Using GRACE to estimate surface water and groundwater withdrawal for irrigation

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UCC HM

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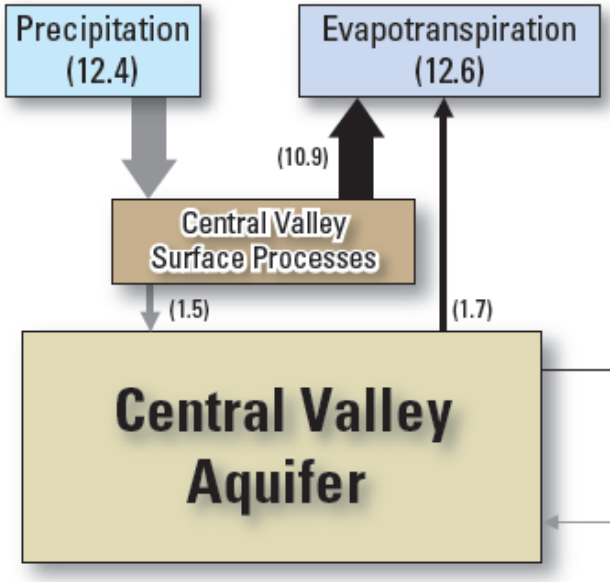
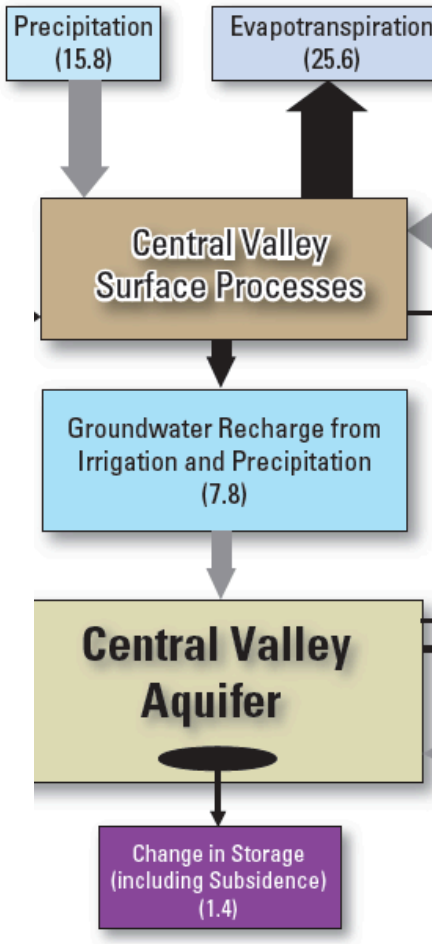
Pre-development



Williamson et al., 1989

development



Faunt et al., 2009

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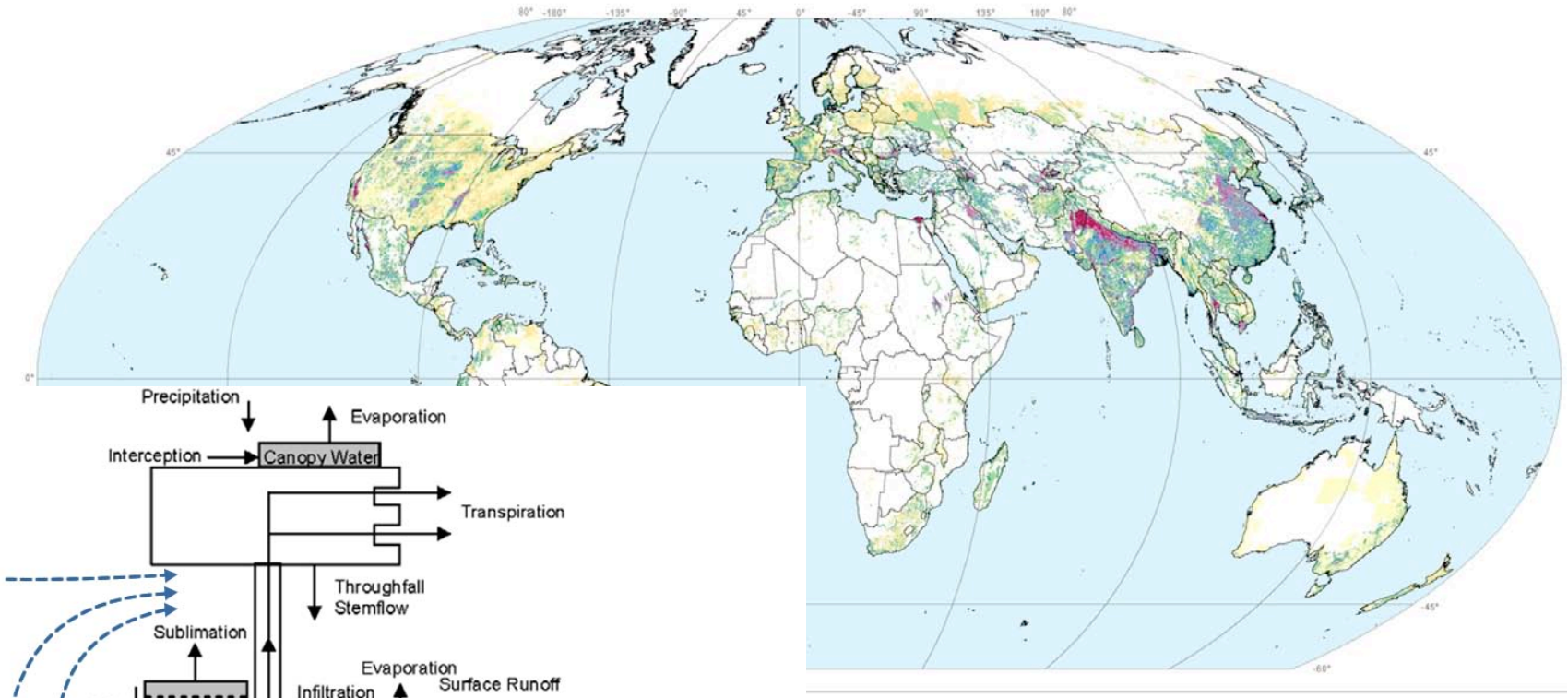
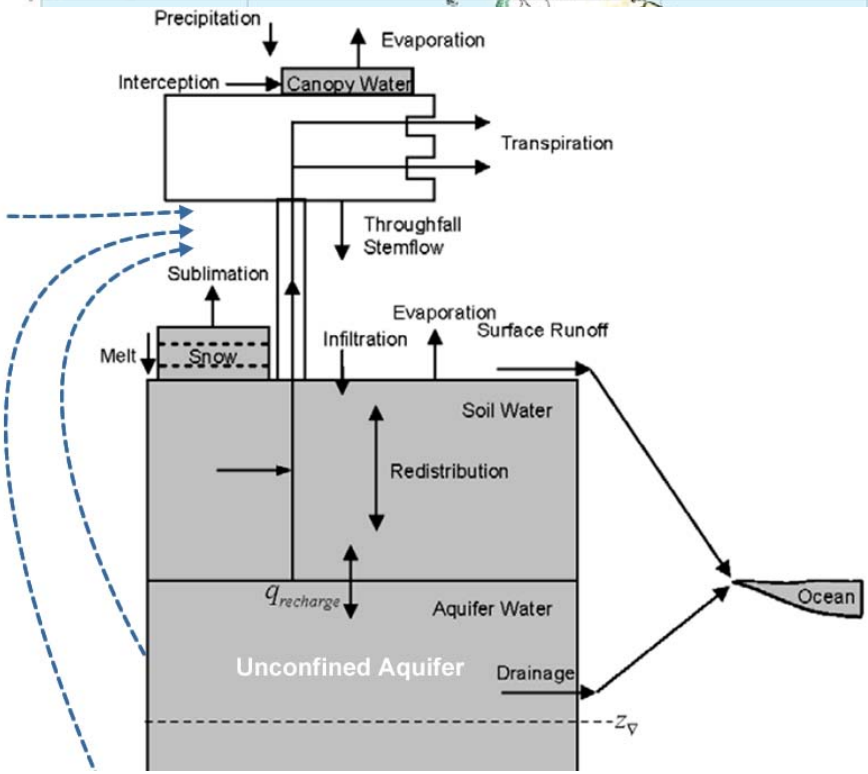
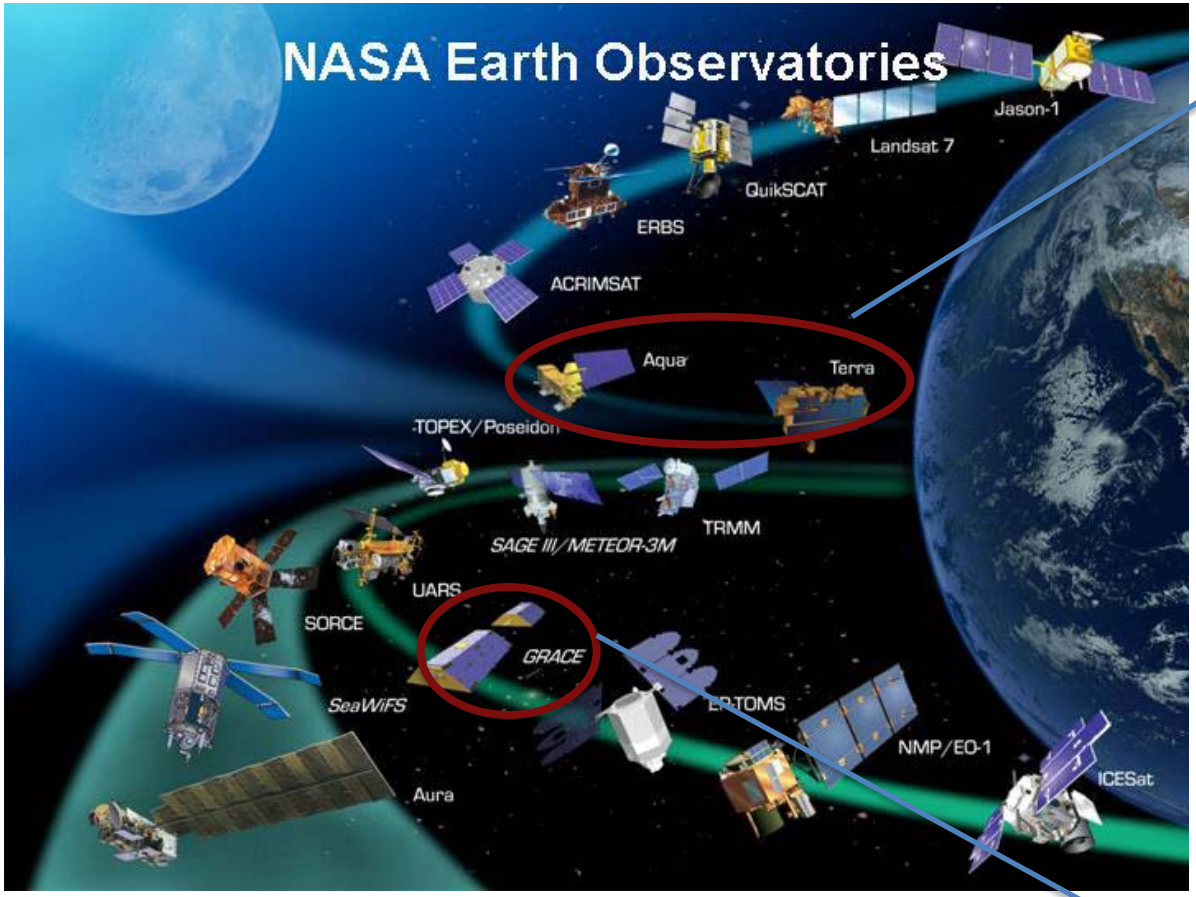


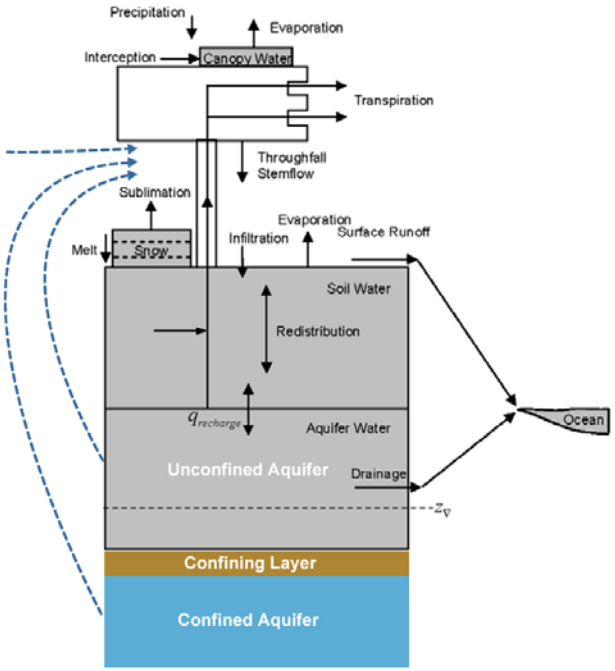


FAO Irrigation Map

Using satellite data to quantify these two fluxes

ET estimates by MODIS

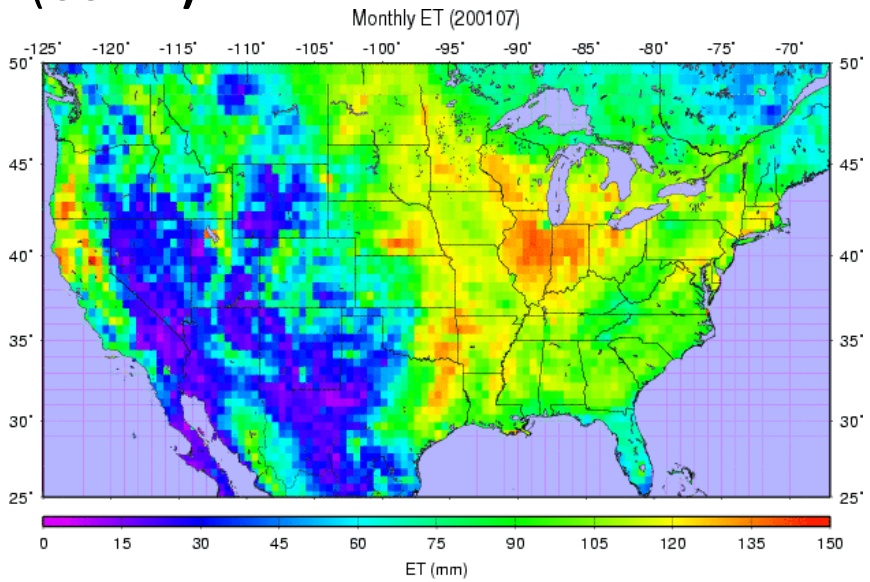




Total water storage variations from GRACE

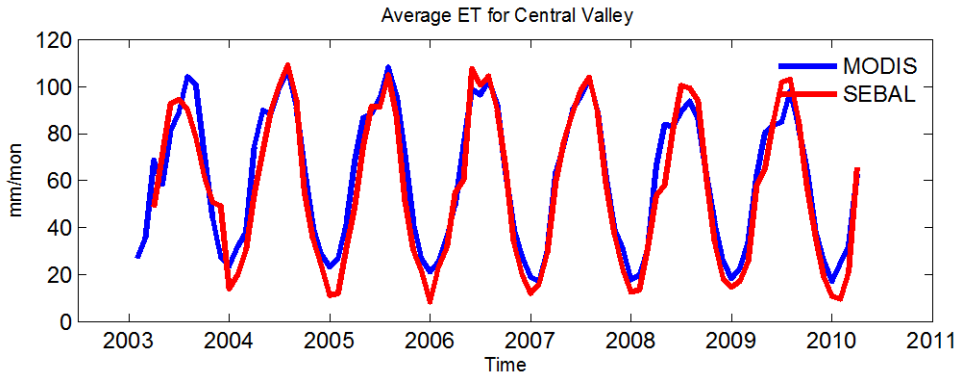
ET Estimate

United States Agricultural Monitoring (USAM)



The surface energy balance algorithm for land (SEBAL)

From Ray Anderson



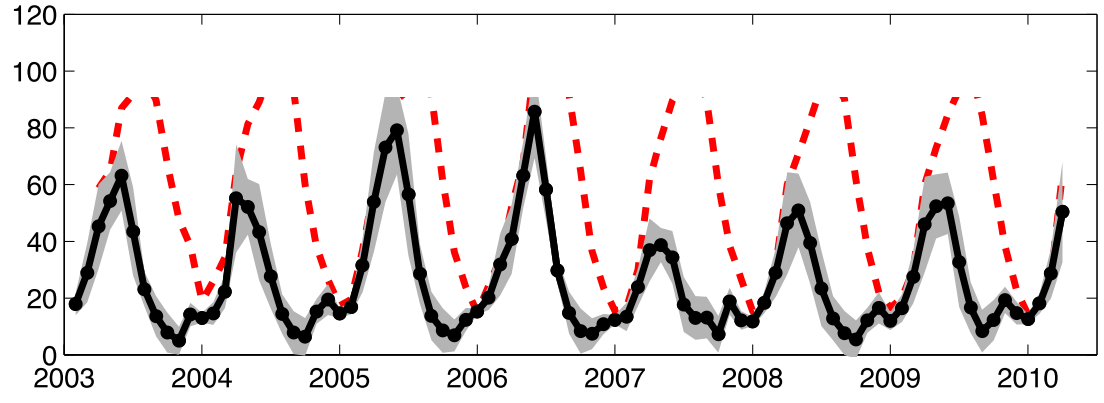
The MODIS data include Land Cover Type, Surface Reflectance, *Land Surface Temperature*/Emissivity, Vegetation Indices, and Albedo.

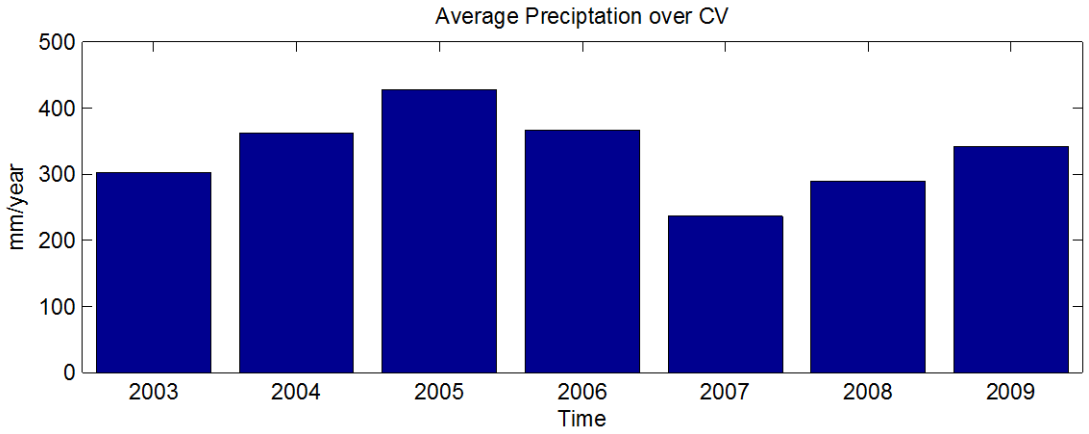
Surface radiation components are obtained from Surface Radiation Budget Data.

Input data:
Surface T, surface emissivity, veg indices, and albedo from MODIS.
Incoming solar, air humidity, net longwave radiation, and air temperature data from CIMIS (The California Irrigation Management Information System)

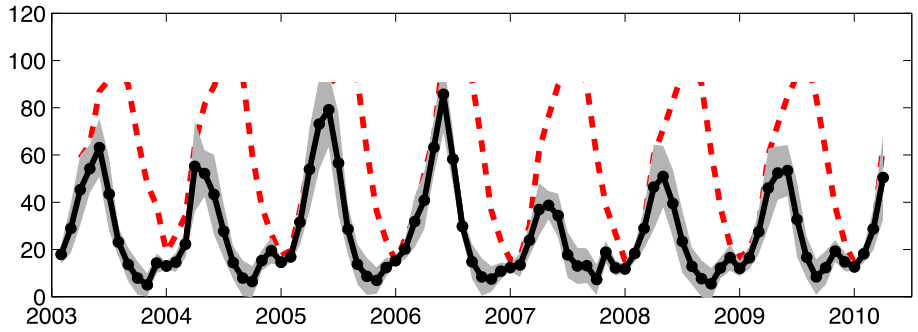
Compare the ET of 4 different LSMs to observations

1) CLM
2) MOSAIC
3) NOAH
4) VIC



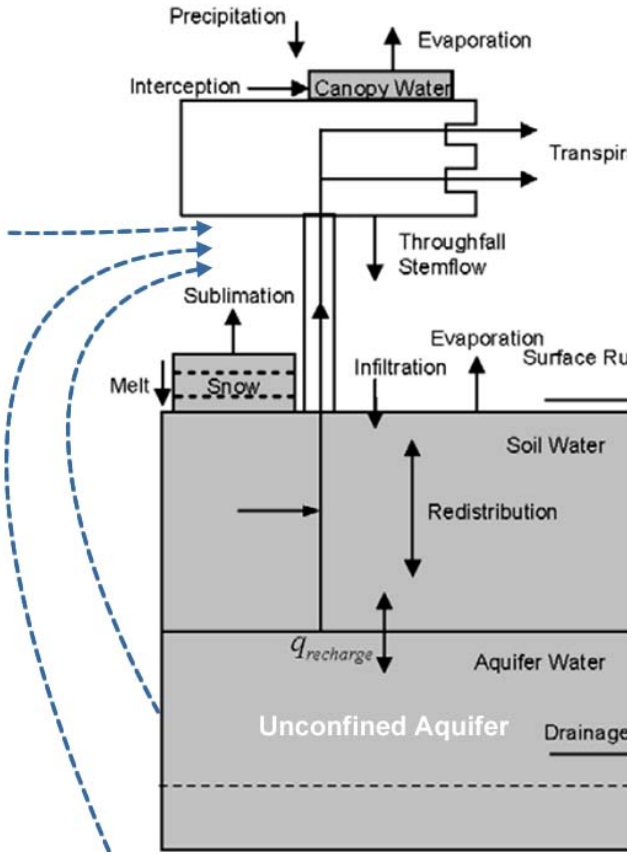


lower envelope estimate of irrigated water demand



700 +- 5 mm/yr vs 350 +- 20 mm/yr

How much water *at least* needs to be applied
(The difference between actually ET & model ET)



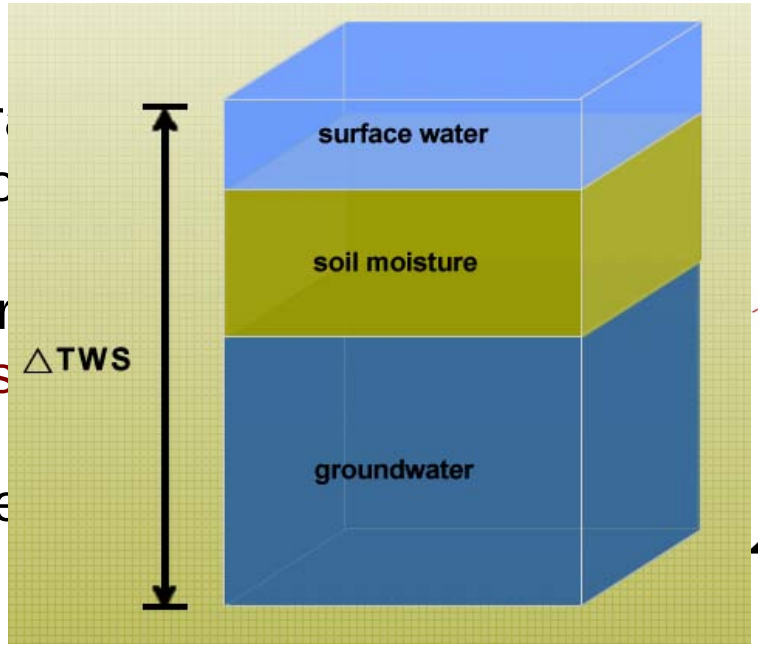
$$\frac{dS}{dt} = In - Out$$

What is GRACE?

Science Goals

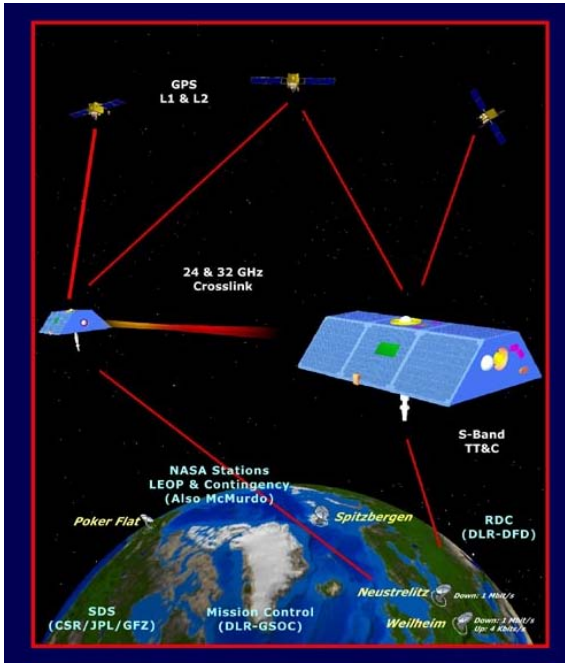
High resolution gr
Science applicatic

➔Precise measur
between the two s
accurate maps of
monthly and longe



NASA

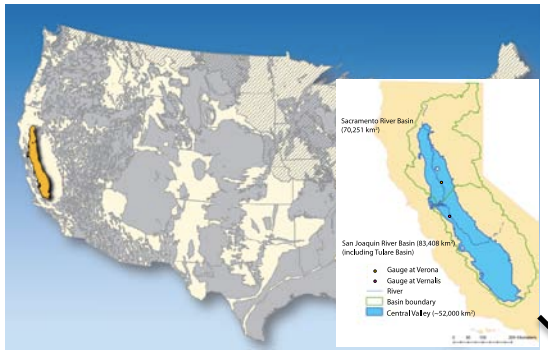
DLR

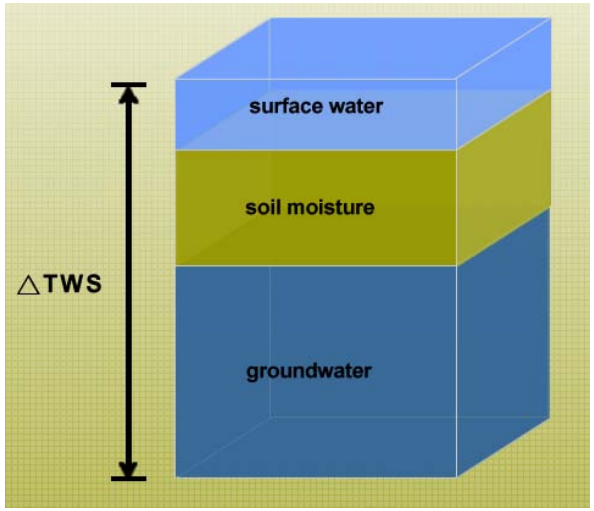


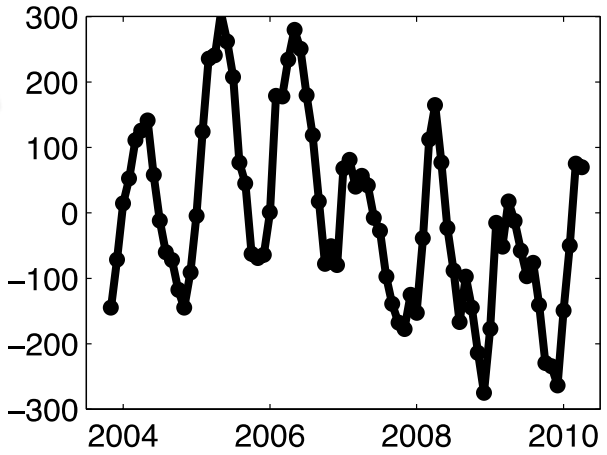
Orbit

Launched: March 17, 2002, two satellites in tandem orbit
Altitude: ~500 km (15 orbits per day)
Separation Distance: ~220 km

GRACE



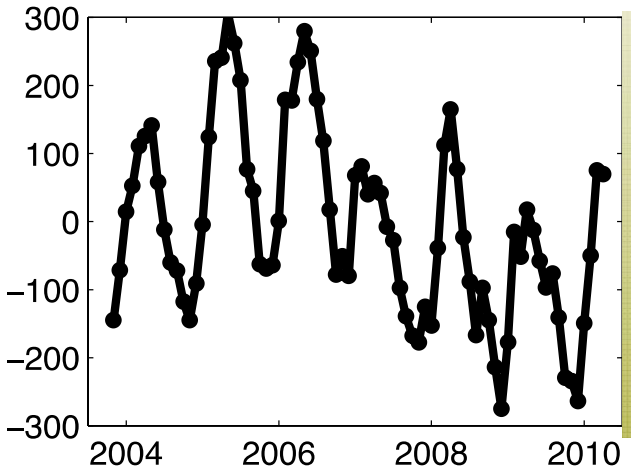


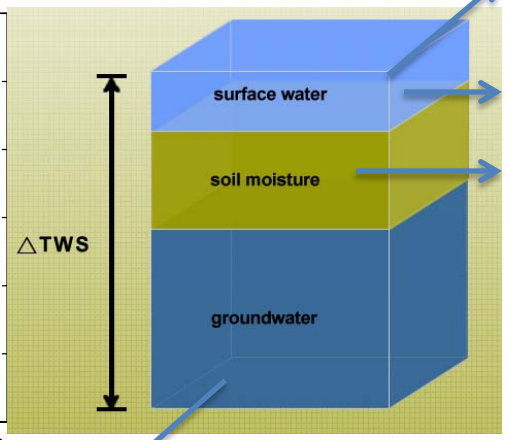


From Swenson

Decomposition of GRACE total water storage signal

GRACE





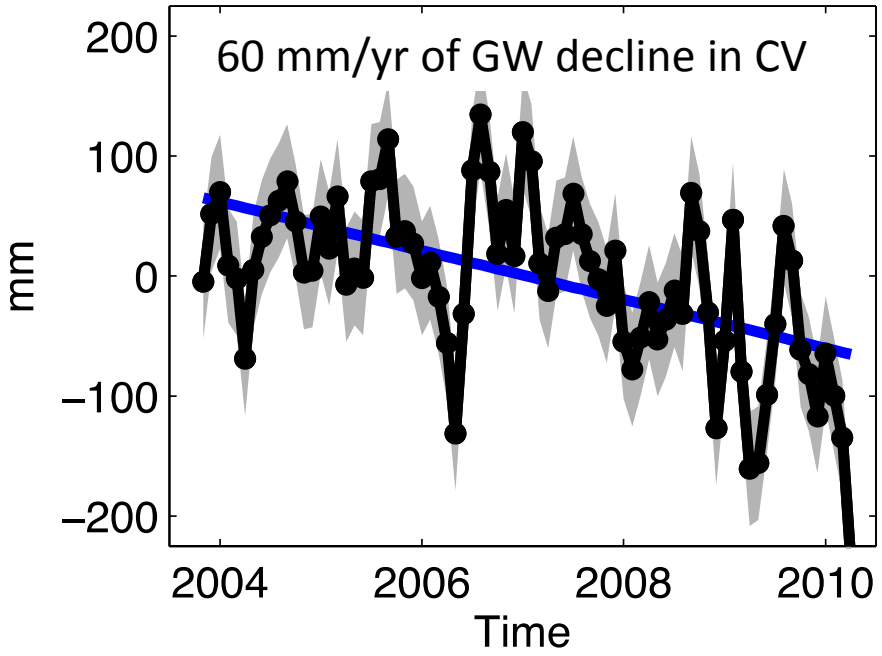
Snow: NSIDC
(National Snow and Ice Data Center)

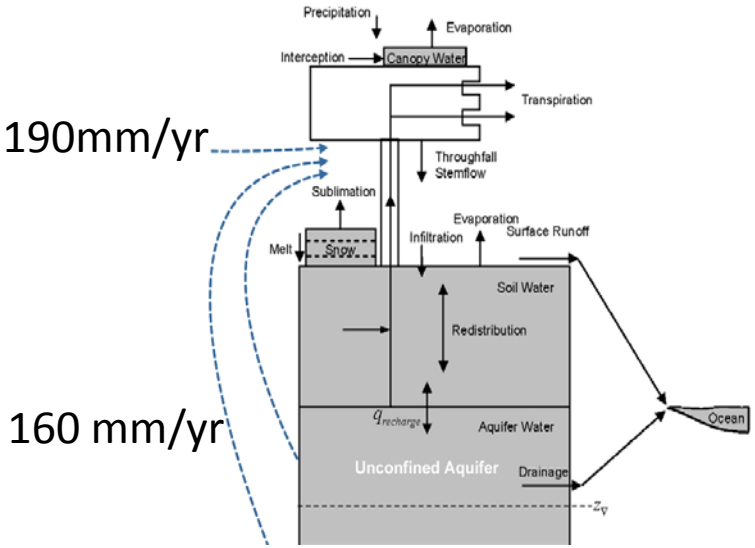
Surface Water: 20 largest dams/lakes

Soil Water: 3 models results

$$GW' = TWS' - Snow' - SW' - SM'$$

GRACE estimated groundwater pumping rate





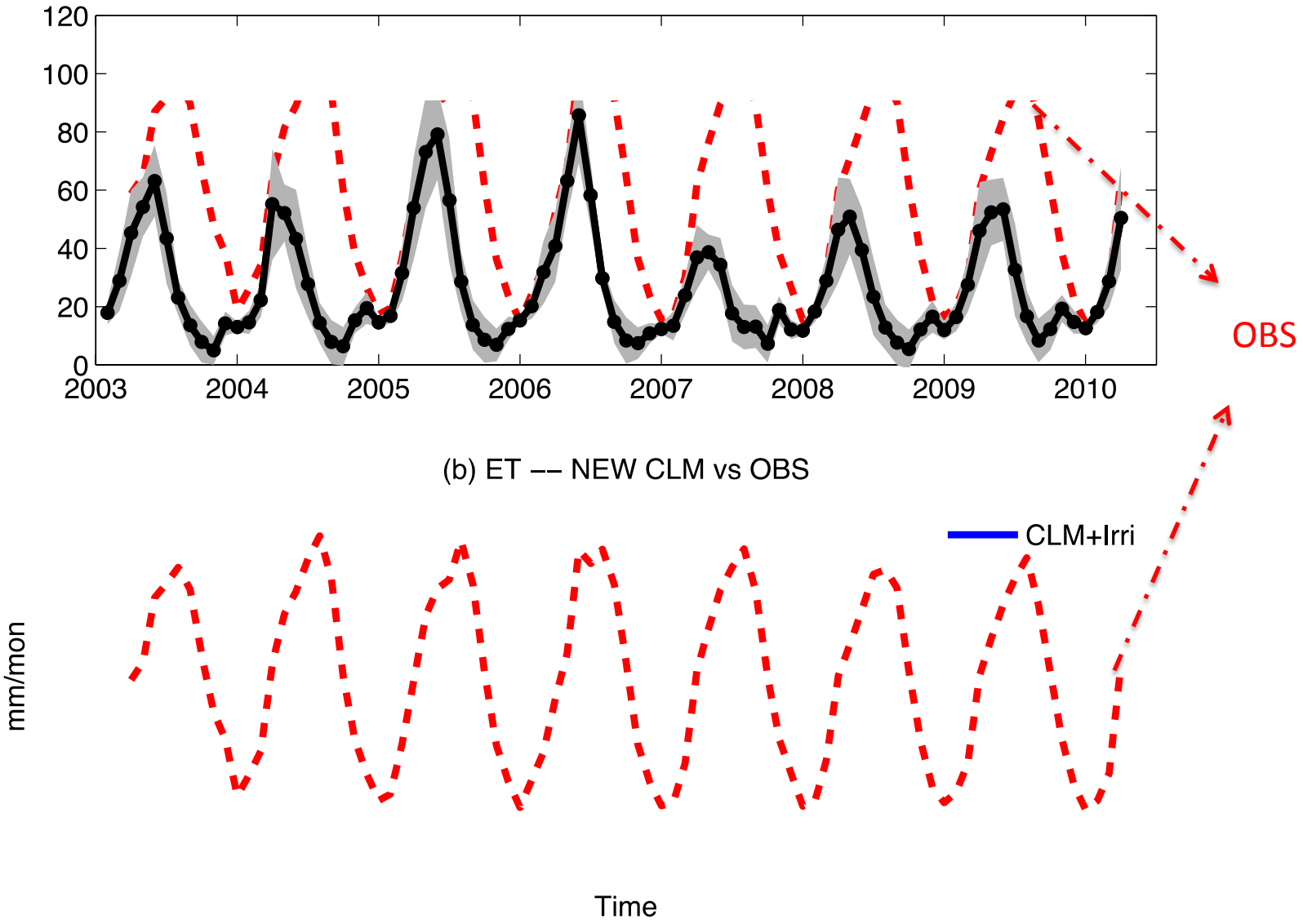
$$\frac{dGW}{dt} = GWR - pumping$$

$$= 160 \text{ mm/yr}$$

Surface water use statistics (240 mm/yr) from State Water Project, US Bureau of Reclamation, and canal streamflow data from California Data Exchange.

Total irrigated water demand (~400 mm/yr) in CV, Wisser et al., 2008

Results


120
100
80
60
40
20
0
2003
2004
2005
2006
2007
2008
2009
2010
OBS
(b) ET –– NEW CLM vs OBS
CLM+Irri
mm/mon
Time

Caveat:

- Constant irrigated water?
- GW withdrawal from confined and unconfined aquifers globally?

Future work:

- Apply this approach globally
- Couple to GCM to see human fingerprint on the climate