

Downscaling GRACE for groundwater management in California's Central Valley

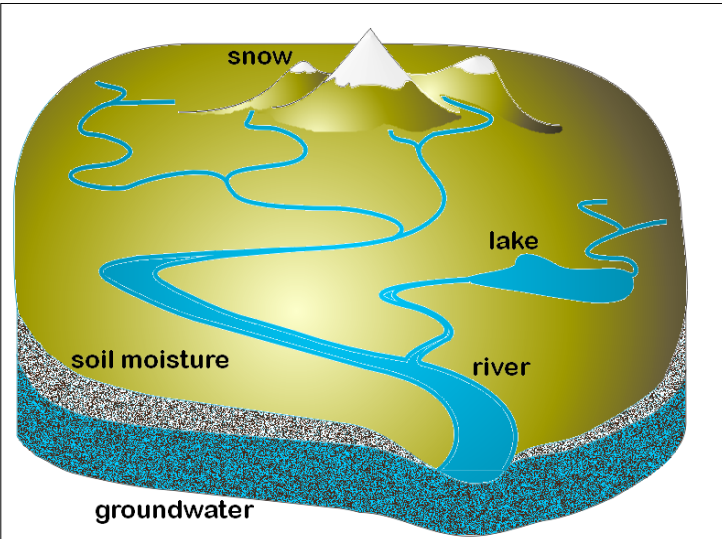


NSF
 Michelle Miro and Jay Famiglietti
 Toward Sustainable Groundwater in Agriculture: 2nd International Conference Linking Science and Policy
 June 28-30, 2016, Burlingame, CA
 JPL WATER

NASA Gravity Recovery and Climate Experiment (GRACE)

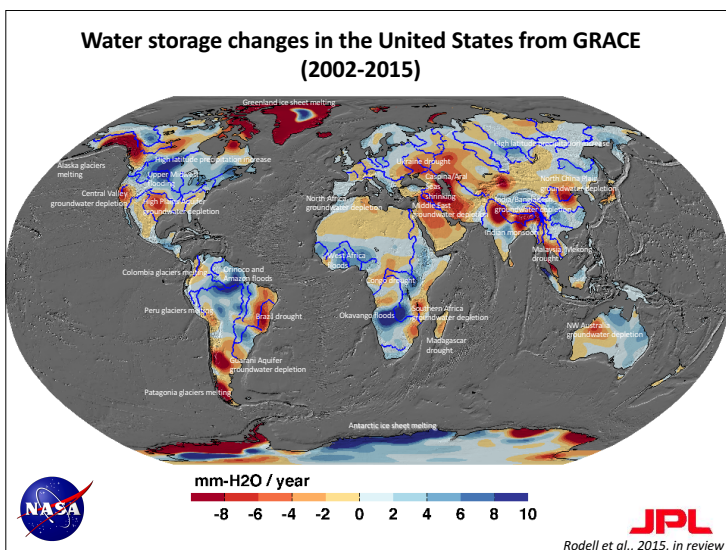
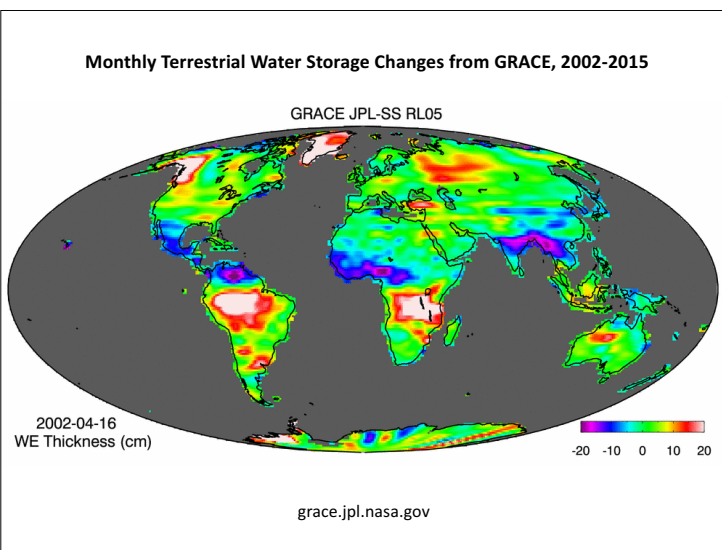
- Launched in 2002
- Functions like a 'scale in the sky' that can weigh the *monthly* increases or decreases in *total* water storage in large (>150,000 km²) regions with an accuracy of 1.5 cm

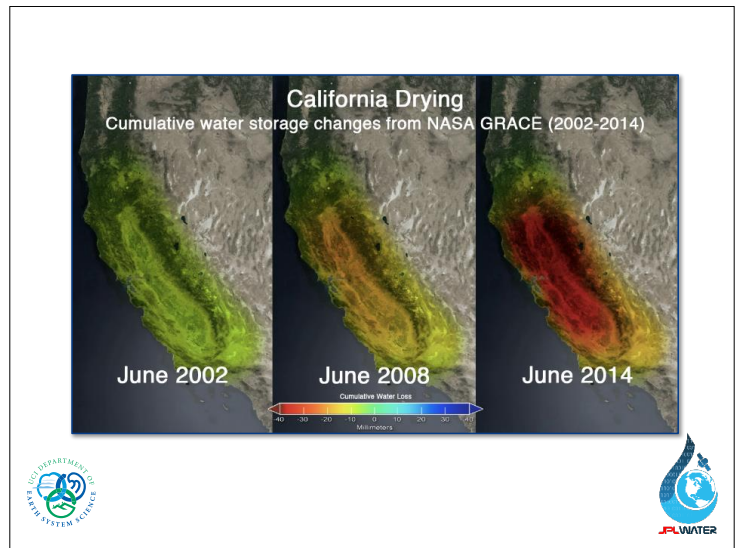
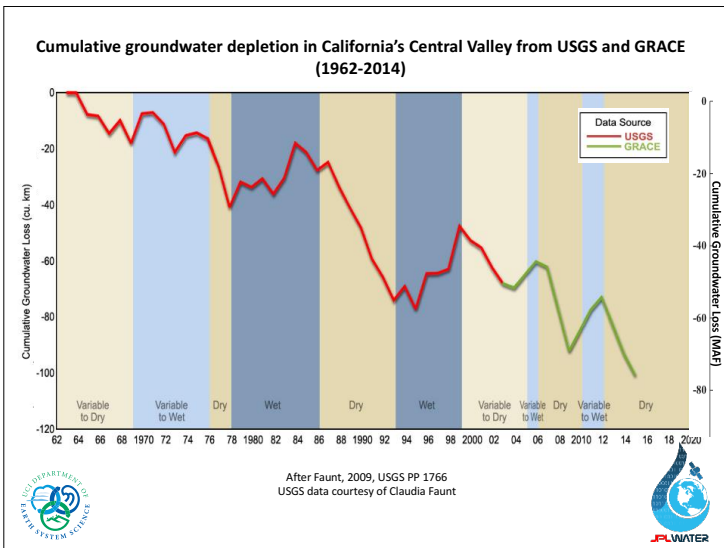
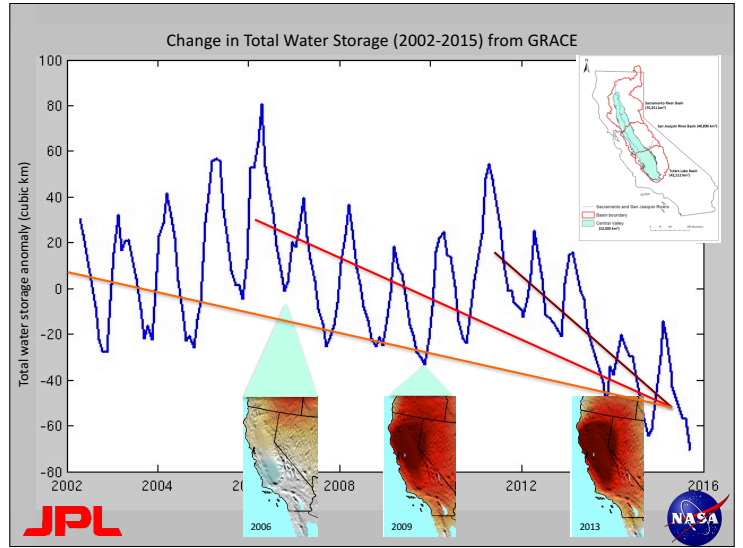
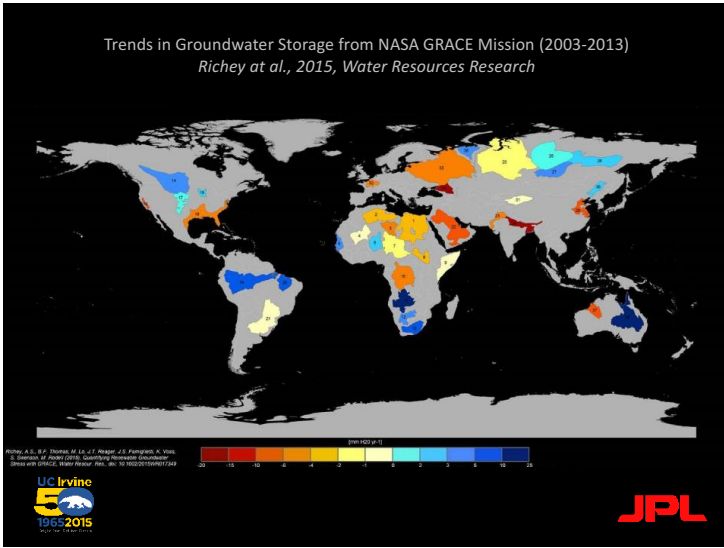
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NASA GRACE Follow-On (GRACE-FO)
 To launch in 2017

JPL NASA

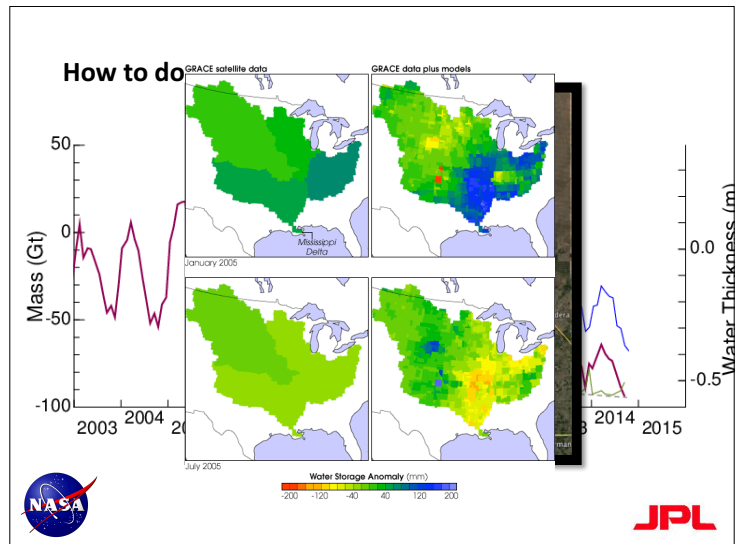




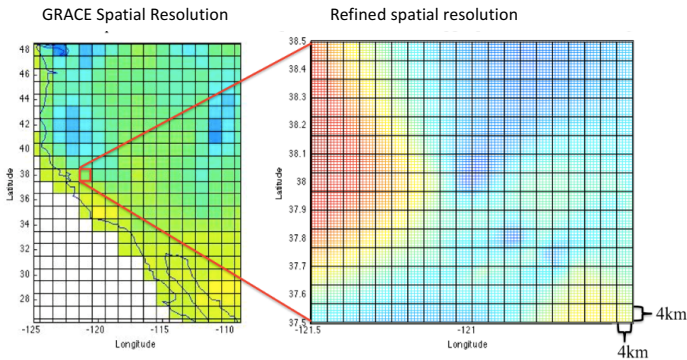
Some GRACE Water Policy/Management Accomplishments to Date

- Rodell et al., 2009 India paper key impetus for national hydrogeological groundwater mapping (India Ministry of Water Resources)
- Famiglietti et al., 2011 California paper and follow-on work key contribution to justifying need for Sustainable Groundwater Management Act (State Water Resources Control Board)
- Both key justifications for selection of GRACE-FO as a climate continuation mission (NASA Climate Architecture document) to launch in 2017
- The physics will always limit a space-based time-variable gravity mission to tens of thousands of square kilometers, so...

NASA JPL

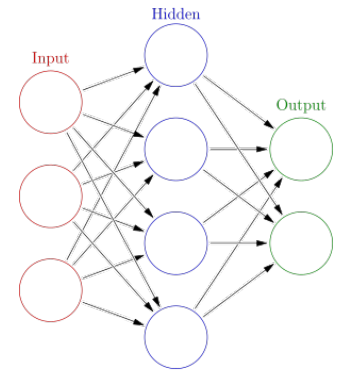


Improving GRACE's spatial resolution through numerical downscaling

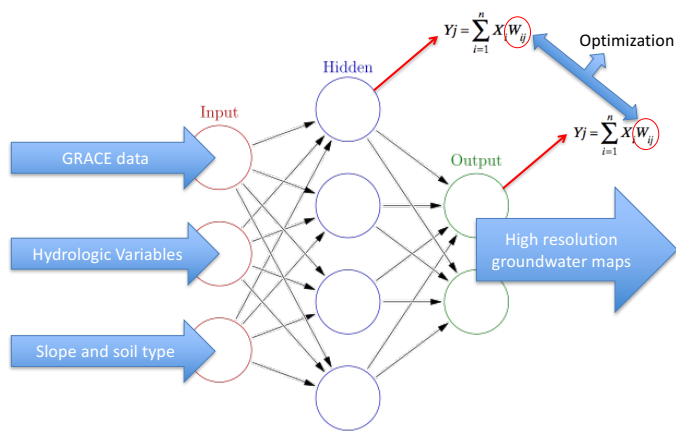


Artificial neural networks for numerical downscaling

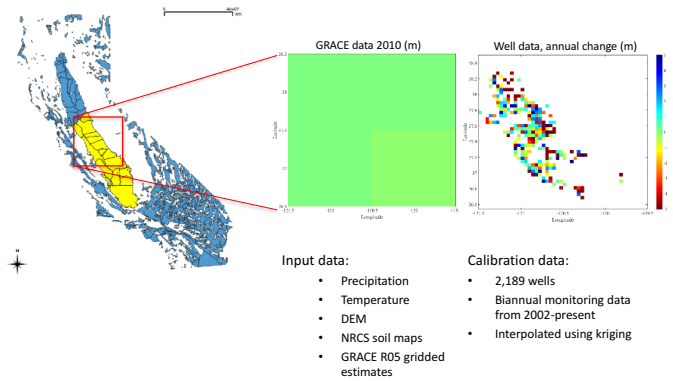
- Can efficiently and comprehensively handle large, diverse and noisy spatial datasets.
- Their architecture offers four main advantages:
 - Machine learning
 - Computational speed
 - High level of flexibility
 - Robustness
- ANNs derive non-linear, empirical relationships between a set of input and output variables.



Source: Turban et al., 2008

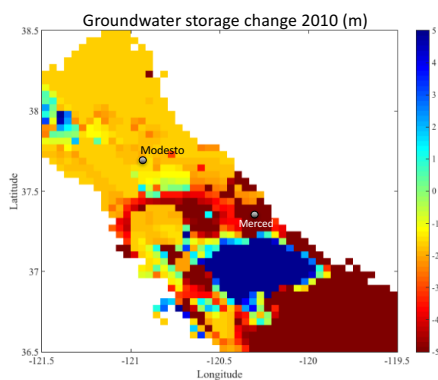


Input and calibration data



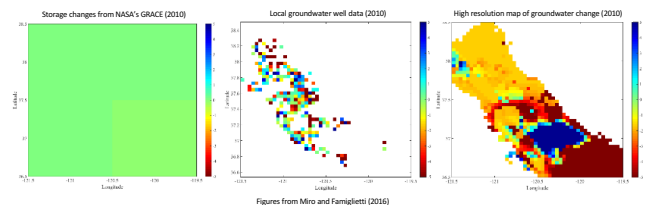
Figures from Miro and Famiglietti (2016)

Downscaling model output maps



Figures from Miro and Famiglietti (2016)

Downscaling offers new spatial resolution

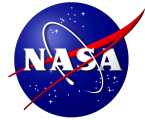


Output at 10-fold higher resolution

- Spatial resolution of GRACE:
- 1 degree by 1 degree - 200,000 km²
- Spatial resolution of output maps:
- 4km by 4km - 16 km²

Acceptable NSE values

- Calibration - 0.1911 to 0.8200
- Validation - 0.3546 to 0.8302
- 0 - 1 is acceptable, 1 is ideal



Jet Propulsion Laboratory
Western Water Applications Office

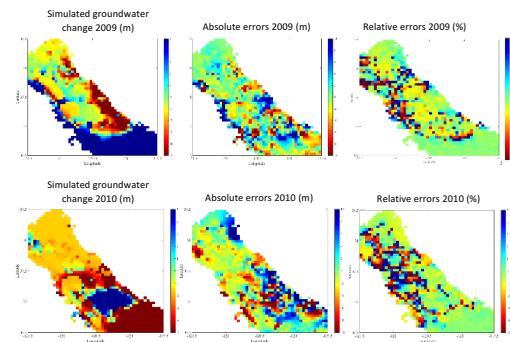
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Model output and errors



Figures from Miro and Famiglietti (2016)

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