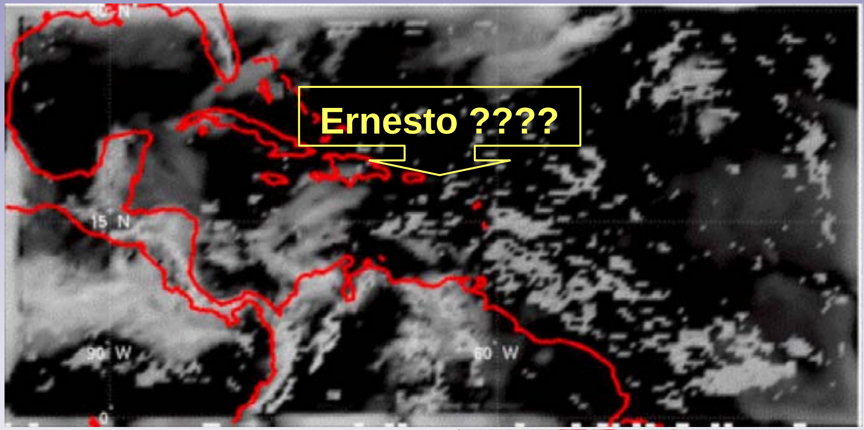
GPS Remote Sensing in Severe Storm Prediction
Tropical Storm Ernesto

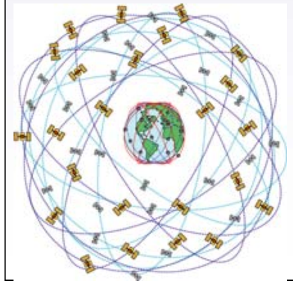


Observed Cloud Cover
Infrared Photo 8/26/2006

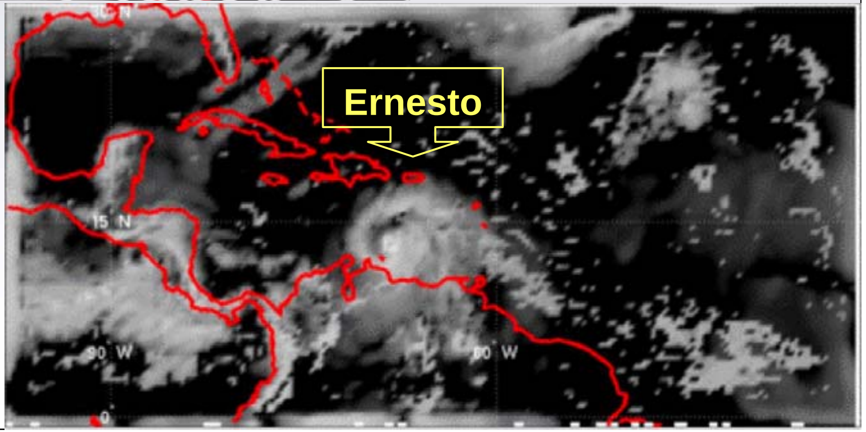


Cloud Cover Model
without GPSRO



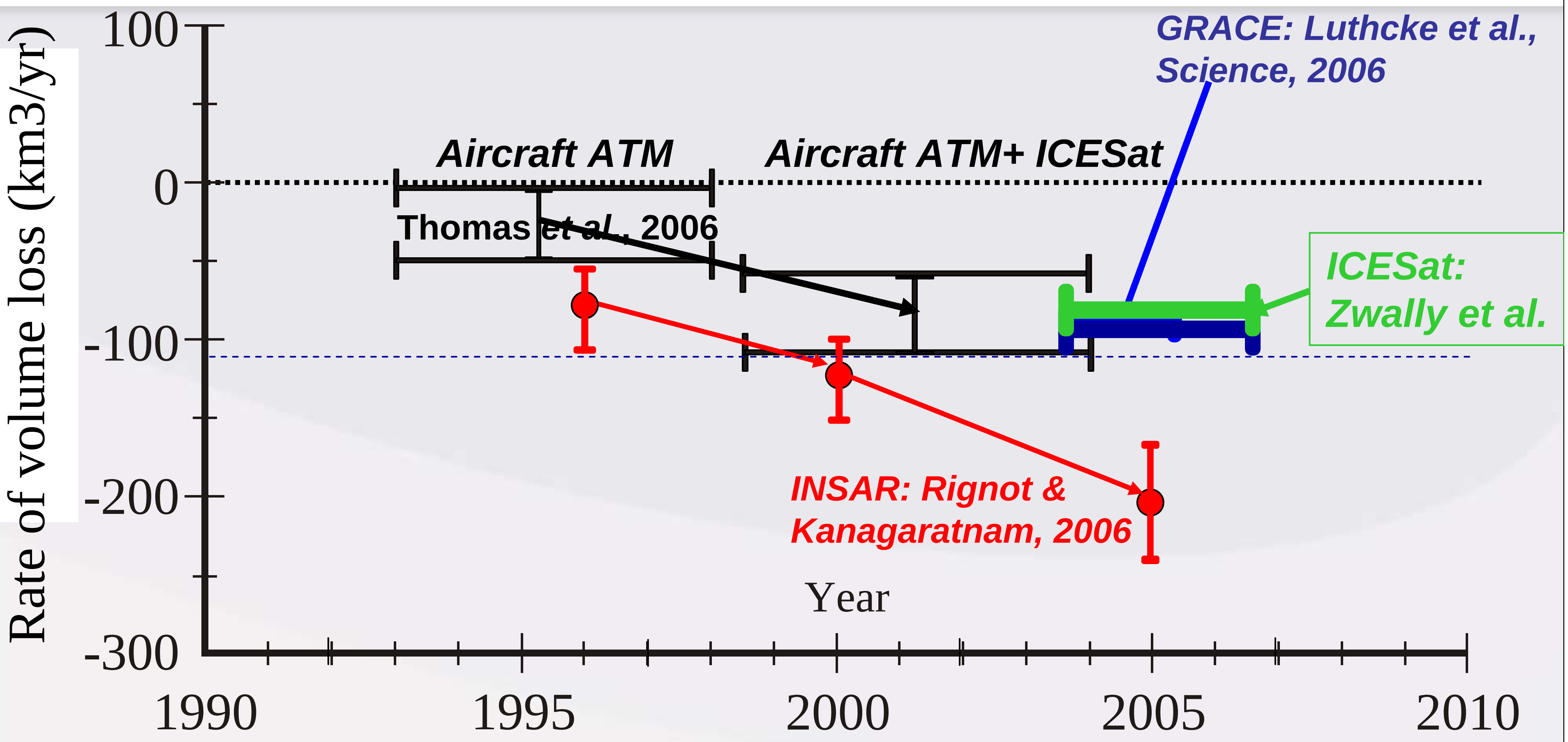


Cloud Cover Model with
15 GPSROs



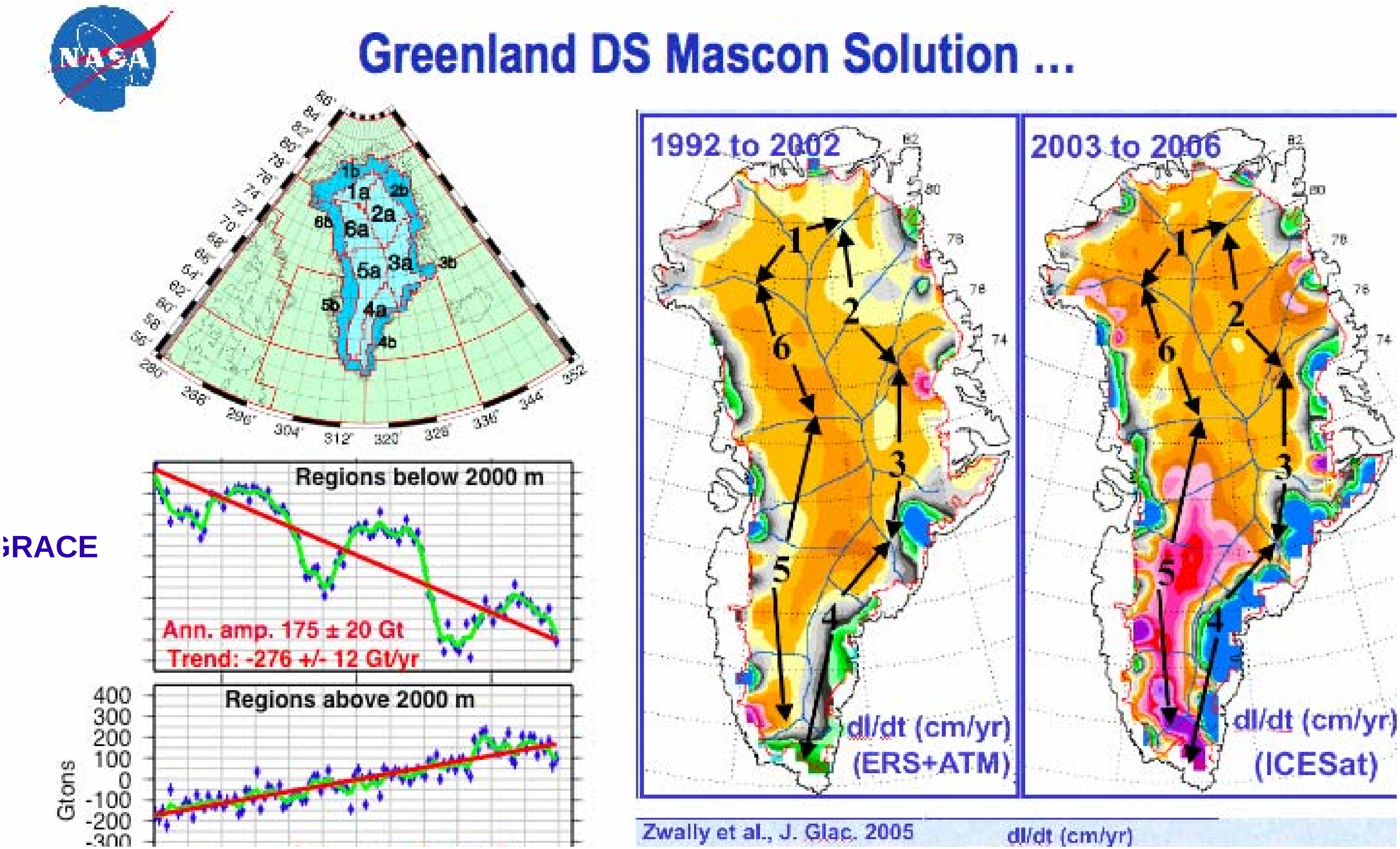
The GRACE Satellite Mission and its International Science Team Has Significantly Advanced the Importance of Space Geodesy to Earth Science

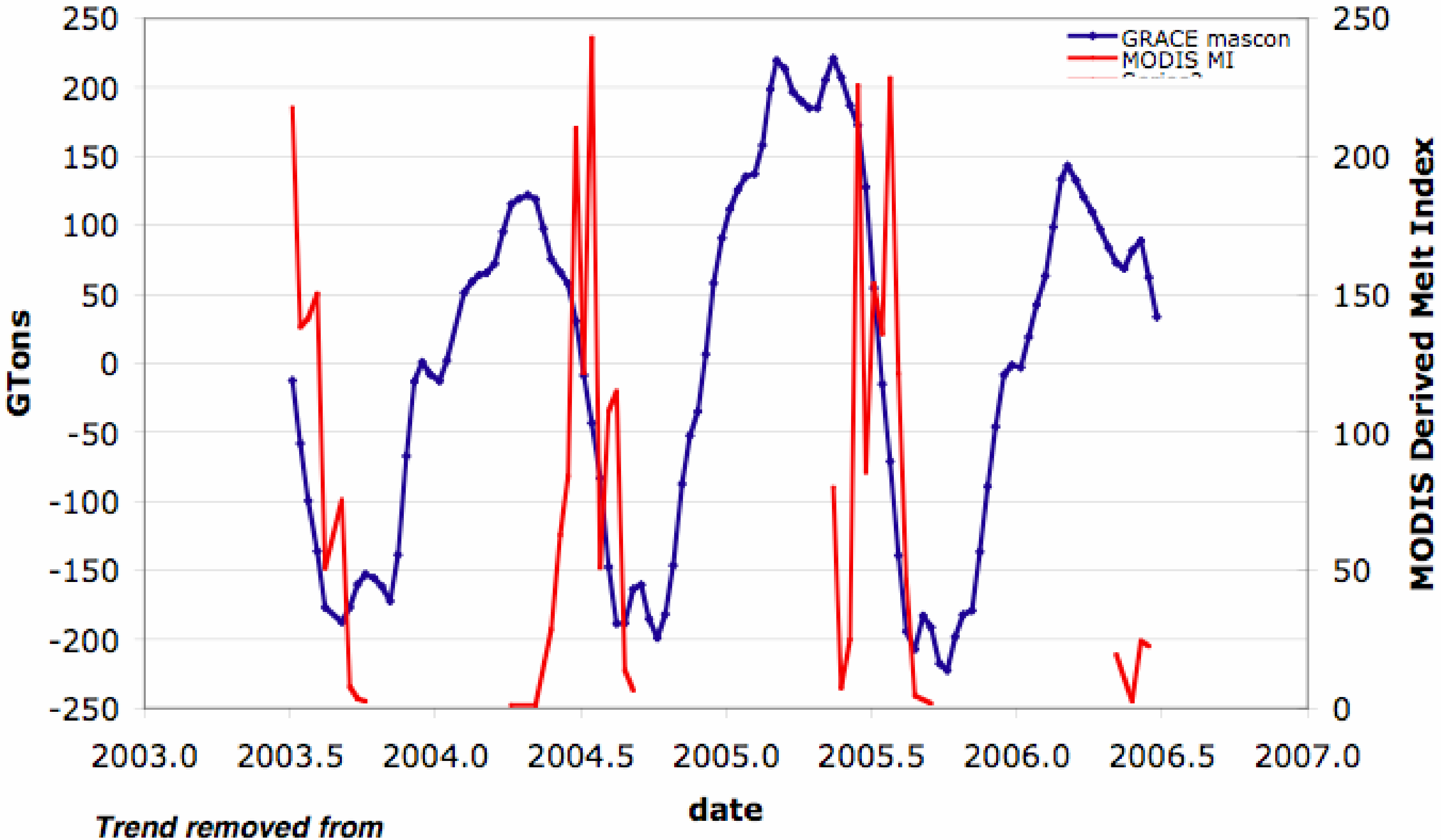
The Change in the Greenland Mass Balance since 1993 as observed by different instruments



This shows the Greenland Mass loss as observed by three different instruments, aircraft ATM(laser), GRACE and INSAR. The observations start with the 1993 aircraft measurements, when the icecap was not losing mass, to the present, when the icecap is losing between 100 and 200 km^3/yr. Although there are differences among the three approaches, they are each consistent with an increasing loss since the mid-1990s.

GRAVITY, Microware and Laser Altimetry Measurements of the Greenland Ice Sheet Ablation



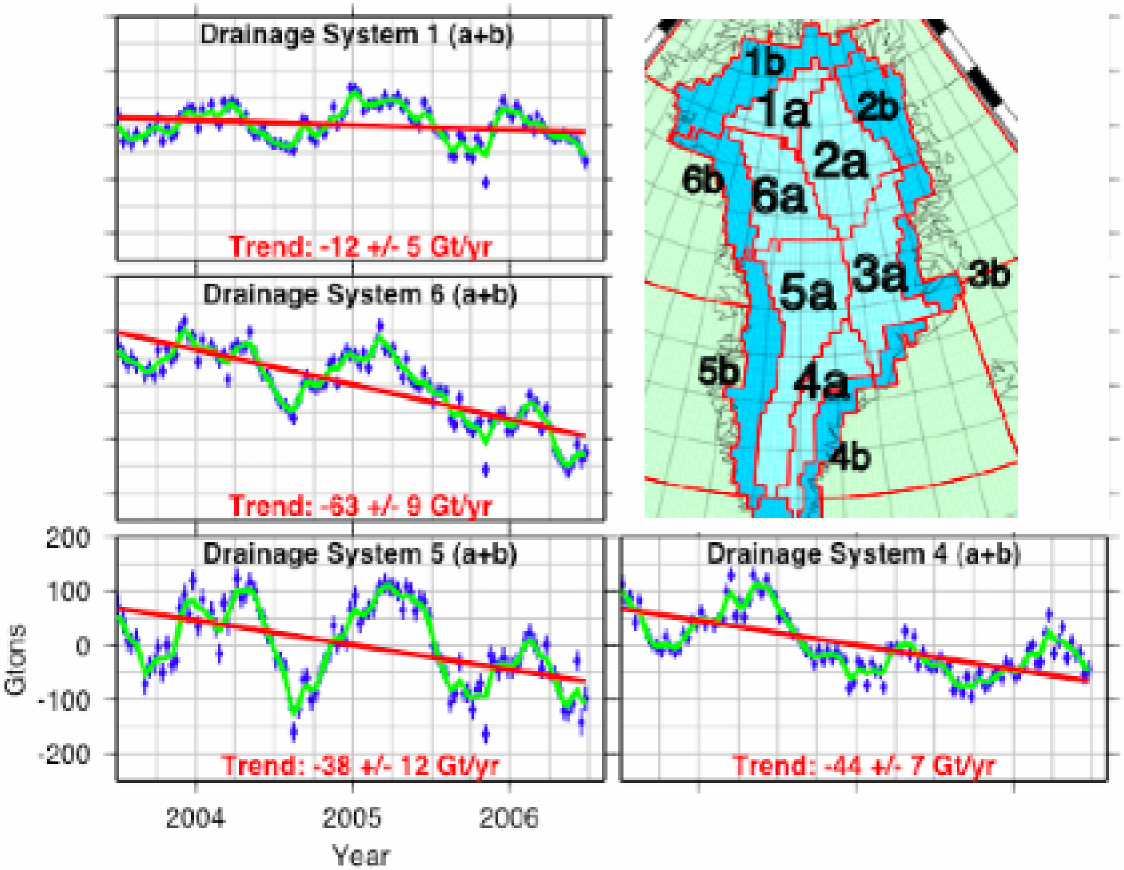


Trend removed from GRACE mascon time series …

* Hall, D.K., R.S. Williams Jr., S.B. Luthcke, N.E. DiGirolamo, "Greenland Ice Sheet Surface Temperature, Melt and Mass Loss: 2000-2006," *Journal of Glaciology*, IN PRESS, 2007.

S.B. Luthcke et al., NASA GSFC, code 698

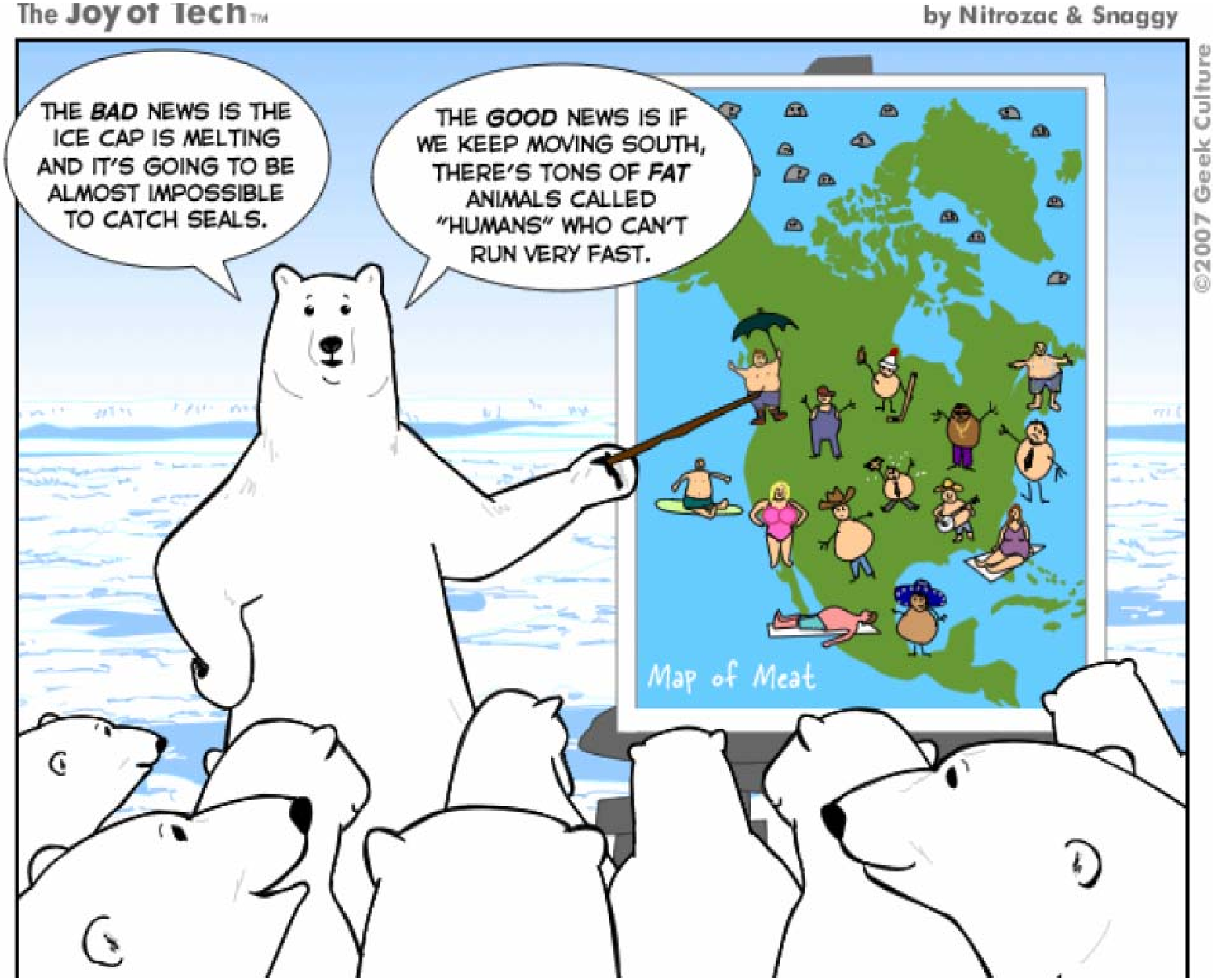
GRACE mass loss duration vs. MODIS melt duration *(Hall et al.)*



Drainag e System	MODIS melt season duration % change 2005 - 2004 *(Hall et al.)*	GRACE mass loss duration % change 2005 - 2004
1	125 %	54 %
3	-15 %	-12 %
4	-6 %	-33 %
5	12 %	10 %
6	117 %	130 %

- *MODIS data shows significant increase in 2005 melt season duration for DS 1 and 6.*
- *GRACE data shows significant increase in mass loss duration in DS 1 and 6.*

S.B. Luthcke et al., NASA GSFC, code 698


The Joy of Tech™
by Nitrozac & Snaggy
THE *BAD* NEWS IS THE ICE CAP IS MELTING AND IT'S GOING TO BE ALMOST IMPOSSIBLE TO CATCH SEALS.
THE *GOOD* NEWS IS IF WE KEEP MOVING SOUTH, THERE'S TONS OF *FAT* ANIMALS CALLED "HUMANS" WHO CAN'T RUN VERY FAST.
Map of Meat
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