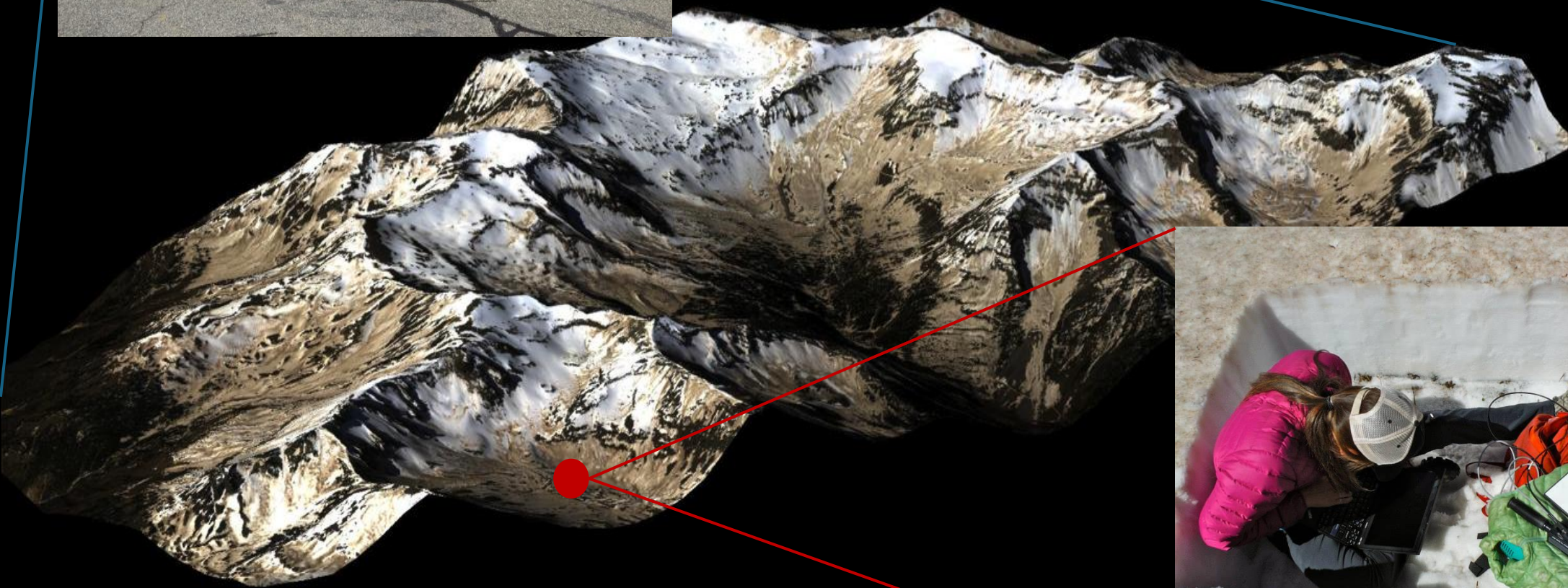
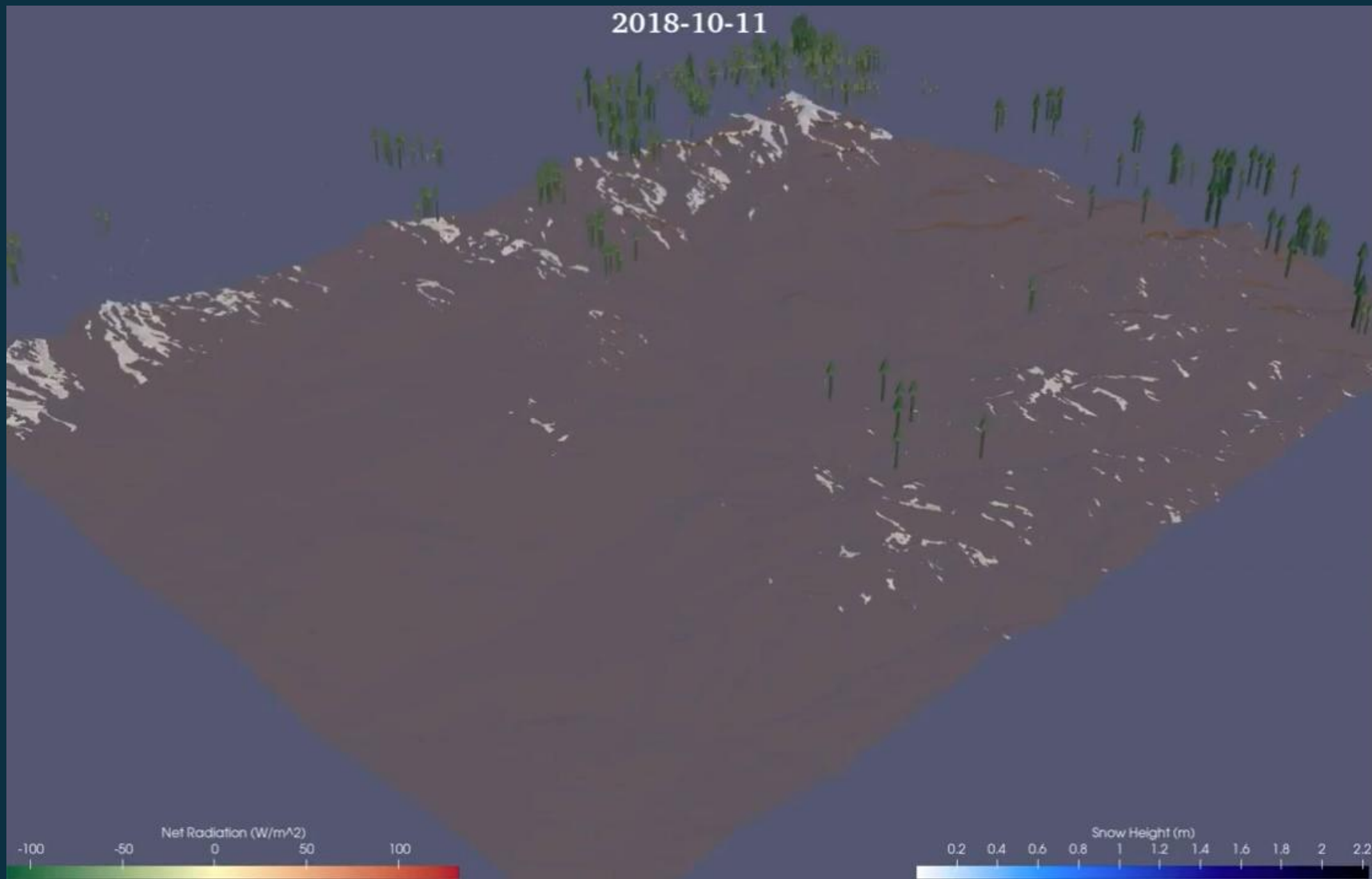


Advancing Hydrologic Prediction with Remotely Sensed Snow Cover and Albedo







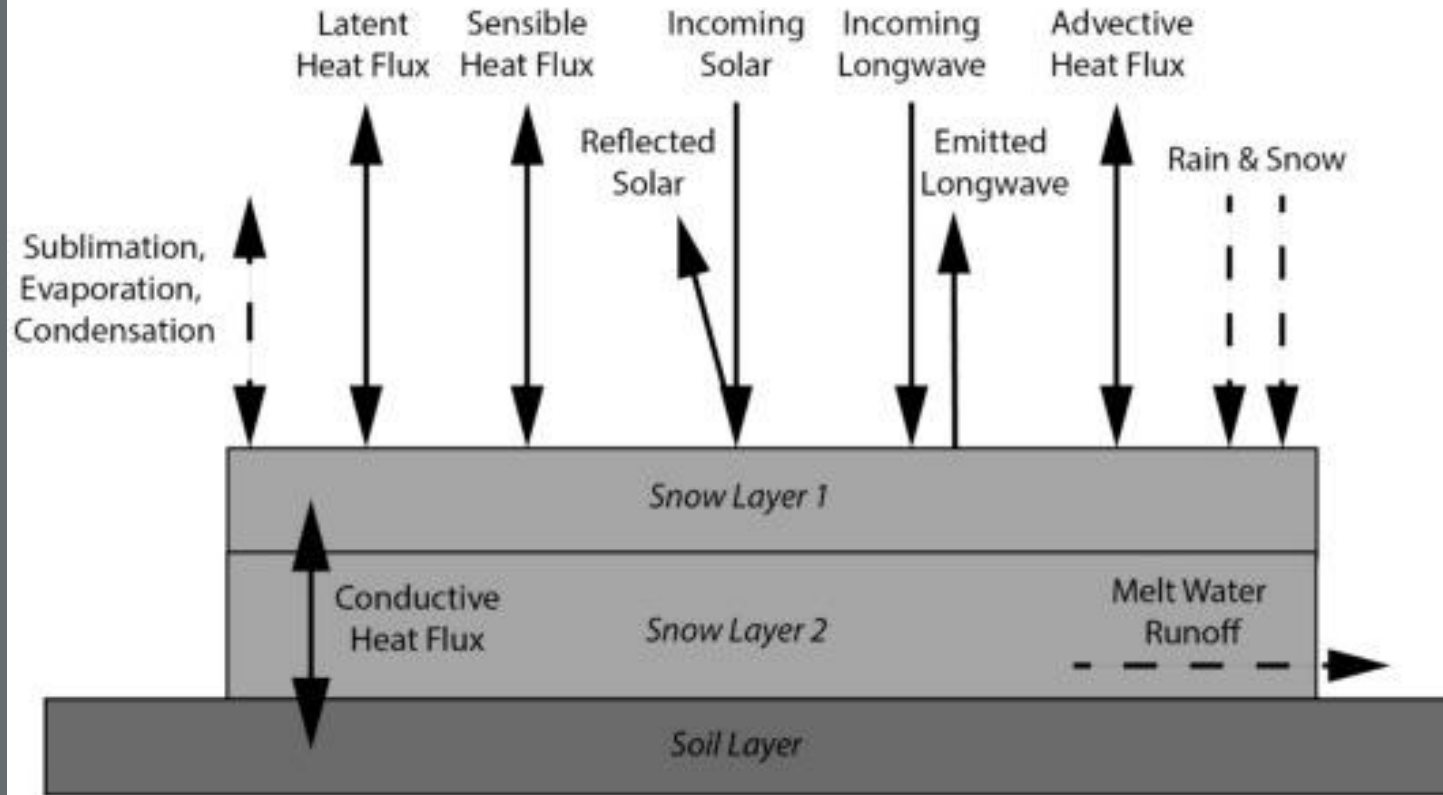
Hypothesis: Process-based modeling that integrates remotely sensed albedo could inform snowmelt timing, especially in ‘problem basins’ like those impacted by dust on snow.

Tradition Approach: Radiation in process-based snow models is parameterized, albedo as time since snowfall, a by-product of development when there were few measurements and RT was intractable.

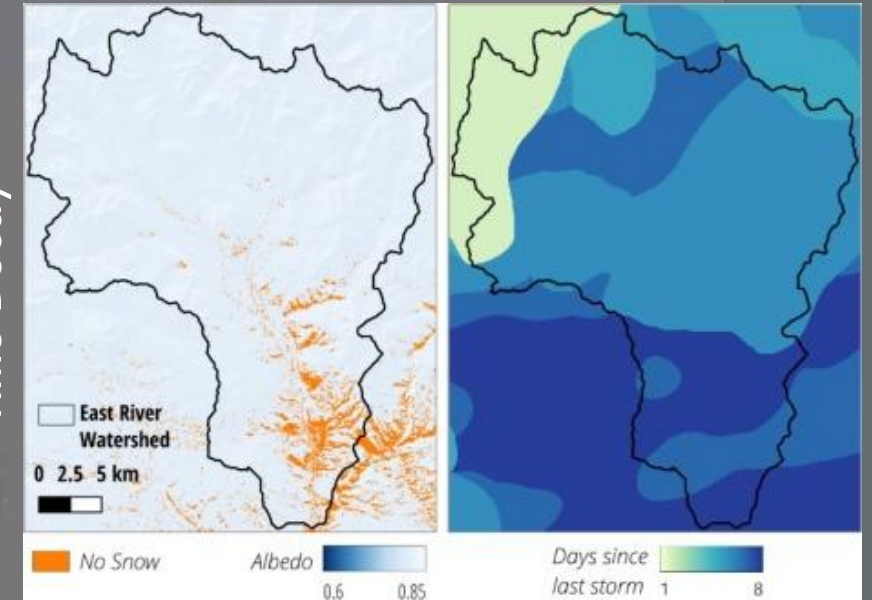
2018-10-11

East River, CO
April 15th Example

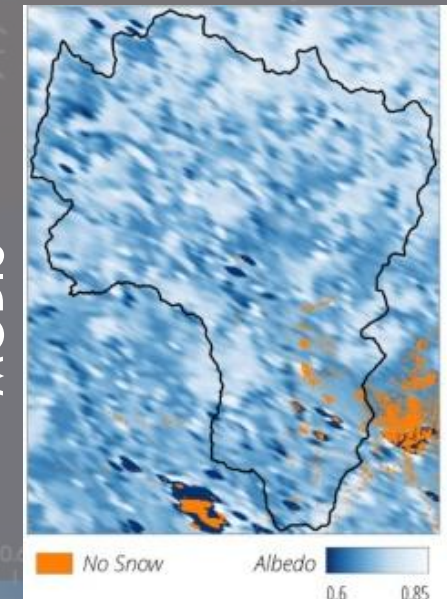
iSnobal Conceptual Diagram



Time Decay



MODIS

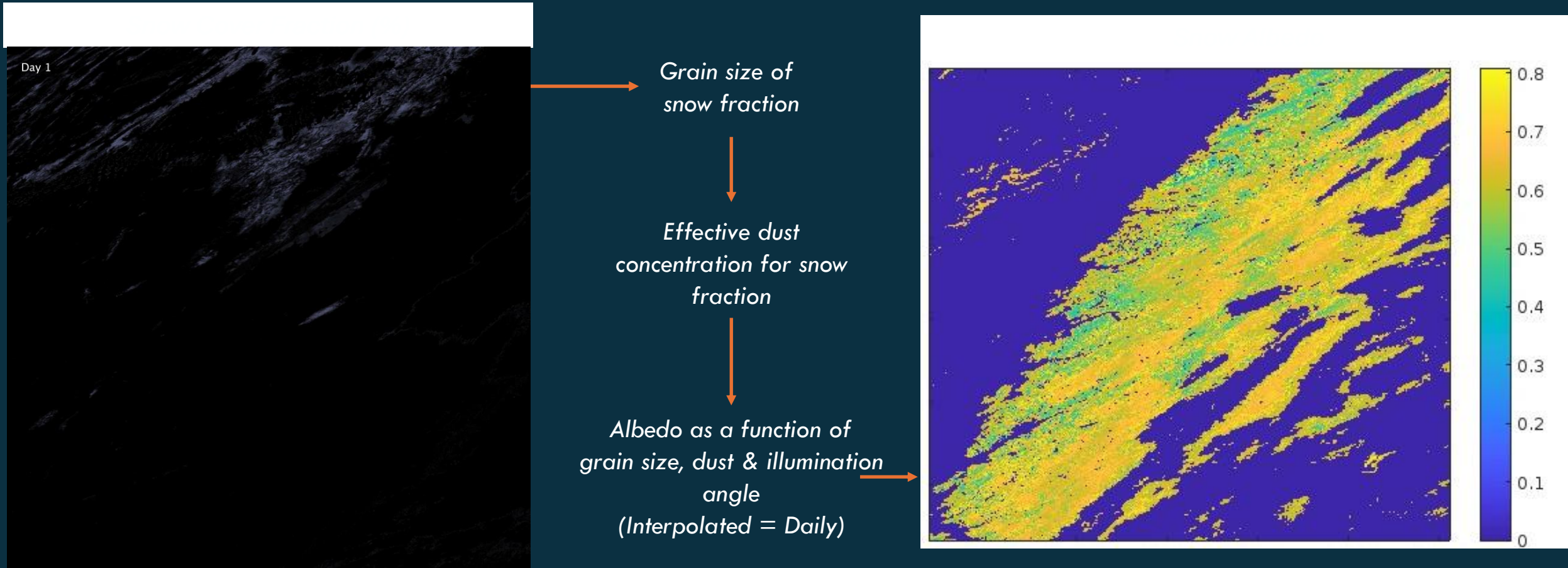


Model Forcing from HRRR

Incoming radiation is downscaled and terrain corrected

Run hourly, 50 - 100 m

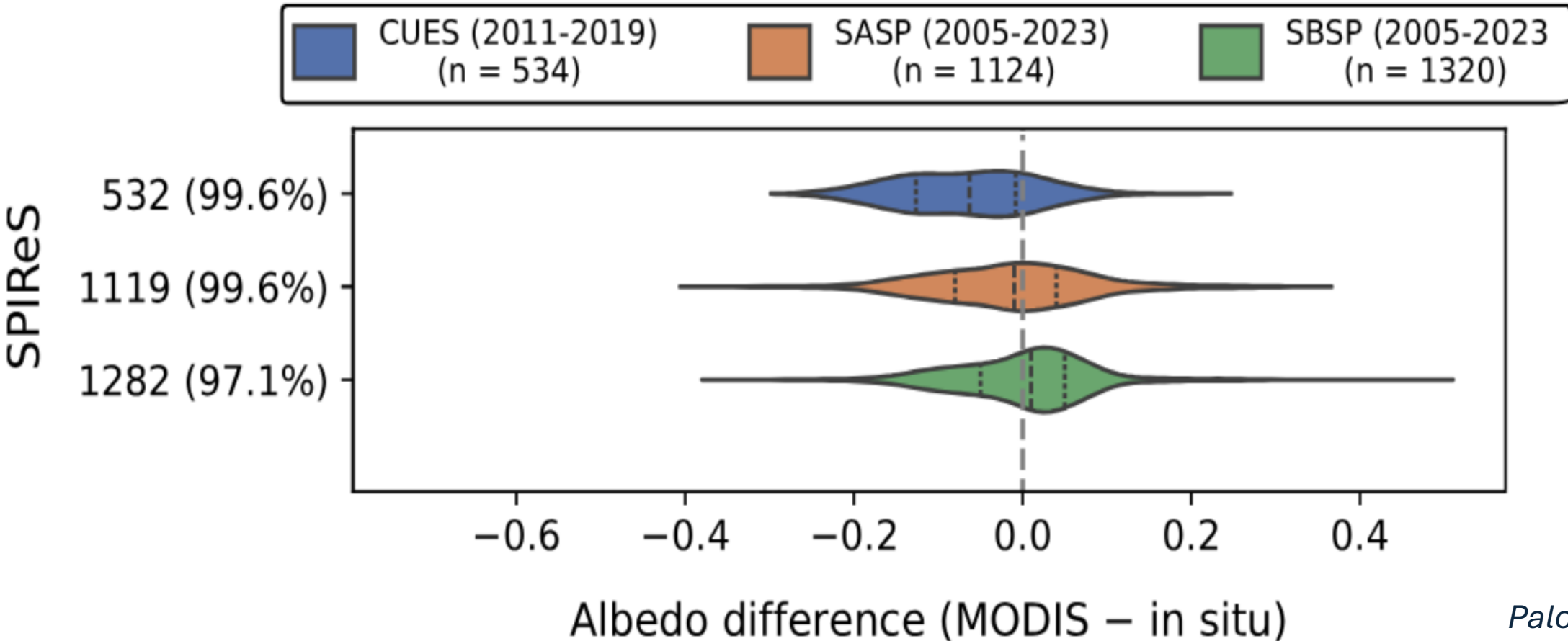
Remote Sensing *Fractional Snow Albedo*



Snow Property Inversion from Remote Sensing Bair et al., 2021

Open Access: Multispectral data (MODIS, VIIRS, Landsat) currently run in house at University of Utah

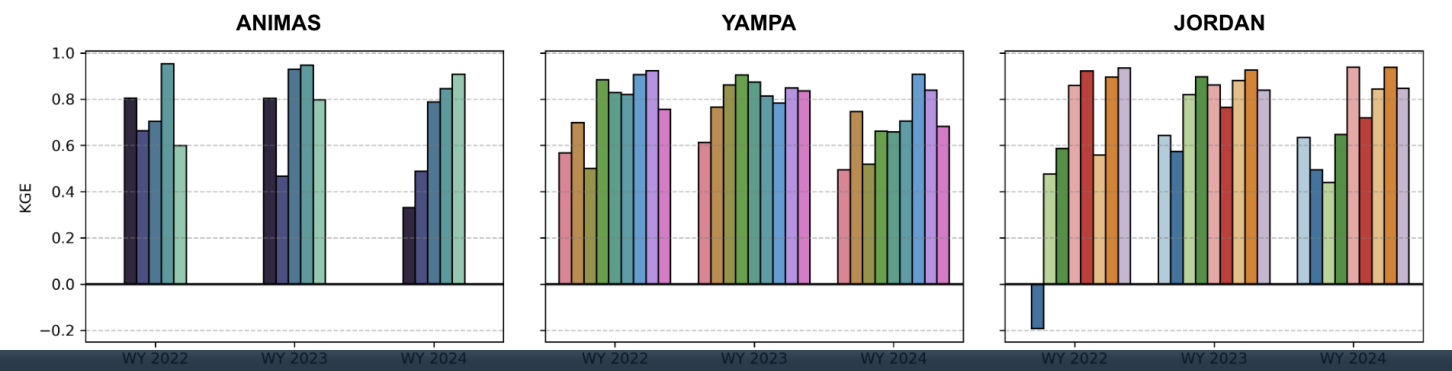
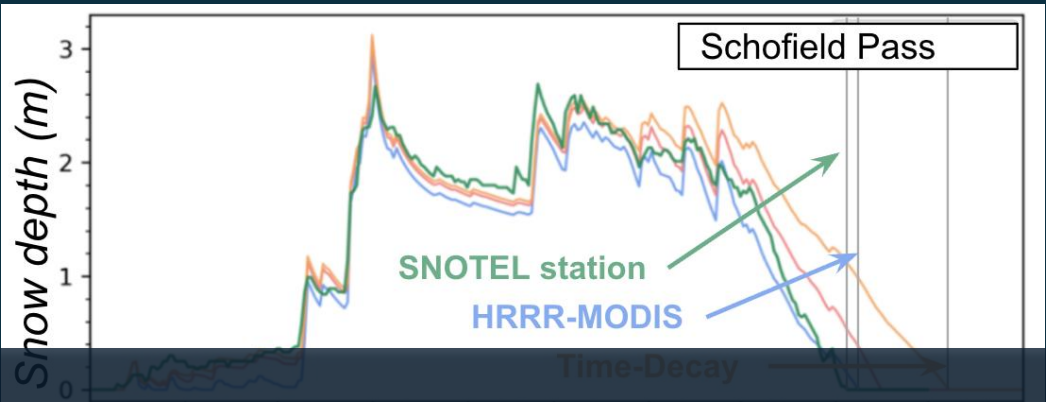
Remote Sensing *Fractional Snow Albedo*



Snow Property Inversion from Remote Sensing *Bair et al., 2021*

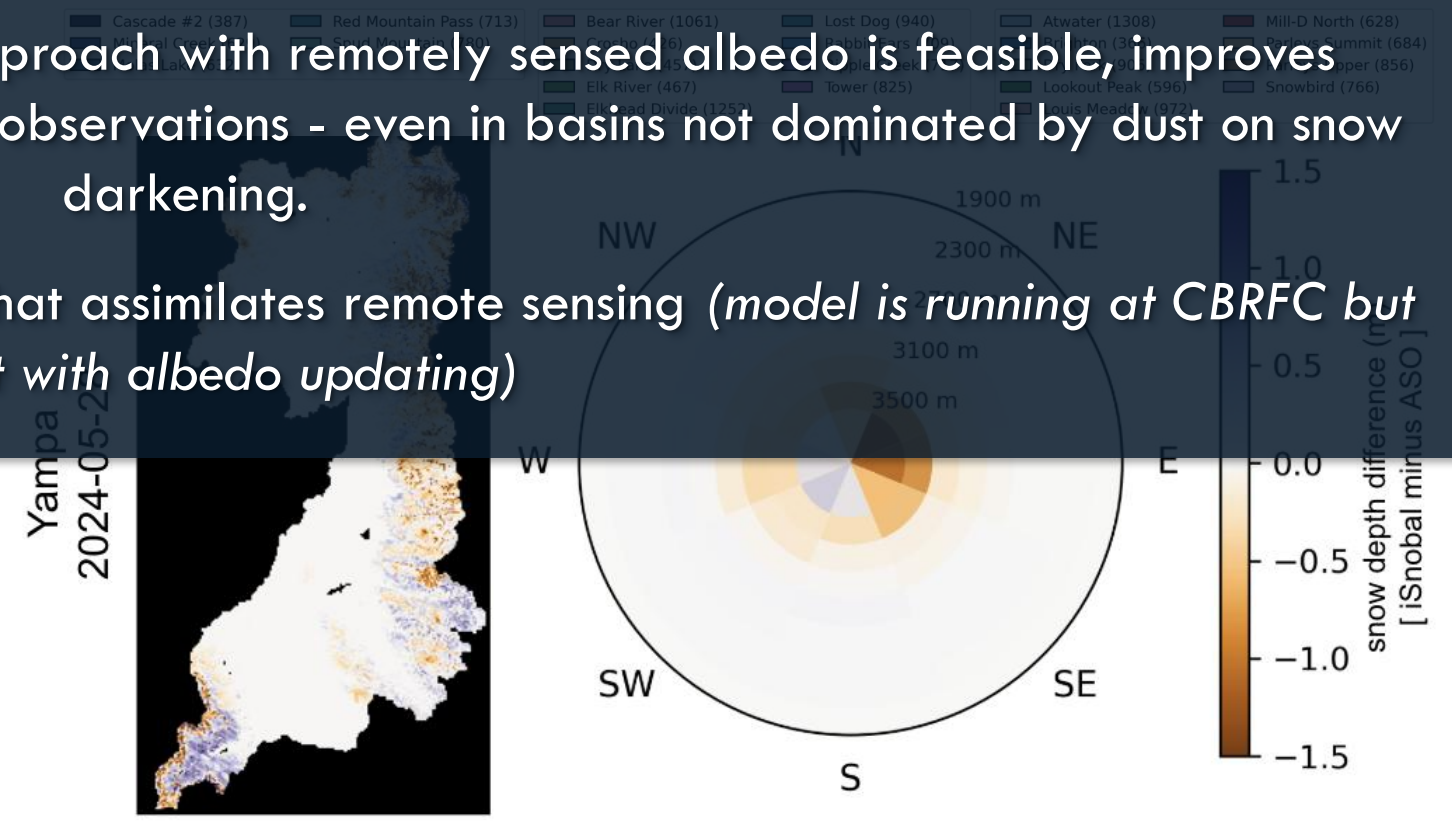
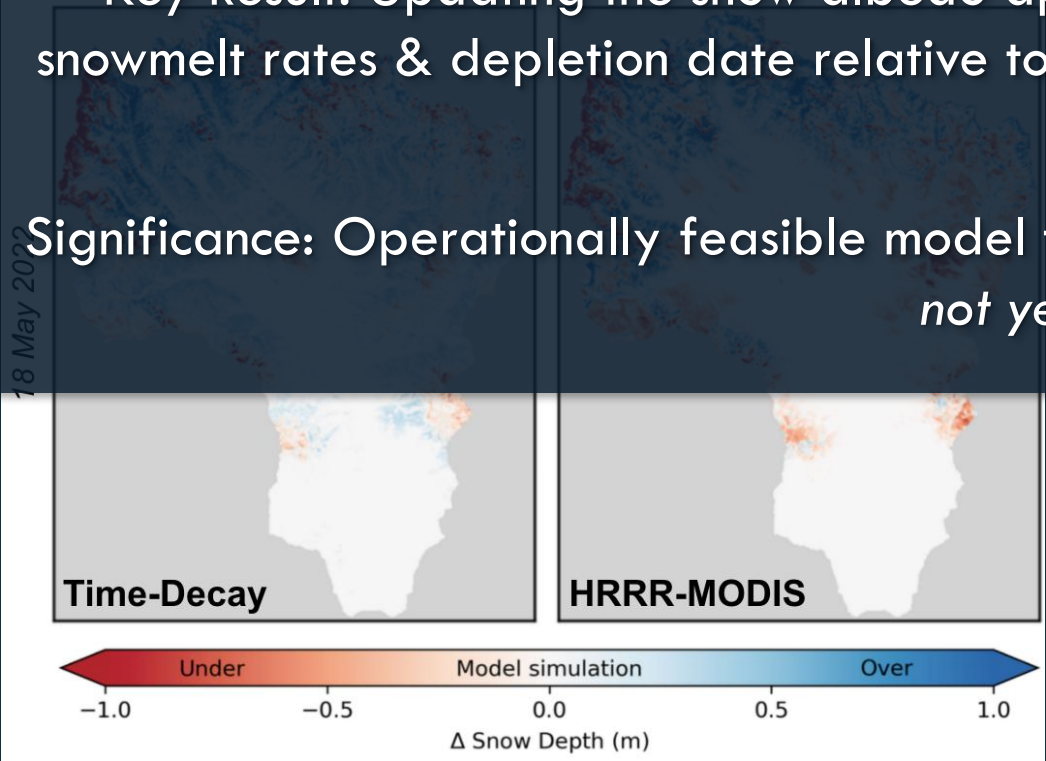
Open Access: Multispectral data (MODIS, VIIRS, Landsat) currently run in house at University of Utah

Albedo Remotely sensed vs time-decay parameterized iSnobal



Key Result: Updating the snow albedo approach with remotely sensed albedo is feasible, improves snowmelt rates & depletion date relative to observations - even in basins not dominated by dust on snow darkening.

Significance: Operationally feasible model that assimilates remote sensing (*model is running at CBRFC but not yet with albedo updating*)



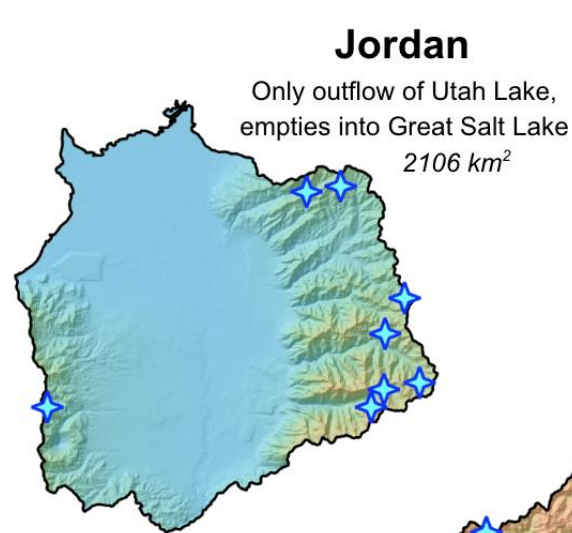
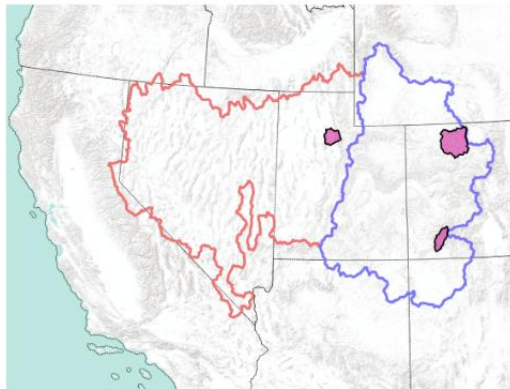
Value of Process Based Model *Energy Balance Across Snow Regimes*

STUDY AREAS

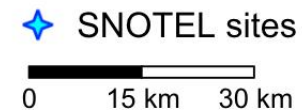
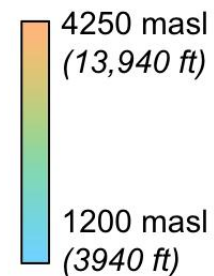
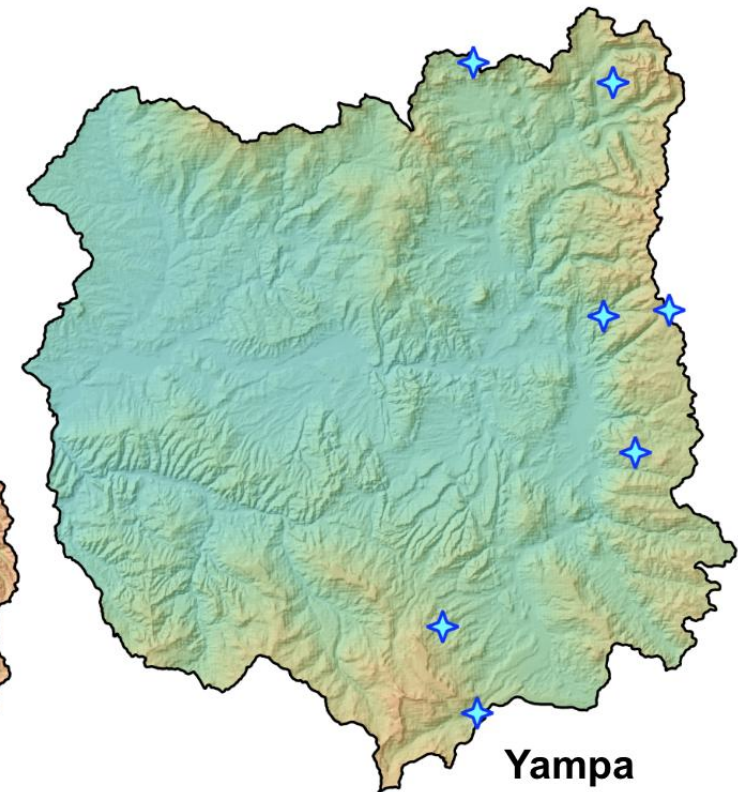
Snow-dominant headwater basins of the **Upper Colorado River Basin** and the **Great Basin** for **WY 2022–2024**

Storm snow
climate class

- Boreal
- Tundra
- Ephemeral
- Prairie
- Montane Forest

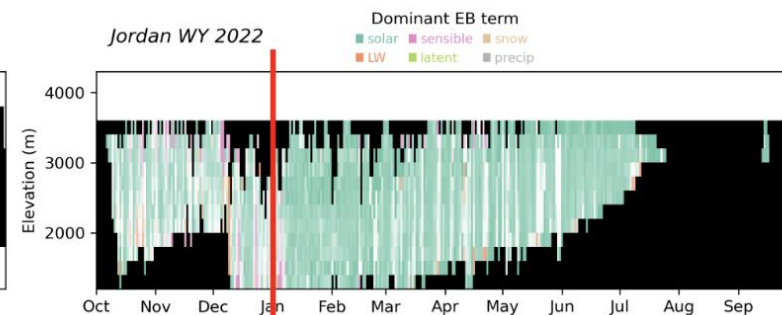
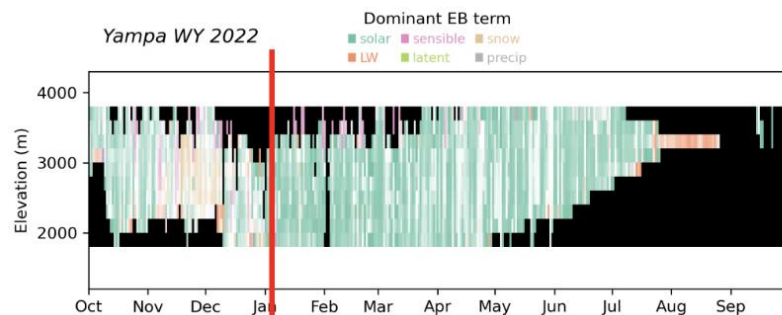
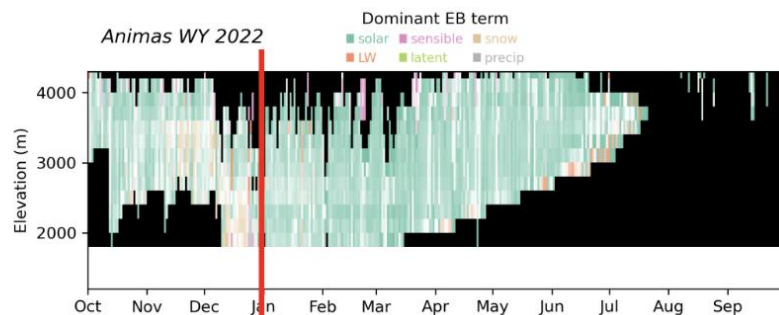


Animas
Contains tributary
of San Juan River
1986 km²

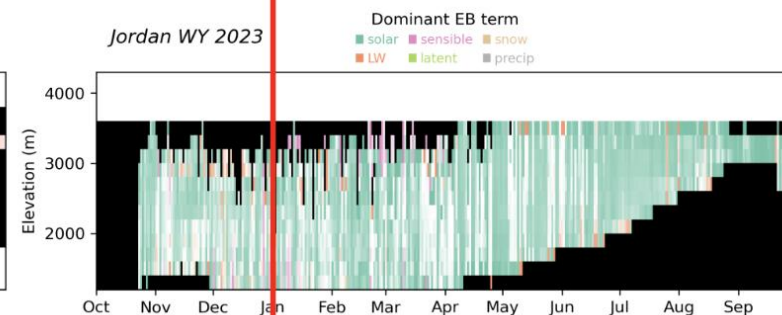
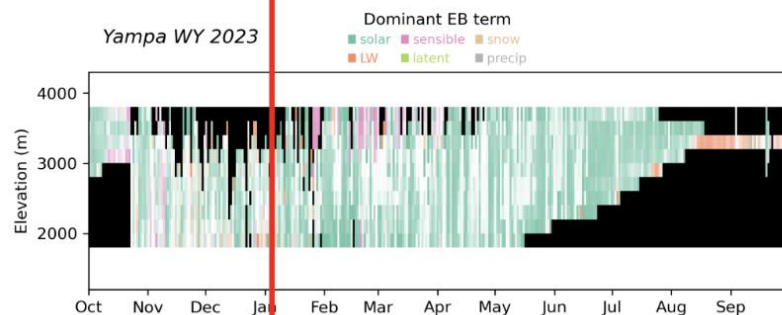
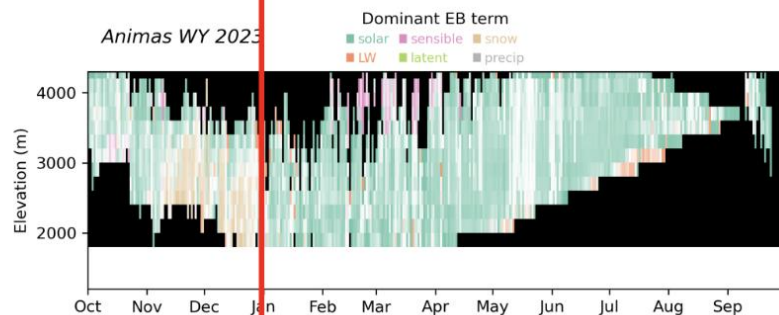
A topographic map of the Animas basin. The map shows the basin's outline and internal topography with a color gradient from light blue to brown. Several blue star symbols representing SNOTEL sites are marked along the eastern and southern edges of the basin.

Snow Energy Balance *Net solar dominates melt*

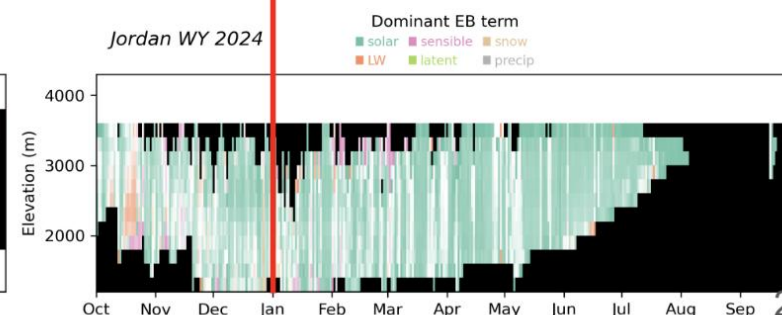
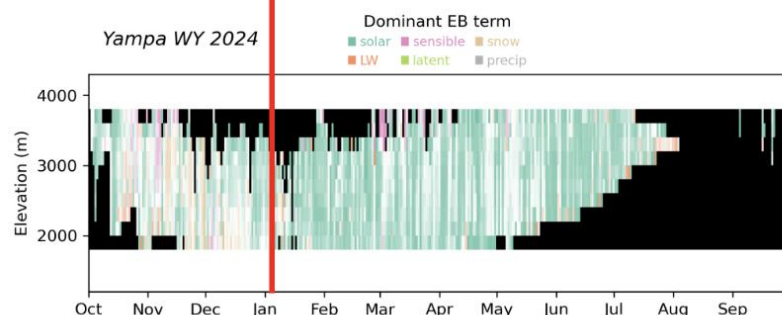
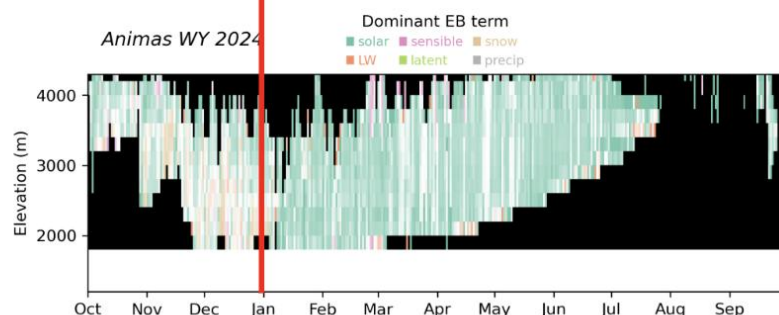
WY 2022



WY 2023



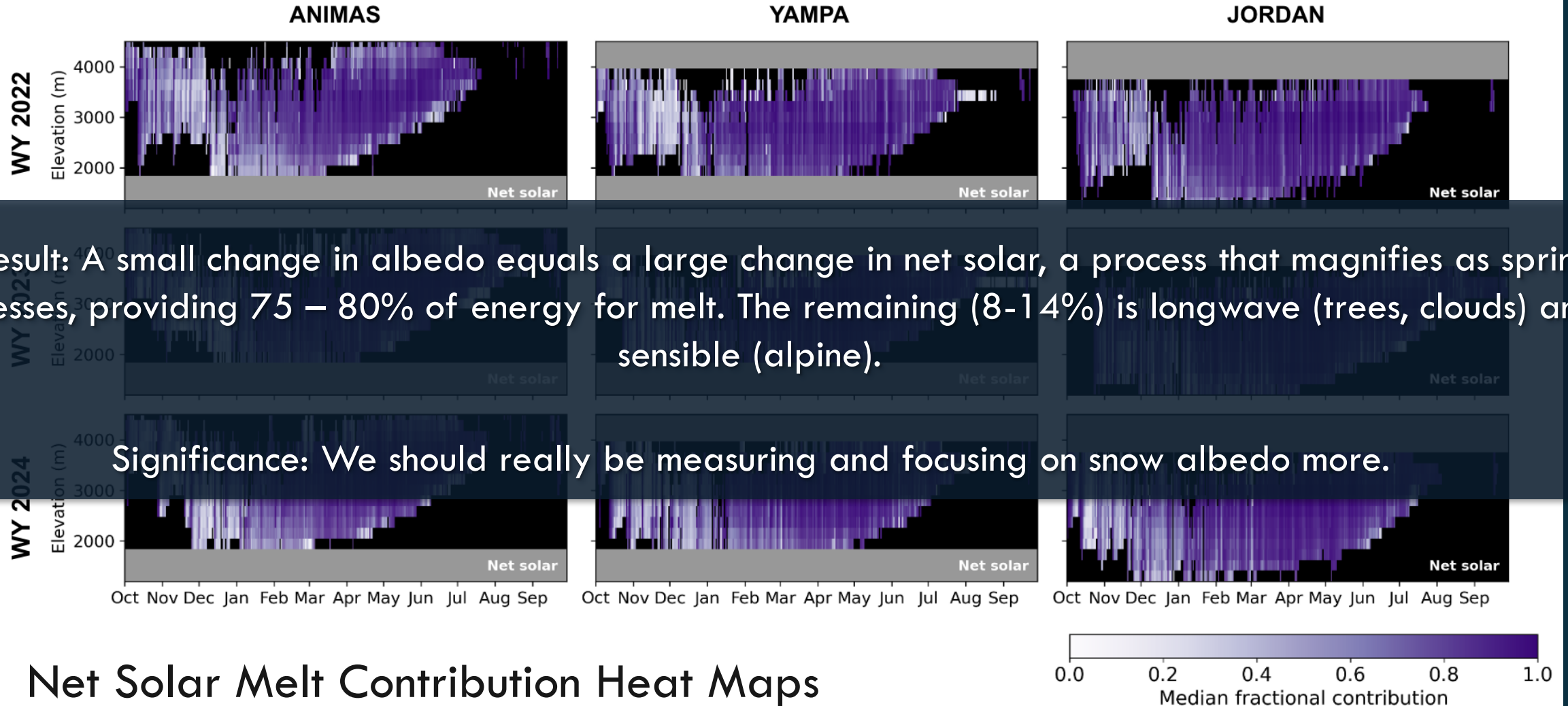
WY 2024



Energy Balance Heat Maps



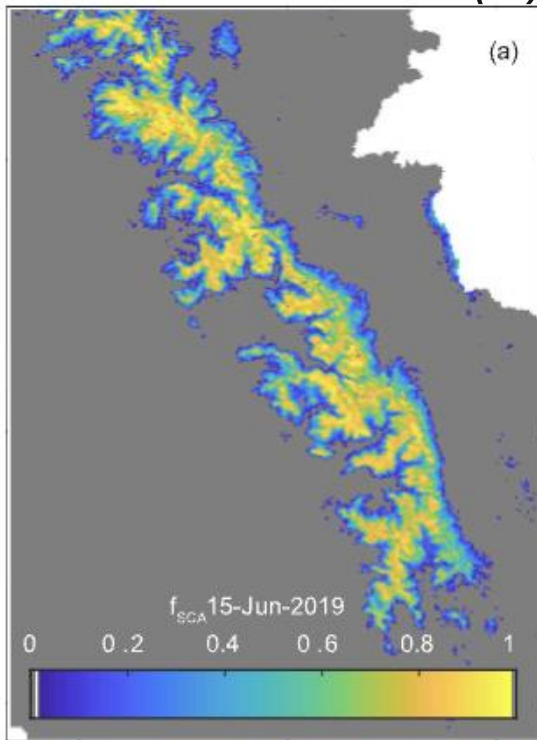
Net solar dominates melt *Snow Albedo Really Matters*



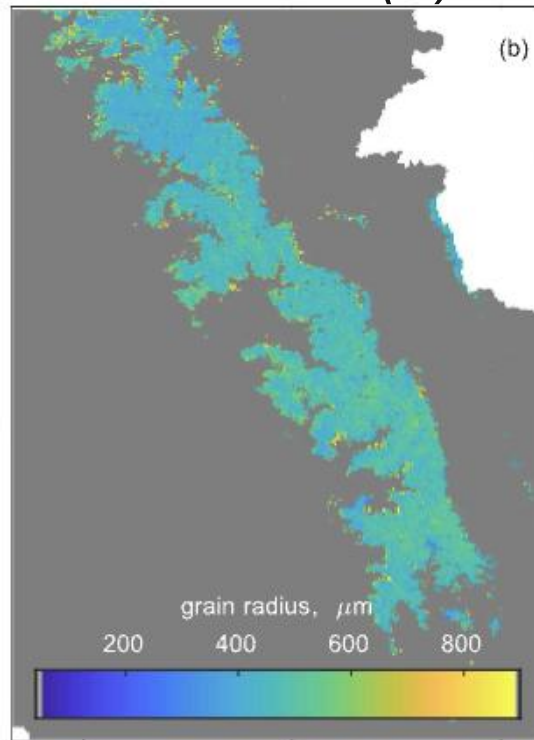
Challenge *Snow albedo is not measured from satellites*



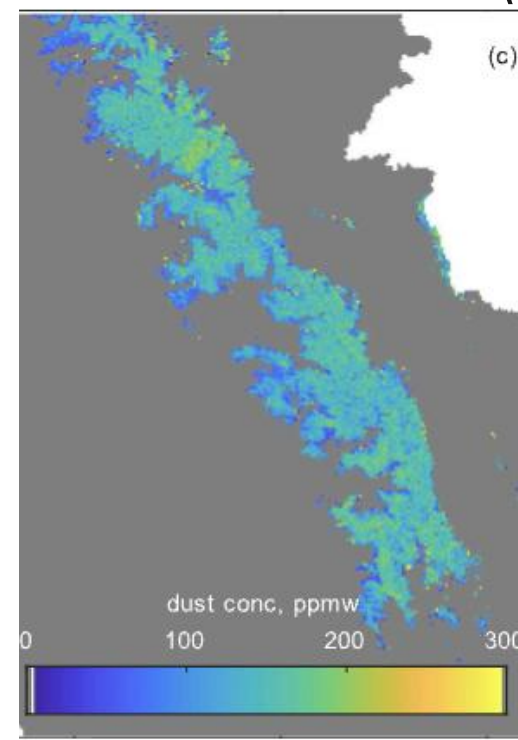
Fractional Snow (R)



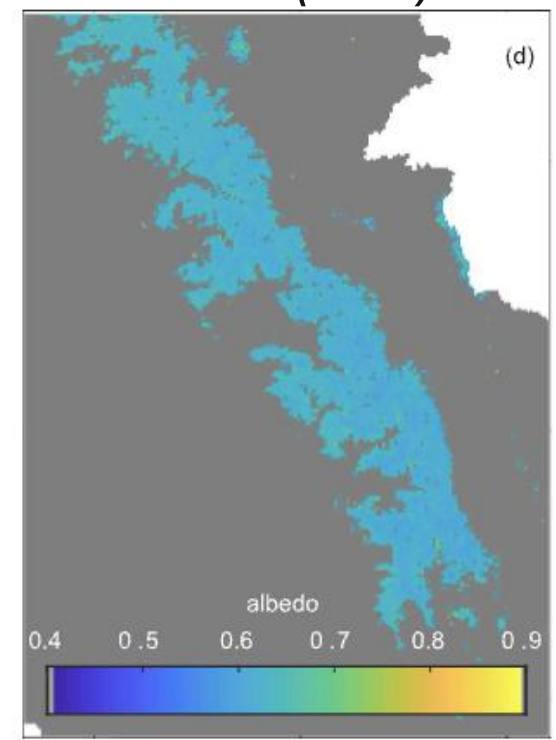
Grain Size (R)



Dust Concentration (R)



Albedo (LUT)



MODIS True Color

Land Surface Albedo

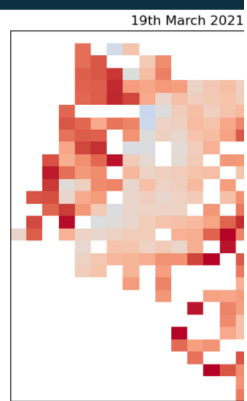
Sierra Nevada, CA June 15th, 2019

Challenge Retrievals, Scale, Clouds, Trees

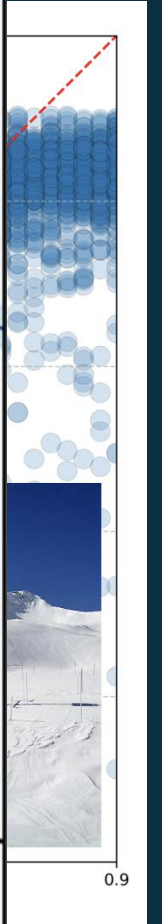
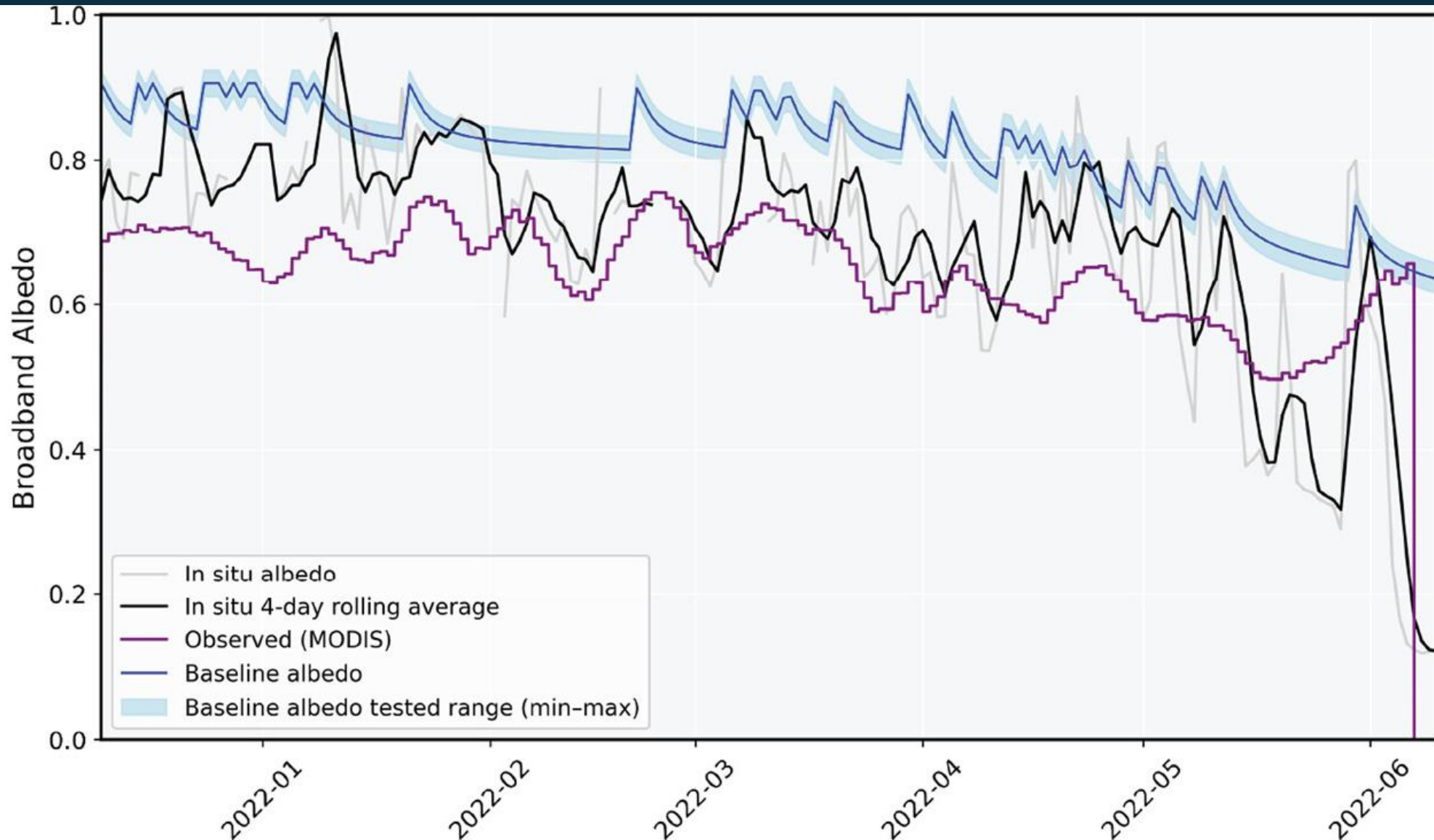
Grain Size



Albedo

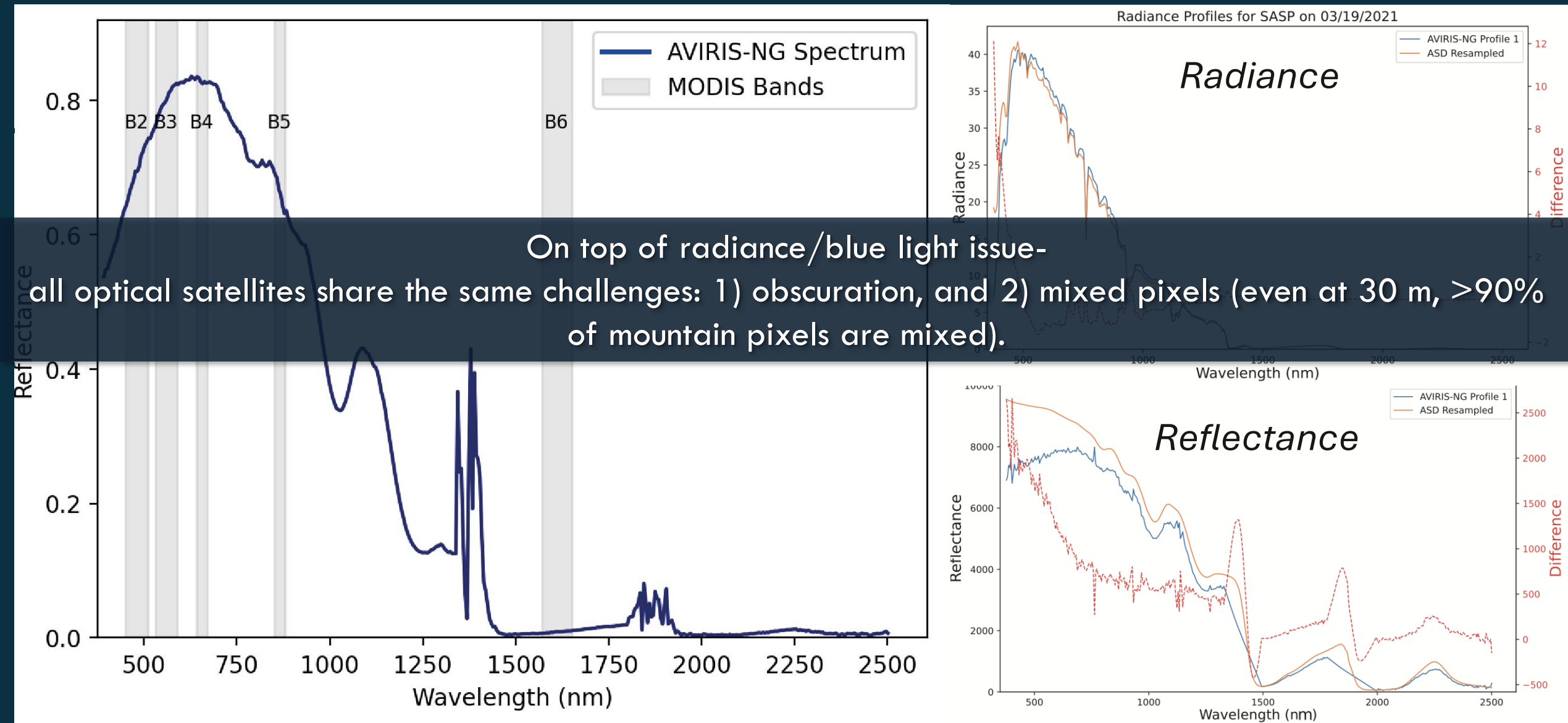


Cor



tu
bias

Hyperspectral will save the day?! *Not yet.*



Suggestions for NASA

- Focus on snow albedo alongside SWE
 - How much water **and** when (and how fast) it will melt
- We can retrieve snow albedo, but it's not 'solved'
 - Mixed pixels, cloud obscuration, scale mismatch
 - New methods to combine fine and coarse scale retrievals and **gap fill**
- Snow specific cal/val and optical property ground validation campaigns (ground snow observatory?!)
- No single satellite will ever give us all the information we need about snow - fused snow dataset with SWE *and* optical properties
- More integrated watershed focused efforts, SWE is not runoff

Questions/comments: m.skiles@utah.edu

