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Sea Ice Ridge Detection from ICESAR 2007

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Synthetic aperture radar (SAR) imagery can be used to capture sea ice surface deformation features including rafted ice, shear zones, pressure ridges and rubble ice caused by the divergence, convergence and shear of sea ice. It has been shown that pressure ridges can be observed as bright, curvilinear features in C-band and L-band SAR satellite images. A comparison of airborne L-band and C-band SAR data to identify deformation features (ridge) has concluded that L-band is preferable in most cases. To investigate in more detail how sea ice can be observed by SAR, the airborne measurement campaign ICESAR 2007 has been conducted. In this study, we use L-band and C-band airborne SAR data sets to detect ridges from the ICESAR 2007 campaign. Our region of interest (ROI) is the Fram Strait. One goal of this study is to identify possibilities if deformed ice areas can also be detected with the lower resolution (40 m) SAR of the Sentinel-1 satellite mission. We therefore consider the parameter configurations of the Sentinel-1 mission as a baseline in our study. Traditional techniques for ridge detection include line detection, edge detection, and direct threshold method. These methods are insufficient without considering the intensive speckle noise and contextual information in such high spatial resolution SAR imagery like we use here from ICESAR 2007. Another obstacle is to separate ridges from other deformed features in the SAR imagery. For tackling these issues, we propose using a structure tensor algorithm for ridge detection in the ICESAR 2007 data sets. For the tensor structure algorithm, sea ice ridges are described as the target enhanced by the tensor matrix and surrounding pixels are suppressed as the background using the weighted gradient distance. The length to width ratio is used to preserve ridge shaped features and avoids that they are being filtered out as noise. The structure tensor algorithm is validated for the ICESAR L-band HH and HV SAR imagery with a spatial resolution of 1.5 m using the coincident optical imagery taken from the airplane. Three ridges are selected as the training samples and the remaining are used as the testing samples. The backscatter coefficients Beta0 is calculated from ICESAR L-band SAR data set as the input variable. The assessment of the results by the optical imagery verifies the effectiveness of the structure tensor algorithm for ridges detection. The high temporal frequency of the Sentinel-1 overpasses provides a large amount of observations of ridges in SAR data, which could be exploited for ridge detection. The spatial resolution, however, is much lower than the airborne data. It will be tested if the Sentinel SAR data is well suited for surface deformation retrieval. In the future, an algorithm will be developed that considers richer texture information applied for ridge detection and an attempt will be made to apply it on a series of Sentinel-1 SAR images to overcome the disadvantages of speckle noise and degraded details.