GRACE Measurement of Total Water Storage Variations Over Texas

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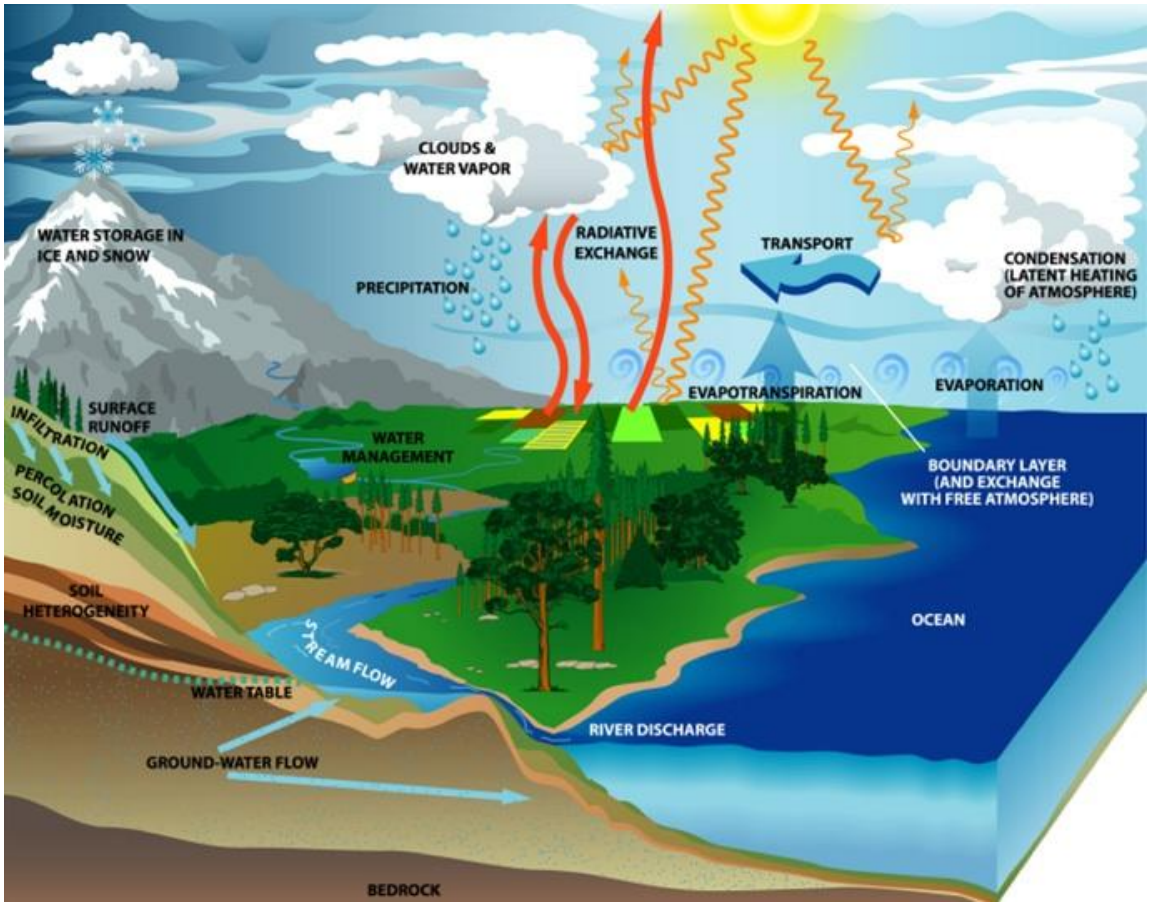
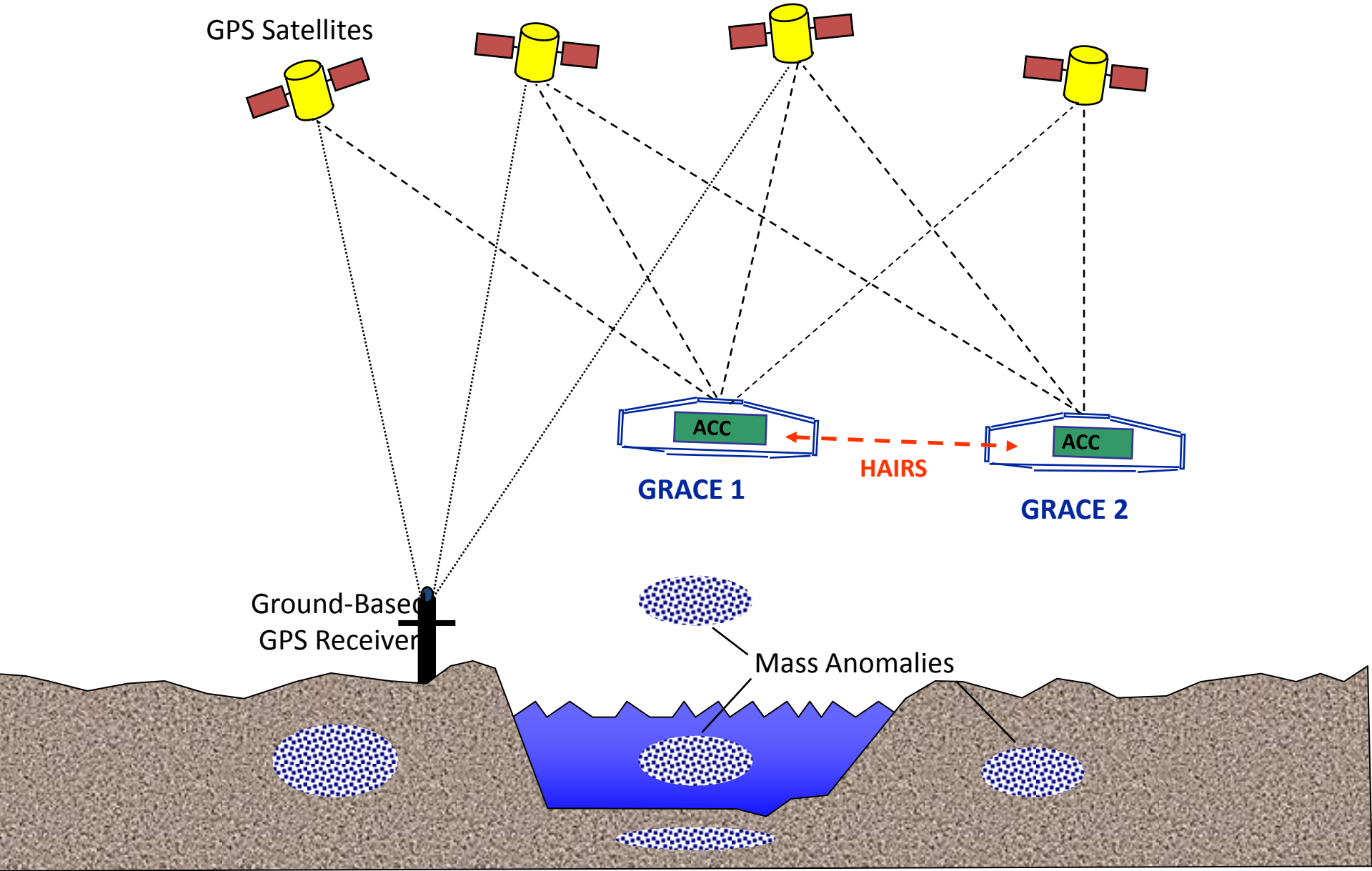
GRACE Observations and The Global Water Cycle



Global Gravity Measurements determine Mean Global Mass Distribution and the Temporal Variations which measure change in water mass of land and oceans

GRACE measures the change in all forms of the water stored on land after precipitation has been stored as snow, filtrated into the ground, evaporated or departed a basin as stream flow

Grace Mission Concept



GRACE MASS FLUX MEASUREMENT

Sample the globe every 30 days

Convert 30 day data set into Gravity Model representative of mass distribution during each sample interval

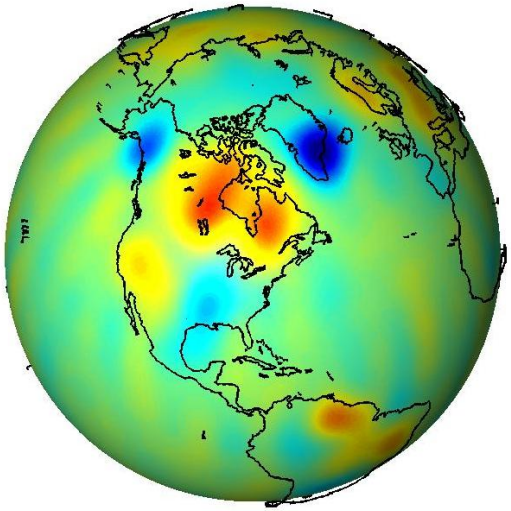
- Six hour global output from ECMWF Meterological Model provides rapid atmospheric mass transport
- Surface pressure and winds from ECMWF Models is used to force Ocean Model to obtain high frequency Ocean response to atmospheric forcing

Average ~ 100 monthly solutions(10 year mission life) to obtain accurate long term mean

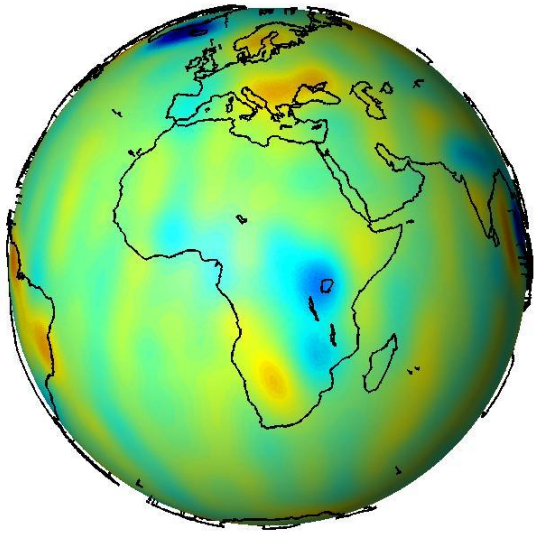
Difference monthly solutions from the long term mean to obtain monthly variability

Secular/Episodic Gravity Changes

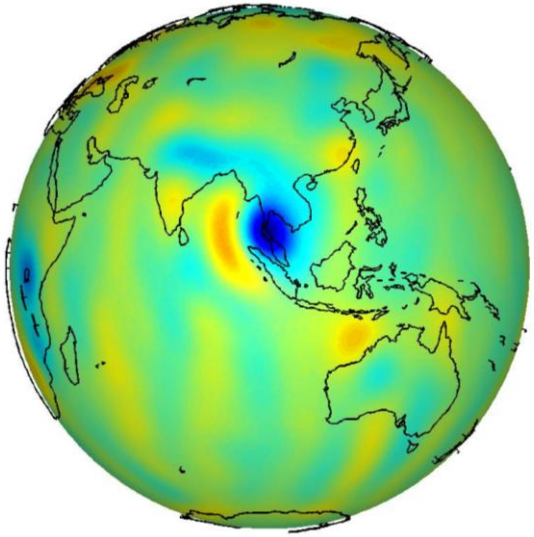
Difference of two 2-year means (2003-2004 and 2005-2006)
(degree/order 30 or ~700 km resolution)



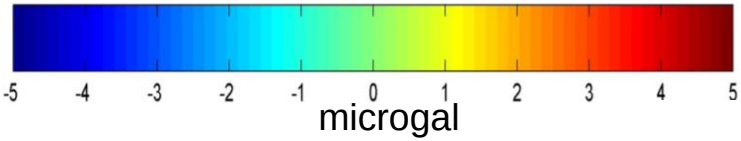
GIA over Canada;
Greenland & Alaska
ice mass losses

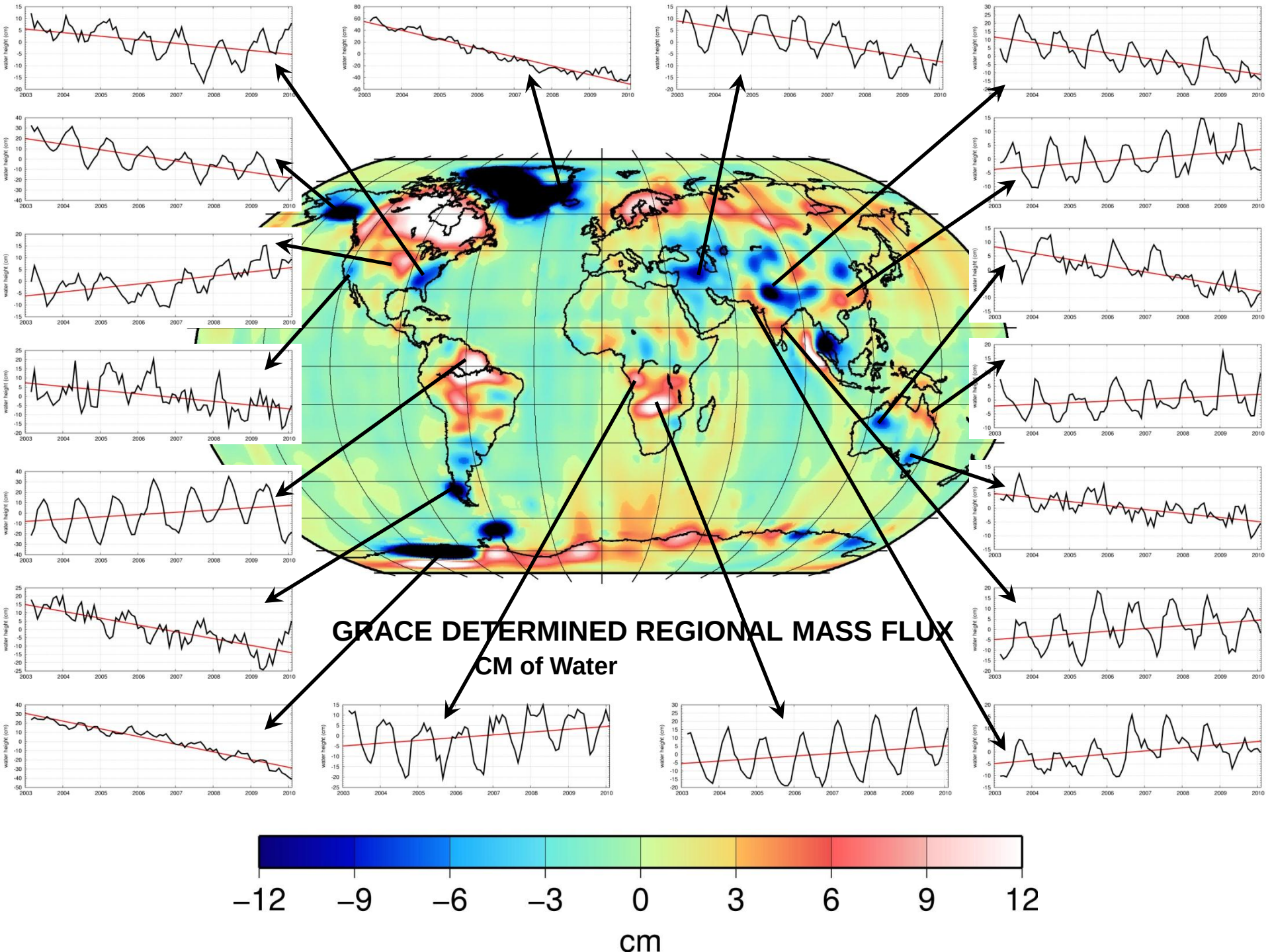


Lake Victoria basin
mass loss

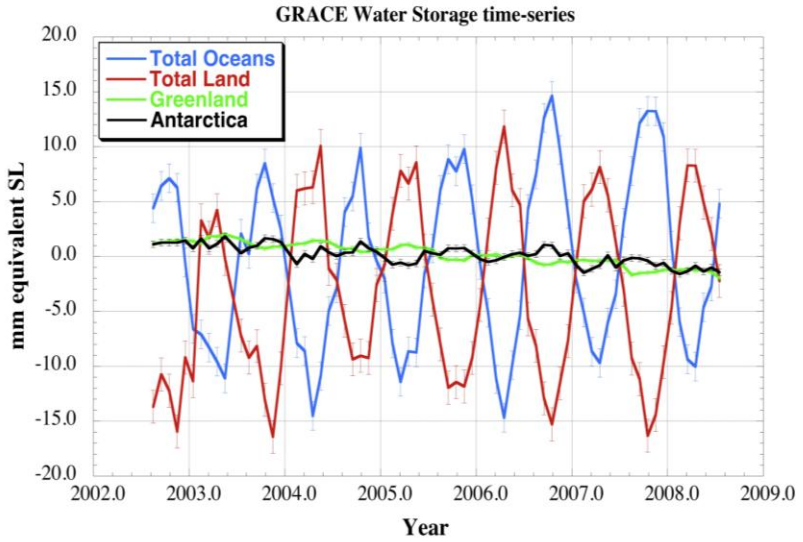


Sumatra-Andaman
Earthquake




GRACE DETERMINED REGIONAL MASS FLUX
CM of Water
−12
−9
−6
−3
0
3
6
9
12
cm

GRACE Global Mass Estimate

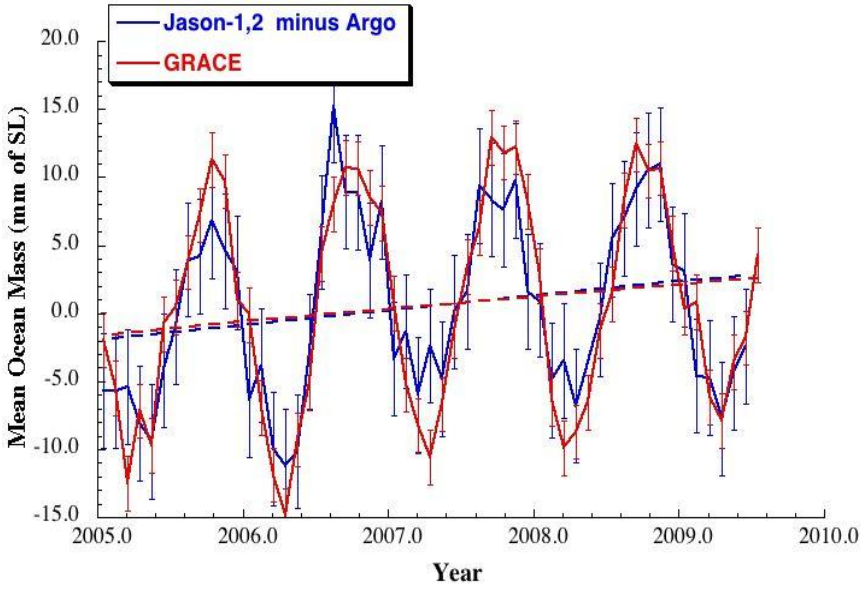


Trends (mm/yr)

Ocean = 1.2± 0.3

Land = 0.3 ± 0.5
Greenland = -0.60 ± 0.1
Antarctica = -0.40 ± 0.2

Famiglietti, 2009



GRACE/Jason/Argo Closure

Grace Trend(2003-2009.5) = 1.3+/-0.8 mm/yr

Chambers,, 2009

Rate of Ice volume change:

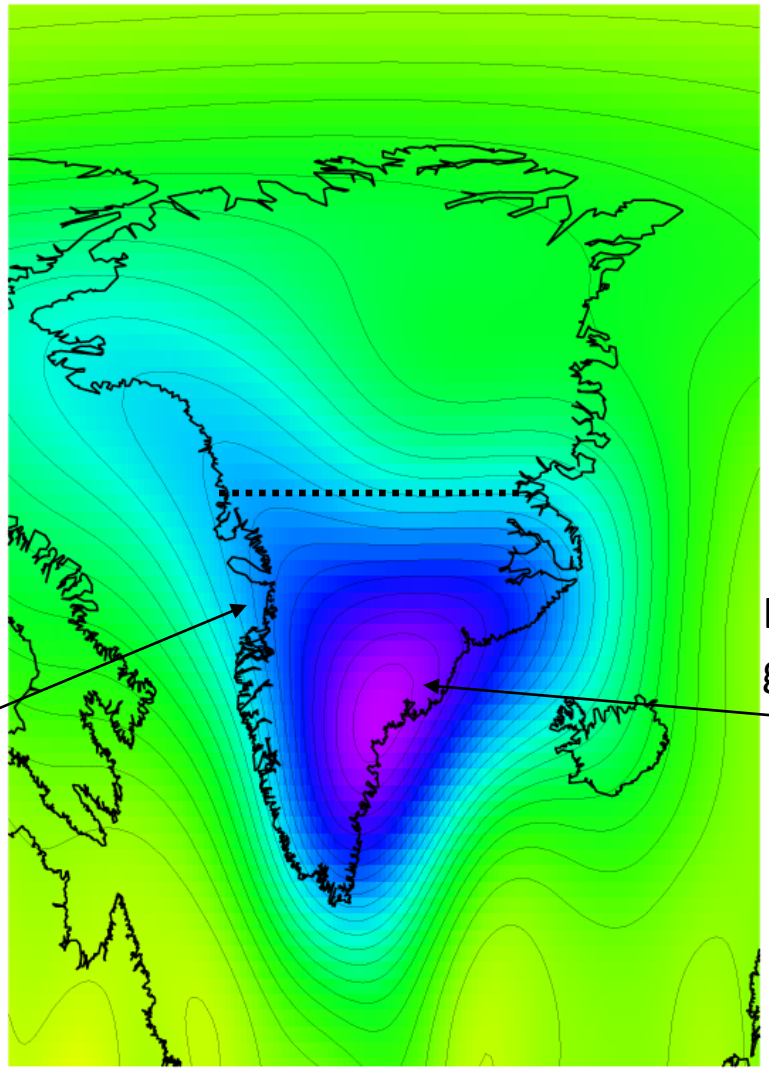
All Greenland: -250 km^3/yr

South Greenland: -186 km^3/yr

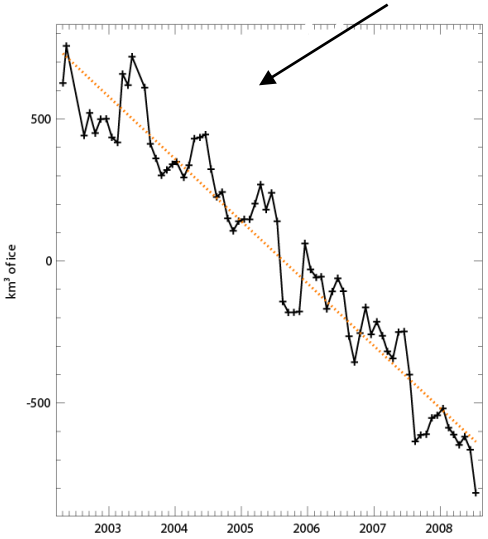
North Greenland: -64 km^3/yr

-250 km^3/yr = 0.65 mm/yr sea level rise

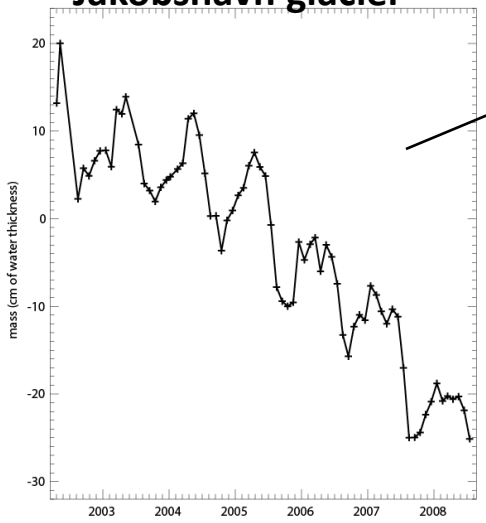
April, 2002 – June, 2008



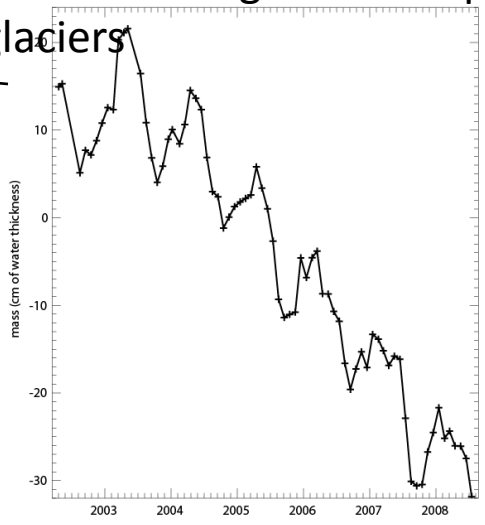
Total Greenland ice volume



Jakobshavn glacier



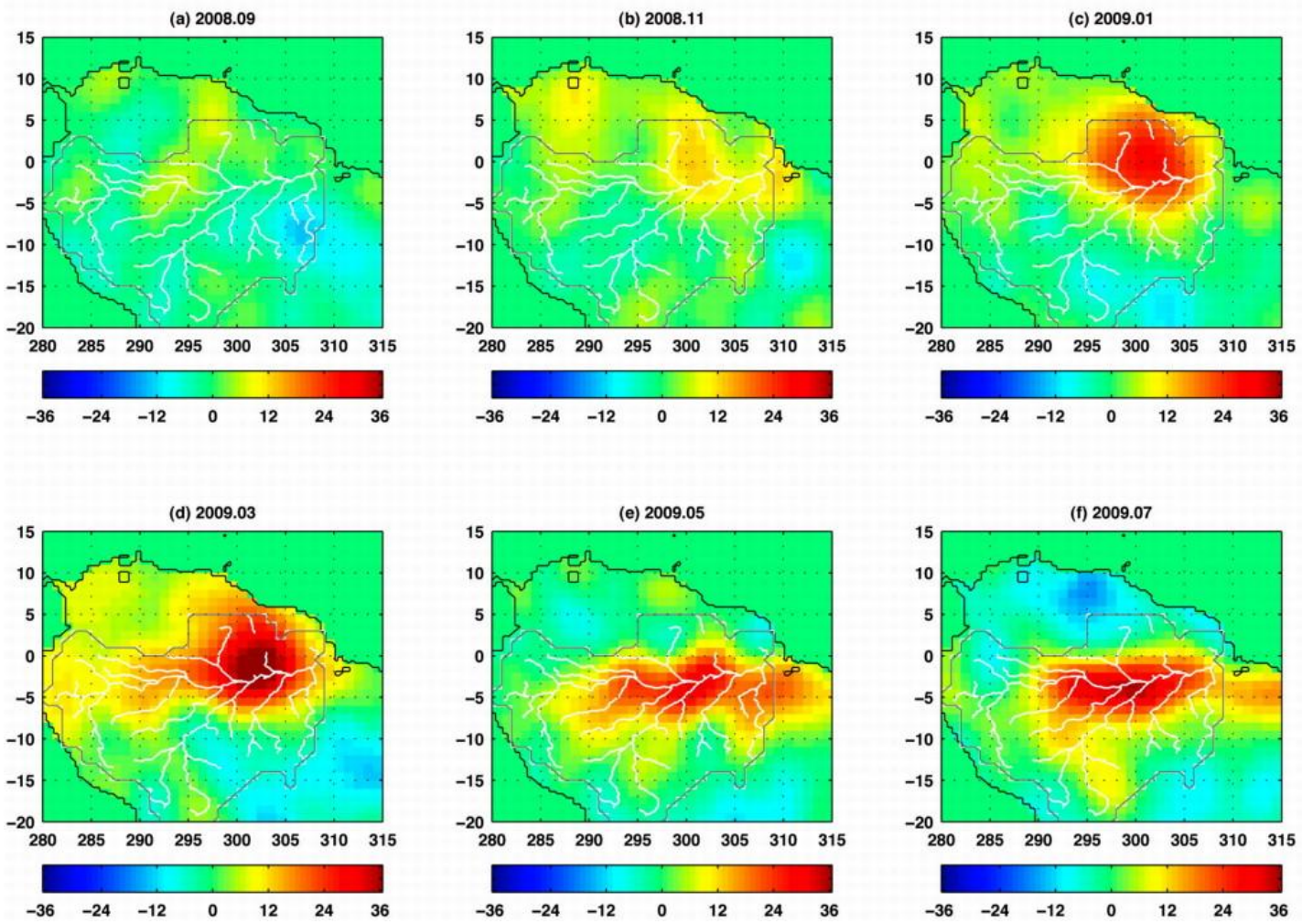
Helheim+Kangerdlussuaq glaciers



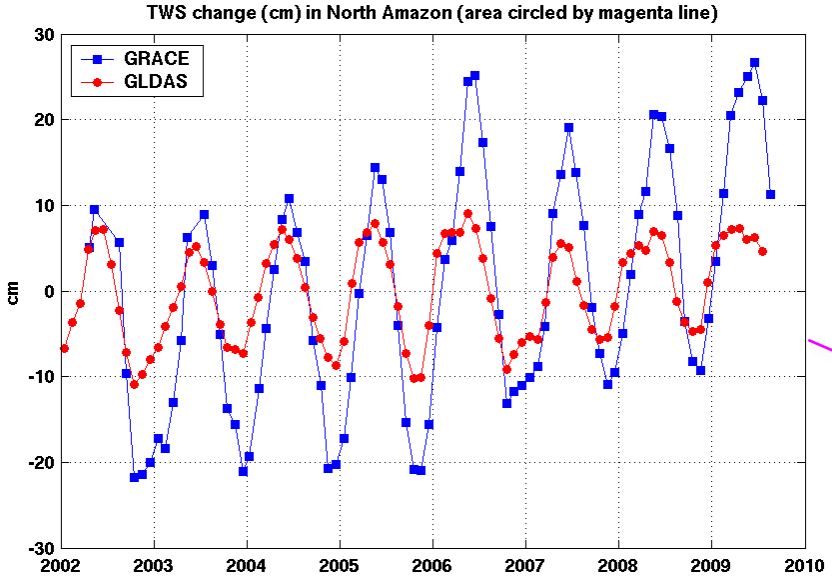
400 km smoothing

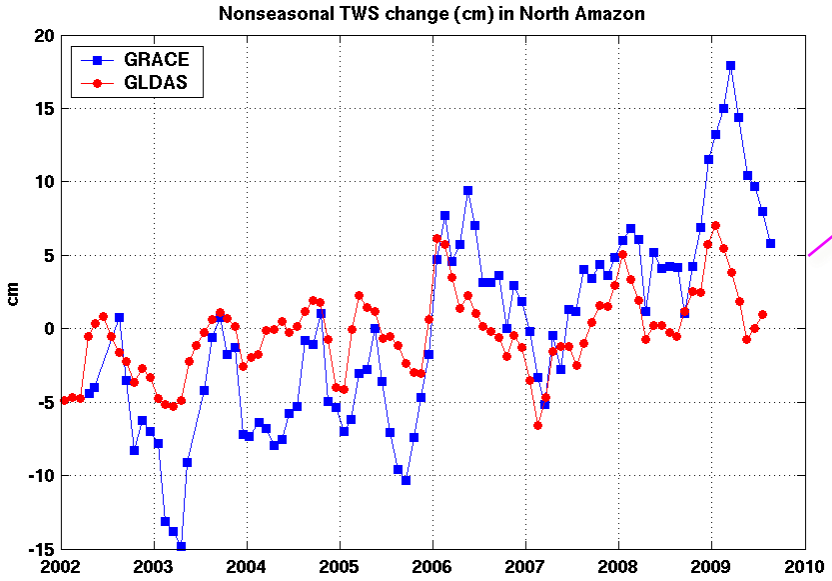
Wahr and Velicogna (2008)

Development of the exceptional 2009 Amazon flood from GRACE

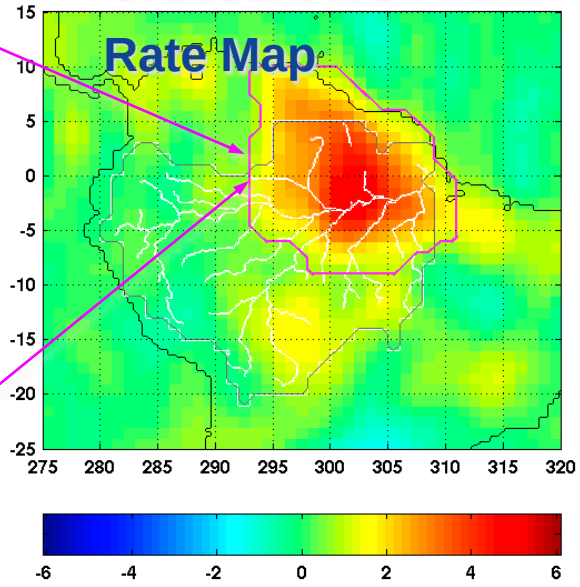


GRACE observed monthly TWS anomaly (seasonal signal is removed)





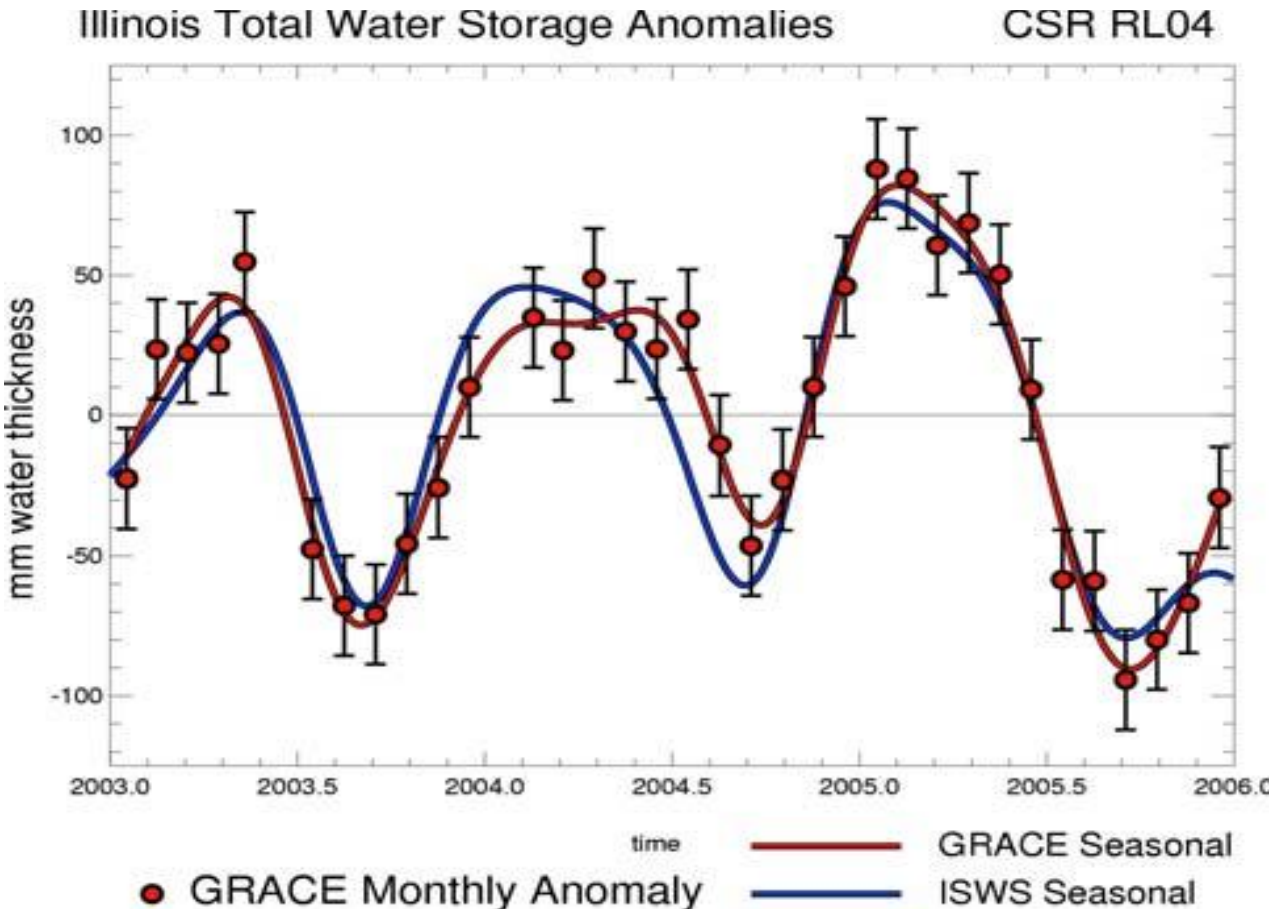
GRACE TWS Rate Map



Units: cm/yr of water thickness

Groundwater Monitoring

Estimates match groundwater well measurements



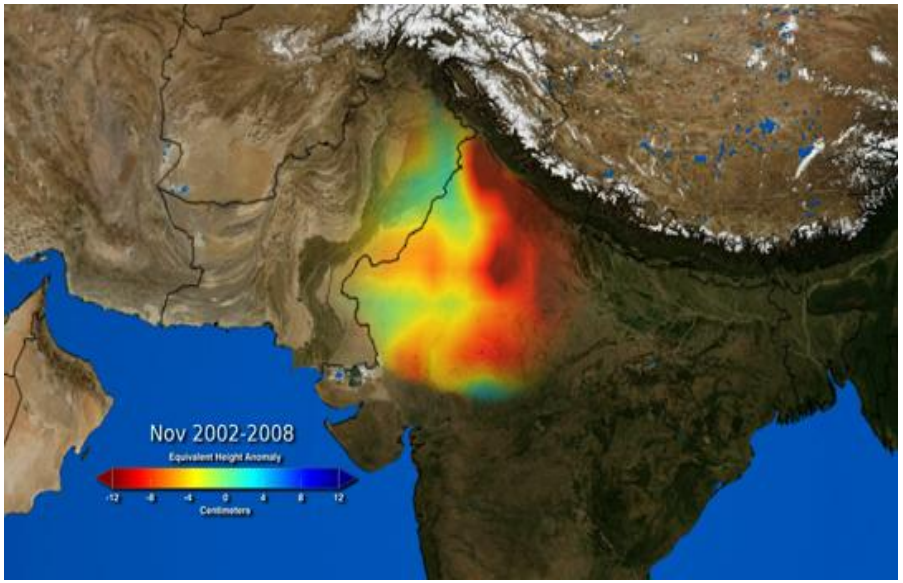
Swenson, 2007

Illinois

280,000 sq km

Method is applied in regions where groundwater is not well monitored, but depletion is likely: Africa, Middle East, etc.

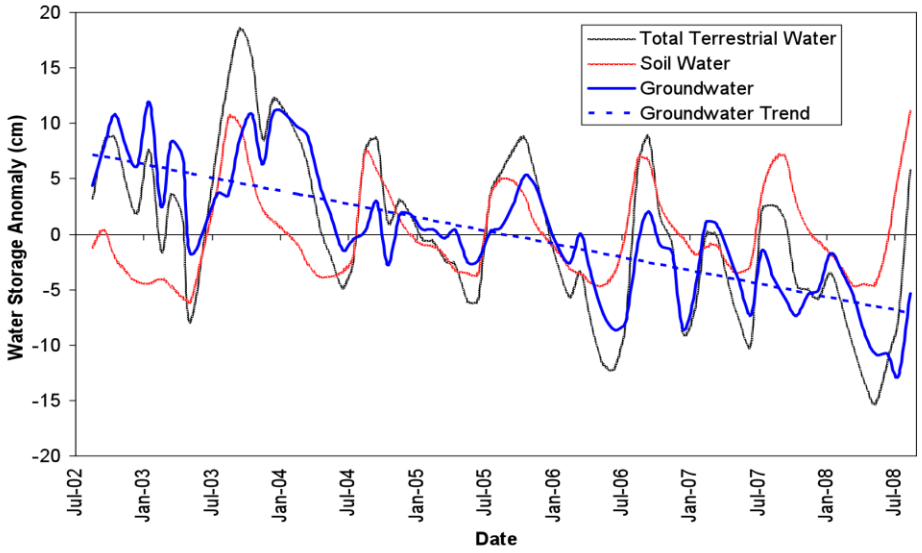
GRACE DETECTS GROUNDWATER LOSS IN INDIA



Pattern of groundwater depletion in NW India

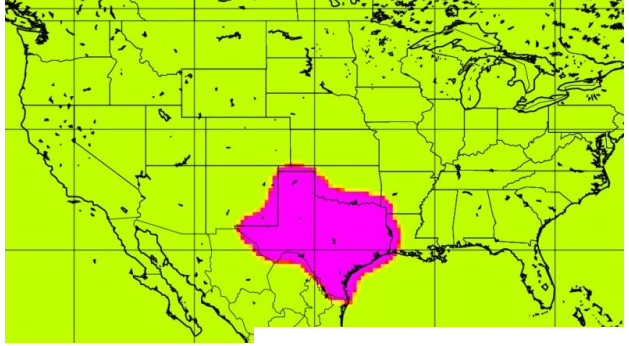
Loss of 109 km^3
(3 Lake Meads)
over 72 months

Rodell et al., 2009



Applications to State requirements

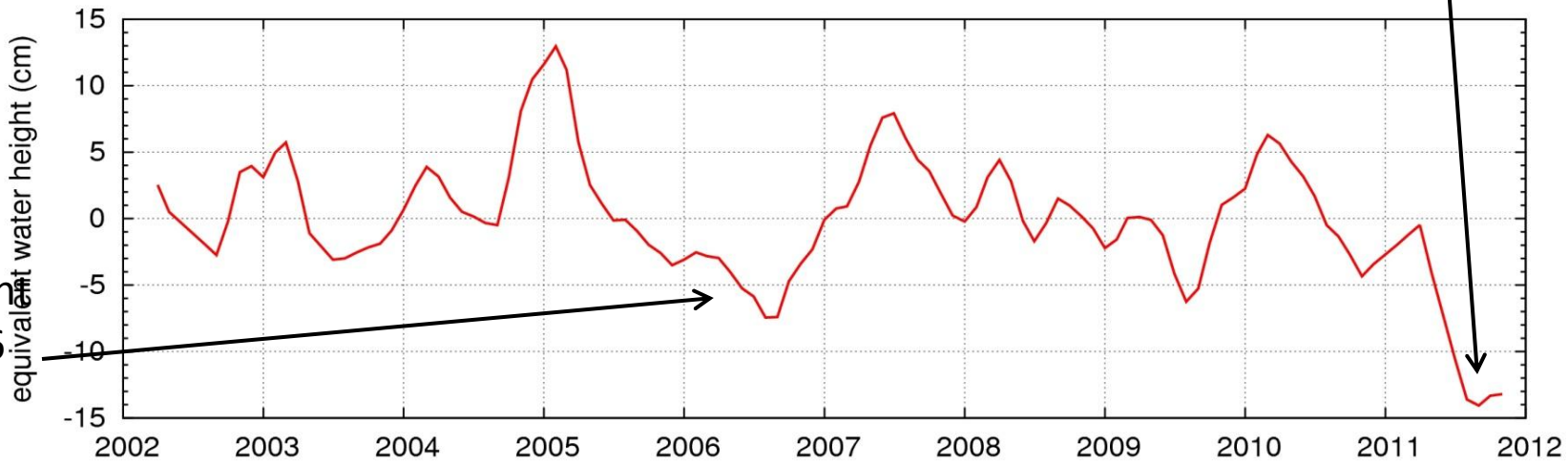
- Observation from previous slides:
  - Grace observations are global, homogeneous, very accurate and nearly synoptic
  - Successful application in global studies has demonstrated a paradigm shifting capability for science applications.
  - Data is released at monthly intervals four to six weeks after month end
- Support of Texas State operational activities requires:
  - Determining appropriate products and
  - Developing a system for rapid delivery of products
    - A Rapid Product with a daily delivery has under study



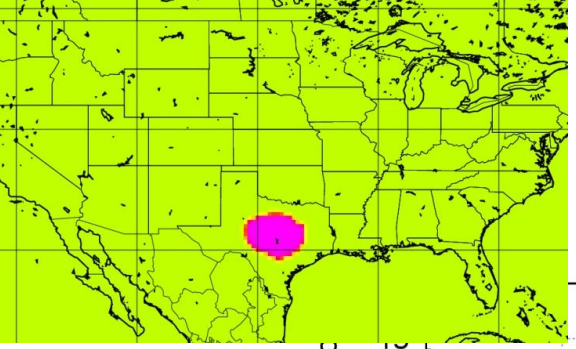
GRACE Observed Total Water Variation

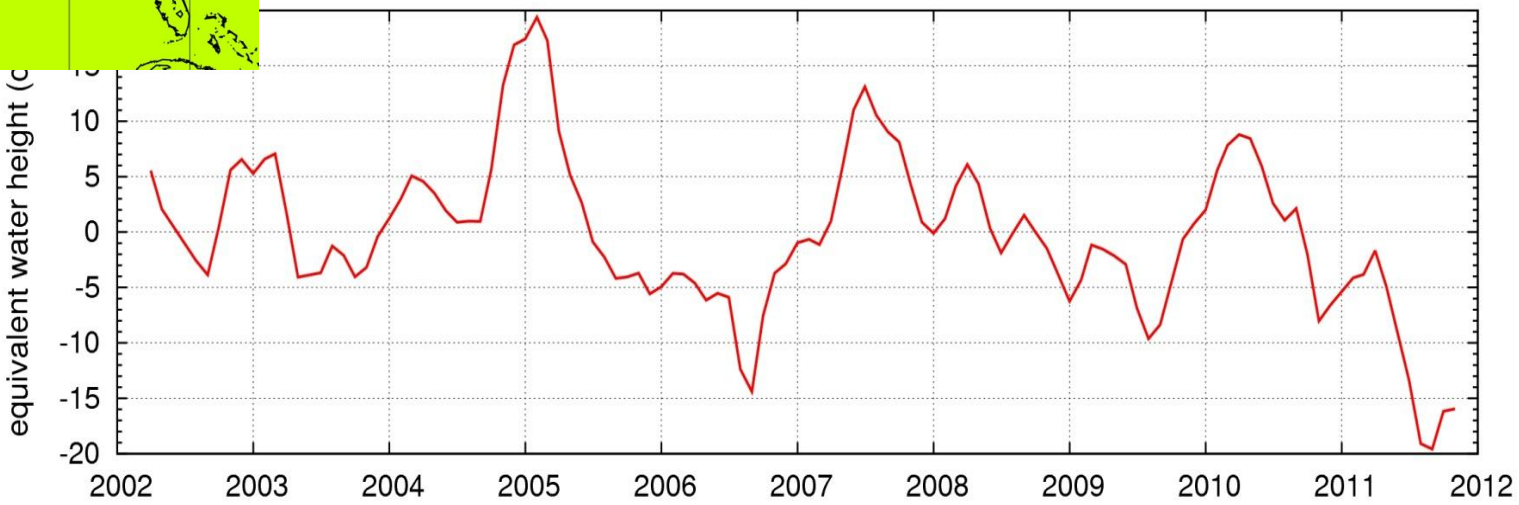
Texas Drought
2011

Texas Drought
2005-2006

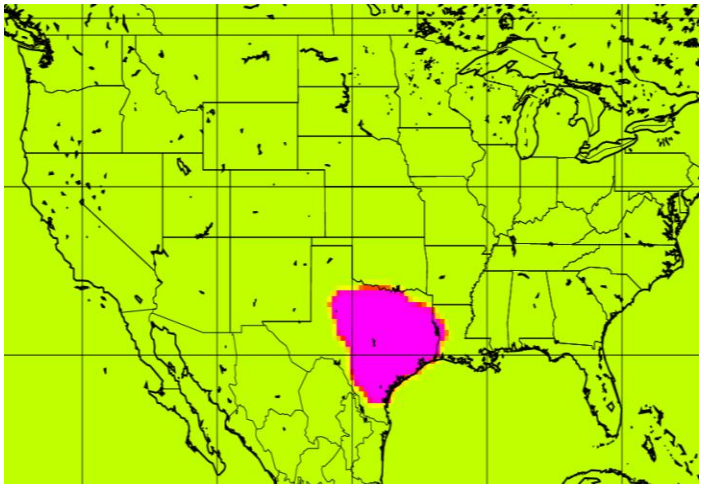


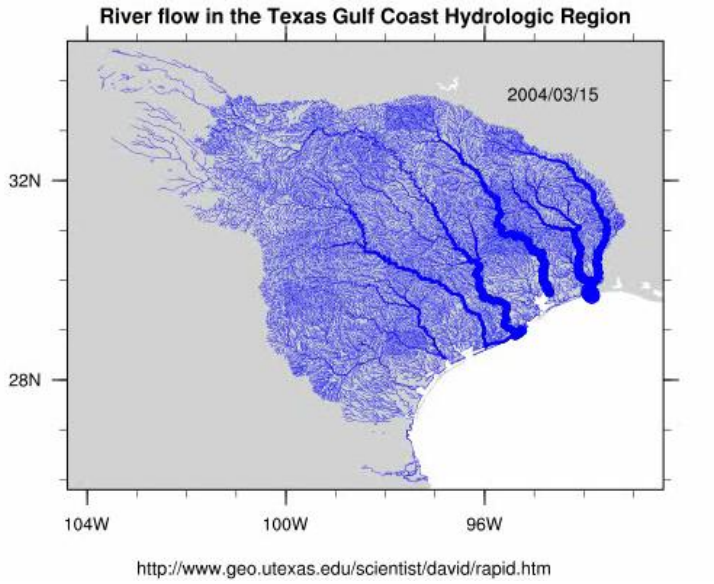
GRACE Hill Country TWS Estimate Compared With Bexar J-17 Water Level



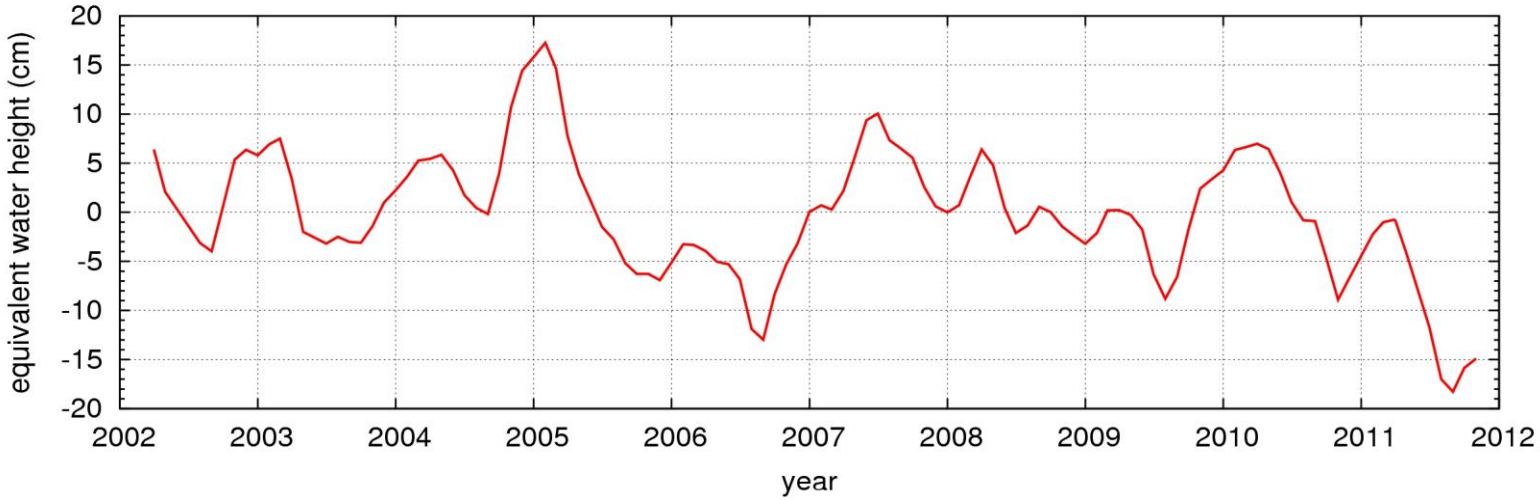


Texas Gulf Coast Hydrologic Region





Area= 404,993 km^2



Proposed Effort

- Conduct Study to Develop Best Approach for Realizing the GRACE Observed Texas TWS Variations.
- Realization of a GRACE Rapid Product to support water resource and drought response decisions
- Assimilation of GRACE Results into Hydrological Models to improve spatial and temporal resolution
- Use of GRACE data along with other satellite, insitu and model data to develop a forcast capability for water management and drought mitigation activities.

END

For more on GRACE, visit: http://www.csr.utexas.edu/grace