MACSSIMIZE: An upcoming campaign to focus on the development and evaluation of Arctic snow emissivity models suitable for use in assimilation of satellite microwave sounder data

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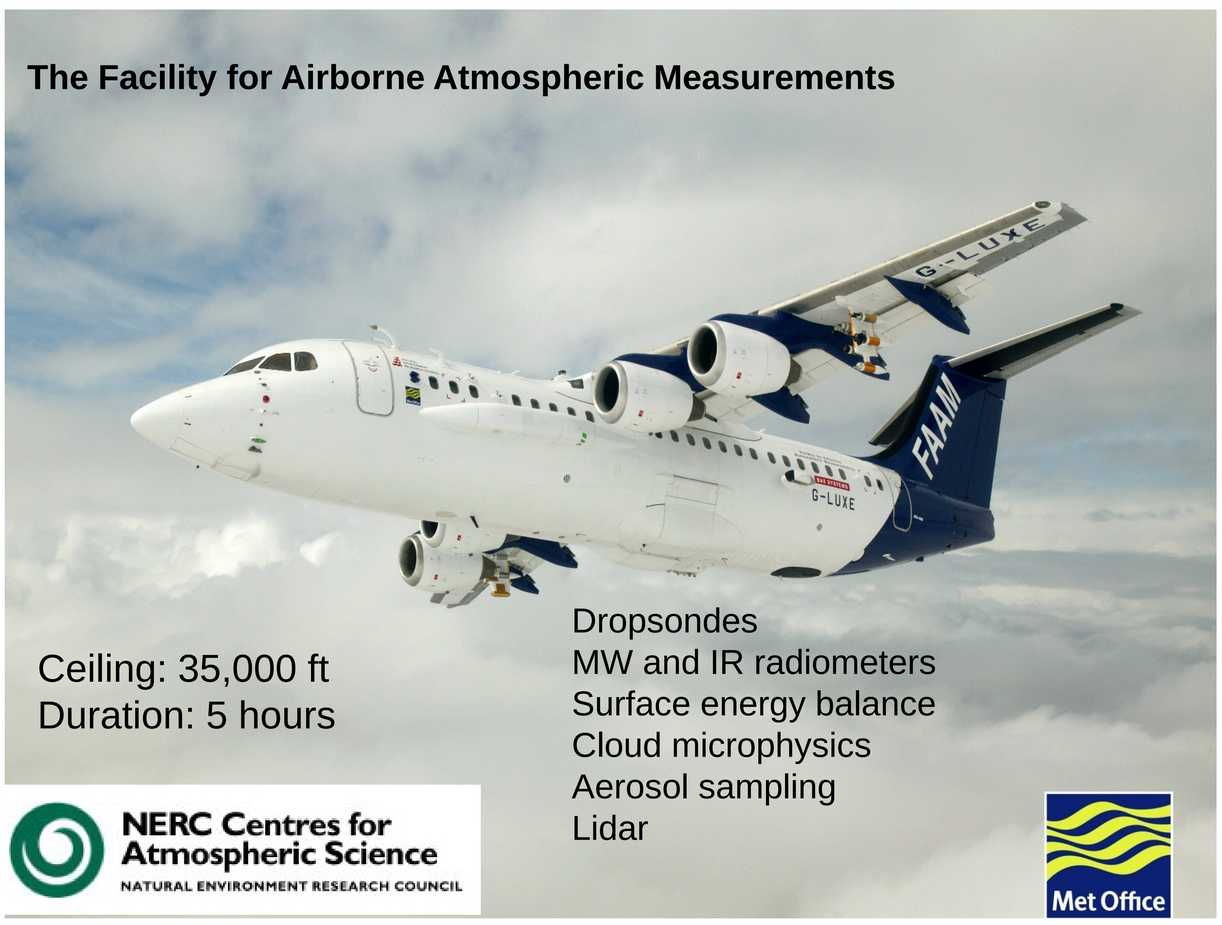
Abstract: This presentation will focuses on the snow and sea ice emissivity objectives and methodology for MACSSIMIZE. The novel instrumentation available on MACSSIMIZE should allow evaluation of snow microwave emission models in the 20-200 GHz frequency range to degrees of certainty greater than that achieved in the past. The ground-based snow pit measurements will provide snow microstructural and thermodynamic measurements that will be used to improve snow physical models for use in future NWP models. Such models should produce a model formulation able to generate snow stratigraphic sequences typical of Arctic snow conditions for the first time. Coupling such snow emissivity and physical modules into a NWP model will allow the production of a forward model useful for assimilation of microwave sounder data over the polar regions.

MACSSIMIZE Campaign in Mar. 2018:

- FAAM aircraft based in Fairbanks, AK
- Flights over land-fast and pack sea ice and snow-covered land
- Ground campaign where measurements of snow microstructural properties can be made on lake ice and snow-covered land near Inuvik, NWT, Canada.
- Need retrievals of emissivity from the microwave instruments on FAAM that are nearly coincident with the ground-based measurements of snow properties.
- FAAM will fly at low level to minimize the atmospheric gaseous absorption.
- Channels at 23.8, 50.3, 89, 118, 157, 183.3, 243, and 325 GHz. Retrievals performed as described in Harlow (2009).
- Simultaneous retrieval of effective radiating temperature and emissivity at 118, 183 and 325 GHz due to multiple dual-passband channels at one each.



Location of Ground Site:

- Trail Valley Creek chosen due to its legacy of snow measurements in recent years by collaborators Chris Derksen and Richard Essery.
- Example of a tundra site with snow characteristics typical of arctic snow packs that develop on surfaces with sparse or no vegetation. Such surface types dominate the Arctic in terms of areal coverage.
- Tundra snowpacks are characterised by depth hoar overlain by wind slab. As depth hoar is made up of large grains while wind slab consists of tightly packed, fine-grained snow.
- Past research has shown that emissivities in the 89-183 GHz range are sensitive to the depth of the windslab as well as the profiles of correlation lengths, density and water content.
- Emissivities in the 10-60 GHz range can yield information about the snow water equivalent of the snow pack up to limiting values where the emissivity differences saturate with respect to further increases in water equivalent (eg., Derksen et al., 2010)...

Analysis

Snowpack microstructural profiles observed at the ground sites will be used to drive snow radiative transfer models such as SMRT or MEMLS. These will generate simulated emissivity spectra that can be validated against the airborne retrievals generated with the radiometers on FAAM. The snow thermal and microstructural data will also be used the evaluate snow physical models suitable for coupling with an NWP model within an surface scheme such as JULES or CLM.

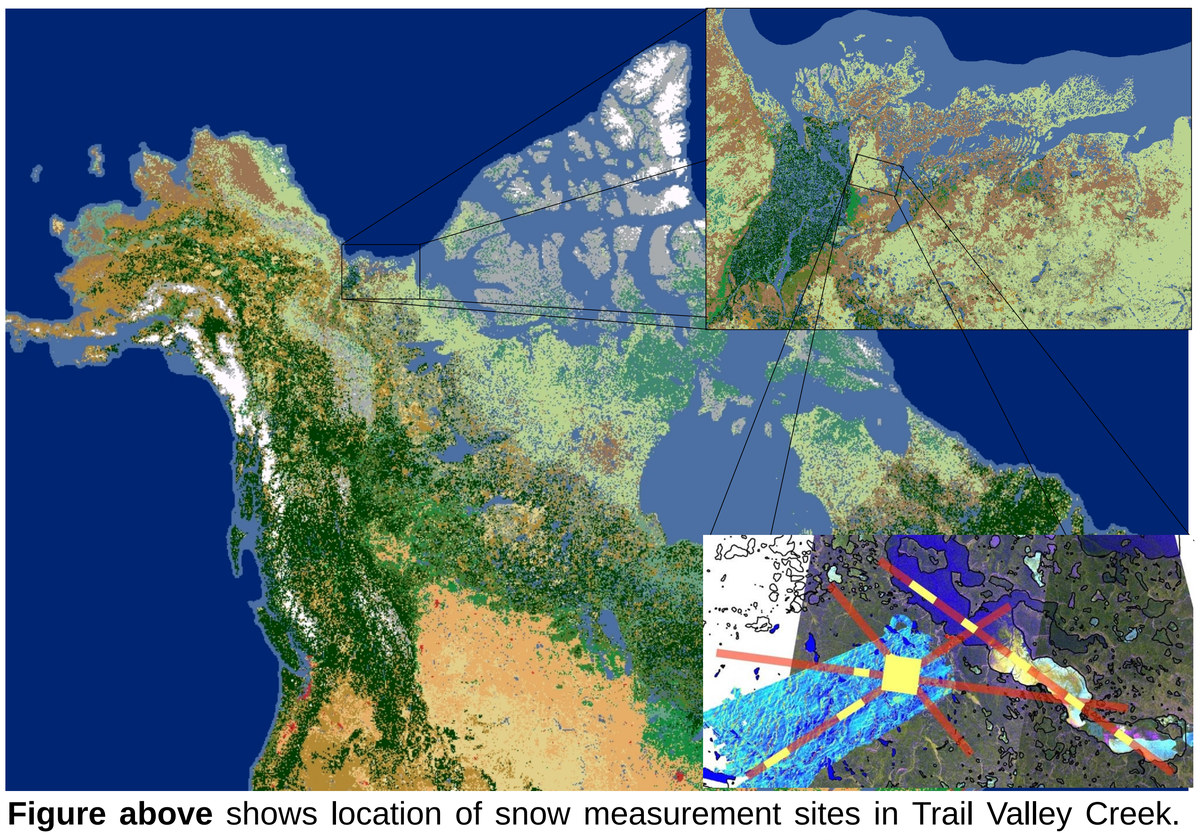
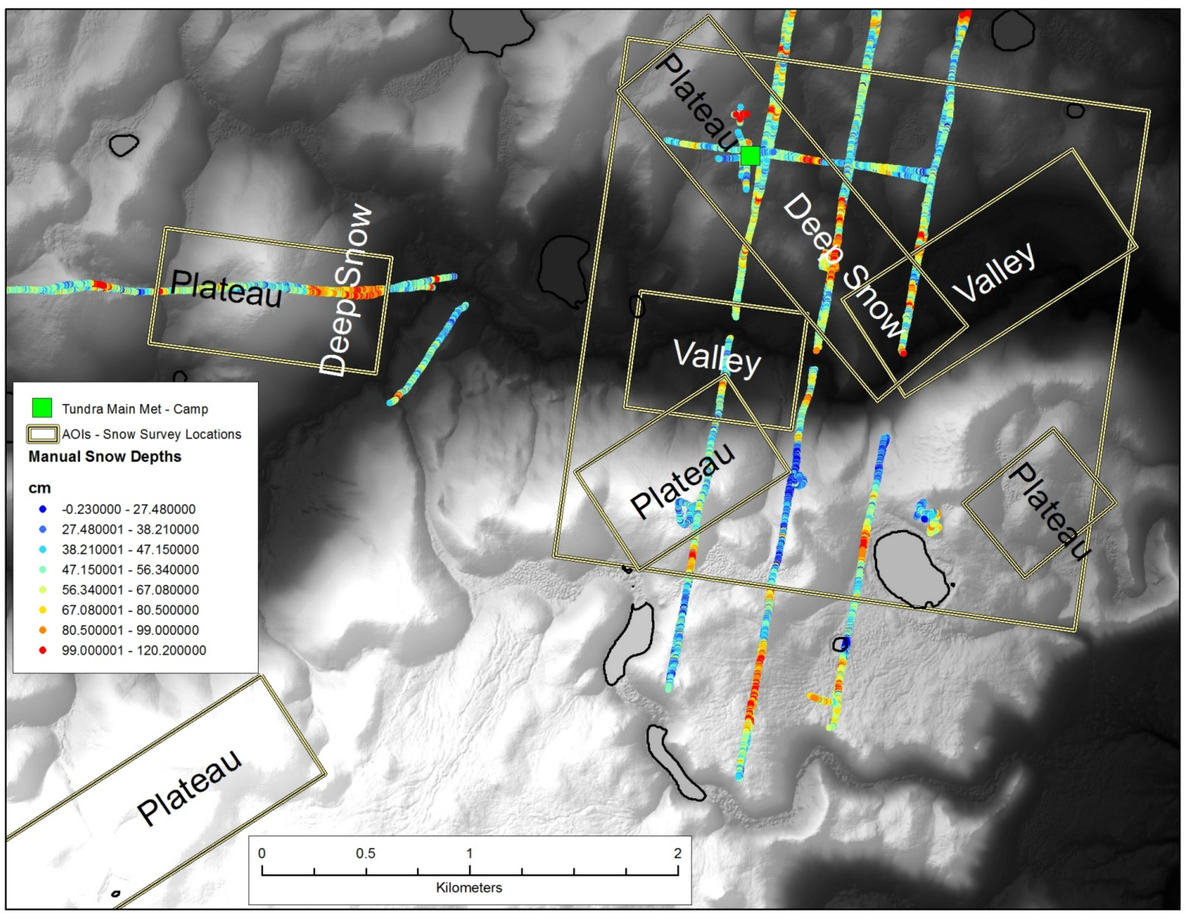


Figure above shows location of snow measurement sites in Trail Valley Creek. These are depicted on the NALCMS landcover map (https://landcover.usgs.gov/nalcms.php) in the main figure and upper right panel. The lower right panel shows proposed flight tracks overlaid on lidar snow depths over TVC (shades of blue) and TerraSAR imagery emphasising lake ice surface roughness (figure courtesy Peter Toose). Flight tracks are chosen to sample a variety of snow cover conditions over land and lake ice. Yellow boxes are areas selected for intensive snow sampling. **Figure below** shows areas of intensive snow sampling (boxes), snow depth surveys (color), and elevation in grey-scale.



References

C. Derksen et al. (2010) - *Development of a tundra-specific snow water equivalent retrieval algorithm for satellite passive microwave data*, Rem. Sens. Environ., 114(8): 1699-1709.

R.C. Harlow (2009) - *Millimeter microwave emissivities and effective temperatures of snow covered surfaces: Evidence for Lambertian surface scattering.* IEEE Trans. Geosci. Remote Sens., 47(7): 1957-1970.

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