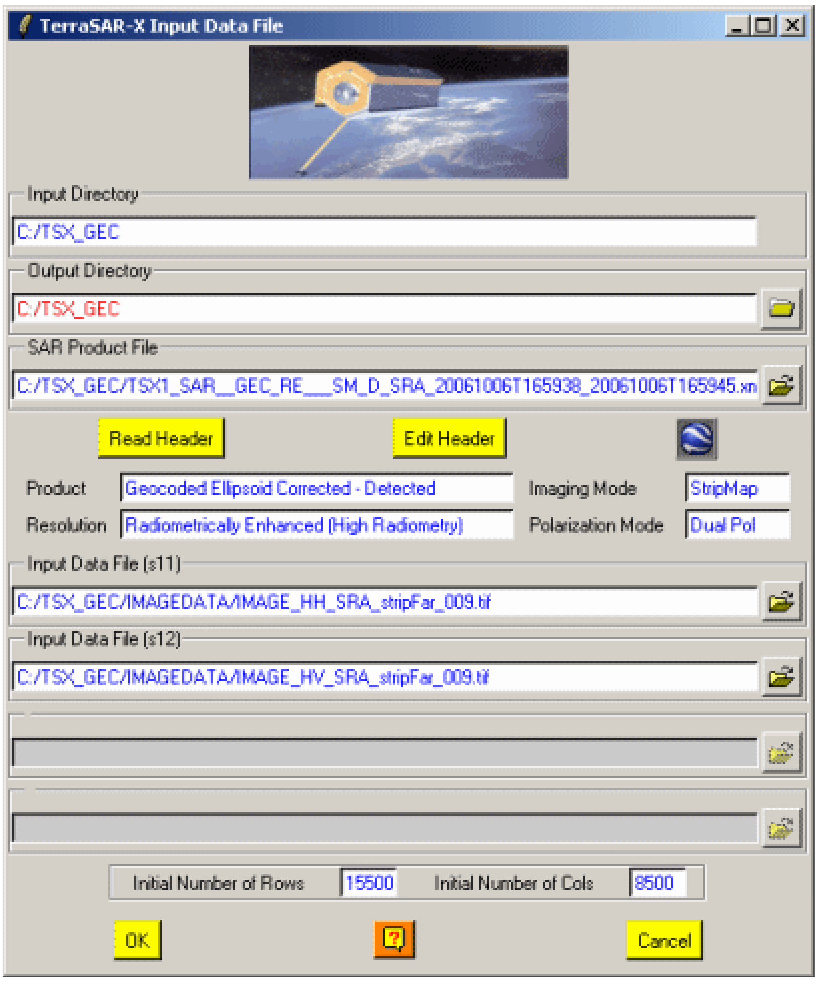
TerraSAR-X Input Data File



Description:

This program sets and configures the main characteristics of the Input Data Files in order to convert polarimetric data sets encoded using the TerraSAR-X specific data format to PolSARpro compatible binary data.

Comments:

Parameters written in Red can be modified directly by the user from the keyboard.

Input/Output Arguments:

Input Directory	Indicates the location of the considered **Main Directory (MD)** containing the TerraSAR-X data file to be converted.
Output Directory	Indicates the location of the converted data output directory

SAR Product File Correspond to the TerraSAR-X product File (product.xml)

Read/Edit Header:

Read Header Input TerraSAR-X Product file contains header blocks describing the polarimetric data characteristics
The output header ascii file is: *Product_header.txt*

Edit Header Users have the possibility to edit the product header file.

If Google Earth application is installed on the machine, users have the possibility to visualize the footprint of the measured scene.

Image Characteristics:

From the input TerraSAR-X Product File, some image characteristics are automatically extracted : the **Product ID,** the **Image Mode,** the **Geometric Resolution** and the **Polarisation Mode**

Product Identifier The following options for geometrical projection and for data representation will be selectable:

- **SSC:** Single Look Slant Range, Complex representation
- **MGD:** Multi Look Ground Range, Detected representation
- **GEC:** Geocoded Ellipsoid Corrected, detected representation
- **EEC:** Enhanced Ellipsoid Corrected, detected representation

Single Look Slant Range Complex (SSC)

Geometric Projection: Azimuth – Slant Range (time domain) This product is the basic single look product of the focused radar signal. The pixels are spaced equidistant in azimuth (according to the pulse repetition interval PRI=1/PRF) and in slant range (according to the range sampling frequency) and the data are represented as complex numbers. Each image pixel is processed to zero Dopper coordinates, i.e. perpendicular to the flight track. Spotlight products will be processed to zero Doppler coordinates like stripmap products with an artificial PRF selected large enough to hold the total processed Doppler spectrum. The SSC product is intended for scientific applications that require the full bandwidth and the phase information, e.g. SAR interferometry and interferometric polarimetry

Multi Look Ground Range Detected (MGD)

This product is a detected multi look product with reduced speckle and approximately square resolution cells on ground. The image coordinates are oriented along flight direction and along ground range. The pixel spacing is equidistant in azimuth and in ground range. A simple polynomial slant to ground projection is performed in range using a WGS84 ellipsoid and an average, constant terrain height parameter. The advantage of this product is that no image rotation to a map coordinate system is performed and interpolation artifacts are thus avoided. Consequently, the pixel localization accuracy is lower than in geocoded products.

Geocoded Ellipsoid Corrected (GEC)

Geometric Projection: Map geometry with ellipsoidal corrections only (no terrain correction performed). The GEC product is a multi look detected product. It is projected and re-sampled to the WGS84 reference ellipsoid assuming one average terrain height. Available grid formats are UTM and UPS. As the ellipsoid correction does not consider a DEM, the pixel location accuracy varies due to the terrain. For other types of relief, the terrain induced SAR specific distortions will not be corrected and significant differences can appear in particular for strong relief and steep incidence angles.

Enhanced Ellipsoid Corrected (EEC)

Geometric Projection: Map geometry with terrain correction, using a digital elevation model (DEM). Like the GEC, the EEC is a multi look detected product. It is projected and re-sampled to the WGS84 reference ellipsoid. The image distortions caused by varying terrain height are corrected using an external DEM. Available grid formats will be either UTM or UPS. Terrain induced distortions are corrected using a DEM. Therefore the pixel localization in these products is highly accurate. The accuracy still depends on the type of terrain as well as the quality and resolution of the DEM and on the incidence angle. The EEC will be generated using the best available digital elevation model (DEM) at PGS. These DEMs will be compiled from different sources like SRTM/X-SAR, SRTM/C-band, ERS-tandem data, DTED-1 and DTED-2. Remaining gaps will be filled with GLOBE-data. SRTM is the best globally available source of elevation data and provides an excellent basis for the rectification of the SM and SC modes. However in case of undulated terrain it is still relatively coarse with respect to the horizontal resolution of the HS and SL modes.

Image Mode

The instrument timing and pointing of the electronic antenna can be programmed allowing a numerous combinations. From the many technical possibilities four imaging modes have been designed to support a variety of applications ranging from medium resolution polarimetric imaging to high resolution mapping.

- **HS:** High Resolution Spotlight
- **SL:** Spotlight
- **SM:** Stripmap
- **SC:** ScanSAR

Stripmap Mode (SM)

This is the basic SAR imaging mode. The ground swath is illuminated with a continuous sequence of pulses while the antenna beam is pointed to a fixed angle in elevation and azimuth. This results in an image strip with constant image quality in azimuth.
Stripmap can be operated in single or in dual polarization mode resulting in one or two image layers, respectively. Each polarization channel is identified by two letters where the first

letter denotes the transmit polarization and the second one refers to the receive polarization. The dual polarization mode is implemented by toggling the transmit or receive polarization between consecutive pulses.

Spotlight Modes (HS et SL)

Spotlight mode uses phased array beam steering in azimuth direction to increase the illumination time, i.e. the size of the synthetic aperture. The larger aperture results in a higher azimuth resolution at the cost of azimuth scene size. In the extreme case of starring spotlight the antenna footprint would rest on the scene and the scene length corresponds to the length of the antenna footprint.
Because of the small size of the X-Band antenna footprint a starring spotlight mode is not foreseen for TerraSARX. Instead, two variants of sliding spotlight mode are designed with different values for azimuth resolution and scene size. For the product identification they are named “Spotlight” and “High Resolution Spotlight”.
High Resolution Spotlight Mode (HS) is designed for an azimuth resolution of 1 meter resulting in an azimuth scene size of 5 km. In the **Spotlight Mode (SL)**, the beam steering velocity is lower than in high resolution spotlight mode resulting in reduced azimuth resolution and increased azimuth scene extension.

ScanSAR Mode (SC)

In ScanSAR mode electronic antenna elevation steering is used to switch after bursts of pulses between swathes with different incidence angles. In the designed TerraSAR-X ScanSAR mode 4 stripmap beams are combined to achieve a 100 km wide swath.
Due to the switching between the beams only bursts of SAR echoes are received, resulting in a reduced bandwidth and hence, reduced azimuth resolution. The ScanSAR swathes are composed exclusively from stripmap beams, i.e. they use the calibrated stripmap antenna patterns.

Geometric Resolution

The theoretical maximum slant range resolution of TerraSAR-X in single polarization is 0.89 meter based on the range bandwidth of 150 MHz if no spectral weighting is applied. For detected products the maximum resolution is deliberately reduced by weighting the range spectrum with a Hamming window (coefficient 0.75) in order to suppress the sidelobes of the point target response (PTR) function to -20 dB. This results in a slant range resolution of 1.0 meters.
For the products, a possible processing and instrument degradation margin of 10% is included in the reported performance values. This leads to a slant range resolution of 1.1 m for detected products. Complex products will have no Hamming window applied and the user may either exploit the full resolution of 1.0 meters at the cost of higher sidelobes or he may apply his own spectral weighting.
In azimuth the theoretical resolution in stripmap mode is half the

antenna length (4.8 m / 2 = 2.4 m). Due to finite sampling of the sin(x)/x shaped Doppler spectrum aliasing always occurs. In the processor, bandwidth reduction and spectral shaping is performed in order to reduce the ambiguities caused by aliasing (improving the signal azimuth ambiguity ratio “SAAR”) and to improve the shape of the PTR. A constant resolution of 3 meters is a design goal for all stripmap single polarization products. The processed Doppler bandwidths in single polarization and dual polarization modes will be about 2266 Hz and 1066 Hz, respectively.
In dual polarization mode the effective PRF per channel is decreased and the effective resolution of the products will be adjusted to 6 meters, i.e. half of the single polarization resolution. An analogous strategy is applied on dual polarization spotlight data.
Note : For the complex SSC products the resolution is given in azimuth and slant range (assuming the nominal 150 MHz range bandwidth). For all detected products the geometric resolution is given in ground range.
In the detected product variants the resolution is reduced (the number of looks is increased accordingly) in order to reduce speckle and thermal noise, i.e. to improve the radiometric resolution. Two different strategies have been followed in order to design two variants of detected products. One is optimized for resolution (spatially enhanced) and one is optimized for radiometry (radiometrically enhanced). In both variants a square sized ground resolution cell is implemented.
The pixel spacing of spatially enhanced products is adjusted to satisfy the Nyquist sampling criterion (half the resolution for detected products) and to multiples of one meter if adequate. Because the radiometrically enhanced products have already been smoothed, they are sometimes sampled somewhat coarser.

In the complex SSC product the pixel spacing is given by the natural sampling of the radar, i.e. the pulse repetition frequency (PRF) and the range sampling frequency (RSF).

Spatially Enhanced Products (SE)

The spatially enhanced product is designed for the highest possible square ground resolution. Depending on imaging mode, polarization and incidence angle the larger resolution value of azimuth or ground range determines the square pixel size. The smaller resolution value is adjusted to this size and the corresponding reduction of the bandwidth is used for speckle reduction.

Radiometrically Enhanced Products (RE)

The radiometrically enhanced product is optimized with respect to radiometry. The range and azimuth resolution are intentionally decreased to significantly reduce speckle by averaging approximately 7 looks to obtain a radiometric resolution of about

1.5 dB. The SNR that generally decreases with larger incidence angles is also considered assuming a backscatter of –6 dB at 20° and -12 dB at 50°. Because of the lower resolution, the required pixel spacing can be reduced and the product data size decreases significantly.

Polarisation Mode

Single Polarization and Dual Polarization are the two standard modes which are possible for each image mode, except ScanSAR, which is restricted to single polarization.
Furthermore two more polarization modes, Quad Polarization and Twin Polarization are technically possible. They are currently not available as Basic Products.

- **S:** Single Polarisation
- **D:** Dual Polarisation
- **Q:** Quad Polarisation (Not a standard product)
- **T:** Twin Polarisation (Not a standard product)

Input Data Files

Correspond to the input polarimetric channel data files, encoded using the TerraSAR-X format, to be processed.

Initial Number of Rows/Columns:

The image numbers of rows and columns are initialised to the input data set dimensions.