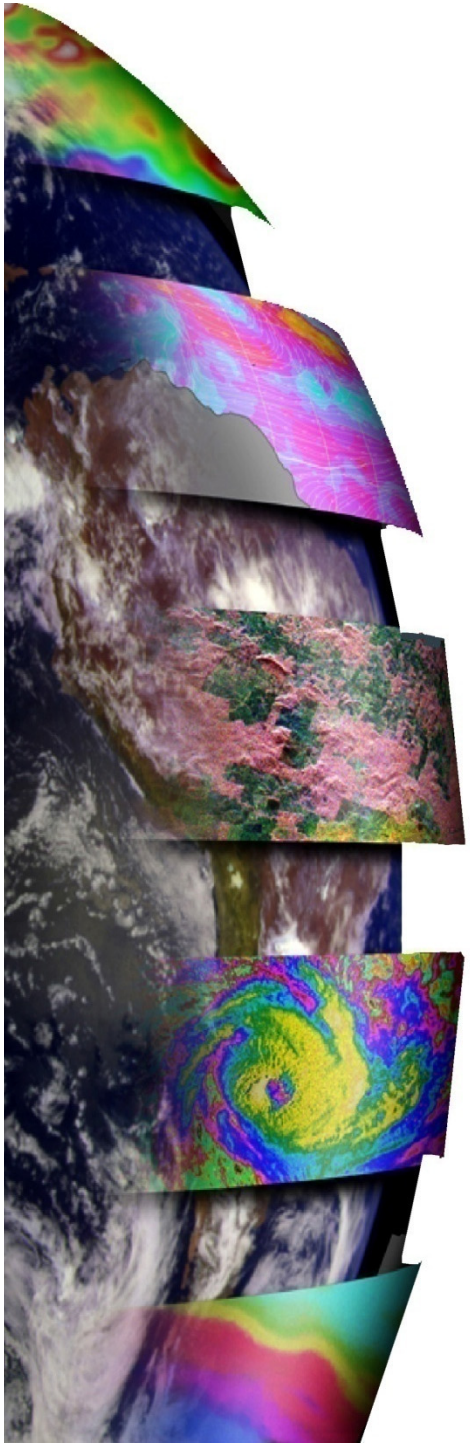
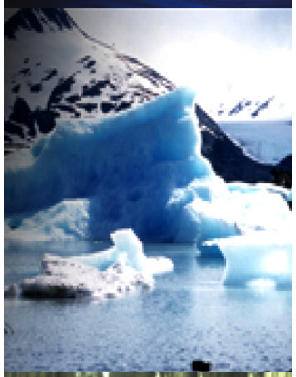
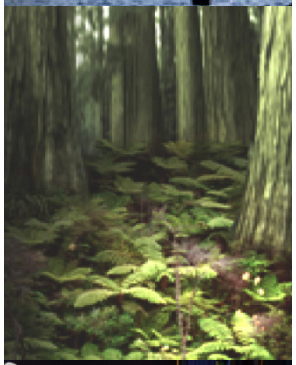


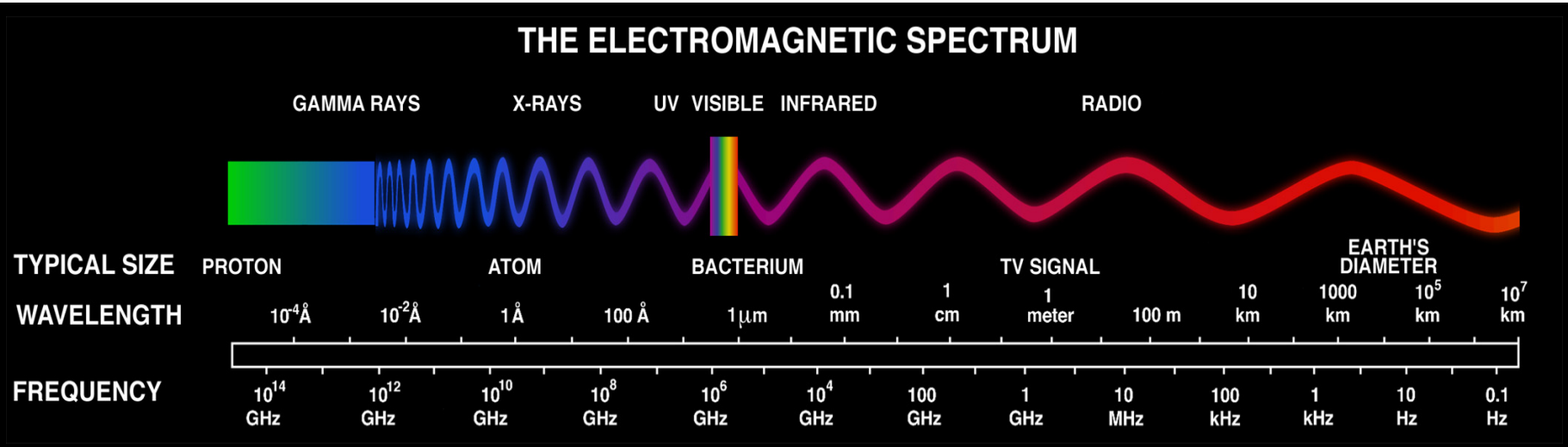
Eyes on the Earth
The Critical Role of Satellites in Understanding our Environment

Dr. Diane Evans
Director for Earth Science
and Technology
Jet Propulsion Laboratory

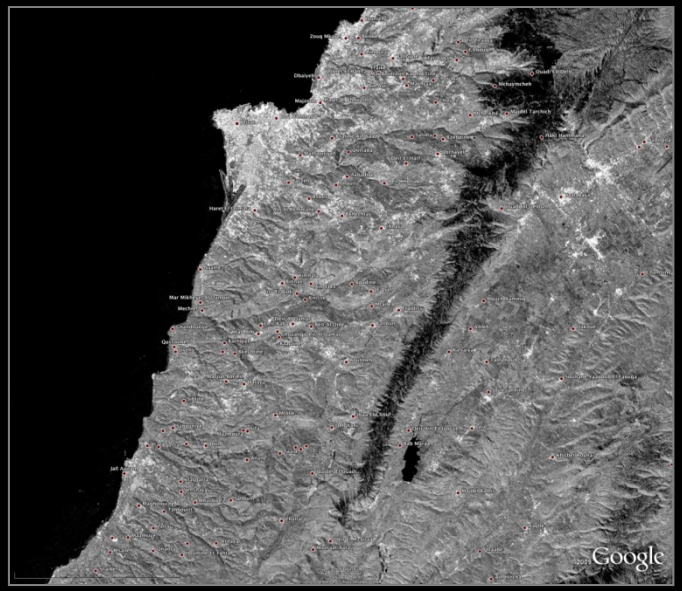
January 21, 2010






THE ELECTROMAGNETIC SPECTRUM
GAMMA RAYS
X-RAYS
UV
VISIBLE
INFRARED
RADIO
TYPICAL SIZE
PROTON
ATOM
BACTERIUM
TV SIGNAL
EARTH'S DIAMETER
WAVELENGTH
10-4Å
10-2Å
1 Å
100 Å
1 µm
0.1 mm
1 cm
1 meter
100 m
10 km
1000 km
105 km
107 km
FREQUENCY
1014 GHz
1012 GHz
1010 GHz
108 GHz
106 GHz
104 GHz
100 GHz
1 GHz
10 MHz
100 kHz
1 kHz
10 Hz
0.1 Hz

Google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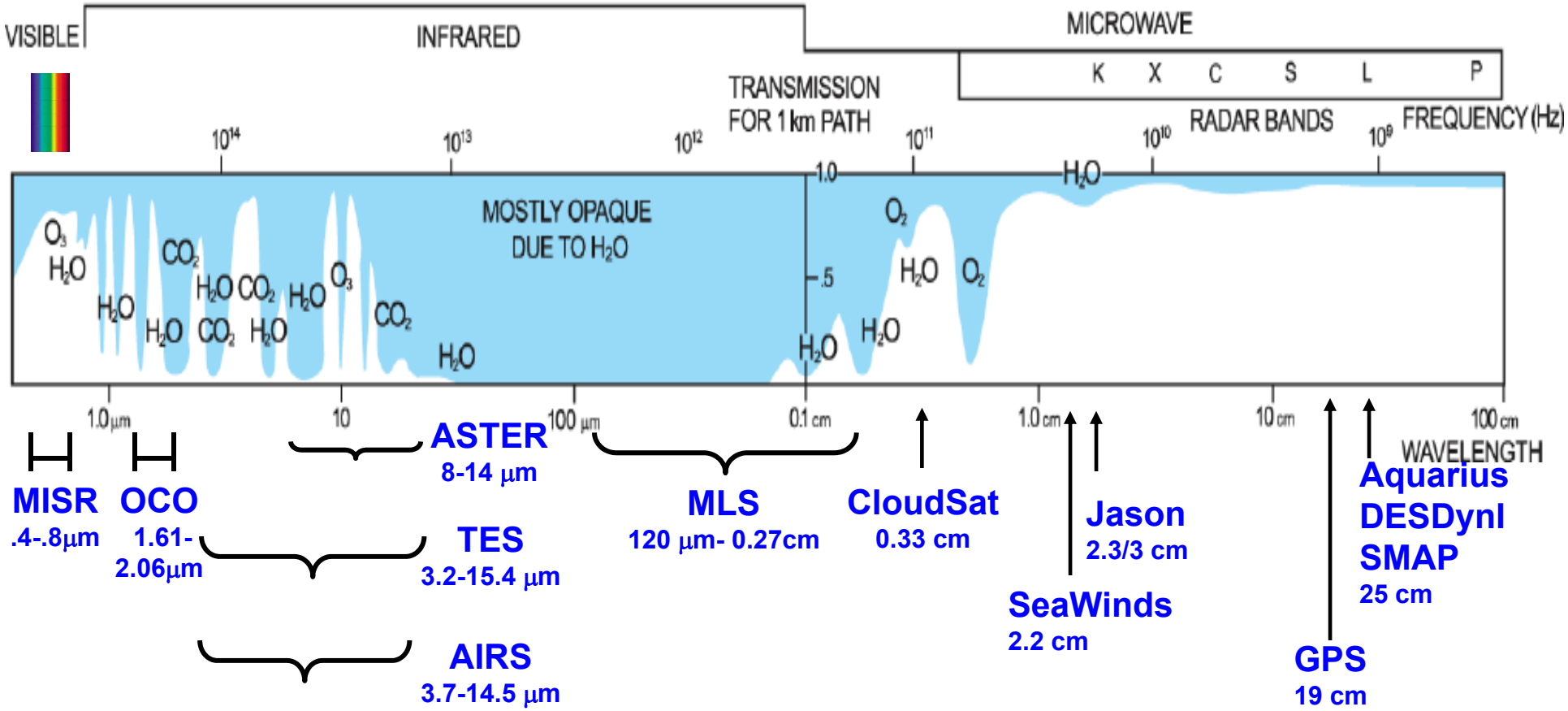
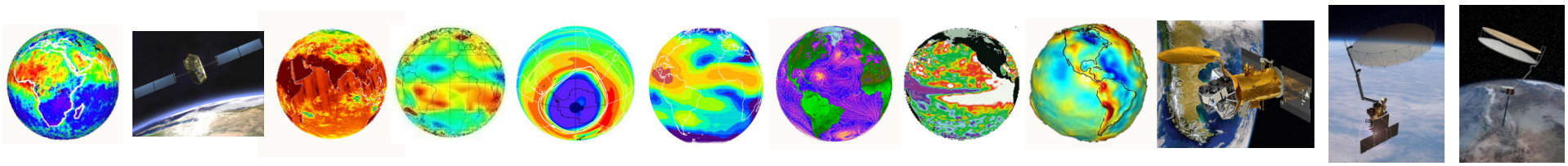
Seeing Earth in a New Way

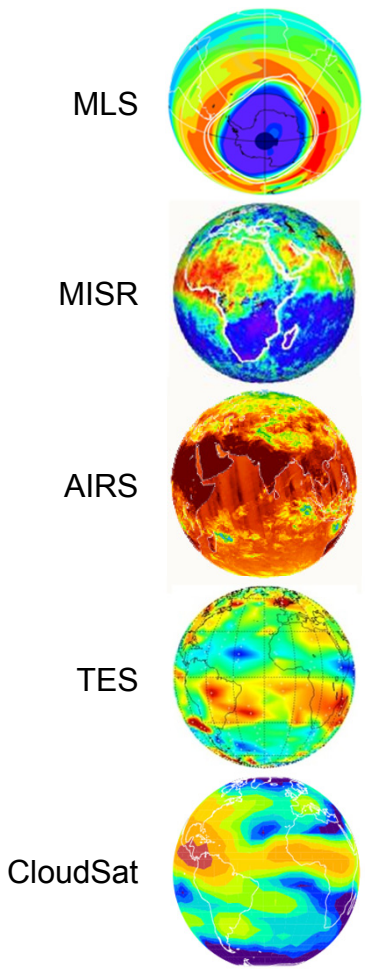


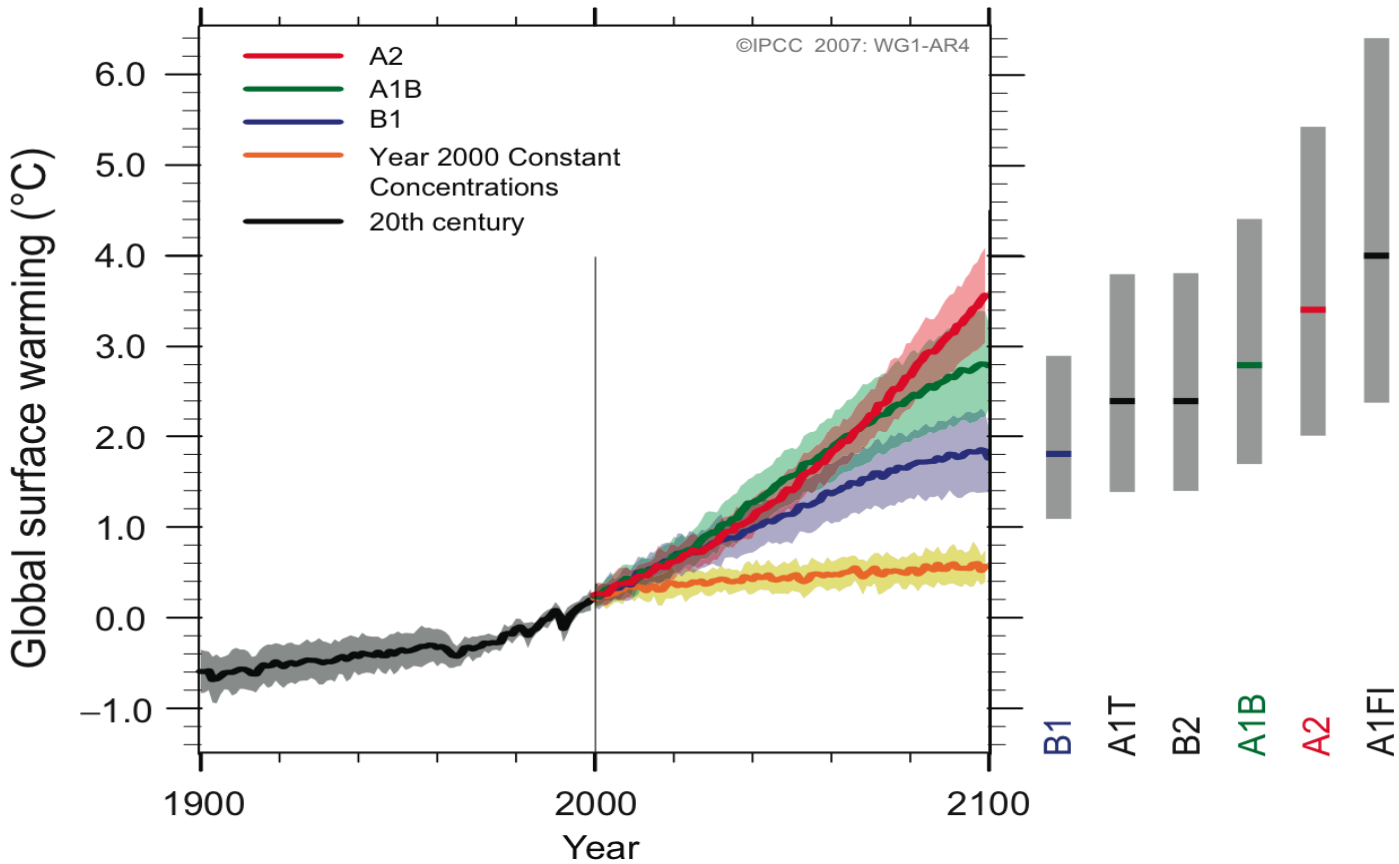


Aerosols | Carbon Dioxide | Water Vapor | Ozone | Cloud Properties | Ocean Winds | Sea Surface Height | Gravity | Ocean Salinity | Soil Moisture | Surface Change

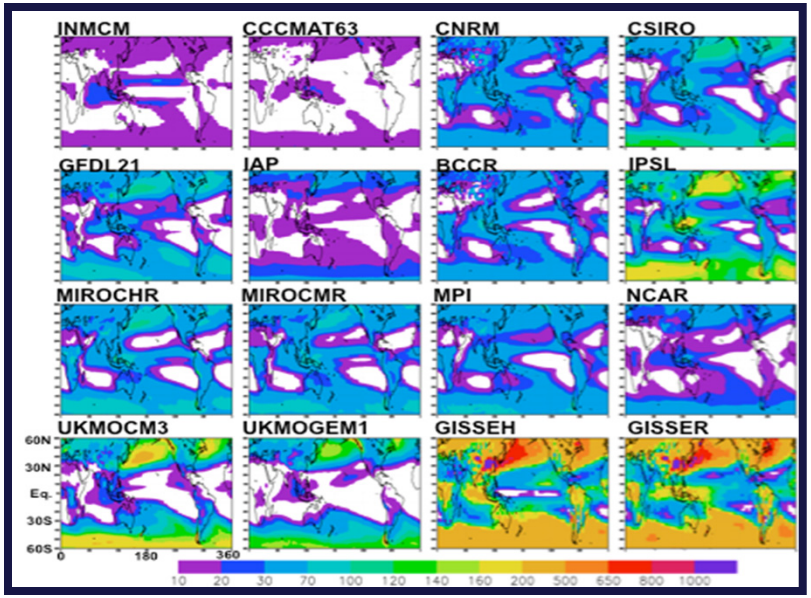
Role of Satellites in Global Change

Minimizing Uncertainties in Models

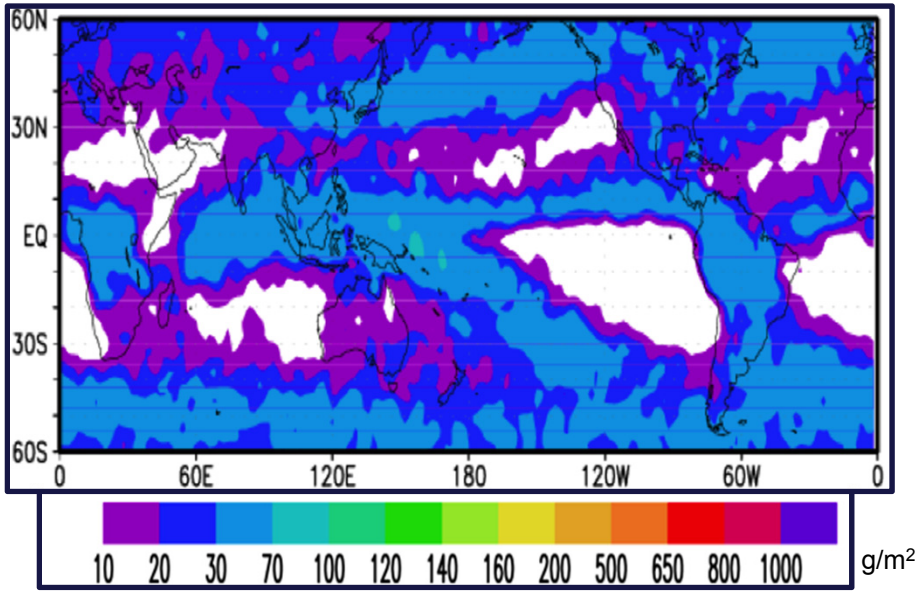




JPL Data will be Used to Assess Models for the Next IPCC Assessment (AR5)



Estimates of Cloud Ice Concentrations from Models Used in the IPCC 4th Assessment

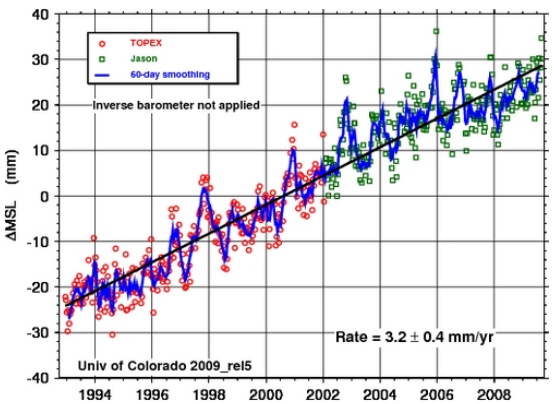


Actual Global Ice Concentrations Observed by CloudSat

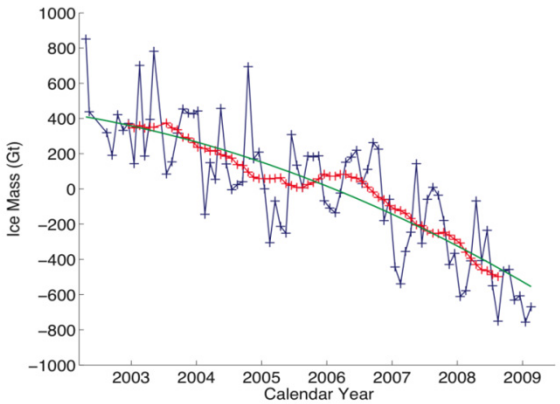
Waliser (2009)

Role of Satellites in Global Change

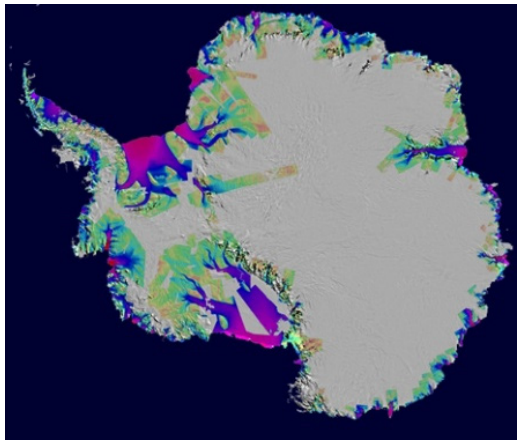
Direct Observations



Altimetry
Sea Level Rise
1992-2009
(Nerem, 2009)

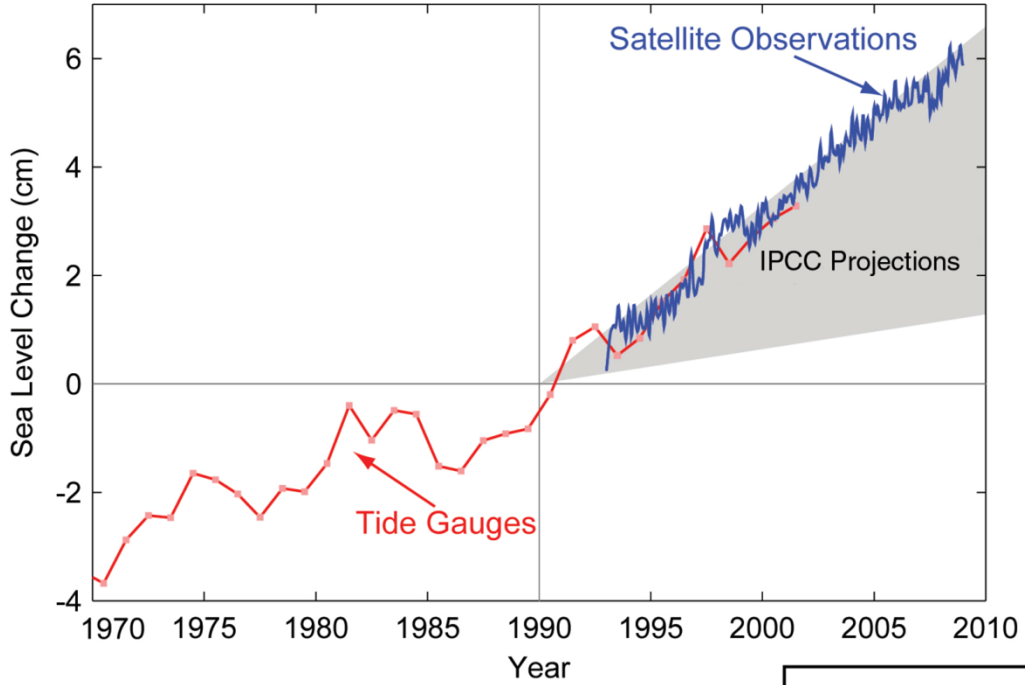


GRACE
Antarctic ice loss
2002-2009
(Velicogna, 2009)



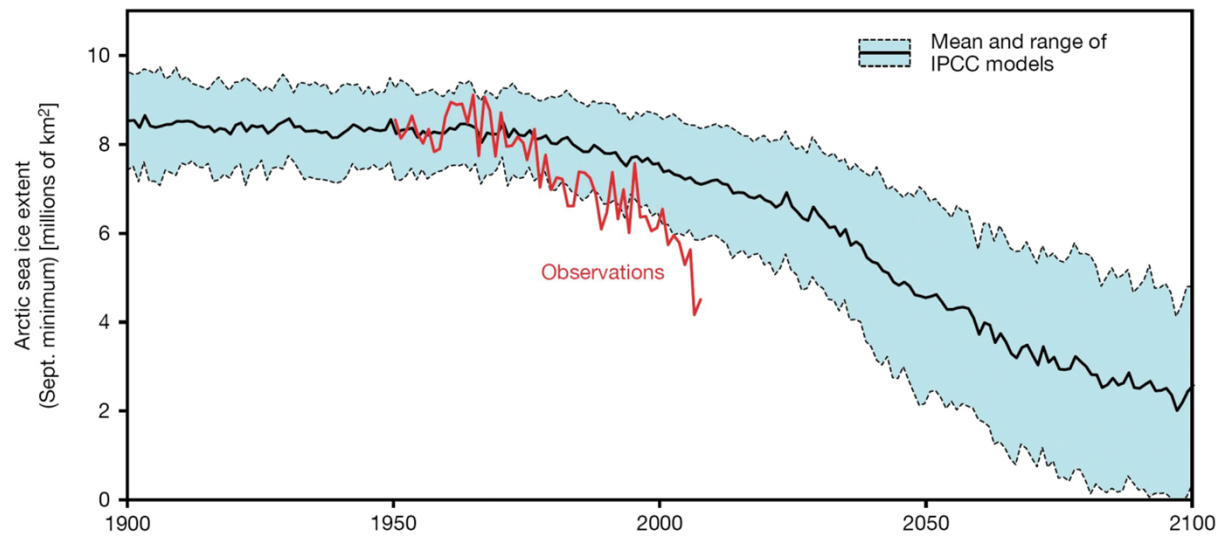
InSAR
Antarctic ice loss
1996-2006
(Rignot, 2008)

Comparison of Model Projections with Satellite Observations



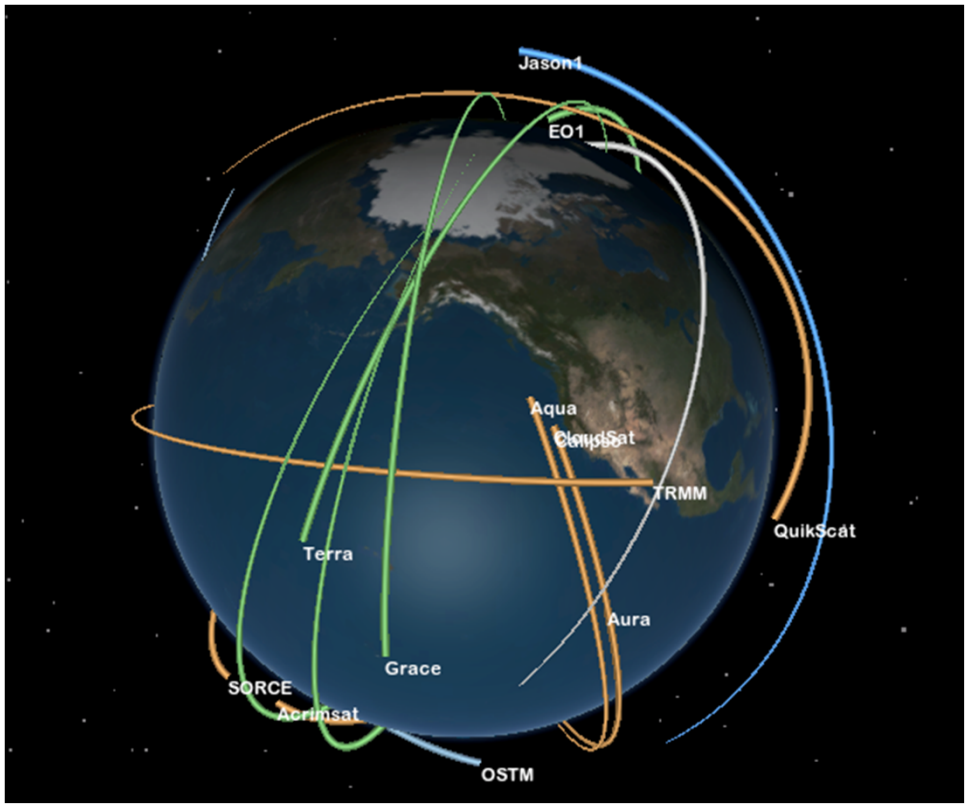
Sea Level Change (cm)

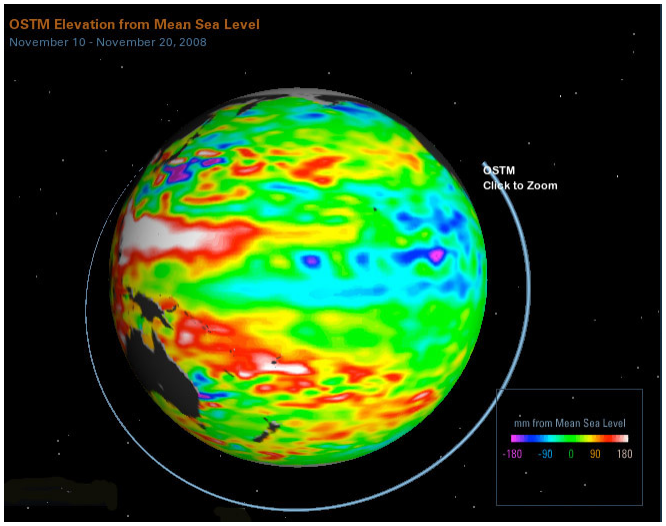
Sept. Sea Ice Extent (millions of km²)



The Copenhagen Diagnosis, 2009

Eyes on the Earth

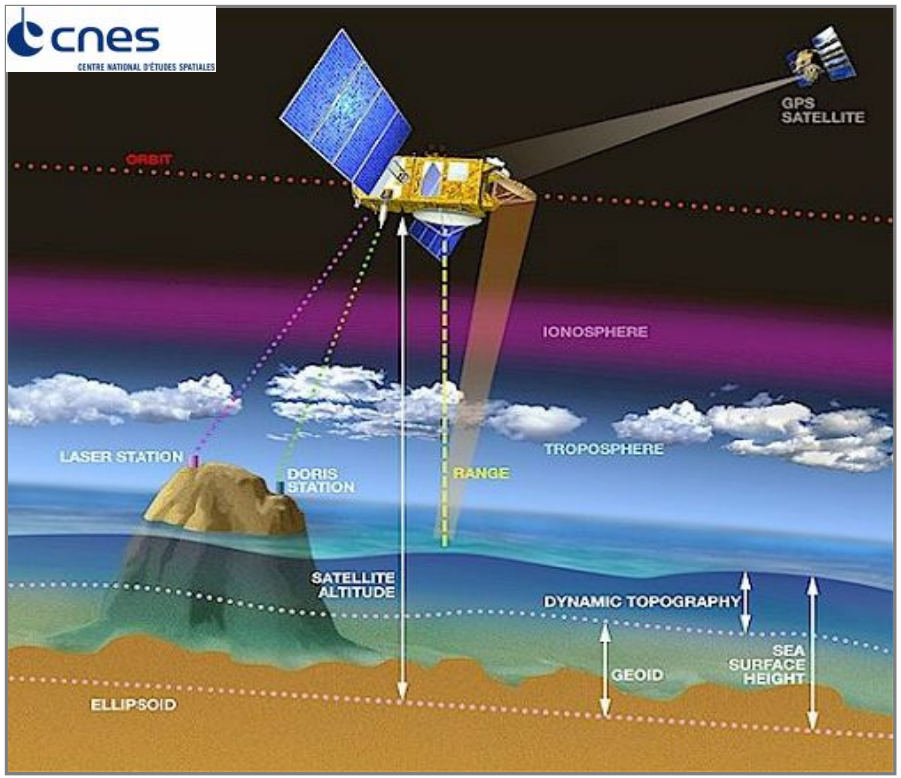


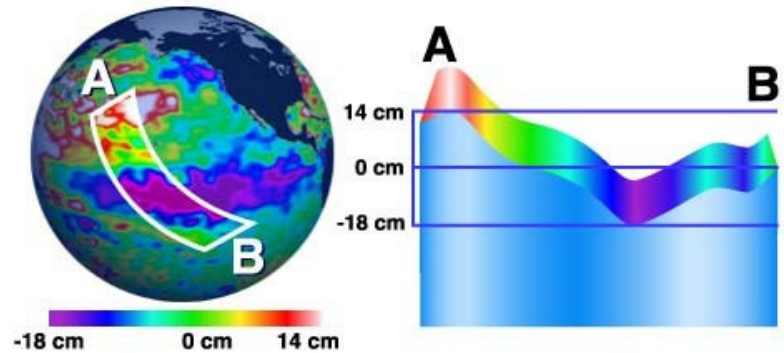


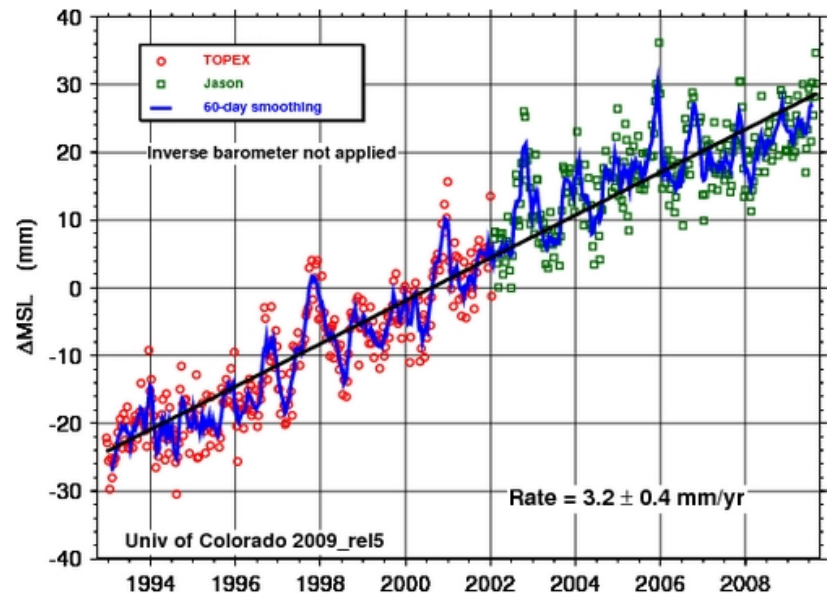
Sea Level

http://climate.nasa.gov

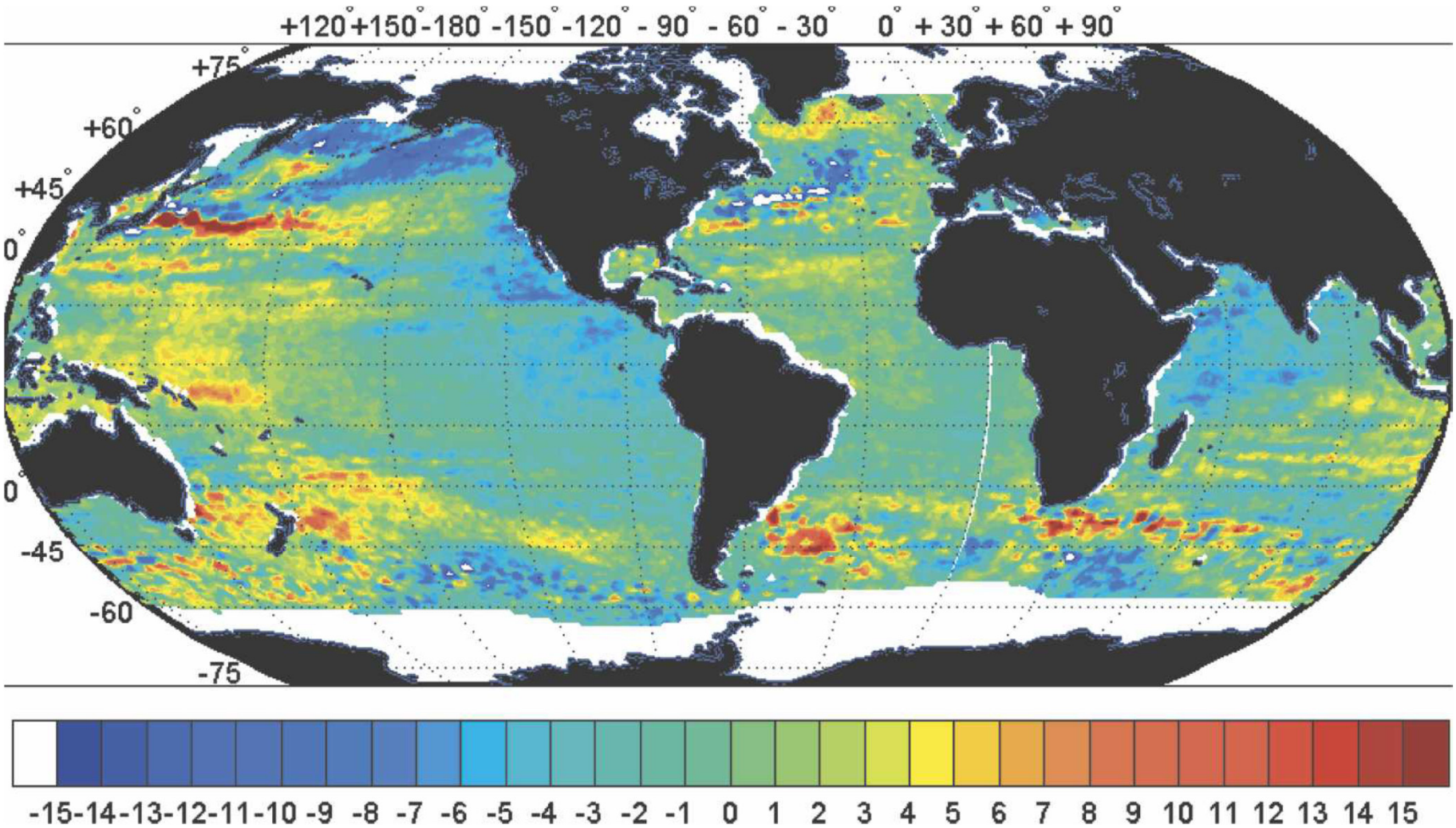
Measuring Changes in Sea Level







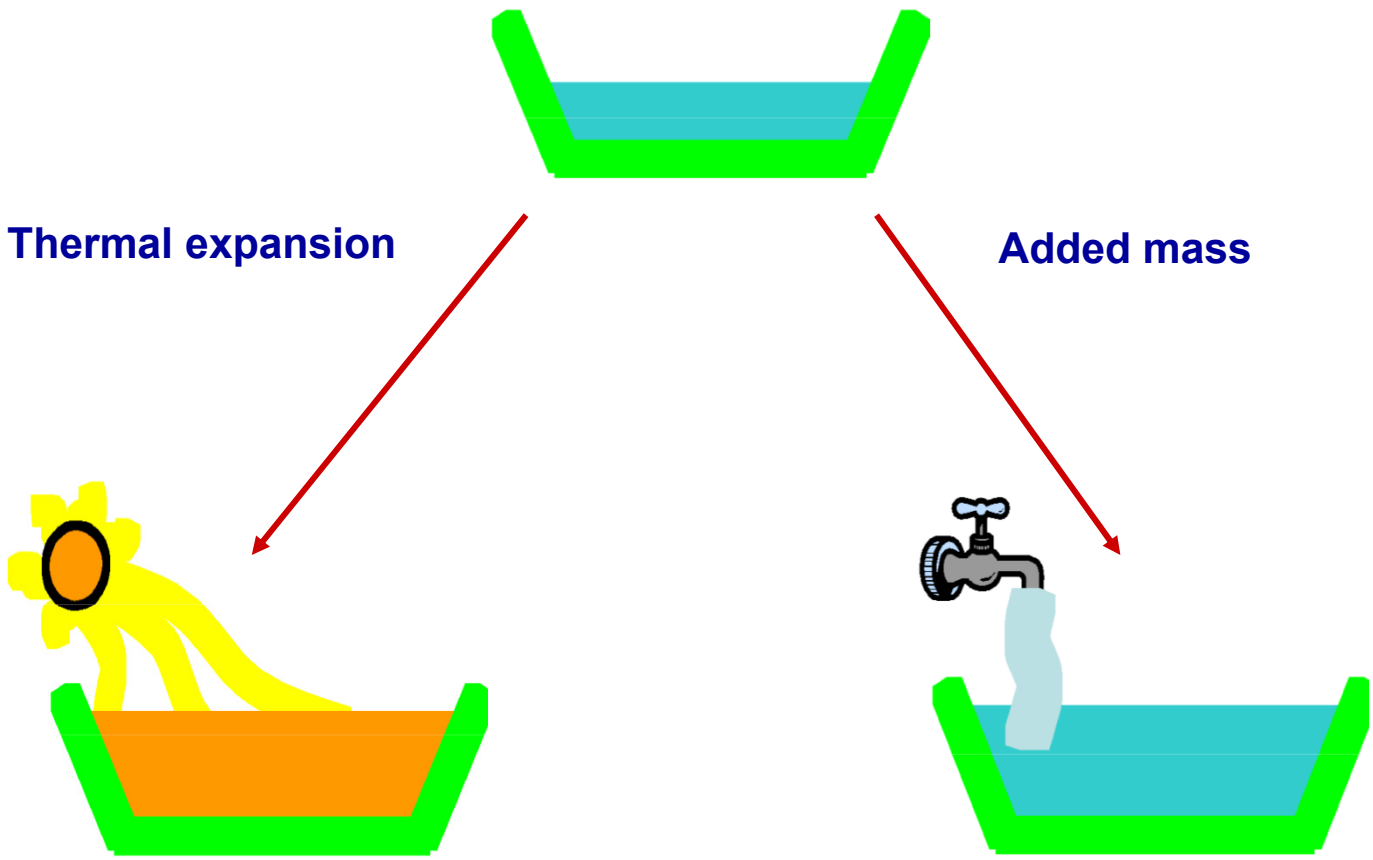
Sea Level Trend Measured by Altimetry



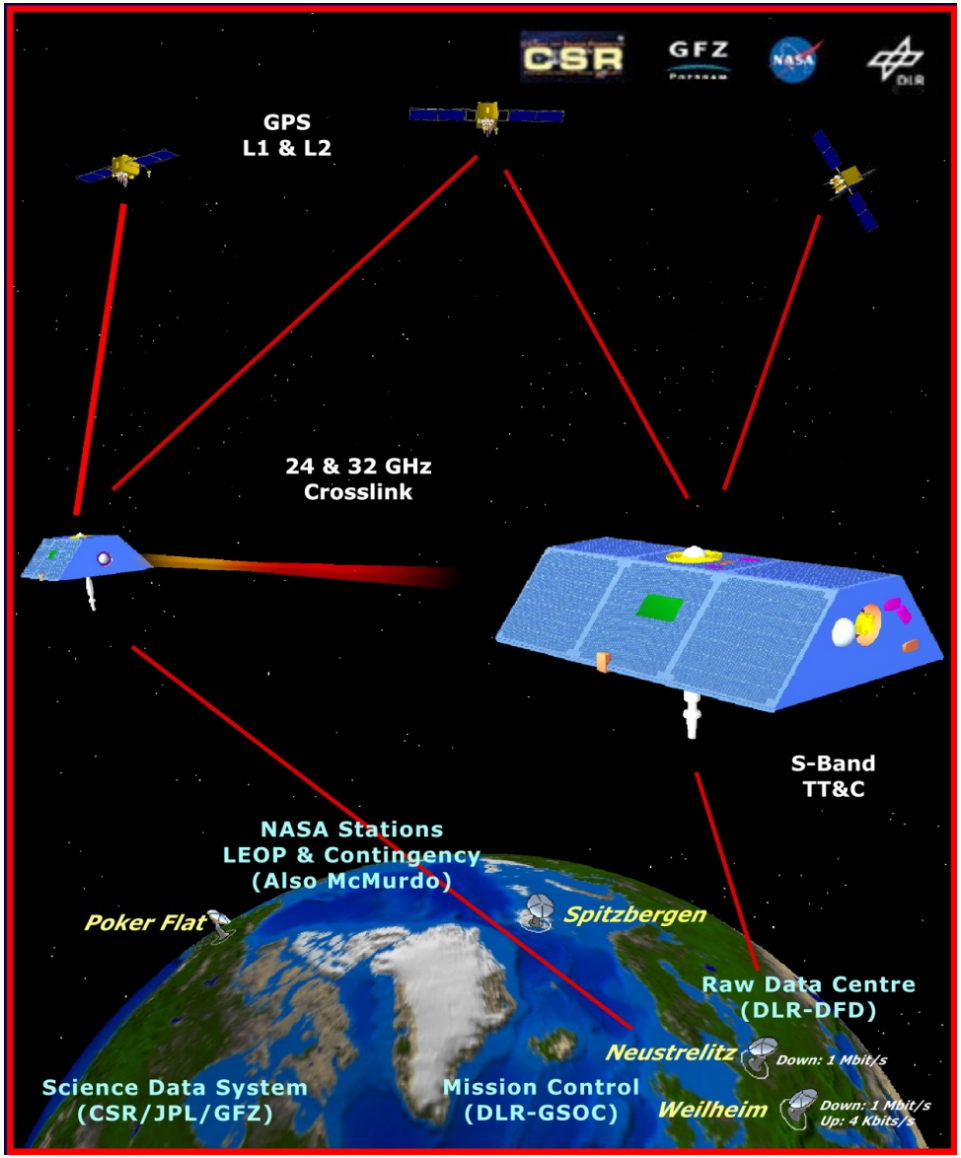
Twelve-year (1993–2004) trend in sea level (mm yr1) with mean of 2.8 mm yr1 removed.

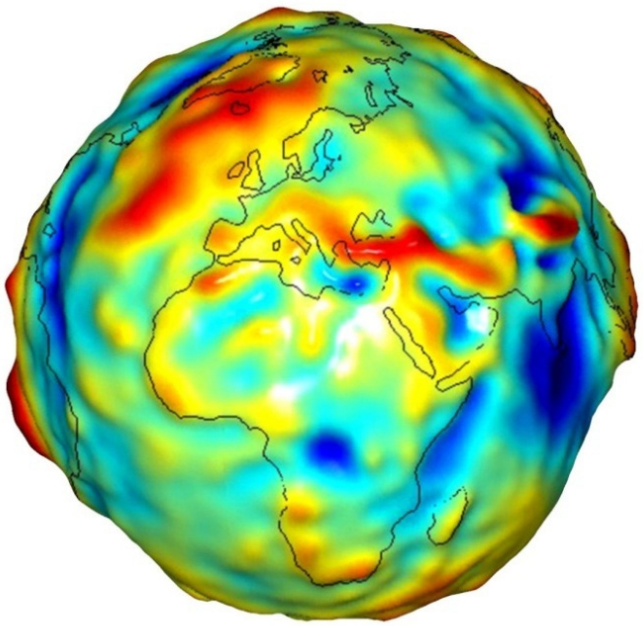
Wunsch et al (2007)

Why is Sea Level Rising?



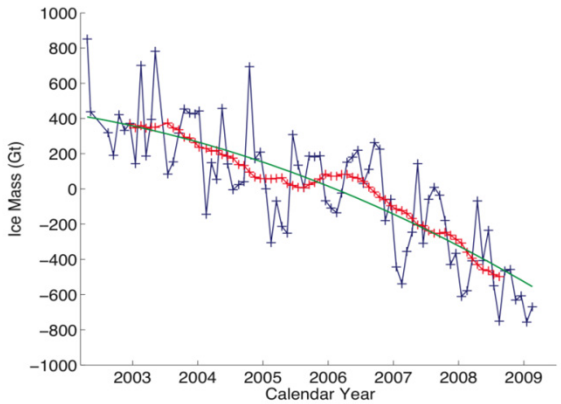
Gravity Recovery and Climate Experiment (GRACE)

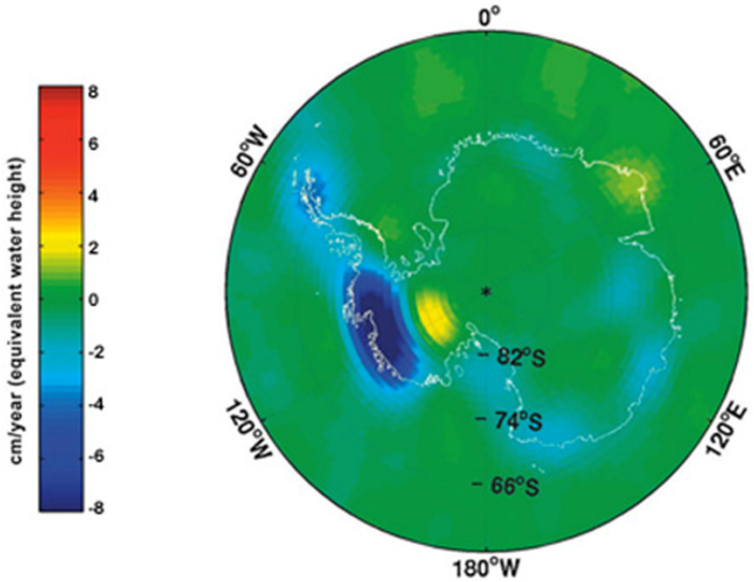




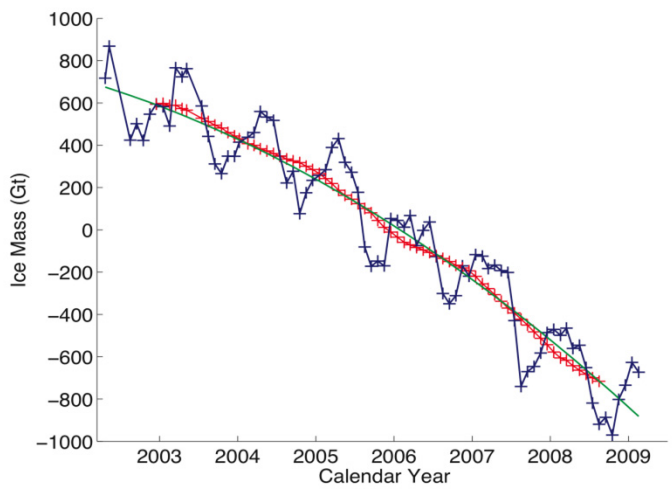
GRACE Gravity Model

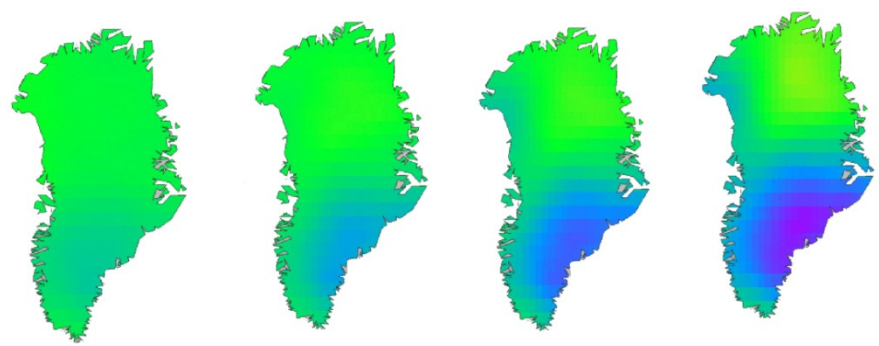
Measuring Changes In Ice Mass with GRACE





University of Texas at Austin Center for Space Research



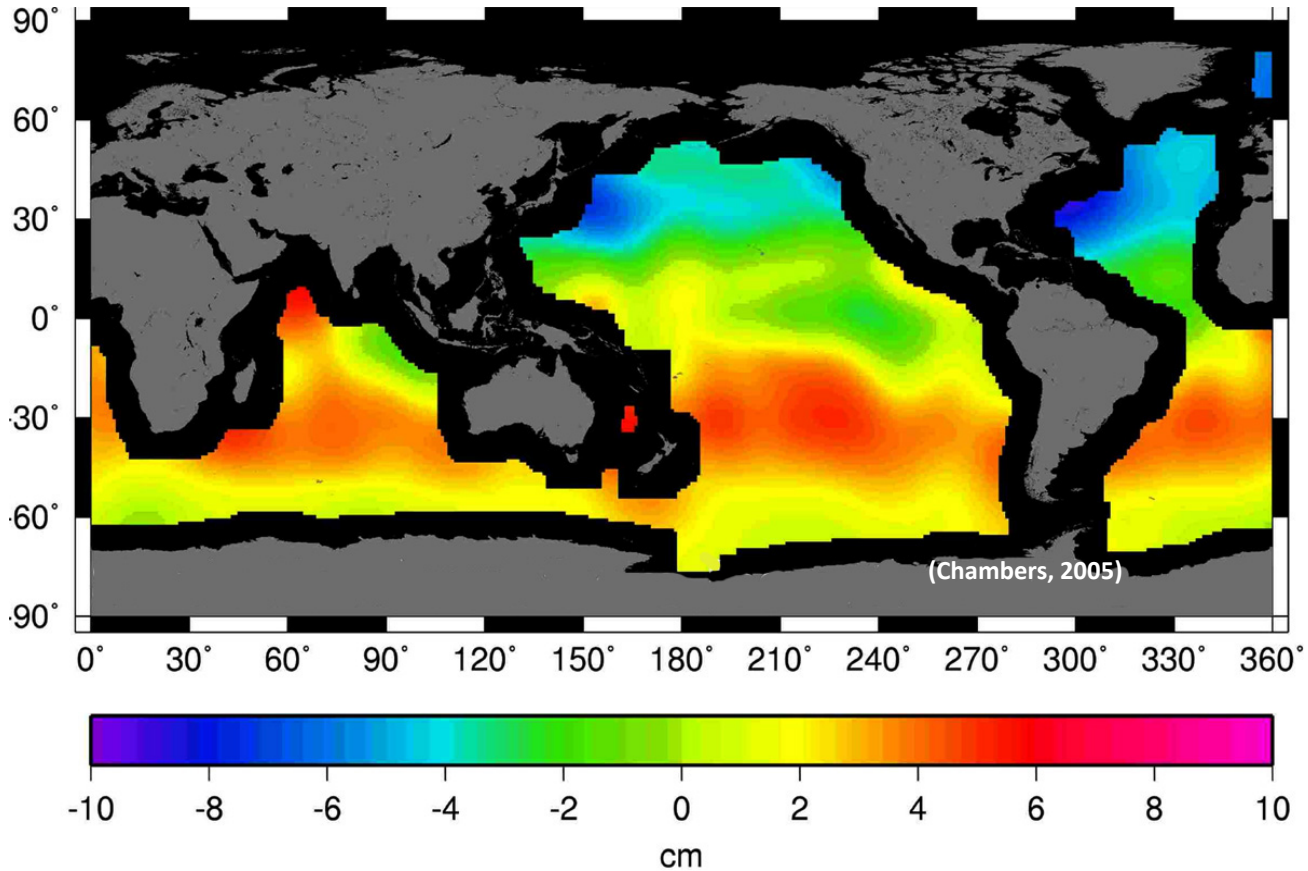


2004 2005 2006 2007

(Velicogna, 2009)

M. Watkins (JPL)

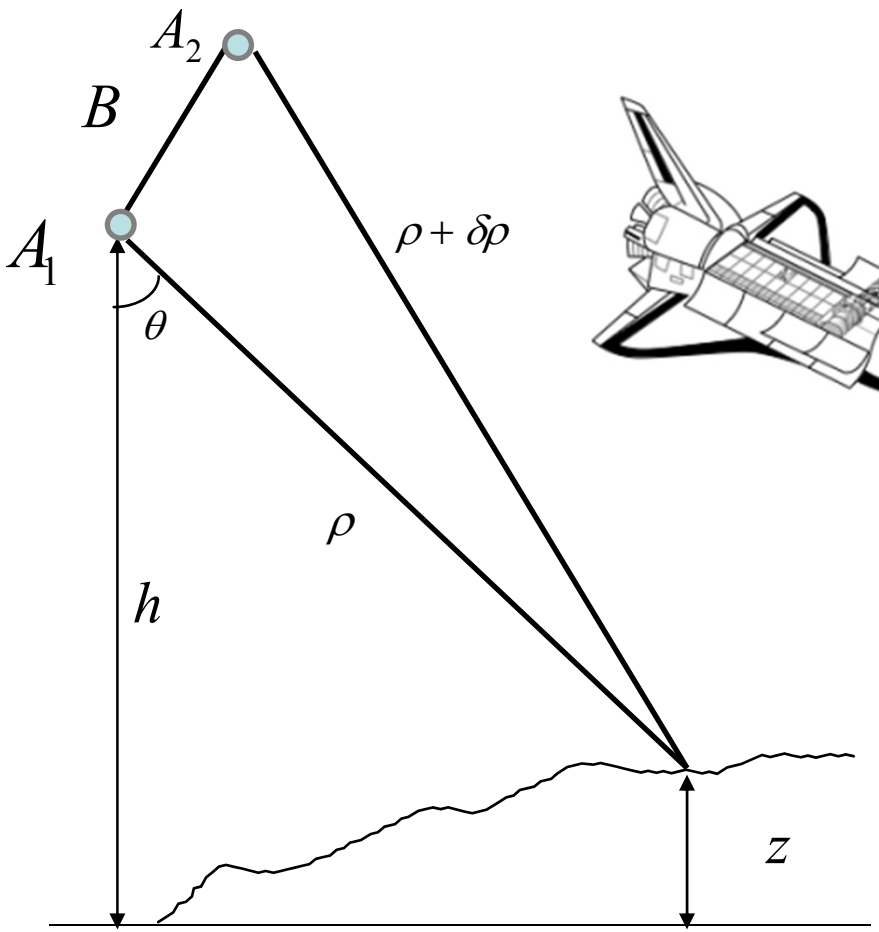
Contributions of Ice Melt and Thermal Expansion From Jason and GRACE

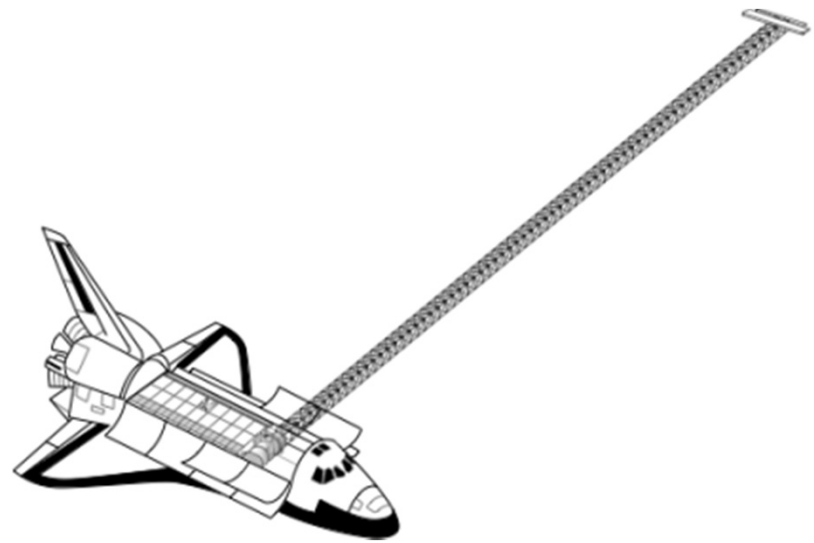


Sea Surface Topography - Mass change = Thermal Expansion of the ocean

Interferometry Basics

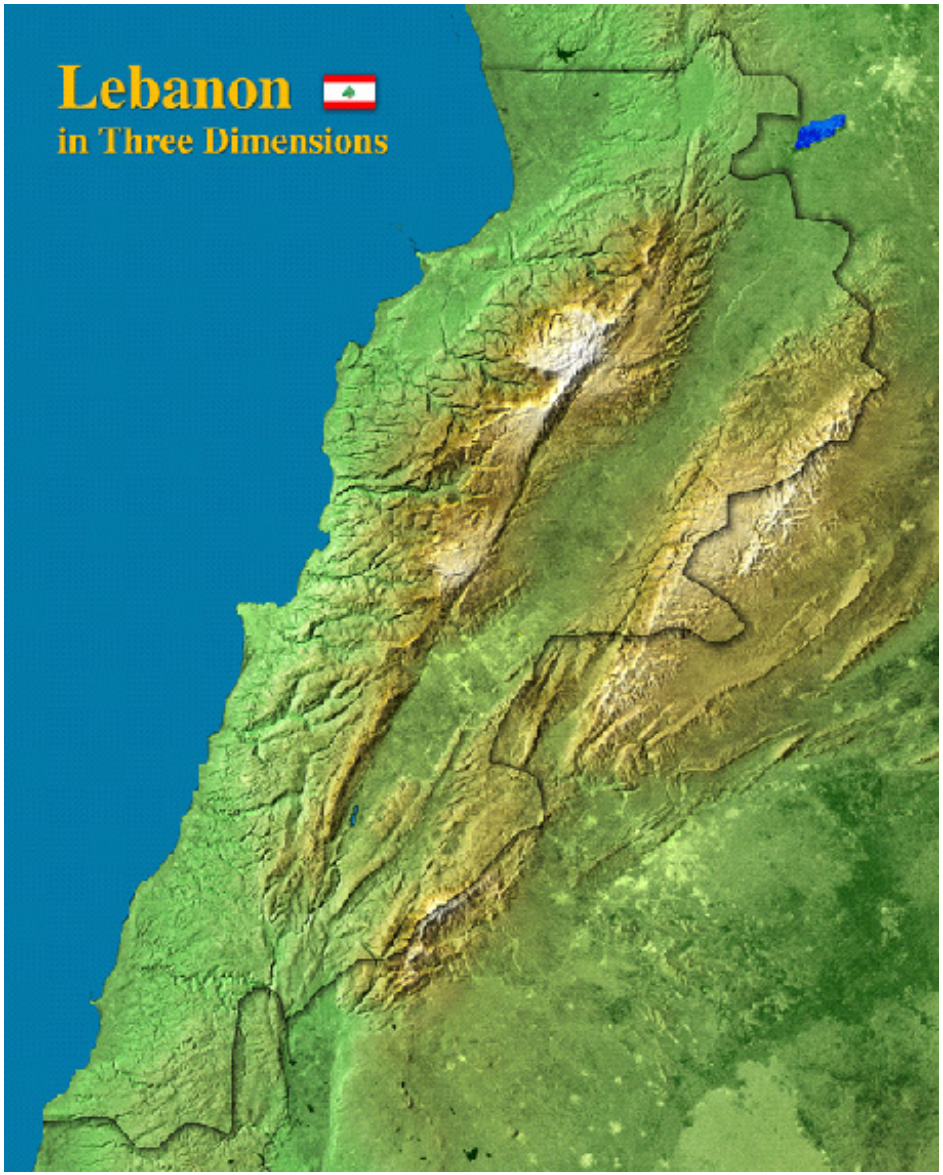
Single Pass
(Topography)



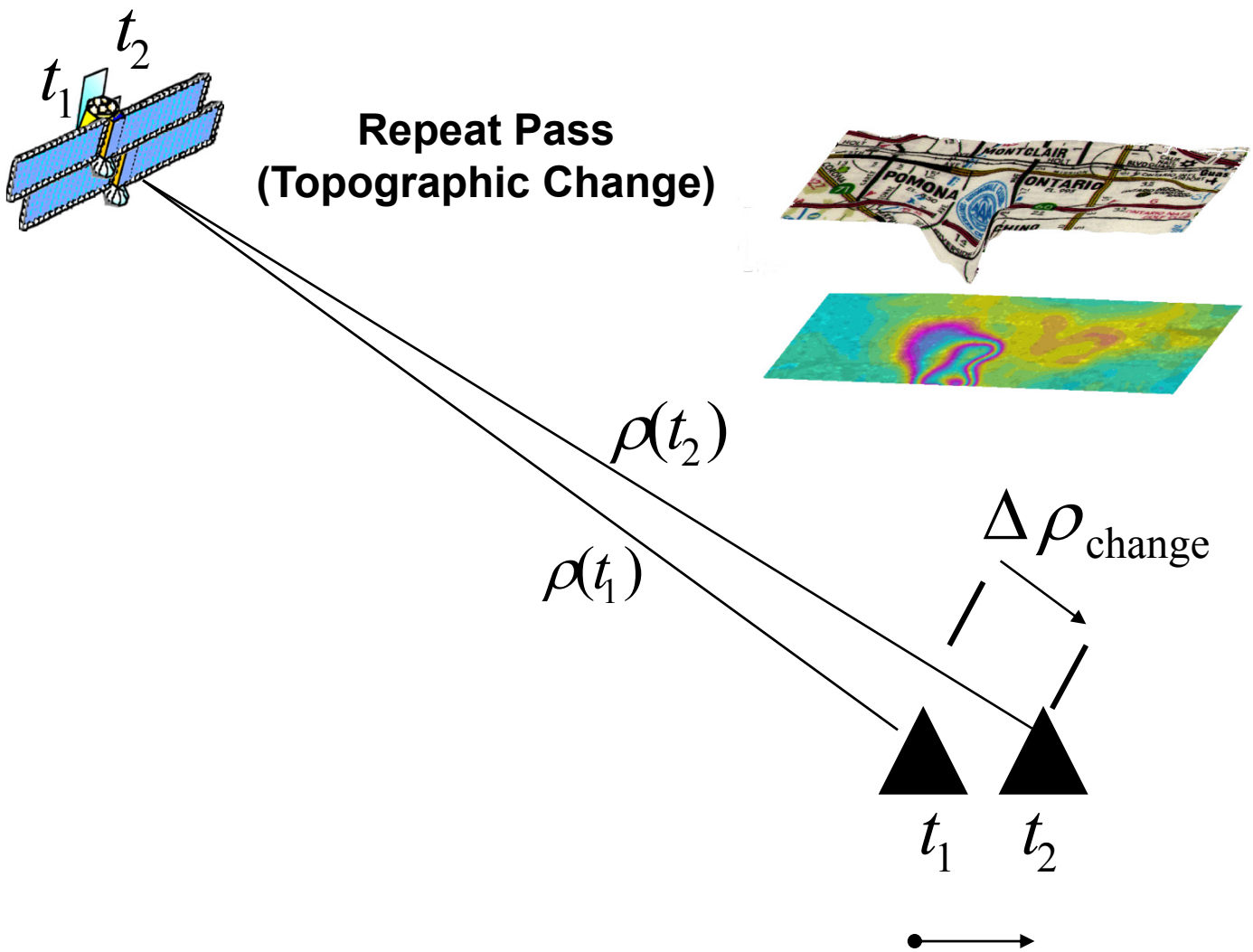


Shuttle Radar Topography Mission
February 11-22, 2000

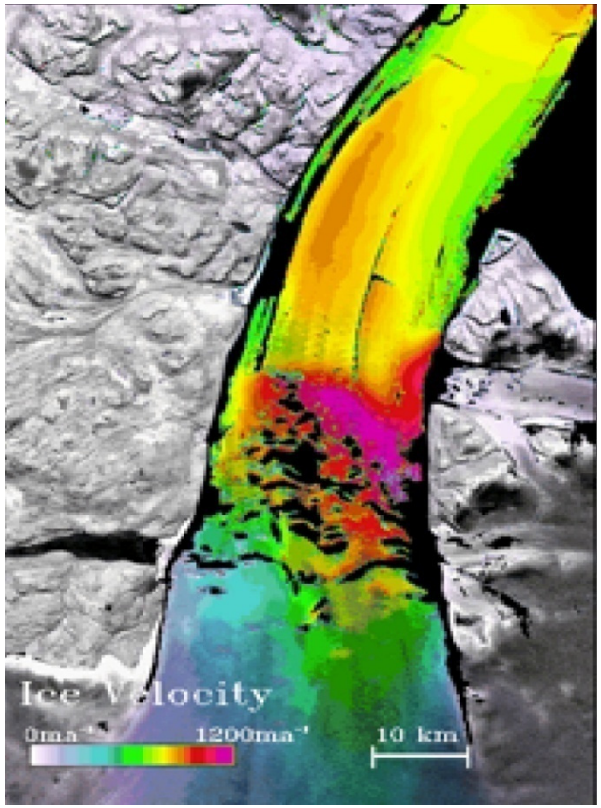
SRTM



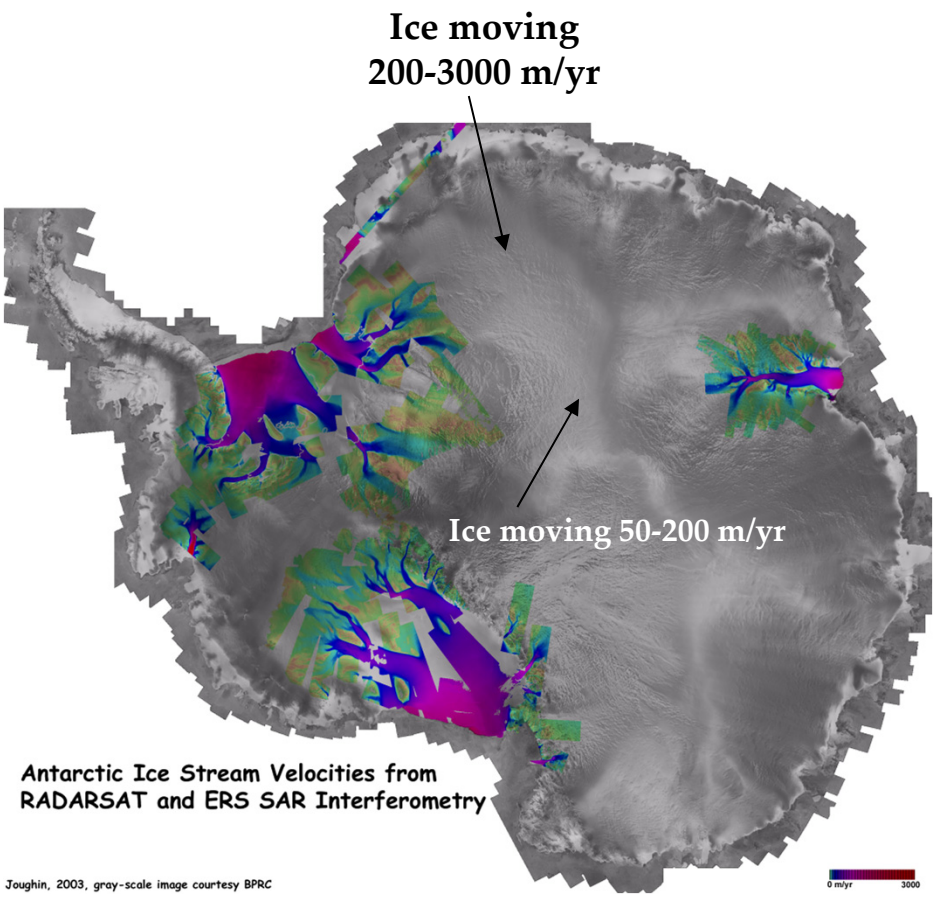
Interferometry Basics

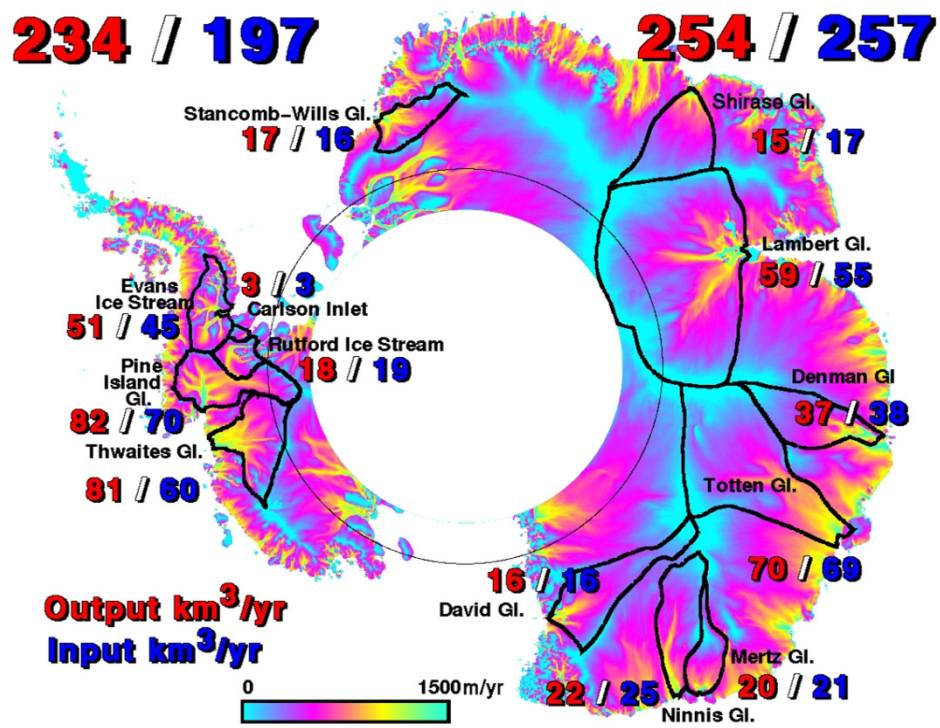


Monitoring Glaciers: Then And Now

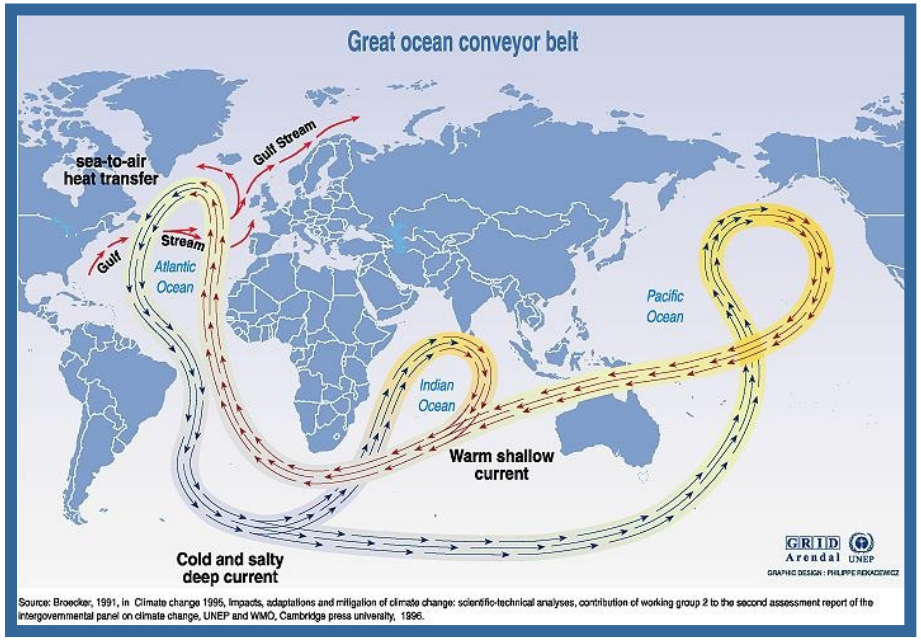


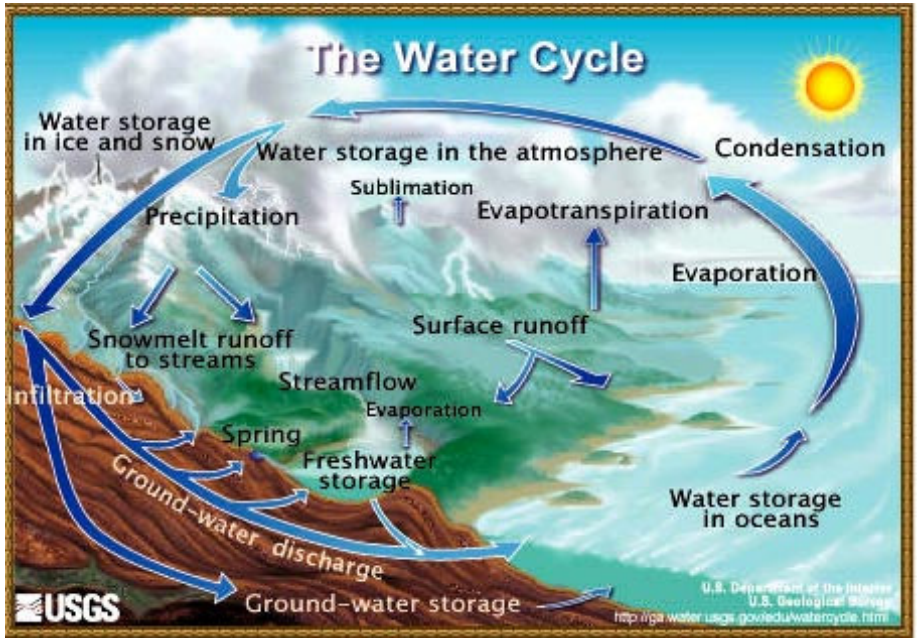
Measuring Ice Loss In Antarctica



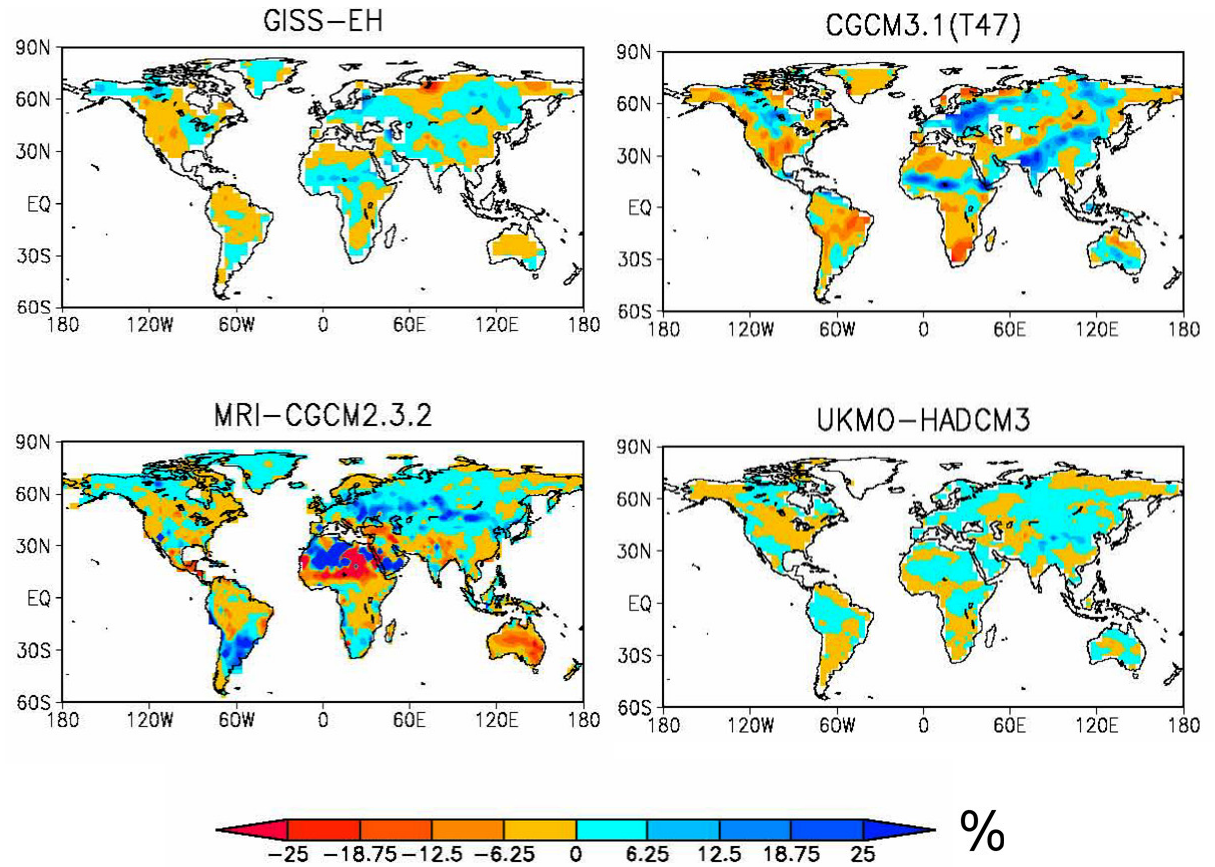


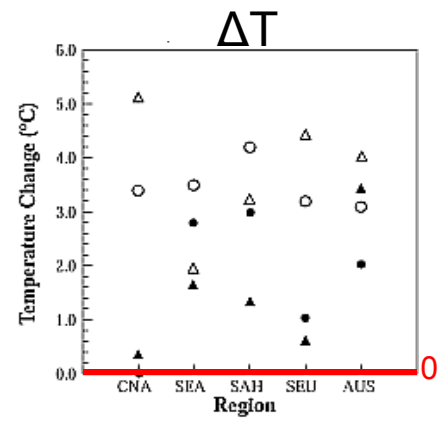
Oceans Impact on Water Availability

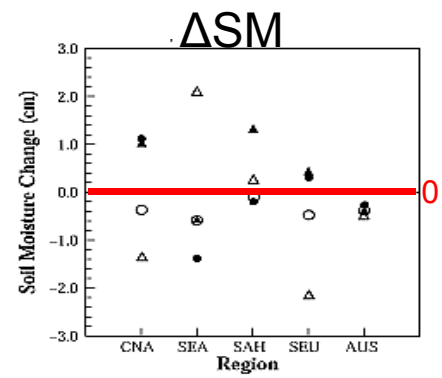




Model Forecasts of Soil Moisture



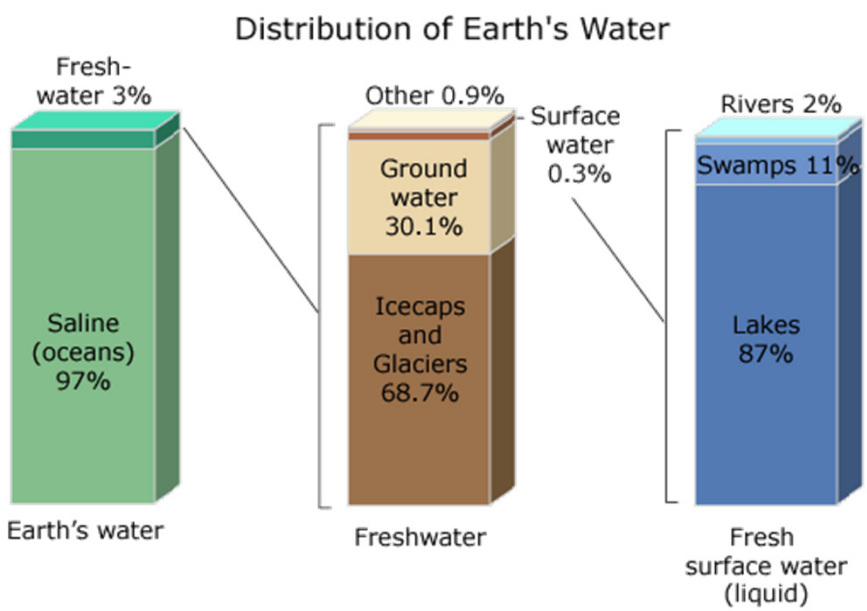




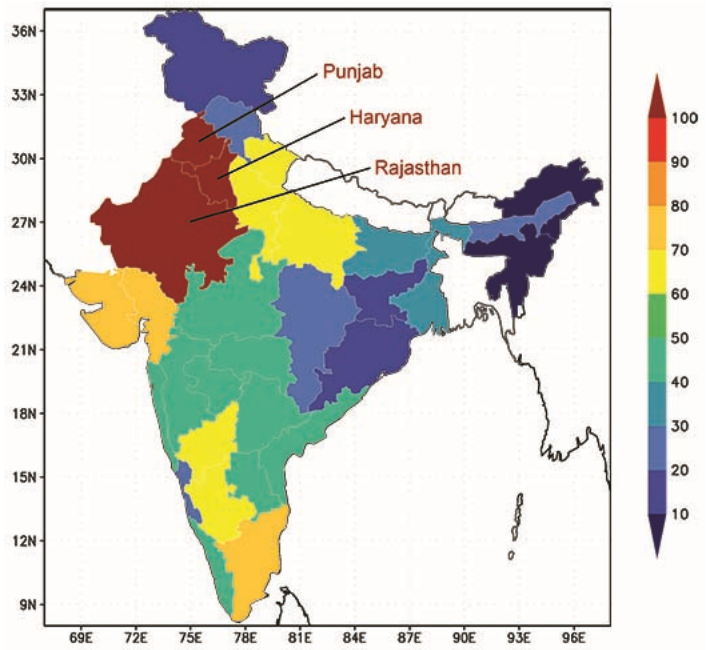
△ MPI(x) ○ UKMO(w) ▲ MPI + Aer(y) ● UKMO + Aer(z)

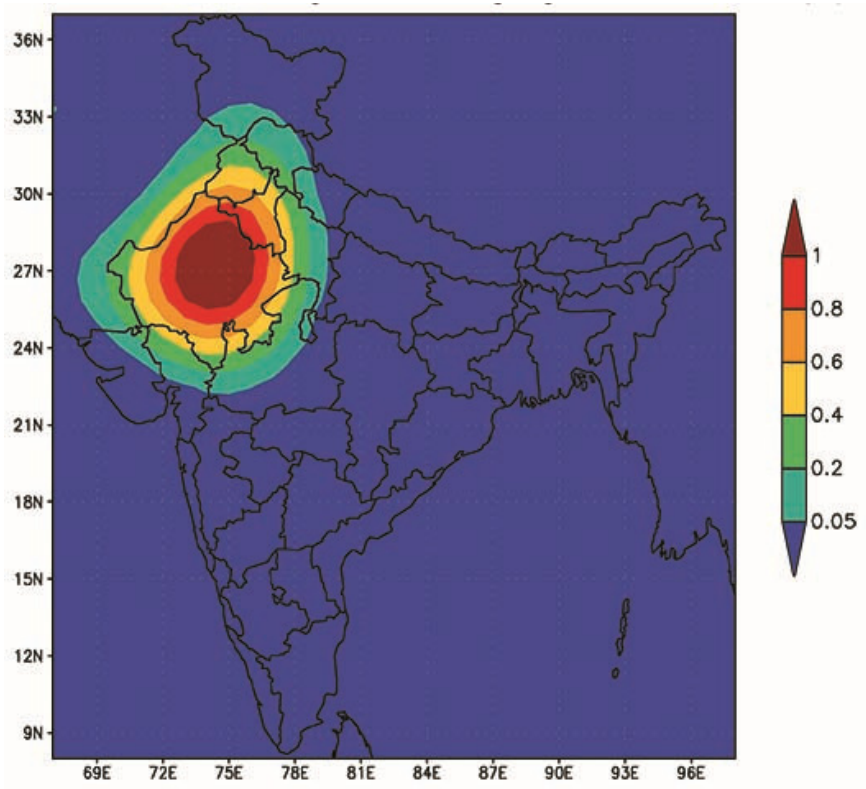
Li et al., (2007): Evaluation of IPCC AR4 soil moisture simulations for the second half of the twentieth century, *Journal of Geophysical Research*, 112.

Understanding Changes in Water Storage



Ground Water Depletion in NW India

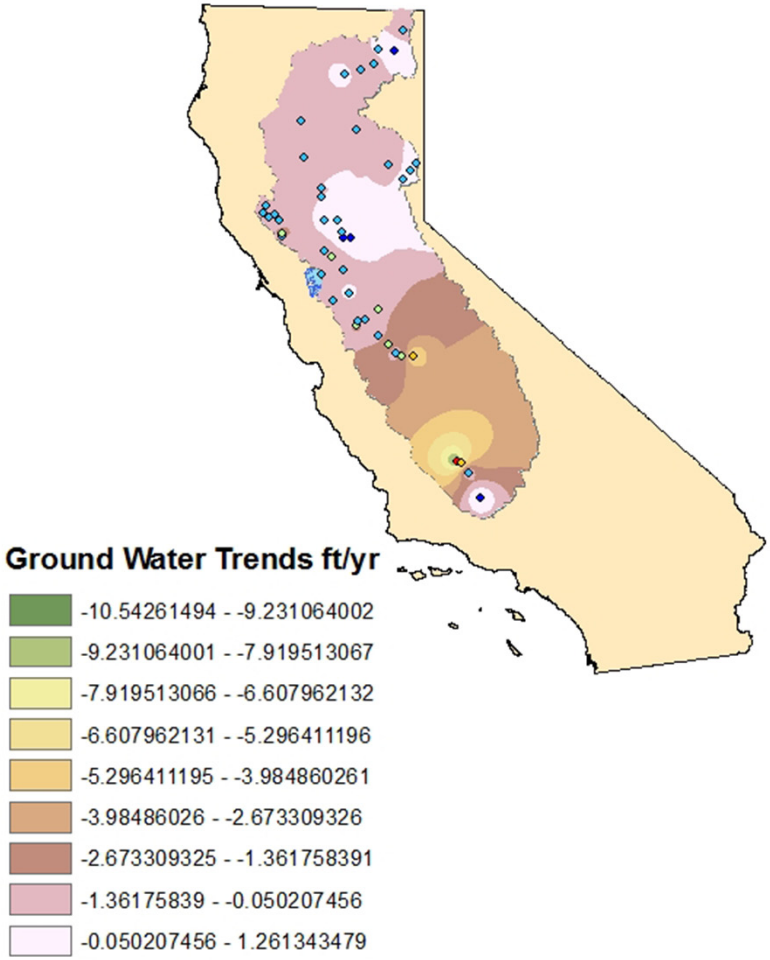


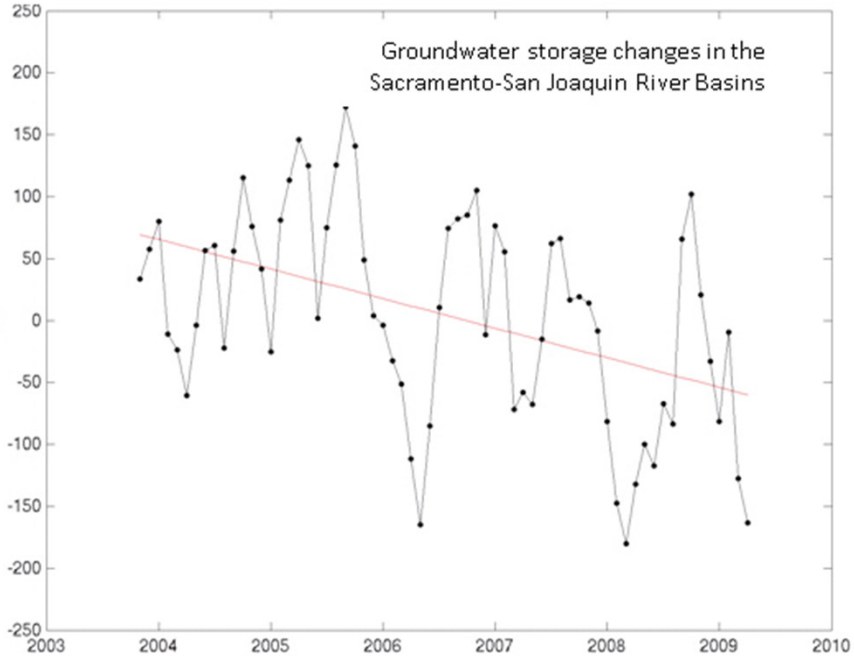


Rodell, et al. (2009)

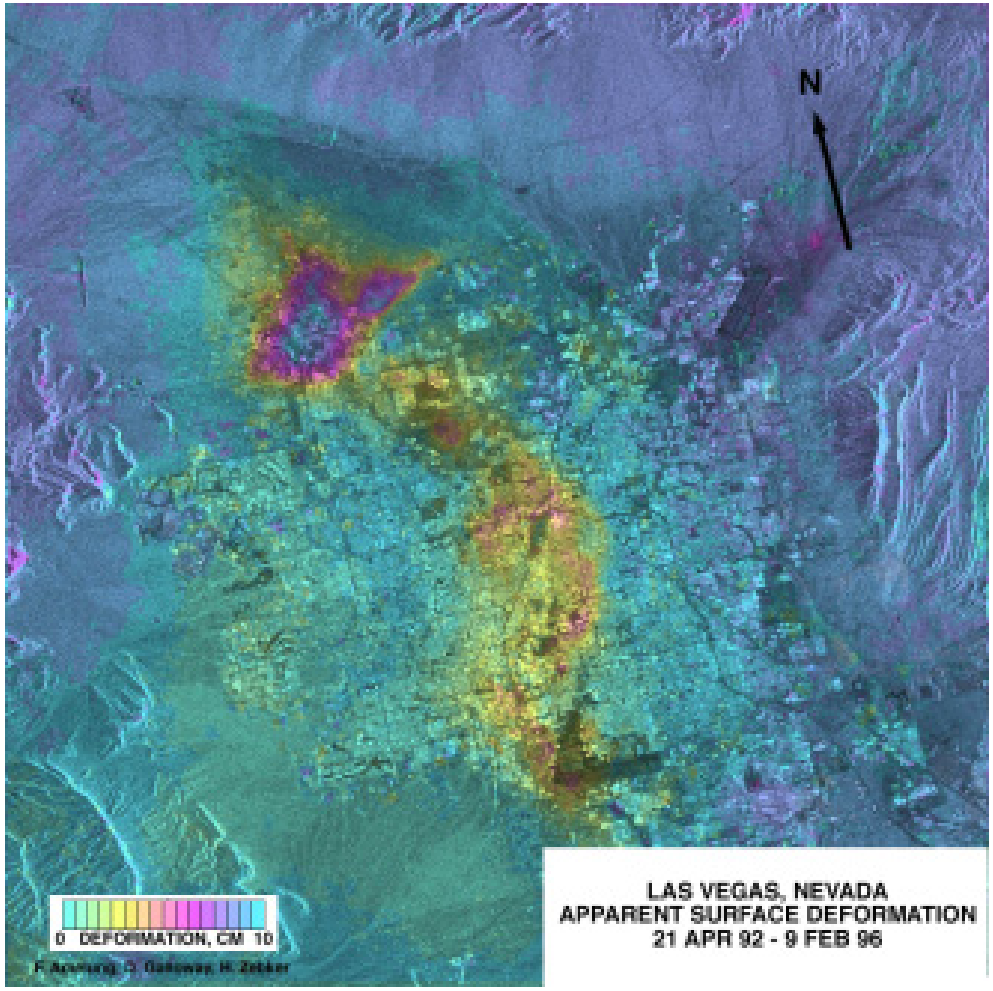
- Groundwater levels declining by 1 meter every 3 years.
- More than 109 cubic km of groundwater disappeared between 2002 and 2008

Groundwater Loss in California Observed by GRACE

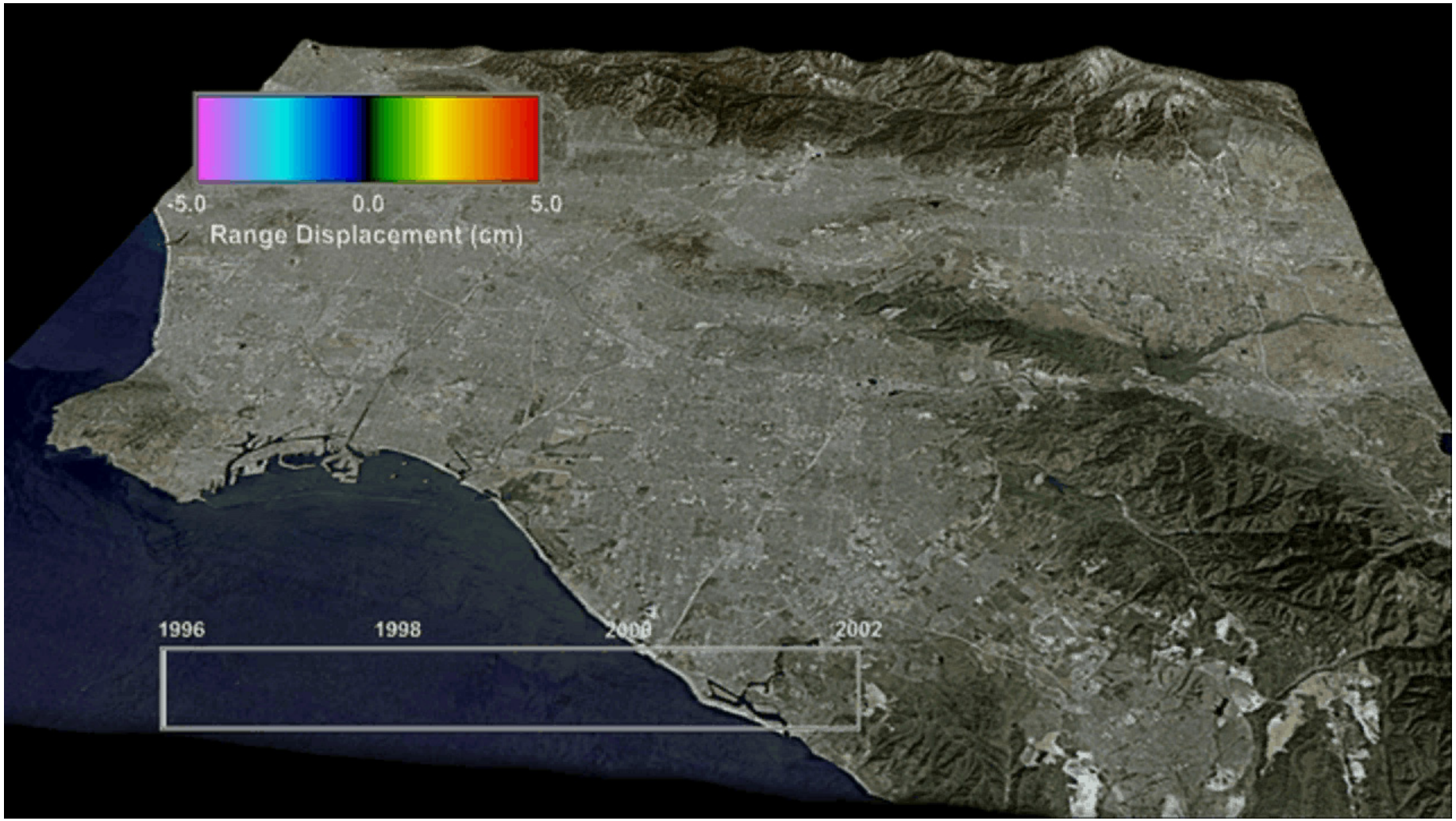




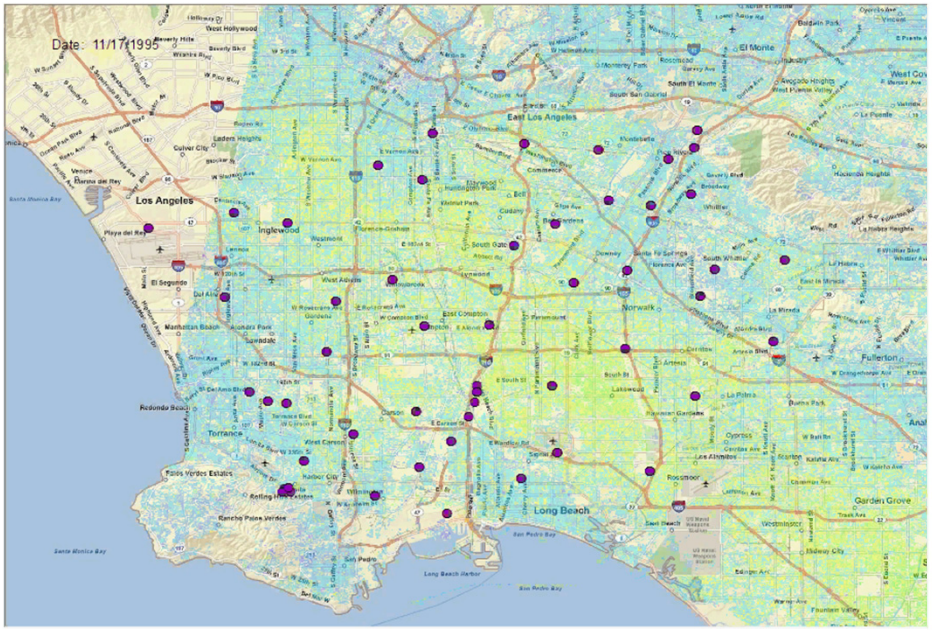
Las Vegas InSAR Data

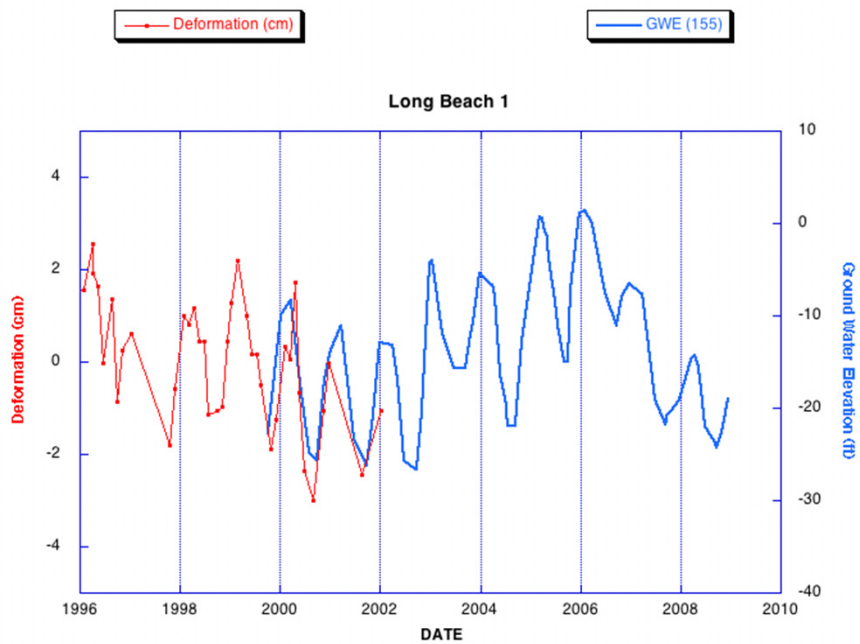


LA InSAR Data



Relationship of Deformation to Groundwater Well Elevation



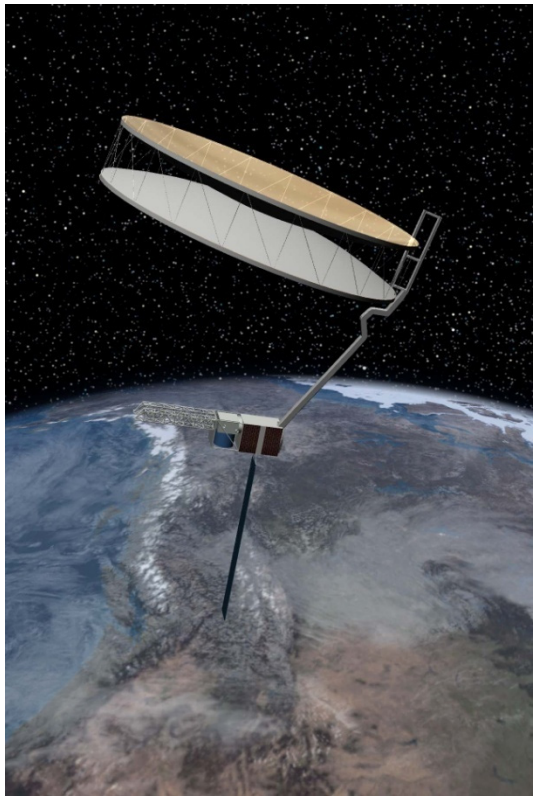


http://webgis.irea.cnr.it/

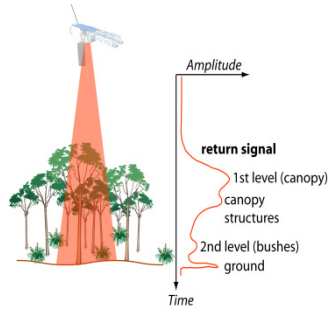
...to know our
Past, Present
and Future.

Backup

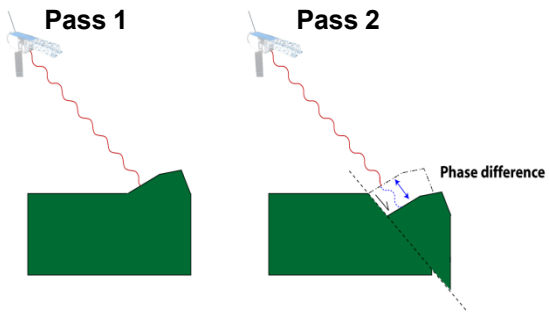
Deformation, Ecosystem Structure, and Dynamics of Ice (DESDynI)



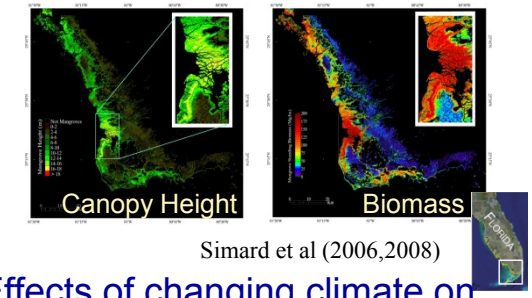
DESDynI will combine an interfermetric L-band radar (InSAR) and multibeam lidar



Height and structure of forests

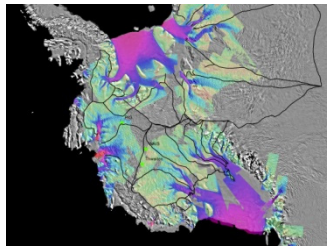


Ice sheet dynamics
Changes in Earth's Surface

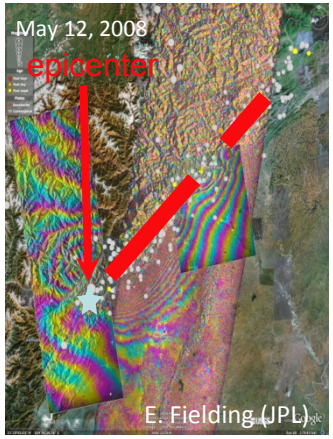


Simard et al (2006,2008)

Effects of changing climate on habitats and CO_2

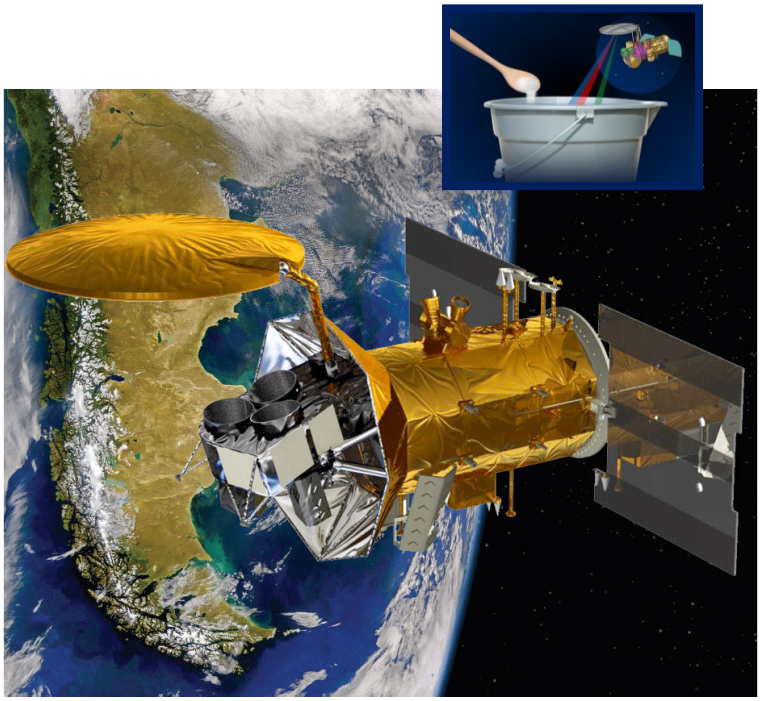


Response of ice sheets to climate change & sea level rise

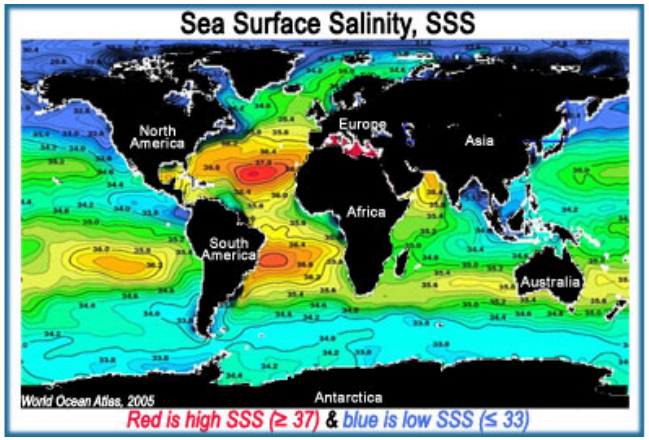


Natural hazard forecasts

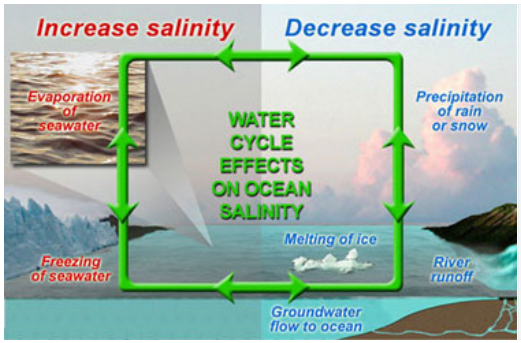
Aquarius will Launch in 2010

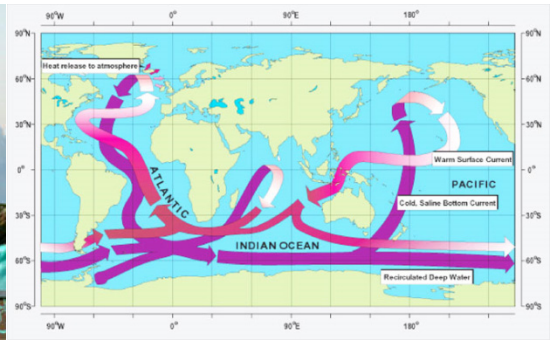


Salinity changes impact precipitation and ocean circulation

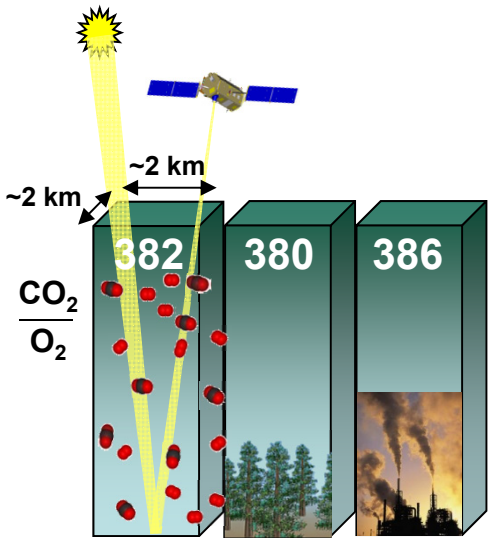


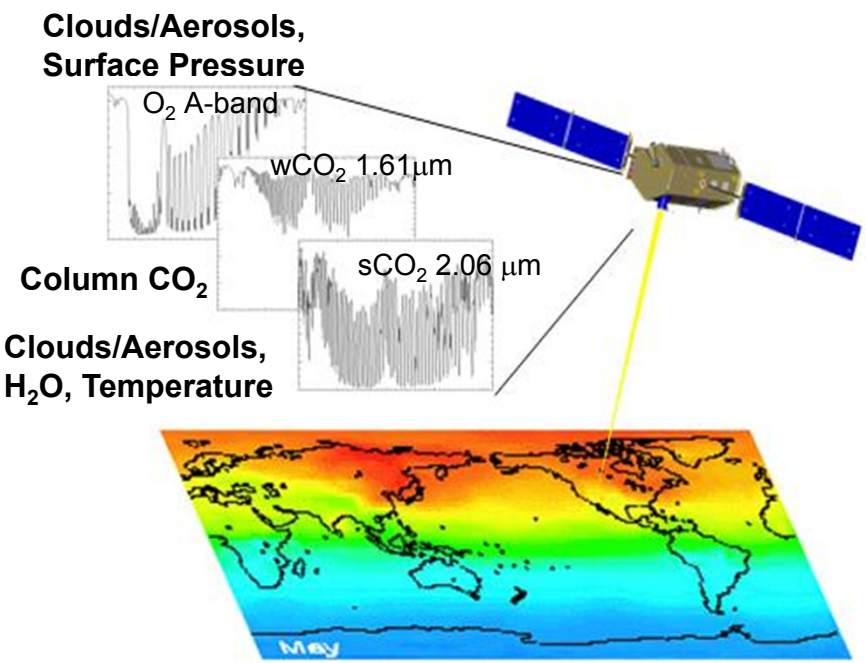
Aquarius will use an L-band radar and radiometer to make monthly maps of sea surface salinity with precision of .2 PSU and resolution of 150 x 150 km.



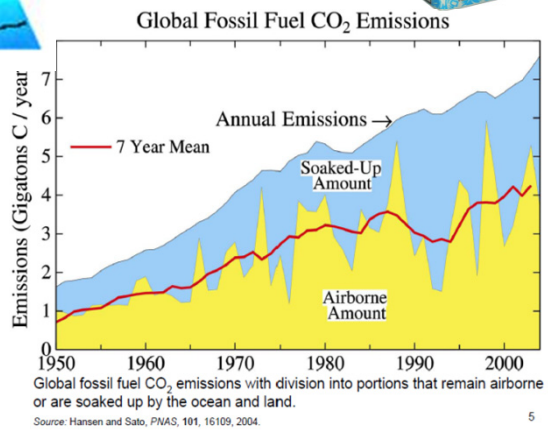


Orbiting Carbon Observatory (OCO)



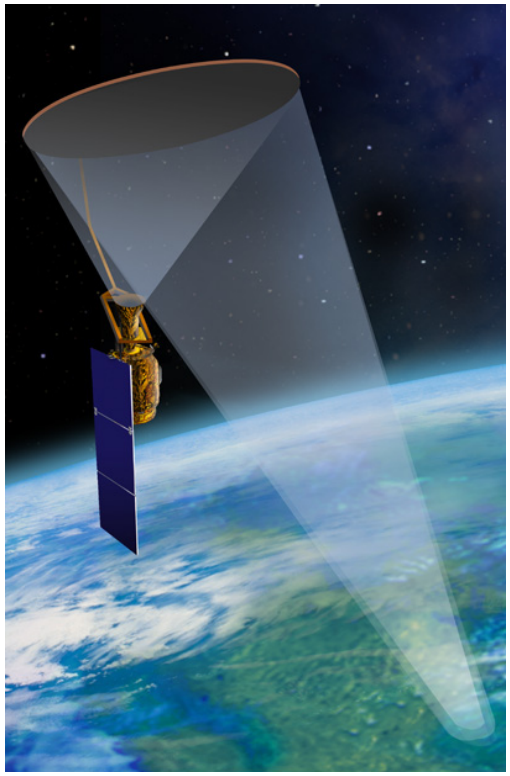


Only ~58% of the >200 Gt C humans have added to the atmosphere since 1958 is staying in the atmosphere

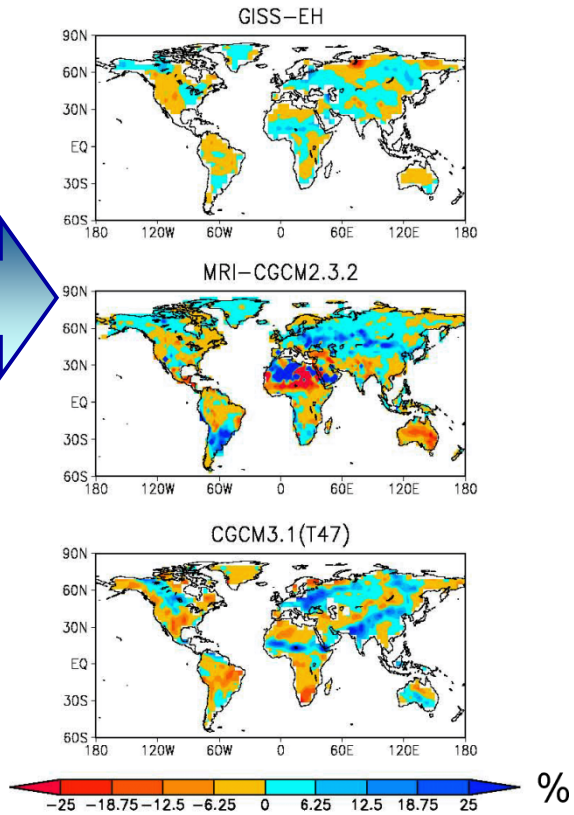


OCO will measure reflected sunlight with 3 bore-sighted, high resolution grating spectrometers with enough precision (1–2 ppm) to resolve sources and sinks of CO_2 at a scale of 1000 km

Soil Moisture Active and Passive (SMAP) Mission is Underway

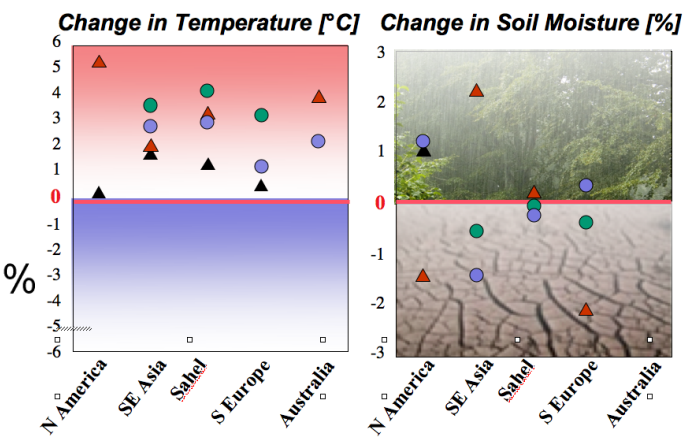


SMAP will use a rotating 6-m deployable mesh antenna shared by an L-band radar & radiometer to map soil moisture with an accuracy of 4% and resolution of 10 km every 3 days

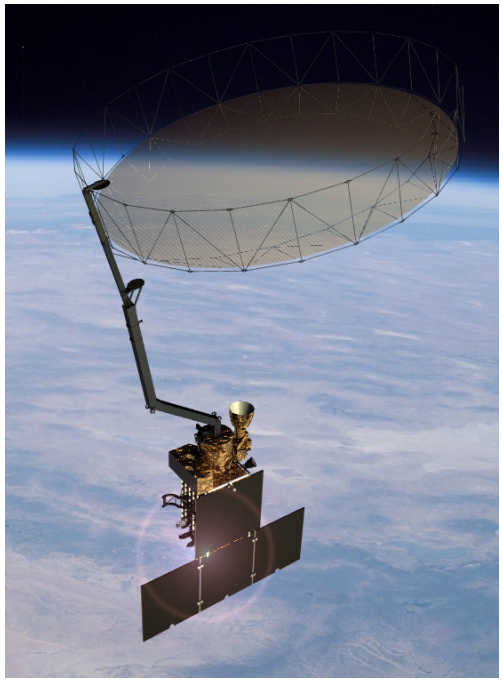


Li et al., (2007)

IPCC models for future soil moisture changes (%) show significant disagreement

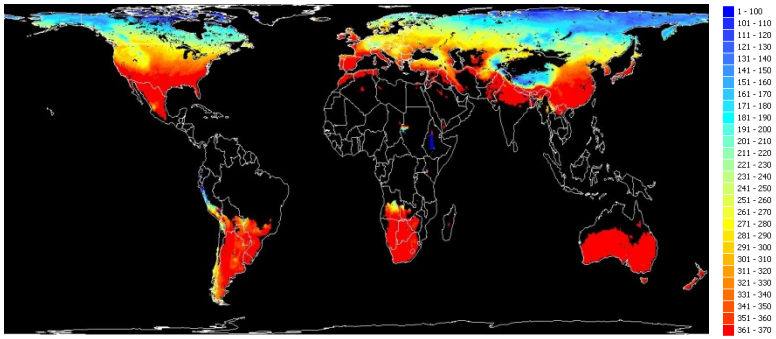


Soil Moisture Active and Passive (SMAP) Mission is Underway



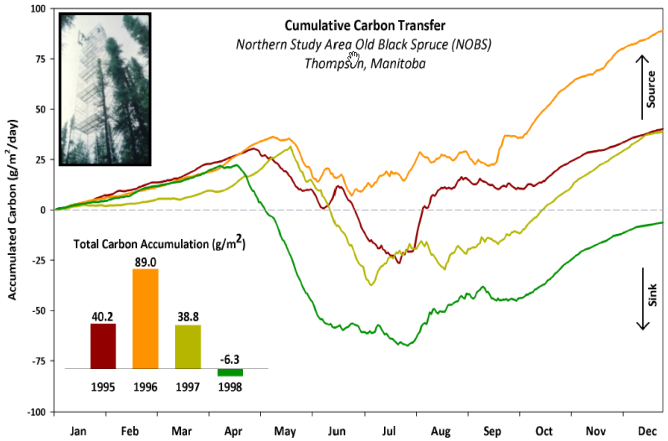
SMAP will use a rotating 6-m deployable mesh antenna shared by an L-band radar & radiometer to map soil moisture with an accuracy of 4% and resolution of 10 km every 3 days

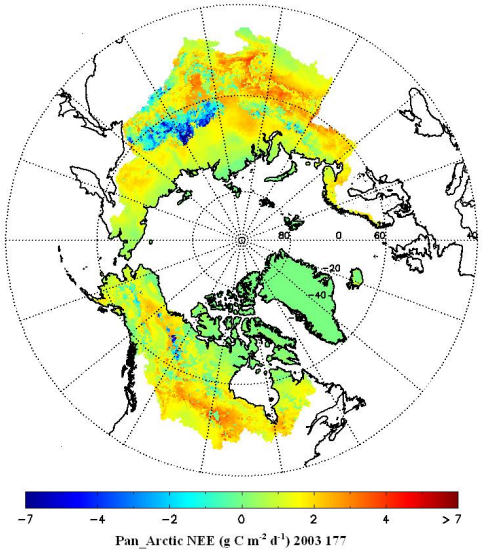
Annual Unfrozen period



How sensitive is the regional carbon cycle to climate variability and climate change?

Landscape freeze/thaw dynamics drive boreal Carbon balance



Are Northern land masses sources or sinks for atmospheric Carbon?

Simulated SMAP Output Product: Mean Daily net CO_2 Exchange