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UNSUPERVISED TERRAIN CLASSIFICATION OF COASTAL ARCTIC ENVIRONMENTS BY MEANS OF POLARIMETRIC TERRASAR-X SYNTHETIC APERTURE RADAR (SAR) AND TANDEM-X DIGITAL ELEVATION MODEL (DEM) DATA

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Remoteness and inaccessibility of the arctic pose a challenge to derive continuous and area wide information of the earth surface and its temporal dynamic. With respect to expected changes in the eco- and geosystem, forced by changing climate conditions, remote sensing can aid quantification of the present state and occurring changes. Active synthetic aperture radar systems (SAR) are suitable to monitor arctic environments, since the operation is independent from insolation or shadowing of clouds.
Objective of our work is to develop higher level products of polarimetric SAR data (PolSAR) and digital elevation model (DEM) data that abet the classification of the arctic land surface in an automated way. For this purpose we will show: 1) The utilization of co-polarized (HH/VV) TerraSAR-X (TSX) Stripmap data for unsupervised land cover classification. 2) First outcomes from unsupervised morphometric classification based on TanDEM-X (TDX) DEM data.
German TSX and TDX radar satellites are capable to acquire X-Band data with high spatial resolution of large areas with one single acquisition. Measuring different states of polarization enables to characterize the type of backscatter and to relate this information with the type of coverage. DEM of TDX campaign will be the first global (pan-arctic) dataset with a spatial resolution of 12 meter. The DEM is derived by helix orbit configuration of TSX and TDX satellites, which allows preforming single-pass SAR interferometry. We will show TDX elevation model data of the Mackenzie Delta region (NWT (Northwest Territories), Canada) acquired in 2012.
Test sites of our study are located in the Western Canadian Arctic, where presented results will focus on the Mackenzie Delta region. Transferability of the approach will be tested for Herschel Island (Yukon, Canada), Banks Island (NWT, Canada), James Bay (Québec, Canada) and Lena Delta (Sakha, Russia).
Both PolSAR and DEM data are classified using pixel-based unsupervised classification techniques. A Non-Local Means filter is used prior the classification to remove noise, to generalize the data and to keep fine structures and details. The classification of the PolSAR data is based on an iterative threshold classifier separating land from water. In the following land classes are derived using Fuzzy-K-Means and Maximum Likelihood classification (MLC) techniques based on Bayes theorem. MLC allows to estimate the quality of the classification and to derive continuous as well as discrete classifications. Morphometric classes are derived using elevation, slope, curvature and texture. After threshold based classification MLC is applied to estimate the quality of the classification.
Results indicate that general land cover classes, such as Water, Bare Soil, Tundra Vegetation or Wetlands, are well distinguishable with the proposed approach (overall classification accuracy of approx. 75-95 %). Preliminary morphometric classification results highlight different shore types such as Low Lying Tundra or Tundra Cliffs. Reference data were carried out during two ground truthing campaigns in 2012 and 2013 and from high resolution airborne imagery acquired by Alfred Wegener Institute for Polar and Marine Research (AWI) during the “Polar 5 Campaign” and contemporaneously to the field data acquisition.