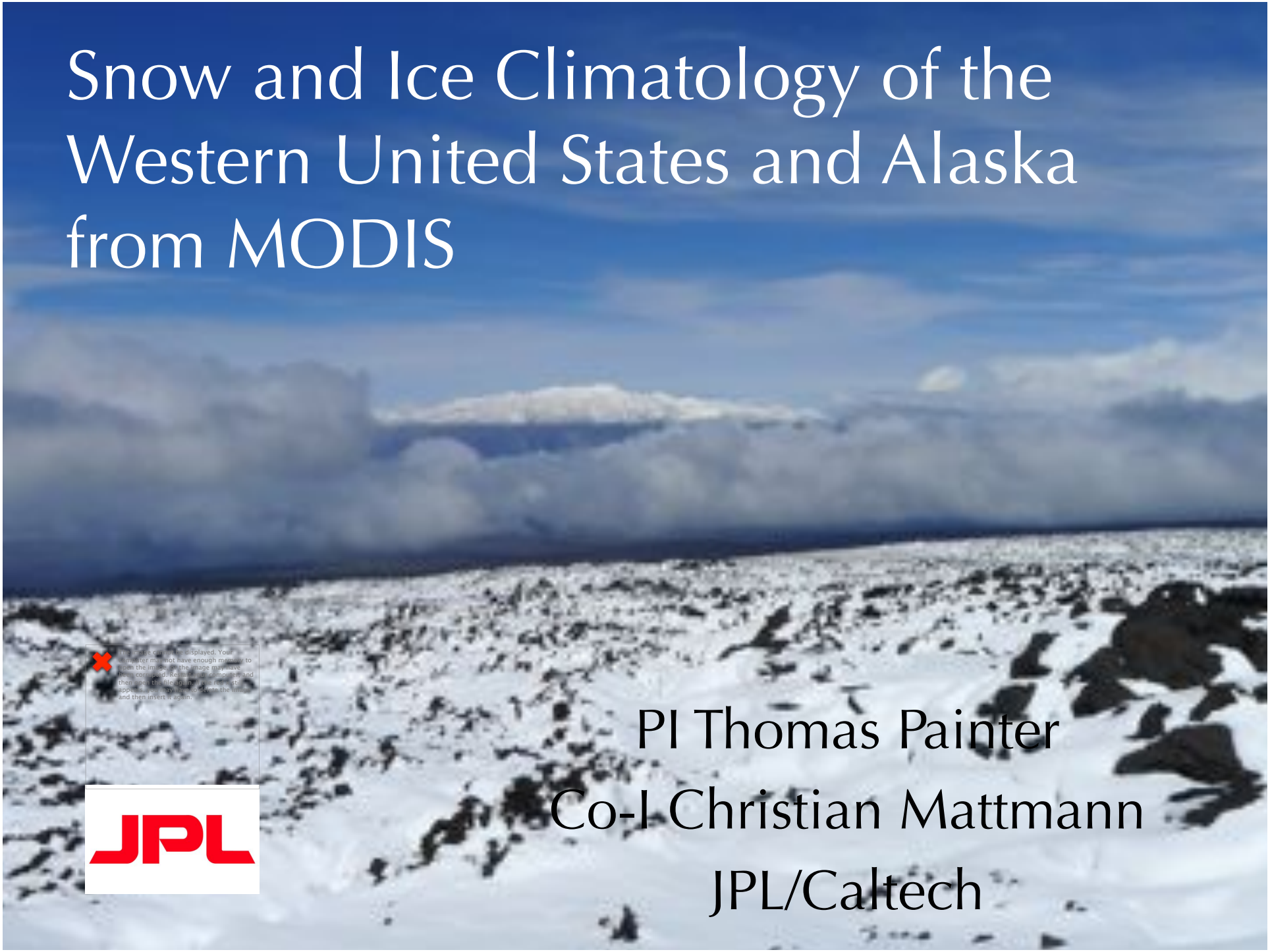
Snow and Ice Climatology of the Western United States and Alaska from MODIS



PI Thomas Painter
Co-I Christian Mattmann
JPL/Caltech

Project Flow

- MODIS climatology for Western US and Alaska across 2000 to 2012
- Snow cover, dust-radiative forcing
  - MODSCAG: daily and 8-day products
  - MODDRFS: daily and 8-day products
- Minimum exposed snow and ice
  - Annual per pixel and vector products
- Partnering with SW, NW, and Alaska NCA regions

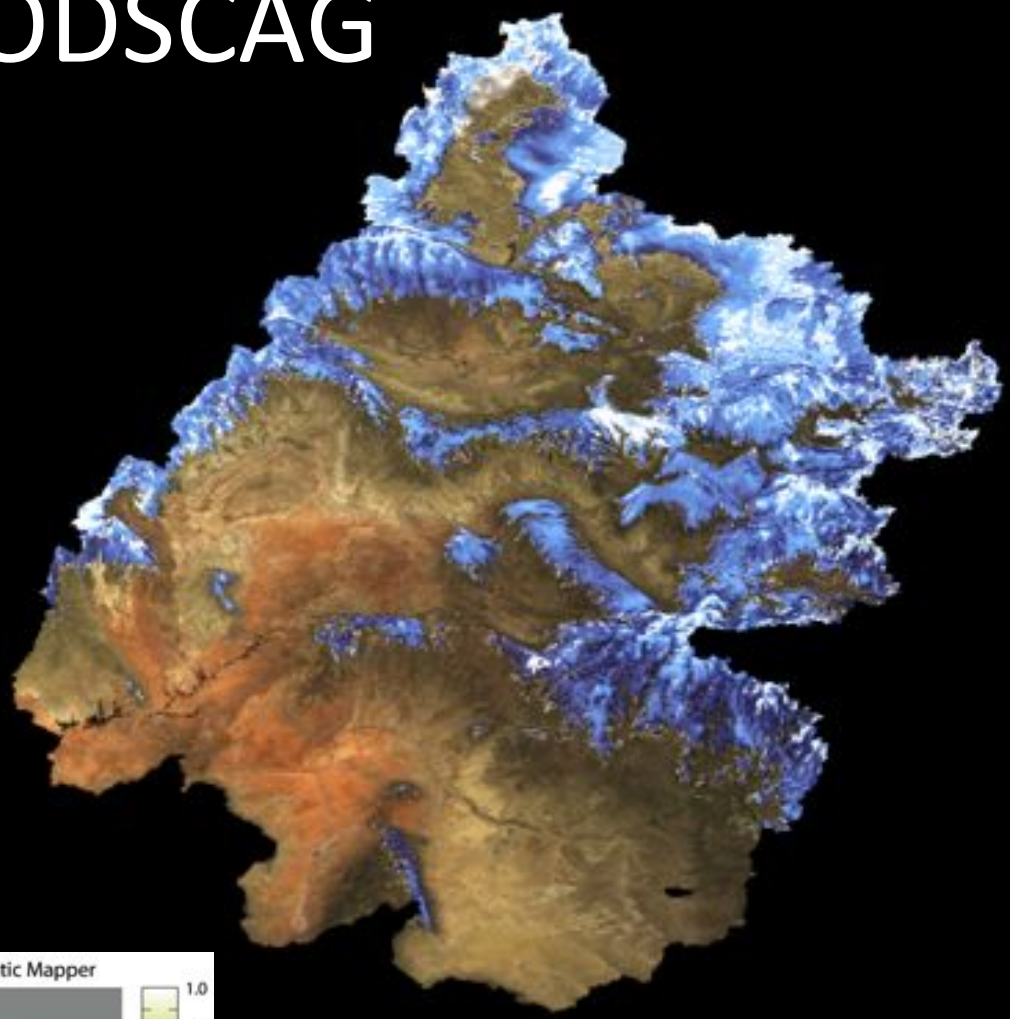
Team

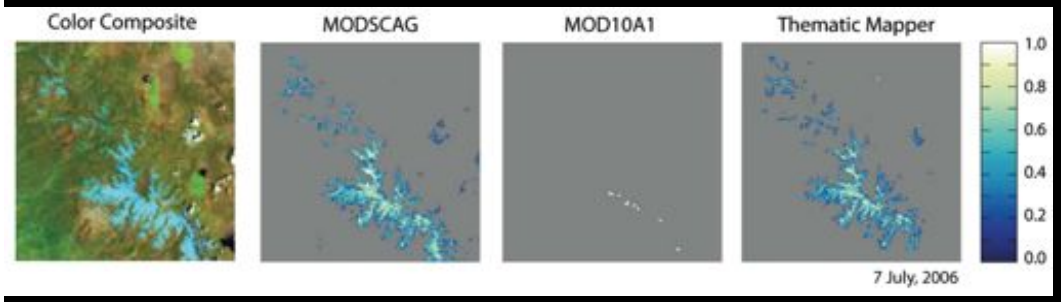
- Dr. Thomas Painter – PI
- Dr. Chris Mattmann – Co-I and Data System Lead
- Mr. Cameron Goodale – science algorithm integration/developer
- Ms. Annie Bryant – Ph.D. student, University of Utah, MOD-DRFS
- Mr. Andrew Hart – User Interface developer, SNOTEL site integration
- Ms. Mckenzie Skiles – Ph.D. Student, UCLA, SNOTEL site algorithms
- Mr. Paul Ramirez – Apache OODT infrastructure, GIS Portal
- Mr. Paul Zimdars – System Administration
- Starting July 2, Karl Rittger, Caltech postdoctoral fellow

MODSCAG

JPL MODSCAG algorithm
(Painter et al 2009)
Spectral mixture analysis of
MODIS Surface
Reflectance products

Daily 500 m coverage in
late morning and early
afternoon from NASA
satellites Terra and Aqua



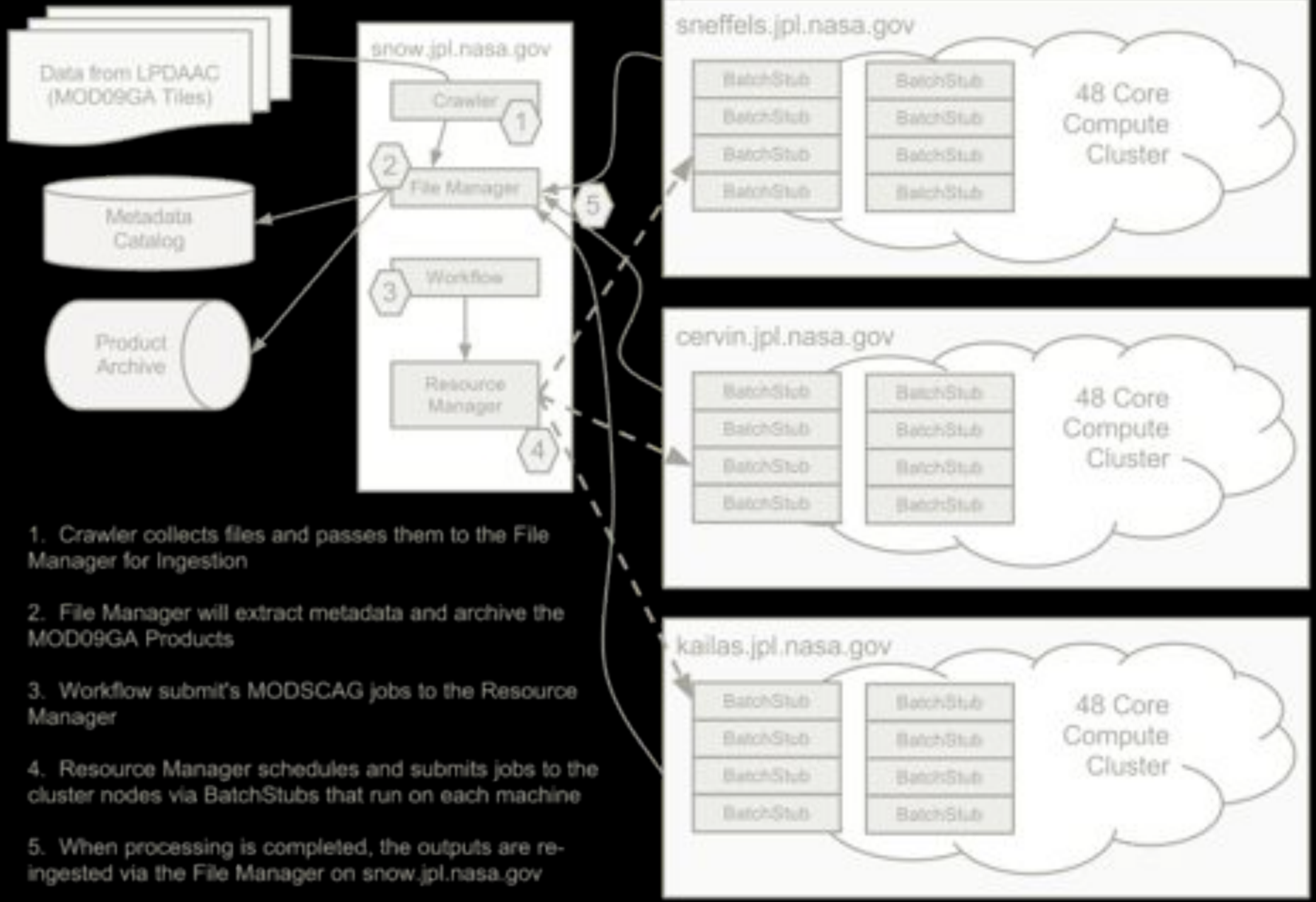


Upper Colorado River Basin
March 9, 2009

2 Stages of Processing

- Historical Tiles over the Western United States
  - Time Range: 2000 - Present
  - h08v04, h08v05, h09v05, h09v04, h10v04
- MODIS Near Real-Time Products
  - Time Range: Dec 2011 - Present
  - Western United States
  - High Asia

MODSCAG Historical Data Processing (144 Cores)



1. Crawler collects files and passes them to the File Manager for Ingestion

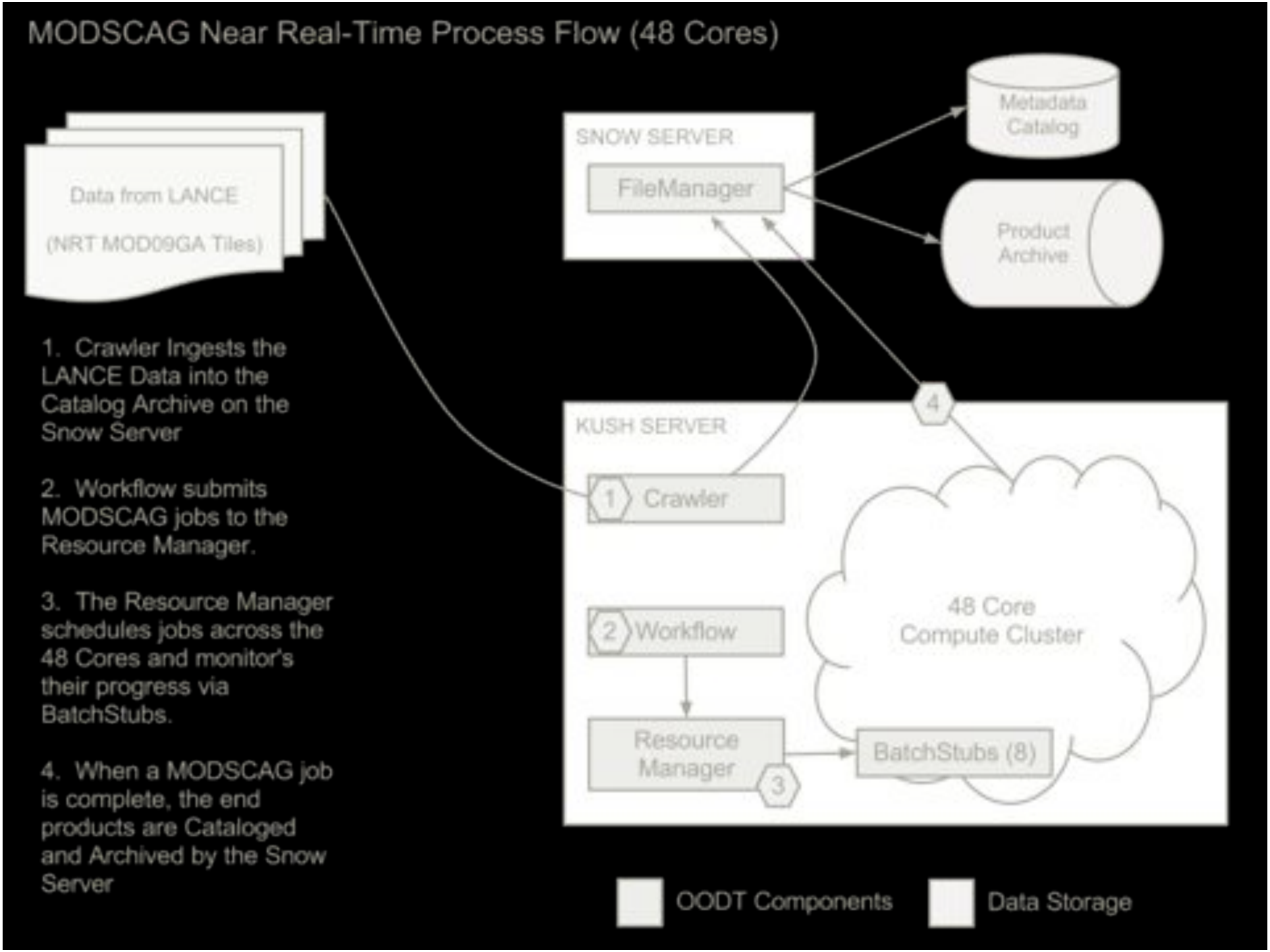
2. File Manager will extract metadata and archive the MOD09GA Products

3. Workflow submit's MODSCAG jobs to the Resource Manager

4. Resource Manager schedules and submits jobs to the cluster nodes via BatchStubs that run on each machine

5. When processing is completed, the outputs are re-ingested via the File Manager on snow.jpl.nasa.gov

MODSCAG Near Real-Time Process Flow (48 Cores)



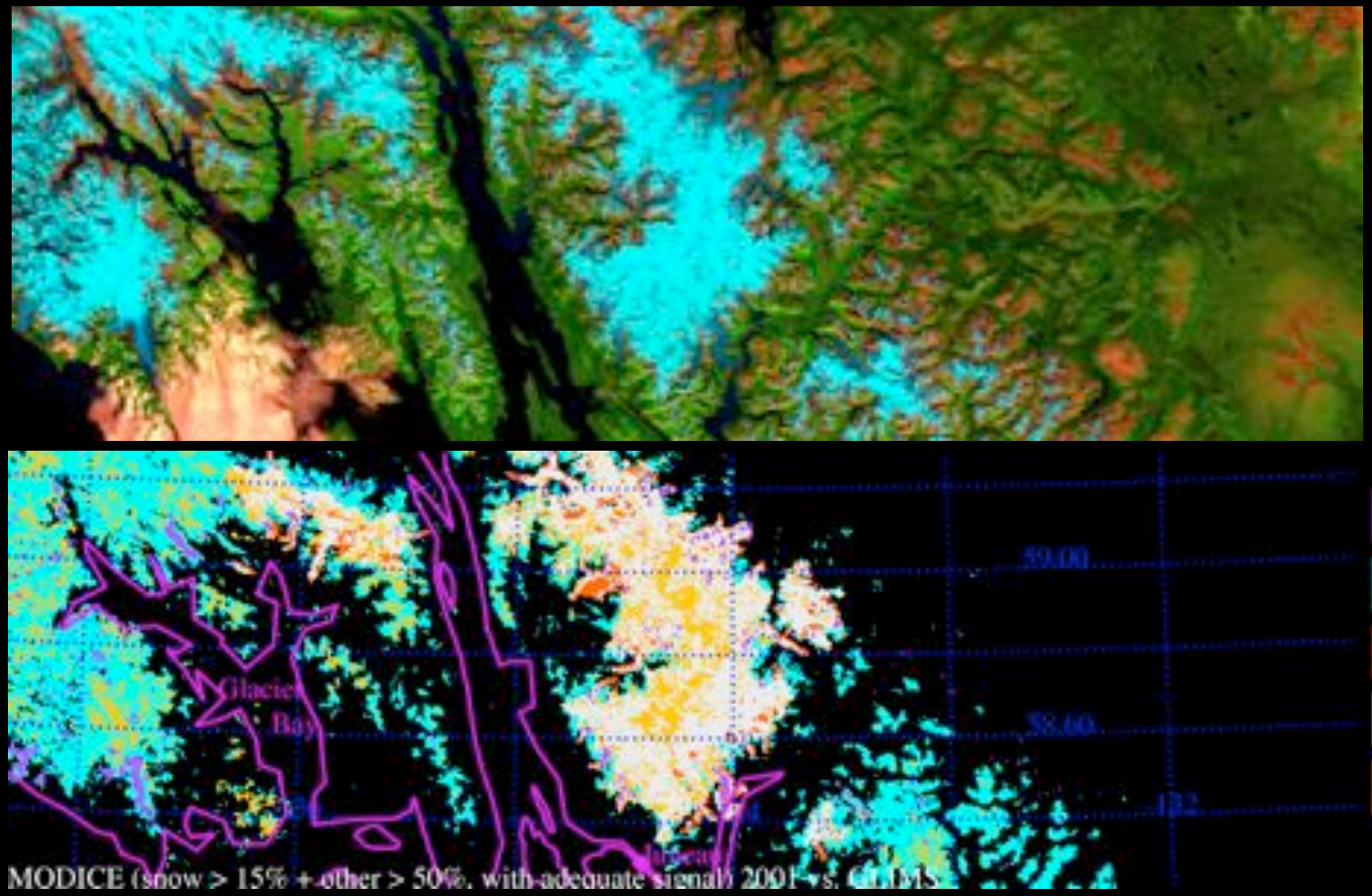
1. Crawler Ingests the LANCE Data into the Catalog Archive on the Snow Server

2. Workflow submits MODSCAG jobs to the Resource Manager.

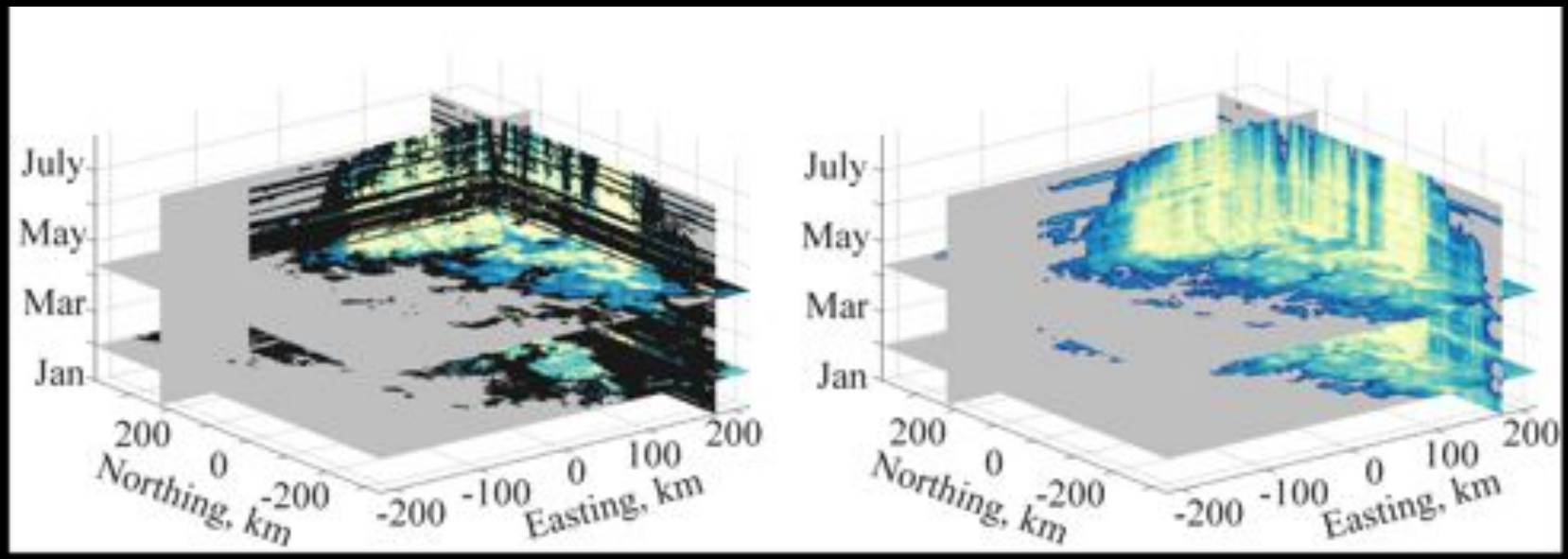
3. The Resource Manager schedules jobs across the 48 Cores and monitor's their progress via BatchStubs.

4. When a MODSCAG job is complete, the end products are Cataloged and Archived by the Snow Server

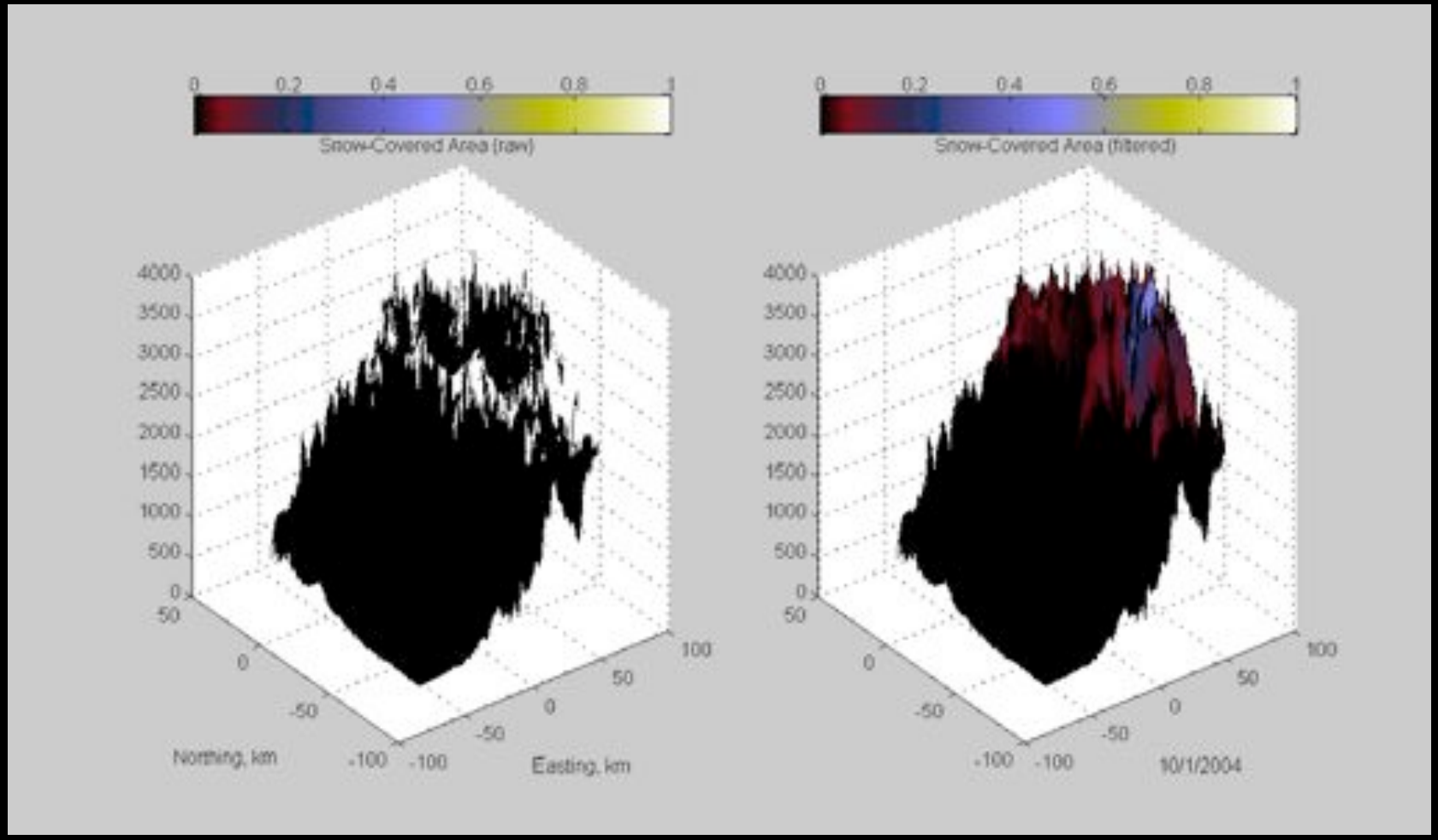
MODICE – Permanent Snow and Ice



Time-Space Continuity



From *Dozier, Painter, and Frew* (2008), Adv. Water Res.

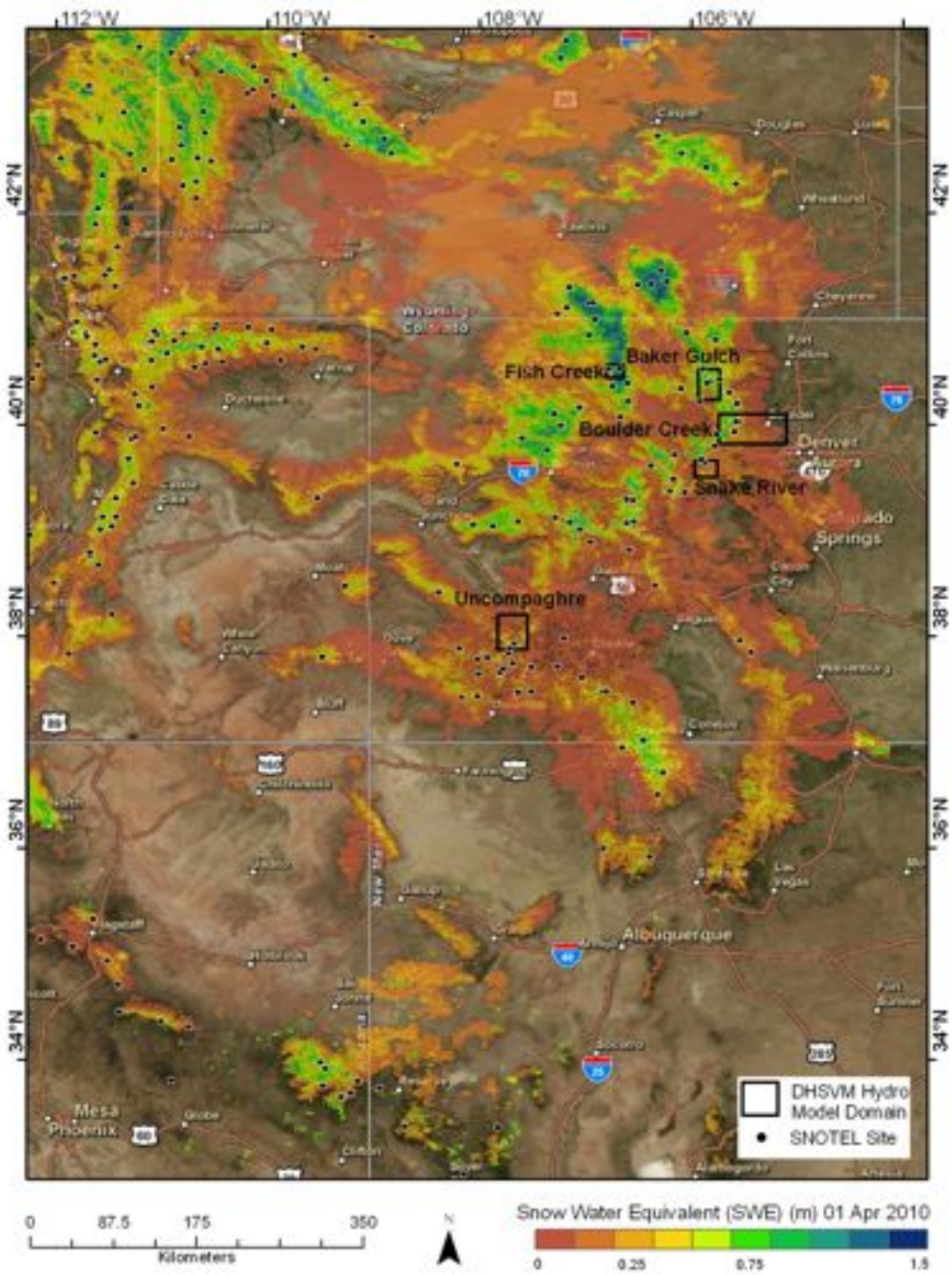


Merced River Basin, California 2005

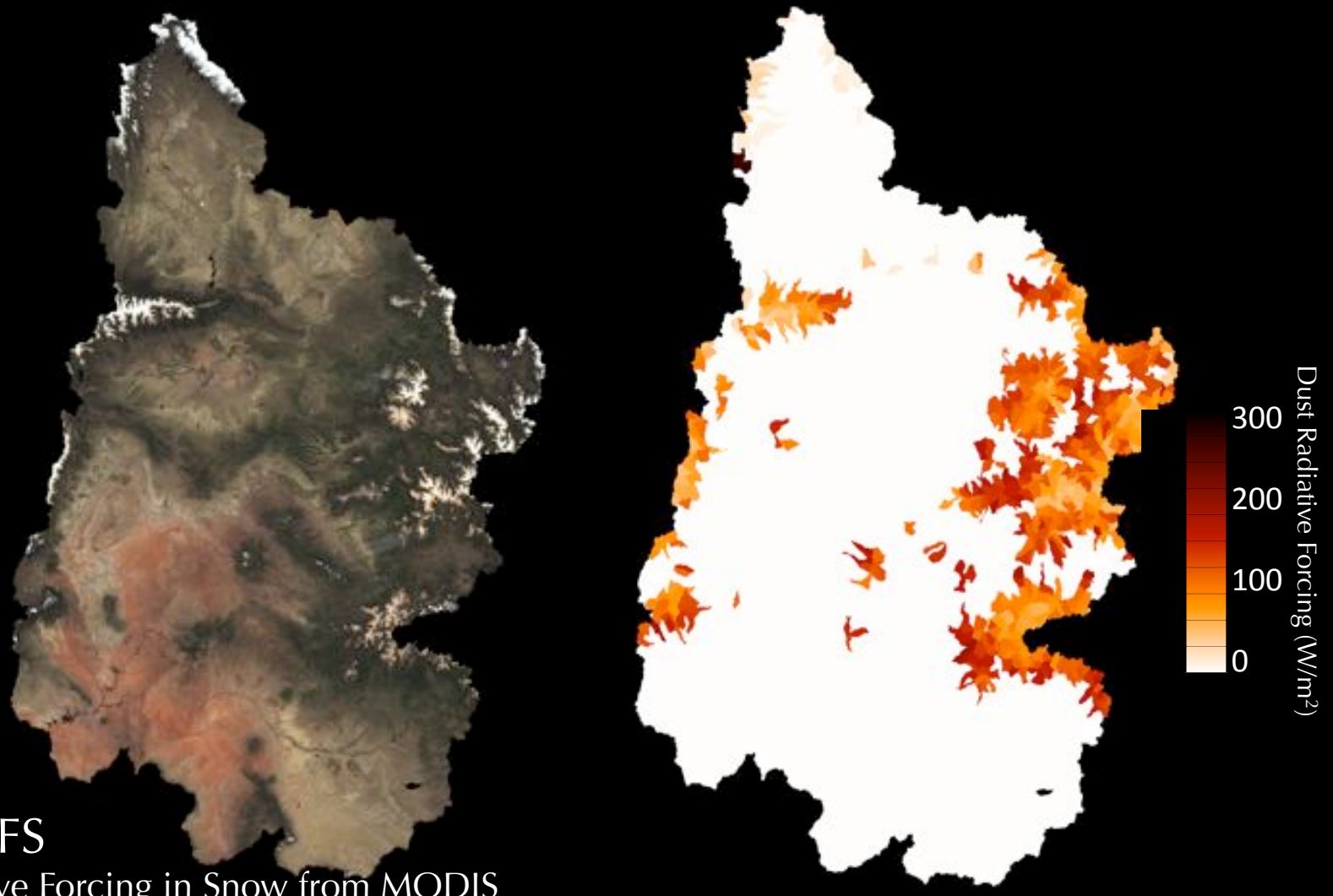
April 1, 2010 SWE Reconstruction

Anchored from MODSCAG snow covered area

Molotch et al, in prep



Dust Radiative Forcing



MODDRFS

Dust Radiative Forcing in Snow from MODIS

Painter and Bryant, 2012

17 May 2009

MOD-DRFS Processing

Obtain MOD09GA Surface Reflectance Tiles for the Upper Colorado River Basin (h08v05, h09v04, h09v05, h10v05).

↓

MODSCAG/MOD-DRFS file preparation: HDF extraction of surface reflectance bands, cloud properties, solar and sensor geometry.

↓

MOD-DRFS algorithm computes radiative forcing by dust on snow.

↓

MODSCAG/MOD-DRFS post-processing: cloud masking and de-striping

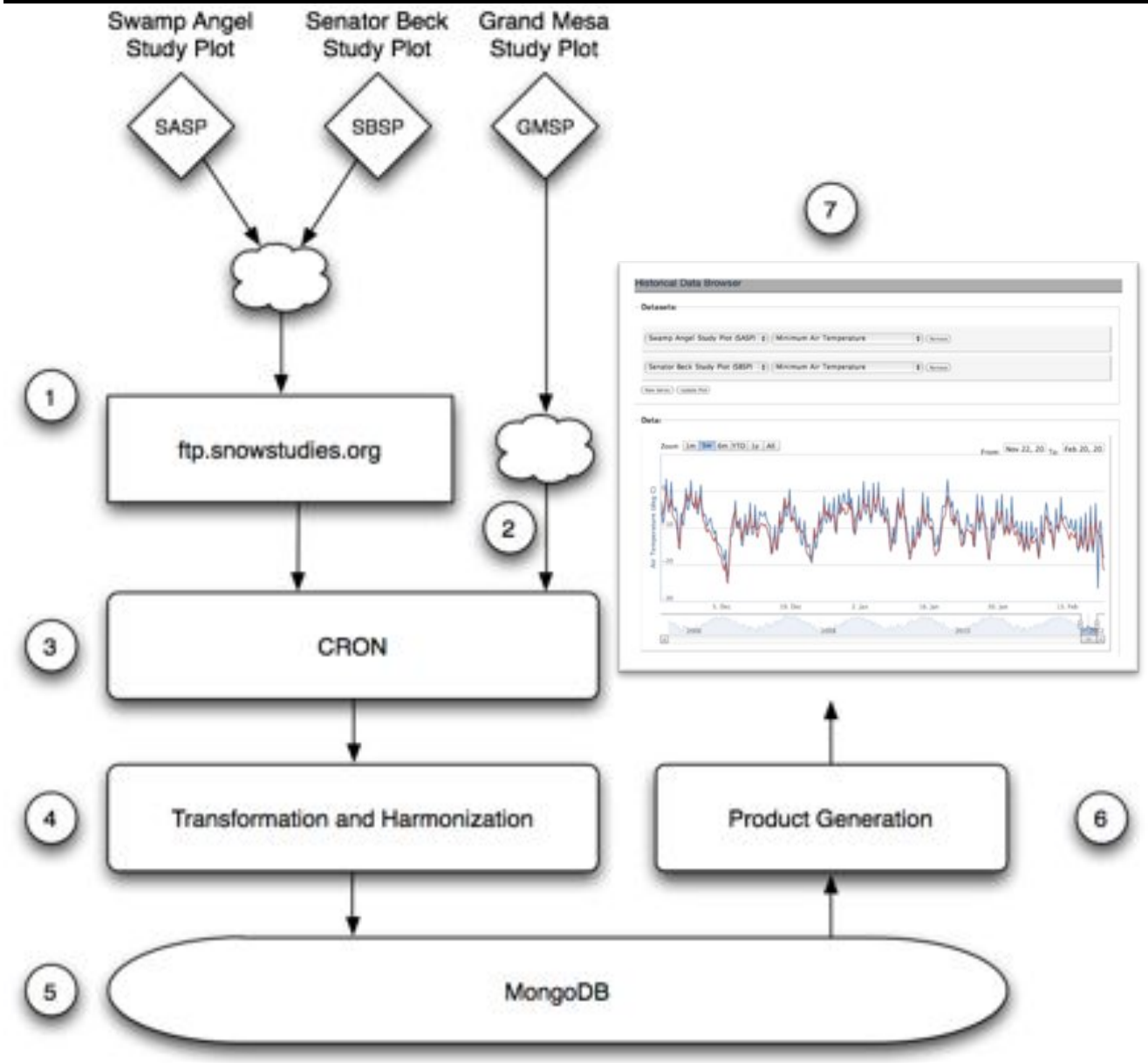
Western Energy Balance of Snow

- Western Energy Balance of Snow (WEBS)
  - Historical And Near-Real-Time Access
- Towers deployed in several key snow areas
- Connect to towers and pull down data actively

WEBS Data Processing

- Historical data:
  - Swamp Angel Study Plot: WY 2006 – Present
  - Senator Beck Study Plot: WY 2006 – Present
  - Grand Mesa Study Plot: WY 2009 – Present
- Near-real-time collection:
  - Automated hourly refresh rate
- Data Access
  - Interactive browser-based visualization
  - Customizable data product download

WEBS Data Collection Architecture



1) Data from SASP and SBSP staged to ftp.snowstudies.org

2) Data from GMSP obtained by direct connection to the tower

3) A Cron job pulls down the latest hourly data

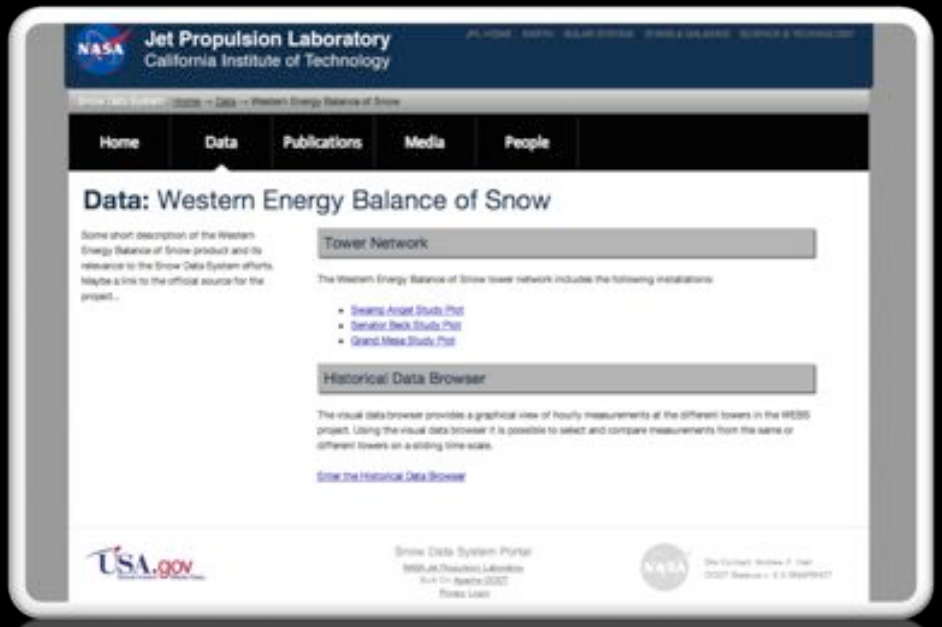
4) Data from all stations is homogenized and cleaned

5) Data is stored in MongoDB for fast, scalable querying

6) Data is selectively extracted and formatted as needed for data delivery

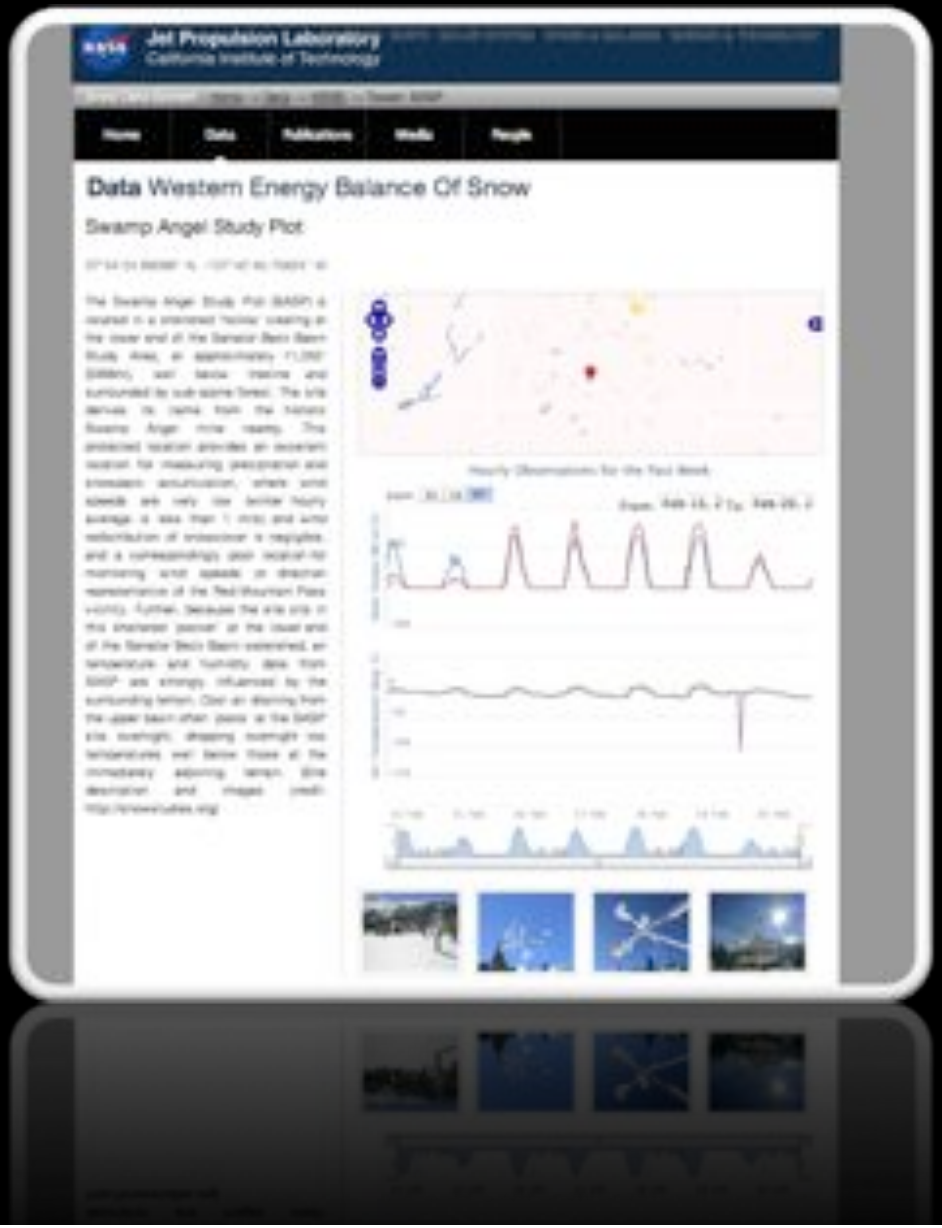
7) Users interact with, and request, data via a browser-based interface.

WEBS Browser Interface



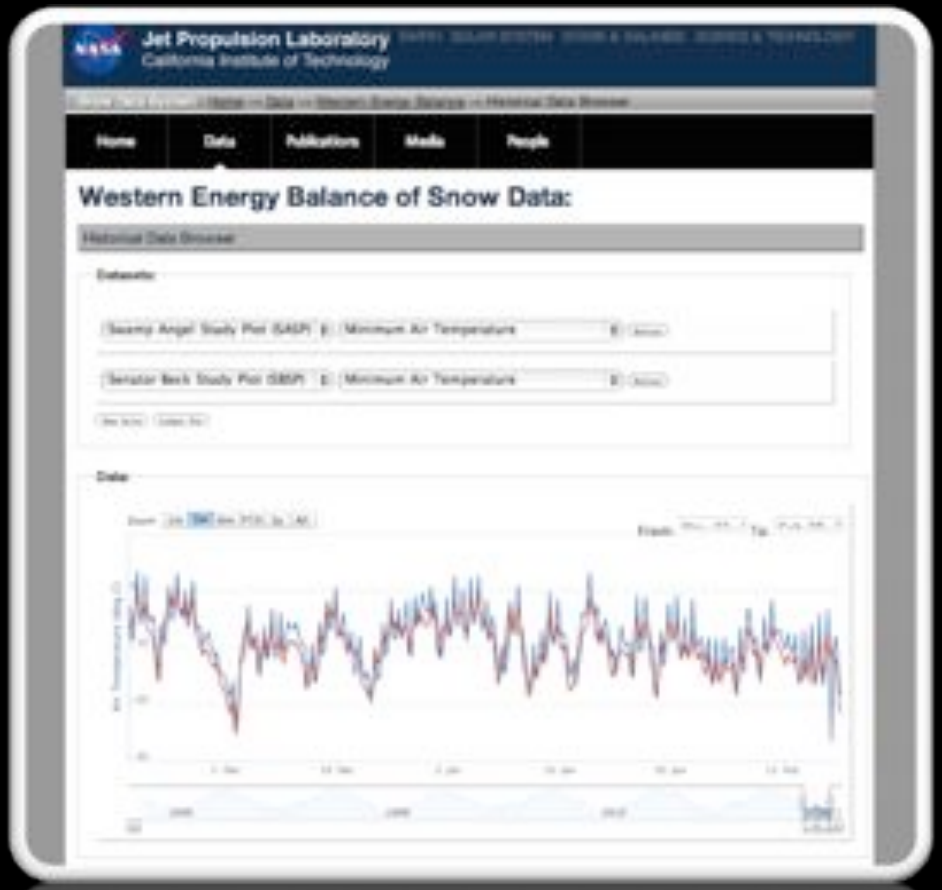
- Access to tower-specific information
- Access to the full range of historical data

WEBS Browser Interface

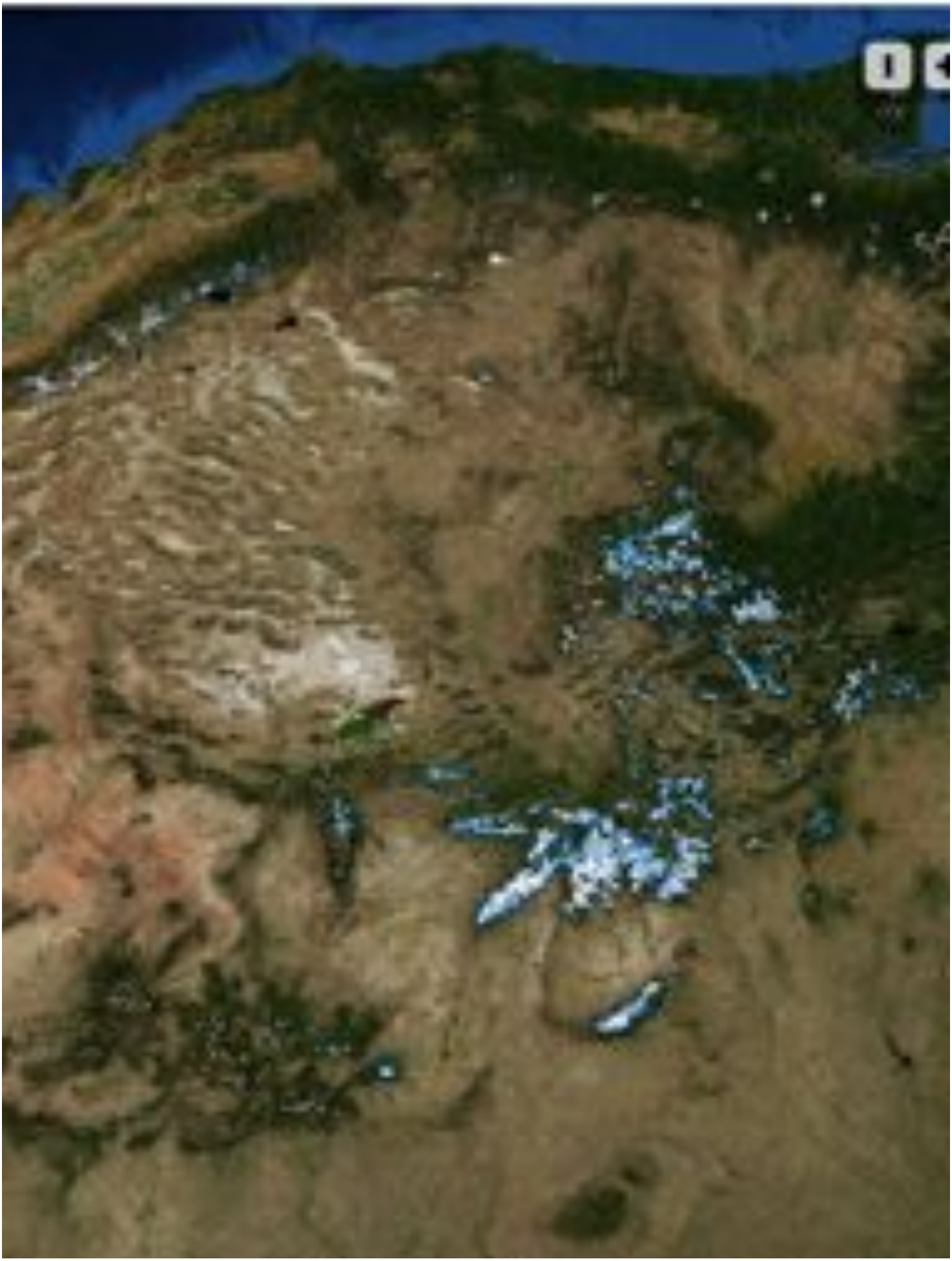


- Detailed Tower Information
  - Geographical location
  - Equipment background
  - Latest observational data
  - Site Photos

WEBS Browser Interface



- Interactive data visualization
  - Select towers
  - Select parameters
  - Select date ranges
  - Select download format

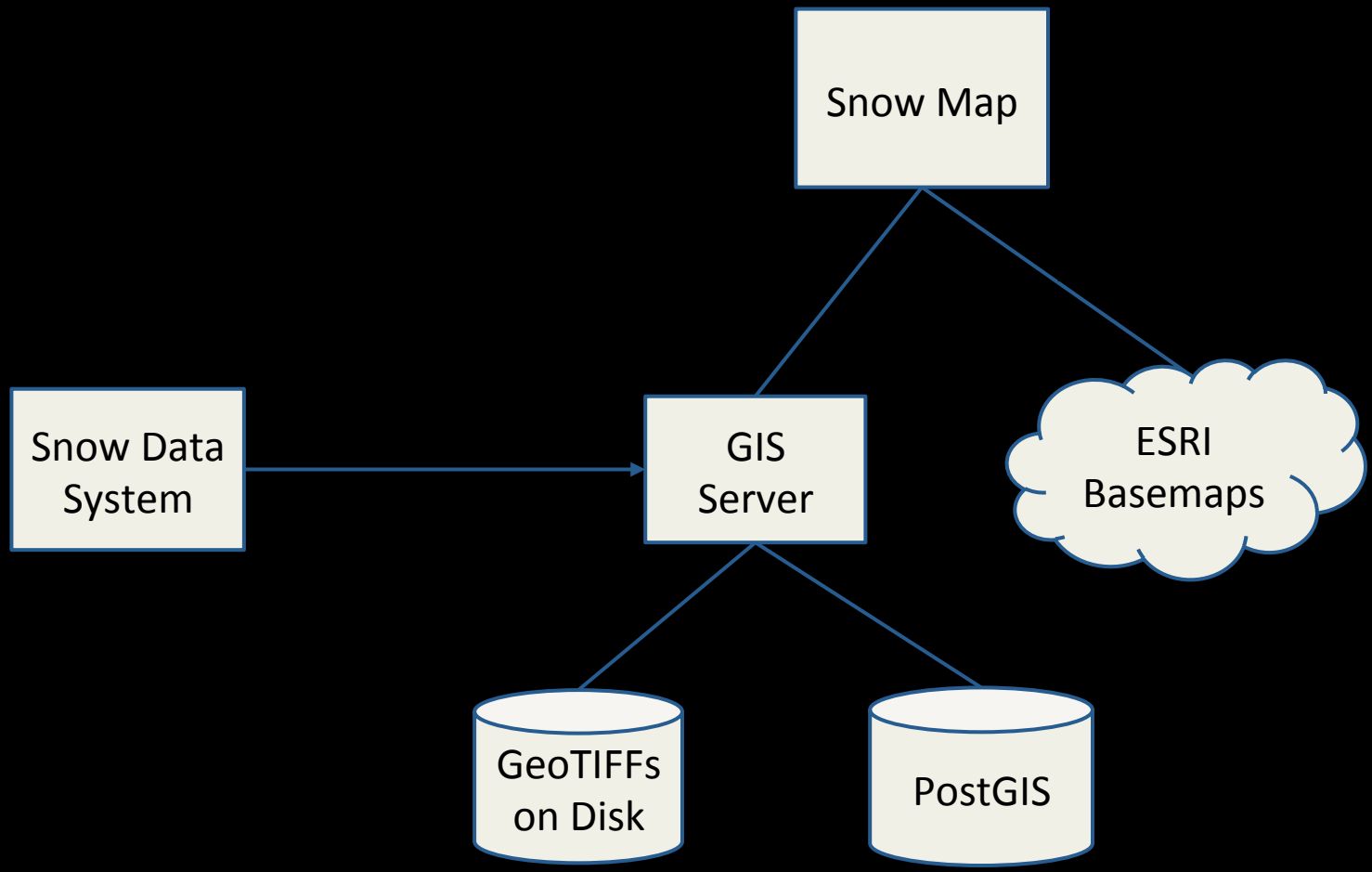


Partnering/Collaborations

- Discussions underway with
  - NOAA Colorado Basin River Forecast Center
  - California Department of Water Resources
  - Bureau of Reclamation
- Discussions ongoing with ESRI
- Partnering with UCLA on WEBS
  - McKenzie Skiles
- NSIDC, Mary Jo Brodzkik & Marilyn Kamanski


Questions?

Snow Map Architecture



Snow Map Detail

- Use WMS
  - Many GIS components support this out of the box.
  - For instance, Leaflet that we use for our map
- Layers exposed via WMS will be timed based
  - Historical dataset
  - Lance NRT
- Define styles for the data using Styled Layer Descriptor
  - SLD is a standard and supported by most GIS servers
  - Easily change styles or support multiple styles per layer
  - Clients can pick from available styles on a layer
- Expose tower based information using WFS
  - Click on a tower to get a graph
- Publish our own basemap if needed
  - For instance a hillshade or color hillshade on the DEM used during processing