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Examining Scattering Mechanisms within Bubbled Freshwater Lake Ice using a Time-Series of RADARSAT-2 (C-band) and UW-Scat (X-, Ku-band) Polarimetric Observations

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This study identifies the dominant scattering mechanism for C-, X- and Ku-band for bubbled freshwater lake ice in the Hudson Bay Lowlands near Churchill, Canada, using a winter time series of fully polarimetric ground-based (X- and Ku-band, UW-Scat) scatterometer and spaceborne (C-band) synthetic aperture radar (SAR, Radarsat-2) observations collected coincidentally to in-situ snow and ice measurements. Scatterometer observations identify two dominant backscatter sources from the ice cover: the snow-ice, and ice-water interface. Using in-situ measurements as ground-truth, a winter time series of scatterometer and satellite acquisitions show increases in backscatter from the ice-water interface prior to the timing of tubular bubble development in the ice cover. This timing indicates that scattering in the ice is independent of double-bounce scatter caused by tubular bubble inclusions. Concurrently, the co-polarized phase difference of interactions at the ice-water interface from both scatterometer and SAR observations are centred at 0° throughout the time series, indicating a scattering regime other than double bounce. A Yamaguchi three-component decomposition of SAR observations is presented for C-band acquisitions indicating a dominant single-bounce scattering mechanism regime, which is hypothesized to be a result of an ice-water interface that presents a rough surface or a surface composed of preferentially oriented facets. This study is the first to present a winter time series of coincident ground-based and spaceborne fully polarimetric active microwave observations for bubbled freshwater lake ice.