Geophysical Research Abstracts
Vol. 21, EGU2019-5973, 2019
EGU General Assembly 2019

Sea ice-water classification on dual-polarized Sentinel-1 imagery during melting season

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We provide a sea ice-water classification product with high spatial resolution of 40 m and high temporal resolution of one day using Sentinel-1 Synthetic Aperture Radar (SAR) data. The classification is applied during the melting season in the Fram Strait region in the Arctic. During summer seasons, the contrast between backscatter intensities of different ice types observed by SAR is reduced due to the decreased surface roughness caused by melt water and wet snow on sea ice. The wet or melted snow strongly reduces the SAR penetration depth and thus suppresses all volume scattering contribution from within the sea ice. The backscatter coefficients of sea ice and open water thus become more similar. The ambiguity in SAR backscatter coefficients between ice and open water (OW) is further increased within the marginal sea ice zone (MIZ). Winds and ocean currents can increase SAR backscatter in the MIZ, which leads to ambiguities between water and ice. The penetration of SAR corresponding to the wavelength of microwave may reduce the contrast between thin ice and open water, thus decrease the separability of some ice types, especially for OW and thin ice. In summary, the melting season represents the most challenging time of the year for reliable ice-ocean classification from SAR data. We propose here a new approach to overcome these problems by using mixture statistical distribution based conditional random fields (MSTA-CRF). To obtain reliable ice-water classification at the same time with fast computation time suitable for operational applications the MSTA-CRF is adopting the superpixles approach in the fully connected CRF model. The MSTA-CRF is a spatial and contextual model, which integrates statistical distributions (Gamma, Weibull, Alpha-Stable, et al) to model backscatters of ice and water to overcome effects of speckle noise and wind roughened open water. Dual-polarization Sentinel-1 A & B SAR data with 40 m spatial resolution is available several times per day within the Fram Strait region and thus a big data volume needs to be processed. Setinel-1 observations over Fram Strait from June to September during the four years 2015-2018 were collected and classified in ice and water areas. For validating the proposed algorithm and results manually derived ice chart from the Norwegian Meteorological Institute (MET) are used. For processing the large data amounts and automatically classify ice-water, we first build a training dataset by selection 10 samples of ice and 10 samples of water from each SAR image. For the training tasks of a certain image, training samples for each categories consists of three part, same month, sample year but different month, and different year, the ratio of them is 2:1:1. The left Sentinenl-1 SAR data from June to September in 2018 is used as input for the trained MSTA-CRF model. Results are discussed and analyzed showing that the proposed mixture statistical distribution based CRF algorithm (MSTA-CRF) can provide a good performance with about 90% accuracy on ice-water classification and performs better than other state-of-the art algorithms.