The Influence of Snow Depth Observation Timing and Uncertainty on Data Assimilation Improvements to SWE

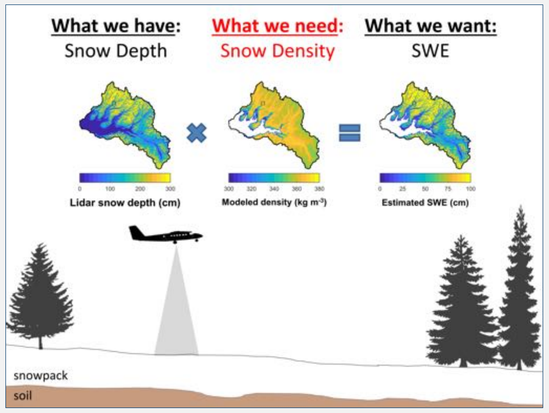
Eric Smyth, Mark S. Raleigh, and Eric E. Small

eric.smyth@colorado.edu

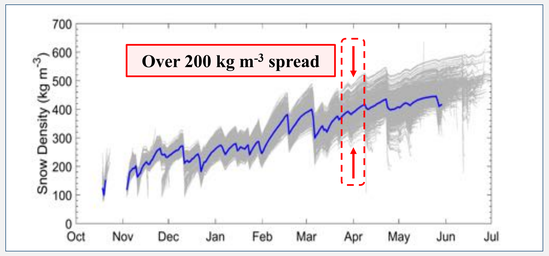
Geological Sciences
UNIVERSITY OF COLORADO **BOULDER**

Motivation

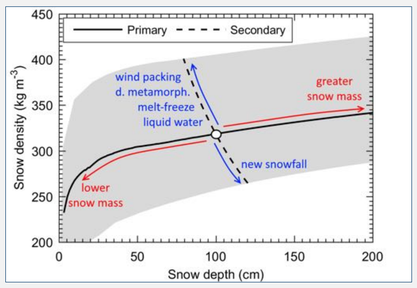
1. Snow water equivalent (SWE) from remotely sensed snow depth (e.g. airborne lidar) relies on modeled snowpack density



2. But models[1] show a wide range of uncertainty in snow density

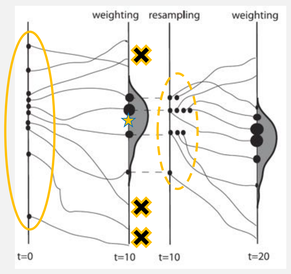


3. Snow density and depth are linked through physical processes

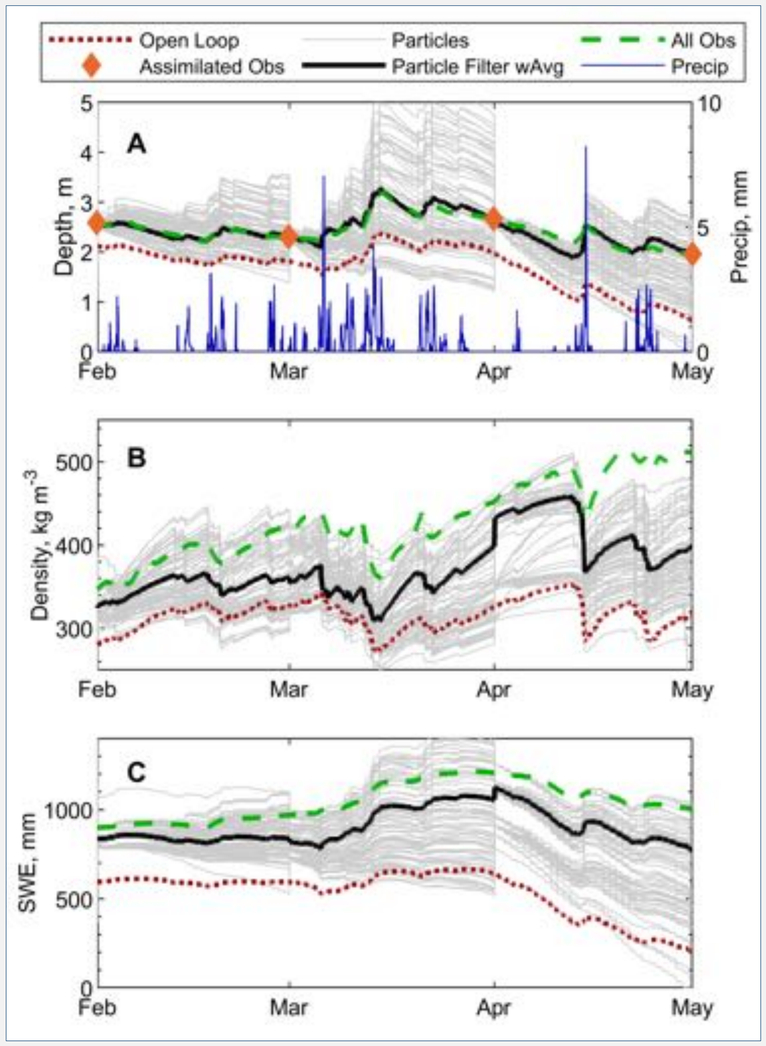


4. Assimilation of snow depth with the Particle Filter[2] can guide the model to a more realistic simulation of snowpack

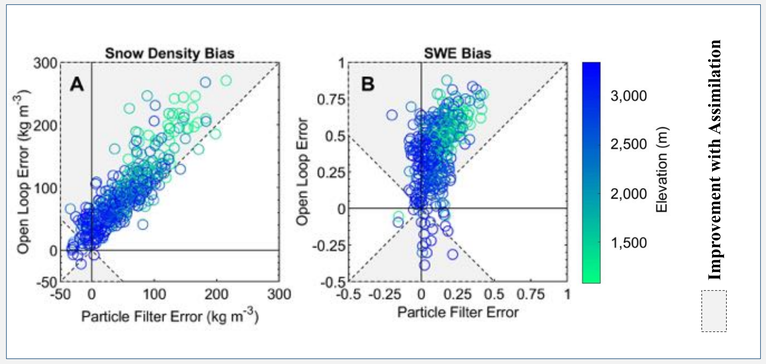
1. Generate ensemble of models, varying inputs and model parameters
2. Compare observations ☆ to each model: closest runs get a high "weight"
3. Eliminate ✖ low weight models, make copies of those with highest weights
4. Calculate weighted average over time: the "best estimate"



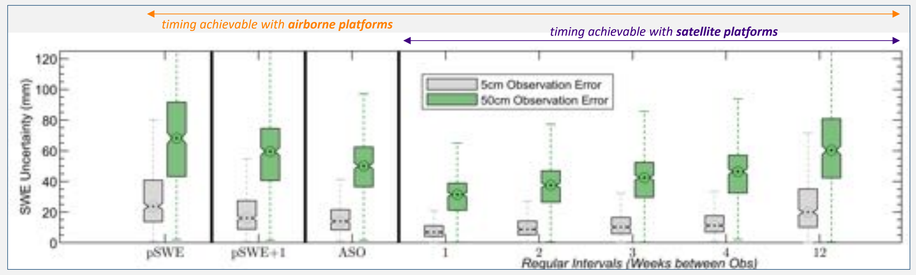
The Particle Filter improves density and SWE[3]…



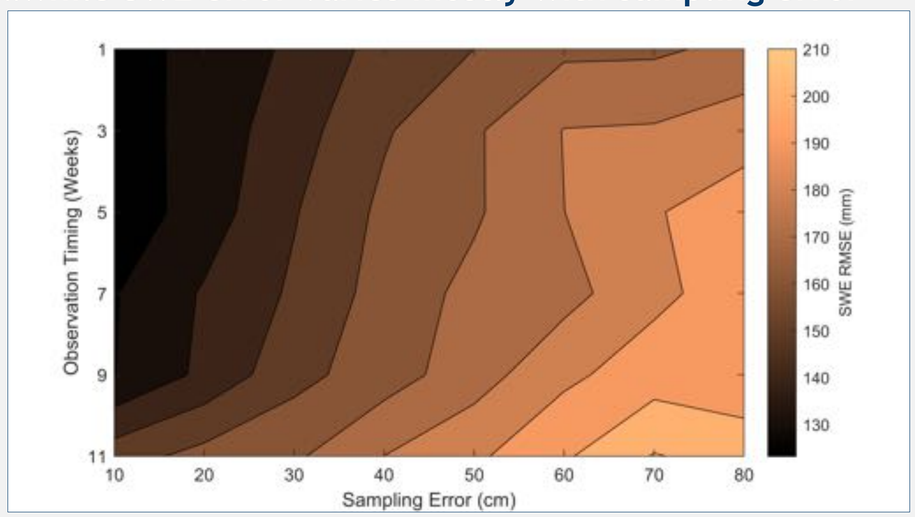
…across climates and years with SNOTEL data



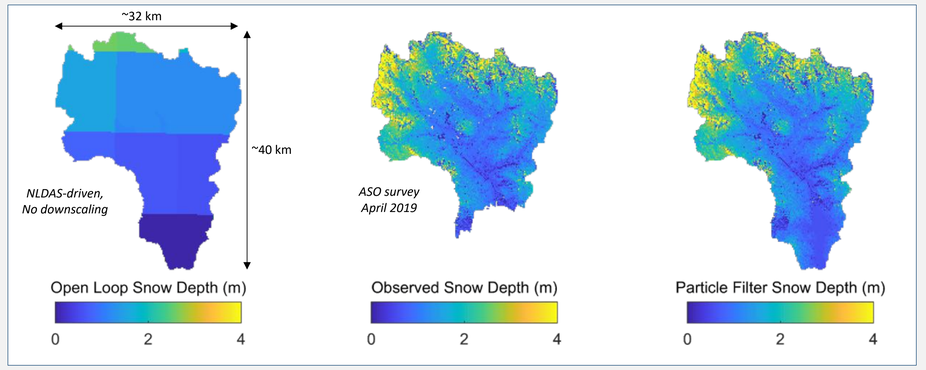
SWE uncertainty varies with sample error *AND* timing[4]…



…while SWE error varies mostly with sampling error



Assimilation is feasible at the basin scale: East River, CO



References

[1] Essery, R. (2015). A factorial snowpack model (FSM 1.0). *Geoscientific Model Development*, 8(12), 3867–3876.
[2] van Leeuwen, P. J. (2009). Particle Filtering in Geophysical Systems. Monthly Weather Review, 137(12), 4089–4114. https://doi.org/10.1175/2009MWR2835.1
[3] Smyth, E. J., Raleigh, M. S., & Small, E. E. (2019). Particle Filter Data Assimilation of Monthly Snow Depth Observations Improves Estimation of Snow Density and SWE. Water Resources Research, (4), 1296–1311. https://doi.org/10.1029/2018WR023400
[4] Smyth, et al. (in review)

Acknowledgements

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