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Climate forcing of Physical and Electrical Properties of Snow- Covered Sea Ice

The snow cover on first-year (FYI) sea ice is a critical component of the marine cryosphere because it controls ice accretion and ablation rates due to its relatively small thermal conductivity. The snow acts to insulate the sea ice from the warming atmosphere during the spring to summer transition and ultimately regulates winter sea ice thickness and summer melt behavior, and largely determines its mechanical strength which ultimately controls sea ice summer break-up potential. For example, if the sea ice grows in winter with a thin snow cover, the ice thickness will be minimized. This thin snow cover is then more likely to melt earlier in spring, thereby flooding the ice surface with melt water, lowering the reflectivity and absorbing more solar radiation, leading to earlier sea ice ablation.

My overarching research program objectives are to: 1) Improve our understanding of the spatial and temporal thickness distribution of snow on FYI, 2) Improve our understanding of the physical and electrical properties associated with these distributions and 3) Upscale estimates of snow thickness on FYI with spaceborne active microwave sensors from algorithms developed using surface-based sensors.

The scientific approach uses: 1) the multi-frequency and polarimetric capabilities of both surface and space-borne microwave remote sensing systems, 2) a unique suite of coincident in-situ measured snow geophysical and electrical property data from Arctic field stations and 3) computer/mathematical modelling of snow covered sea ice physical and electrical processes. These are employed in concert to develop inversion algorithms to estimate snow thickness distributions on FYI. Snow properties from various types of FYI will be obtained annually at both Arctic (Cambridge Bay, NU - CHARs, during 2017-2022) and sub-Arctic (Churchill Marine Observatory from 2018-2028) locations. The latter location will include controlled laboratory studies on our ability to measure contaminants, including oil, from active microwaves. An Oil in Sea Ice Mesocosm (OSIM) and Environmental Observing system at the CFI Innovation funded Churchill Marine Observatory on which I serve as co-PI will provide world class infrastructure to undertake this research program.

By developing, testing and validating snow thickness estimates on FYI from data collected in situ and via these microwave systems, I expect this research to provide critical information on FYI snow cover which can be incorporated within sea ice, microwave scattering and climate models towards better understanding the near and long-term fate of Arctic sea ice. Canada will benefit from the enhanced information generated from this project through the research outputs and results which can directly inform climate scientists and policy makers regarding the expected increase in marine navigation of our Arctic waters (both cruise tourism and intercontinental shipping).