

Synthetic Aperture Radar based Sea Ice Type Retrieval using Deep Neural Network

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Abstract: Sea ice monitoring has attracted increasing attention over the last few decades. Besides the scientific interest in sea ice, the operational aspect of ice charting is becoming more important due to the growing navigational possibilities in an increasingly ice-free Arctic, especially over the North East and North West passages. For this purpose, space-borne SAR imagery has become an invaluable tool, in particular for its higher resolution compared to traditional passive sensors. Previously, mostly single polarimetric datasets were investigated in supervised and unsupervised classification schemes for sea ice investigation. Despite proven sea ice classification achievements on single polarimetric data, a fully automatic, general purpose classifier for single-pol data has not been established due to the large variation of sea ice manifestations, weather and incidence angle impacts. Recently, through the advent of polarimetric SAR sensors, polarimetric features have moved into the focus of ice classification research. The higher information content of two or four channels promises to offer greater insight into sea ice details and overcome some of the shortcomings of single-polarimetric classifiers. In parallel, deep learning techniques for image processing have developed rapidly. Convolutional Neural Networks (CNN) have now achieved human-level image recognition ability with minimal pre-processing. Once trained, CNN can automatically extract and weight the complex spatio-polarimetric features needed for SAR image classification. Instead of providing a single label for each input image, the problem of semantic segmentation is to classify images pixel-wise, to identify regions belonging to each predefined class. Here too, CNN based network architectures have proved very successful.

Therefore, this work is intended to explore the potential of deep learning techniques and polarimetric SAR for the application of automated sea ice charting in Near Real Time (NRT).

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Densely Connected Convolutional Networks (DenseNets) are a recent development in network architecture designed to improve accuracy and ease of training by introducing additional connections between otherwise non-consecutive layers. Skip connections between layers with common resolution, allow the network to analyse the image at multiple scales simultaneously. Reducing the burden of training is particularly relevant, given the very limited amount of labelled data available for this task.

Ancillary data from national ice services, *in situ* measurements from various Arctic campaigns and expert judgement are utilized to identify and verify the governing ice regimes.