

Integrated Geodetic Observations in Support of Hydrological Studies

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IGCP 565 Workshop 5: Water Security for Africa
Bringing Together Research, Monitoring, and Managing

October 29–30, 2012
Johannesburg, South Africa

GRACE Gravity

GRACE Measurement Principle

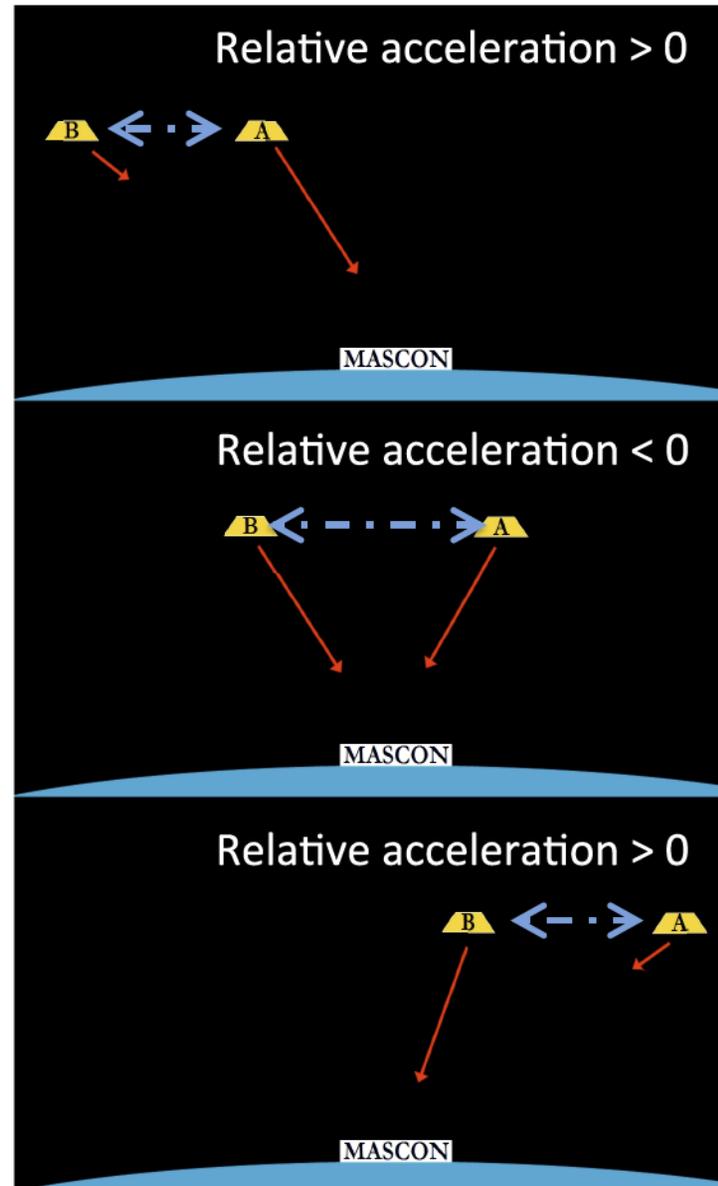
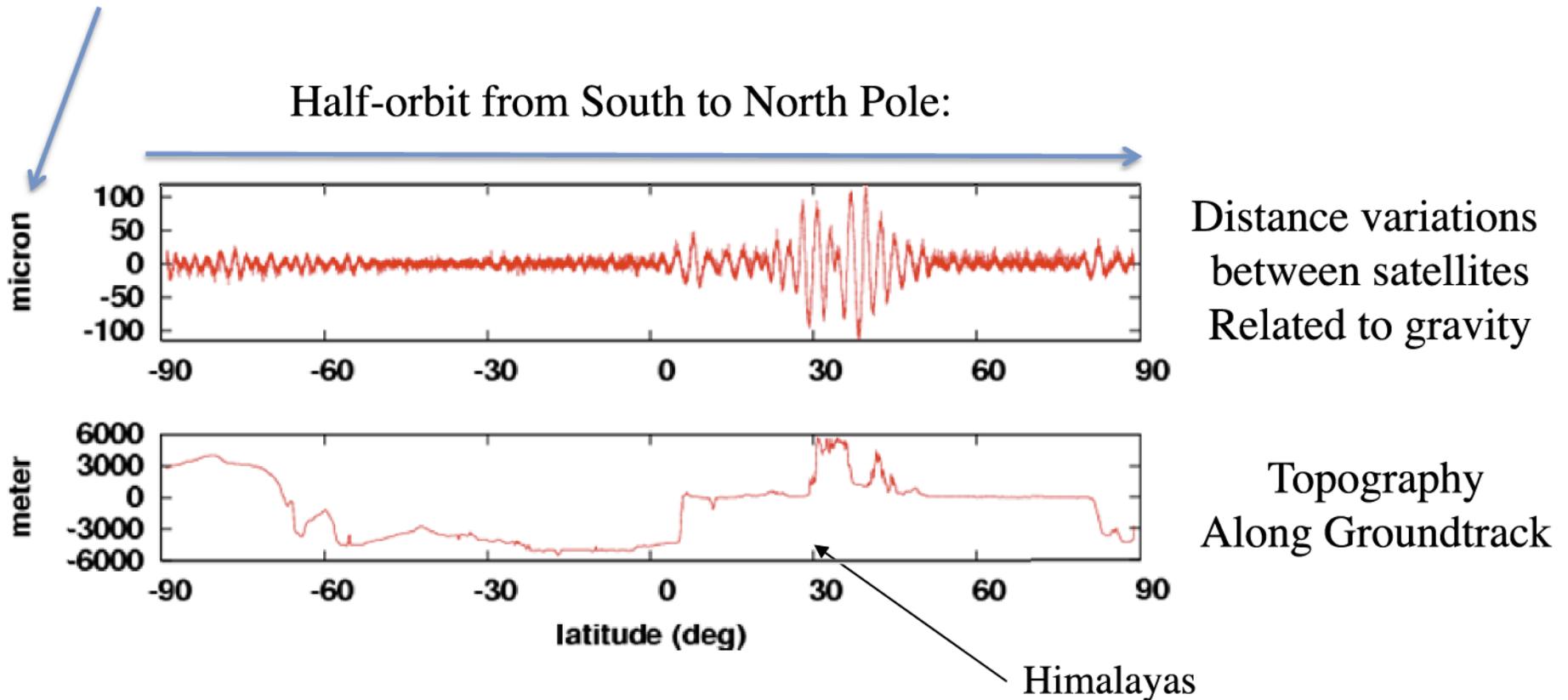


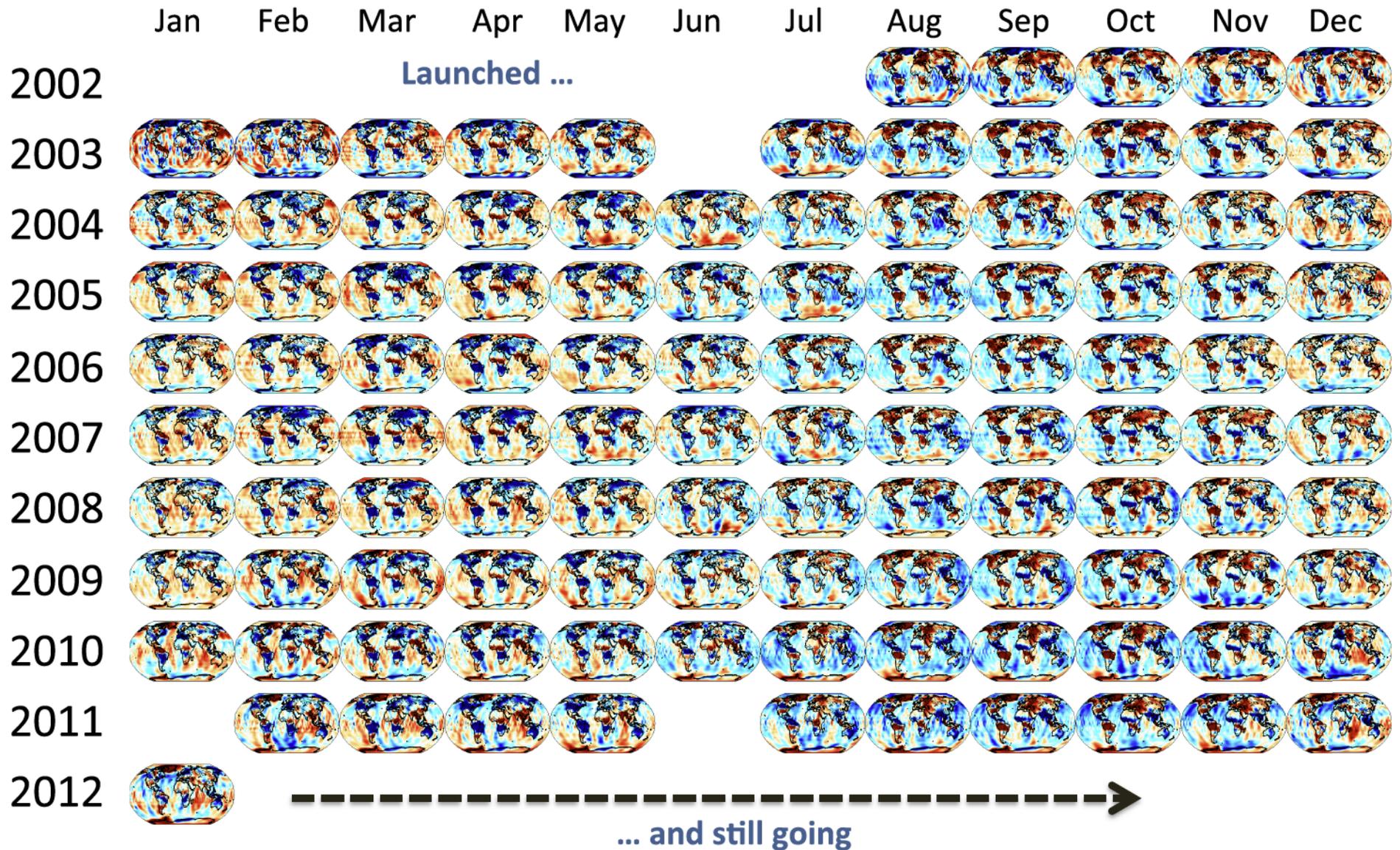
Fig. by
Brian Killett (JPL)

Example of GRACE Ranging Data

Note: the thickness of a human hair is ~50 micron!

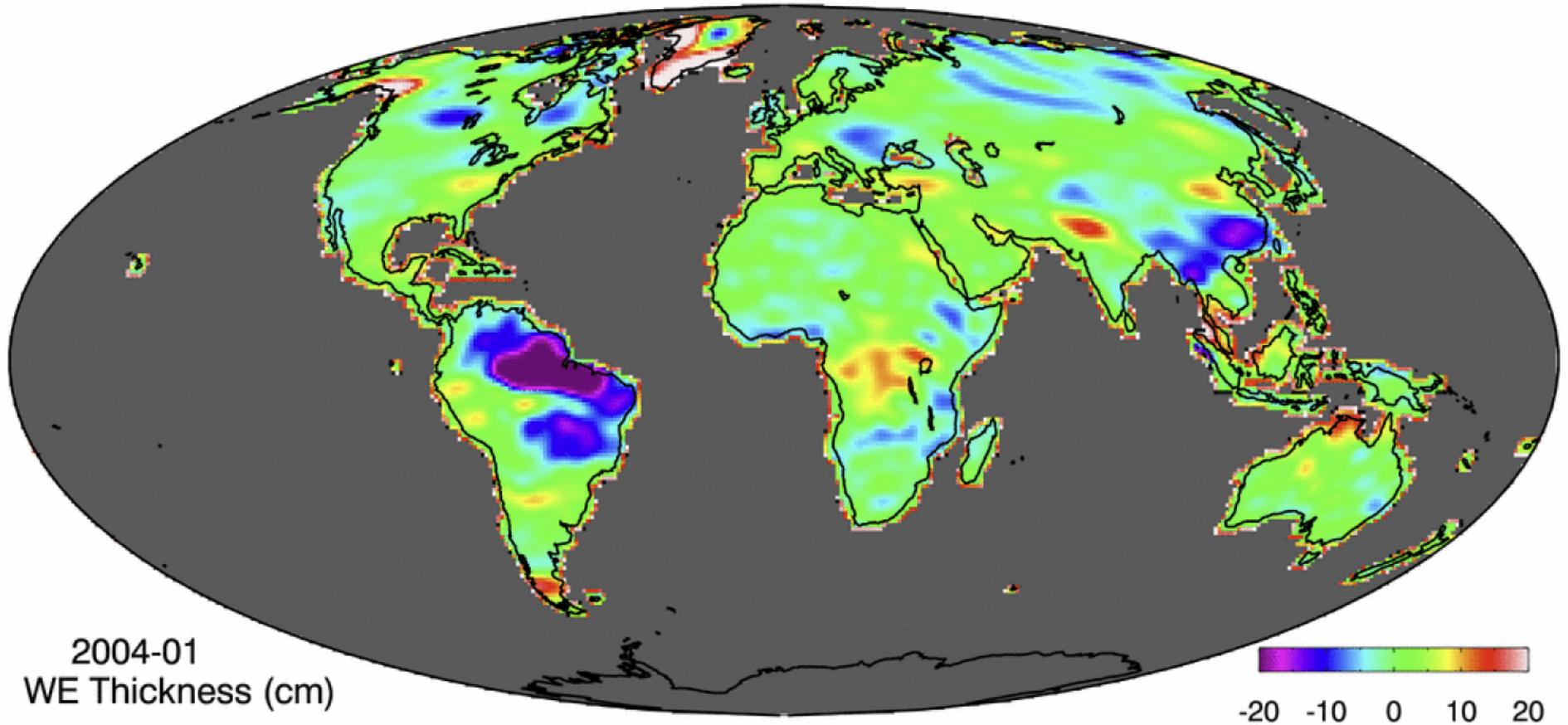


10 Years of Monthly Gravity Maps



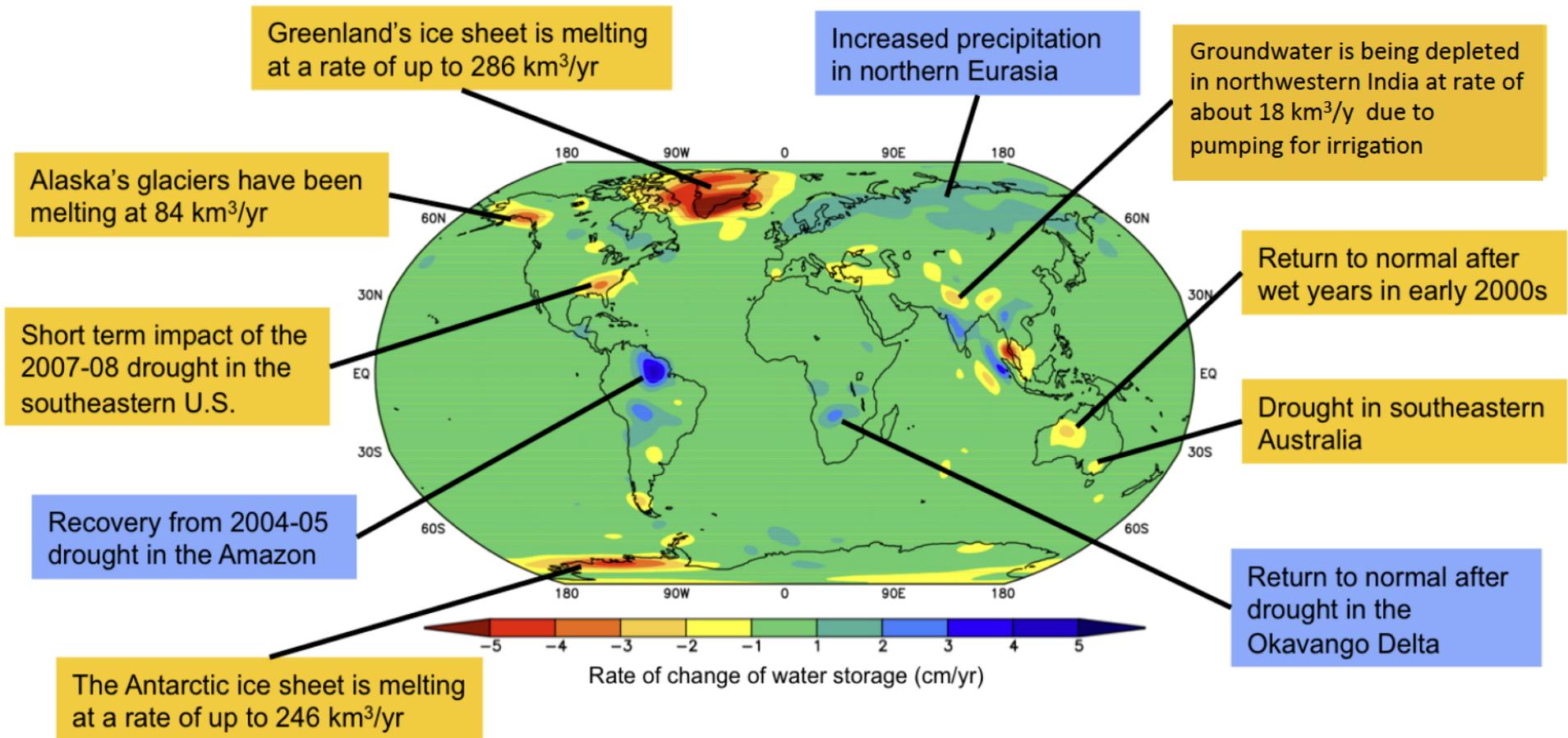
GRACE Land Gravity Animation

GRACE CSR-SS RL05



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

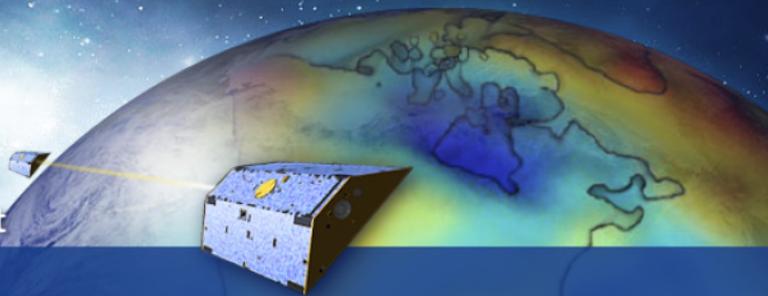
GRACE Mass Trends (2002–2010)





GRACE Tellus[™]

Gravity Recovery and Climate Experiment



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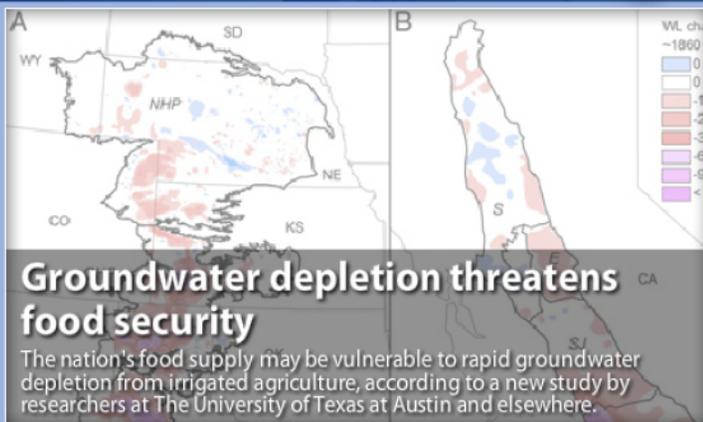
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Multimedia

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Data

[GRACE release 05 data available](#)

[GRACE release 05 data available >>](#)

DYNAMIC OCEAN TOPOGRAPHY

A time-mean Dynamic Ocean Topographic, and derived geostrophic velocities, computed from a mean sea surface and a GRACE-based geoid >>

ERROR IN GIA MODEL FIXED

The coding error previously reported has been fixed, the corrected GIA grids are online, and the GRACE monthly grids using the corrected GIA are also online. >>

Highlights

GRACE on Times Square

GRACE scientist, Jay Famiglietti teams with 'Heads Up! 2012' and National Geographic >>

GRACE 10th Anniversary

JPL's Media Release >>

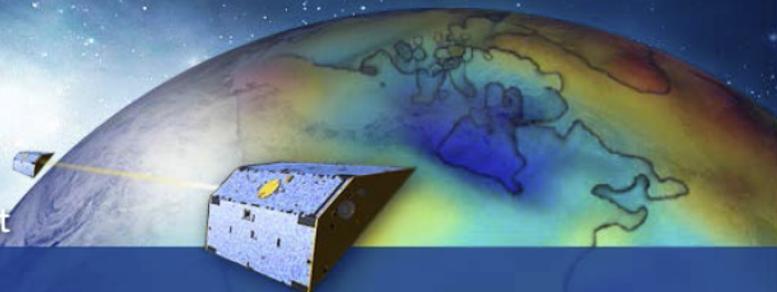
2012 GRACE Science Team Meeting

Potsdam, 17-21 September 2012 ABSTRACT DEADLINE Sunday, 5 August, 5pm PDT >>



GRACE Tellus

Gravity Recovery and Climate Experiment



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Introduction

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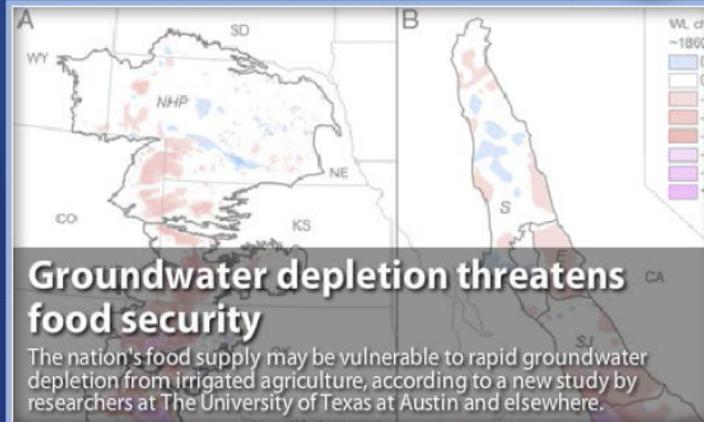
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GRACE MONTHLY MASS GRIDS

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- GRACE MONTHLY MASS GRIDS - OCEAN
- Interactive Browsers
- PGR & Trends
- GLDAS Land Water Content (monthly)
- ECCO Ocean Bottom Pressure (monthly)
- Dynamic Ocean Topography
- GRACE 'Months'
- Degree 1
- Weekly 5x5 Gravity Harmonics
- Degree 2

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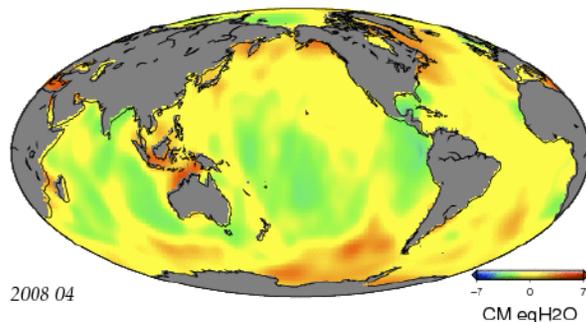
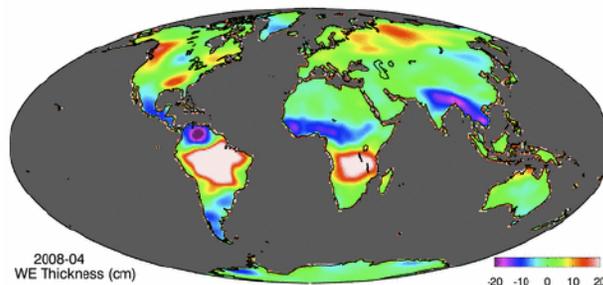
Acknowledge and Cite

WHAT IS 'EQUIVALENT WATER THICKNESS'?

The observed monthly changes in gravity are caused by monthly changes in mass. The mass changes can be thought of as concentrated in a very thin layer of water at the surface, whose thickness changes. In reality, *much* of the monthly change in gravity is indeed caused by changes in water storage in hydrologic reservoirs, by moving ocean, atmospheric and cryospheric masses, and by exchanges among these reservoirs. Their vertical extent is measured in centimeters, much smaller than the radius of the Earth or the horizontal scales of the changes, which are measured in kilometers. Some changes in gravity are caused by mass redistribution in the 'solid' Earth, such as that following a large earthquake, or that due to glacial isostatic adjustment; in those cases the concept of 'equivalent water thickness' does not apply, even though it is possible to compute the quantity.

The mass of the atmosphere is removed during processing using ECMWF fields, so these grids do not reflect atmospheric variability over land or continental ice (Greenland, Antarctica), except for errors in ECMWF.

An ocean model is used to remove high frequency, wind and pressure-driven ocean motions during processing. The resulting gravity fields would not reflect ocean variability if the model were perfect. To use these results over the oceans, the GRACE solutions provided here have the monthly averaged ocean model grids **added back**. This is one of the reasons we provide OCEAN and LAND grids separately. Other reasons include removal of land signals from ocean grids, scaling of land grids, and more.



Data available here are changes in equivalent water thickness. The basic method is explained in Wahr et al., 1998. The land and ocean grids are processed differently.



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Gravity Recovery and Climate Experiment



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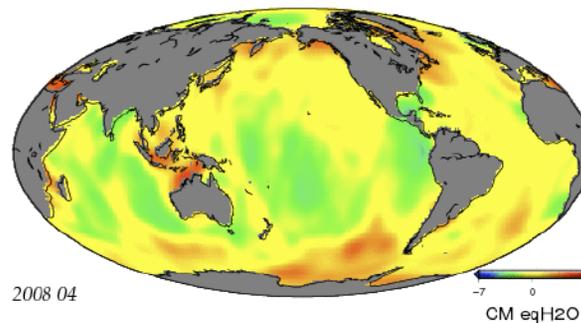
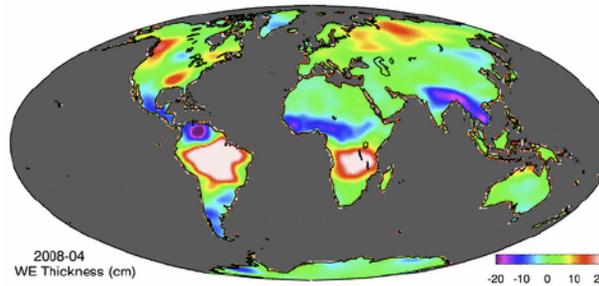
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GRACE

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Plot Type Amplitude

Min Max
Latitude -40.5 40.5
Longitude -20.5 55.5

Min Max
Scale 0.0491 200
Smoothing Radius 400

Action Time Series Basin
Click on plot to generate **Time Series Basin**

Map Annotations

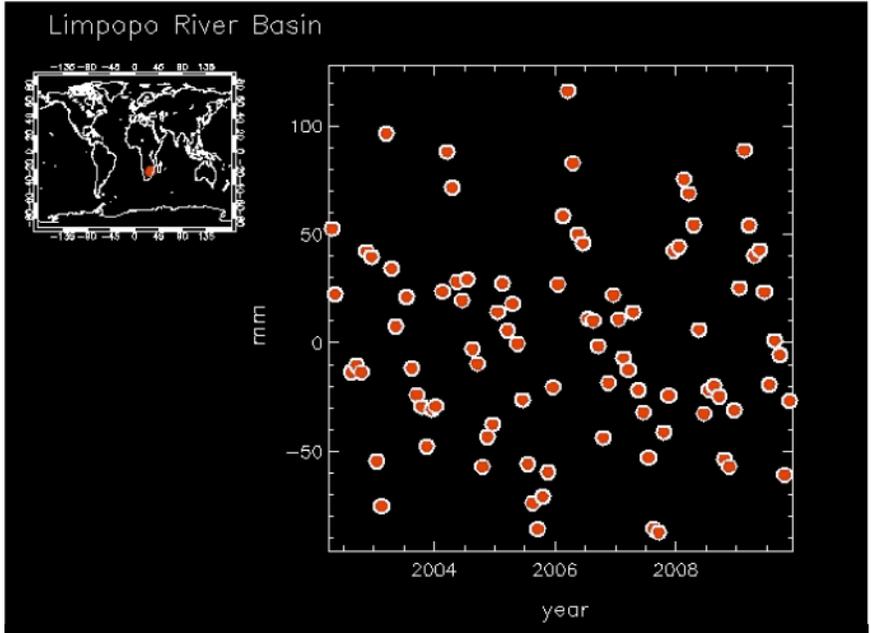
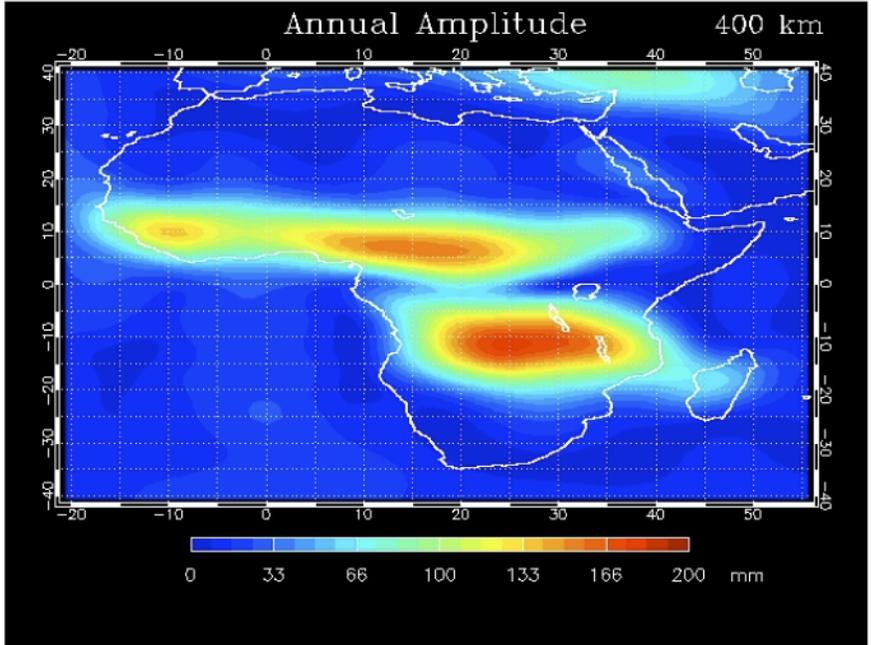
<input checked="" type="checkbox"/> Coasts	<input type="checkbox"/> Countries
<input type="checkbox"/> Rivers	<input type="checkbox"/> States
<input type="checkbox"/> Topography	<input type="checkbox"/> Local Projection

Time Series Seasonal Fit:
None

Error Bars None

Data Center / Release CSR RL04 DS

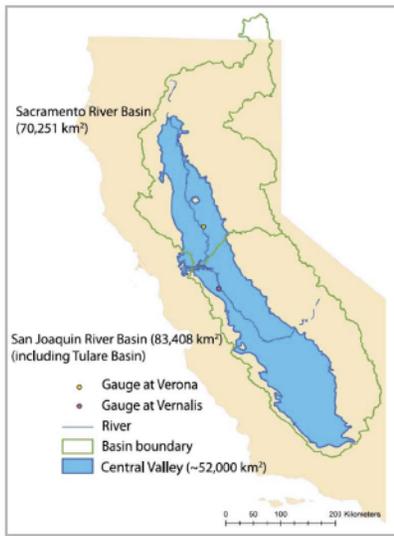
Make data available for download



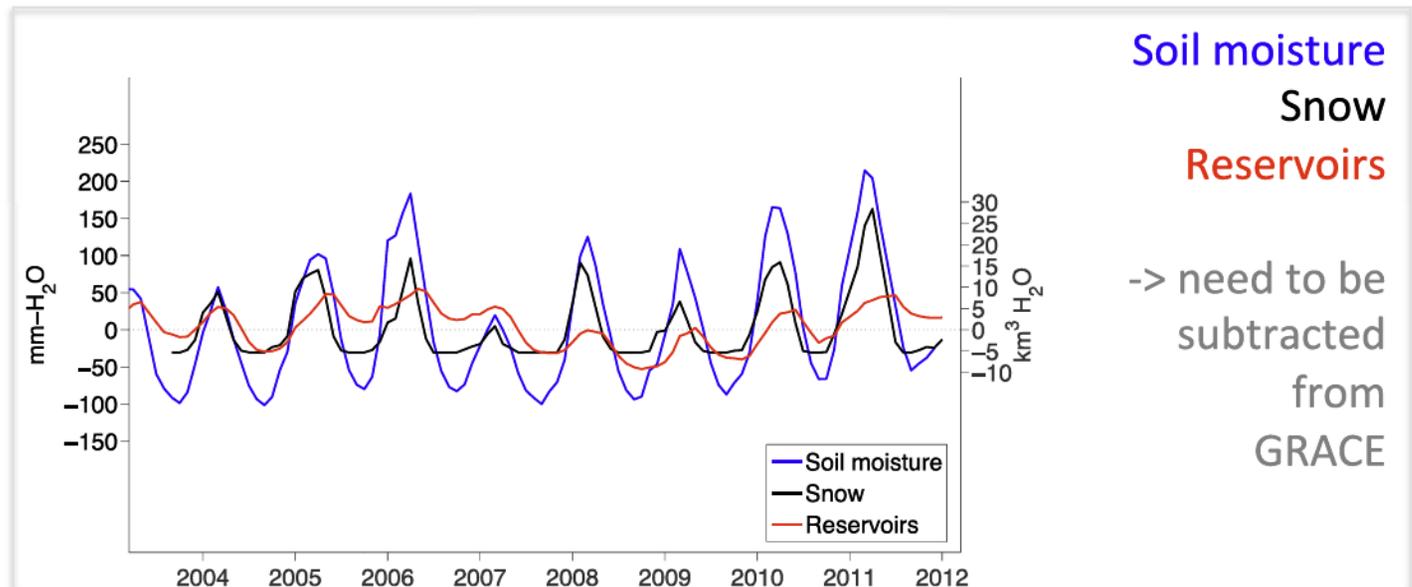
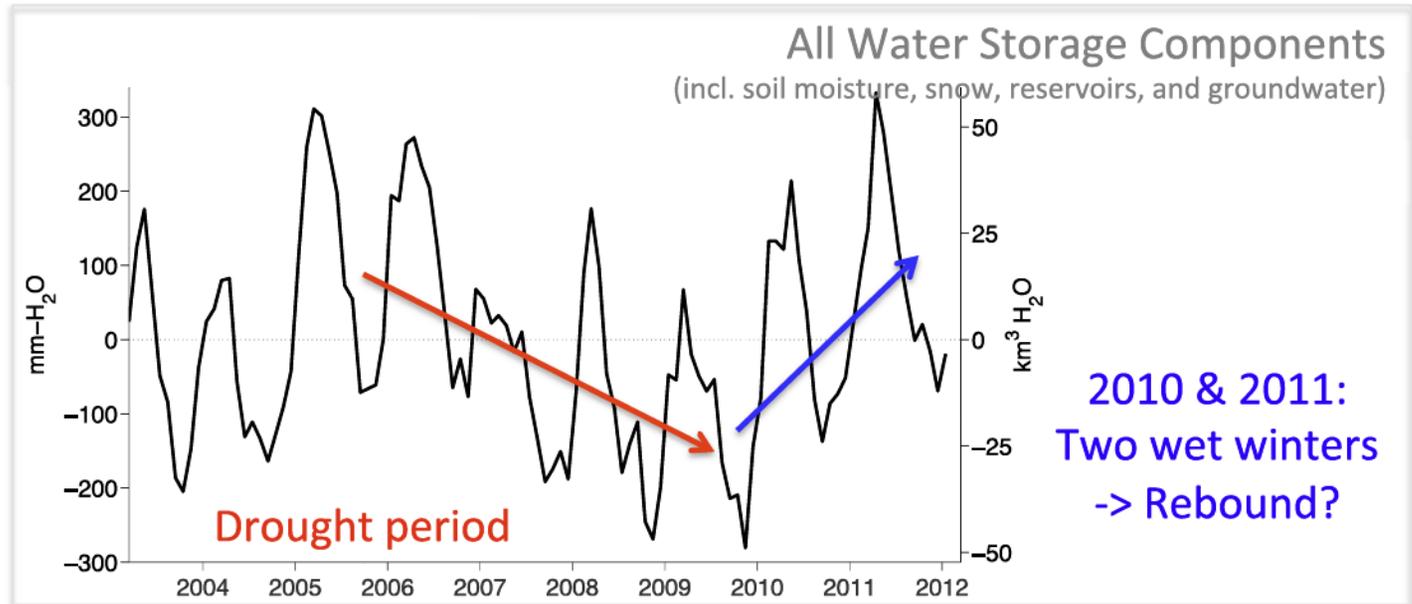
<http://geoid.colorado.edu/grace/grace.php>

California's Central Valley

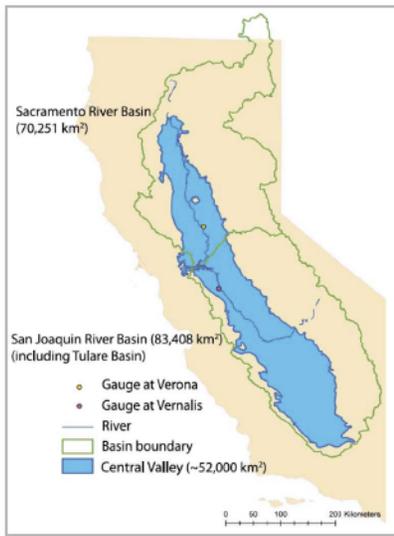
Water Storage Change (2003-2011)



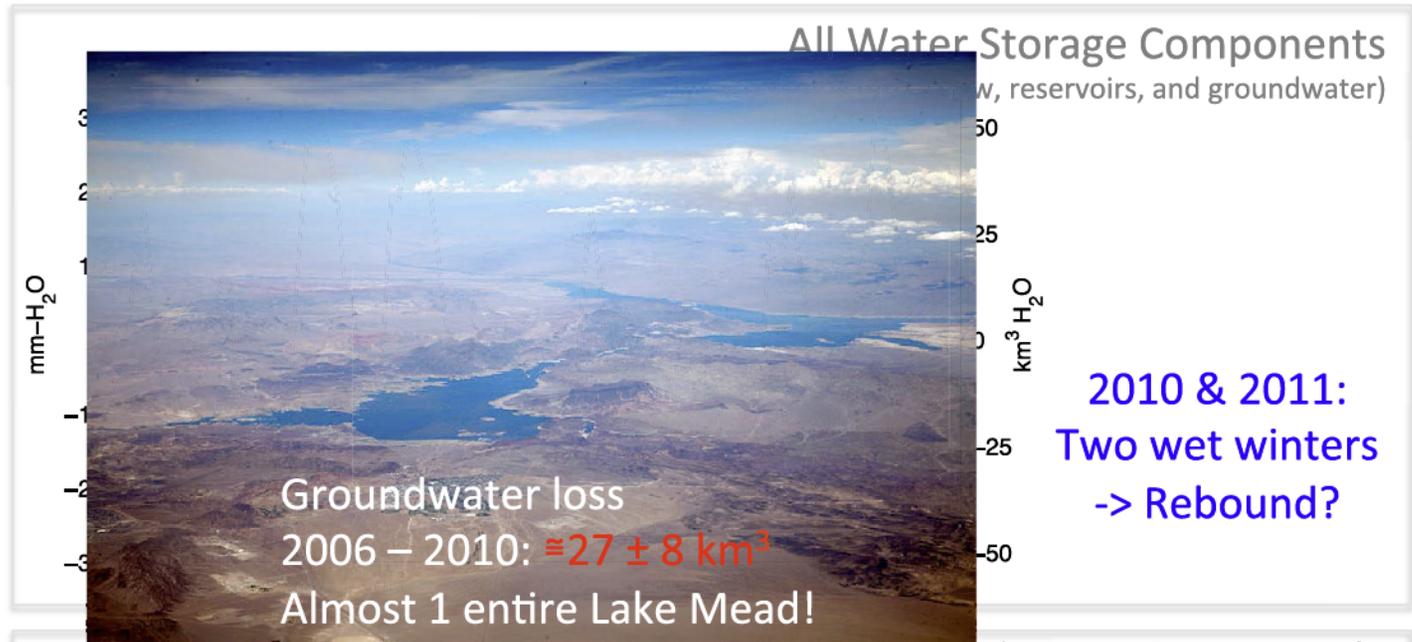
Map from Famiglietti et al., 2011



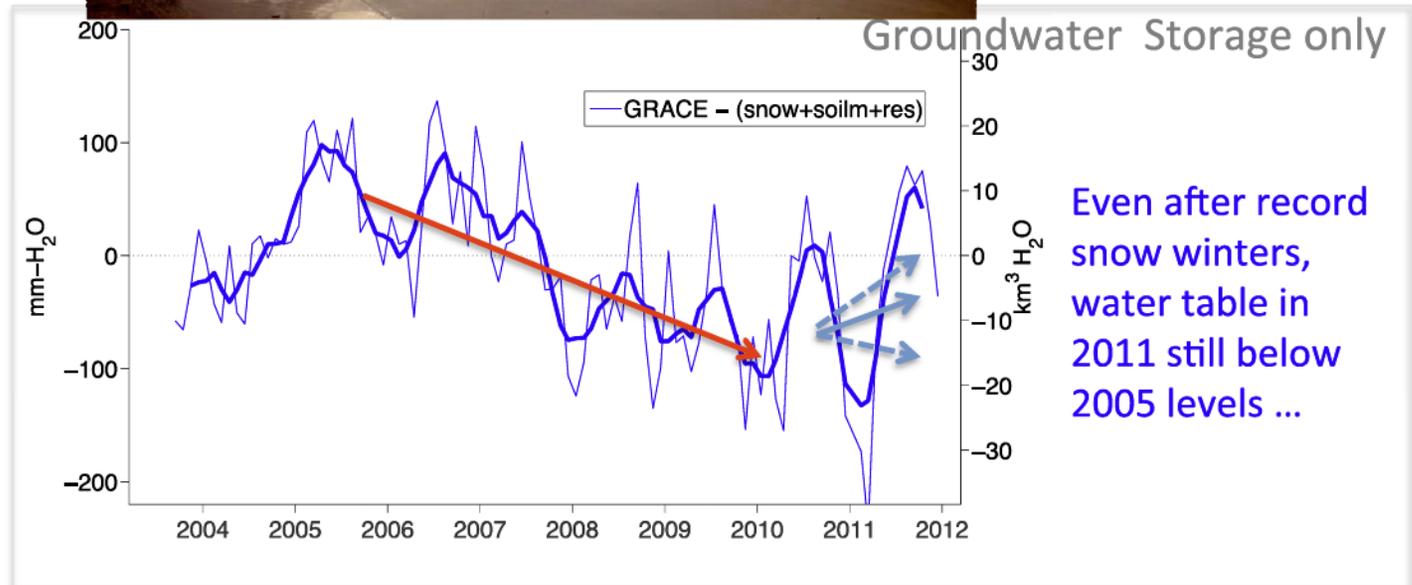
Groundwater Change (2003-2011)



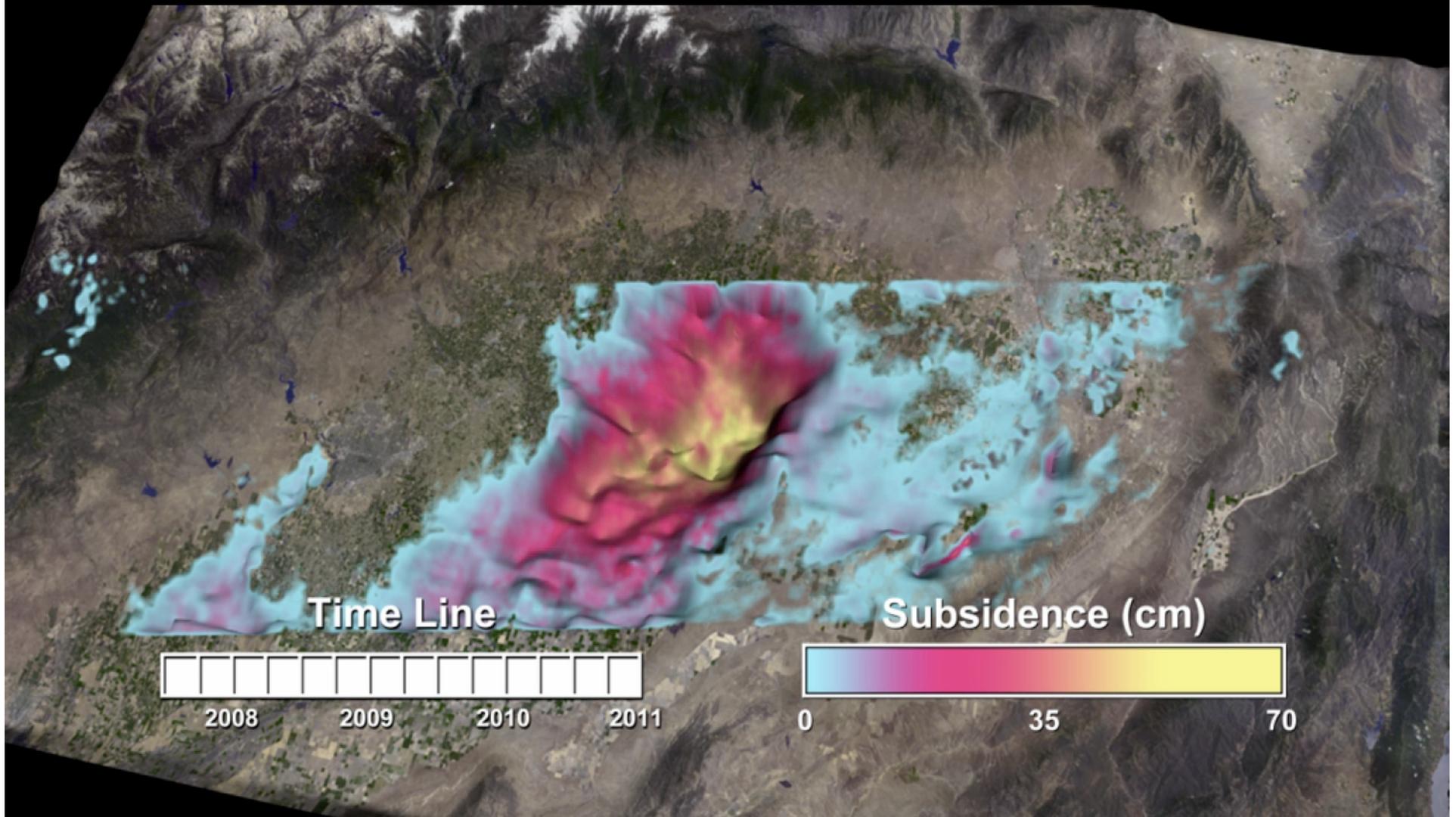
Map from Famiglietti et al., 2011



2010 & 2011:
Two wet winters
-> Rebound?



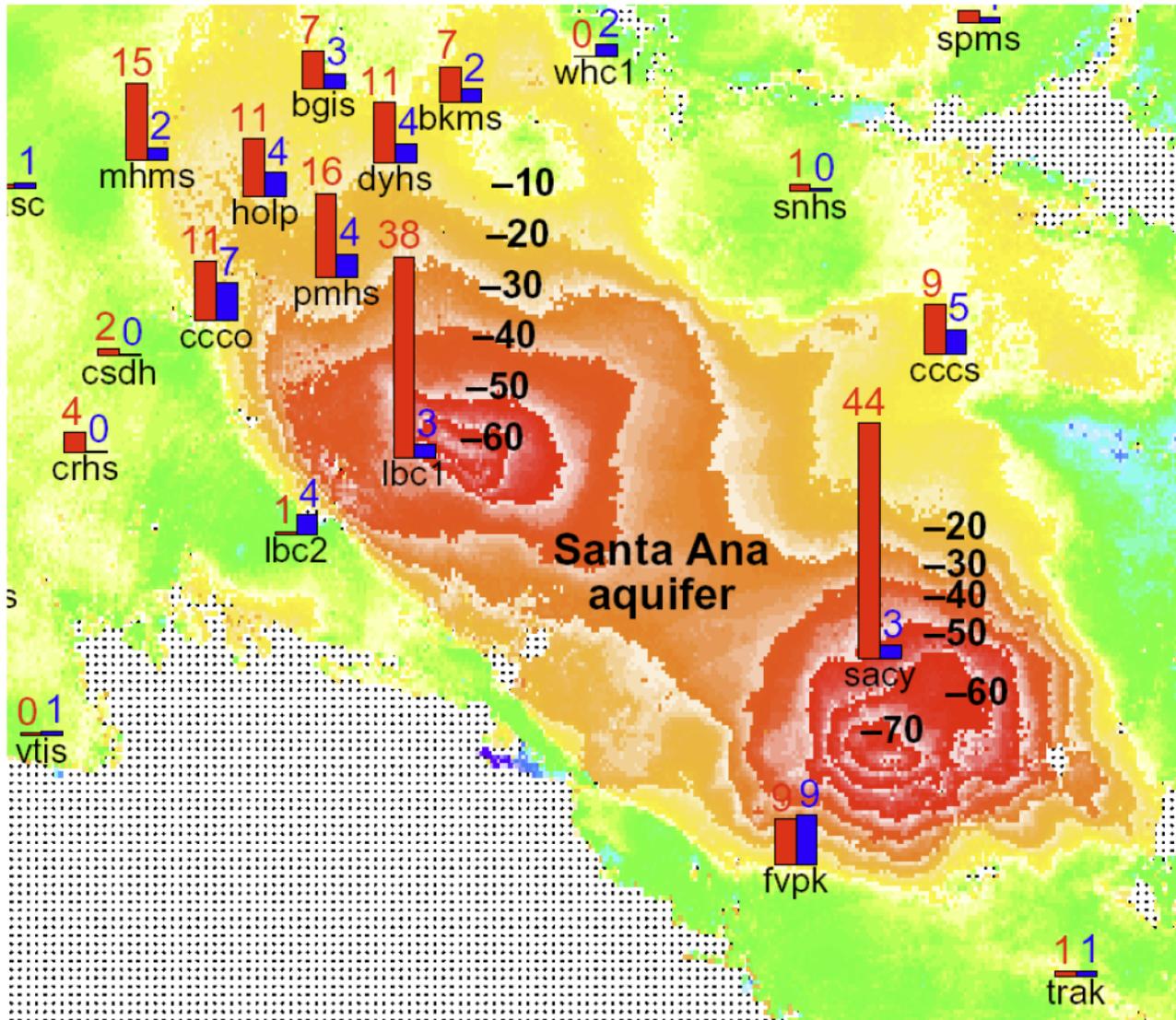
California's Central Valley



Source: NASA/JPL

Los Angeles Basin

Seasonal Variations in Height

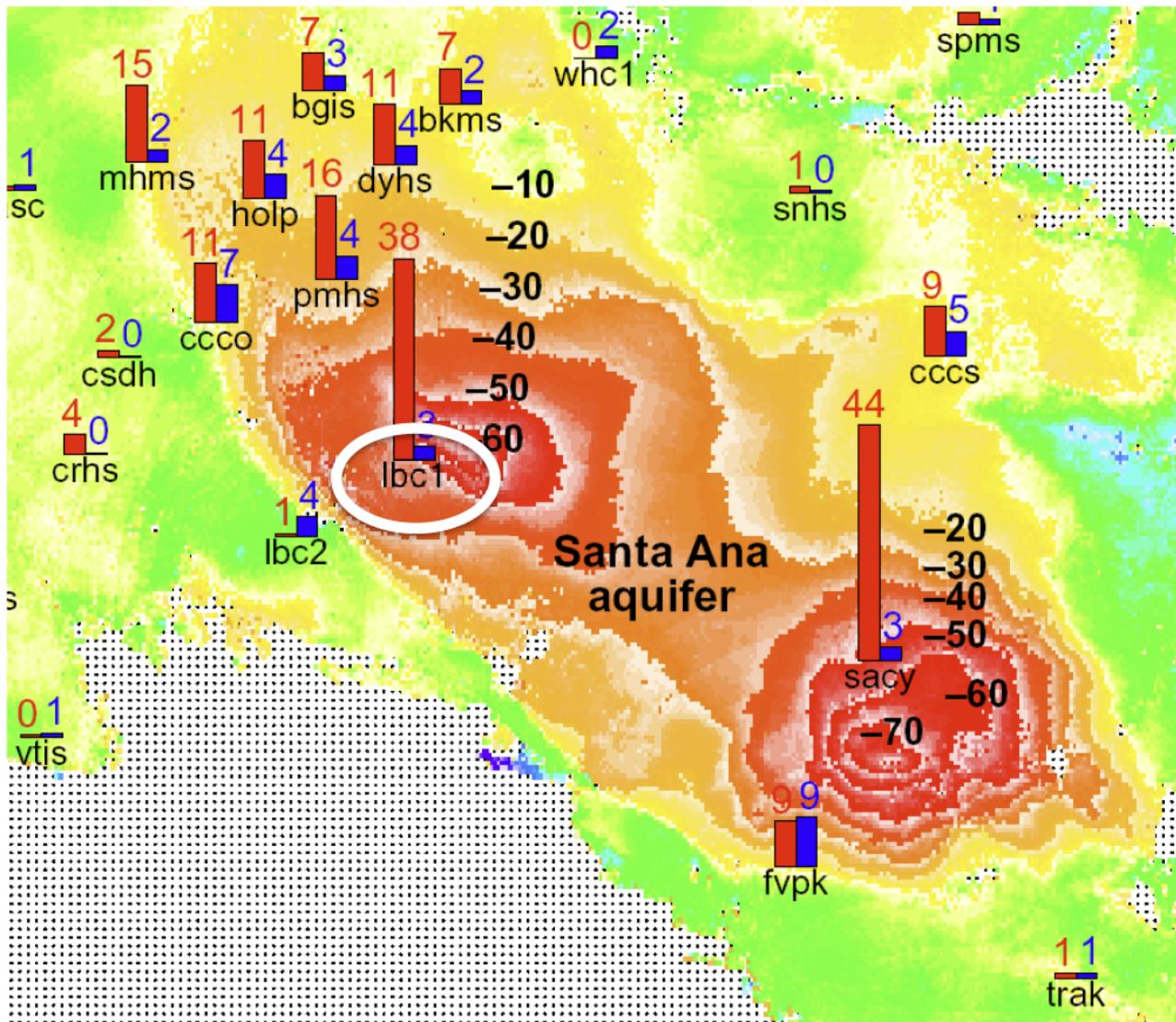


Color bars:
Peak-to-peak amplitude (in mm) of annual change in vertical (red) and horizontal (blue) position of GPS stations caused by water management in LA Basin during 1996-2002

Background:
InSAR image of subsidence (in mm) during 20 February 1999 to 14 August 1999

(Argus et al. 2005)

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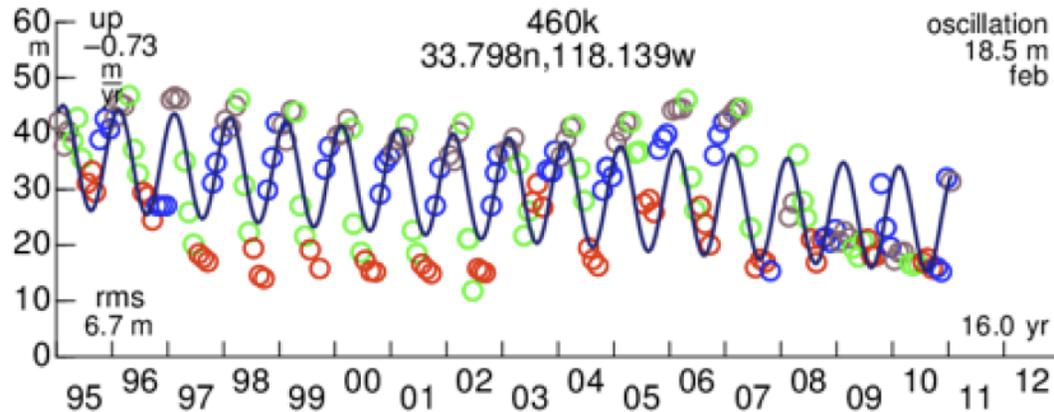


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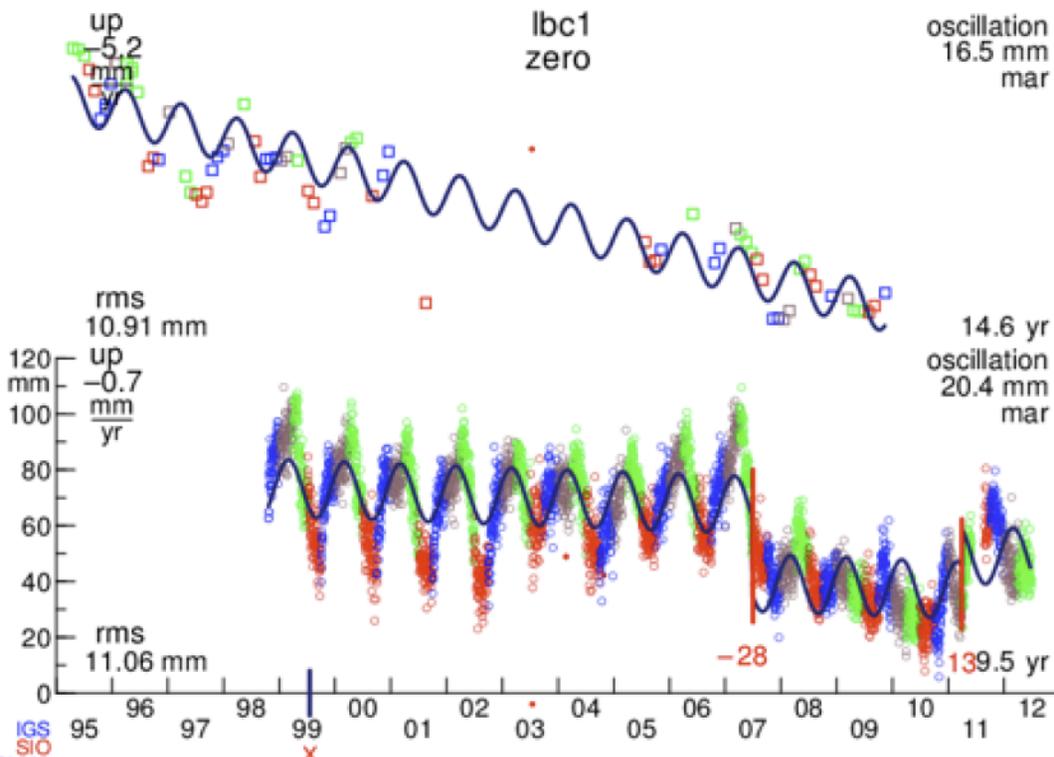
Background:
InSAR image of subsidence (in mm) during 20 February 1999 to 14 August 1999

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Drought During 2007–2010



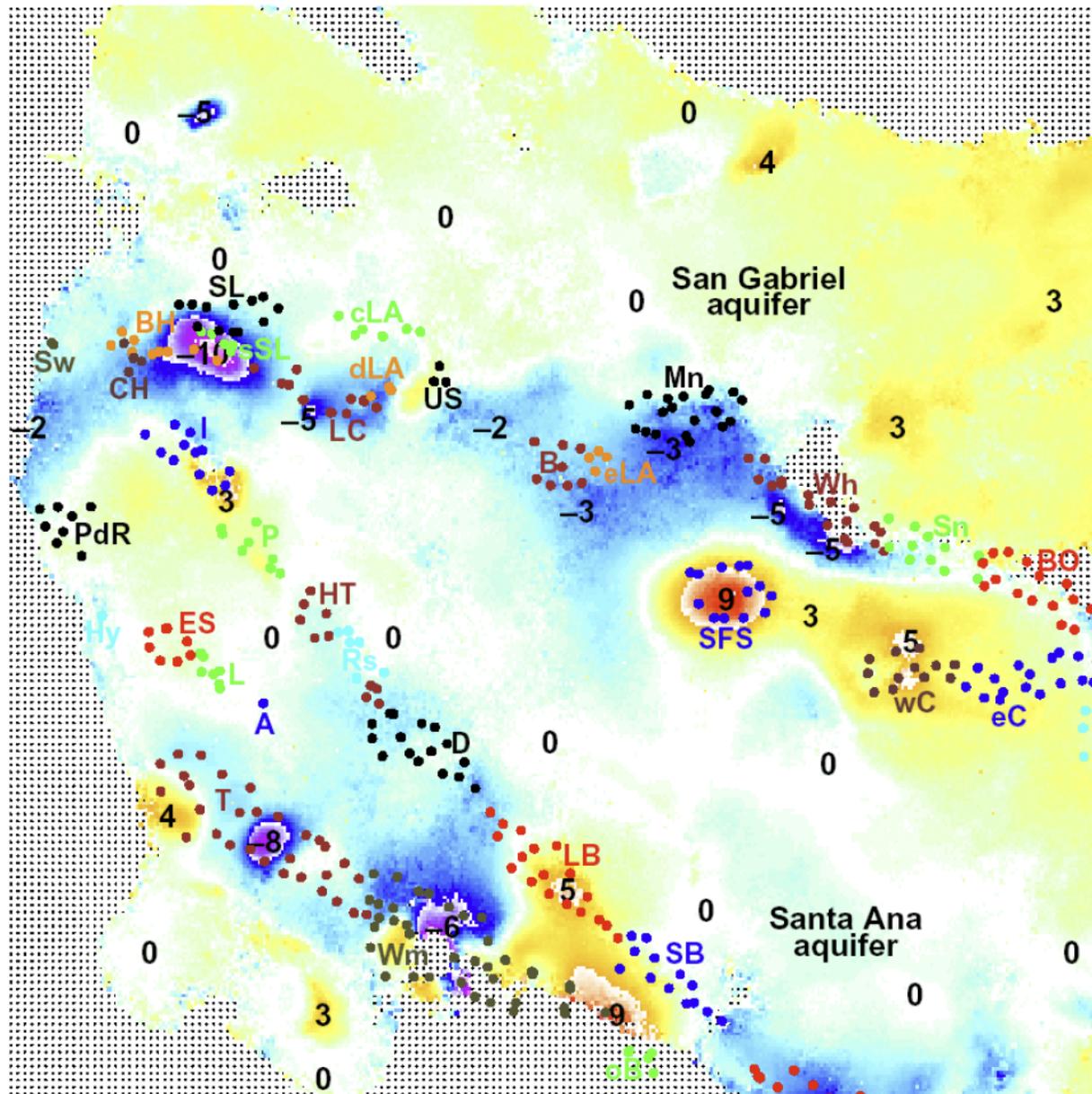
Top:
Change in water level (in meters) of water well 460K (located 4 km southwest of GPS station “lbc1”)



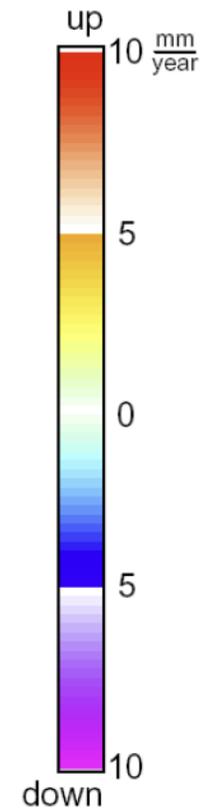
Middle:
Change in height (in mm) of GPS station “lbc1” measured by InSAR

Bottom:
Change in height (in mm) of GPS station “lbc1” measured by GPS

Height Rate-of-Change (1992-1999)



Background:
InSAR image of rate-of-change
of surface height (in mm/yr)
during 1992-1999



Dots:
Locations of oil fields (uplift
is due to repressurization of
abandoned oil fields)