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SAR ice thickness mapping in the Beaufort Sea during autumn 2015 using wave dispersion in pancake ice

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Pancake and frazil ice represent an important component of the Arctic and Antarctic cryosphere, especially in the Marginal Ice Zones. In particular, pancake ice is the result of a freezing process that takes place in turbulent surface conditions, typically associated with wind and wave fields. The retrieval of its thickness by remote sensing is, in general, a very difficult task. This study presents our ongoing work in the EU SPICES project, in which we aim to use the results of theory and observations developed so far in order to refine a processing system for routinely deriving ice thicknesses in frazil-pancake regions of the Arctic and Antarctic. The change in dispersion of ocean waves as they penetrate into pancake icefield is analyzed in order to derive ice thickness estimation. The spectral changes in wave spectra from imagery provided by space-borne SAR systems (mainly Cosmo-SkyMed and Sentinel-1 satellites) is used to retrieve pancake ice thickness run trough by the R/V Sikuliaq research cruise in the Beaufort Sea (October-November 2015). During several experiments, a line of wave buoys was deployed along a pre-declared line, which could thus be covered by simultaneous overhead Cosmo-SkyMed images. The inversion procedures was then applied to SAR images, the final goal being the comparison between the ice thicknesses measured in situ and those inferred from SAR wave number analysis with the application of a viscous theory.
Results show a broad agreement between observed thicknesses and those retrieved from the SAR, the latter slightly overestimating the former in several case studies. In the case of November 1, for example, the agreement is excellent (SAR retrievals 4.9, 5.0, 6.5 cm; observed mean 6.7 cm); on October 11 the agreement is also very good between the SAR retriveal (21 cm) and the output from an along-track EM-sounder; on October 23-24 the SAR retrieval of 18.1 cm is double the observed pancake thickness of 8.7 cm, but this difference can be ascribed to the presence of large floes in the icefield. Even though quite resilient to relatively large changes in viscosity, the method resulted very sensitive to i) the input wind speed accuracy, ii) the presence of different ice types than frazil-pancake in the enquired region, iii) the exact co-location between the SAR extracted sub-scenes and the in situ measurements.