Olympic Mountains SWE Reanalysis Model Validation

Carina Thompson, Eric Gagliano, Hannah Besso

Background

Importance

-Snow provides a significant source of water to approximately ⅙ of the world's population (Barnett et al. 2005)

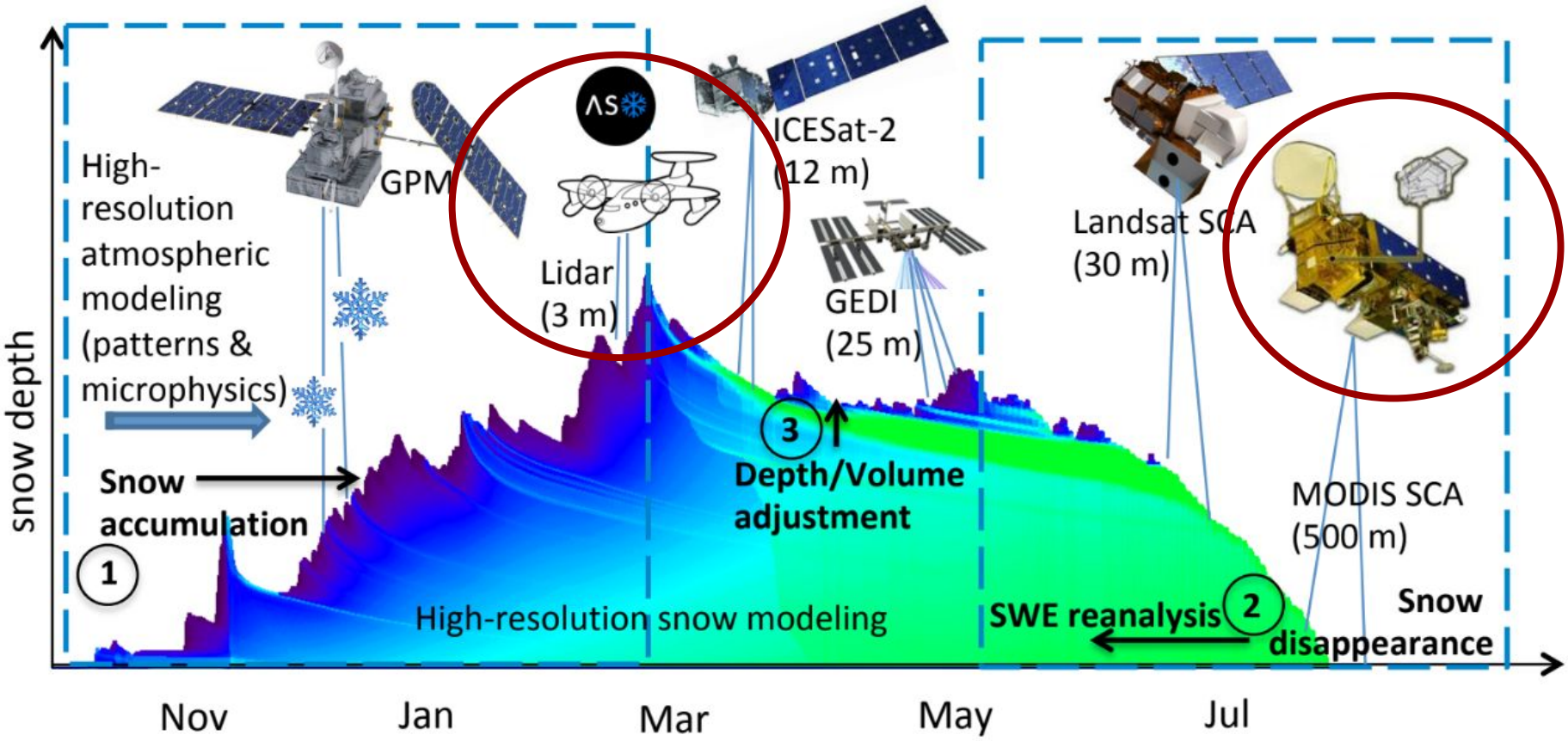
Problem

-Despite the importance throughout the melt season, we still lack in situ snow measurements

"Solution"

-Combine remote sensing tools and SWE Reanalysis models for estimating snow depth

Remote Sensing + Modeling



Project Purpose

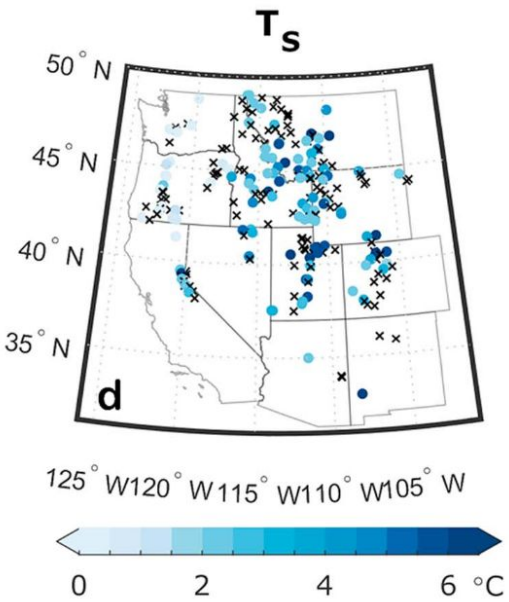
-How well does Particle Batch Smoother SWE Reanalysis Model work over the Olympics?

-Does changing the temperature threshold improve model capabilities?

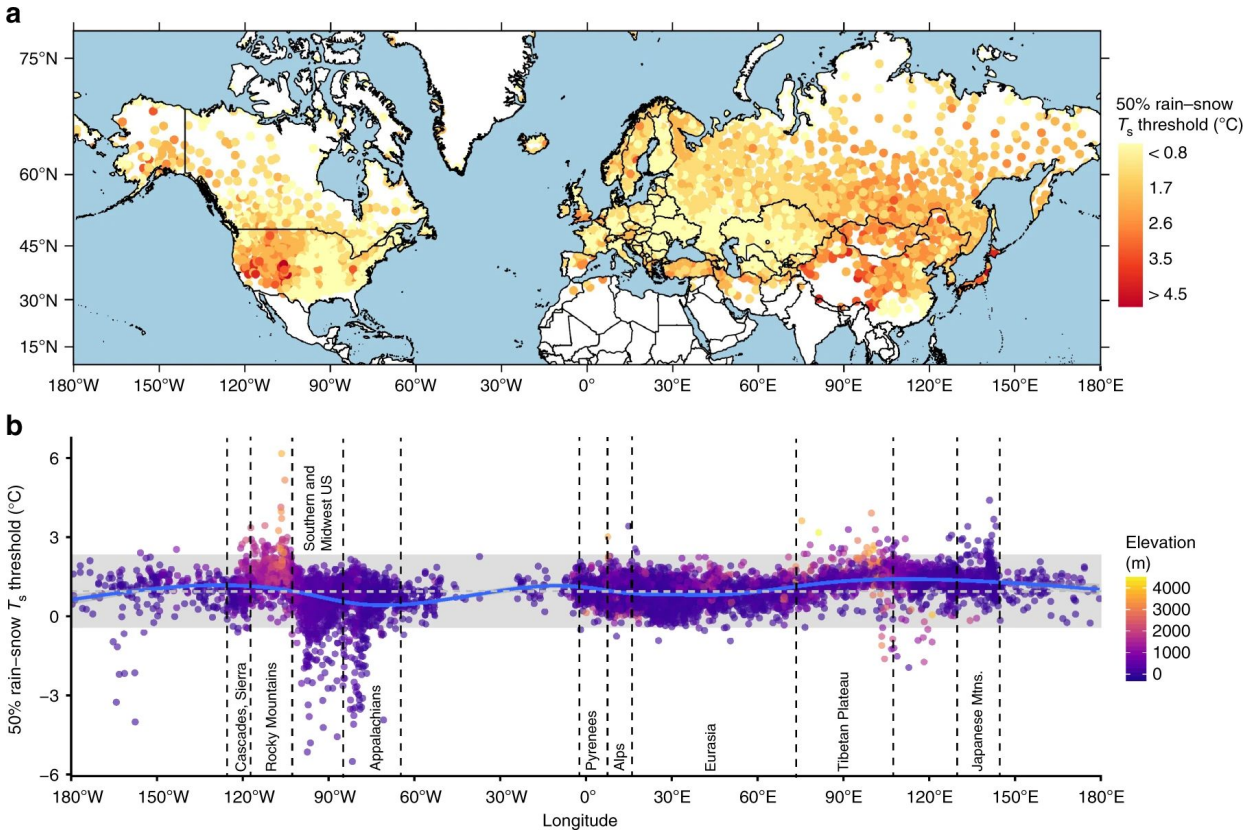
Particle Batch Smoother (PBS) SWE Reanalysis Model

- Particle Batch Smoother method is fairly new, as opposed to a Kalman-based Ensemble Batch Smoother
- Finer resolution (90m) over the Sierra had high accuracy (mean error: 3cm, rmse: 13cm)
- New version for the entire continental US at 500m resolution has not been fully tested yet
- Made parameter assumptions, including rain vs snow temperature partition

Temperature Partitioning



Sun et. al., 2019



Jennings et. al., 2018

Why the Olympic Mountains?

-Unique meteorological and vegetation characteristics

-High resolution airborne lidar for two dates in 2016

Methods

Collect Data → Process Data → Analyze the Data

Process Model Outputs

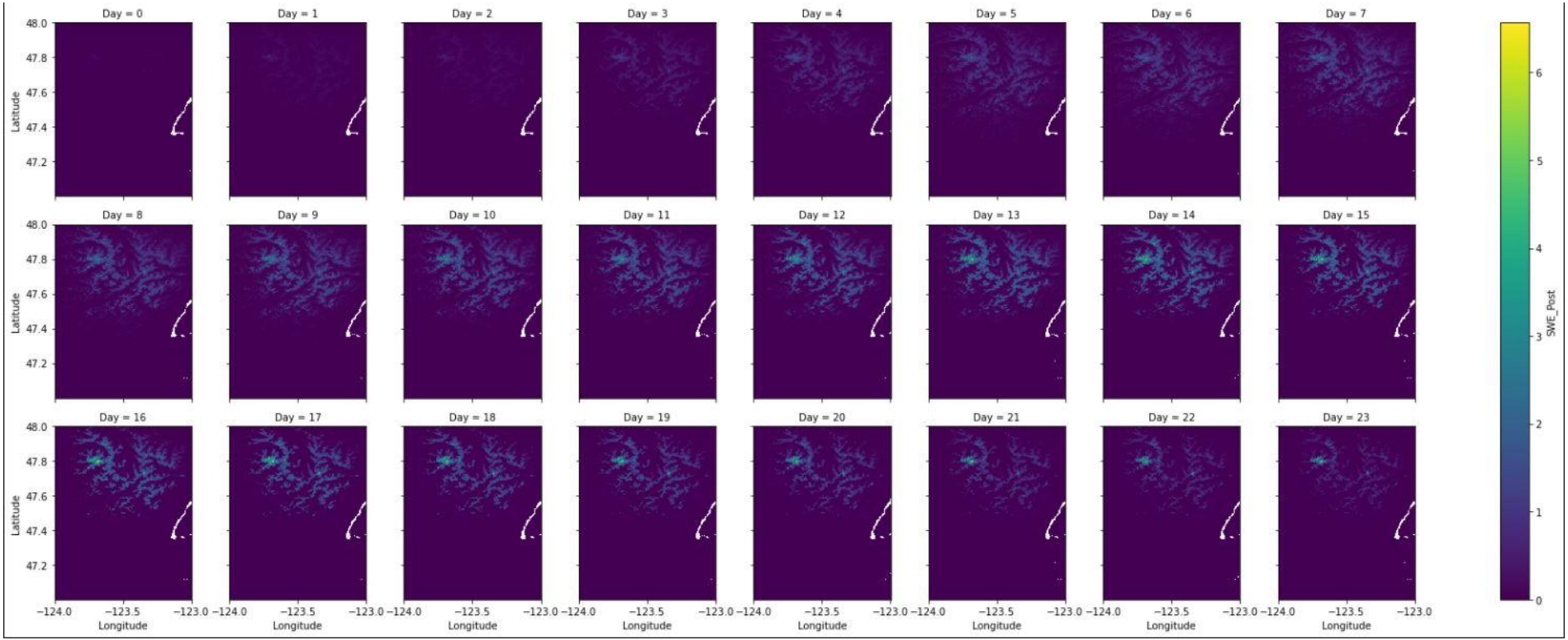
Upscale ASO

Reproject and Align

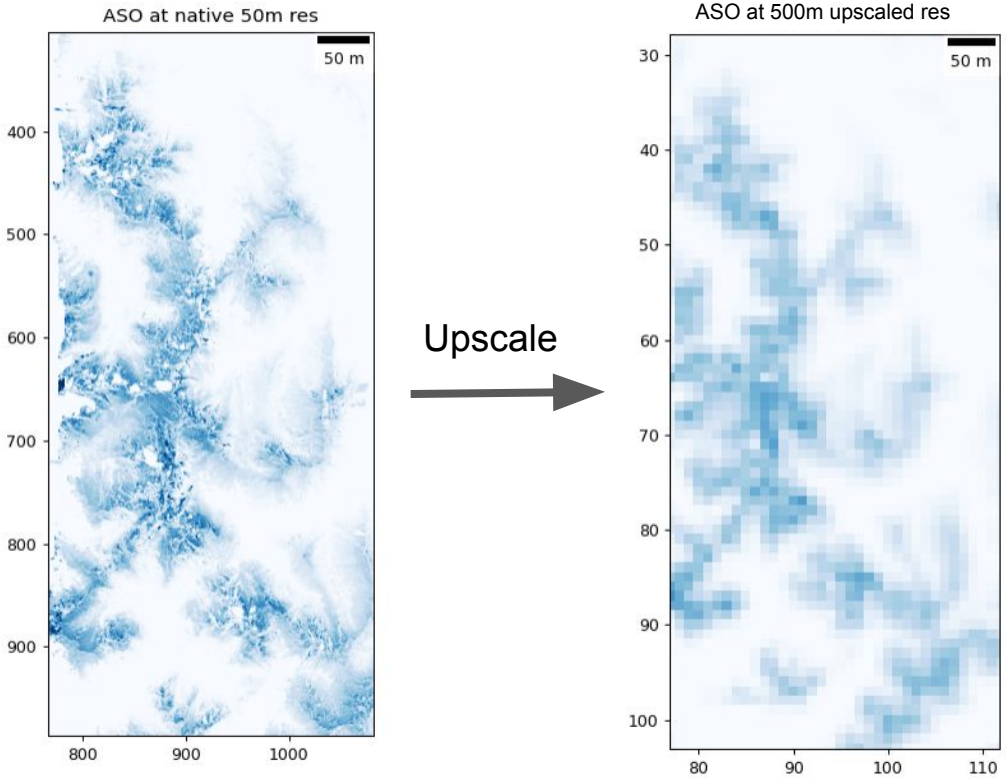
Difference Datasets

Compute Statistics

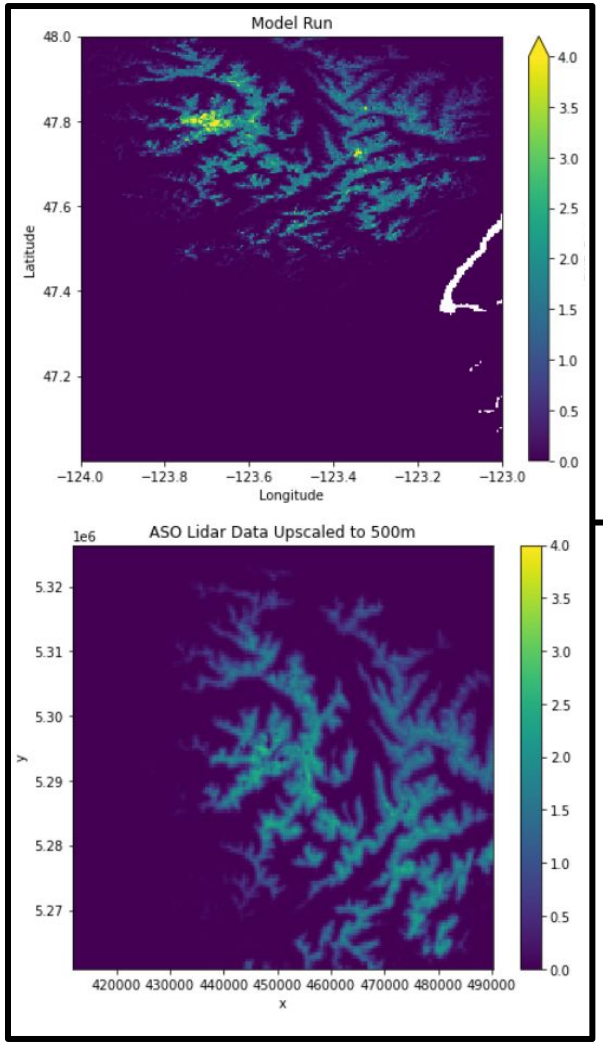
SWE Particle Batch Smoother Reanalysis Model

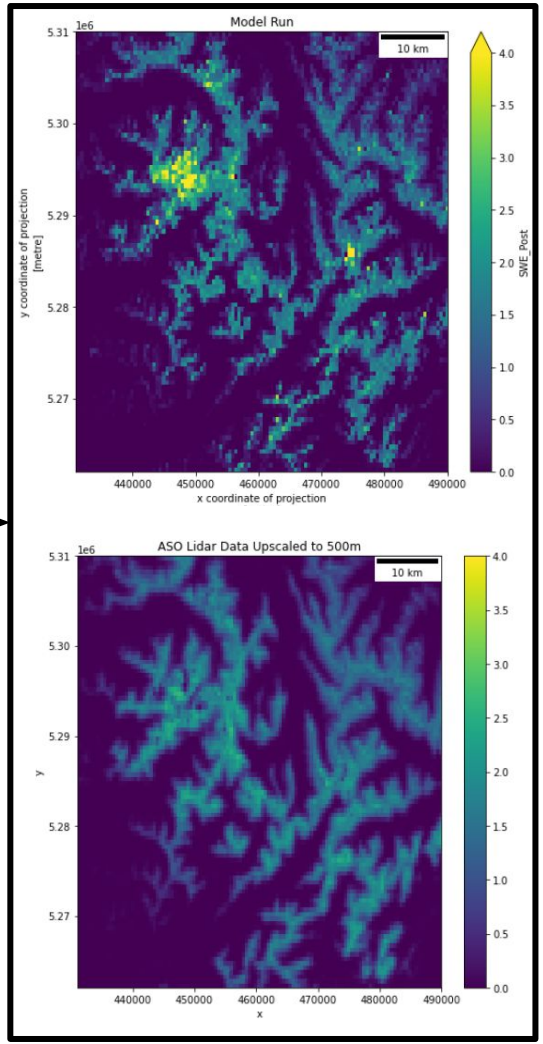


Upscaling to Model Resolution



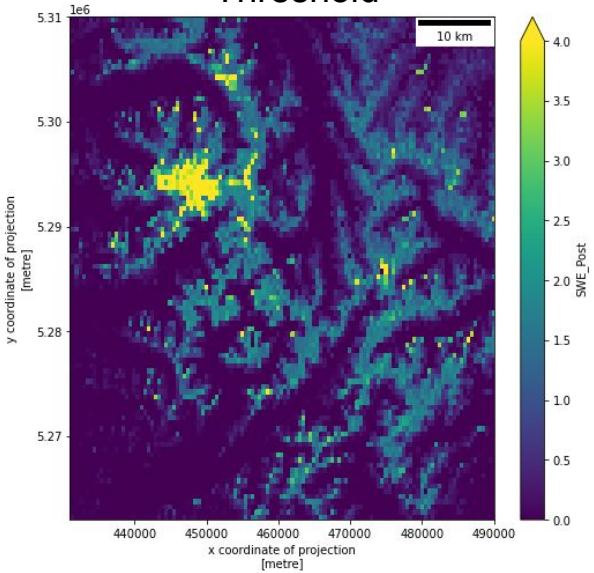
Spatial Alignment



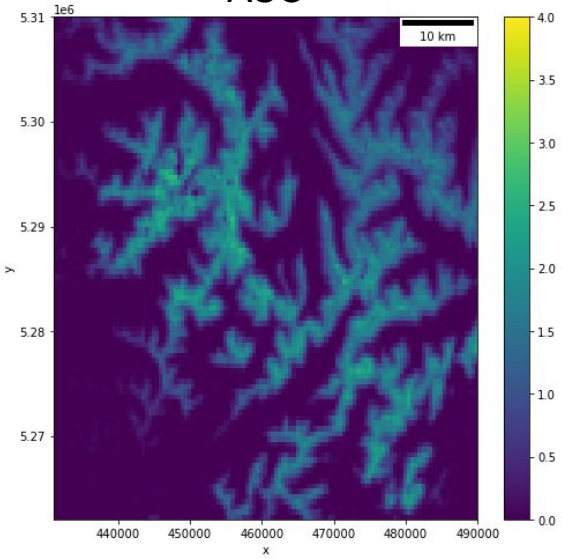


Dataset Differencing: 2 °C Threshold, March 29

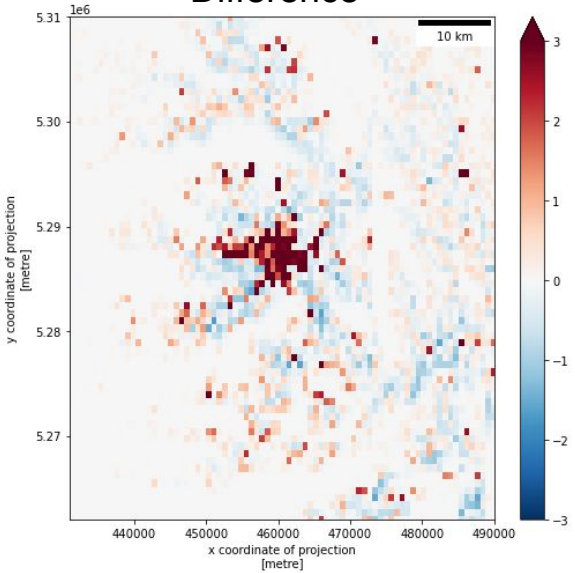
Model with 2 °C Threshold



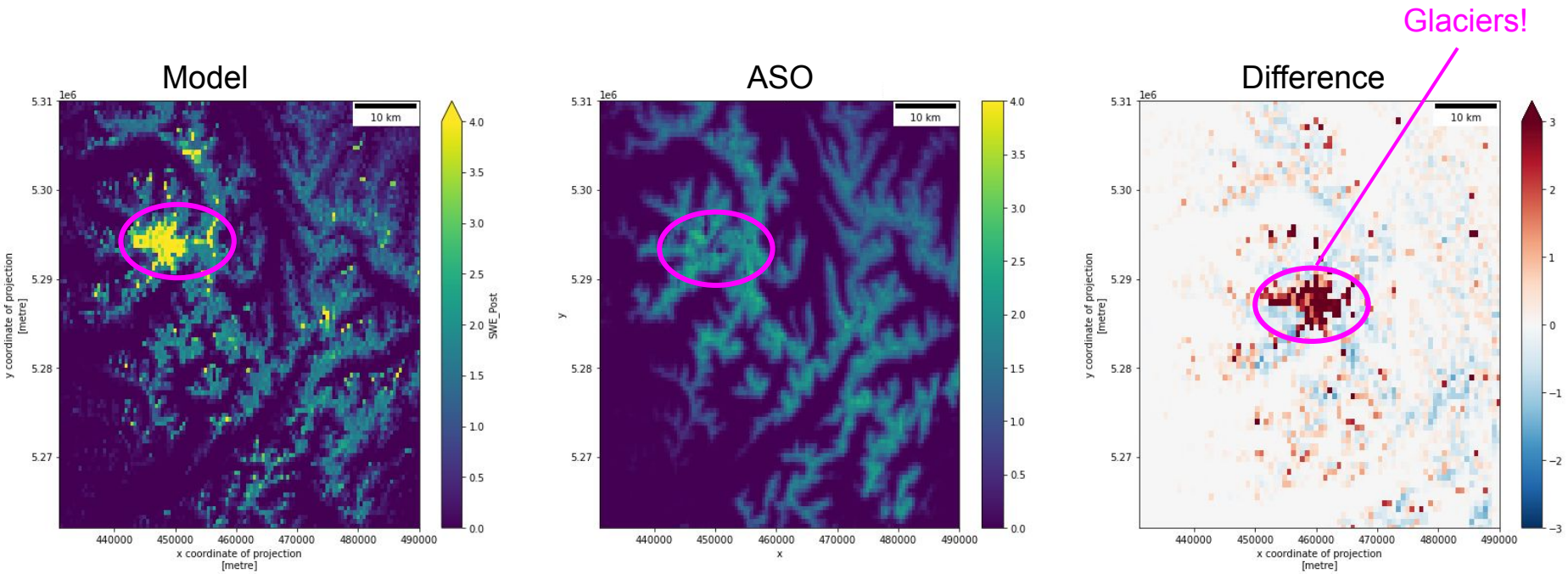
ASO

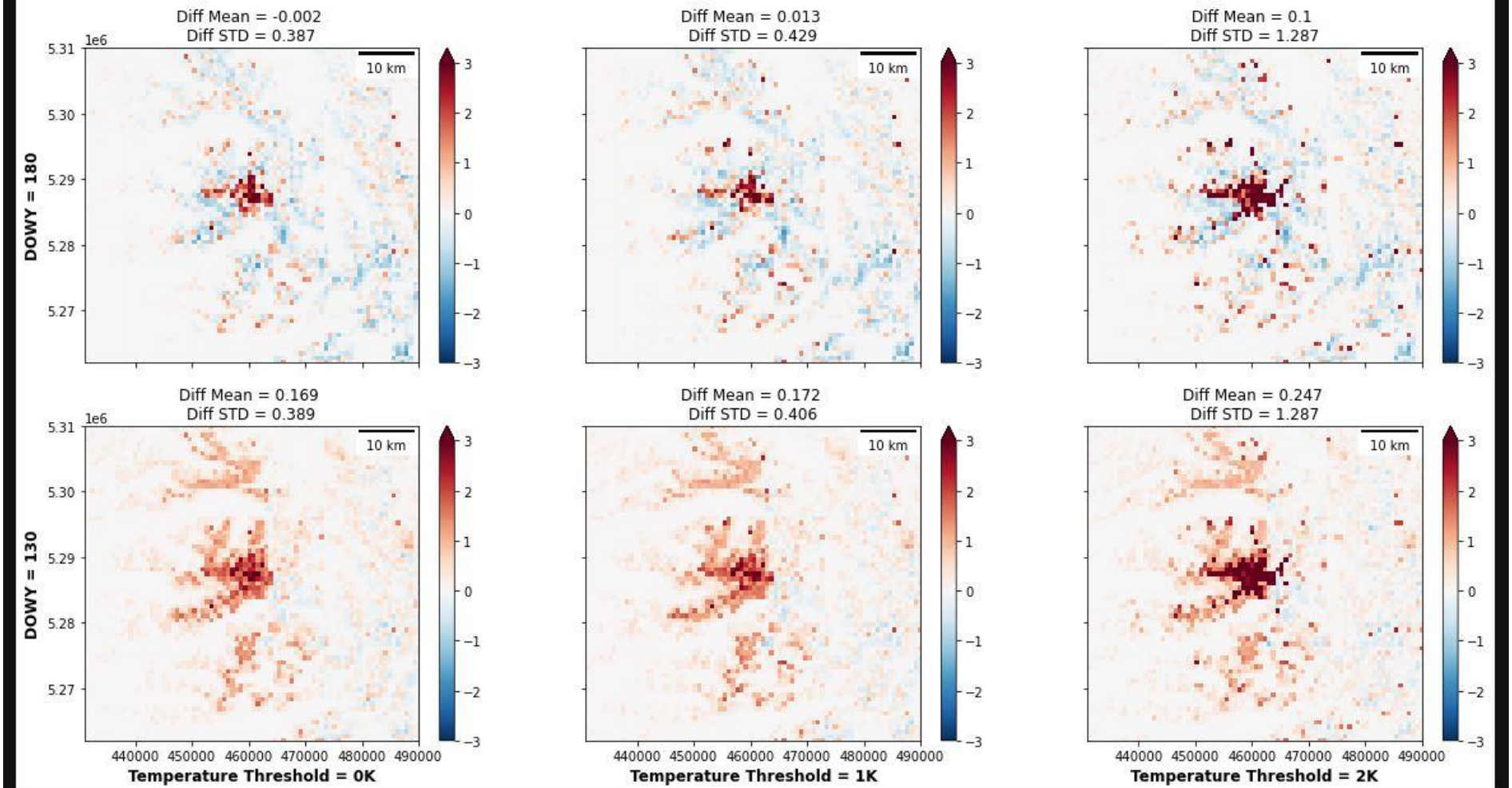


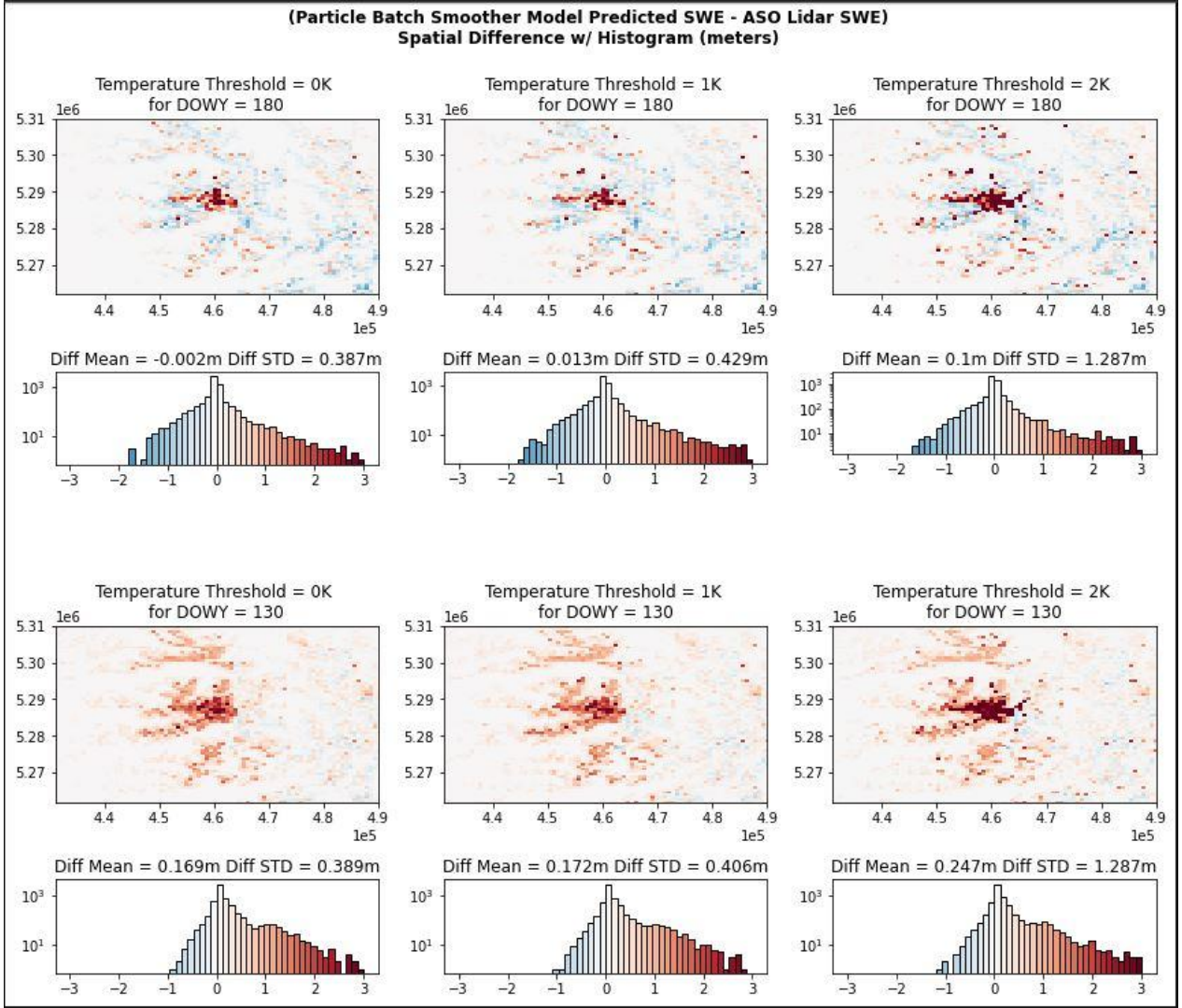
Difference

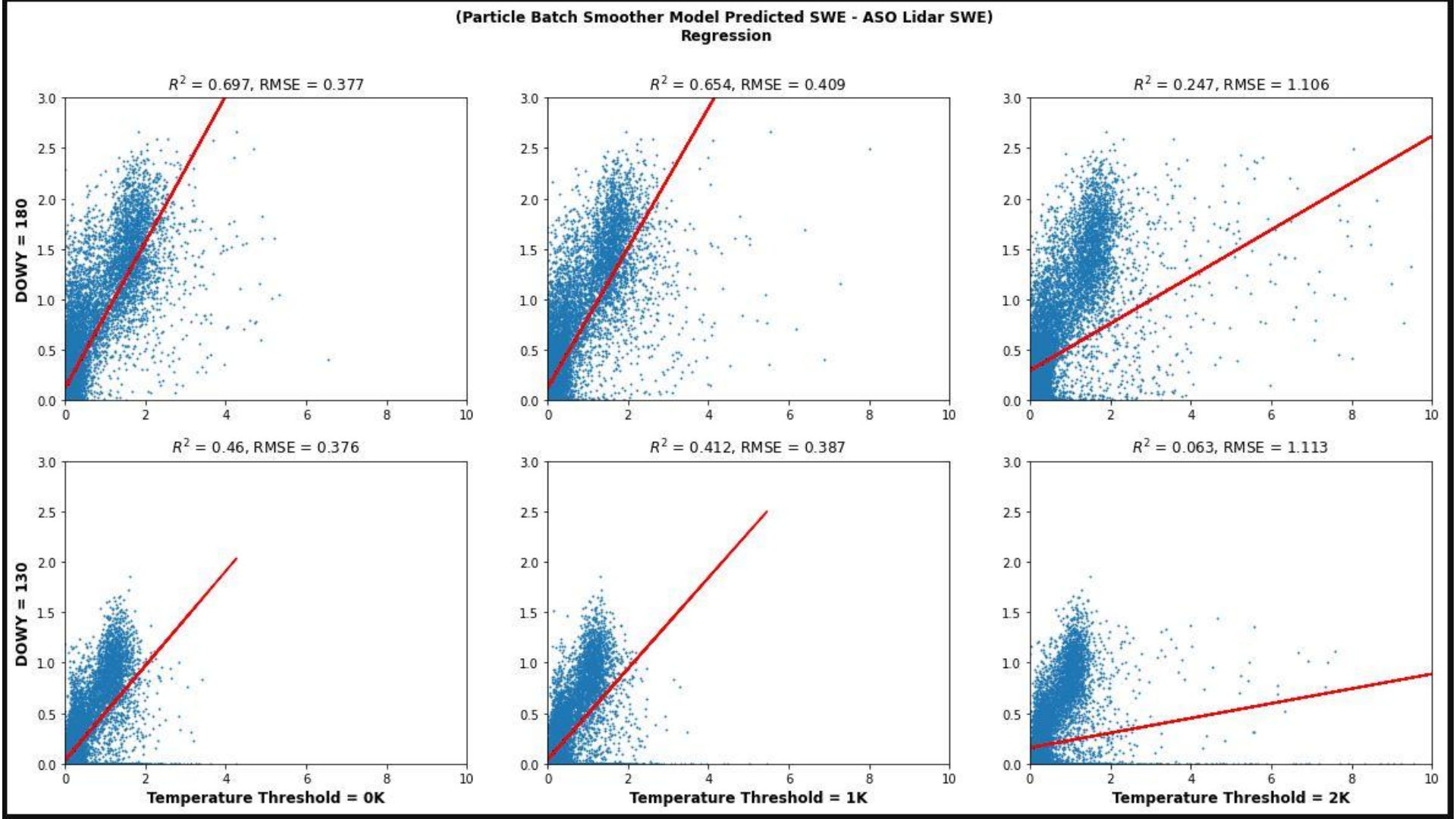


Dataset Differencing: 2 °C Threshold, March 29




(Particle Batch Smoother Model Predicted SWE - ASO Lidar SWE) Difference
Diff Mean = -0.002
Diff STD = 0.387
Diff Mean = 0.013
Diff STD = 0.429
Diff Mean = 0.1
Diff STD = 1.287
Diff Mean = 0.169
Diff STD = 0.389
Diff Mean = 0.172
Diff STD = 0.406
Diff Mean = 0.247
Diff STD = 1.287
1e6
5.31
5.30
5.29
5.28
5.27
10 km
DOWY = 180
DOWY = 130
3
2
1
0
−1
−2
−3
440000
450000
460000
470000
480000
490000
Temperature Threshold = 0K
Temperature Threshold = 1K
Temperature Threshold = 2K


(Particle Batch Smoother Model Predicted SWE - ASO Lidar SWE)
Spatial Difference w/ Histogram (meters)
Temperature Threshold = 0K
for DOWY = 180
Diff Mean = -0.002m Diff STD = 0.387m
Temperature Threshold = 1K
for DOWY = 180
Diff Mean = 0.013m Diff STD = 0.429m
Temperature Threshold = 2K
for DOWY = 180
Diff Mean = 0.1m Diff STD = 1.287m
Temperature Threshold = 0K
for DOWY = 130
Diff Mean = 0.169m Diff STD = 0.389m
Temperature Threshold = 1K
for DOWY = 130
Diff Mean = 0.172m Diff STD = 0.406m
Temperature Threshold = 2K
for DOWY = 130
Diff Mean = 0.247m Diff STD = 1.287m
1e6
1e5

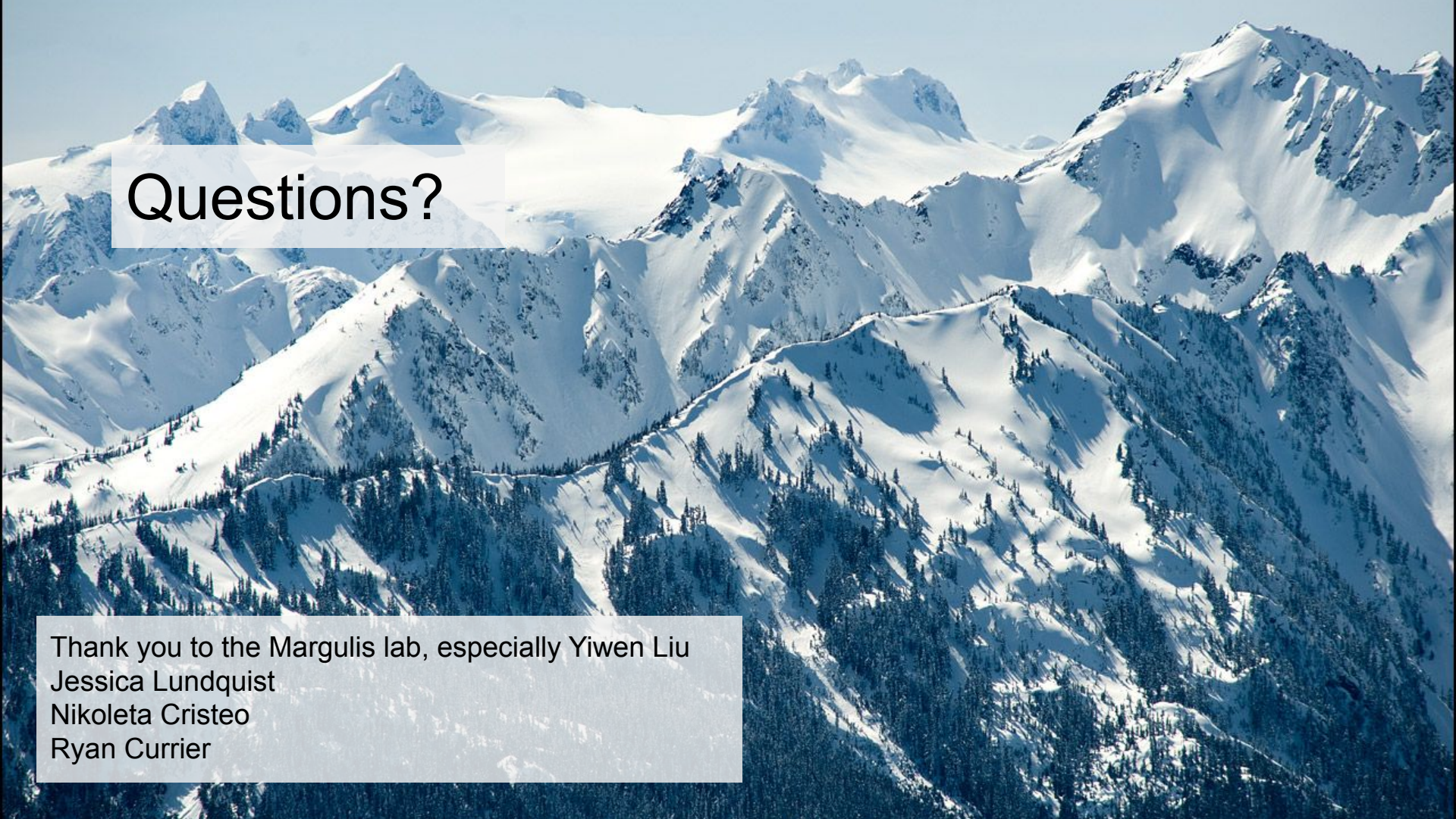

(Particle Batch Smoother Model Predicted SWE - ASO Lidar SWE)
Regression
R^2 = 0.697, RMSE = 0.377
R^2 = 0.654, RMSE = 0.409
R^2 = 0.247, RMSE = 1.106
R^2 = 0.46, RMSE = 0.376
R^2 = 0.412, RMSE = 0.387
R^2 = 0.063, RMSE = 1.113
DOWY = 180
DOWY = 130
Temperature Threshold = 0K
Temperature Threshold = 1K
Temperature Threshold = 2K

Conclusions

- 0°C is the most effective temperature threshold
- Regionalizing the temperature threshold can improve the R^2 values by a factor of seven*
- We recommend the model use regional temperature thresholds for partitioning to improve modeling of SWE
- *Errors and outliers in data, likely from glaciers

Next Steps

1. Redo differencing & regression analysis after masking out glaciers
2. Recalculate error metrics after removing outliers
3. Temperature threshold analysis / quantify model improvement



Questions?

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