University of Victoria | Graduate Studies

Notice of the Final Oral Examination
for the Degree of Master of Science

of

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BSc (University of Victoria, 2016)

"On the Estimation of Physical Roughness of Sea Ice in the Canadian Arctic Archipelago using Synthetic Aperture Radar"

Department of Geography

Tuesday, August 6, 2019
2:00 P.M.
David Turpin Building
Room B215

Supervisory Committee:
Dr. Randall Scharien, Department of Geography, University of Victoria (Supervisor)
Dr. David Atkinson, Department of Geography, UVic (Member)

External Examiner:
Dr. Edwin Nissen, School of Earth and Ocean Sciences, UVic

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Dr. Francis Lau, School of Health Information Science, UVic

Dr. David Capson, Dean, Faculty of Graduate Studies

Abstract

Sea ice surface roughness is a geophysical property which can be defined and quantified on a variety scales, and consequently affects processes across various scales. The sea ice surface roughness influences various mass, gas, and energy fluxes across the ocean-sea ice-atmosphere interface. Utilizing synthetic aperture radar (SAR) data to understand and map sea ice roughness is an active area of research. This thesis provides new techniques for the estimation of sea ice surface roughness in the Canadian Arctic Archipelago using synthetic aperture radar (SAR). Estimating and isolating sea ice surface properties from SAR imagery is complicated as there are a number of sea ice and sensor properties that influence the backscattered energy. There is increased difficulty in the melting season due to the presence of melt ponds on the surface, which can often inhibit interactions from the sensor to the sea ice surface as shorter microwaves cannot penetrate through the melt water. An object-based image analysis is here used to quantitatively link the winter first-year sea ice surface roughness to C-band RADARSAT-2 and L-band ALOS-2 PALSAR-2 SAR backscatter measured at two periods: winter (pre-melt) and advanced melt. Since the sea ice in our study area, the Canadian Arctic Archipelago, is landfast, the same ice can be imaged using SAR after the surface roughness measurements are established. Strong correlations between winter measured surface roughness, and C- and L-band SAR backscatter acquired during both the winter and advanced melt periods are observed. Results for winter indicate: (1) C-band HH-polarization backscatter is correlated with roughness (r=0.86) at a shallow incidence angle; and (2) L-band HH- and VV-polarization backscatter is correlated with roughness (r=0.82) at a moderate incidence angle. Results for advanced melt indicate: (1) C-band HV/HH polarization ratio is correlated with roughness (r=-0.83) at shallow incidence angle; (2) C-band HH-polarization backscatter is correlated with roughness (r=0.84) at shallow incidence angle for deformed first-year ice only; and (3) L-band HH-polarization backscatter is correlated with roughness (r=0.79) at moderate incidence angle. Retrieval models for surface roughness are developed and applied to the imagery to demonstrate the utility of SAR for mapping roughness, also as a proxy for deformation state, with a best case RMSE of 5 mm in the winter, and 8 mm during the advanced melt.