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Automatic classification of the Arctic sea ice from Envisat/ASAR images using Neural Networks

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Satellite radar systems have an important ability to observe the earth's surface, independently from cloud and light condition. This property of satellite radars is very useful in Arctic during polar night and severe weather condition. Information derived from radar sensors can be used in applications supporting regional sea ice mapping and monitoring, iceberg monitoring, as well as marine transport, industrial activities and fisheries support. It is necessary to give the operational information near real time in the convenient form for users (ice charts). The scattering characteristics of the surface from SAR images are defined by backscatter intensity. It is a function of radar frequency, incidence angle and polarization. SAR backscatter depends on many physical parameters of ice cover, such as surface roughness, salinity, air incorporations, crystal structure and other ice characteristics; it is possible to classify SAR imagery into several ice types. The main sea ice parameters including ice stages, concentration, ice edge and polynyas location, ice-surface features and others, have be derived from radar images. With regular acquisition of high-resolution SAR data the volume of obtained data sets increases drastically and visual interpretation of these images and retrieval of sea-ice parameters becomes laborious.

Here we introduce new developed techniques of the Arctic sea ice automatic classification based on interpretation ENVISAT Advanced Synthetic Aperture Radar (ASAR) images.

In order to solve the problem of automatic classification of sea ice types in ASAR images we use Neural Network (NN) approach and textural characteristics for ASAR polarization options. The structure of the NN was optimized for the sea ice classifica-

tion. The standard product for ASAR Wide Swath Mode images (WSM) with150-m resolution and width approximately 400 km were used for processing. For obtaining backscatter values, ASAR images were calibrated using BEST (Basic Envisat SAR Toolbox) software. As the NN inputs we use texture of ASAR images. The number of neurons in the first layer (input layer) corresponds to the number of textural image characteristics, which are obtained from the computation of the Grey Level Co-occurrence Matrix (GLCM). Passing through the network the input vector is reorganized into the resulting vector in the NN output. The number of neurons at the output layer corresponds to the number of the qualified sea ice classes. The neural networks have been trained with supervision. The learning method tries to minimize the current errors of all processing elements. This global error reduction is created over the time by continuously modifying the input weights until acceptable network accuracy is reached. As learning classes we use the next ice classes: open water, new ice, young ice, first year ice, rough first year ice and multiyear ice. After NN learning it is necessary to test and compare results of the acquired automated sea ice classification with the expert estimations and *in situ* sea ice data.

We have applied and tested this algorithm to analysis of sea ice conditions in the Kara Sea. The procedure included the processing of satellite images massive with using trained NN, automated receiving characteristics of ice cover, and the analysis of their variability. Good comparison between automated classification of the sea ice and real characteristics of ice cover in the Kara Sea showed possibility of successfully application of this technique for interpretation of ASAR sea ice data.