## The Third Pole and the Fourth Paradigm

#### Jeff Dozier University of California, Santa Barbara





#### Third Pole defined by characteristics, not a bounding box

- Mid-latitudes, not in Arctic or Antarctic
- Snow and ice dominate the cycles of water, energy, and biogeochemistry
- Therefore in the mountains
- Snow a crucial water resource for broader region, inside and outside the area where snow falls
- Glaciers integrate snow accumulation and ablation, so their change in size shows longer-term trends
- Energy cycles and the topography affect regional climate



 An "exaflood" of observational data requires a new generation of scientific computing tools – Jim Gray



### The FOURTH PARADIGM

**DATA-INTENSIVE SCIENTIFIC DISCOVERY** 

DATA-INTENSIVE SCIENTIFIC DISCOVERY

FOURTH PARADIGM

#### The Fourth Paradigm

- 1. Thousand years ago Experimental Science
  - Description of natural phenomena
- 2. Last few hundred years Theoretical Science
  - Newton, Maxwell, Planck, . . .
- 3. Last few decades Computational Science
  - Simulation of complex phenomena
- 4. Today Data-Intensive Science
- Use data sets from many different sources
  - Captured by satellite and airborne sensors
  - Generated by simulations
  - Captured by sensor networks

Leading to sets of tools and technologies to support data federation and collaboration

- For analysis and data mining
- For data visualization and exploration
- For scholarly communication and dissemination



$$B_{\lambda} = \frac{2hc^2\lambda^{-5}}{e^{hc/(k\lambda T)} - 1}$$







#### Snow pillows, snow courses, study sites in Western U.S.



## Snow-pillow data for Leavitt Lake, 2929 m, Walker R drainage, near Tuolumne & Stanislaus basins





Forecasts in many parts of the Third Pole simply don't exist

#### News item from IRIN (UN)

KABUL 21 September 2011 "The current dry spell sweeping across Afghanistan's northern, northeastern and western provinces could lead to a large-scale food crisis and the humanitarian community should act quickly to ensure this does not degenerate into a disaster, government and aid officials warn."

• How the Fourth Paradigm help?

# Reconstructing SWE (AFTER THE SNOW IS GONE) from optical imagery and a snowmelt model









#### Implications for data management and delivery

First, kudos to the DAACs, especially for search and availability

- Subsetting along the spatial and temporal dimensions
- Distinction between anywhere and everywhere
- Virtual products, distinction between "lazy" and "eager" production
- Co-locate data and computing, for cloud provision

(Animation of the Karakoram Anomaly)