Improving Satellite Mountain Snowfall Magnitudes with SWE-Reanalysis and GPROF-NN

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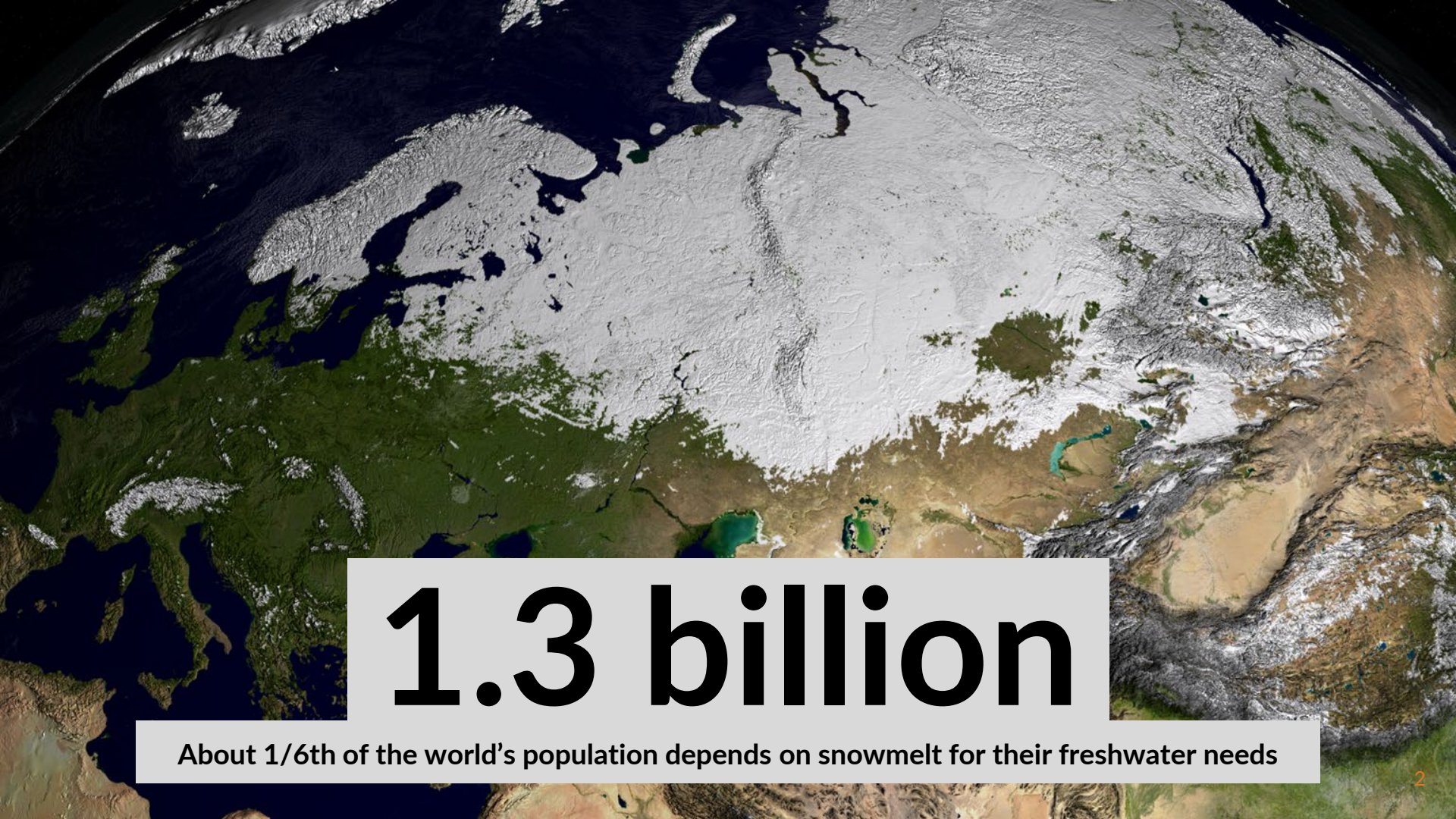


1.3 billion

About 1/6th of the world's population depends on snowmelt for their freshwater needs

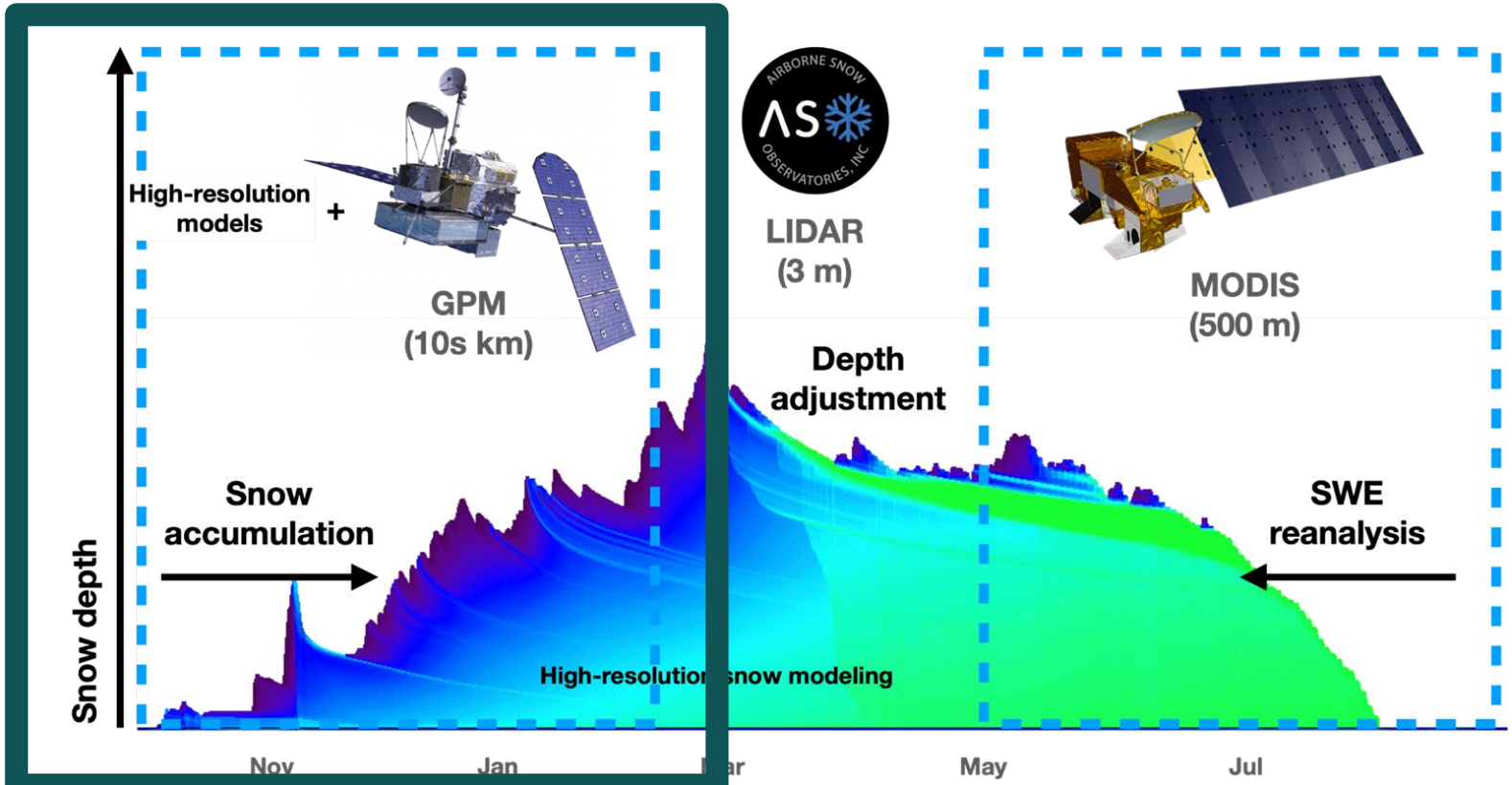
70%

of runoff arrives as snow in the Western U.S.

There are clear, negative trends in snow resources

- Global extent of snow-covered area on land has been declining *(Brown, 2000; Mudryk et al. 2017)*
- The mass of snow (SWE) is also declining *(Brown, 2000; Kunkel et al., 2016)*
- Snow is melting sooner *(Liston and Hiemstra 2011)*
- Winter precipitation is arriving increasingly as rain
- The number and intensity of winter snowfall events appears to be declining *(Lute et al., 2015)*
- There is a worldwide reduction in glacier mass balance *(Gardner et al. 2013)*

Most critical first step is improving seasonal snowfall accumulations



1.

Western U.S. Snow Reanalysis

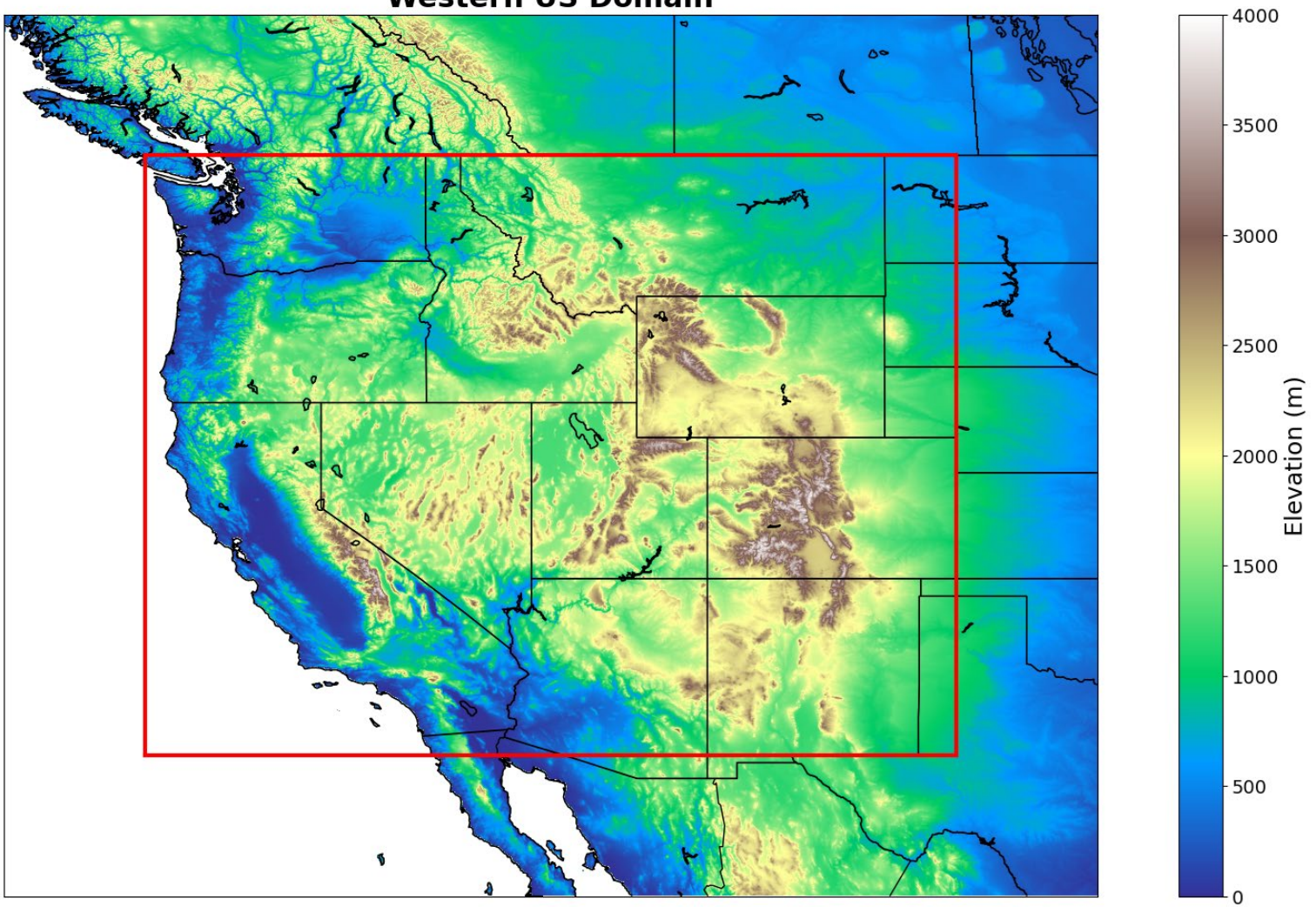
2.

GPROF Models

GPROF V7, GPROF-NN 1D, GPROF-NN 3D

3.

Methods and Results


Western US Domain
4000
3500
3000
2500
2000
1500
1000
500
0
Elevation (m)

The WUS-SR product weights priori SWE time series with LandSat fSCA measurements

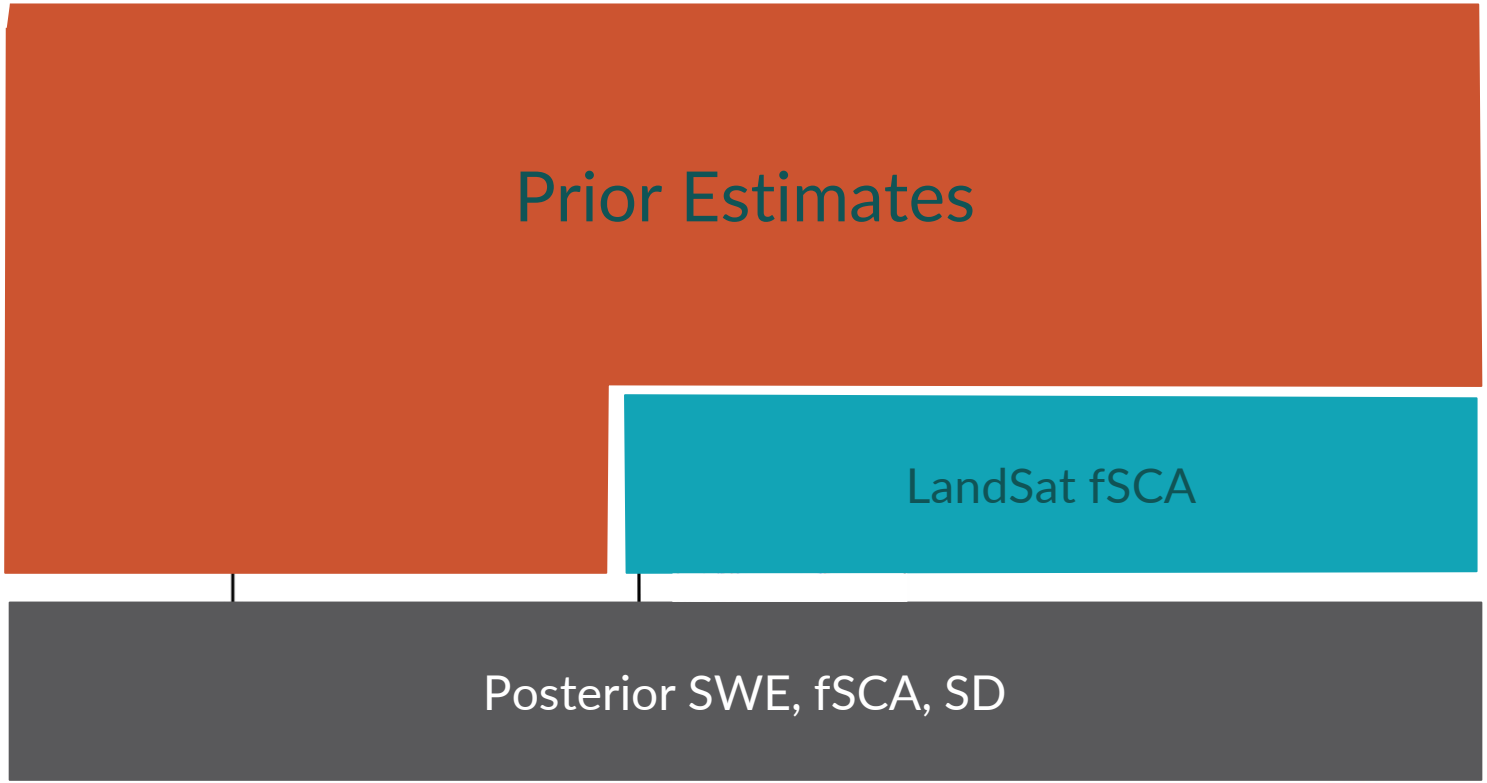


Figure 2 from Fang et al. 2022

WUS-SR correlates well with independent SNOTEL SWE for peak WY SWE across large watersheds.

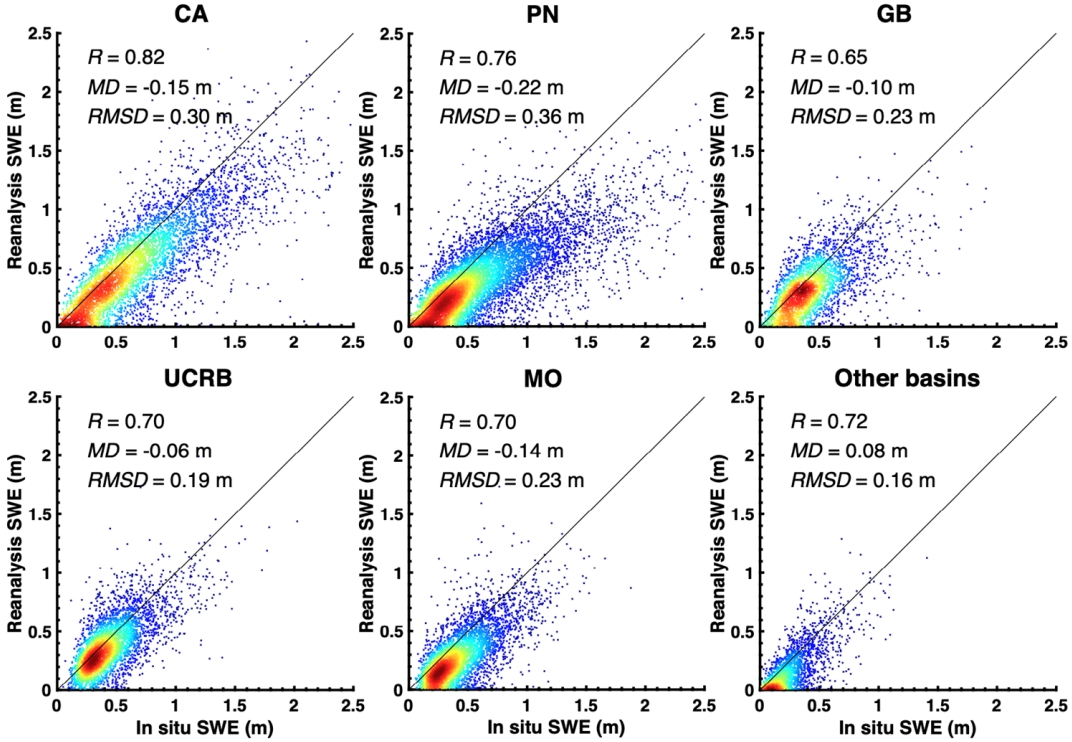


Figure 2 from Fang et al.

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Methods and Results

GPROF v7

Bayesian inversion technique that weights apriori database entries that are radiometrically consistent with observed TBs

GPROF-NN 1D

Fully connected neural network that retrieves single pixels based on observed TBs

GPROF-NN 3D

Incorporates spatial information into the retrieval using a CNN

1.

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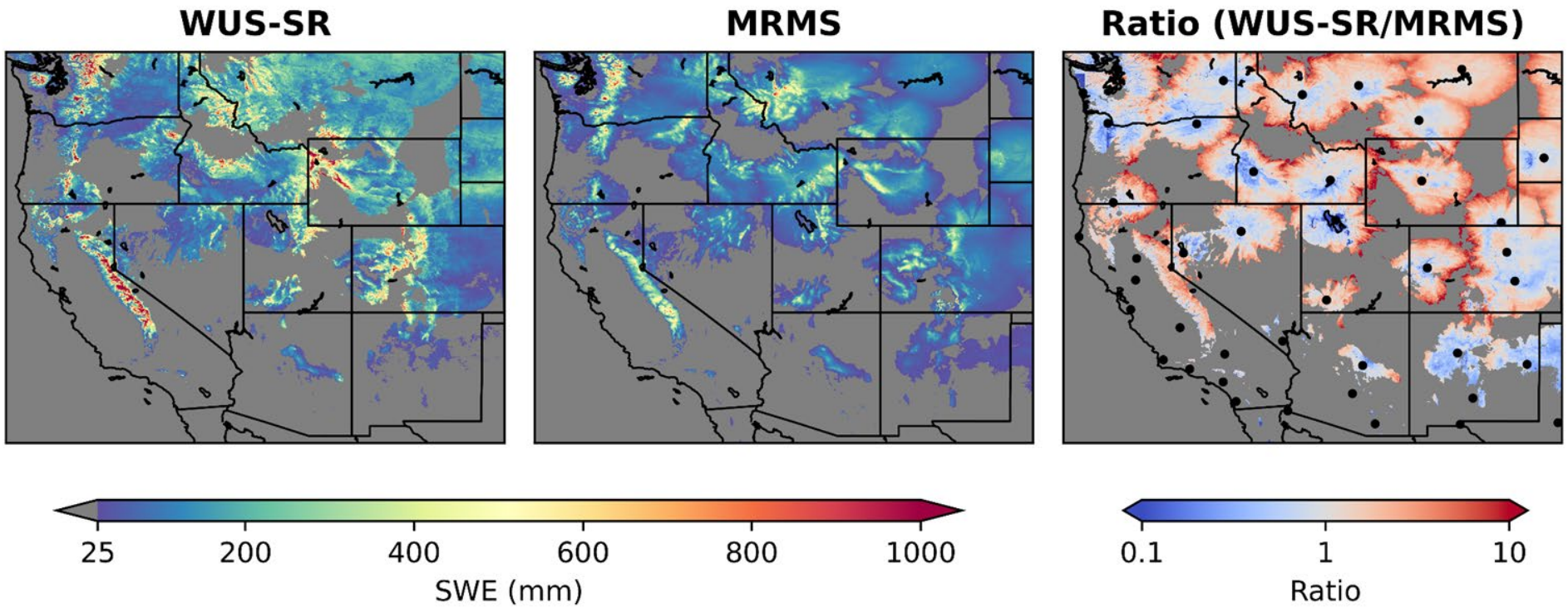
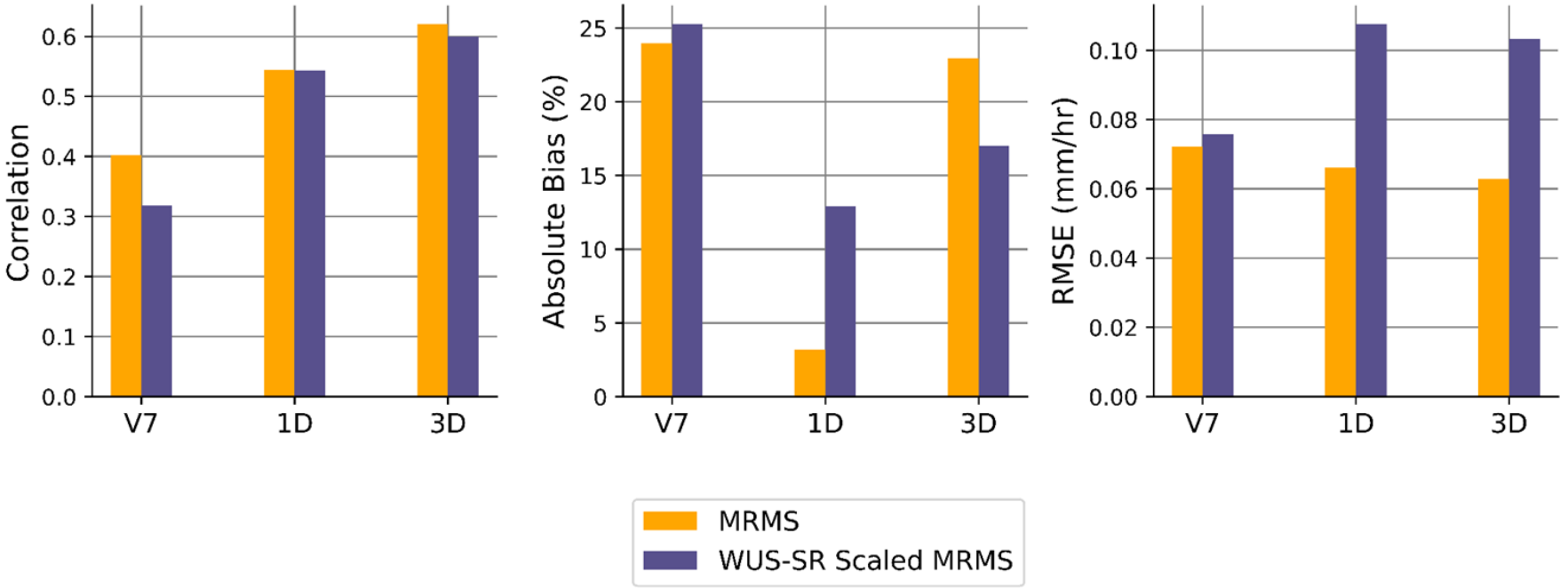
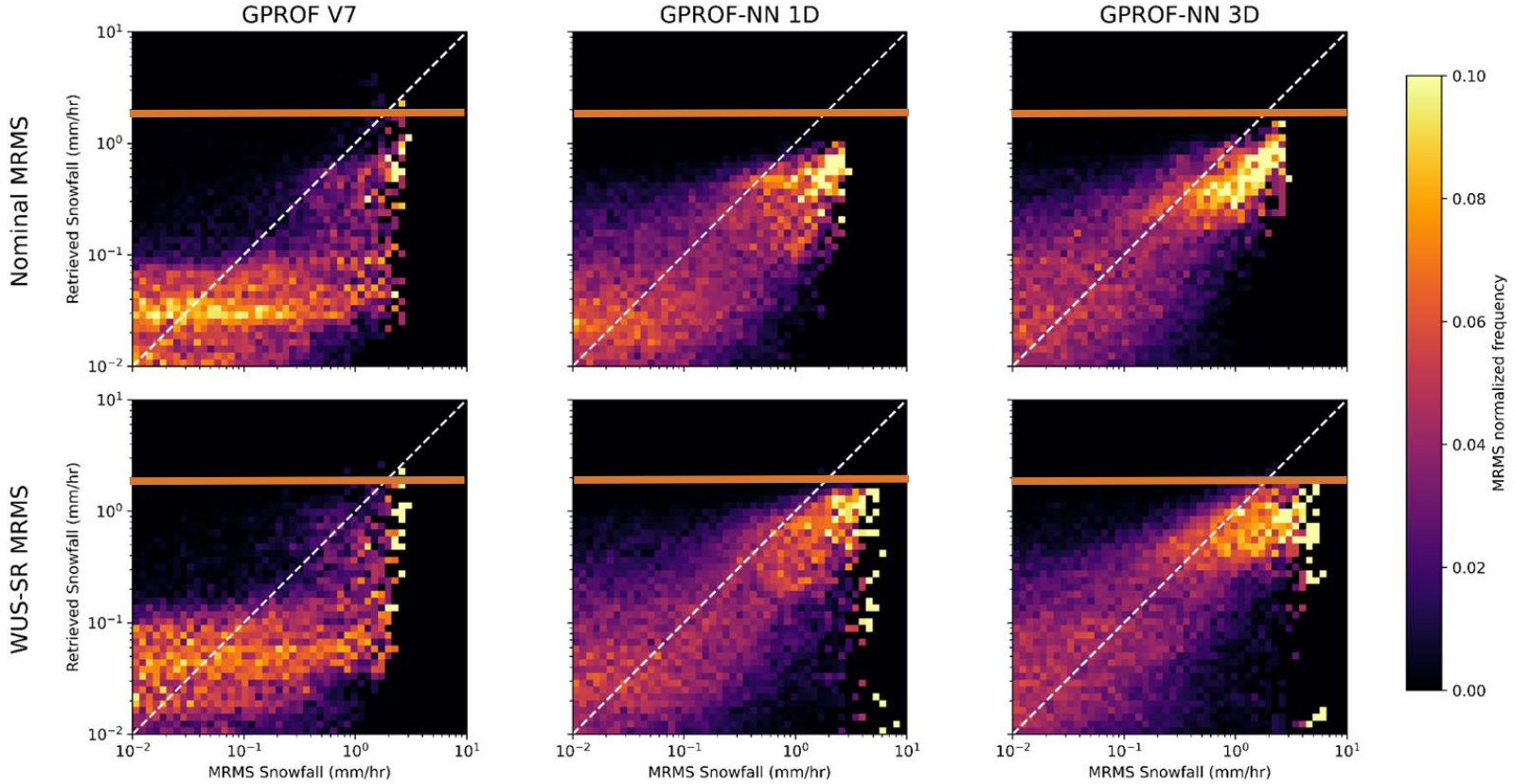
The ratio between water year snowfall accumulations are used to create scale factors



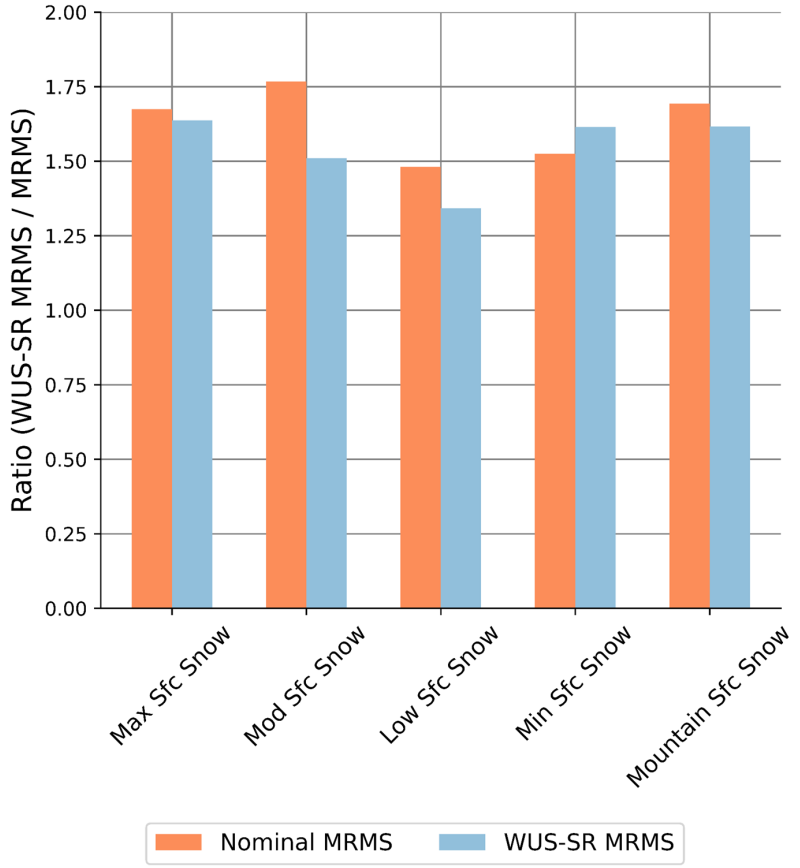
GPROF-NN models outperform GPROF V7 in terms of quantitative statistics.

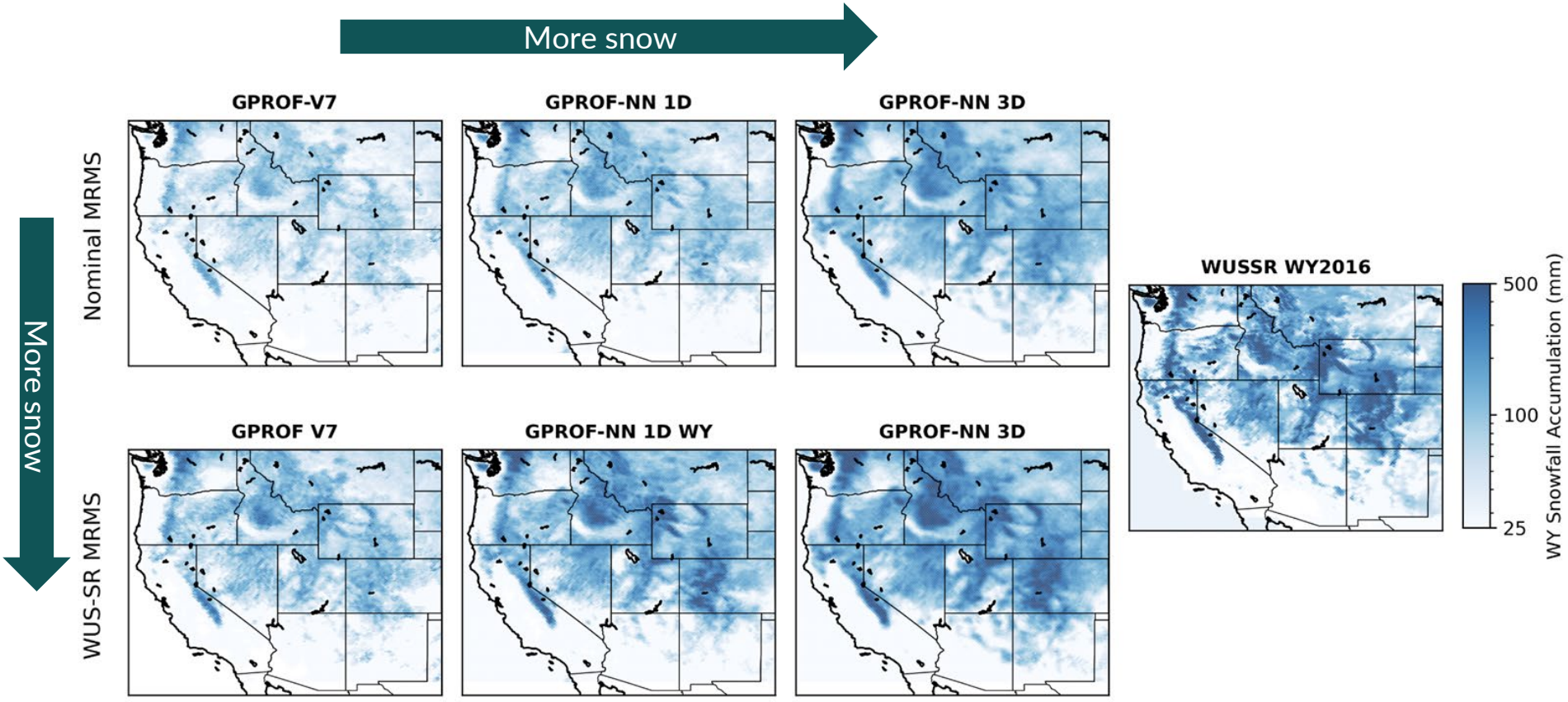


WUS-SR scaled snowfall show noticeable increases in instantaneous snowfall.

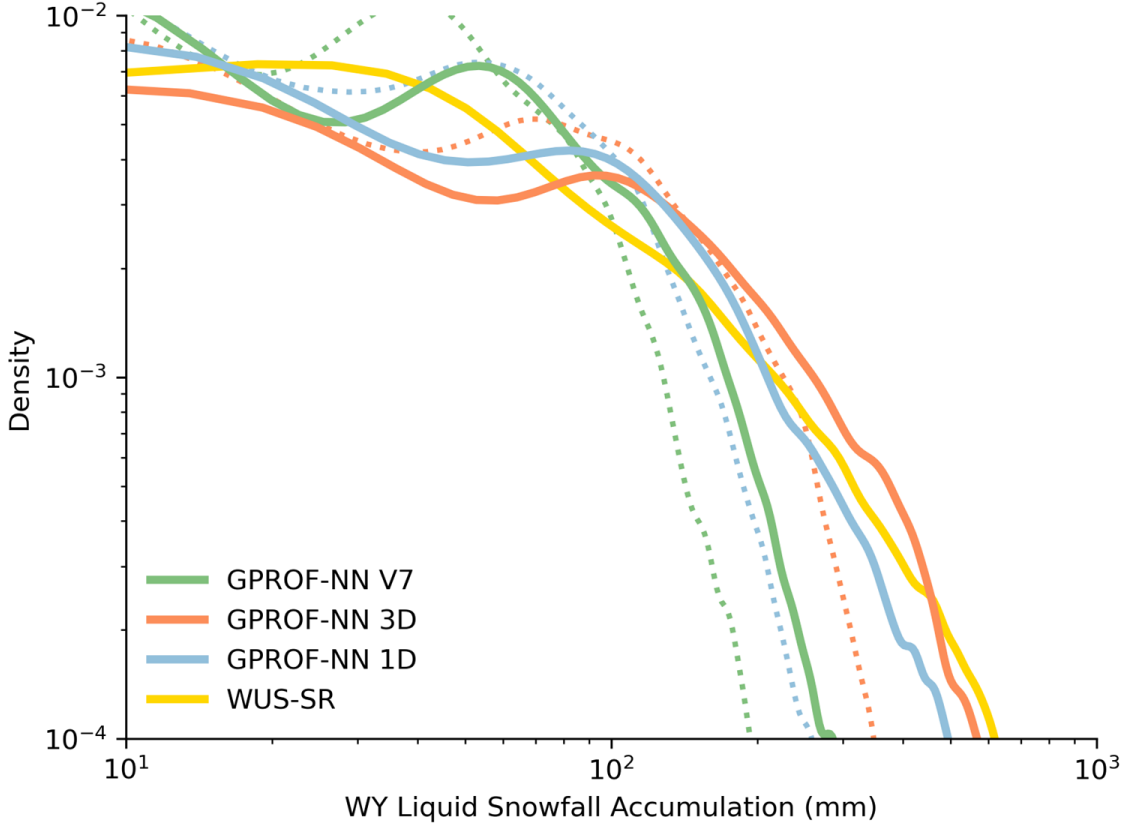


WUS-SR scaling is properly handled through the GPROF-NN models

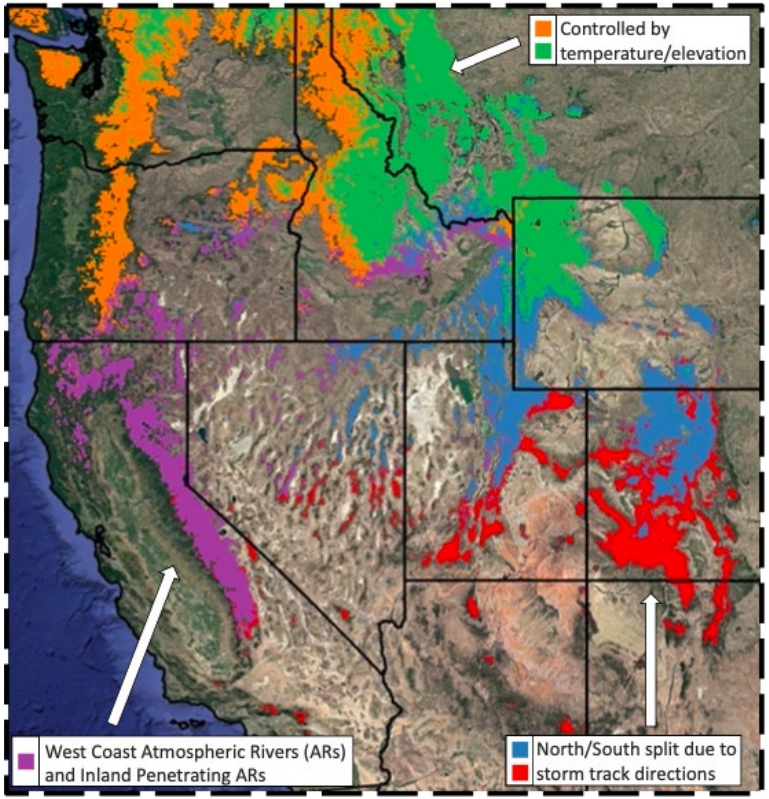



More snow
More snow
Nominal MRMS
WUS-SR MRMS
GPROF-V7
GPROF-NN 1D
GPROF-NN 3D
GPROF V7
GPROF-NN 1D WY
GPROF-NN 3D
WUSSR WY2016
500
100
25
WY Snowfall Accumulation (mm)

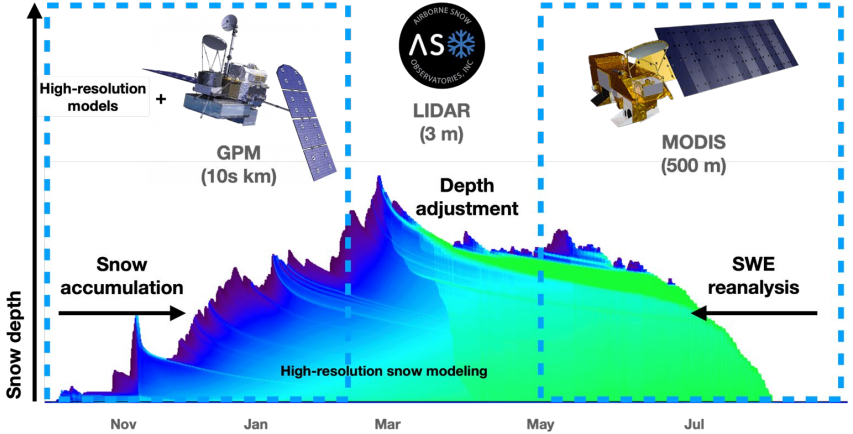
GPROF-NN models are better able to match WUS-SR water year snowfall accumulations at higher accumulations.



Clustered correlated interannual SWE variability



SWE-Reanalysis + ML Retrieval as input to SnowModel



Future Work

Thank You
Questions?

Extra Slides

USCRN-MRMS Z=αS^2