Moving to spatially-distributed modeling: Snow as a surrogate for some key challenges

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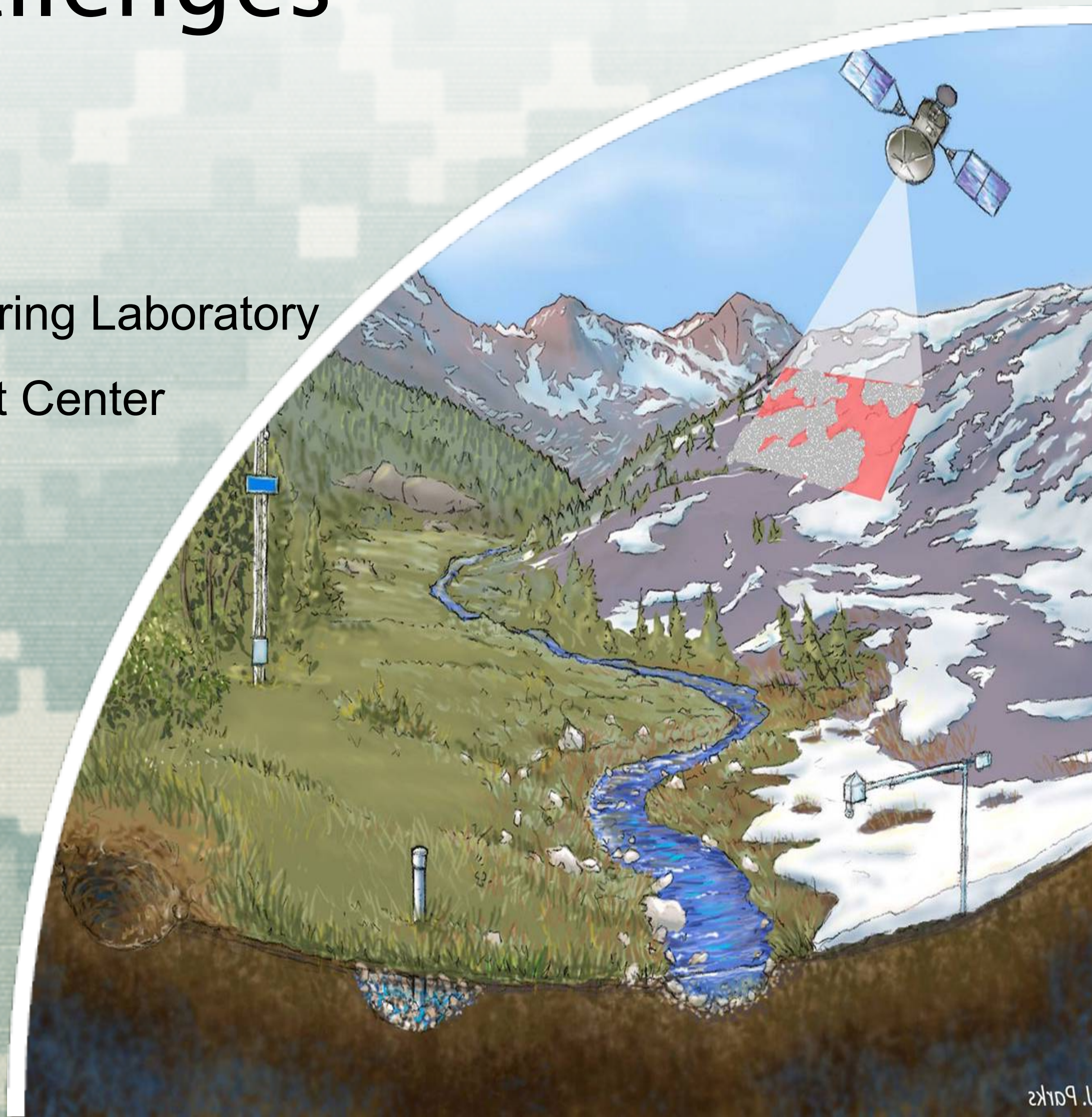

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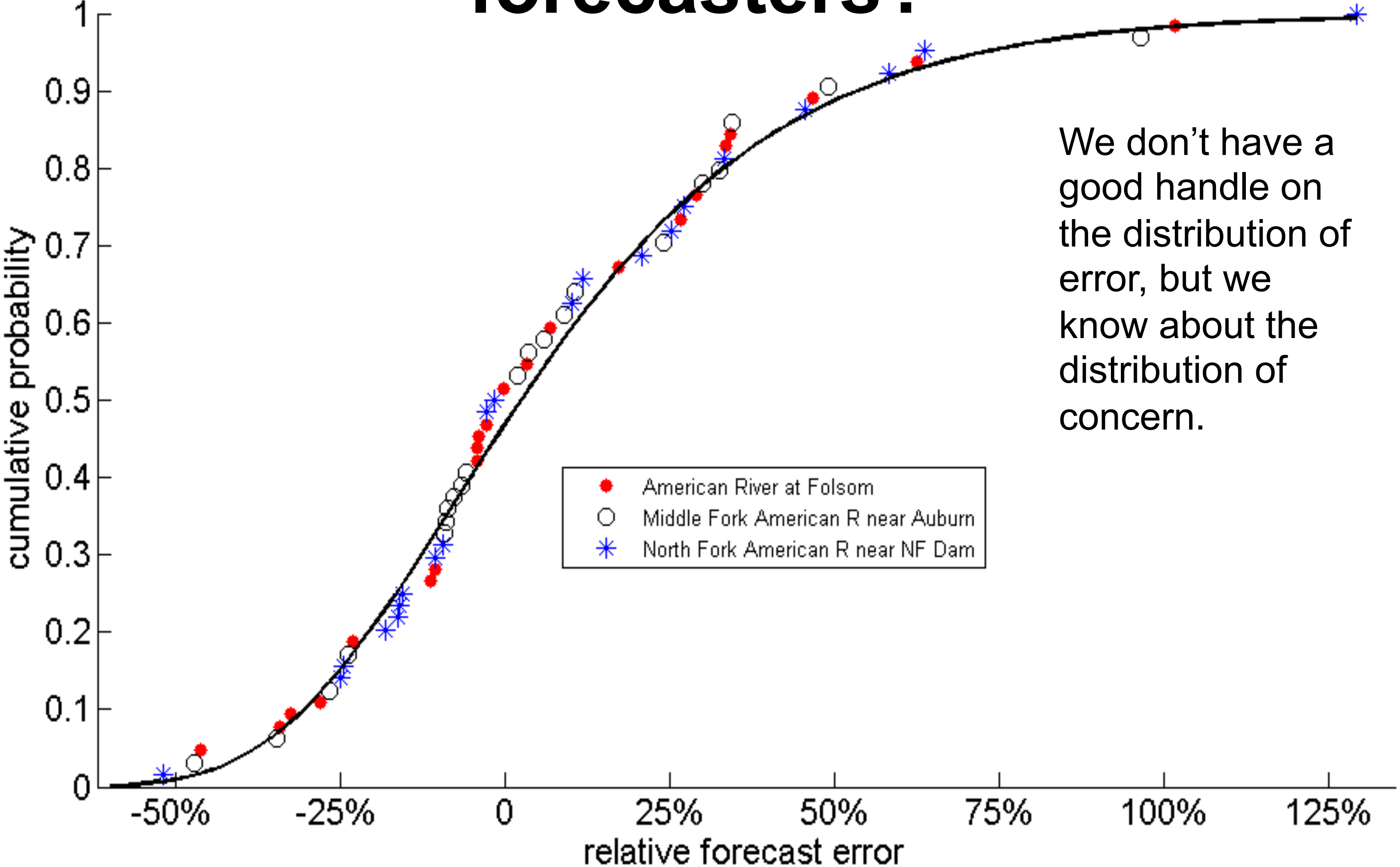
Does snow present a problem for forecasters?

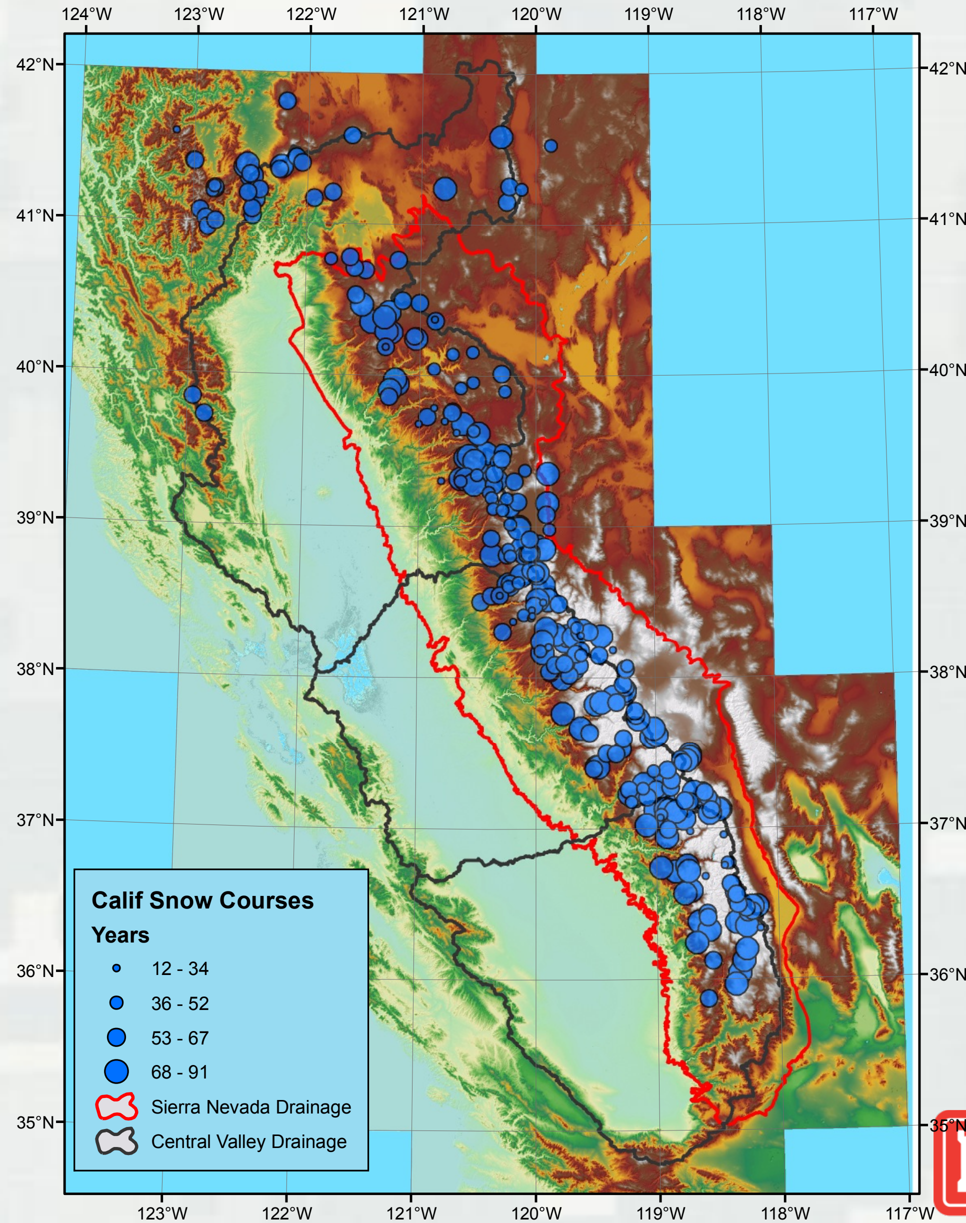


We don't have a good handle on the distribution of error, but we know about the distribution of concern.

(R. Rice, UC Merced)

But we measure and measure!

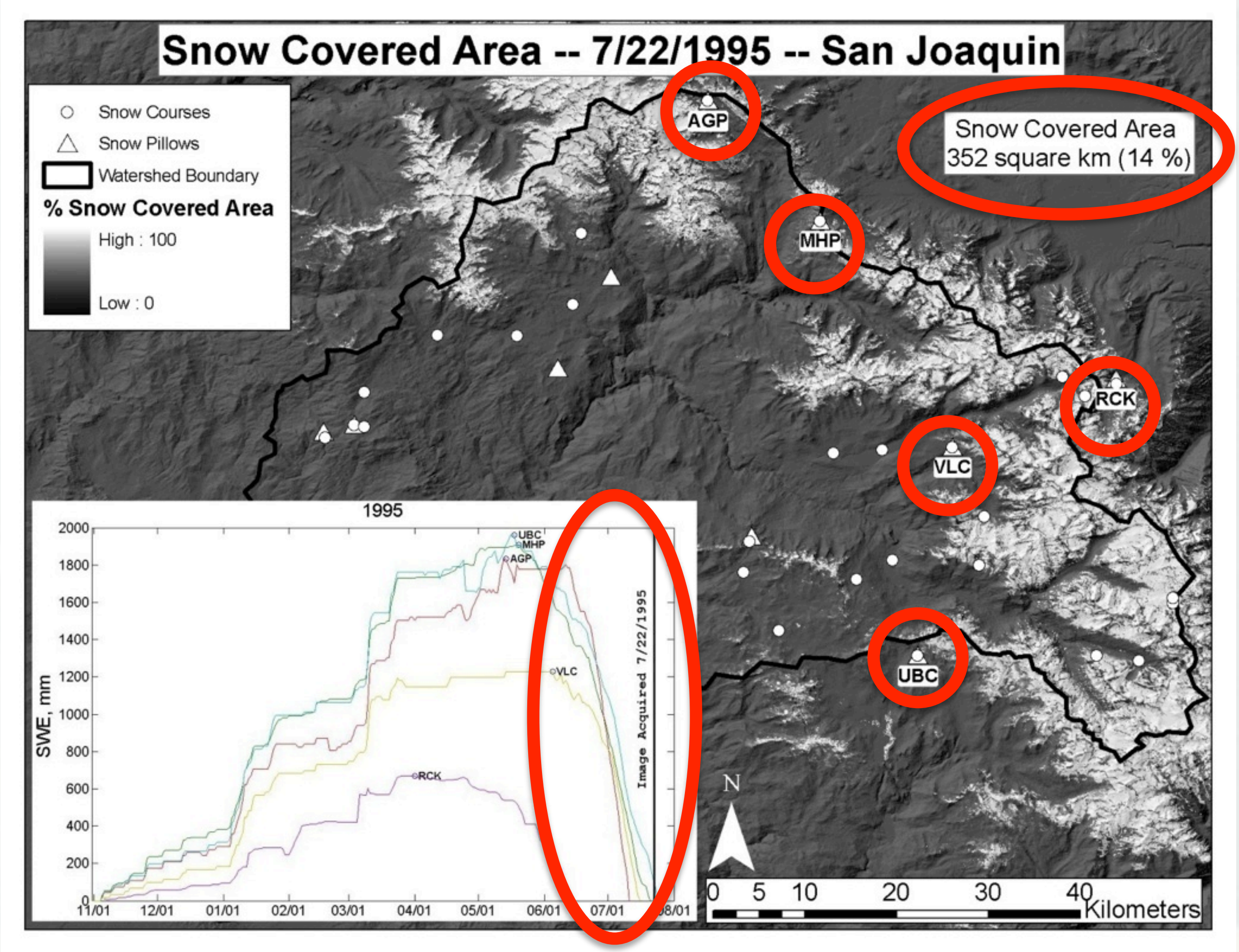
- 398 snow courses in California
- 213 have "long-term" data:
  - Measurements in more than 50 years
  - Starting by 1950
  - Continuing through 1995



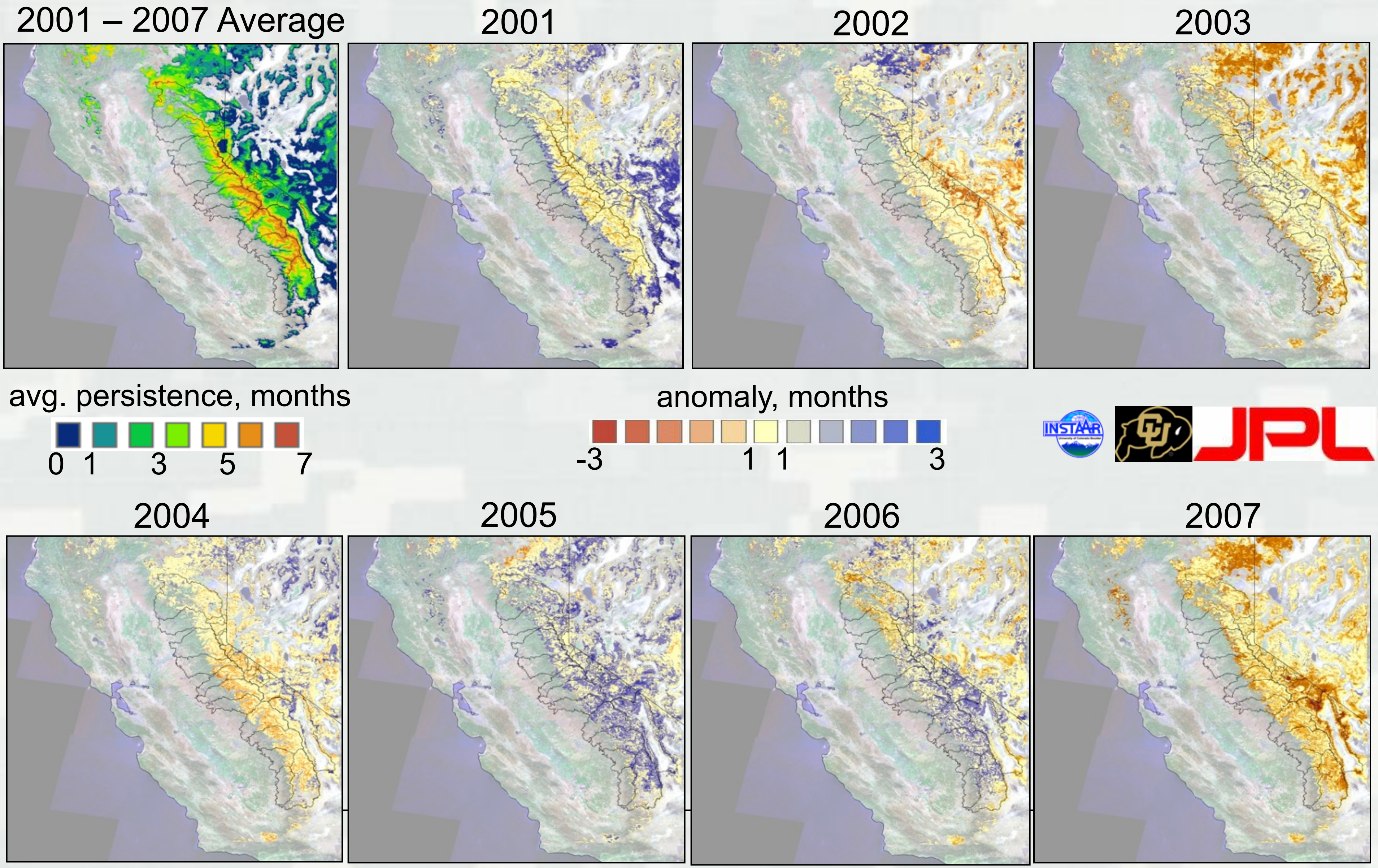
What more can we do? What don't we know?

- Timing of snow runoff results a combinations from areal depletion and vertical processes (mountains), while volumes seem to wander extremes.
  - ► Mapping snow helps us understand what today looks like, spatially.
  - ► Measuring snow in critical zones helps us monitor relations between area and volume.
  - ► Modeling snow can tell us the trends in estimated volumes.

Interpolation issues: persistent and high elevation snowpack



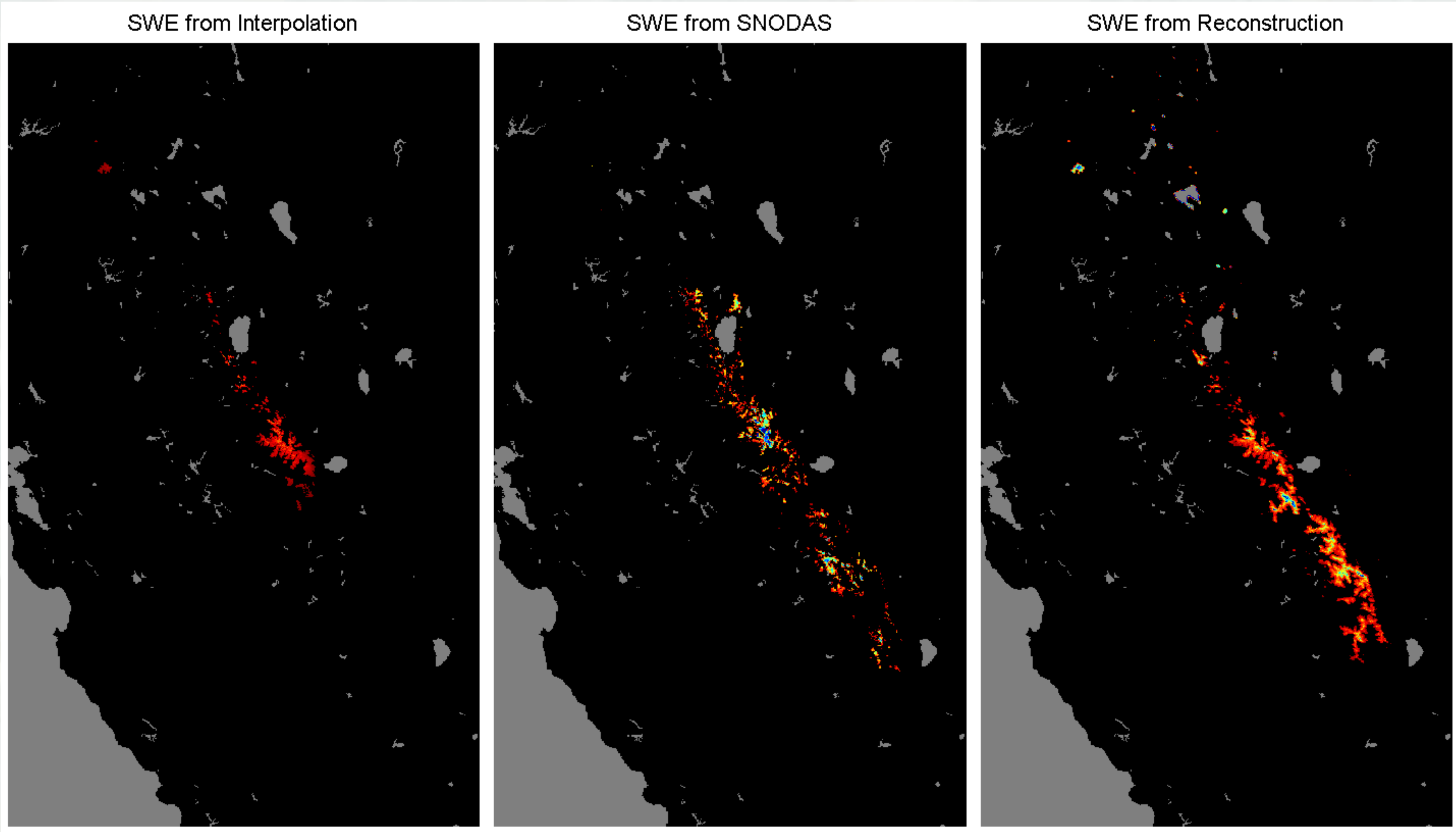
Snow extent shows us persistence, which exhibits nomalies:



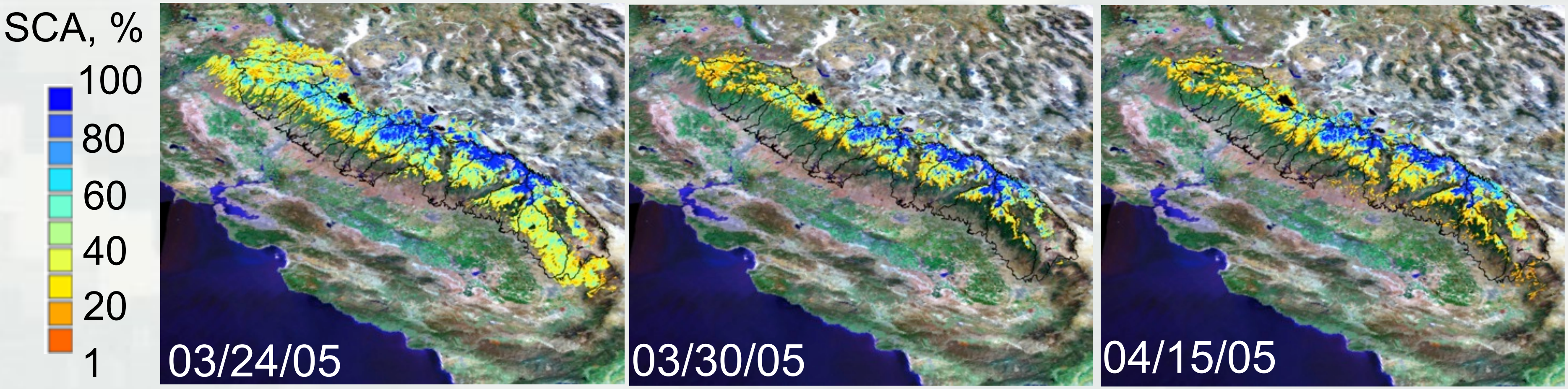
What if we merge area with observations?

- Spatial interpolation gives us significant errors due to the locations of ground observations; not many where we see the action (low and high).
- “Spatial calorimetry” exploits the persistance maps, merging observations to give us a hind site “reanalysis”.

Lets look how these compare for 2006.



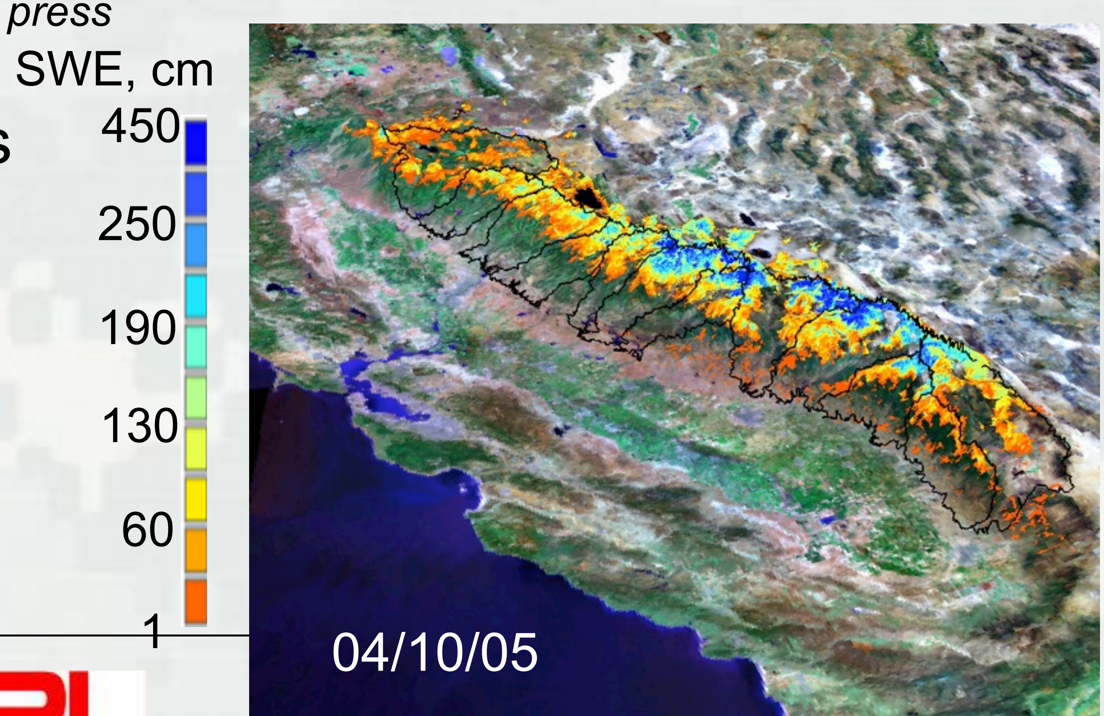
Range-Scale Snow Cover: MODIS



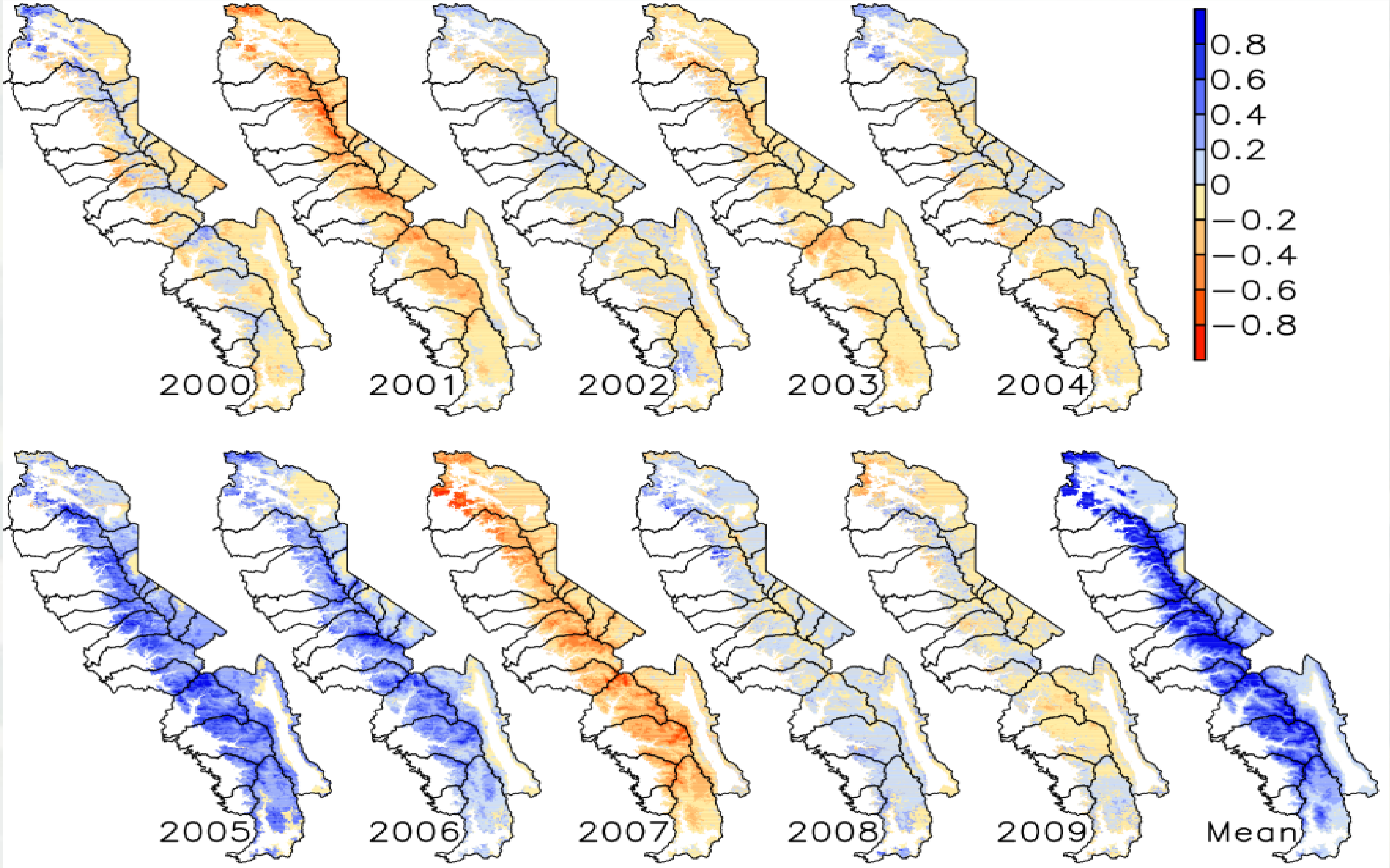
MODSCAG – Dozier et al., in press

Due to lower initial mass snow disappeared rapidly in N. Sierra.

Areas with persistent snow cover had greatest mass.



Snow Water Equivalent Anomalies

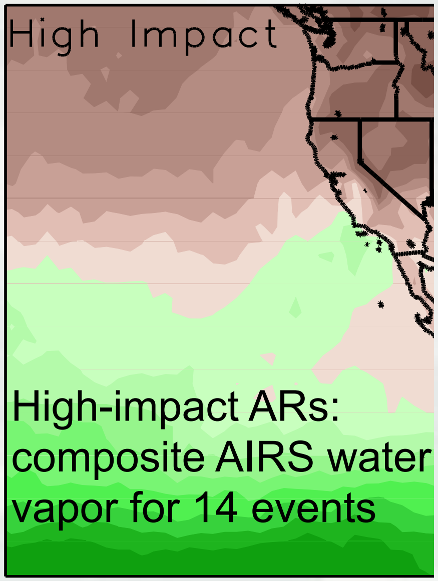


Guan, Molotch, Dozier, Painter in prep.

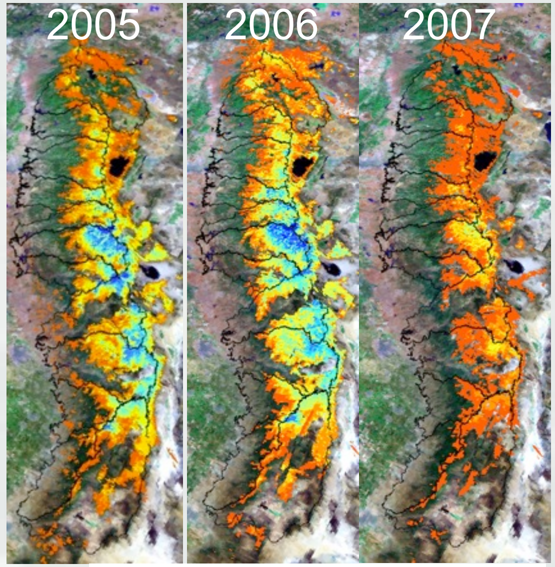
So what? Why go to all this effort?

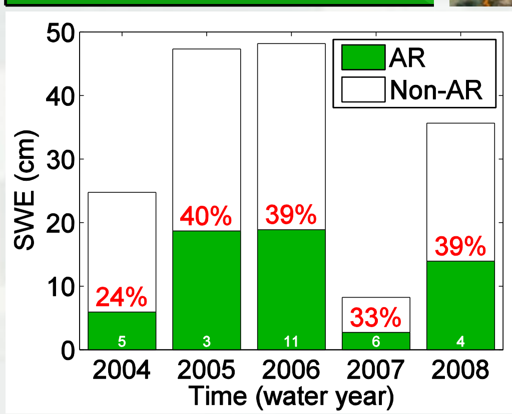
- Scientifically satisfying, since we have a better idea of what we've missed.
  - *Confirmed what we suspected; large "shallow" low elevation snow and the high country pack explain much.*
- Compliments emerging ideas about precipitation delivery and "integrated invetigations".
- Opens the door to new operational analyses.

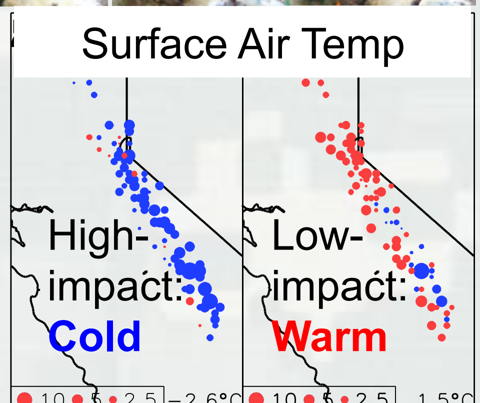
This type of analysis links Atmospheric Rivers and Snow Accumulation in the Sierra Nevada



MODIS-model recon SWE







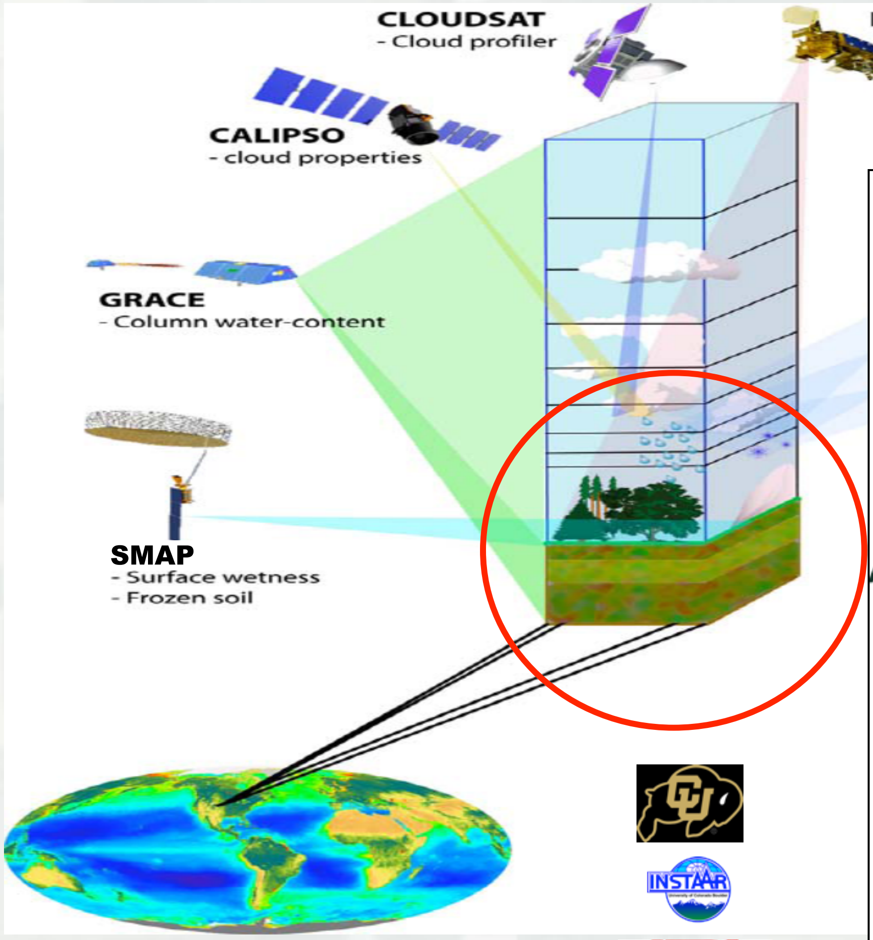
- Atmospheric rivers account for up to ~40% of the total seasonal snow accumulation

- Surface air temperature partly controls amount of snow accumulation

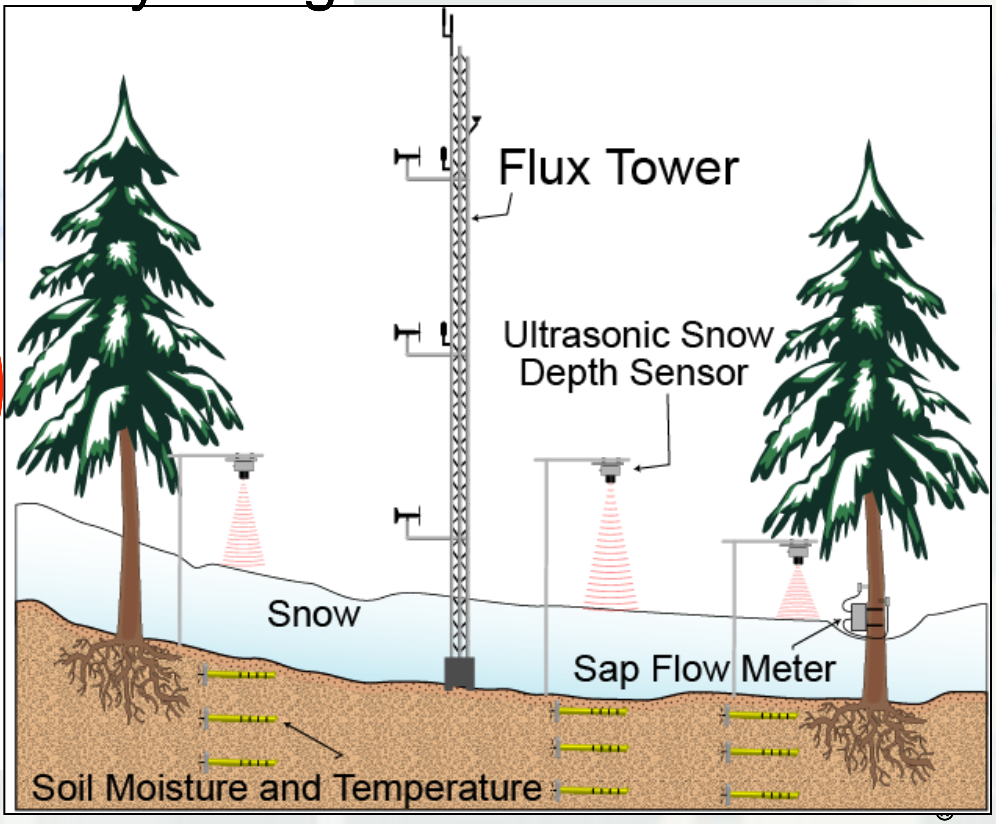
Results illustrate utility of the SWE reconstruction product in understanding hydrologic impacts of extreme precip. Events.

Guan, Molotch, Waliser, Fetzer, and Coauthors, *GRL, 2010*

This level of effort broadens our topic spectrum.



Hydrologic Instrument Cluster



Molotch et al., 2009 - Ecohydrology

Can we use the reconstruction to index the past?

- Operational updating and compilation of a SWE library:
  - ► We have the tools to exploit large data sets to answer a variety of questions, scientific, operational, and for communicating with the public.
  - ► Based on SWE data stacks, we can ask about the most similar priors, and what ran off then.