Complex Wishart Distribution-Based Change Detection with Polarimetric TerraSAR-X Imagery

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High spatial and temporal resolution SAR systems such as TerraSAR-X and TanDEM-X allow for the reliable detection of land cover and land use changes. Here, we present a change detection method based on the complex Wishart distribution. The scattering amplitudes measured in a polarimetric SAR image in which horizontal and vertical polarized pulses are both emitted and detected may be represented by the vector $\mathbf{s} = (S_{hh}, S_{hv}, S_{vv})^\top$, $S_{hv} = S_{vh}$ (reciprocity) which is often assumed to be zero-mean, complex multivariate normally distributed. A maximum likelihood estimate for the complex covariance matrix of the distribution can be realized with a random matrix having a complex Wishart distribution with $m$ degrees of freedom, provided that the components of the matrix are independent and identically distributed (i.i.d). In a lookaveraged polarimetric SAR image in covariance matrix format, the pixels are provided in the form of the according covariance matrix estimates and therefore, when multiplied by $m$, they are complex Wishart distributed. In general, however, the contributing observations are correlated and therefore not i.i.d. In that case, the so-called equivalent number of looks (ENL), usually estimated from the image data themselves, may be used to parameterize the distribution. Recently a multivariate maximum likelihood estimator for ENL was proposed which makes optimal use of the polarimetric observations. For two co-registered, look-averaged quad polarimetric images acquired at times $t_1$ and $t_2$, a per-pixel, generalized likelihood ratio test for equal covariance matrices has a critical region, assumed to be the same for both images. The associated asymptotic probability of obtaining a smaller value of the test statistic is given in the maximum likelihood estimate for the complex covariance matrix, so that the decision threshold can be chosen for any desired confidence level. In this contribution we illustrate the above change detection procedure with single, dual and quad polarimetric TerraSAR-X images and examine its sensitivity to the ENL parameter. The images were acquired over North Rhine-Westphalia, Germany, within the Enviland2 project.