Wishart Wizard Documentation

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Overview

The Wishart Wizard is a graphical user interface (GUI) implemented in IDL as an extension for the remote sensing image analysis environment ENVI. It provides a simplified and user-friendly platform for performing multivariate change detection with bitemporal polarimetric SAR imagery. The change detection procedure implemented exploits the complex Wishart distribution of polarimetric SAR image observations in look-averaged covariance matrix format in order to define a per-pixel change/no-change hypothesis test (Conradsen et al., 2003). It includes approximations for the probability distribution of the test statistic, and so permits quantitative significance levels to be quoted for change pixels. In addition, an improved multivariate method (Anfinsen et al., 2009) is used to estimate the *equivalent number of looks* (ENL) of the look-averaged images, which is a critical parameter of the hypothesis test.

If SARscape is licensed in the ENVI environment, the Wizard accesses the SARscape API at the IDL scripting level to expose only that functionality necessary for the change detection analysis, thus guiding the user and simplifying the processing chain. If SARscape is not present, open source alternatives for the required preprocessing are available and are described in this documentation.

The software can be downloaded or cloned from the GitHub repository

https://GitHub.com/mortcanty/wishartwizard

Processing chain

Figure 1 shows the processing sequence for generating a change map from two polarimetric SAR images provided at the single look complex (SLC) processing level. First of all, two multi-look images in covariance matrix format are generated from the SLC data (step 1). This format consists of separate files for each of the covariance matrix elements, one file for each of the real diagonal elements and two for each of the complex above-diagonal elements. These are then geo-referenced and terrain corrected with a DEM (step 2).

The first two processing steps can be performed with the SARscape polarimetric features and basic geo-coding modules if these are available in the ENVI environment. The Wizard exposes the necessary functions in its main menu. Otherwise they can be carried out externally and prior to further processing in the Wishart Wizard with the open source software packages PolSARpro (European Space agency), together with MapReady (Alaska Satellite Facility). PolSARpro is first used to create multi-look images in co-

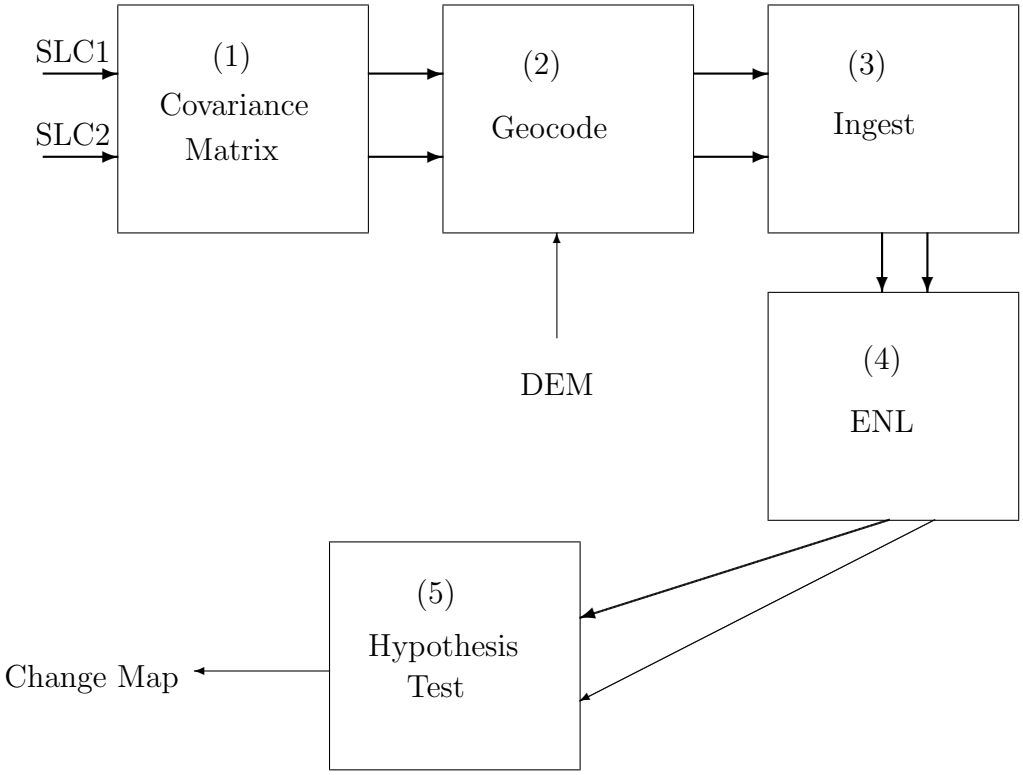

Figure 1: Processing chain.

variance matrix format (step 1), which are then exported to MapReady for geo-referencing and terrain correction with a DEM (step 2).

The resulting matrix element images are then ingested into the Wizard in ENVI standard format floating point images (step 3) consisting of 9 bands for quad polarimetric, four bands for dual polarimetric, and one band for single polarimetric images. In step 4, the ingested images are processed to determine a global value for the equivalent number of looks (ENL) before being passed to the change detection algorithm (step 5). The final product is a geo-referenced change map showing changes at the desired significance level. An example is shown in Figure 2.

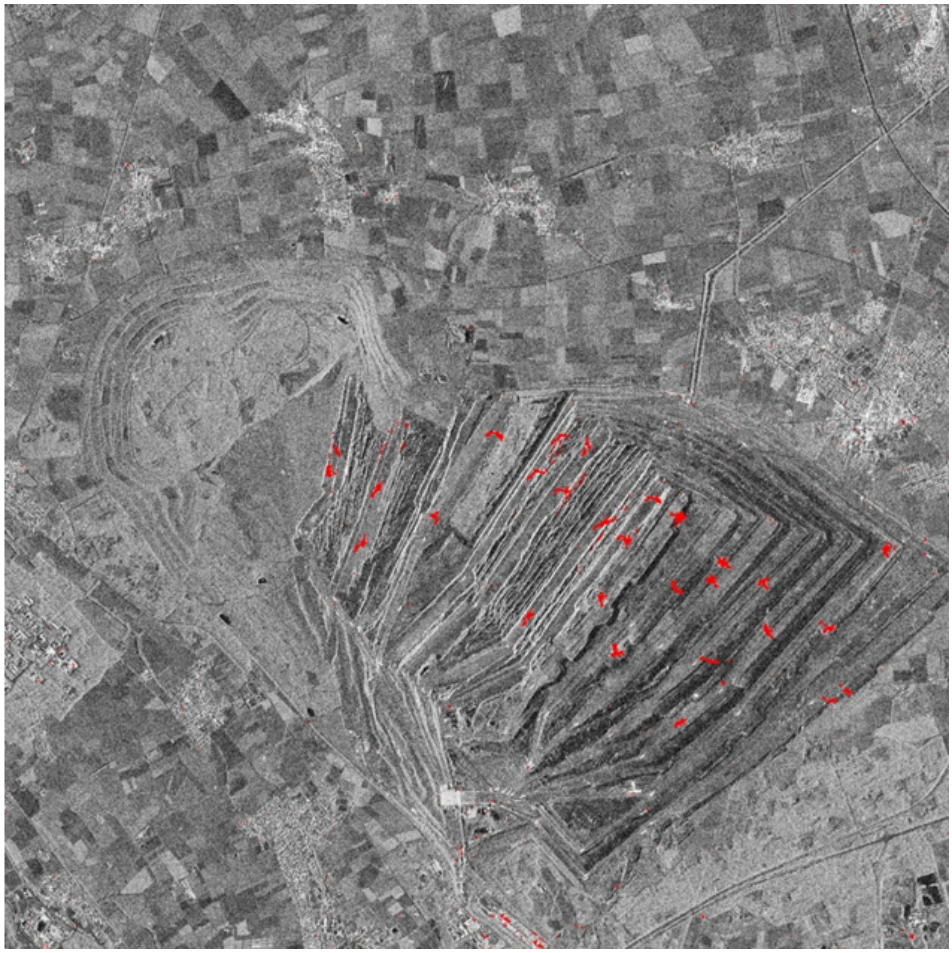

Figure 2: Changes at the 1% significance level for TerraSAR-X quad polarimetric images over an open cast mine in Germany.

Main Menu

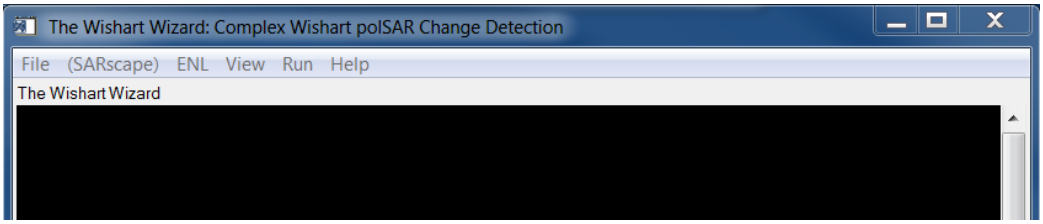

Figure 3: The main menu.

The main menu of the Wizard is shown in Figure 3. The program checks on startup for the availability of SARscape, and the corresponding menu item is grayed out if SARscape in not present.

SARscape Menu

xxx

SARscape/Set working directory

xxx

SARscape/Clear working directory

xxx

SARscape/Set range looks

xxx

SARscape/Set DEM

xxx

SARscape/Import SLC

xxx

SARscape/Geocode

xxx

File Menu

xxx

File/Ingest first image bands

xxx

File/Ingest second image bands

xxx

File/Load first image

xxx

File/Load second image

xxx

File/Save first image

xxx

File/Save second image

xxx

File/Save current view to ENVI

xxx

File/Quit

xxx

ENL Menu

xxx

ENL/Set ENL1

xxx

ENL/Set ENL2

xxx

View Menu

xxx

Run Menu

xxx

Help Menu

xxx

References

Anfinsen, S., Doulgeris, A., and Eltoft, T. (2009). Estimation of the equivalent number of looks in polarimetric synthetic aperture radar imagery. *IEEE Transactions on Geoscience and Remote Sensing*, 47(11):3795–3809.

Conradsen, K., Nielsen, A. A., Schou, J., and Skriver, H. (2003). A test statistic in the complex Wishart distribution and its application to change detection in polarimetric SAR data. *IEEE Transactions on Geoscience and Remote Sensing*, 41(1):3–19. Internet http://www2.imm.dtu.dk/pubdb/views/publication_details.php?id=1219.