SnowEx Implementation Plan Alaska 2021-2022: Snow Water Equivalent & Depth

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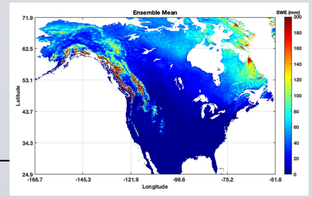
Importance of high-latitudes to global SWE

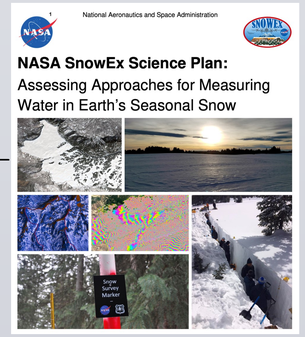
- The science plan identifies gaps in remote sensing sensing of depth and SWE for boreal and tundra snowpacks
- These together represent most of the globe's snow cover and SWE
- To be global, a future proposed snow measurement strategy must address high-latitude snow
- High-latitude terrains have unique and variable permafrost, water, and vegetation characteristics that change seasonally and annually



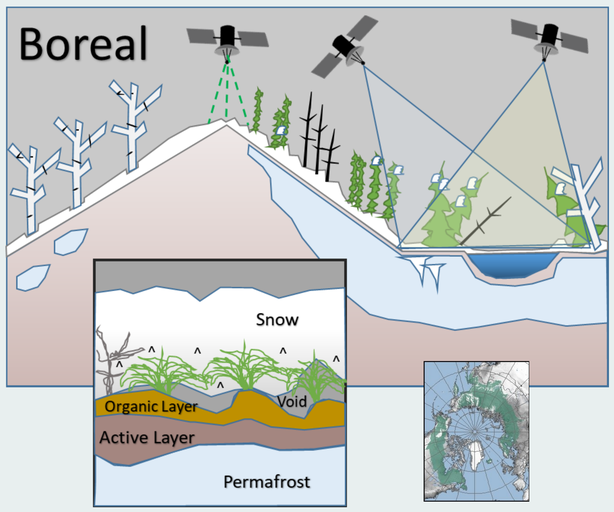
The Snow Ensemble Uncertainty Project (SEUP) found that these regions include 70-85% of the total snow water storage in North America (Kim et al., in review).

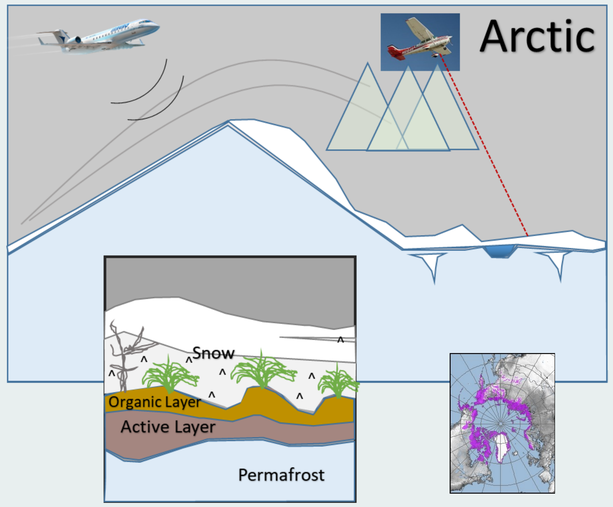
Links to science plan

- LiDAR, L-band InSAR and Ku-band radar are listed as "Mission Critical"
- SfM for snow depth has developed significantly since the science plan was written: likely component of our strategies going forward
- Gaps are specifically mentioned for how substrate affects these observations



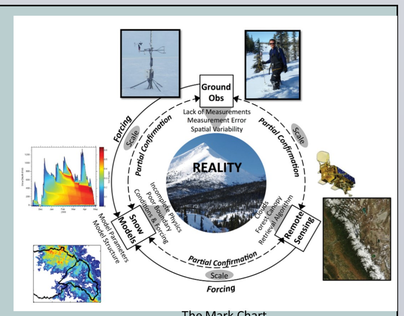
How well do snow depth retrieval methods (e.g., lidar and SfM) work where "bare earth" surfaces fluctuate, due to the variable permafrost, water, and vegetation characteristics ubiquitous at high latitudes?





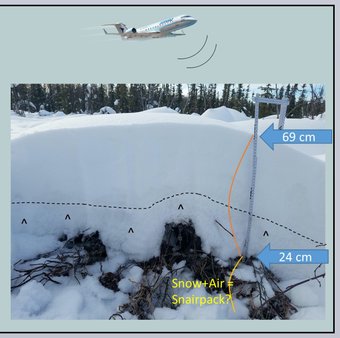
How well do methods that integrate multiple types of data with process-based models help to fill in observational gaps?

This question is important considering complementary nature of LiDAR and SfM. E.g. LiDAR works in the dark, but has limited spatial coverage.



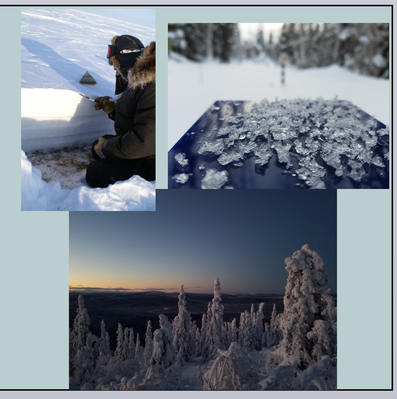
The Mark Chart.

How abundant are void spaces between the snow and ground surfaces, and what are their impacts on remote sensing of boreal and tundra snow?



Tundra snow: How does microstructure model accuracy and scaling issues impact use of models to inform Ku-scattering retrievals?

Taiga snow: How much does Ku penetrate forest canopies in boreal forests?



Measurement Science

- Snow-on and snow-off surface accuracies
- Radar scattering and land cover/permafrost
- Integrating datasets and models

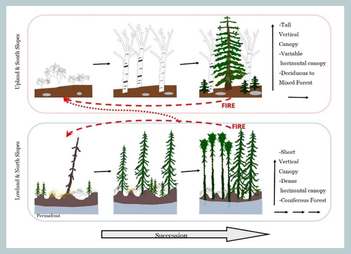
Snow Science

- Snow grain size characteristics
- Vegetation-snow-permafrost interactions

Tools

- Core: lidar, SfM (satellite to drone)
- Science Plan: L-band Interferometric SAR, X- and Ku- band SAR
- Advancing: passive microwave, gamma, FMCW, C-band, and TIR
- Ground Validation (time series and IOP)

How do canopy succession and disturbance impact ground conditions, snow properties, and our ability to estimate SWE in boreal and Arctic landscapes?



How do vertical and horizontal canopy structures impact surface energy, thaw depth, snow properties (e.g., depth, density, moisture, grain type and size, conductivity), and snowmelt?

black spruce, 2013 fire, birch

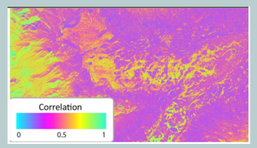
black spruce, 1983 fire; black spruce

How are L-band InSAR SWE change retrievals affected by what lies beneath snow surface, via interferometric decorrelation?

How do model accuracy and scaling issues impact use of models to inform Ku-scattering retrievals?

Additional possibilities to advance other techniques such as C-band SAR.

Additional measurements such as TIR, FMCW radar, and passive microwave considered as beneficial to advancing measurement science



UAVSAR L-band correlation over Grand Mesa. From HP Marshall's April 16, 2020 SnowEx Community presentation. Low correlation impacts SWE change retrieval. Changes in grass and shrub heights may cause low correlation.

Envisioned to have clusters of boreal and Arctic sites to span conditions.

Many accessible sites exist, many that include research infrastructure dating to the 1960s that could be leveraged.