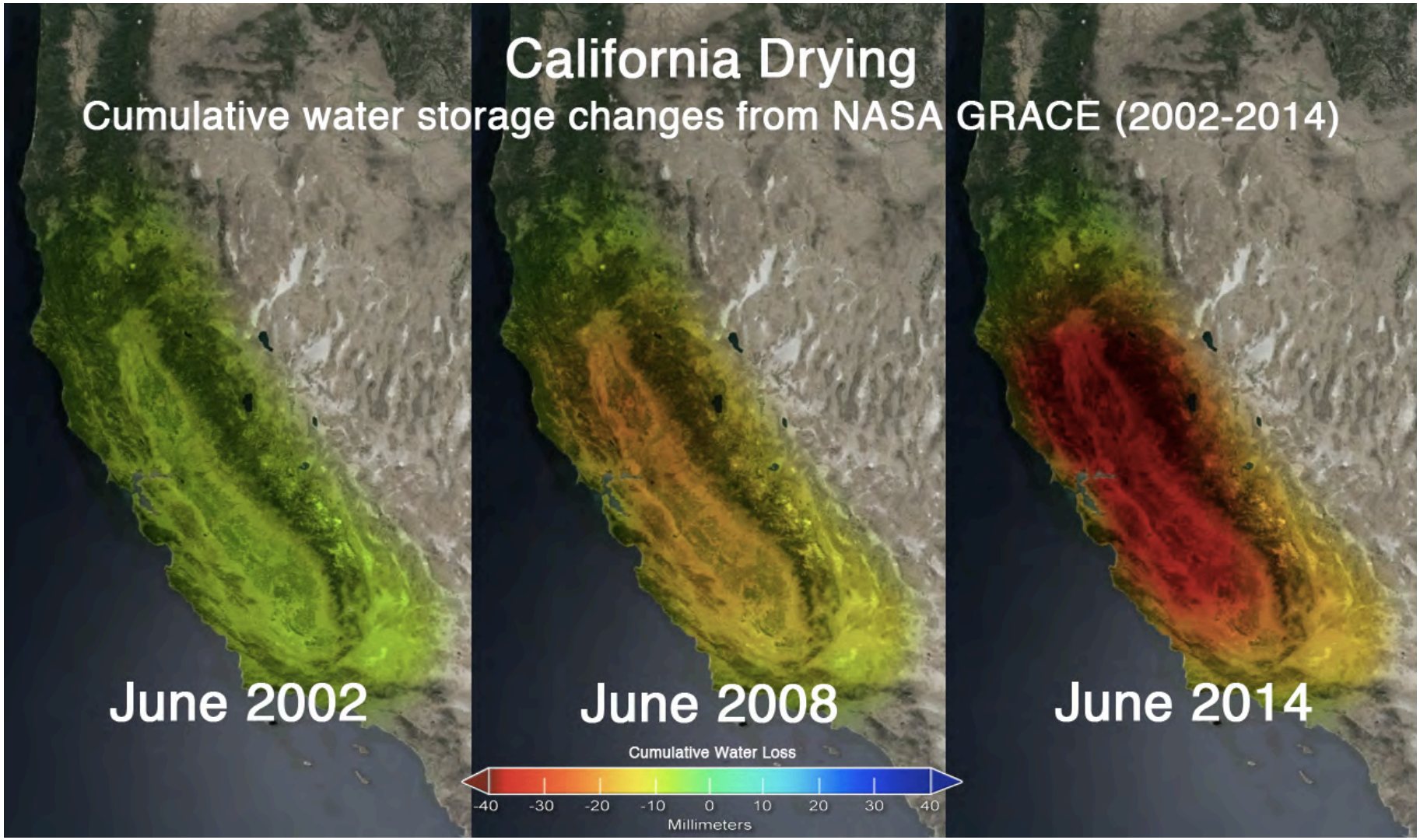

California Drying
Cumulative water storage changes from NASA GRACE (2002-2014)
June 2002
June 2008
June 2014
Cumulative Water Loss
-40 -30 -20 -10 0 10 20 30 40
Millimeters

The Mercury News

CALIFORNIA DROUGHT / EL NIÑO

jobs in Bay Area surpass
com era's peak

Hillsborough: Suspect in crash that killed girl had DUI conviction

Mountain View
child porn charg

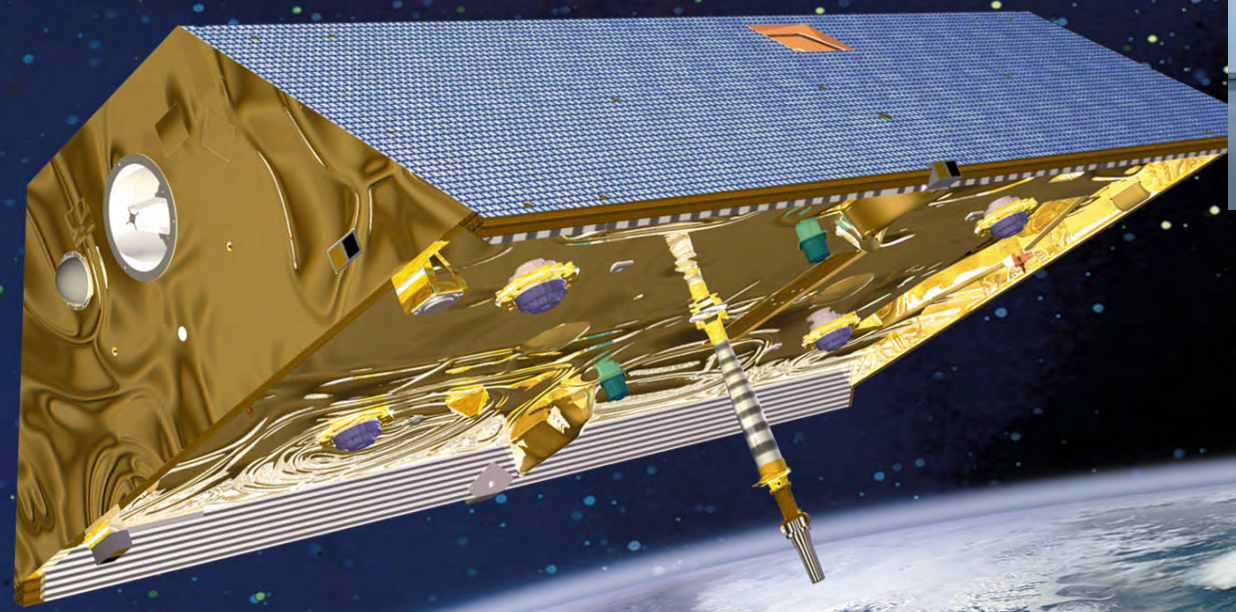
California water saving: 84 percent of agencies choose zero as conservation target

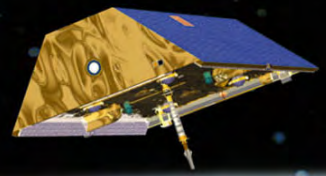
By Paul Rogers, progers@bayareanewsgroup.com

What are satellites telling us about the California drought?

NASA Gravity Recovery and Climate Experiment (GRACE)

- Launched in 2002
- Functions like a 'scale in the sky' that can weigh the *monthly* increases or decreases in *total* water storage in *large (>200,000 km²)* regions with an accuracy of 1.5 cm

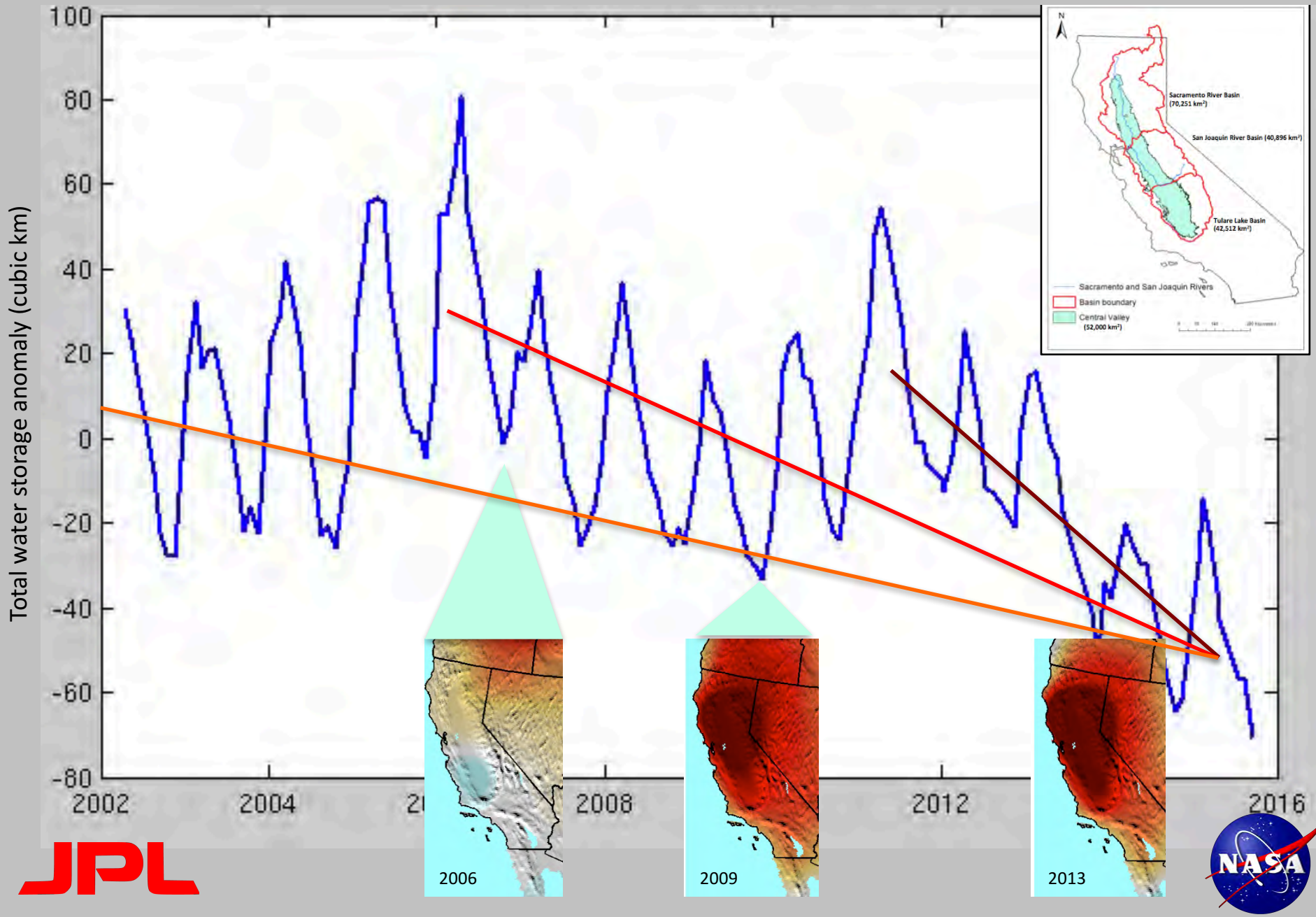




JPL

NASA

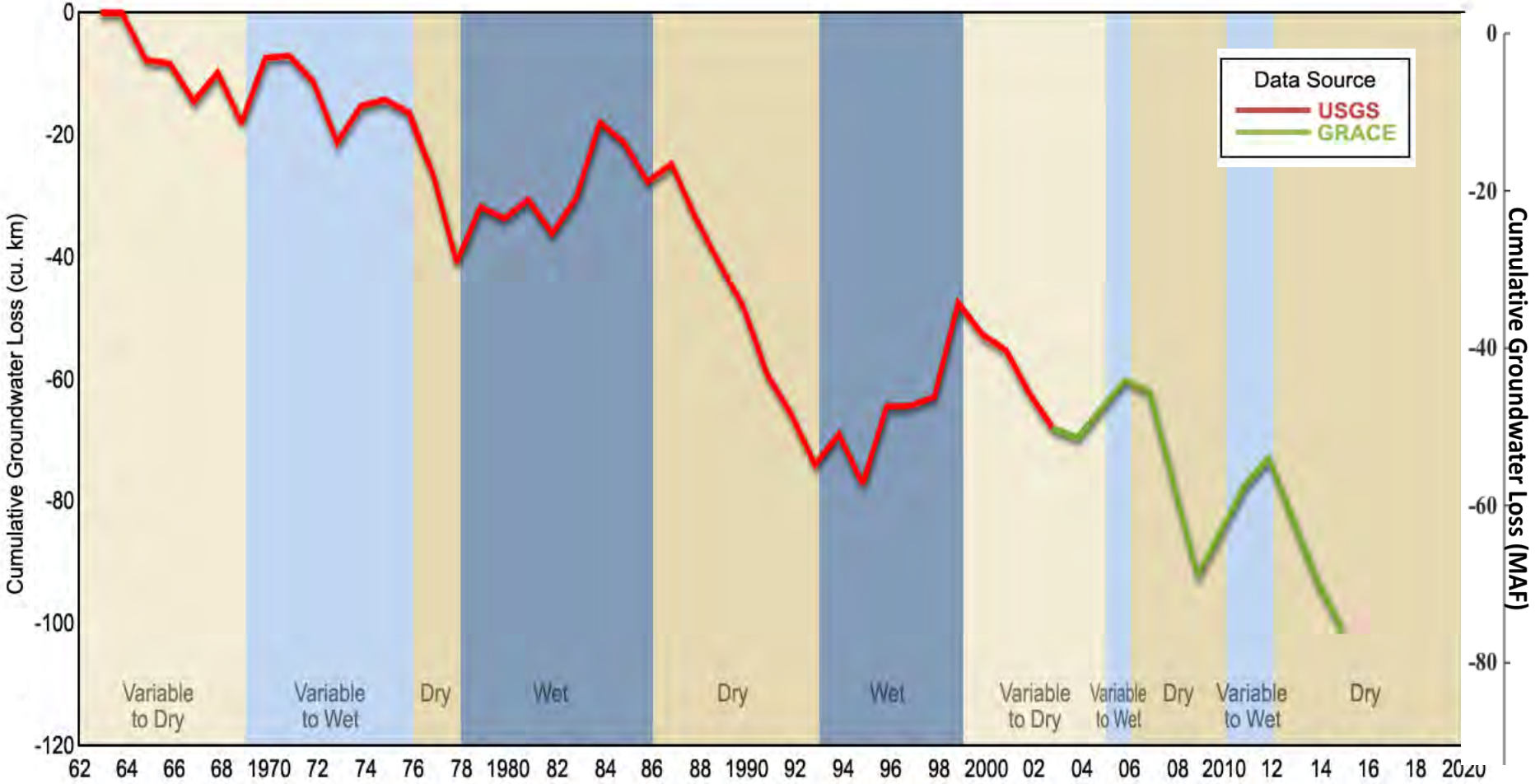
Change in Total Water Storage (2002-2015) from GRACE



JPL

NASA

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

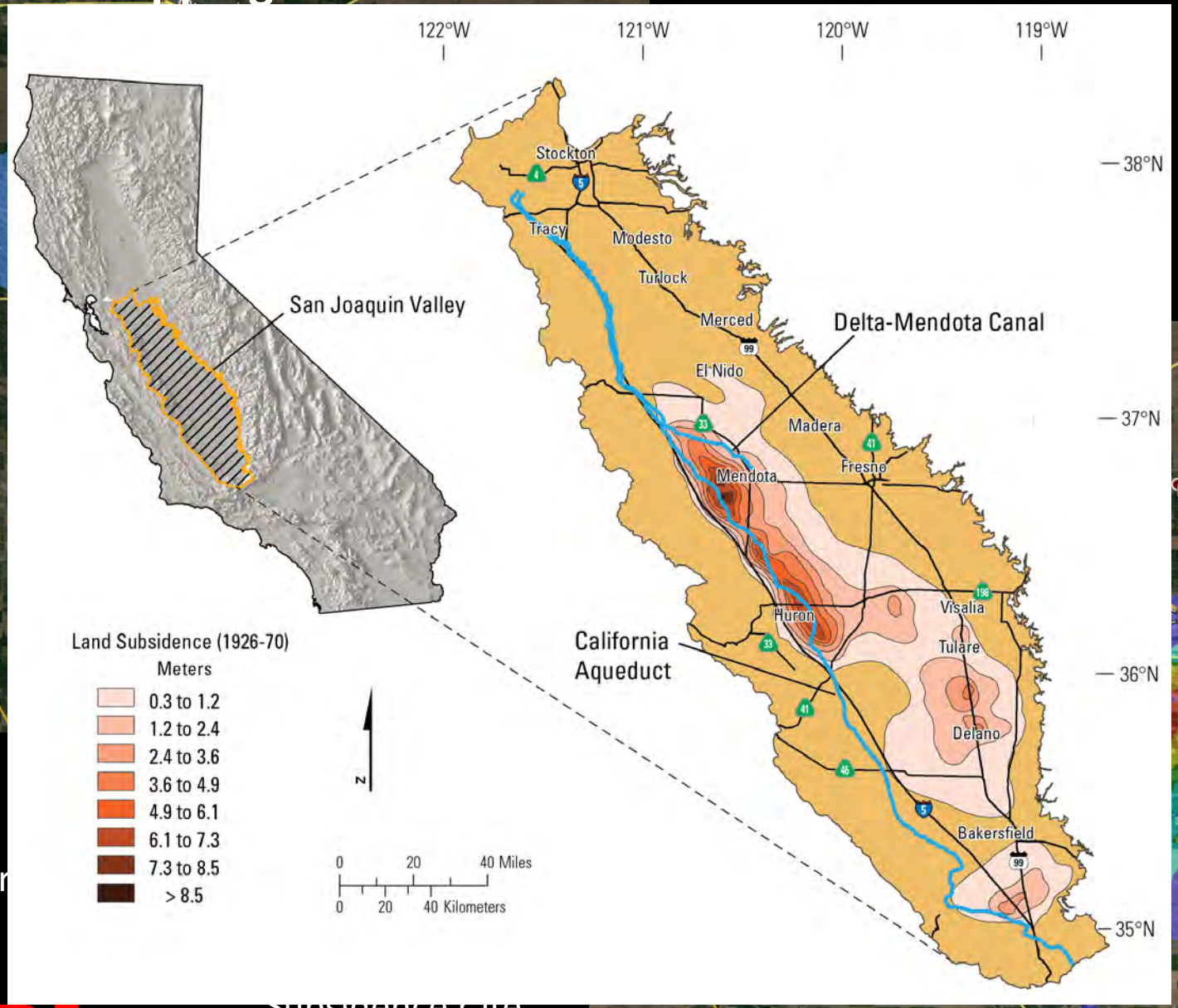


After Faunt, 2009, USGS PP 1766
USGS data courtesy of Claudia Faunt

UCI DEPARTMENT OF EARTH SYSTEM SCIENCE


1925
1955
1977

Mapping Groundwater Induced Subsidence Rates



Slide cour

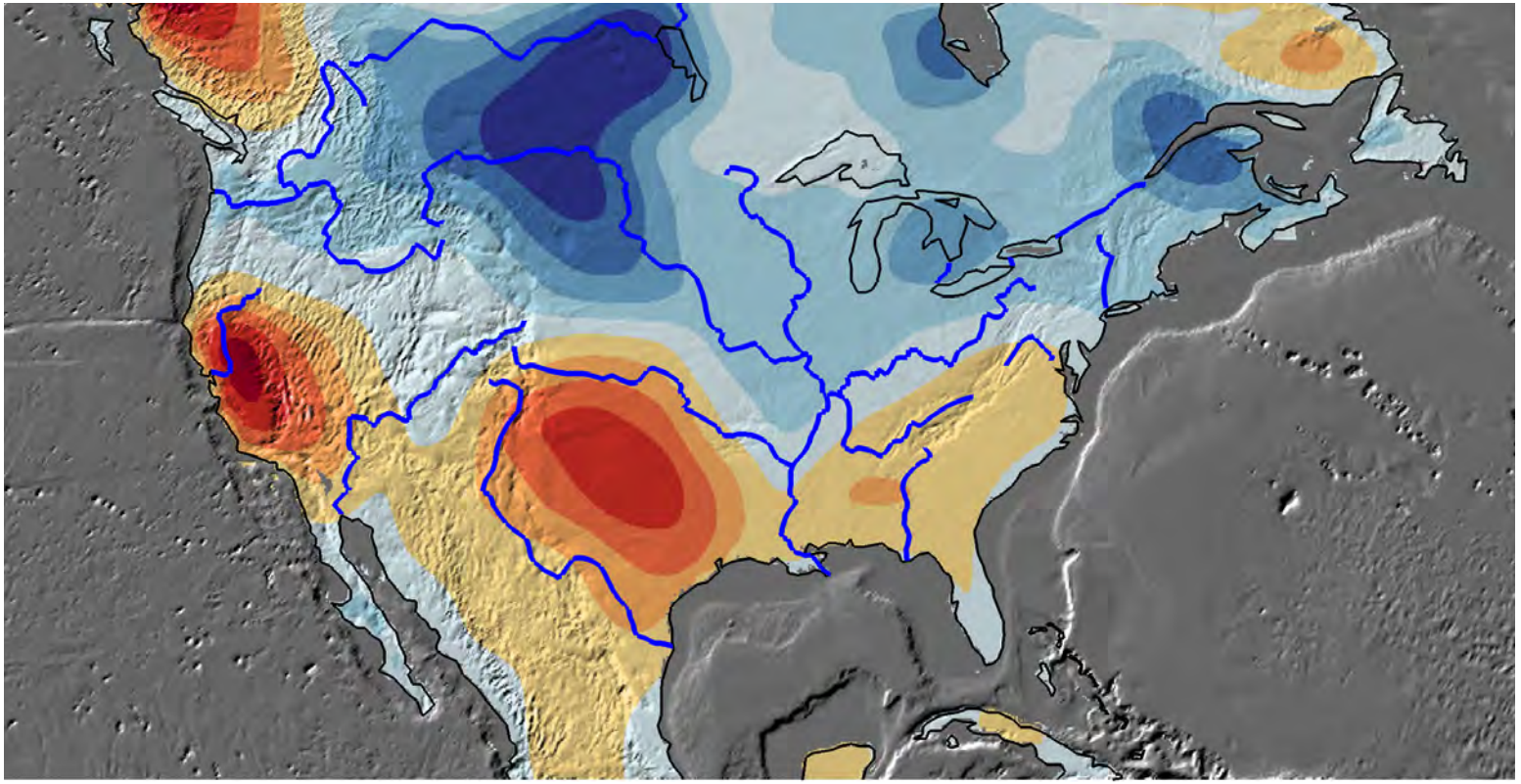
Subsidence rate,
May-October 2014

JPL


1955
1977


2000
2015

Water storage changes in the United States from GRACE (2002-2015)



after Famiglietti and Rodell, 2013
Map pepared by NASA JPL/Caltech from JPL Mascons

Here are the messages

- California suffers from chronic water scarciity
  - Uses more than annual renewable supply because of massive water needs of highly productive food industry
  - Takes the rest from groundwater

- Groundwater disappearing
  - Water table dropping, wells running dry
  - Ave water table depth now 2500’
  - Cost of 2500’ well is $250,000
  - Pumping costs increasing
  - Water quality degrading

- Subsidence a huge risk to infrastructure
  - ¼ of Central Valley at risk due to presence of clays

Here are the messages

- Streams being depleted
  - Aquifer depletion leads to streamflow depletion; streamflow depleting limits aquifer recharge

- Reservoir storage is not the whole piicture
  - Only 1/3 of water supply during drought
  - Bank account analogy

- Joint surface and groundwater management needed

- Population growth and climate change will exacerbate

How have we communicated these?

- **Targets**
  - General public
  - State water managers, decision and policy makers
  - Federal agencies, Congress, State Dept, OSTP, etc

- **Methods and venues**
  - Do the work! Peer-reviewed research.
  - Public and academic speaking
  - Public writing
  - Public media
  - Press releases on key papers
  - State and federal testimony and briefings
  - State visits to legislature, relevant offices
  - Federal visits to congress, relevant offices, etc

What's worked and what hasn't?

- Very tough to know. How do you track how a policy decision is made?

- Known successes
  - Key justification for CA SGMA
  - Key justification for hydrogeologic mapping in India

- Suspected success
  - Mandatory rationing in CA

- Colossal failures
  - Raising awareness of violent conflct, e.g. in Middle East
  - Uptake of our GRACE work by CA DWR

Quotes from an influential California statewide water manager

“You academics are so arrogant”

“You’re always talking about water balance. We don’t care about it”

“I hate models. We use observations. I don’t want to see your PowerPoint on modeling”

“We can’t use your information to make decisions. We are restricted by law to do it differently”

“You talk about managing surface water and groundwater jointly. If you put a hydrologist and a hydrogeologist in the same room, they don’t want to talk to each other. Joint management doesn’t make sense.

“I’m not worried about groundwater at all. We have the SGMA.”

“You academics are so arrogant”

Challenges

- Arrogance issue
  - You think you know better than we do

- Bias against academics
  - Will you be there for the long term, e.g. when you project ends

- Personalities
  - I don’t like you and I am not going to work with you

- Legal constraints:
  - We are required by law to look at these specific data measured this way to make this decision

- Agency turf issues
  - Why are you working with agency X on that, we do that

- Personnel and financial limitations for collaborations, training;
  - Are there resources and people available to work on proposed projects

How are we (at NASA) addressing these challenges now?

The Western States Water Mission

- Integrates key satellite, aircraft and ground-based measurements into a high-resolution model (3 km^2 or less) of California and western U. S. hydrology

- Utilizes a focused, accelerated effort in a flight project framework

- Represents the major features of the natural (snow, surface water, soil moisture, groundwater, streamflow, evapotranspiration) and managed (conveyances, reservoirs, groundwater pumping, irrigation) water cycle in catchment-based framework with explicit river networks

- Provides NASA's best-available estimates of freshwater availability from local-to-regional scales, including: snowcover, snow depth, snow water equivalent; surface water storage and streamflow; soil moisture content; and groundwater levels and storage changes

- Link to models of agriculture, food production, energy production, climate, ecology, etc; and very high resolution models for localized flooding

Jet Propulsion Laboratory
Western Water Applications Center

- Connecting stakeholder needs with NASA capabilities
- Advancing Appllication Readiness Levels of key NASA technologies through internal funding
- Increasing accessibility of NASA observations to stakeholders and decision makers, and ultimately to the general public