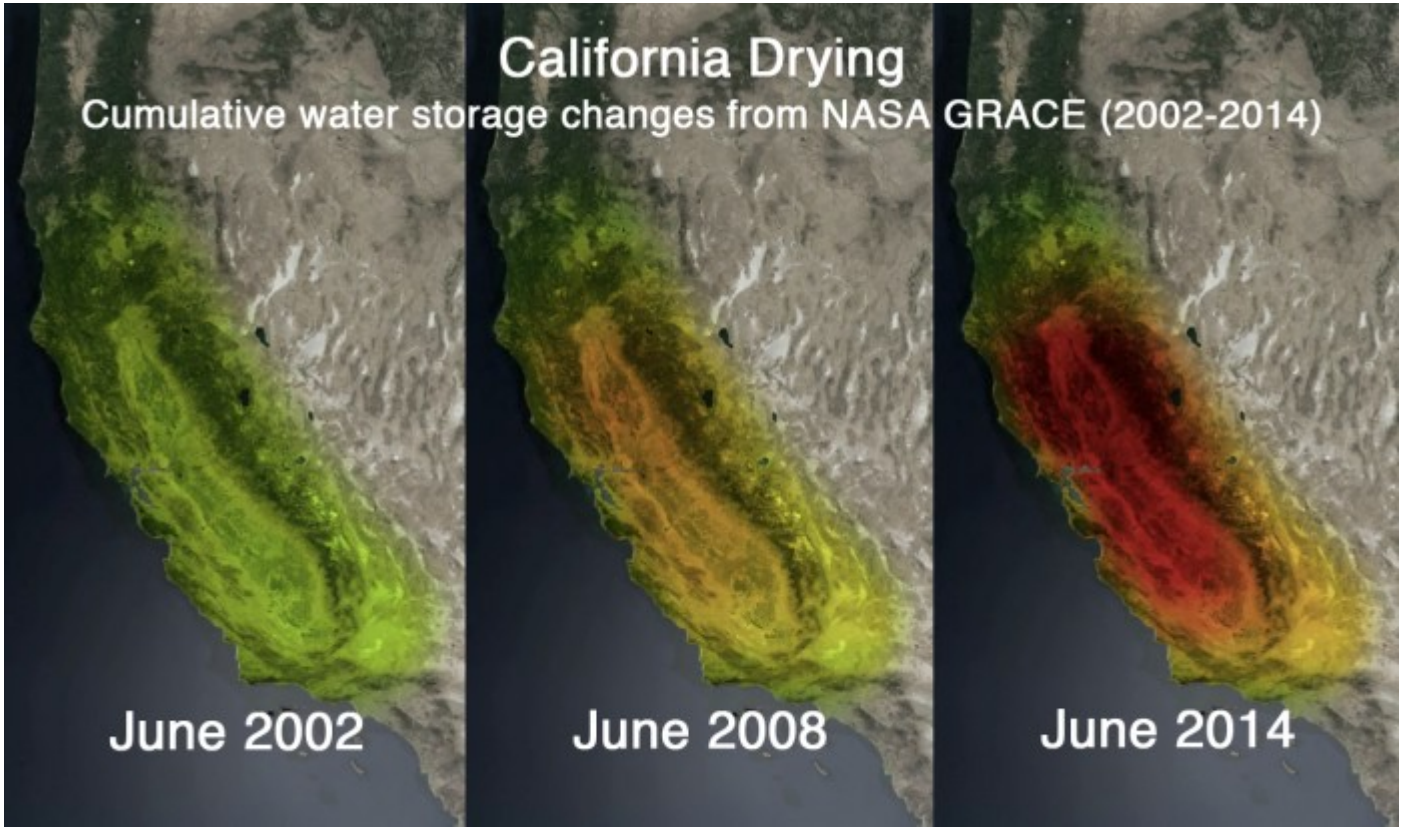
Observing the Epic California Drought from Space

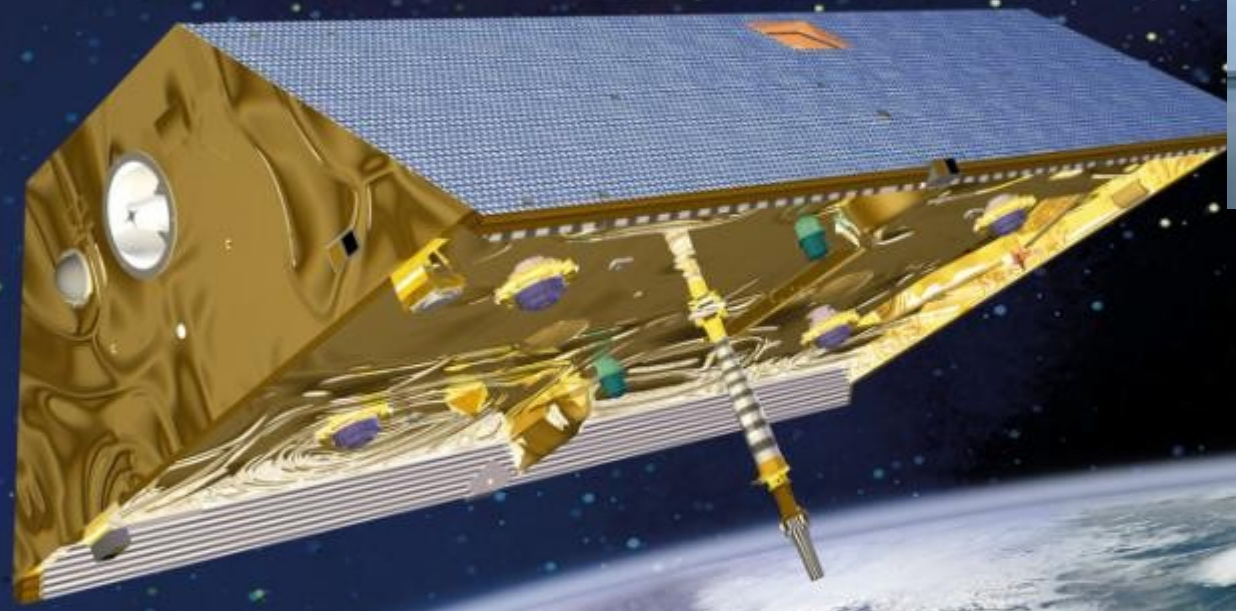


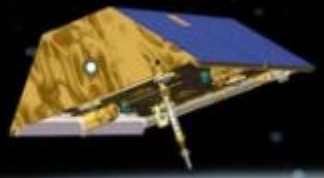
Jay Famiglietti
NASA Jet Propulsion Laboratory, California Institute of Technology, USA
University of California, Irvine, USA

Sustainable Water Resources Roundtable
NASA Ames Research Center, November 20, 2014

NASA Gravity Recovery and Climate Experiment (GRACE)

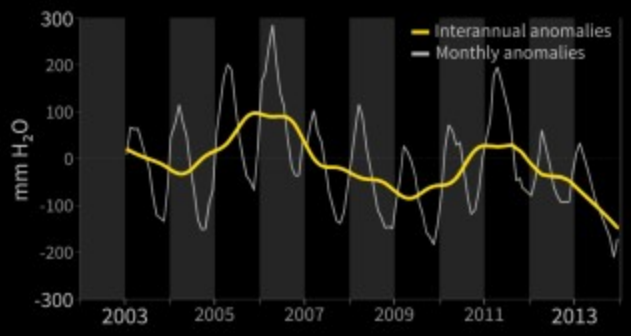
- Launched in 2002
- Functions like a ‘scale in the sky’ that can weigh the *monthly* increase or decrease in water storage in a *large (>150,000 km^2)* region with an accuracy of 1.5 cm

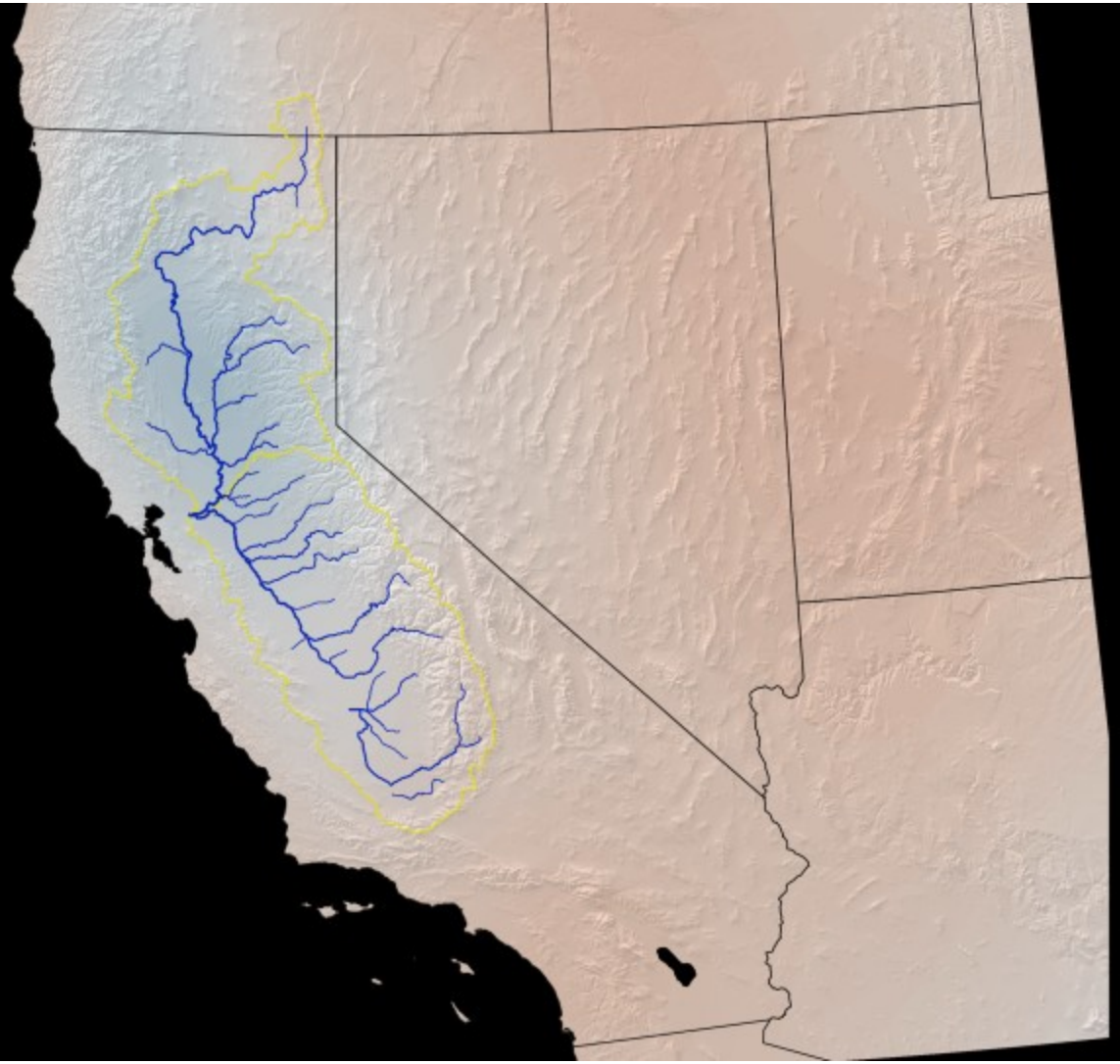




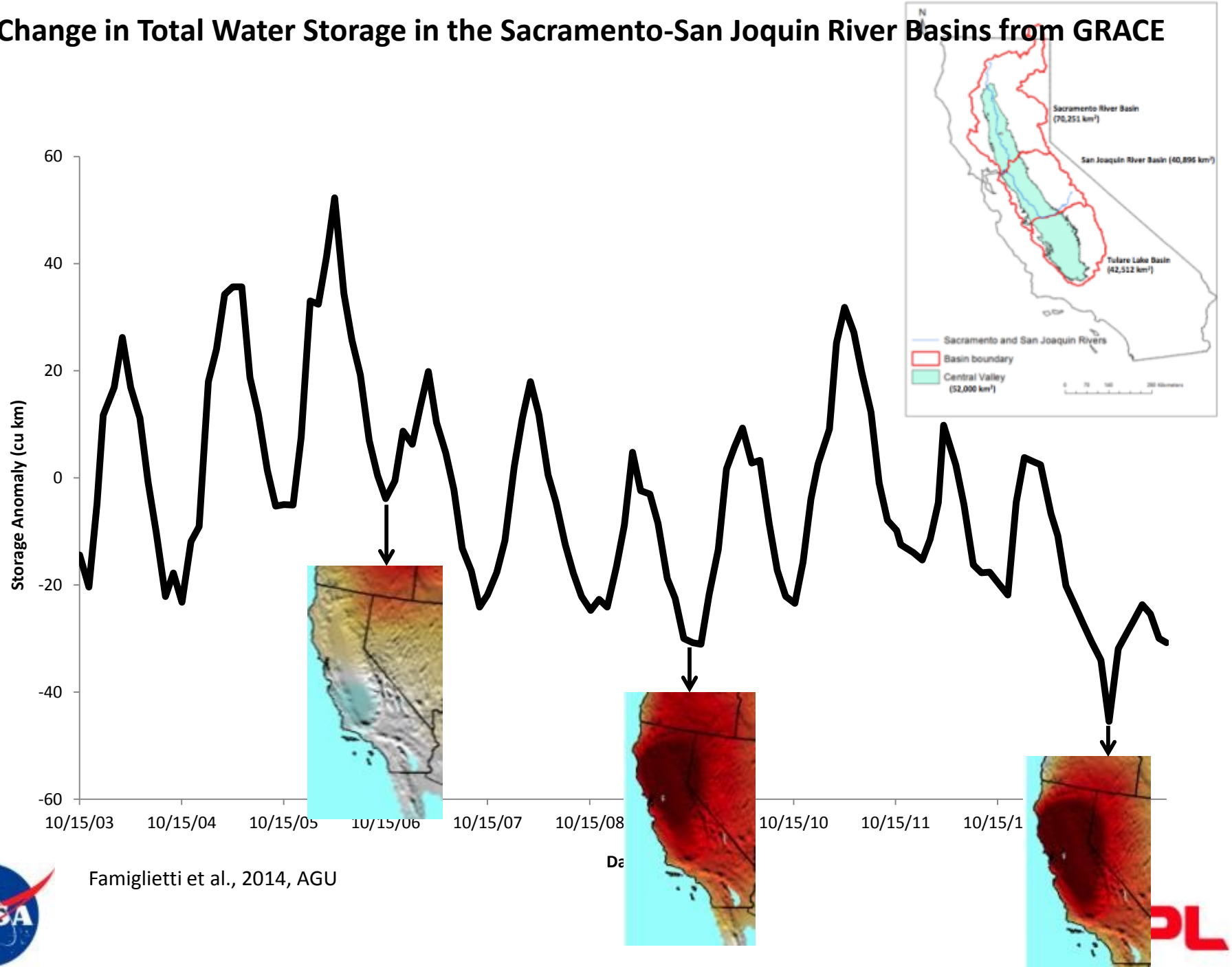
GRACE observations of Terrestrial Water Storage changes in California

2002 05 09



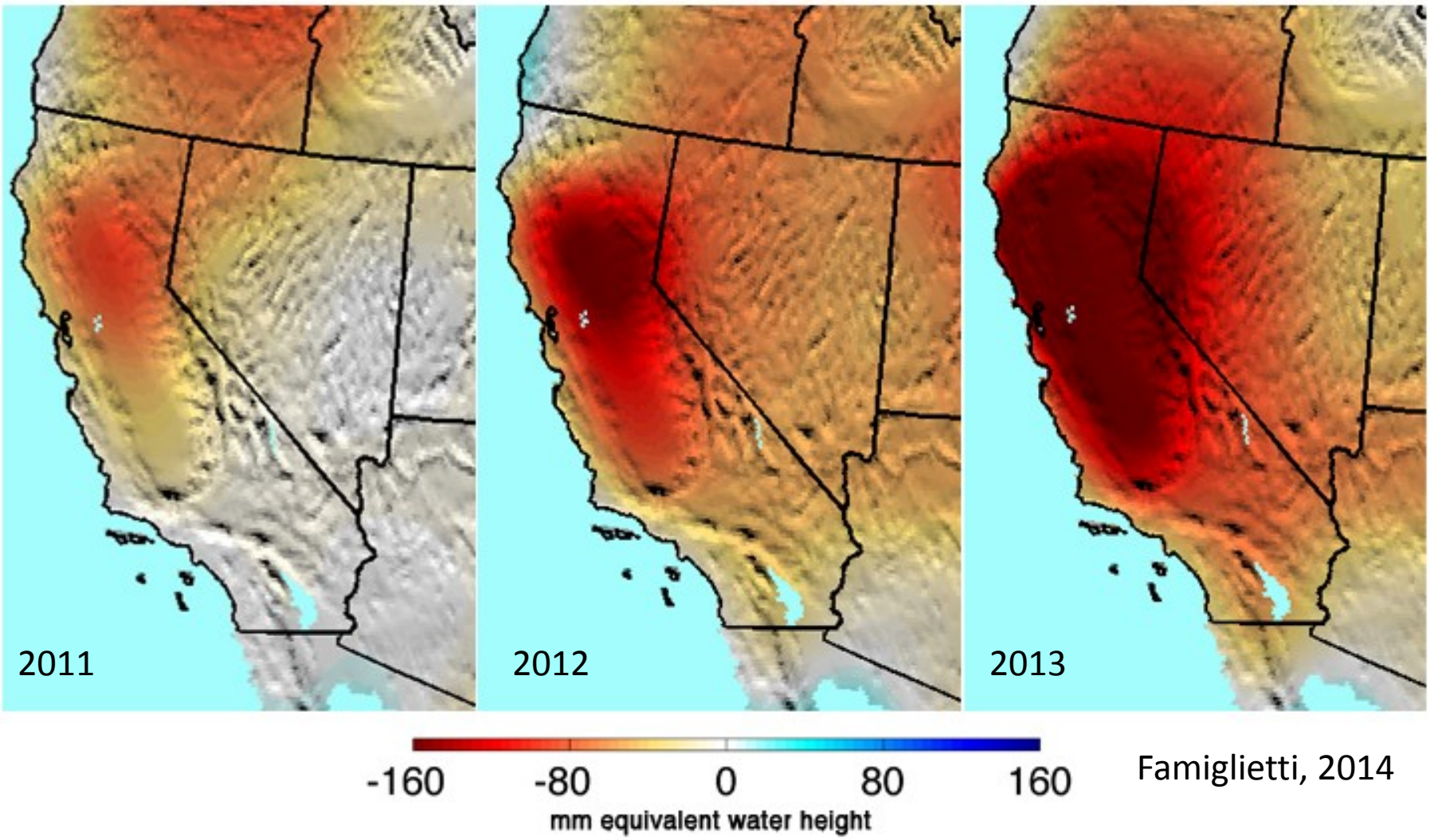


Change in Total Water Storage in the Sacramento-San Joquin River Basins from GRACE



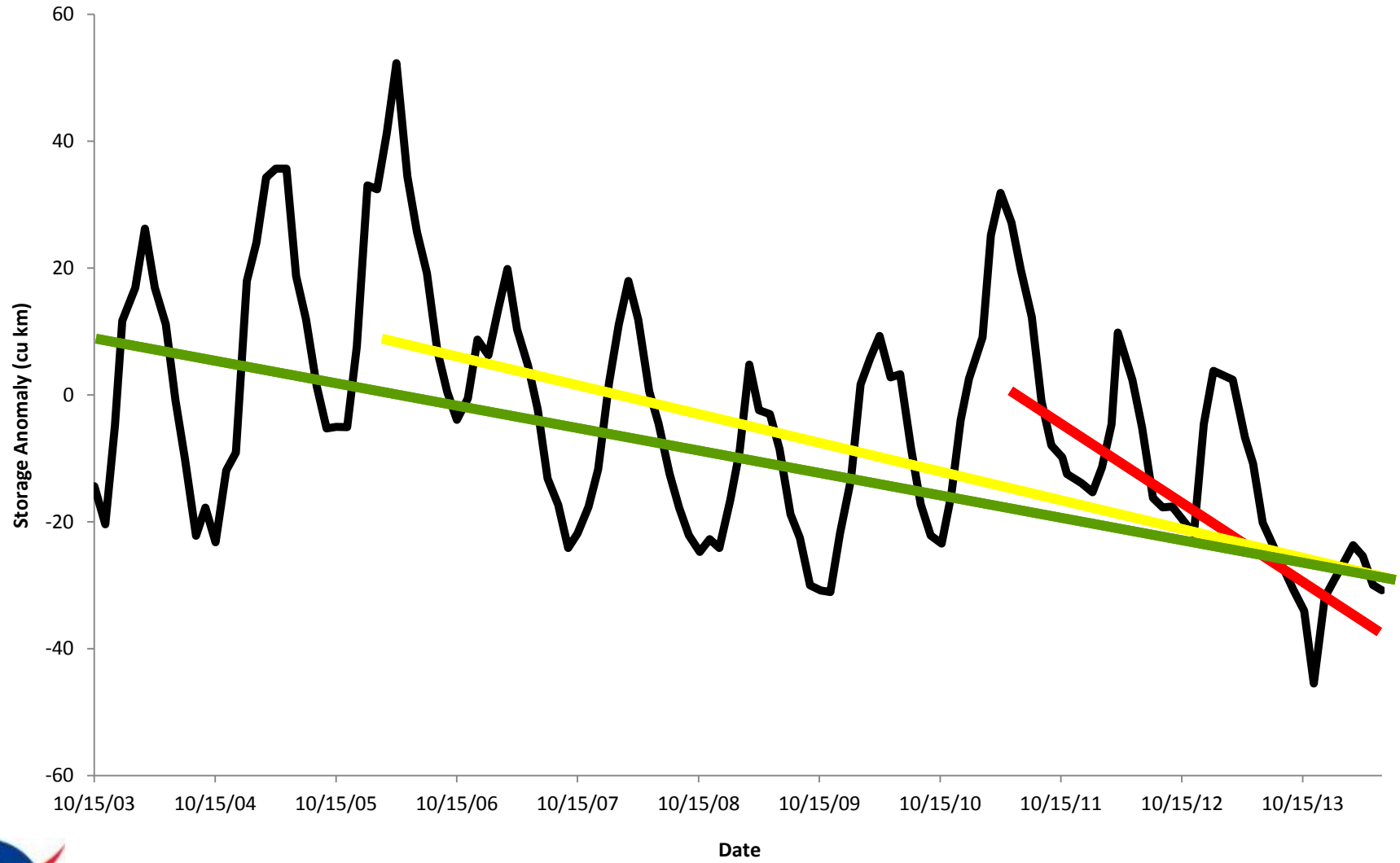
Famiglietti et al., 2014, AGU

Increasing Dry Season (Sept-Oct-Nov) Dryness from GRACE



Famiglietti, 2014

Change in Total Water Storage in the Sacramento-San Joquin River Basins from GRACE

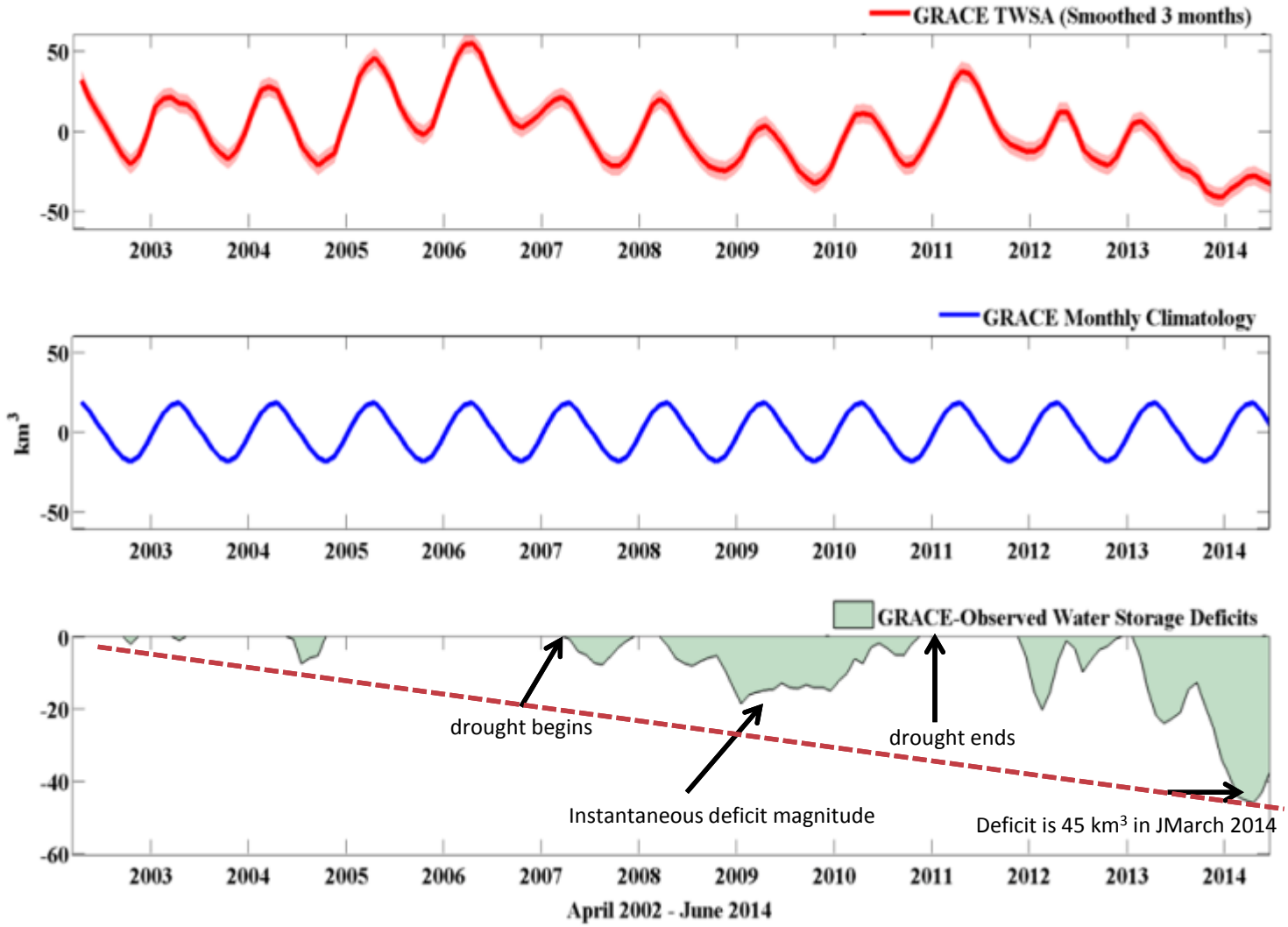


Characterizing California Drought with GRACE

Actual monthly water storage variations

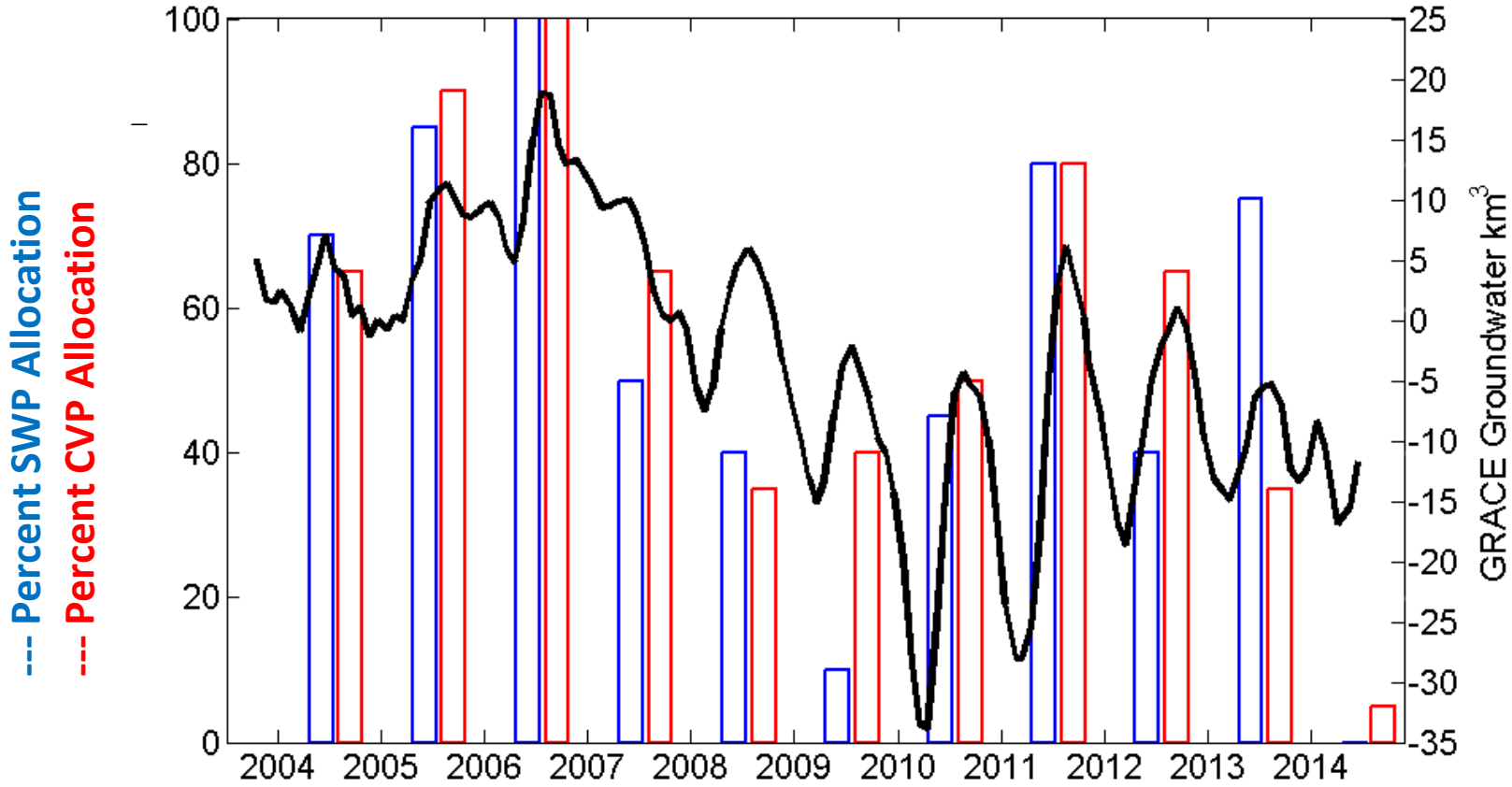
'Normal' range of monthly water storage variations

Differences from 'normal' dry condtions



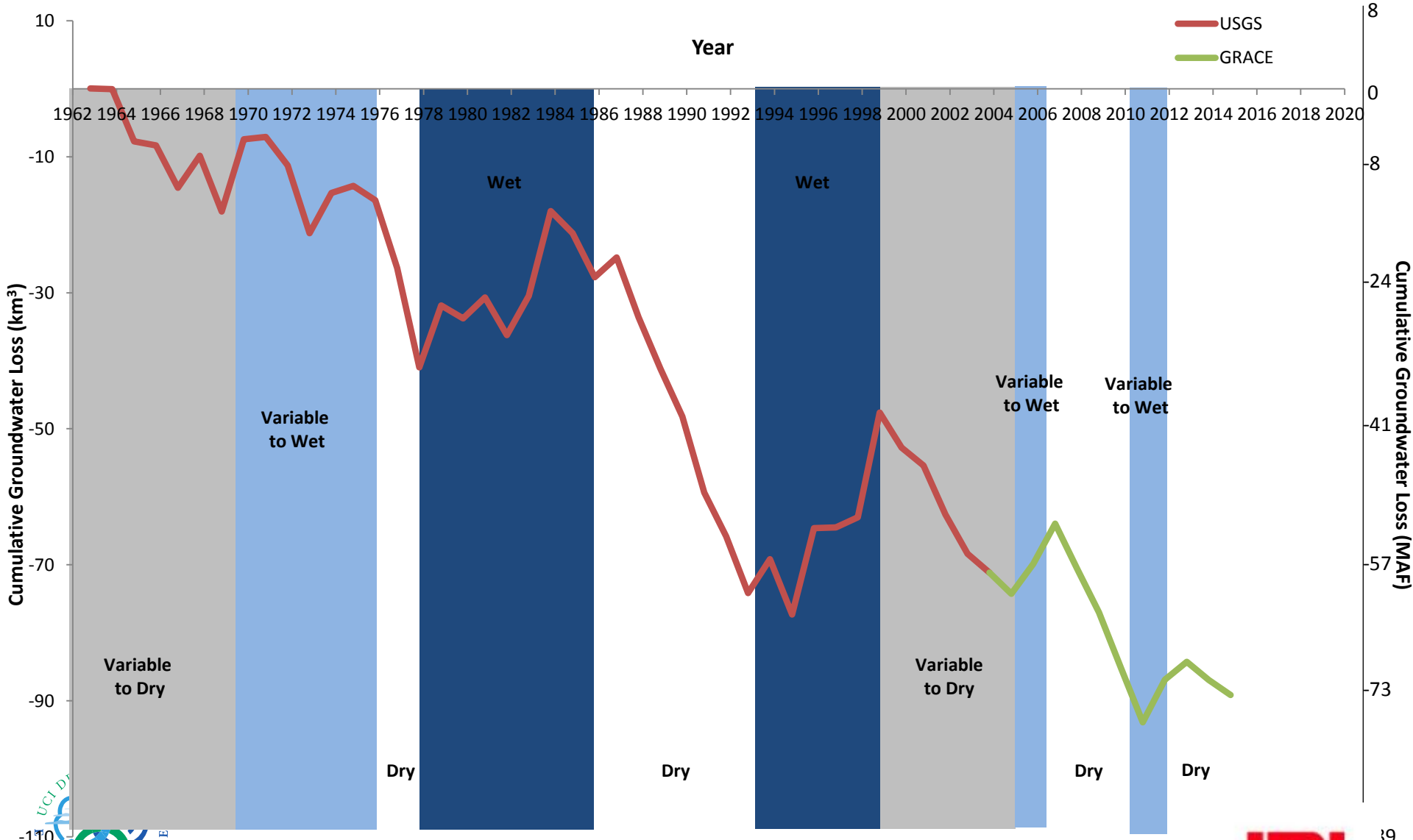
Thomas et al., 2014

Central Valley groundwater depletion from GRACE(2003-2013)
Surface water allocations and groundwater use are closely connected



UCCHM, 2014; Famiglietti et al., AGU, 2014

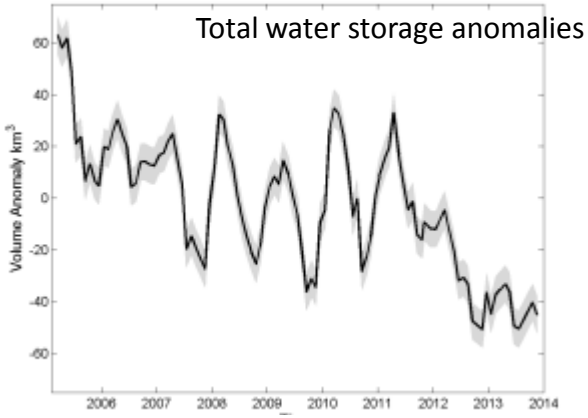
Cumulative Groundwater Depletion in California's Central Valley from USGS and GRACE (1962-2014)

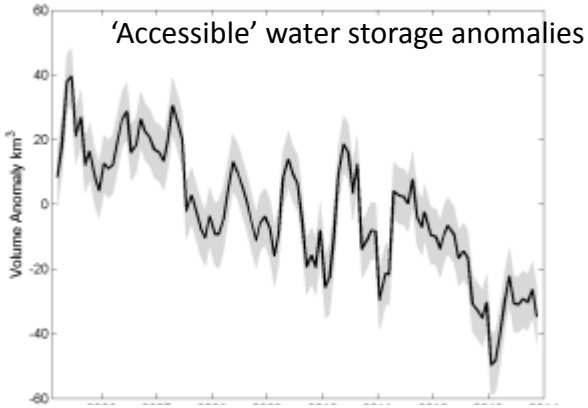


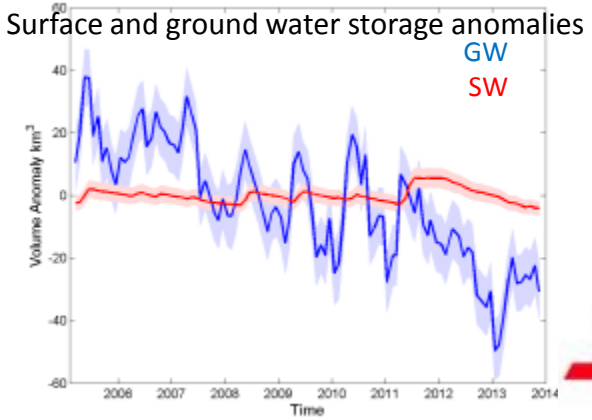
After Faunt, 2009. UCCHM, 2014; Famiglietti et al., 2014, AGU

Groundwater depletion during drought threatens the water security of the Colorado River Basin

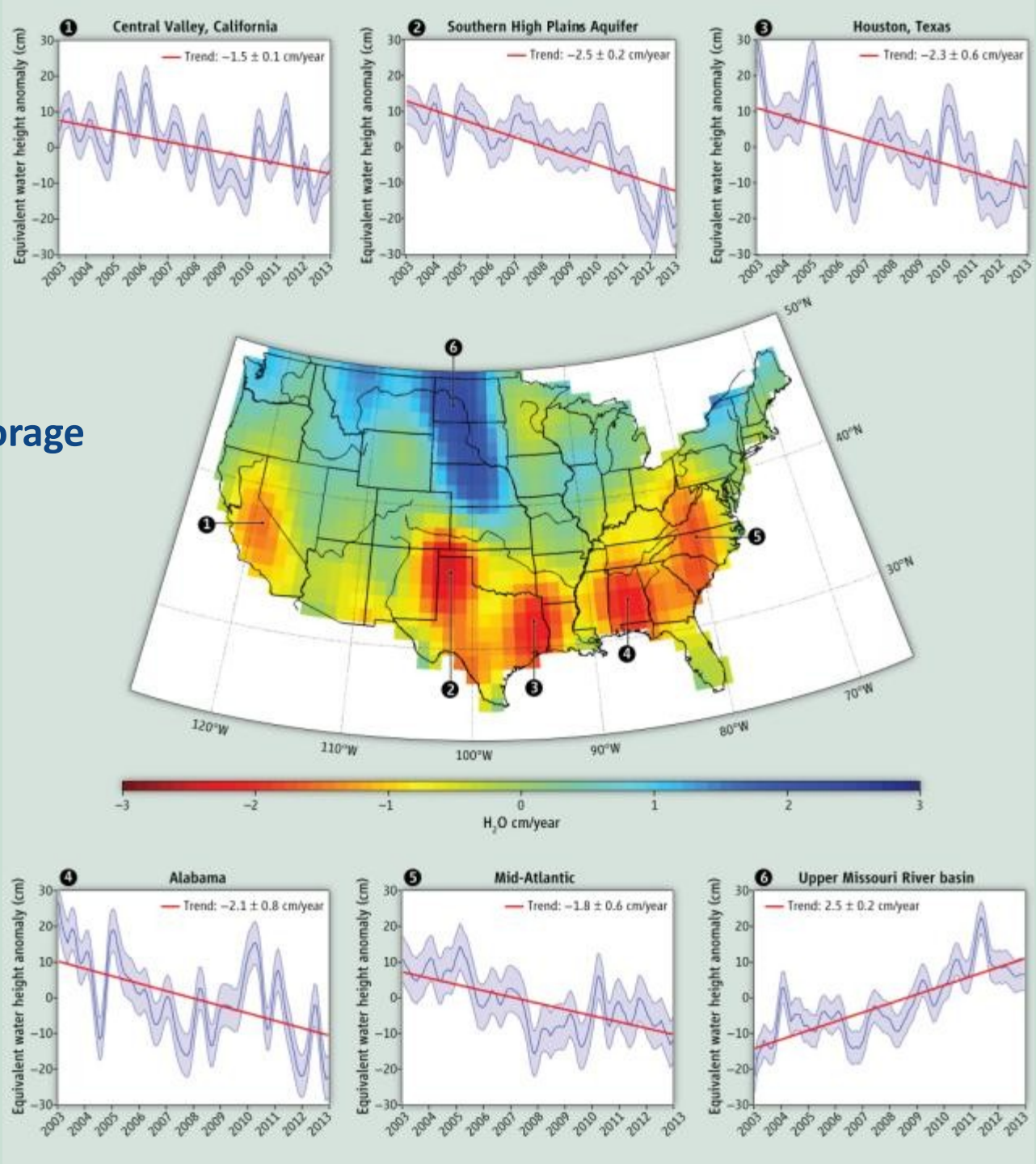
Castle et al., 2014







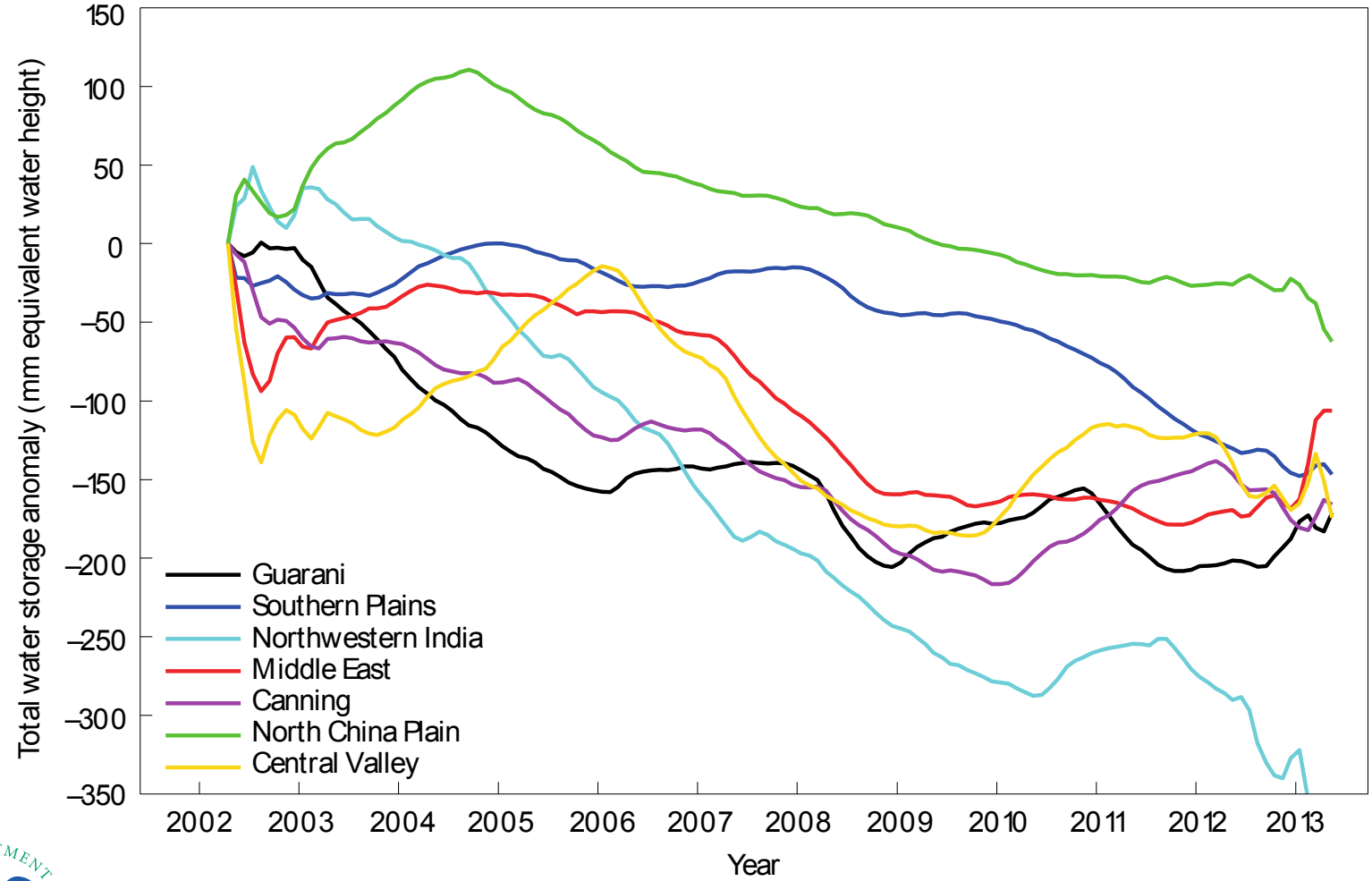
Trends in Freshwater Storage from GRACE, 2003-2012

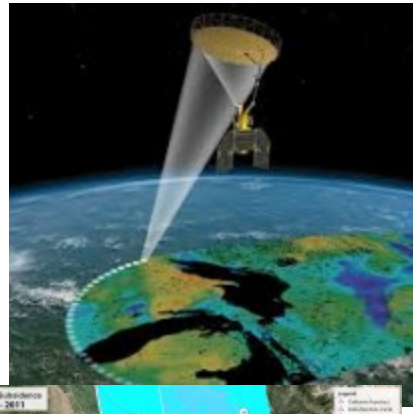
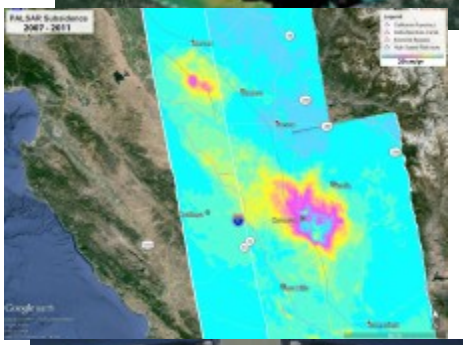


Famiglietti and Rodell, 2013

Total water storage changes in several of the world's major aquifers

Famiglietti, 2014, The Global Groundwater Crisis, *Nature Climate Change*



Potential contributions of NASA/JPL to SWRR and Western US Drought

- Upcoming flagship missions are water focused: SMAP, GRACE-FO, SWOT, NISAR
- Radar observations of levee integrity and subsidence
- Smaller missions and aircaft observatories: ASO, ECOSTRESS
- Advanced predicitive models that integrate ground-based, remotely-sensed and aircraft data for forecasting surface and groundwater availability
- An agriculture focused airborne observatory to measure soil moisture, evapotranspiration, vegetation stress,
- We want to be a go-to source for aircraft and satellite data, and to work with you to make them work for your region. We are in the planning stages of a Center for Snow and Water Availability and we are inviting heavy stakeholder engagement