Simulated and Observed Firn Properties Across the Greenland Ice Sheet

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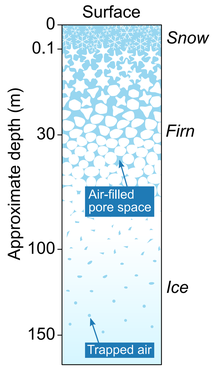
BACKGROUND

The Greenland Ice Sheet's porous firn layer stores meltwater generated at the surface.

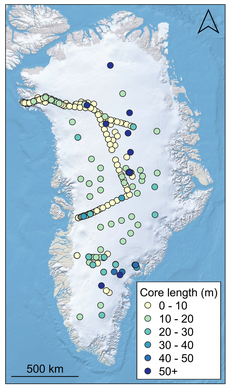
Since firn can buffer the ice sheet's contribution to sea level rise, quantifying the air-filled pore space (firn air content) is important.

In-situ observations and firn models provide ways to investigate key firn properties like firn air content and density.



Key objective: Use observations to evaluate firn models, and examine atmospheric controls on firn properties across the entire ice sheet

DATA & MODELS



Locations of observations

We use two firn models to simulate firn processes across the entire ice sheet and evaluate results with a large (n=700) dataset of observations.

Firn density observations:
- SUMup dataset[1]

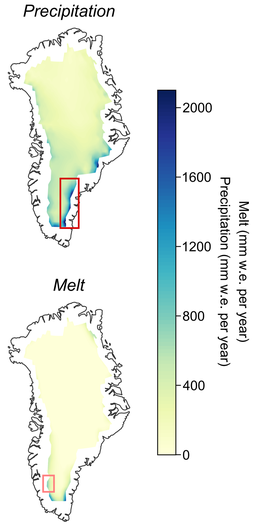
Firn models:
- SNOWPACK[2,3]
- Community Firn Model[4] (CFM)

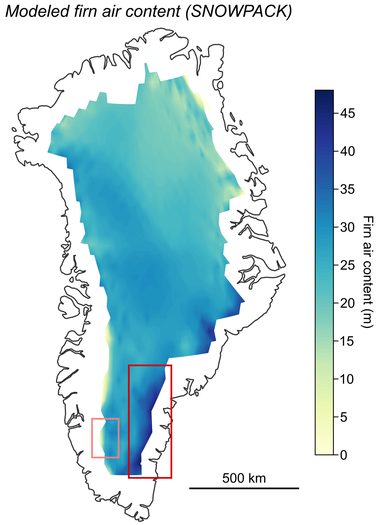
Atmospheric reanalysis input:
- MERRA-2[5]

RESULTS: Atmospheric effects on firn properties

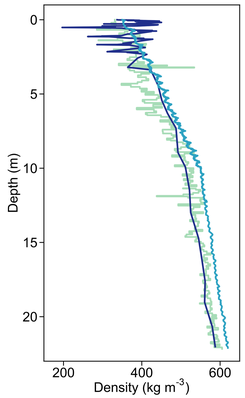
Areas with high precipitation have high firn air content.

Areas with low firn air content experience relatively high melt.



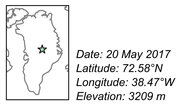


RESULTS: Observed and modeled firn properties



Both models simulate realistic firn density profiles.

Observed and modeled firn density example

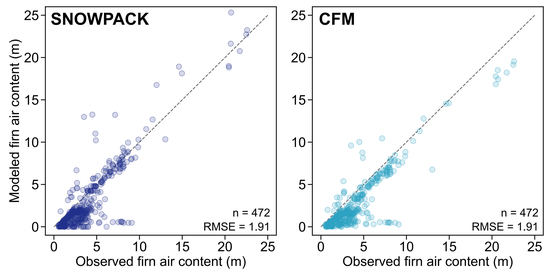


Date: 20 May 2017
Latitude: 72.58°N
Longitude: 38.47°W
Elevation: 3209 m

Observed (SUMup)
Modeled (SNOWPACK)
Modeled (CFM)

Modeled firn air content agrees very will with observed firn air content

Observed vs. modeled firn air content

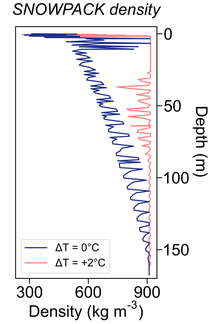


CONCLUSIONS

Firn models perform well in Greenland, and simulated firn properties vary based on atmospheric properties

Since the models generally agree well with observations, we can use them to (1) simulate firn properties across Greenland, and (2) predict how the firn layer may evolve in a warming climate.

Future work will focus on investigating evolving firn properties in the context of climate change. An example of the effect of adding 2°C to the input temperature on firn density is shown to the right.



Key finding: Models overcome the spatial and temporal limitations of observations by simulating realistic firn properties across the entire ice sheet

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