ADVANTAGES OF RADARSAT-2 FOR OPERATIONAL ICE MONITORING

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Environment Canada's Canadian Ice Service (CIS) is responsible for the daily monitoring of Canadian coastal waters for the presence and condition of lake ice, sea ice and icebergs. The provision of regular ice information promotes safe and efficient maritime operations and protects Canada's EEZ by providing reliable and timely information to marine clients. The CIS relies on a suite of both airborne and satellite sensors to detect and characterize ice. In fall of 2008, CIS operations transitioned from the RADARSAT-1 sensor to RADARSAT-2. In the past year, 7000 near real time RADARSAT-2 ScanSAR scenes have been received and analysed by CIS image analysts. Within this past year, the CIS has evaluated the utility of dual polarized (i.e. HH+HV) ScanSAR for operational ice detection. This paper will expand on the following observations.

Prelaunch and early post-launch investigations hinted that the use a dual channel approach in ice detection would be beneficial [1]. After further examination and operational use over the past year, the benefits associated with using both HH and HV ScanSAR data in CIS Operations are further understood and were found to be significant. Identification of primary ice information such as ice-water separation (i.e. ice concentration) and stage of development (i.e. ice type) are significantly improved with the use of HV data, as previously predicted [2]. Signature confusion at HH polarization makes the separation of ice from open water very difficult in the near to mid-range of acquired ScanSAR swath. This confusion is significantly alleviated through the incorporation of the HV channel. At HV polarization, the background ocean clutter is

suppressed and is independent of viewing incidence angle. This results in a more straightforward separation of ice and water in this channel. One identified caveat is that the signal to noise ratio (SNR) of smooth new ice (<10 cm) is too low to permit detection in the HV channel. As a result, while the HV channel is considered a strong complement to the HH channel (especially in the incidence angle range 20-35º), it cannot be used alone in the detection and charting of all ice types. Automated ice segmentation and classification routines also perform better using both HH and HV channels rather than a single channel approach.

The same HH+HV dual channel combination has also improved the detection of multiyear sea ice in high concentrations of seasonal first year ice. At HH polarization, rough first year ice can scatter as brightly as nearby multiyear ice, thus hindering the separation of these ice types. The HV channel is highly sensitive to the volume scattering which occurs in the near surface layers of multiyear ice and, importantly, is not sensitive to the micro-scale surface scattering that occurs over first year ice. As a result, there is a higher contrast ratio between these two ice types in HV, resulting in improved detection. A similar relationship results in improved floe perimeter estimation as well. It will be shown that automated ice motion mapping, which relies on the detection of floe edges, benefits from the use of both the HH and HV channels.

While the use of two channels of SAR data has obvious cost implications related to data transfer, it also has a potential impact on image quality. Downlinking dual channel RADARSAT-2 data in real time requires the use of increased BAQ compression (4 bit to 2 bit) onboard the spacecraft to fit in the available downlink bandwidth. This reduction of BAQ bit sampling reduces the signal to quantization noise ratio. In the paper, the impacts of this increased signal compression are assessed in the context of operational ice detection.

References:

[1]. Flett, D. De Abreu, R. Arkett, M. and M-F Gauthier, Initial Evaluation of Radarsat-2 for Operational Sea Ice Monitoring, *Geoscience and Remote Sensing Symposium, 2008. IGARSS 2008.* Volume: 1, pp. I-9-I-12 (2008)

[2]. Onstott, R.G. *Microwave Remote Sensing of Sea Ice,* Ch. 5 – SAR and Scatterometer signatures of Sea Ice, pp. 73-104. AGU Geophysical Monograph 68, 1992.