

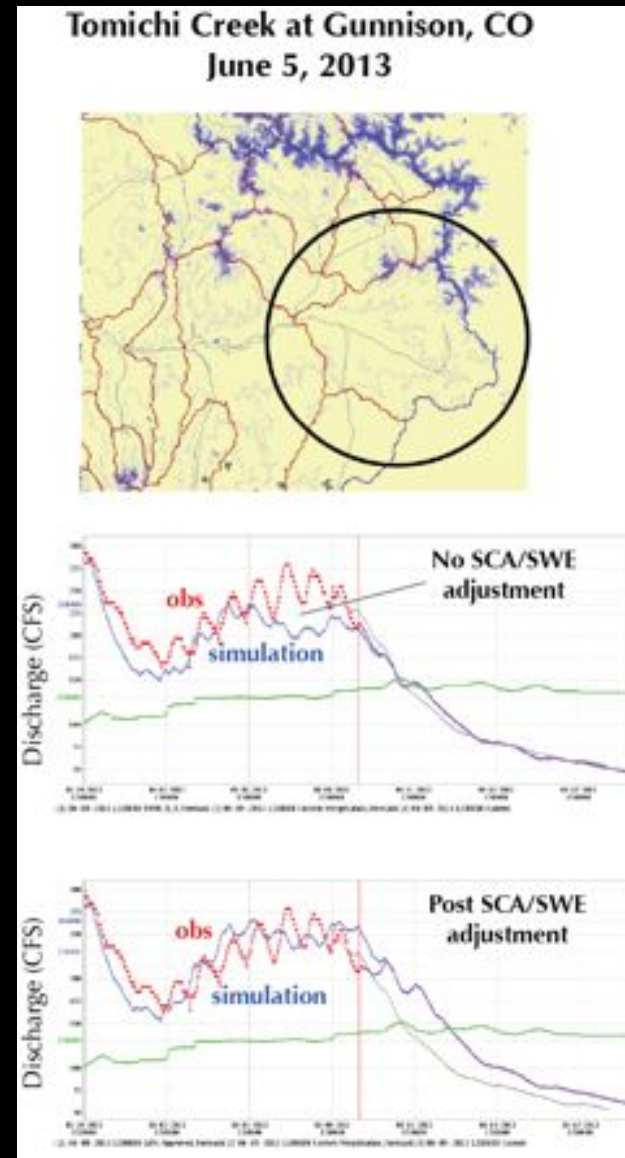
Airborne Snow Observatory: fusion of imaging spectrometer and scanning lidar for quantifying the mountain snowpack



Thomas H. Painter, Kostas Andreadis, Rich Atwater, Dan Berisford, Joe Boardman, Maziyar Boustani, Jeff Deems, Frank Gehrke, Cameron Goodale, Dan Goods, Jason Horn, Peter Kirchner, Shakeh Khudikyan, Danny Marks, Chris Mattmann, Bruce McGurk, Paul Ramirez, Megan Richardson, McKenzie Skiles, Rishi Verma, Adam Winstral, Rojeh Yaghoobi, Paul Zimdars

Collaboration with CBRFC

- NASA Applied Sciences project with CBRFC
- Using satellite retrievals of snow cover to improve forecasting with SWE nudge
- Still need SWE





The way we've measured snow in the West since 1910



The way we
want to see it

.... 39 million times more
coverage



10 km

Albedo

Imaging Spectrometer

0.35-1.05 μm

2 m spatial resolution from 4000 AGL

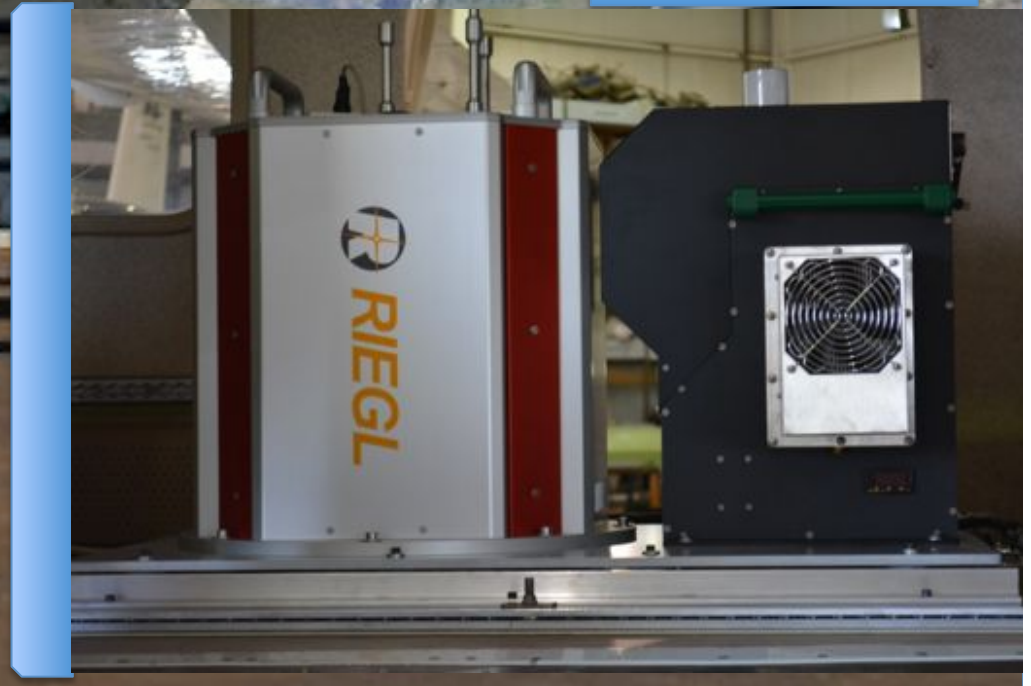


3D Scanning LiDAR

1064 nm

1 m spatial resolution

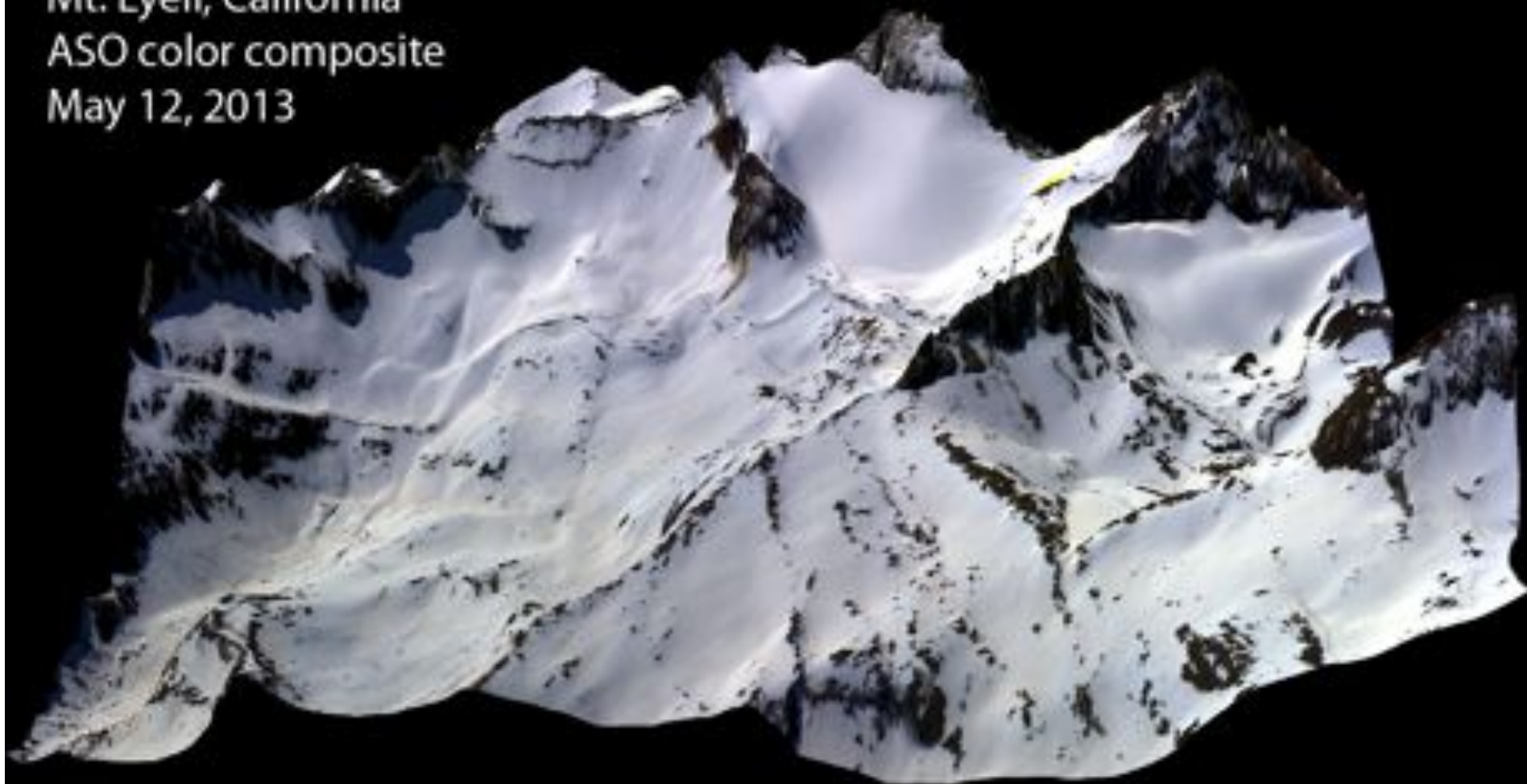
Snow Water Equivalent



AS ❄️

ASO-DM1 Results

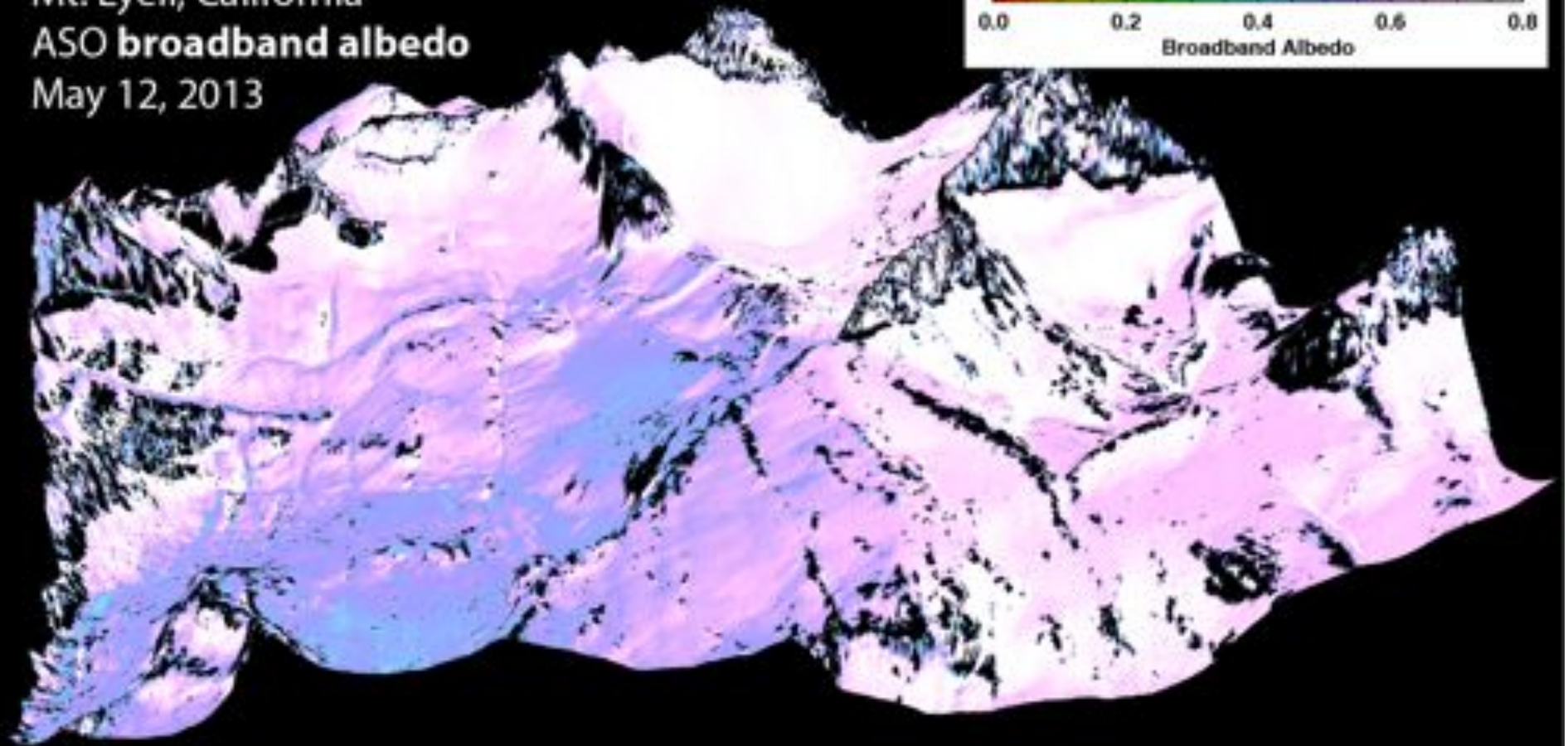
Mt. Lyell, California
ASO color composite
May 12, 2013





ASO-DM1 Results

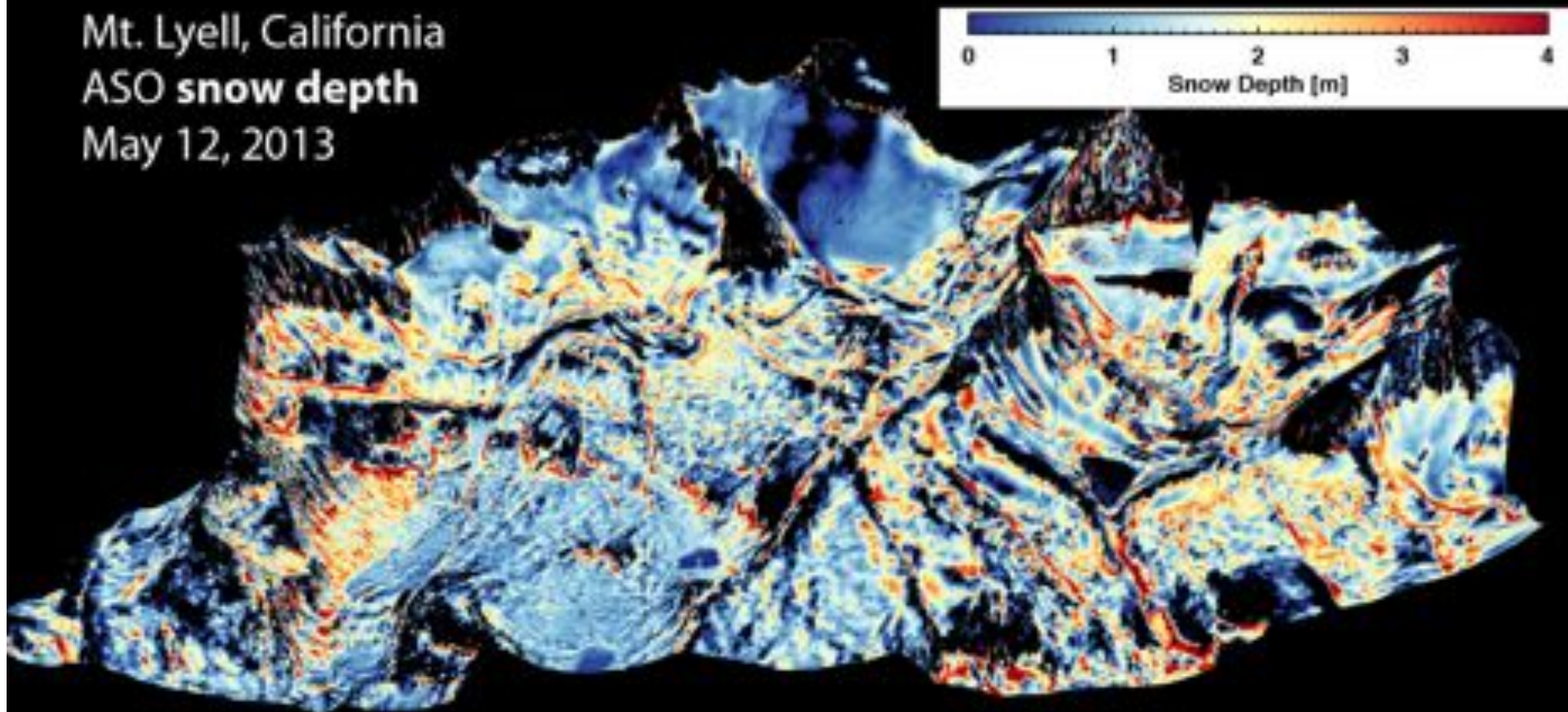
Mt. Lyell, California
ASO **broadband albedo**
May 12, 2013



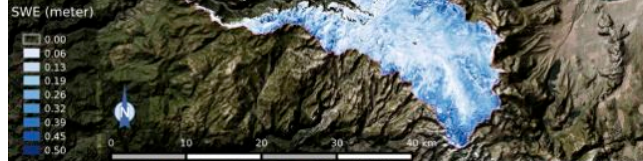
AS ❄️

ASO-DM1 Results

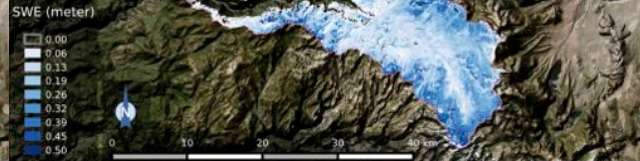
Mt. Lyell, California
ASO **snow depth**
May 12, 2013



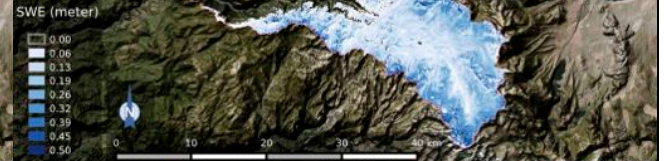
Snow Water Equivalent
Tuolumne Basin
Mar 23, 2014



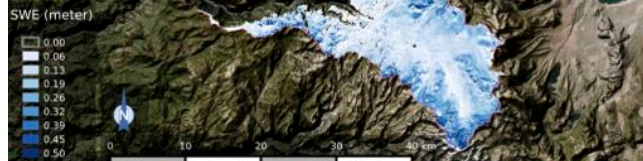
Snow Water Equivalent
Tuolumne Basin
Apr 07, 2014



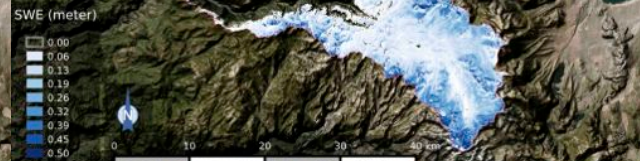
Snow Water Equivalent
Tuolumne Basin
Apr 13, 2014



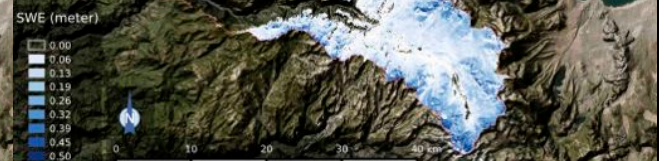
Snow Water Equivalent
Tuolumne Basin
Apr 20, 2014



Snow Water Equivalent
Tuolumne Basin
Apr 28, 2014



Snow Water Equivalent
Tuolumne Basin
May 02, 2014



Snow Water Equivalent
Tuolumne Basin
May 11, 2014



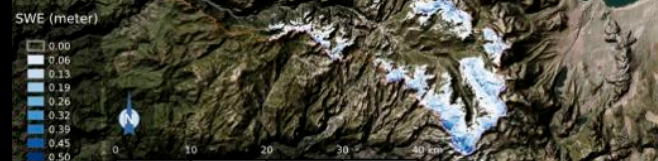
Snow Water Equivalent
Tuolumne Basin
May 17, 2014



Snow Water Equivalent
Tuolumne Basin
May 27, 2014



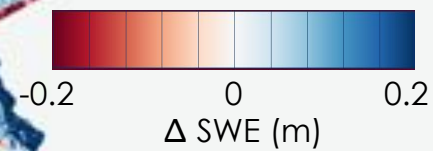
Snow Water Equivalent
Tuolumne Basin
May 31, 2014



Snow Water Equivalent
Tuolumne Basin
Jun 05, 2014

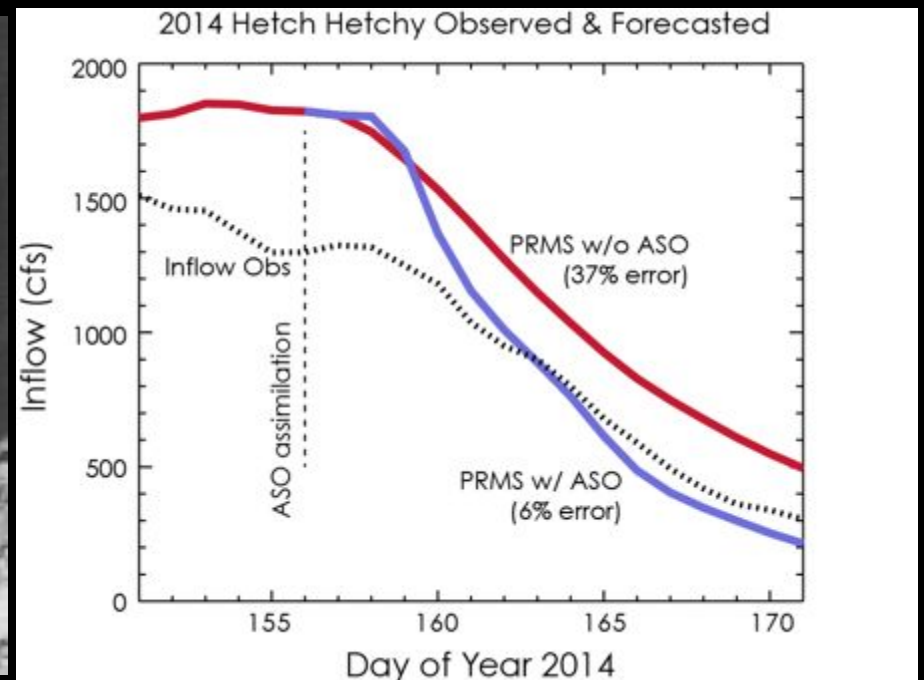


Snowfall
24 March to 7 April 2014
Lyell Fork, Tuolumne



Runoff Forecasting

Hetch Hetchy – Tuolumne River Basin



Snowmelt runoff forecasting with USGS Precipitation/Runoff Modeling System (PRMS)

ASO in California Present + Near Future



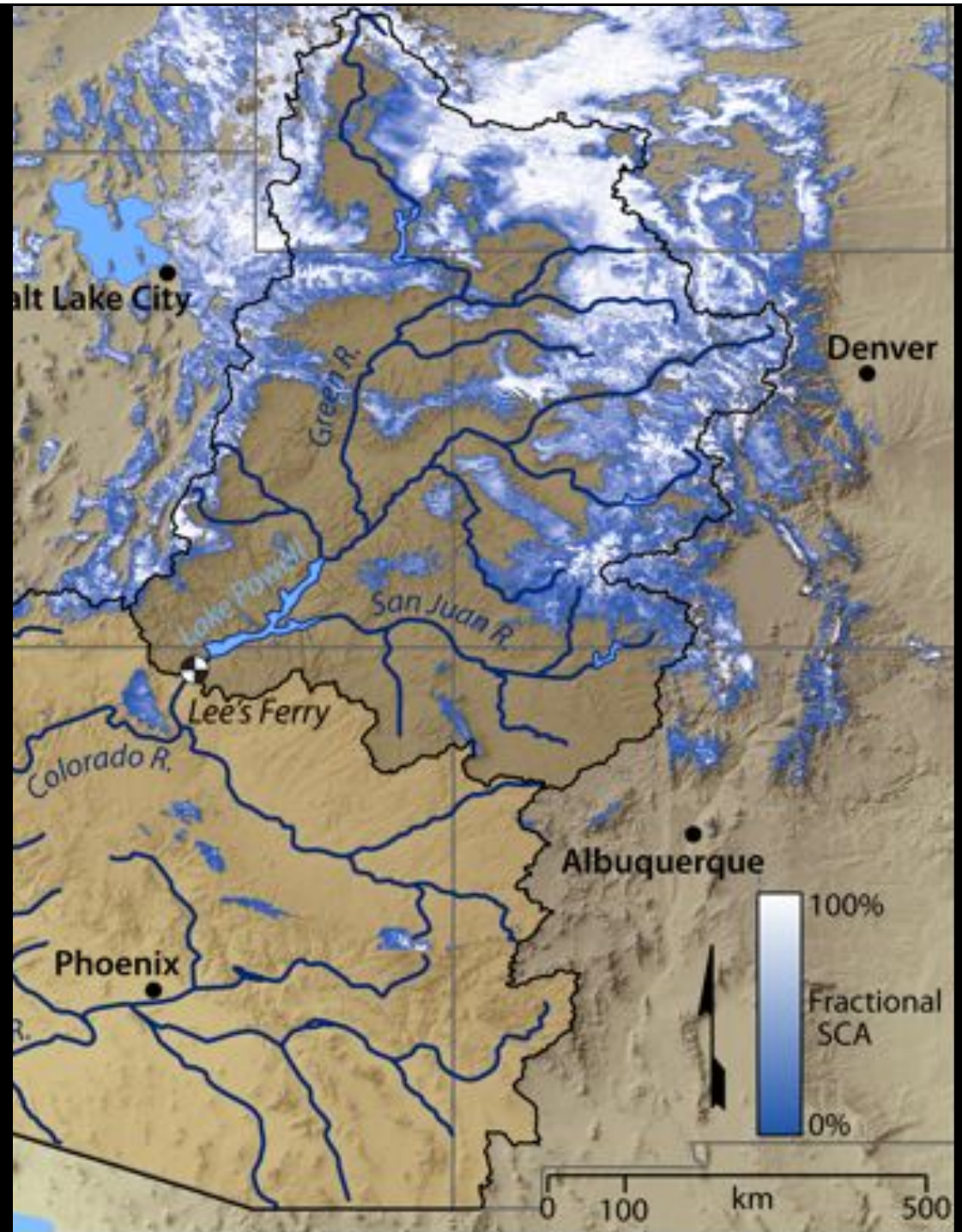
ASO in California Envisioned program



ASO in Colorado Present + Near Future



ASO in Colorado: Envisioned program



Fusions

- Global Precipitation Measurement Mission – validation of snowfall
- Atmospheric Rivers – understanding of snowfall production of ARs
- GRACE – quantitative knowledge of the snow contribution to gravity anomaly

Applications

- Quantitative water allocations
- April-July runoff forecast
- Markedly more accurate weekly snowmelt runoff forecasting
- Hydroelectric generation optimization
- Solid foundation for US-Mexico relations re: Colorado River snow accumulation