Time series SAR investigations of first-year sea ice surrounding the CASES study region for spatio-temporal spring melt information

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INTRODUCTION

Spring melt timing on sea ice is an important parameter because of its physical connection to dramatic decreases in surface albedo (Thomas and Barber, 1998; Yackel et al, 2001). More than 250 synthetic aperture radar (SAR) images acquired from ENVISAT ASAR and RADARSAT-1 were collected from January to July 2004 and processed. Backscatter statistics were derived and analyzed over smooth landfasted first-year sea ice (FYI) within Franklin Bay and the surrounding CASES study region for the purpose of providing spatio-temporal spring melt information.

The objectives are to:

- **Utilize an incidence angle SAR standardization and time series analysis technique to identify sea ice melt onset timing adjacent to and surrounding the CASES study region within the Amundsen Gulf**

- **Assess these spatio-temporal melt onset dates with remote sensed surface forcing derived from the Polar Pathfinder AVHRR-derived (CASPR) dataset** (Wang and Key, 2005).

STUDY AREA

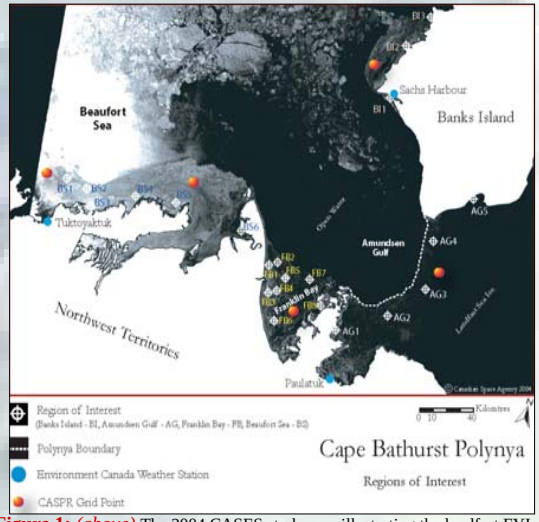
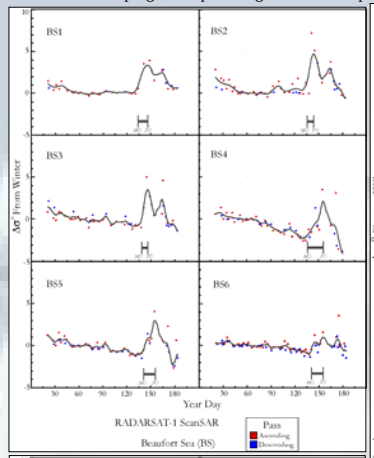


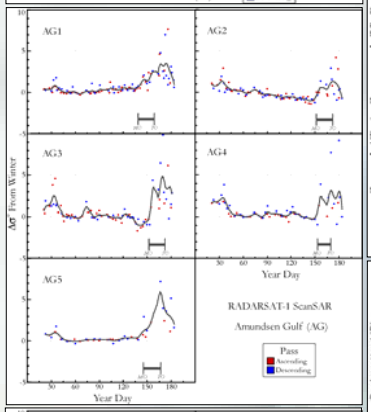
Figure 1: *(above)* The 2004 CASES study area illustrating the landfast FYI locations of SAR time series sites and AVHRR derived surface forcing grid point locations within Franklin Bay and those surrounding the Amundsen Gulf polynya.

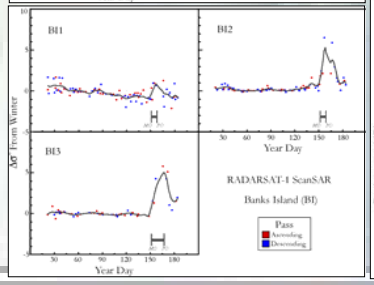
Figure 2: *(right)* The series of figures to the right (6 of them) represent the time series evolution of the microwave backscatter coefficient. The sharp upturn represents the beginning of melt onset (MO). Pond onset (PO) is represented by the first peak in the upturn for Ku-band and occasionally the second peak for C-band. Surface radiation fluxes and air temperature derived from the AVHRR (CASPR) dataset at the 5 orange dot locations is also illustrated. Considerable spatio-temporal information is depicted wrt MO and is the subject of further work.

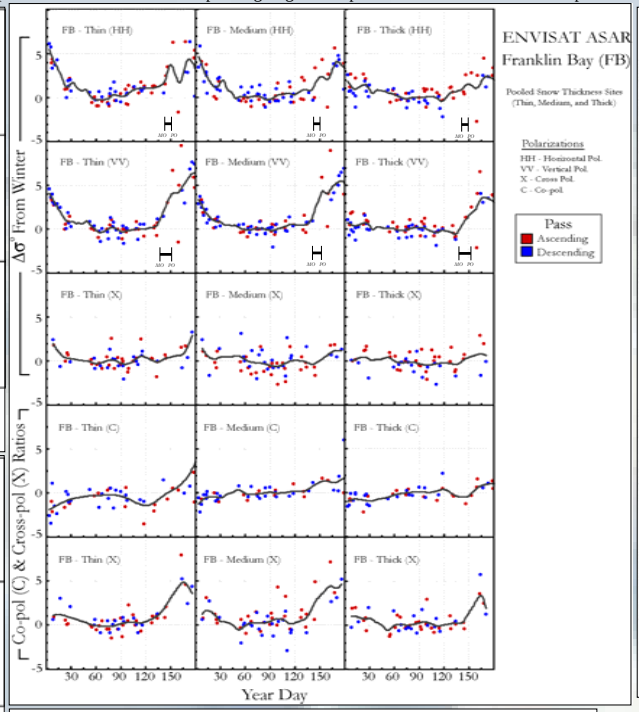
RESULTS & DISCUSSION

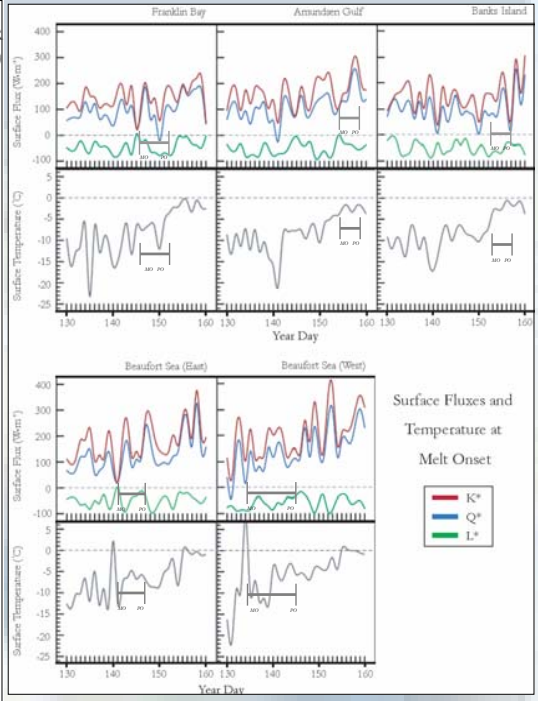
From the ENVISAT ASAR plots (center) we observe that that on YD 145 the air temperature rises above 0°C for the first time, peaking at over 4°C, and a light rain event occurs. The warmer air temperatures drive up the snow/ice interface temperature as well as the snow surface temperature, which reaches 0°C. This strong shift in the weather initiates a new scattering regime. The wetter snow surface likely produces some surface scattering, while the greater amount of liquid water in the snow cover (from rain and snow melt), plus greater brine volumes increases the volume scattering. Even though microwave absorption must increase under this regime, it appears to be dominated by increased scattering. The increase in the cross-pol ratio during the ponding is unexpected, but may be due to drained ice with air bubbles as scattering centers, plus contributions from rubble ice developing at the pond edges. The cross-pol ratio decreases later in the ponding stage as the pond fraction increases and the open water plus wet snow and ice surfaces dominate through surface scattering.

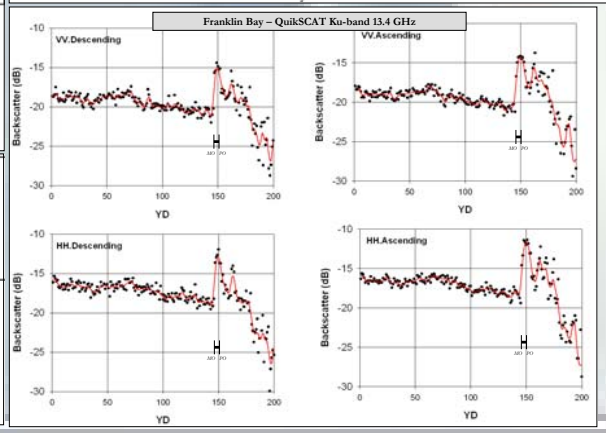












SUMMARY & FUTURE WORK

This preliminary analysis suggests that melt onset (MO) over landfasted first-year sea ice (FYI) can be reliably identified by the sharp upturn in the time series of the microwave backscatter coefficient. Pond onset (PO) can be reliably detected by the first peak thereafter in the time series. The timing of MO is spatially variable around the CASES study region. MO occurs earliest at the Beaufort Sea (BS) sites, followed by Amundsen Gulf (AG) and then Banks Island (BI) sites. The difference in MO timing is up to 25 days between some sites. Future work will investigate the spatially dependent forcing using the CASPR dataset

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