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Cartel

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To: The Nunavut Water Board
Object: Water Licence Application: ***Abstract and Project Description***

Abstract.
Monitoring Arctic temperature and snow cover trends using satellite remote sensing.

Since the 1970s, the Arctic continental zones (>60°N) have witnessed increasingly marked changes, such as increased surface air temperature, earlier snow melt and altered surface freeze/thaw cycles. This proposal is related to a research program of which the goal is to improve the analysis of these climatic variables using satellite microwave observations, sensitive both to temperature and snow cover or ice. The main goal of the measurements program in the Arctic is to better explain the microwave emission using ground-based radiometric measurements associated with measurements of thermophysical proprieties of snow (profiles of temperature, density and snow grain size). A better comparison of the measured signal with in-situ validations will allow the improvement of current satellite monitoring of the Arctic environment. The experimental site, considered for its representativeness, is the summit plateau of the Barnes Ice Cap, Baffin Island, Nunavut, 70°0' N, 73°30' W. The specificity of ground-based measurements is the determination of the snow grain size vertical profiles, which are an important source of error in the retrieval of microwave observations (measurements using an original method based on infrared reflectometry). The benefits of the program for the North are important through a better characterization of the expected warming associated with snow and ice seasonal dynamics (melt onset, water resources, and surface freeze/thaw cycle).

Project description.

Context and importance of undertaken research
Since the 1970s, arctic continental zones (>60°N) have witness the strongest signs of global climate variability and change, related to currently observed global warming such as increase in air temperature, early snow melt periods and modification of freezing/thawing annual cycles. The amplitude of those changes varies from one region to another, where significant warming is measured in the northwest regions of Canada’s Arctic. Snow, with its unique physical characteristics (high albedo, low thermal conductivity/diffusivity), is a key component to the equilibrium of the Arctic system through its role within various climate feedbacks and surface energy balance.

Hence, it becomes crucial to better characterize and understand observed changes during the winter period. Surface observations using satellite remote sensing is critical given the lack of in-situ measurements and weather information. Specifically, passive microwave remote sensing allows a constant coverage, both spatially and temporally, of surface state variables in polar regions. Although satellite archives have existed for about three decades, the quantification of those variables for the development of precise indicators of climate change has yet to be done.

Passive microwave remote sensing, sensitive to temperature and snow conditions, appears to be the best tool to monitor the sate of the Arctic. Brightness temperatures retrieved from the microwave signal allows the extraction of key parameters such as surface and snow/ground interface temperatures, accumulation of precipitation, snow water equivalent (SWE) and snow melt rate. However, the vertical, spatial and seasonal variability of snow cover increases the complexity of the analysis from satellites.

Objective

The principal objective of this project is to better understand and explain passive microwave emission using ground-based radiometric measurements coupled with physical measurements of snow and ice. The goal is to improve the analysis of climate variables of interest for northern regions. A better comprehension of the measured satellite microwave signal requires ground validation.

Study site

A field campaign is planned in March of 2011 on the Barnes Ice Cap, Baffin Island, Nunavut (70°0’N 73°30’W). This site allows the comparison with continent ice shelves such as Greenland and Antarctica that have witness significant changes over the last few decades. A temporary meteorological station will be installed for the duration of the project (about 2-3 weeks). Field measurements will be collected to validate satellite inversions in order to monitor temperature and melt.

Field measurements

Physical snow and ice properties, which are controlling the microwave signal, will be collected: vertical profiles of temperature, stratigraphy, density, grain size, wetness and interface conditions (air/snow, snow/ice). Grains size and shape significantly affect radiative transfer and are a very important source of uncertainty. Our team has developed and published a very unique approach to measure the specific surface area (SSA) of snow grains using infrared reflectometry. This information is crucial to microwave radiative transfer models which will allow us to improve current understanding of how the system affects satellite measurements.