SAR Polarimetry Workstation

The SAR Polarimetry Workstation provides a complete set of tools and applications designed specifically for the processing and analysis of Polarimetric SAR (POLSAR) data.

The SAR Polarimetry Workstation can:

- Assimilate a variety of POLSAR data products in their original distribution formats
- Map product-specific metadata to a set of standardized metadata items
- Provide multiple modes of manual target selection
- Provide a comprehensive set of target analysis operations with both numerical and graphical output
- Provide a comprehensive set of operations on entire datasets

Module Prerequisites

The SAR Polarimetry Workstation is an add-on to Geomatica Core or Geomatica Prime.

POLSAR Data Support

The following POLSAR data products can be read from their original distribution formats:

- AIRSAR
  - Multi-look complex (MLC), standard quad polarization
- ALOS-1 PALSAR
  - JAXA SLC-SD, level 1.1 dual polarization
  - JAXA SLC-SQ, level 1.1 quad polarization
  - Vexcel Standard SLC, level 1.1
- ALOS-2 PALSAR
  - Level 1.1 fully polarimetric data products
- COSMO-SkyMed
  - Level 0 (RAW)
  - Level 1A (SCS), single-look complex slant range
  - Level 1B (DGM), detected ground multi-look
  - Level 1C/1D 0, geocoded GEC and GTC
- CV-580
  - SLC-Q, single-look complex standard quad polarization
  - MLC-Q, multi-look complex standard symmetrized quad polarization
- ENVISAT ASAR
  - Single-look complex (ASA_APS_1P)
  - Precision (ASA_APP_1P)
  - Ellipsoid geocoded (ASA_APG_1P)
  - Medium resolution (ASA_APM_1P)
- RADARSAT-2
  - Slant–range, single-look complex (SLC)
- SIR-C
  - Single-look complex (SLC-Q, SLC-D)
  - Multi-look complex (MLC-Q, MLC-D)

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- UAVSAR Polarimetric
  - MLC (calibrated multi-look cross products)
  - SLC (calibrated single-look complex products)
  - DAT (compressed Stokes Matrix product)
  - GRD (calibrated complex cross products projected to ground)
  - HGT (DEM product)

Metadata Support

Metadata support is crucial to the processing and analysis of POLSAR data. The SAR Polarimetry Workstation reads metadata from POLSAR data products and transforms them to the following standardized metadata items:

- File-level metadata items:
  - Sensor Model Name
  - Sensor Type
  - Product Type
  - Acquisition Type
  - Matrix Type
  - SAR Calibration
  - Microwave Band
  - Polarizations
  - Number of Looks
  - Number of Looks (range direction)
  - Number of Looks (azimuth direction)
- Band-level metadata items:
  - Matrix Element

Most analysis operations on POLSAR data regard such data as a raster of matrices, rather than simply a multi-band raster. The matrices may be of different types: Scattering (complete and incomplete), covariance (complete and incomplete), coherency, and Kennaugh. The metadata read by the SAR Polarimetry Workstation includes items that identify the matrix type and map dataset bands to matrix elements.

Target Selection and Analysis

The SAR Polarimetry Workstation provides three modes of manual target selection that support a comprehensive set of target analysis operations and allows targets of any size and shape to be selected.

- SQUARE NEIGHBORHOOD
  - Defines a target as a square neighborhood centered on a user-selected pixel
  - The neighborhood dimension can be user-specified
  - The neighborhood can be as small as a single pixel
- ARBITRARY REGION
  - Defines a target as the region enclosed by a user-digitized polygon
  - A rectangle sub-option allows you to quickly digitize exact rectangular polygons

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- PIXEL PLUS CLUTTER ESTIMATION REGION
    - Defines a target as a user-selected pixel plus four nearby square regions that are used for estimating clutter
    - The user-specified neighborhood is the size of the square that encloses the overall target
    - The user-specified gap size is the space between the clutter-estimation regions

Target Analysis – Numerical Output

The following target analysis operations that produce numeric (text) output are available:

- Scattering matrix
- Covariance matrix
- Coherency matrix
- Kennaugh matrix
- Correlation coefficient
- Pedestal height
- Total power
- Intensity ratio
- Coefficient of variation
- Fractional polarization
- Polarimetric discriminators
- Pauli component
- Phase difference
- Freeman-Durden parameters
- Van Zyl classification
- Cloude-Pottier parameters
- Huynen parameters
- Cameron parameters

The output from these operations is written to the Numerical Output window. Functionality includes:

- Numerical output automatically regenerated when a new target is selected
- Contents of numerical output window can be exported to a file
- Clear contents of numerical output window at any time

Target Analysis – Graphical Output

The following target analysis operations that produce graphical output are available:

- Polarization response plot (co-polarized and cross-polarized); the plot can be interactively rotated
- Histogram plot of selected parameters derived from matrix elements for extended targets
- 2-D and 3-D scatterplot of selected parameters are derived from matrix elements for extended targets. 3-D scatterplots can be interactively rotated

Output graphs can be exported to the following formats:

- Postscript
- PNG
- GIF

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Functions

With a license for the SAR Polarimetric Workstation, the following programs can be executed either independently or sequentially via an EASI™ or Python™ script. They may also be available in the Algorithm Librarian in Geomatica Focus and the PCI Modeler.

- PSBOXCAR – POLSAR dataset, averaging filter dimensions, and a flag indicating whether the averaging in the range or azimuth directions or bi-directionally to replacement POLSAR channels containing the boxcar-filtered data
- PSCC – contains fully-polarized MLC data and a polarization band selection to a real-values channel representing the complex correlation coefficient if the bands are complex and the non-complex correlation coefficient if the bands are real
- PSCLOPOT – a PCIDSK file that contains entropy, α-angle, and anisotropy feature space to an integer channel in a PCIDSK file that contains the Cloude and Pottier unsupervised classification result
- PSCOMPACT – creates a compact pol data set from the standard configurations.
- PSCOMDEC – Apply decompositions to polarimetric SAR imagery
- PSCOMDIS – Calculate polarimetric discriminators
- PSCONF – estimates the conformity coefficient for each pixel
- PSCONV – converts between different polarimetric SAR matrix representations
- PSEABA – contains fully-polarized MLC data and angular-units flag to four real-values channels that represent entropy, α-angle, β-angle, and anisotropy
- PSFARA – estimates Faraday rotation from fully polarimetric scattering data
- PSFREDUR – contains fully-polarized MLC data to three real-values channels that represent rough-surface scattering, double-bounce scattering, and canopy scattering contributions
- PSG4U2 – estimate the new general four-component scattering power decomposition with unitary transformation of the coherency matrix
- PSINANG – contains an explicit or virtual incident angle array to a real-values channel that contains a nominal incident-angle map
- PSINTRAT – contains dual-polarized or fully-polarized SLC, MLC, or MLD data and polarization channel pair selection to a real-valued channel in a representing intensity ratio
- PSKROG – estimate Krogager decomposition (sphere, diplane, and helix) from fully polarimetric data
- PSPEDHT – contain fully-polarized SLC or MLC data and a flag indicating co-polarized or cross-polarized to a real-values channel that represents the pedestal height
- PSPHDIFF – contains dual-polarized or fully-polarized SLC or MLC data, a polarization channel pair selection, and angular units flag to a real-valued channel representing phase difference
- PSPHDW – estimate the power contributions for plate, helix, diplane and wire
- PSPOLDIS – contains fully-polarized MLC data and a list of polarimetric discriminators to evaluate one or more real-valued channels representing the selected polarimetric discriminators
- PSPOLFIL – contains fully-polarized SLC or MLC data and dimensions of the filter window to speckle-filtered replacement channels
- PSPOLSYN – contains fully-polarized SLC or MLC data to a real-valued channel that represents synthesized backscatter for arbitrary transmit and receive polarizations
- PSPOLSYNC – contains fully-polarized SLC or MLC data and bitmaps that represents two regions to a real-valued channel and synthesized backscatter that maximizes contrast between the two regions

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- PSPOLYSYNR – contains fully-polarized SLC or MLC data and a bitmap that represents a region to a real-valued channel and synthesized backscatter that maximizes return from the region
- PSRECONS – creates a pseudo-full polarimetric covariance matrix
- PSS2C – generates two user-defined coherent channels from fully polarimetric data sets. This module can be used to synthesize any arbitrary pair of polarizations (for example, RH, VV) or compact polarimetric data sets (for example, RH, RV)
- PSSSCM – contains fully-polarized SLC data to an integer channel that contains the symmetric scattering characterization method classification results
- PSSWIS – contains fully-polarized SLC or MLC data and class training statistics to integer channel that contain the supervised Wishart classification result
- PSTOTPOW – contains fully-polarized SLC, MLC, or MLD data to a real-values channel that represents the total power
- PSTOUZIDEC – Touzi decomposition
- PSTOUZIDIS – Touzi discriminator
- PSUSWIS – a PCIDSK file that contains fully-polarized MLC data and either Freeman-Durden or Cloude and Pottier unsupervised classification results (see PSFREDUR or PSCLOPOT) to an integer channel that contains the unsupervised Wishart classification result
- PSVANZYL – contain fully-polarized MLC channel to an integer channel representing the van Zyl unsupervised classification results.
- PSWHITE – contains fully-polarized SLC data to a real-valued channel that represents a 'whitened' single-look image.

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