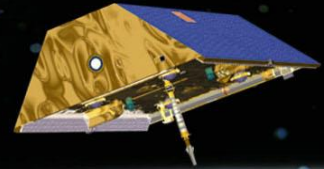
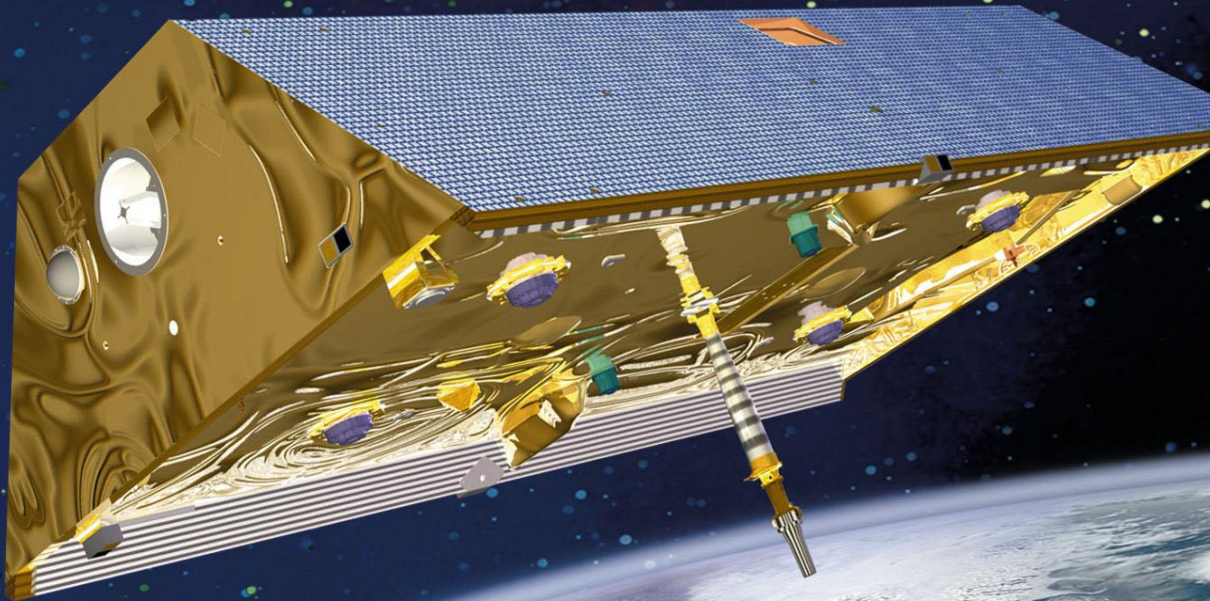
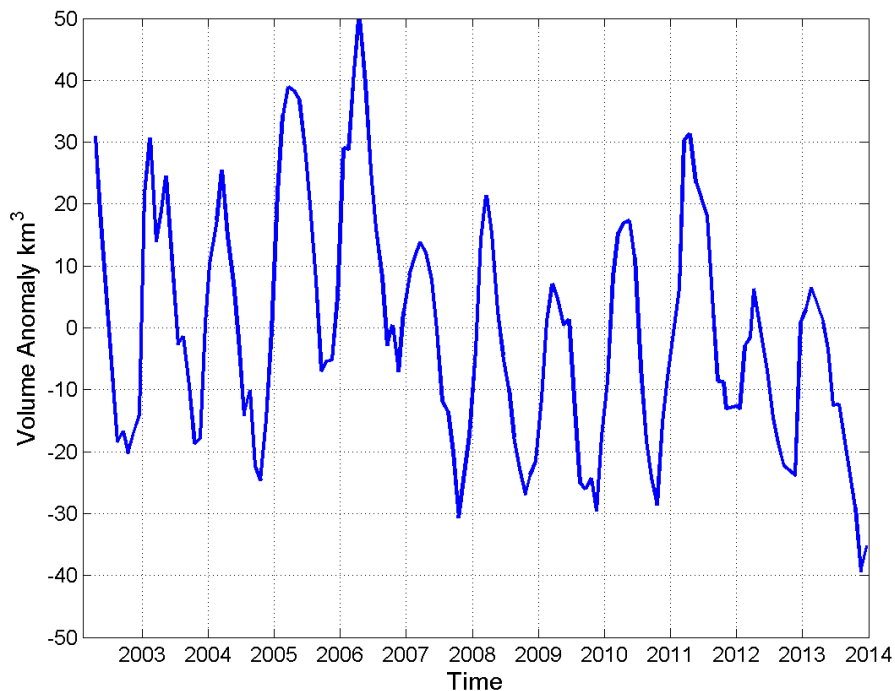
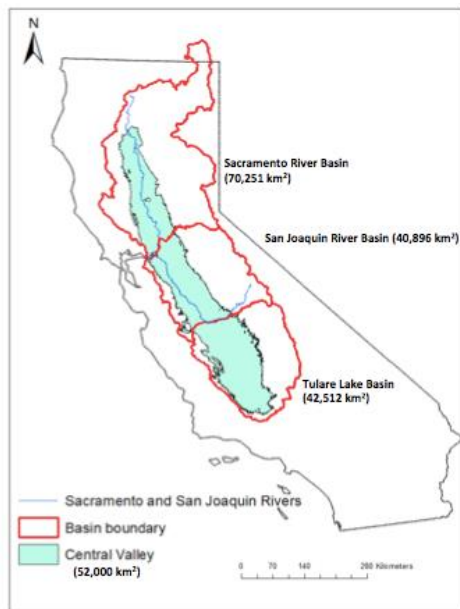


NASA Gravity Recovery and Climate Experiment (GRACE)

- Launched in 2002
- Functions like a 'scale in the sky' that can weigh the *monthly* increase or decrease in water storage in a *large* ($>200,000 \text{ km}^2$) region with an accuracy of 1.5 cm



Total Water Storage Changes in the Sacramento-San Joaquin River Basins from the NASA GRACE Satellite Mission for March 2002- December 2013

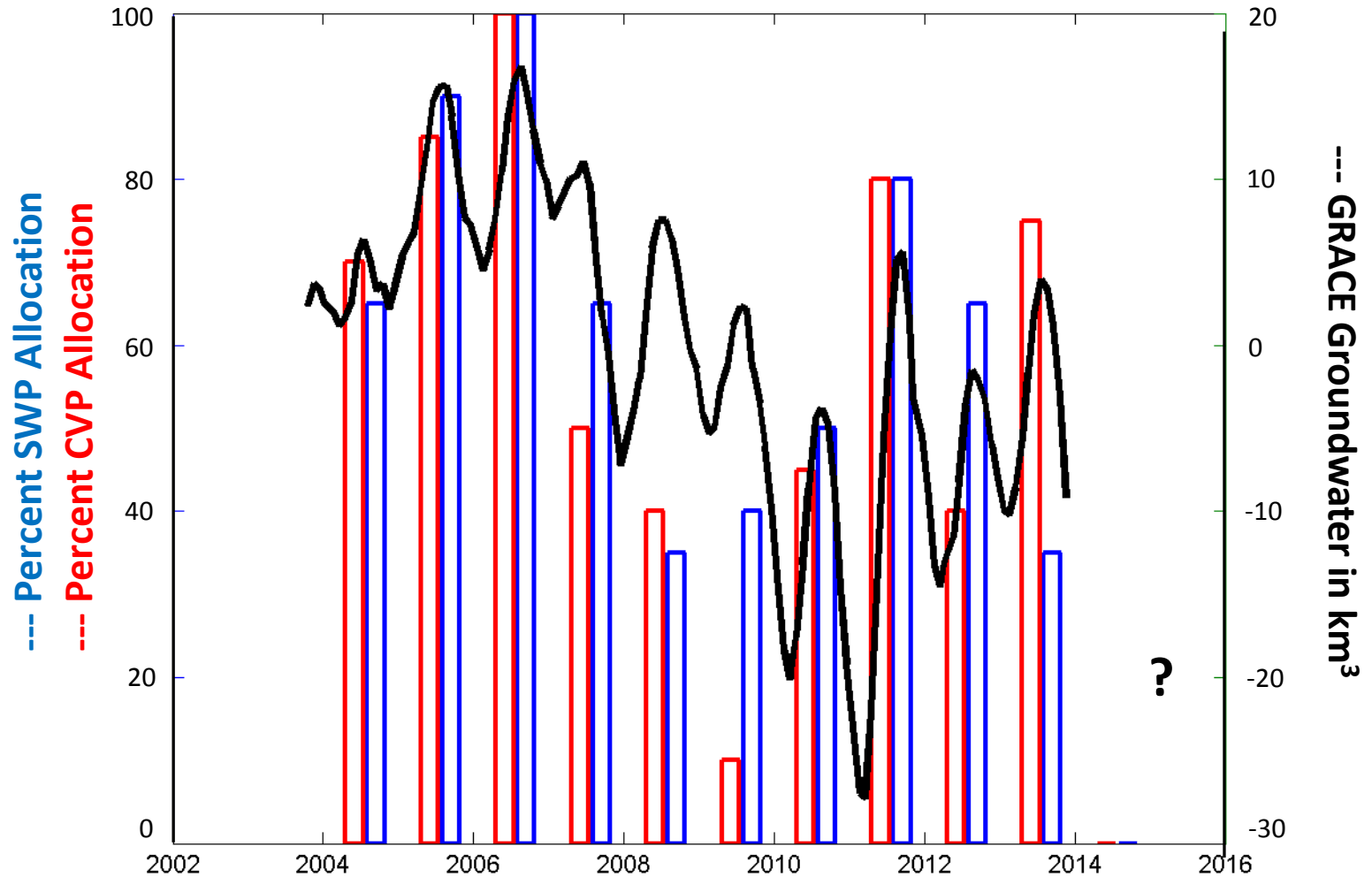


Data courtesy of UC Irvine, National Center for Atmospheric Research, University of Texas, NASA

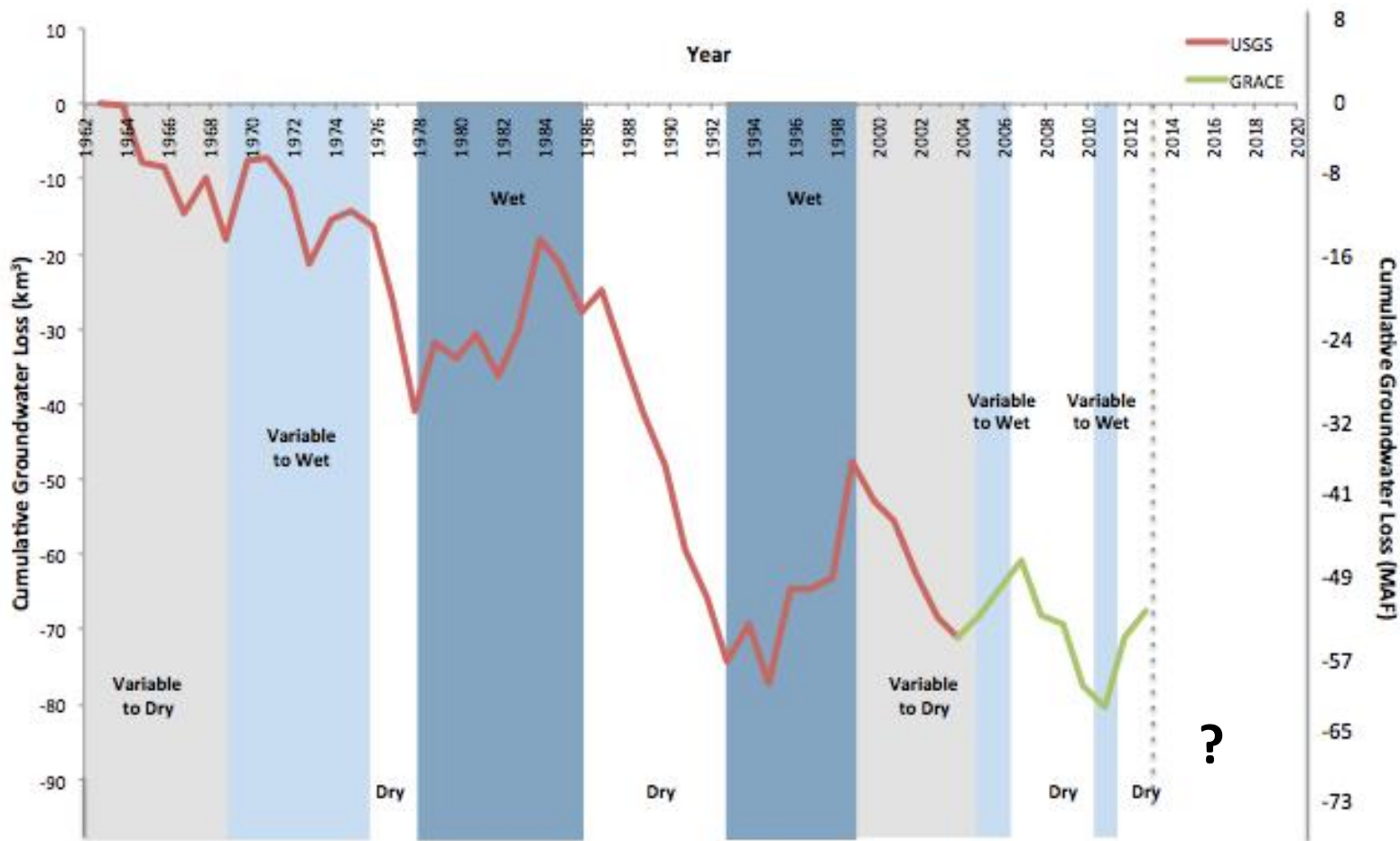
- Monthly changes in all of the snow, river and reservoir storage, soil water and groundwater combined.
- Lowest point since March 2002 is December 2013
- Decline over last 2 years of 25 km³
- Longer term drought going back to 2006?

Central Valley groundwater depletion from GRACE

Surface water allocations and groundwater use are closely connected



Cumulative Groundwater Depletion in California's Central Valley from USGS and GRACE

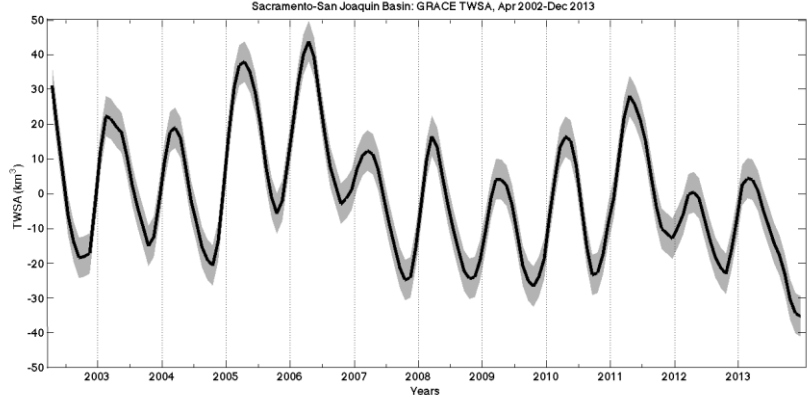


UCCHM, 2014

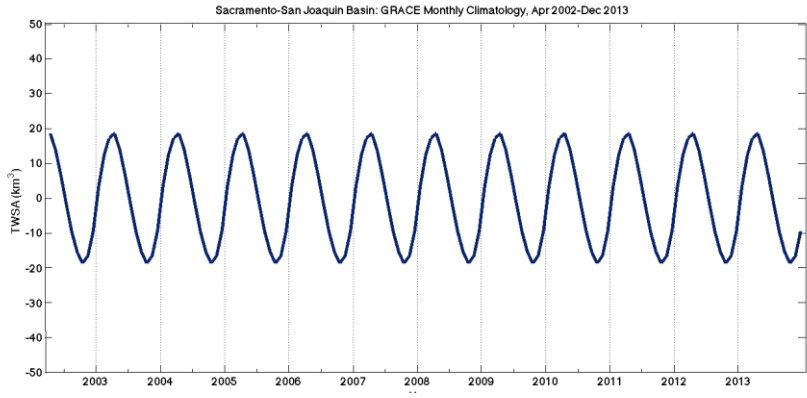
An example of water cycle change from GRACE

Increasing extremes in California

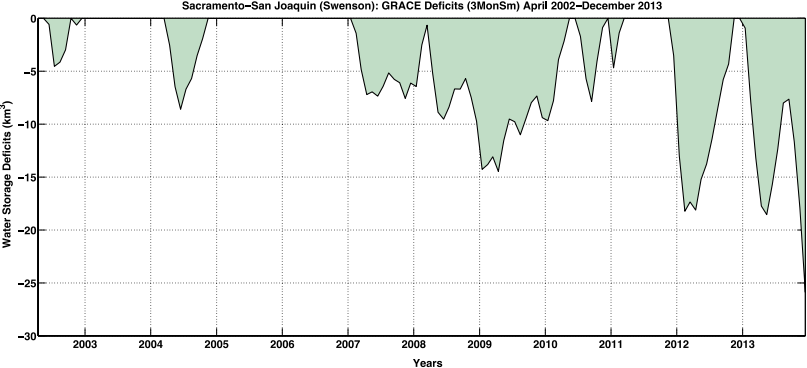
Monthly changes in total water storage



Average changes in total water storage

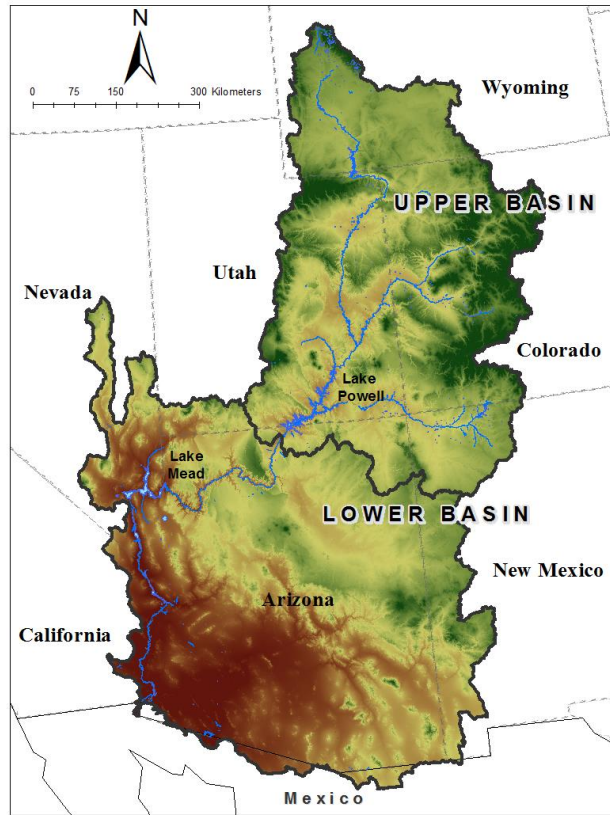


Negative deviations from average water storage conditions

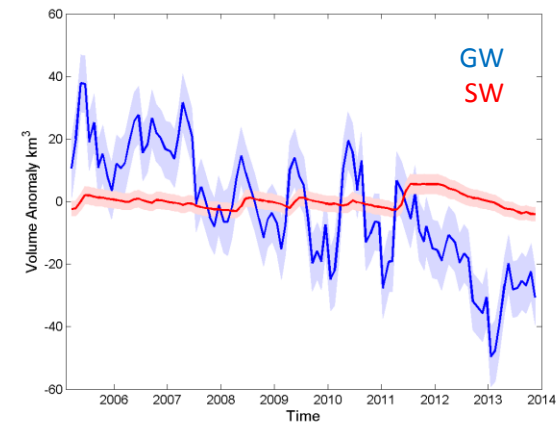
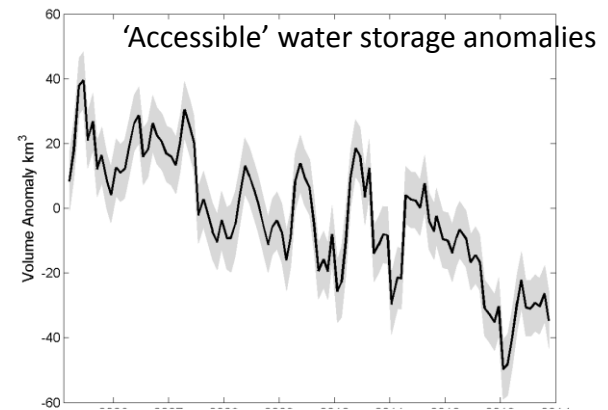
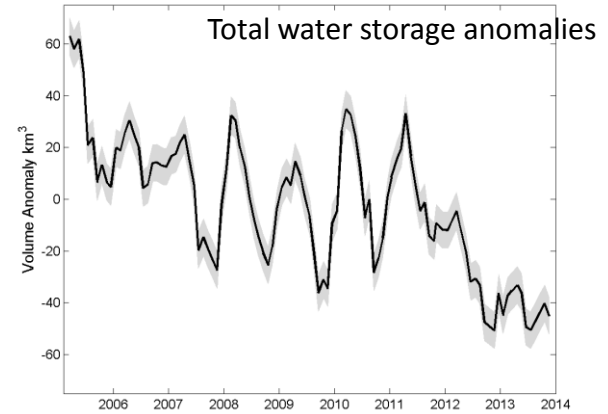


Estimating groundwater storage changes with GRACE

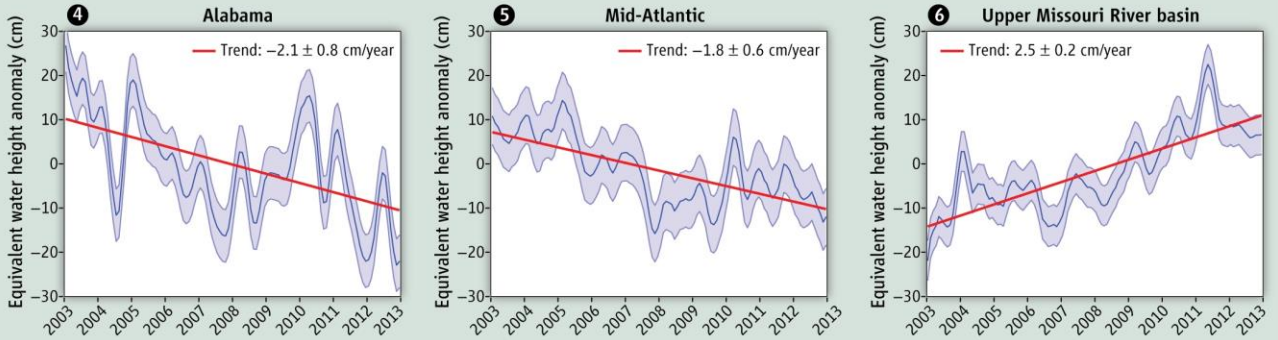
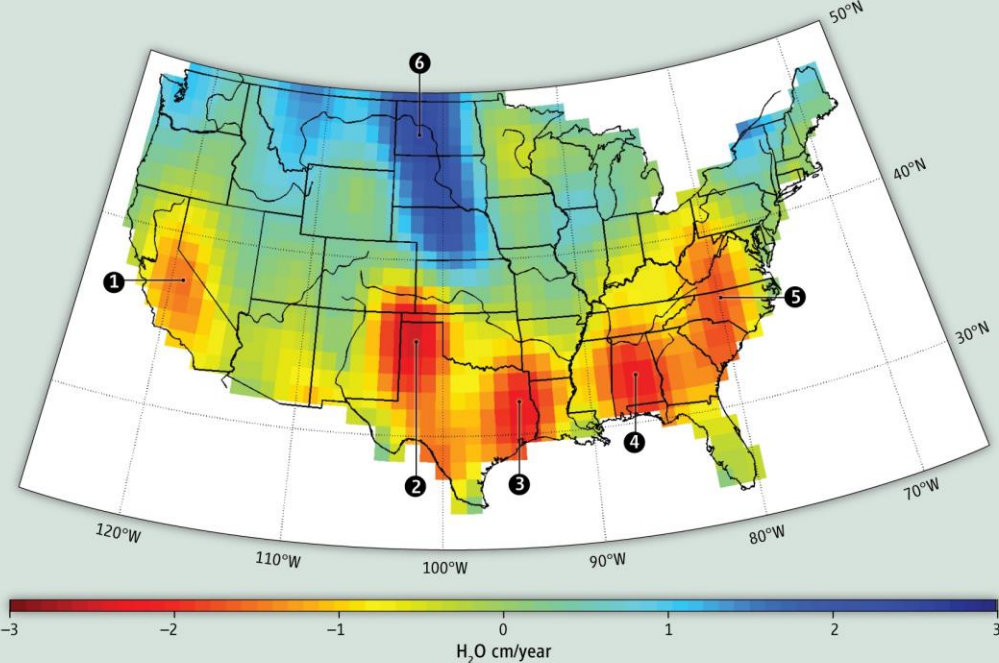
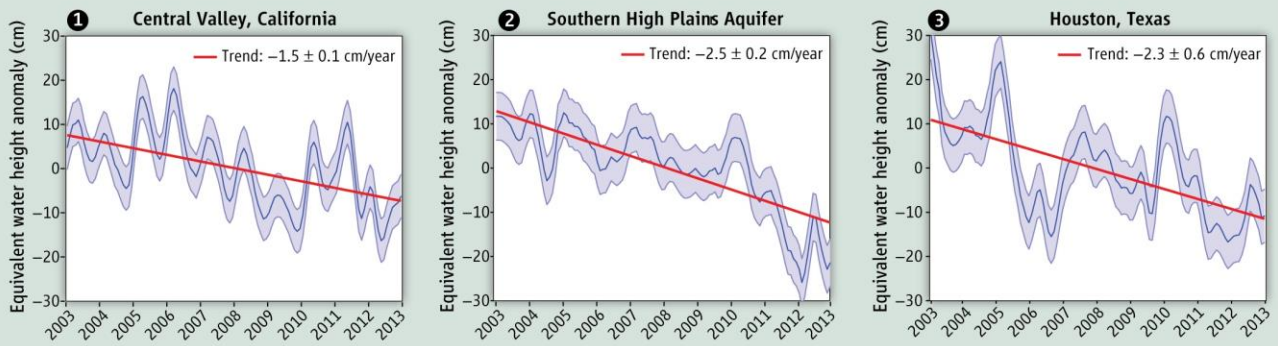
Colorado River Basin



Castle et al., 2014, in review



Trends in Freshwater Storage from GRACE, 2003-2012



I PLEDGE TO
SAVE water BY
not taking
a bath
'til
next SUMMER

