Multivariate analysis of polarimetric SAR images

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Abstract

The author first met G.P.H. Styan at a meeting in Greece 40 years ago. During the years, they have shared the interest in matrices and multivariate statistics, GPHS from a mathematical perspective, KC an applied do. In the presentation those perspectives are combined in some applications of the multivariate complex Wishart distribution in the analysis of radar images.

Due to its all-weather mapping capability independently of e.g. cloud cover, synthetic aperture radar (SAR) data holds a strong potential for change detection studies in remote sensing applications. The radar backscattering is sensitive to the dielectric properties of the vegetation and the soil, to the plant structure (i.e., the size, shape, and orientation distributions of the scatterers), to the surface roughness, and to the canopy structure (e.g., row direction and spacing, and cover fraction). The polarimetric SAR measures the amplitude and phase of backscattered signals in four combinations of the linear receive and transmit polarizations: HH, HV, VH, and VV. These signals form the complex scattering matrix. The inherent speckle in the SAR data is reduced by spatial averaging (at the expense of loss of spatial resolution). In this so-called multi-look case a more appropriate representation of the backscattered signal is the covariance matrix in which the average properties of a group of resolution cells can be expressed in a single matrix. This averaged covariance matrix follows a complex Wishart distribution.

In [2, 3] change detection was analyzed on bi-temporal data. In [4] these results are extended to multitemporal data. A good survey on the relevant theory on multivariate analysis in the complex normal setting is given in [1].

References

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[3] Schou, J., H. Skriver, A.A. Nielsen and K. Conradsen (2003). CFAR edge detector for polarimetric SAR images. *IEEE Trans. Geoscience Remote Sensing 41(1)*, 20–32.

[4] Conradsen, K., A.A. Nielsen and H. Skriver (2012). A test statistic for equality of several complex covariance matrices applied to change detection in truly multi-temporal, full and dual polarization SAR data. Work in progress.