Human Fingerprint of Water Management on Regional Hydrological Cycle

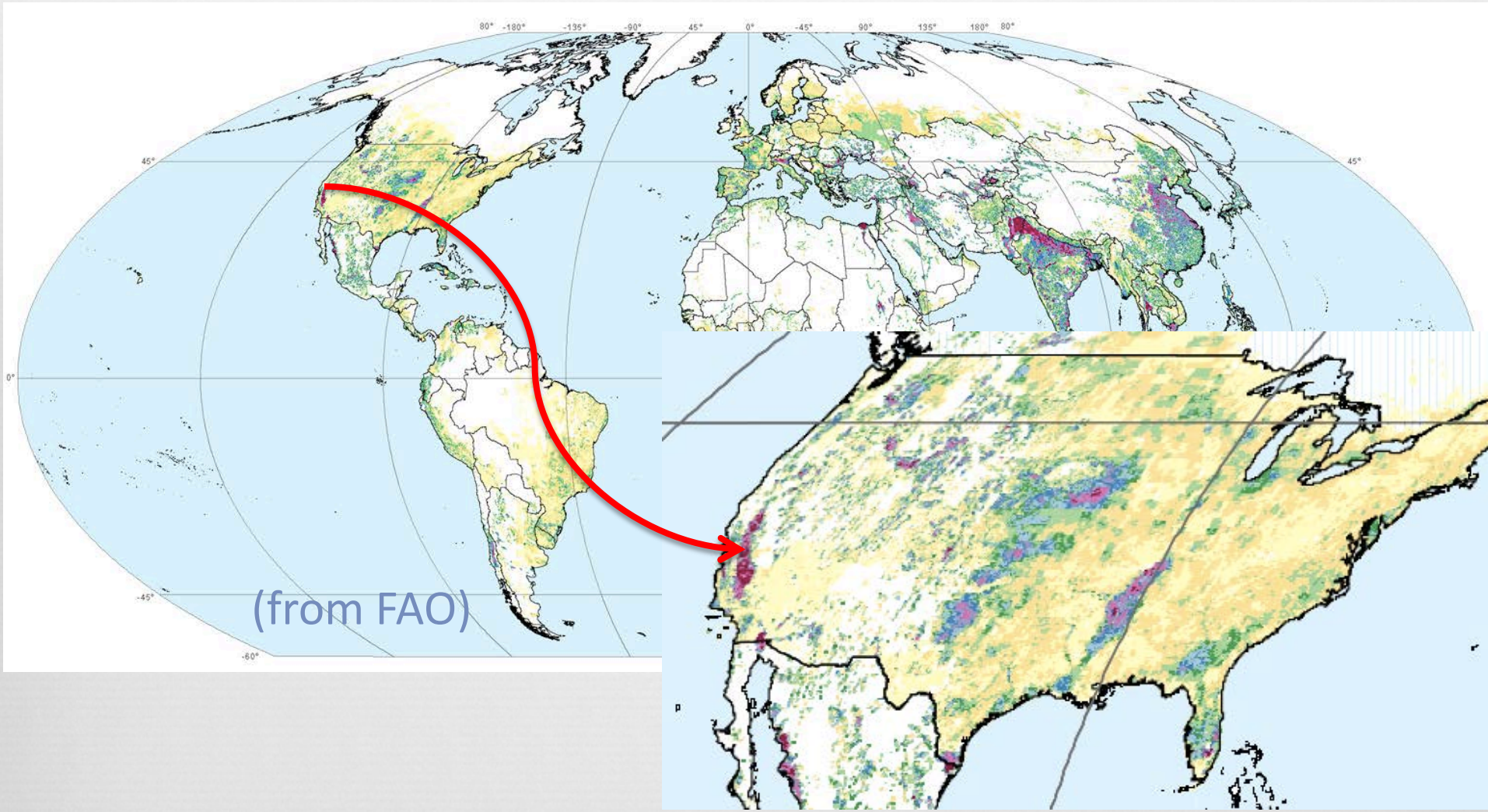
An example of California's Central Valley Irrigation

Min-Hui Lo[1] (minhuilo@ntu.edu.tw) and Jay Famiglietti[2]

[1]Department of Atmospheric Sciences, National Taiwan University, Taipei

[2]Department of Earth System Science, UC-Irvine, Irvine

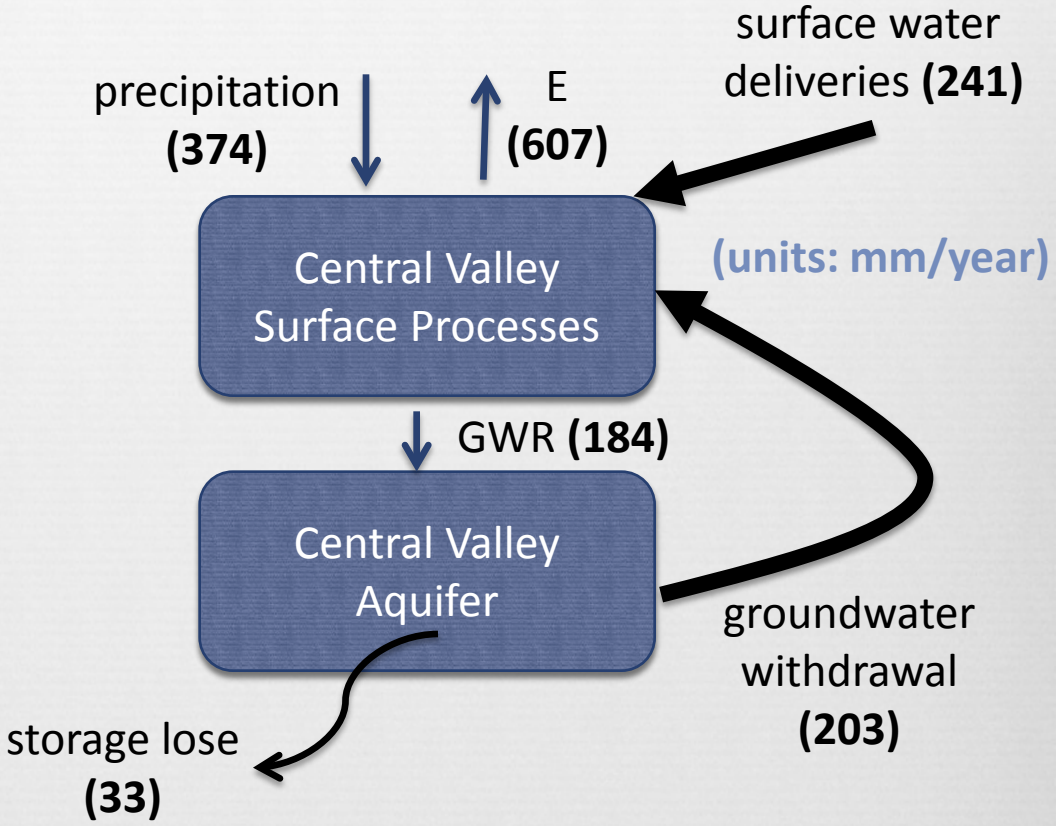
Irrigation intensity



Water budget in heavily irrigated system

California's Central Valley
(52,000 km^2)

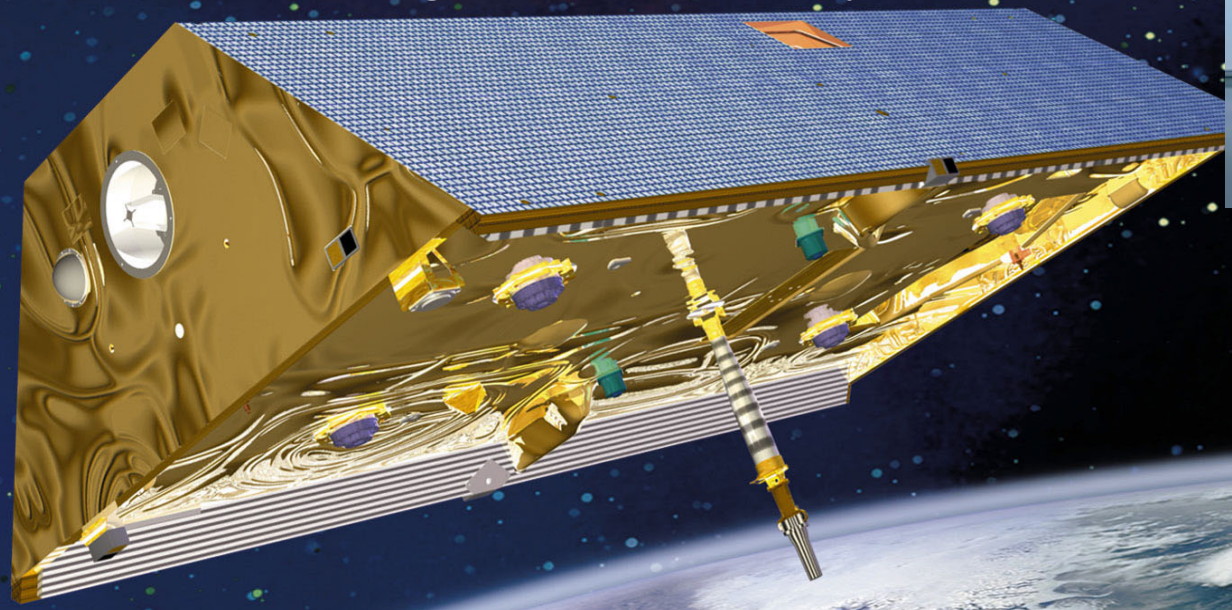
- one of the most productive agricultural regions in the world
- Produces 1/4 of the food in the U.S.

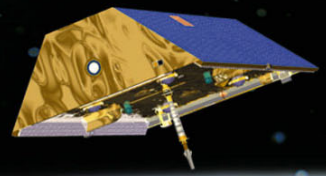


modified from *Faunt et al.* [2009]

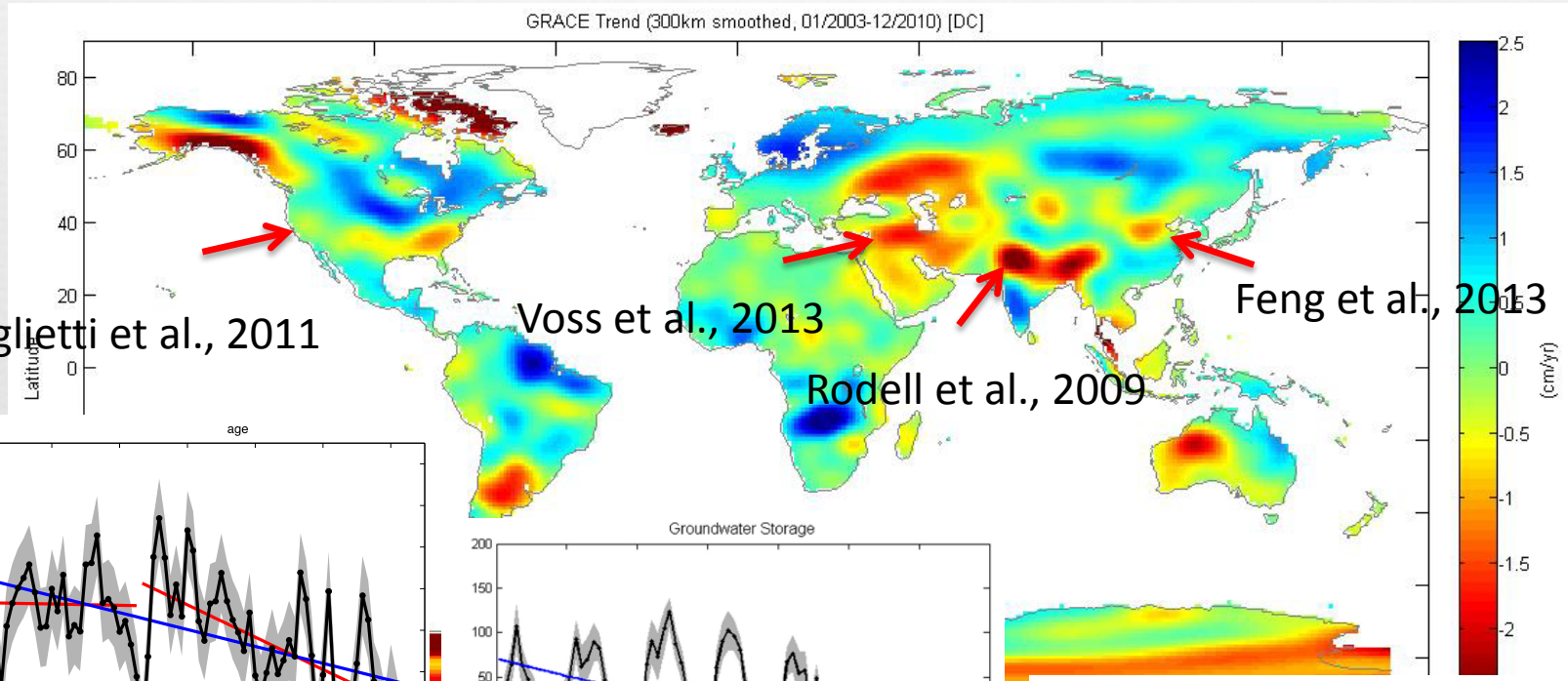
NASA Gravity Recovery and Climate Experiment (GRACE)

- 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 km^2)* region with an accuracy of 1.5 cm





Trends in freshwater availability from GRACE, 2003-2010

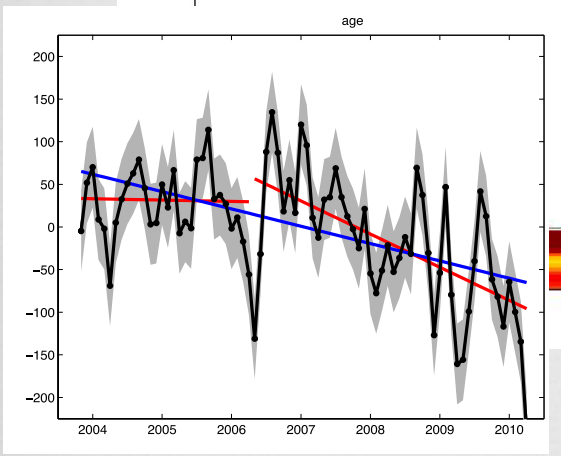


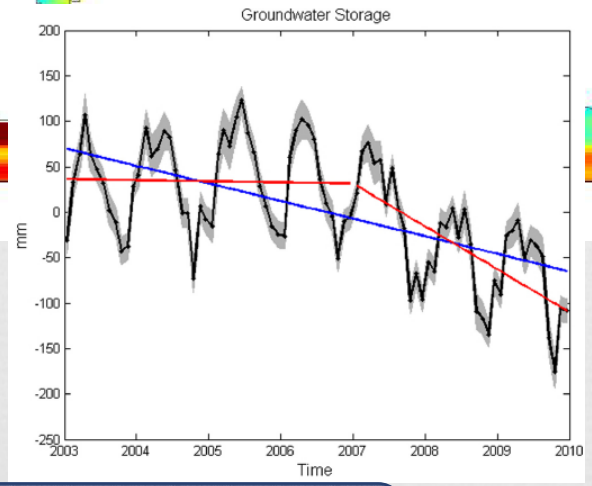
Famiglietti et al., 2011

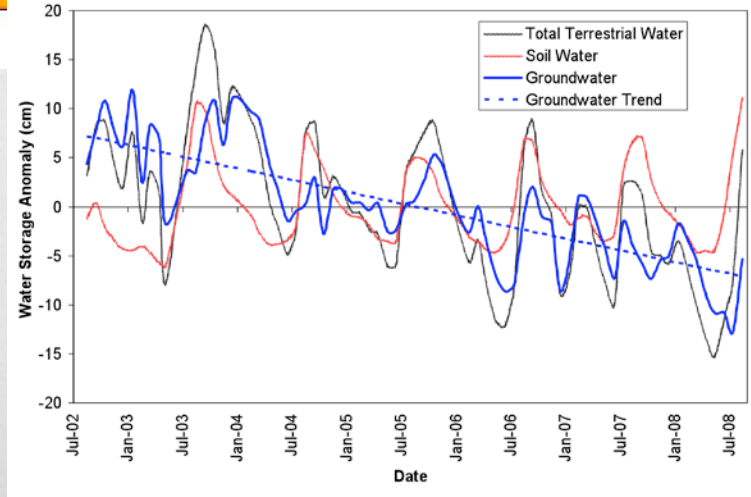
Voss et al., 2013

Rodell et al., 2009

Feng et al., 2013





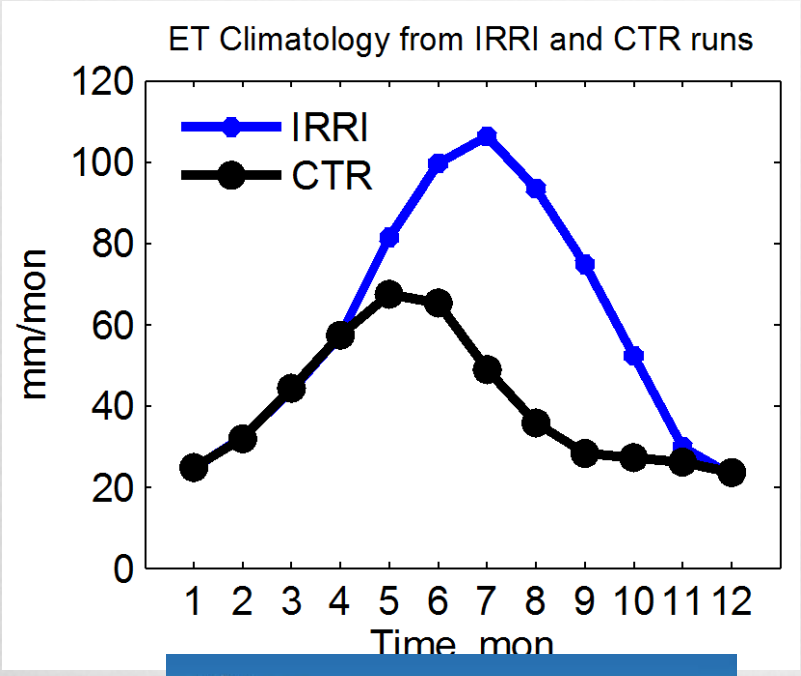


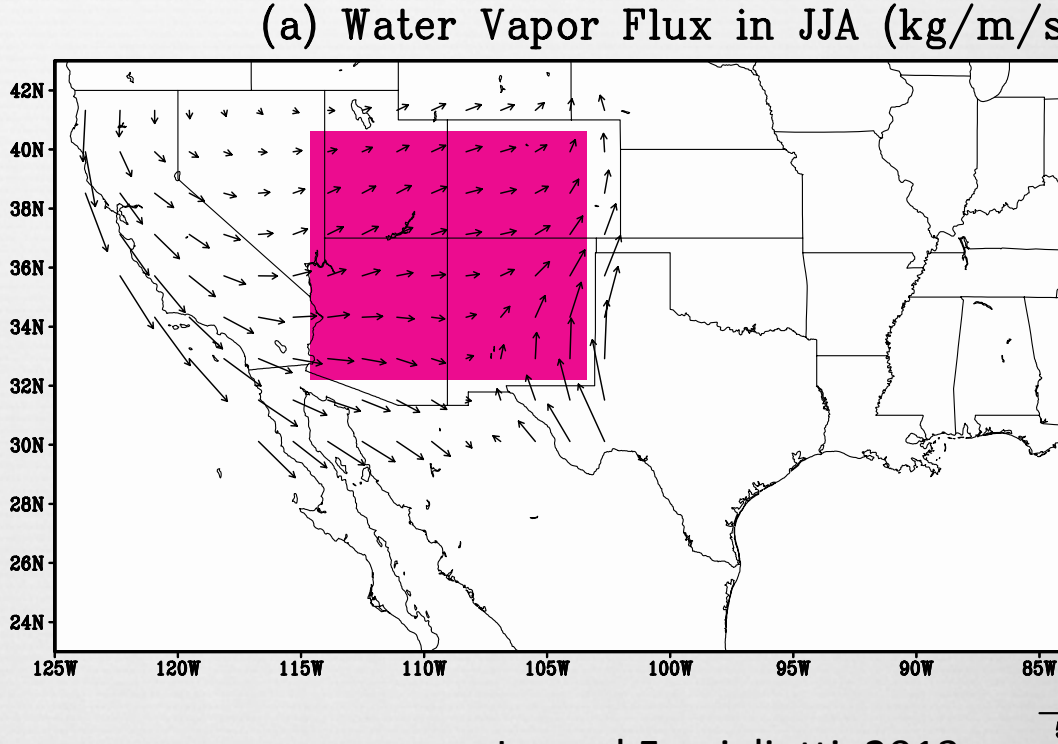
Groundwater withdrawal

Model setup

- NCAR CAM35+CLM35
- SST-fixed AGCM simulation
- Resolution: T85
- 90-year run, averaged over the last 45 years
  - CTR run
  - IRR run: additional irrigation water is added over Central Valley

averaged evapotranspiration over Central Valley

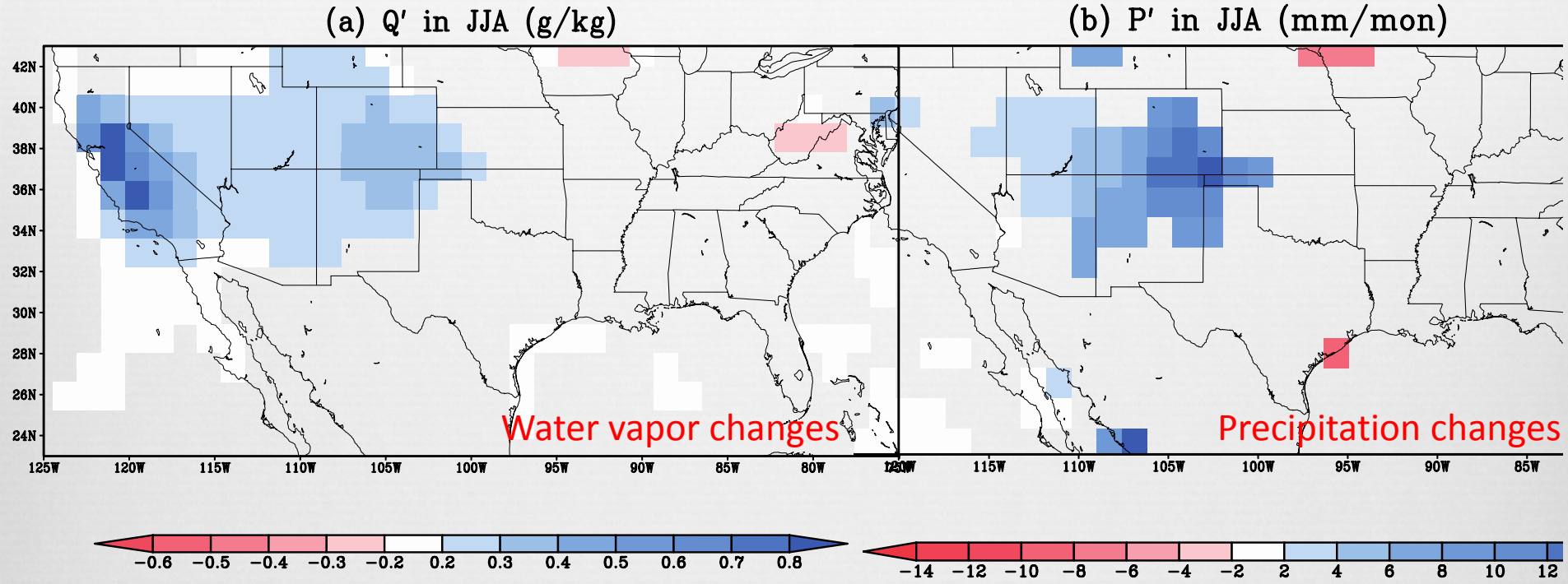




Lo and Famiglietti, 2013

Water vapor fluxes climatology in JJA

Increased water vapor and precipitation



Lo and Famiglietti, 2013

- Increase the precipitation in the existing convection area rather than generating new convections (*Sacks et al.*, 2009)

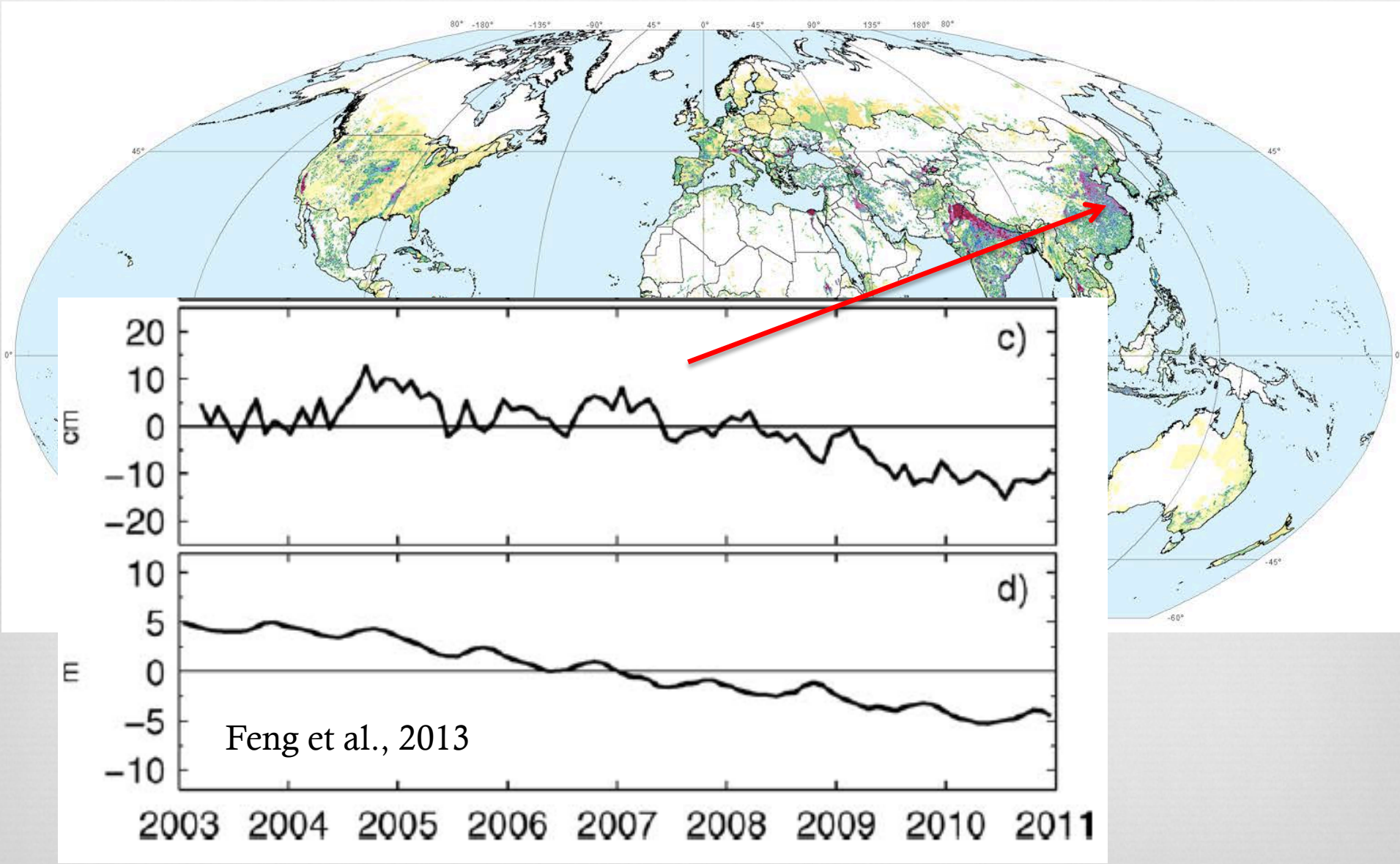
Increase precipitation and runoff over the Colorado River Basin

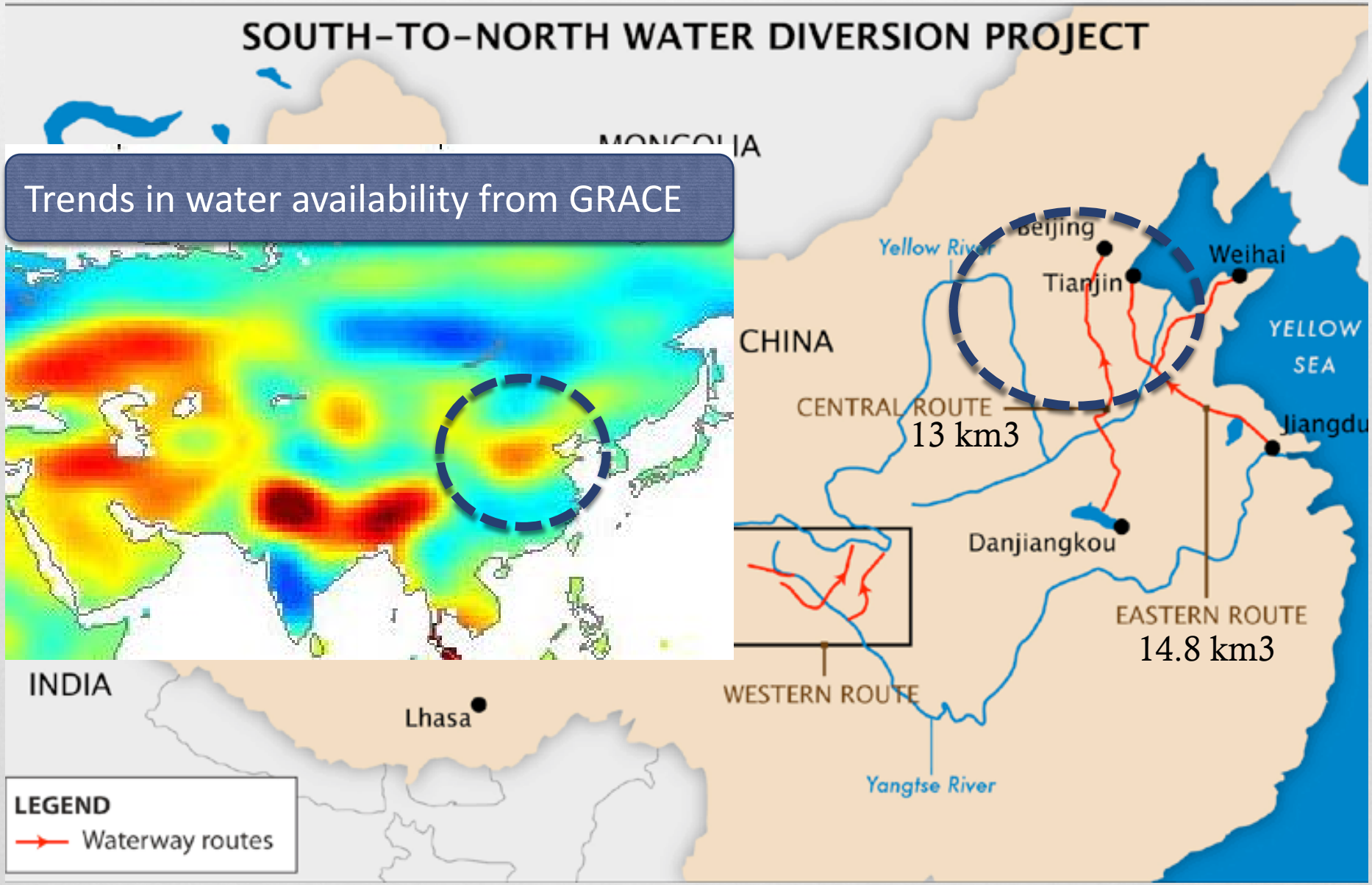
transport 5 km^3 of water from Colorado river to Southern CA

human-induced changes in the hydrological cycle

anthropogenic recycling loop in formed due to irrigation and human water management

North China Plain





from www.waterpolitics.com

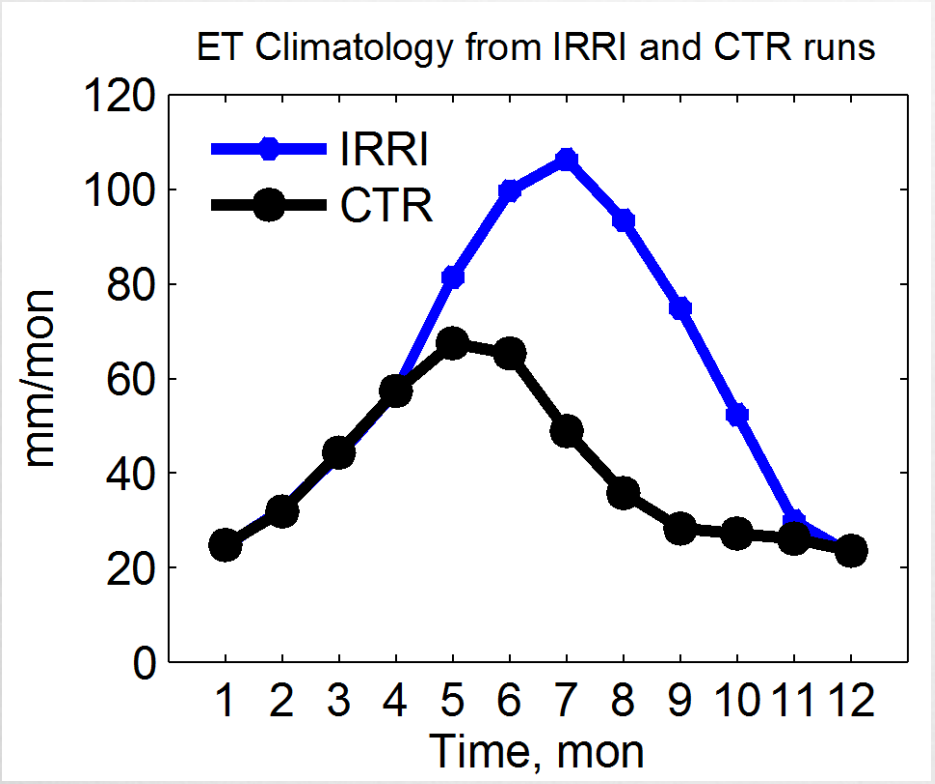
Summary

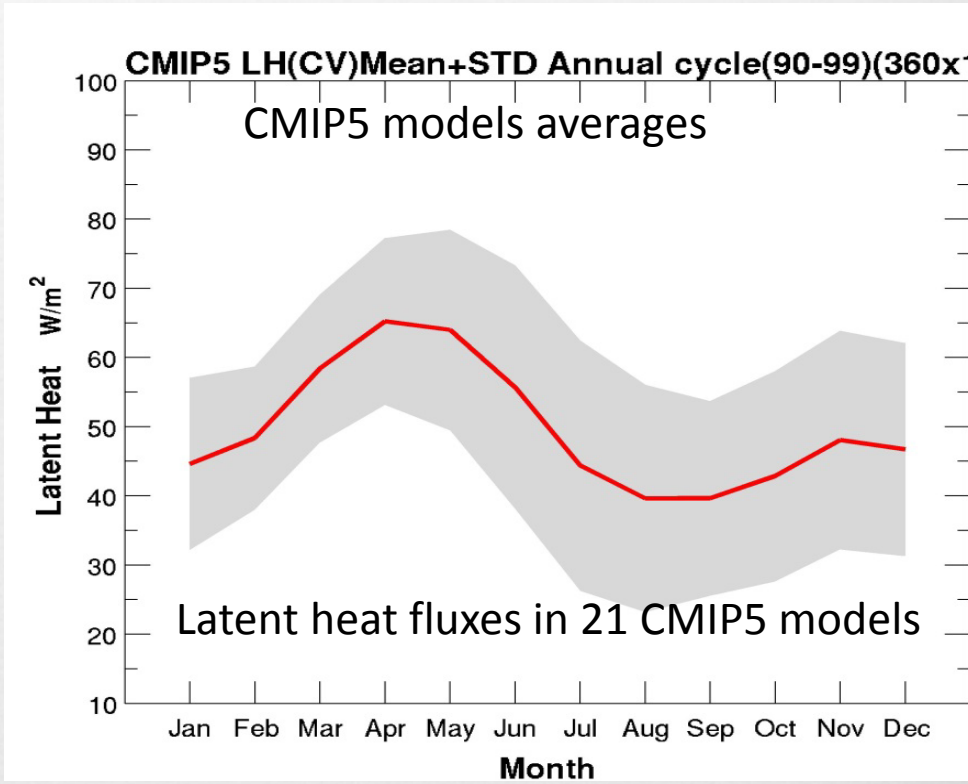
- Irrigation modifies the surface radiation budget.
- The CA underlies the descending branch of the large-scale circulation, which inhibits the occurrence of convection.
- Precipitation in the downwind region of California increases.

➔Form a regional, anthropogenic cycling loop in the water cycle.

➔ Indicate the importance of anthropogenic processes in the climate and water cycle in global climate models.

Evapotranspiration in CMIP5 models over human perturbed region -- Central Valley





Lo et al., in preparation

Relevance to SDWG

- Impacts of Social Change Aspects:
  - Human water management has largely altered the Earth's hydrological cycle and water resources demand (irrigation is just one example)
  - The absence of the human fingerprint of water management in model results in unrealistic simulations of the water cycle

- Model development
  - An interlink between RTM and LSM is needed
  - Trace where the water goes? Isotope might be a very useful tool on such kind of research.

Thanks for your attentions!

Questions?

Please email me

Min-Hui Lo (minhuilo@ntu.edu.tw)