A new generation of spaceborne SAR sensors is being put into operative use. Three of these satellites - ALOS PALSAR, TerraSAR-X and Radarsat 2 - can provide fully polarimetric image products. The availability of dual-polarization and fully polarimetric data, instead of earlier single-polarization data, will enable a deeper analysis of backscattering processes, and thereby pave the way for many new applications for space-borne SAR data. Changes in crop type and growth stage in agricultural fields or forestry and snow cover, will be of the major interests. In this paper, we evaluate and compare five polarimetric change detection techniques on ALOS PALSAR data. Whenever possible, we underline the strong and weak points of each method for a given change detection task. Our experimental approach aimed at providing guidelines for polarimetric change detection.

The study site is located in Kuortane, in central Finland (62°48'33"N, 23°30'50"E). The area is relatively flat (elevation between 38 m and 230 m). Coniferous forest on mineral soil is the dominating land cover type. Three PALSAR fully polarimetric images were acquired over Kuortane in November 2006, March and May 2007. The off-nadir angle was 21.5°, incidence angle 24°, and resolution 25 m. Ortho-rectification with accurate DEM was used. During the November acquisition, some snow was on the ground but the water surfaces were mostly open. In the March scene, the lakes were covered with ice and some floating water on top.

Six polarimetric change detection methods were tested on all pairs of images. The methods do not include polarimetric interferometry methods. Some of these change statistics do not use all the polarimetric information, only a part of it. The tested methods were:

- difference of the products $S_{hh} S_{vv}^\ast$ - [1]
- difference of correlation coefficients between $S_{hh}$ and $S_{vv}$ - [1]
- contrast ratio (Rayleigh quotient) - [2]
- ellipticity of covariance matrix - [2]
- test of equality for two complex Wishart matrixes - [3], also called Bartlett test [2]

In addition, simple methods were implemented, relying on differences or ratios of backscattering coefficients in single polarizations. Combinations of single polarizations change detection indices were tested as well.

Two reference change maps were used to quantitatively evaluate change detection methods. The first reference change map was built by pixel-to-pixel post-classification change detection. The inputs were the 5-class classification from each SAR image (water, field, forest, marsh and urban classes). PolSARpro supervised classification and Corine Land Cover 2000 classification (CLC2000) were used, giving an accuracy of around 80% in each images. The drawback of this method is accumulation of classification errors when building the change map. The second reference change map was obtained by applying an in-house change detection software, AutoChange [4], using as inputs the Pauli decomposition channels (HH-VV, 2HV and HH+VV).

A qualitative comparison was also carried out by visual inspection and comparison. Preliminary results suggested that Contrast ratio and the Wishart test of equality provided good results for both reference change maps.

*Thanks to TEKES, the Finnish Funding Agency for Technology and Innovation, for funding NewSAR project.
Most changes involve seasonality phenomena like ice melting or crop growth. A minor part of the changes were clear cuts occurring between the image acquisition dates. In our experiments, no single change detection index was capable of retrieving all the changes simultaneously. Future work will include comparison of changes with ground truth of clearcuts obtained from the forest administration, better evaluating quantitatively change detection accuracy in forest.

1. REFERENCES


