

IGCP 565 Project:

Developing the Global Geodetic Observing System into a Monitoring System for the Global Water Cycle

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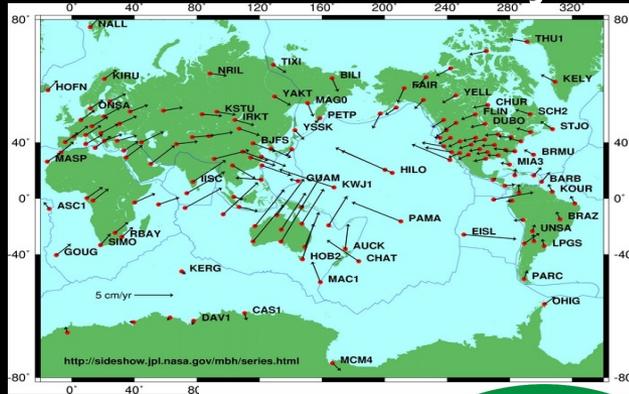
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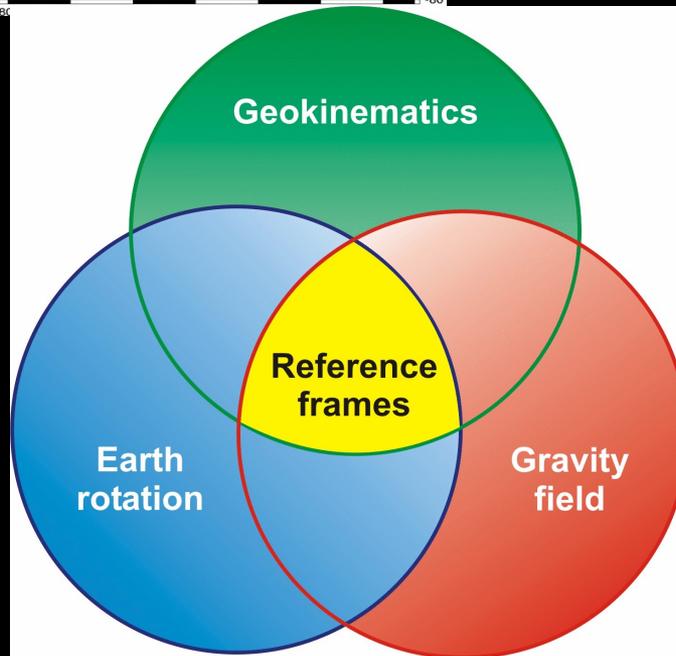
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Geodesy and the Water Cycle



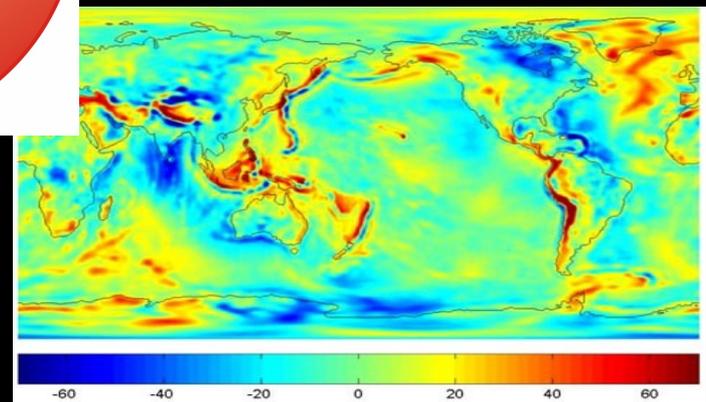
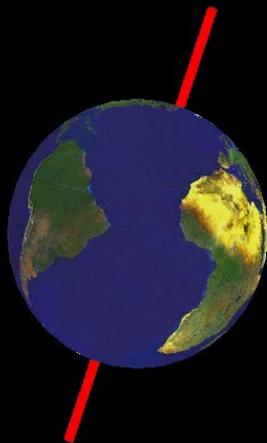
The 'three pillars of geodesy':

- Earth's Shape (Geokinematics)
- Earth's Gravity Field
- Earth Rotation

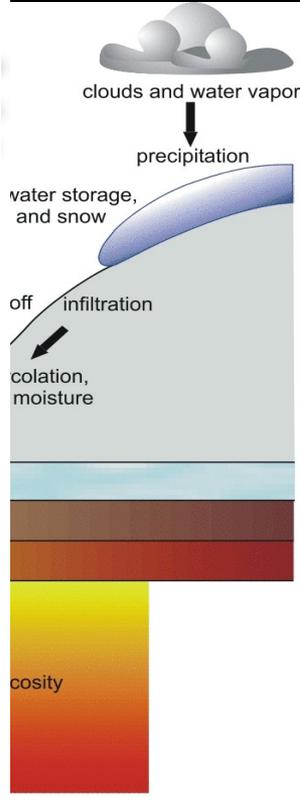
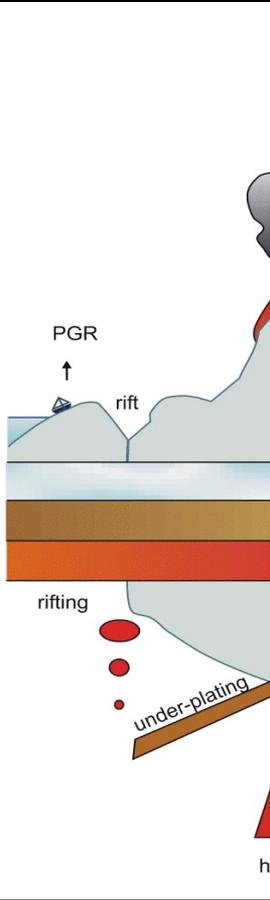
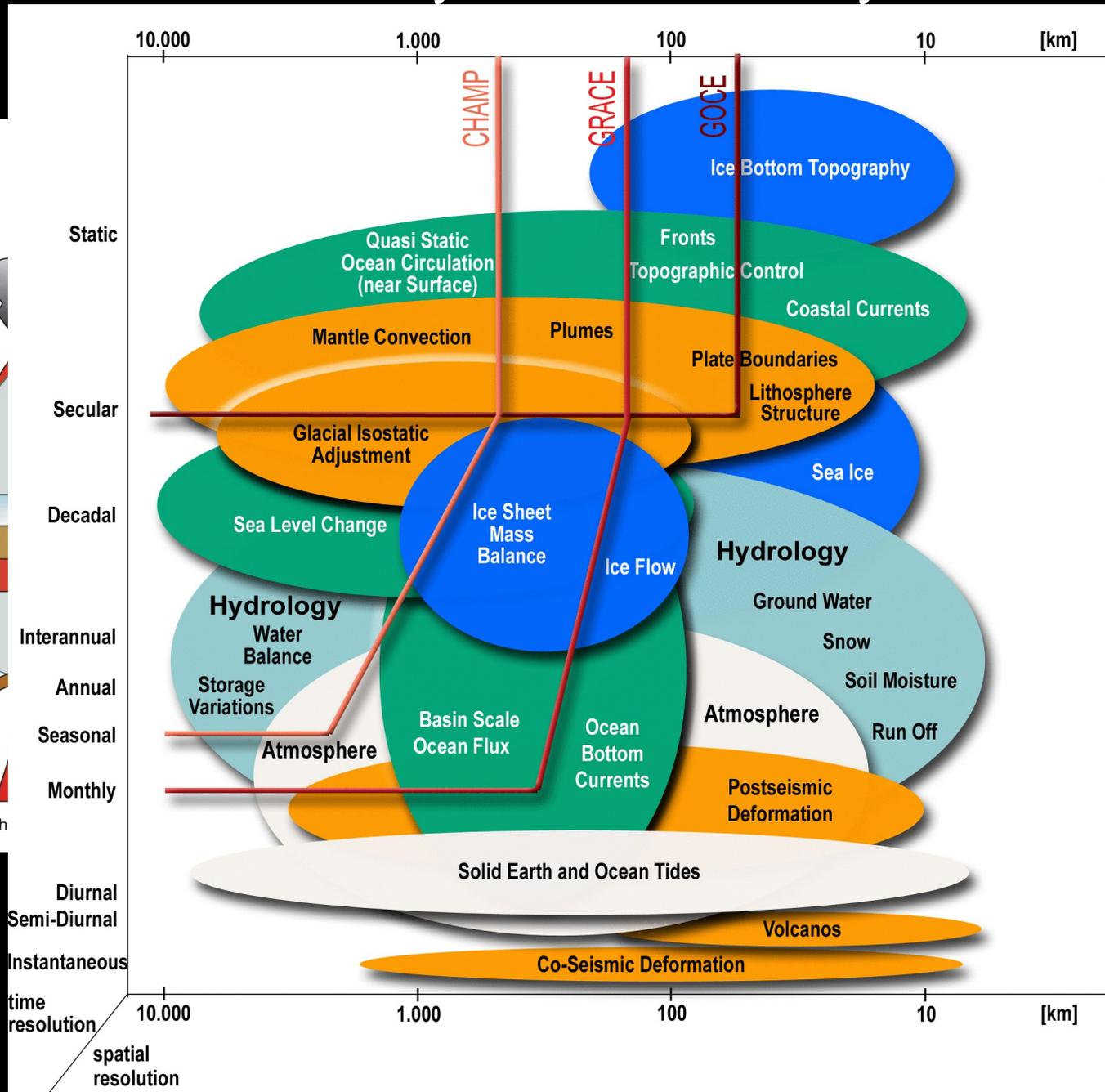


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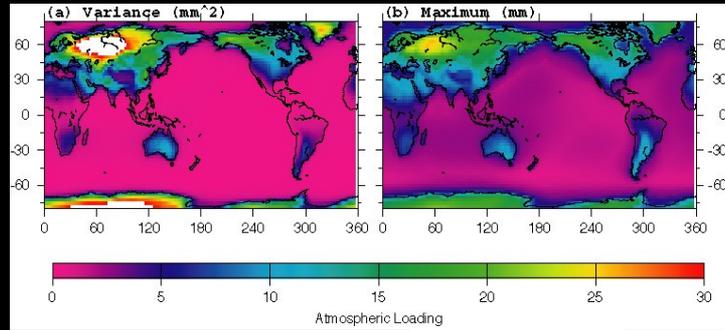
- Reference Frame
- Observations of the Shape, Gravitational Field and Rotation of the Earth



Geodesy and the Water Cycle

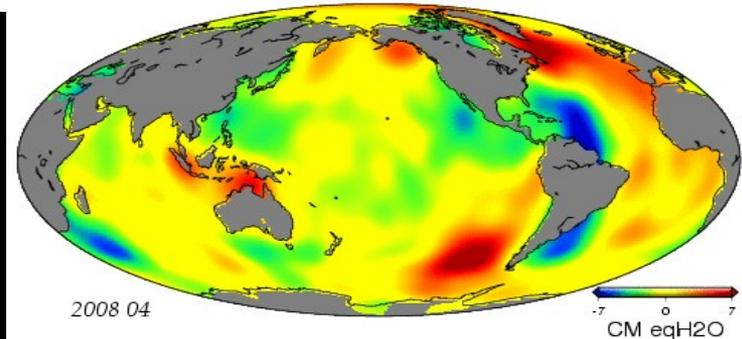
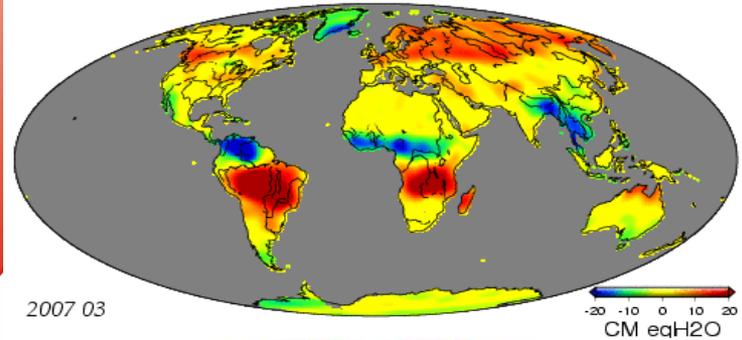
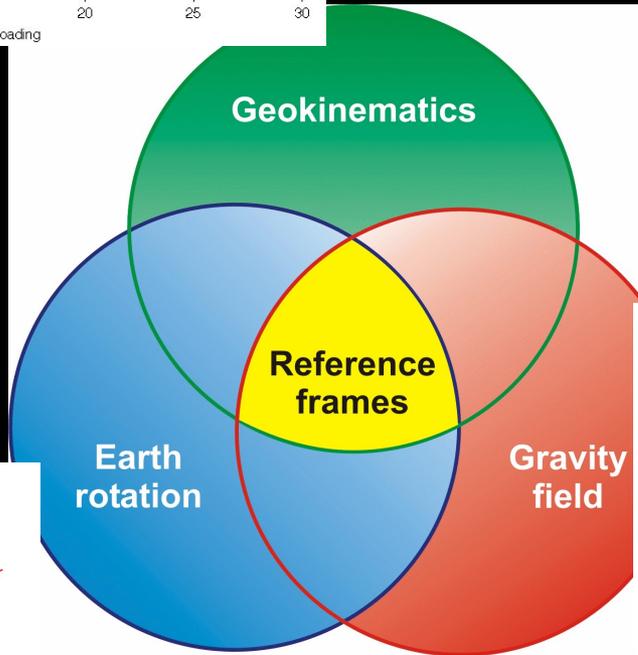


Geodesy and the Water Cycle

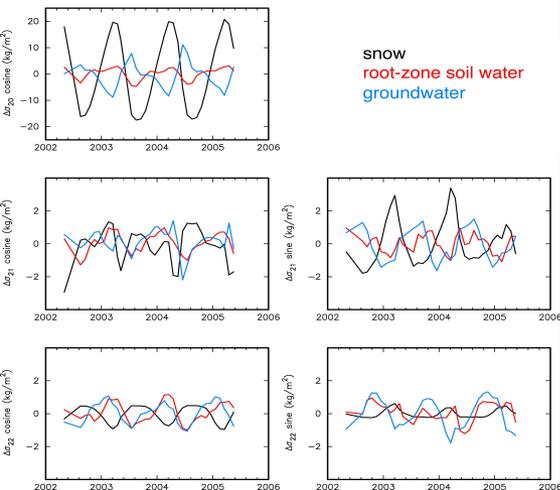


The 'three pillars of geodesy':

- Earth's Shape (Geokinematics)
- Earth's Gravity Field
- Earth Rotation



Degree-2 Mass Load Coefficients





The Global Geodetic Observing System



International
Association of
Geodesy

GGOS is the flagship component of the IAG whose goal is to advance geodetic observing methods for Earth and planetary system science and applications.

The GGOS Mission is to:

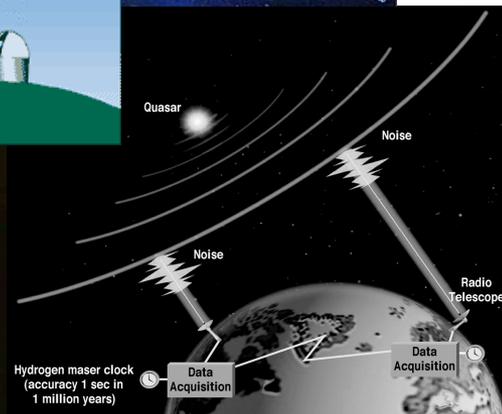
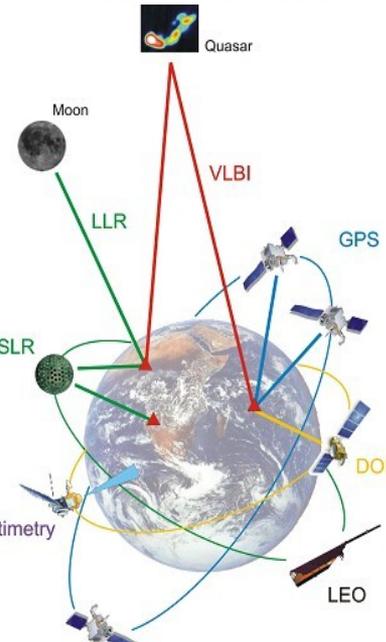
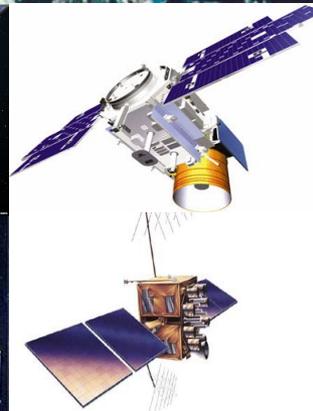
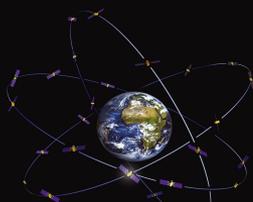
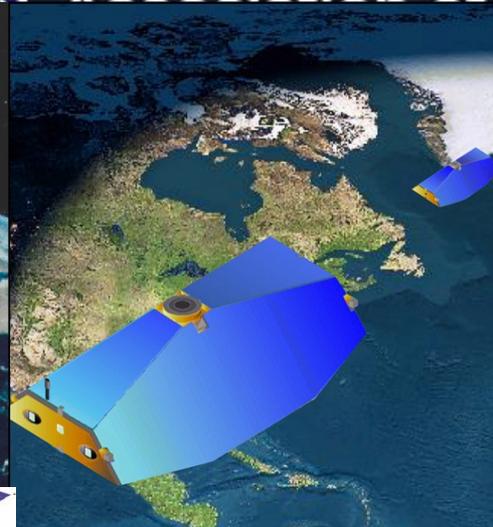
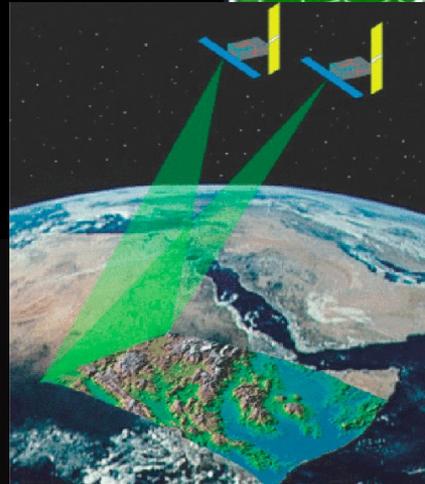
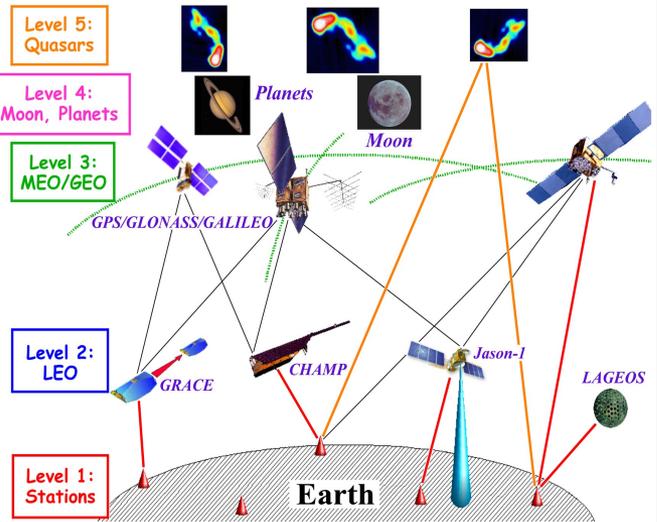
- define** the geodetic infrastructure that is needed to meet scientific and societal requirements;
- advocate** for the establishment and maintenance of this geodetic infrastructure;
- improve** the quality of and accessibility to geodetic observations and products;
- coordinate** interaction between the IAG Services, Commissions, and stakeholders;
- educate** the scientific community about the benefits of geodetic research and the public about the fundamental role that geodesy plays in society.



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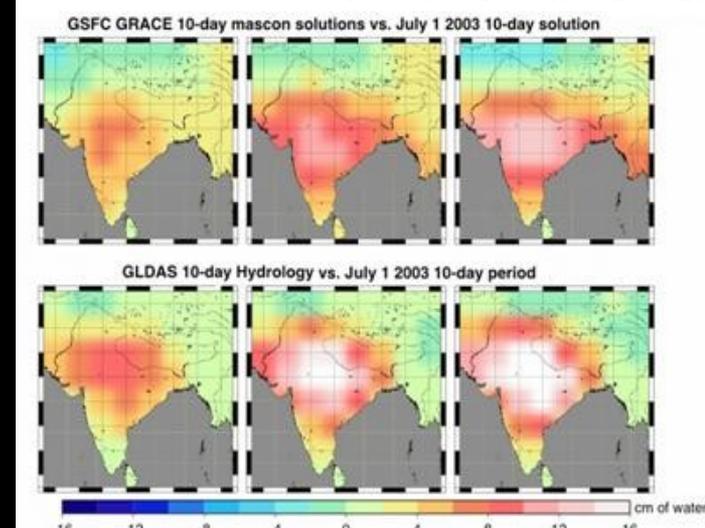
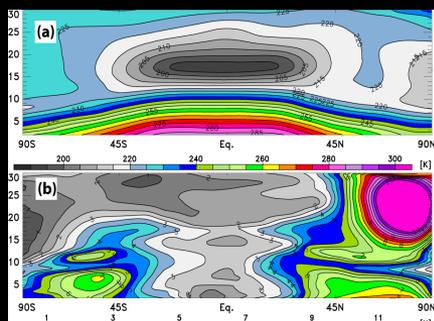
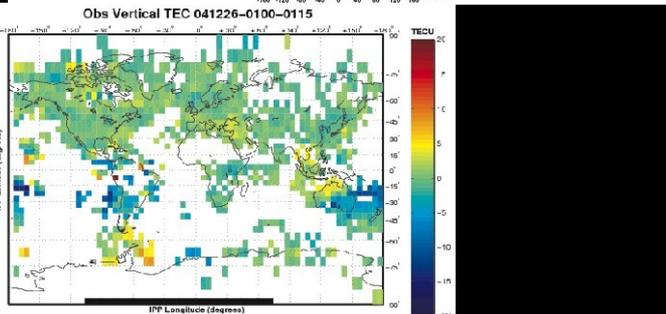
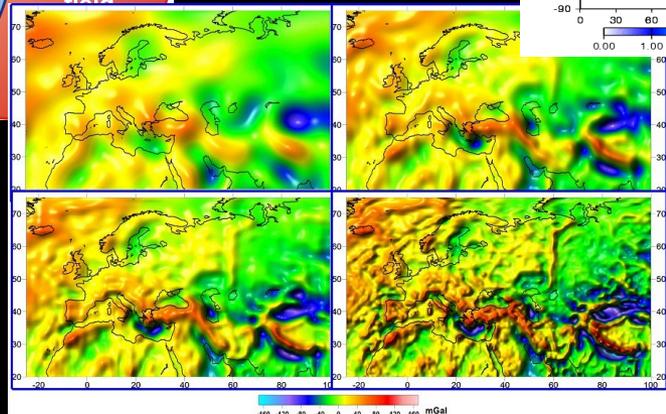
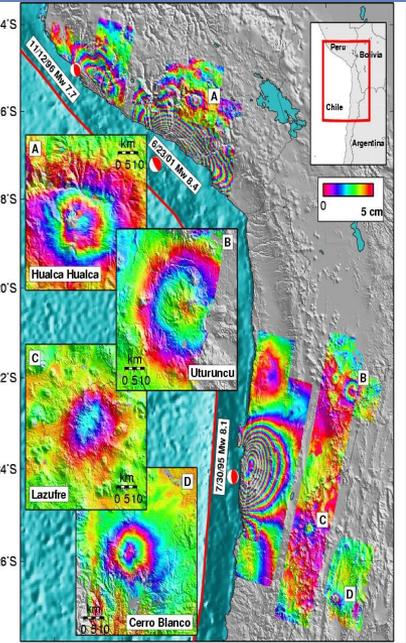
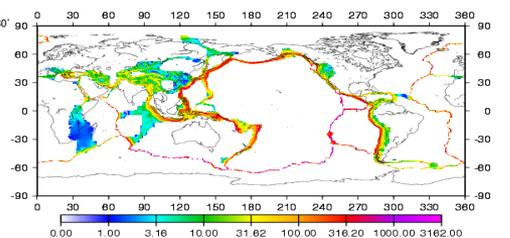
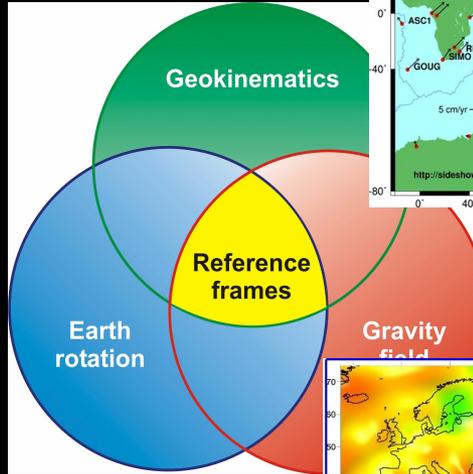
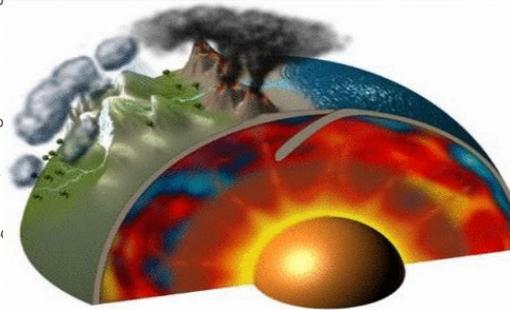
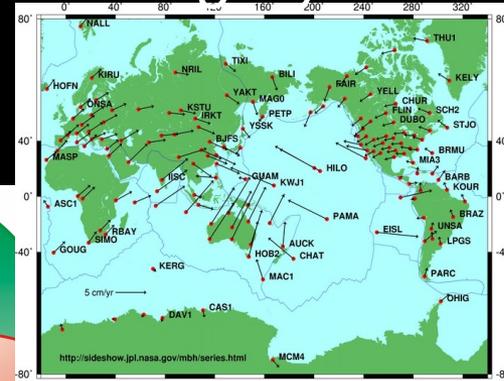




The Global Geodetic Observing System



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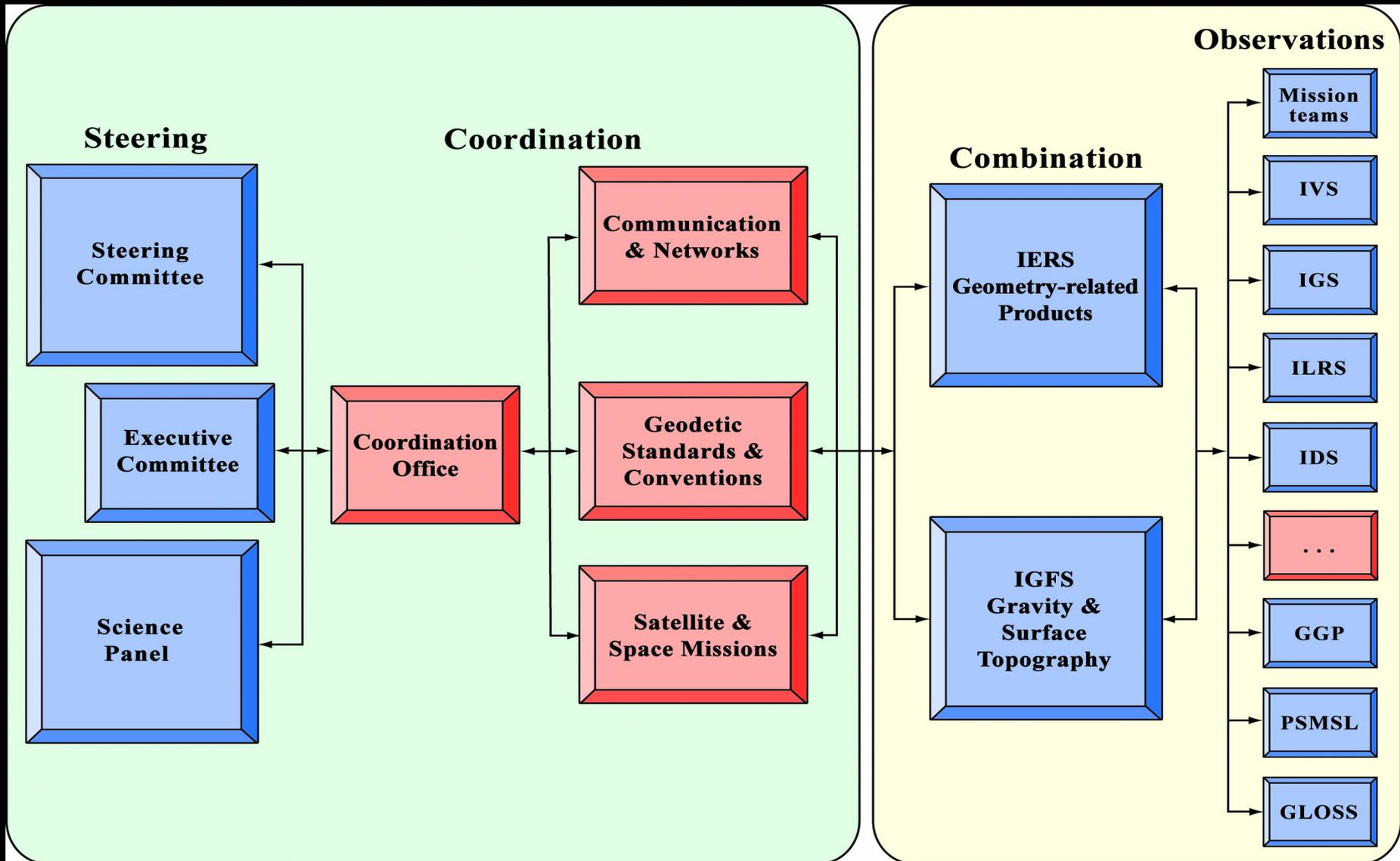




The Global Geodetic Observing System



International Association of Geodesy



*Developing the Global Geodetic Observing System
into a Monitoring System for the Global Water Cycle*

IGCP 565 Objectives



- Explore and develop components of GGOS most relevant for monitoring the water cycle
- Make observations available for assimilation in predictive models of the global water cycle.
- Develop products and algorithms that will allow regional water management to fully utilize the potential of the geodetic techniques for monitoring the regional terrestrial hydrosphere.

*Developing the Global Geodetic Observing System
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IGCP 565 Activities



Research projects:

- on-going projects related to combined analysis of geodetic observations
- proposed projects for assimilation in hydrological models
- planned projects for regional water management

Coordination with:

- GEO Tasks (in particular, Water Tasks)
- IGWCO
- GEWEX
- ...

Specific Activities:

- Series of five annual workshops
- Funding for participants from developing countries
- Maintain a web page (<http://geodesy.unr.edu/igcp565/>)

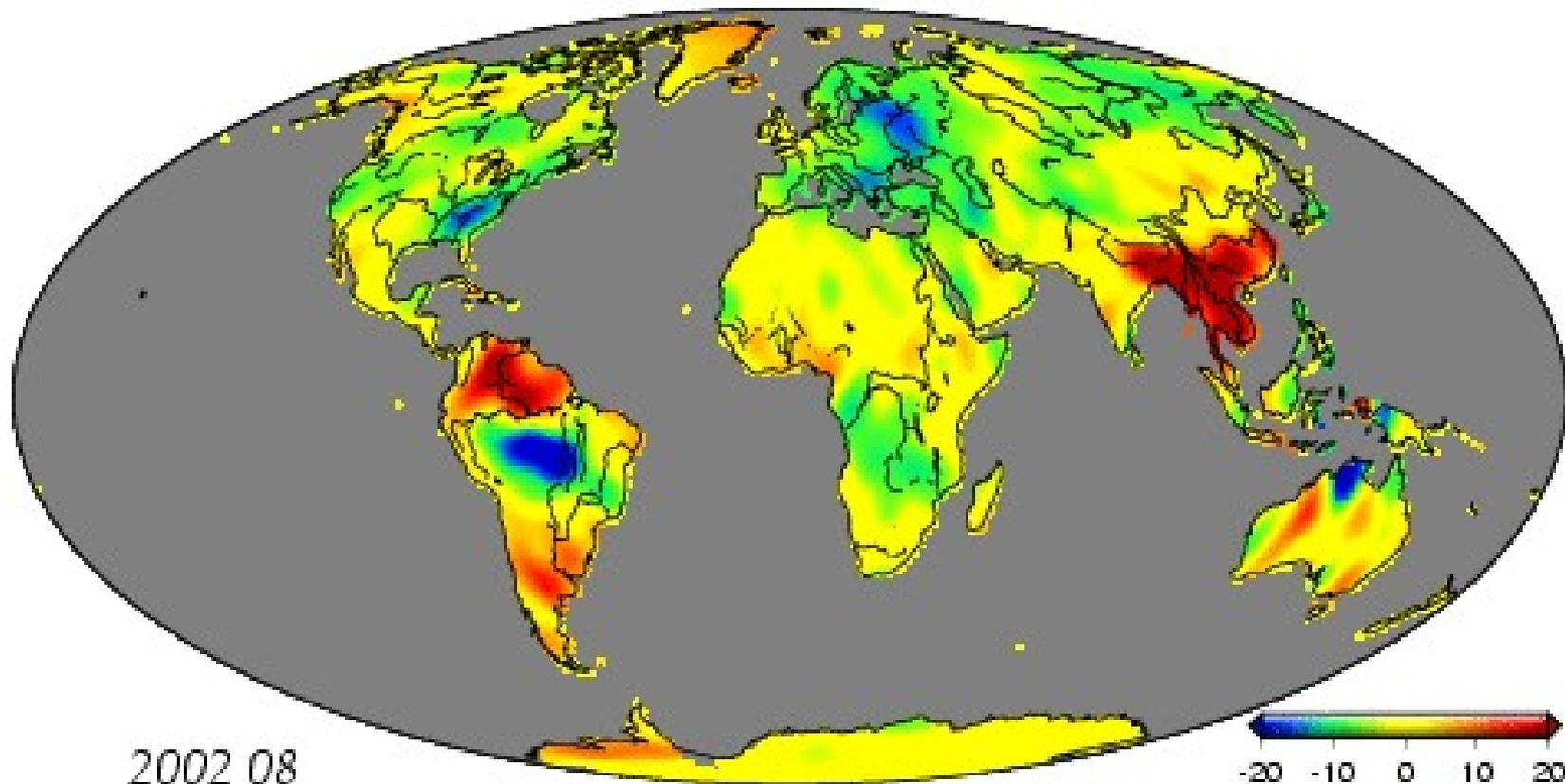
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IGCP 565 Research Projects

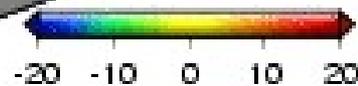


Current Projects:

- Surface Mass Loads from GRACE, GPS, and Earth Rotation Measurements. NASA, (Gross, Plag, Blewitt).
- Development and Evaluation of a California Water and Energy Model, CEC (Miller et al.).
- Environmental Geodesy: Variations of Sea Level and Water Storage in the Australian Region, Australia (Tregoning, Coleman, Featherstone, Rizos, Watson, Awange, Kuhn, Titov).
- TIVAGAM – Time-Variable Gravity and Surface Mass Processes: Validation, Processing and First Application of Satellite Gravity Data (Rothacher et al.).
- Sea Level, Gravity, and the Earth's Rotation (Gross, Song)



2002 08

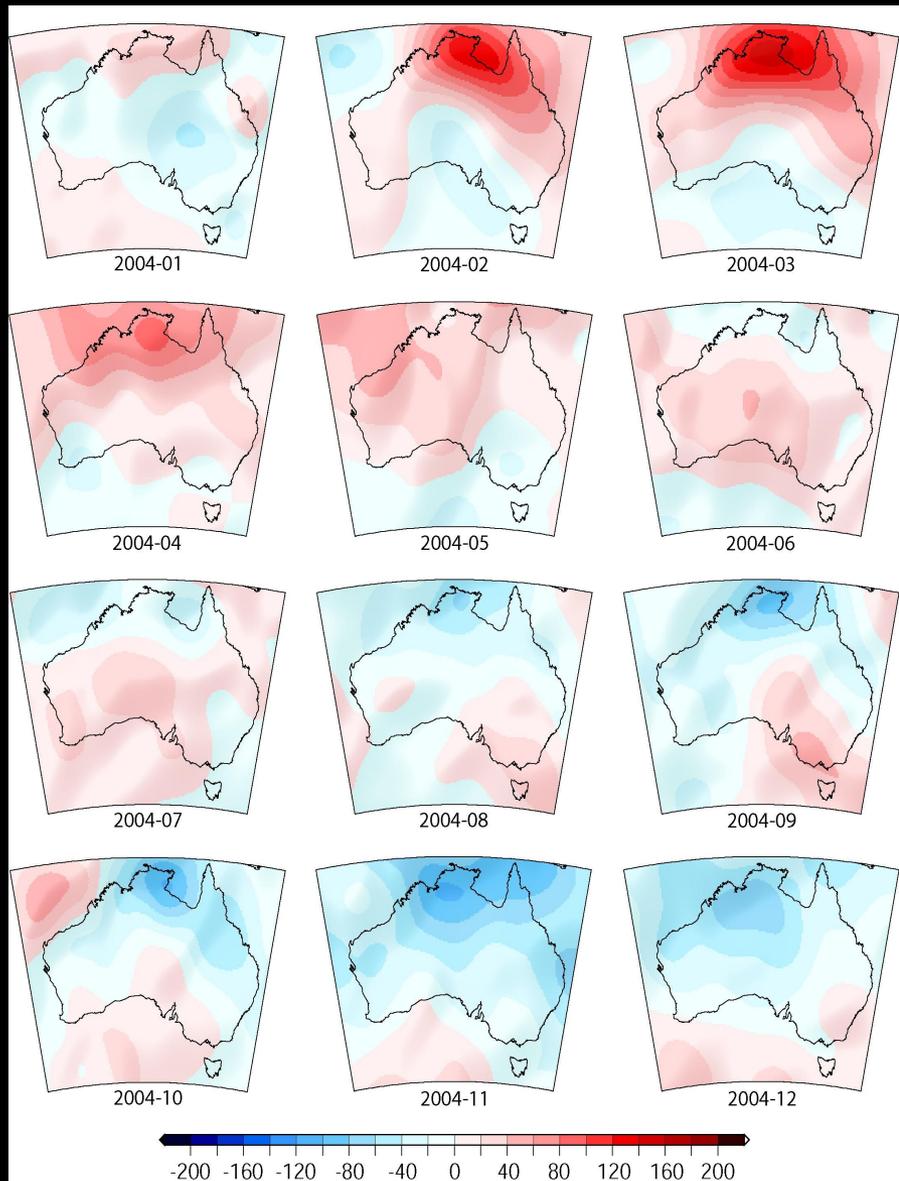


CM eqH2O

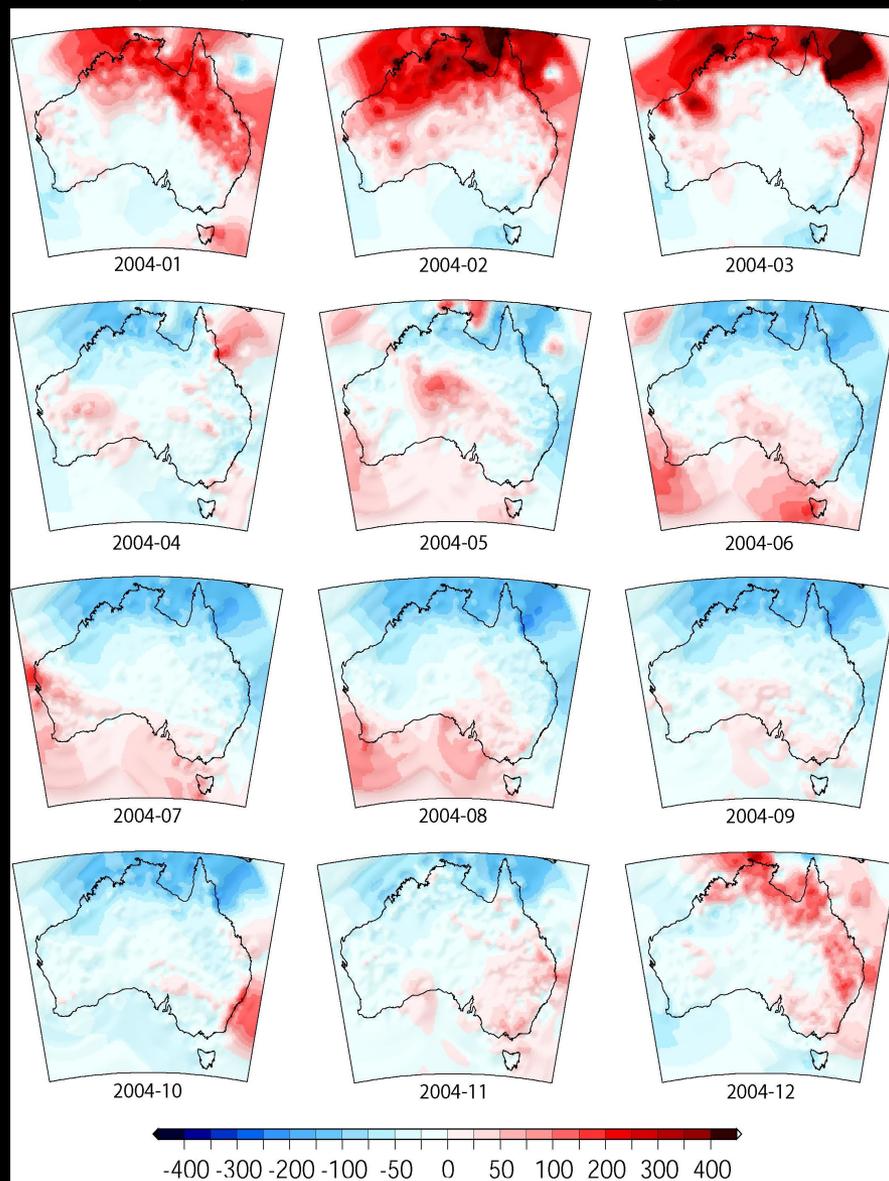
<http://grace.jpl.nasa.gov/information/>

Example: Terrestrial Water Storage

GRACE Mass variations

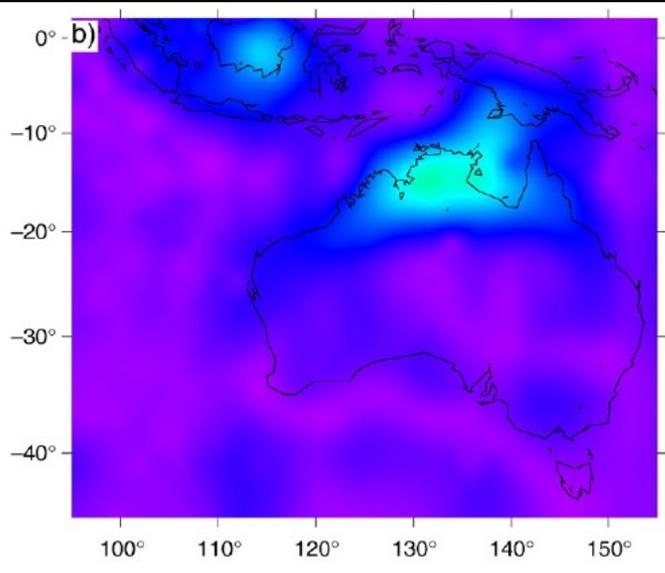


Rainfall from meteorology

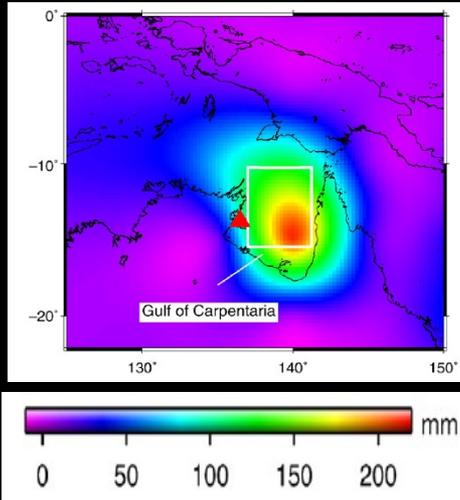


Oceanic – Annual variations

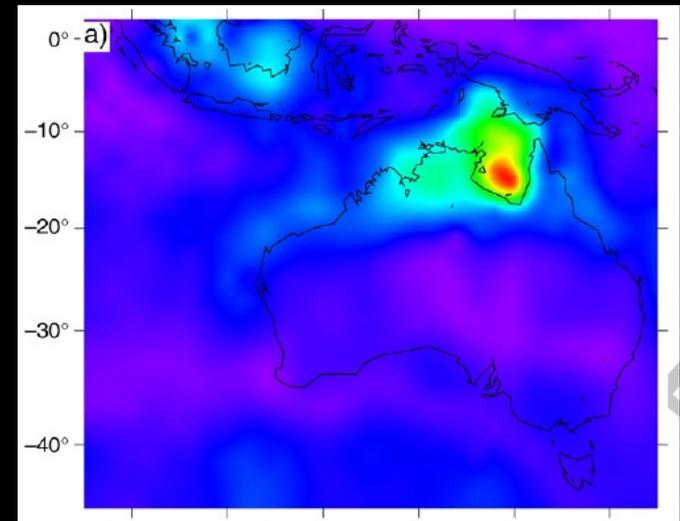
GRGS GRACE
Annual Amplitude



MOG-2D Barotropic
model

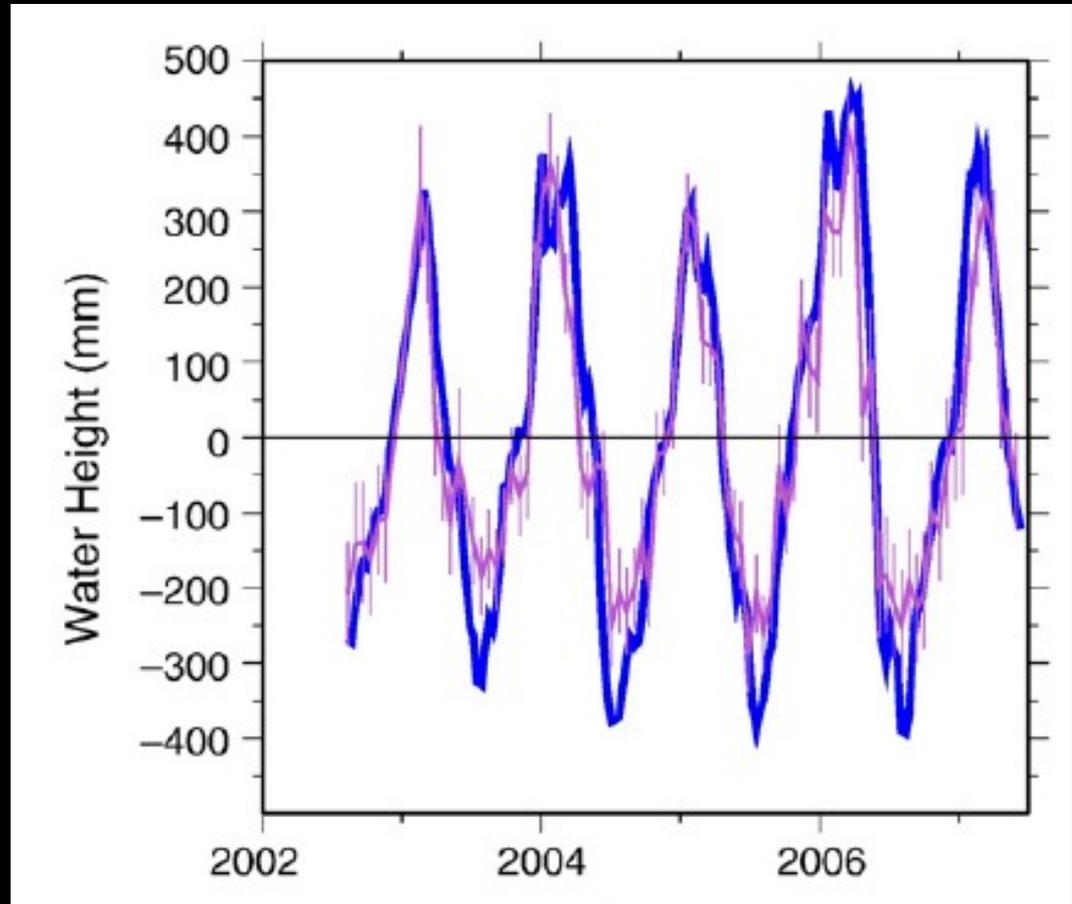


GRACE+MOG-2D



Example: Ocean signals

TIDE GAUGE
GRACE



Tregoning et al (EPSL, 2008)

Central Valley Water Table 'Relative' Response

Joint LBNL-CDWR Drought Simulation

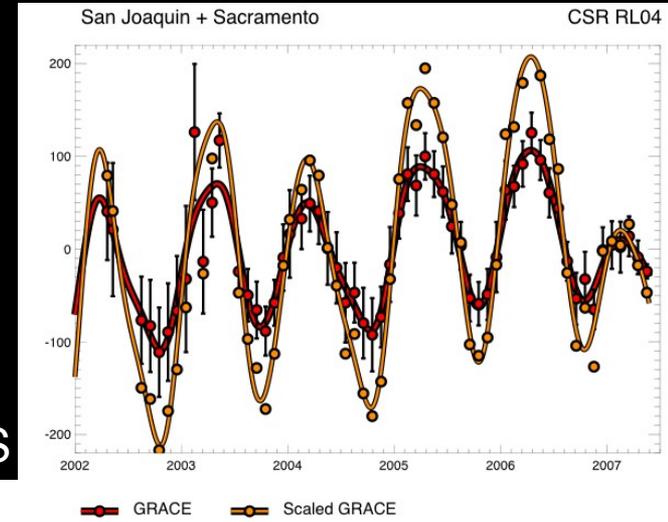
➤ Climate simulations using the IPCC SRES output indicates California Snowpack will be reduced by 60-90% by 2100

➤ Simulating drought scenarios acts as an analogue to climate warming and provides us with a means to analyze impacts.

- Baseline - no surface water reduction

- Drought - 30 - 70 percent surface water reduction

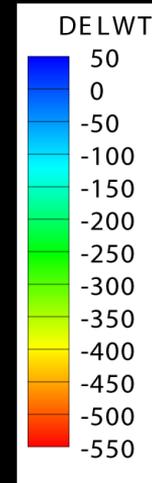
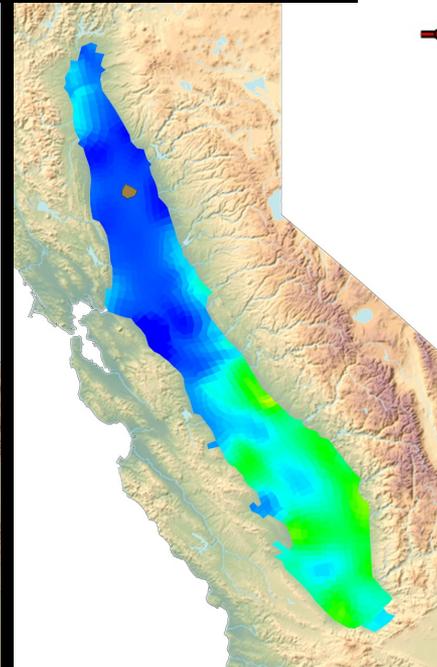
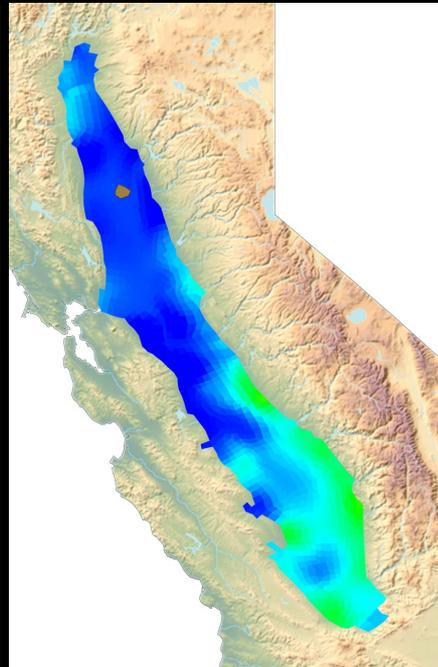
- All simulations used fixed 1973-2003 precipitation, urban demands, cropping etc.



BASELINE

30 YEARS

60 YEARS



Relative WT Change
(Feet)

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IGCP 565 Science Issues



- The development of an integrated dynamic model for the prediction of geodetic signals due to daily to interannual surface mass changes.
- Inversion algorithms for combined geodetic observations for surface mass changes.
- Integration/assimilation of the observations in integrated predictive models of the hydrological cycle.
- Development of products relevant for regional water management.
- How will projected climate change affect the hydrological cycle and the availability of water to society in the various regions?

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IGCP 565 Workshop 1



*December 11, 2008, San Francisco (prior to GRACE
Science Team meeting): Science of geodetic monitoring
of the hydrological cycle*

Workshop will:

- Review the state of the art in understanding the quantitative fluxes in the global water cycle;
- Consider the relation between geodetic observations and mass changes in the main reservoirs of the water cycle;
- Clarify the open science questions that the geodetic observations can help to reconcile;
- Report to the GRACE Science Team meeting.

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IGCP 565 Workshop 2-5



WS2, Autumn 2009, Europe: Geodetic gravity satellite missions

WS3, 2010: Determination of mass transports in the hydrological cycle from geodetic observations

WS4, 2011: Integration of geodetic observations and products in models of the hydrological cycle

WS5, 2012: Improving regional water management in Africa on the basis of geodetic water cycle monitoring

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Summary/Conclusions



The Global Geodetic Observing System has a great potential to contribute to monitoring of the global water cycle, including groundwater changes, on global to regional scales.

The IGCP 565 Project will exploit this potential for support of regional water management.

The IGCP 565 Project will focus on regional applications in Africa.

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IGCP 565 Workshop 2



Autumn 2009, Europe: Geodetic gravity satellite missions

Workshop will:

- address mission requirements, options for the design of the missions, options for the deployments and mission operation, and participation in the science and operational mission teams.
- Particular emphasis will be on the participation of emerging space agencies in Africa and Asia.
- Interact with the GEO Task WA-07-02 (Satellite Water Quantity Measurements and Integration with In-situ Data) and CEOS with the goal to discuss a virtual constellation for water cycle monitoring.
- A delivery will be a Workshop summary report with specific recommendations and agreements for the implementation of GRACE follow-on missions.

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IGCP 565 Workshop 3



*2010: Determination of mass transports in the hydrological cycle
from geodetic observations*

- Workshop will focus on the inversion of geodetic observations for surface mass changes and the relation of these changes to parameters of the global water cycle.
- Key issues will be comparison of models and algorithms, cross-technique and cross-model validation, including meteorological and climatological models of the water cycle at regional and global scales.

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IGCP 565 Workshop 4



*2011: Integration of geodetic observations and products in models
of the hydrological cycle*

- Workshop will focus on algorithms for assimilation of geodetic observations and products into models of components (terrestrial, atmosphere, ocean) the global water cycle.
- Assess the improvements in terms of accuracy, spatial and temporal resolution, and predictive capabilities of the models.

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IGCP 565 Workshop 5



2012: Improving regional water management in Africa and Asia on the basis of geodetic water cycle monitoring

- Workshop will bring together representatives of regional water management authorities and representatives of the research and observation communities involved in the project activities.
- Assess the requirements of regional water management, in particular in developing countries, in terms of products derived from space-geodetic observations and the associated models.
- The goal is to define a set of products in terms of parameter, spatial and temporal resolution, accuracy, and latency, which can be made available in support of regional water management.