



CATALYST
PROFESSIONAL

Radar Ortho Suite Module: Description

The Radar Ortho Suite is an add-on module to CATALYST Professional Essentials.

The Radar Ortho Suite includes rigorous and rational function models developed to compensate for distortions and produce orthorectified radar images. Distortions caused by the platform (position, velocity, and orientation), the sensor (orientation, integration time, and field of view) the Earth (geoid, ellipsoid, and relief), and the projection (ellipsoid and cartographic) are all accounted for using these models. The models reflect the physical reality of the complete viewing geometry and correct all distortions generated during the image formation.

CATALYST is a PCI Geomatics Enterprises Inc. brand, which has been introduced to put our leading-edge technology into the hands of decision makers. CATALYST provides proven algorithms rooted in photogrammetry and remote sensing to offer engineers, environmental management, and geospatial professionals access to leading edge and scalable software solutions and platforms.

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Module Prerequisites

The Radar Ortho Suite is an add-on to CATALYST Professional Essentials bundle and comes included with the following bundles: SAR bundle, Complete bundle, Developer bundle.

Supported Radar Formats

The Radar Ortho Suite supports the following radar sensors:

- ALOS-1 PALSAR
 - ERSDAC PALSAR georeference levels L1.5, L1.5 long, L4.1 and L4.2
 - JAXA PALSAR georeference level 1.5
- ALOS-2 PALSAR (Compact)
 - JAXA PALSAR-2 georeference level 1.1, 1.5, 2.1, and 3.1
- ASAR (ENVISAT)
 - ASAR 1B format
- Capella Space
 - SLC (Single-look complex) int16
 - GEO (Geocoded Terrain Corrected) int16
- COSMO-SkyMed
 - Level 0 (RAW)
 - Level 1A (SCS)
 - Level 1B (DGM)
- Convair-580 (CV-580)
 - Single-look Complex Quad Polarization (SLC-Q)
 - Multi-look Complex Quad Polarization (MLC-Q)
- ERS 1/2(CEOS)
 - ERS CD provides different levels of processing. We recommend the georeferenced level for images produced in Canada and the PRI level produced by ESA.
- Gaofen-3 (GF3)
 - Level 1A SLC data with an associated RPC model for the following observation modes:
 - Spotlight (SL)
 - Ultra-fine stripmap (UFS)
 - Fine stripmap (FSI)
 - Wide fine stripmap (FSII)
 - Quad-pol stripmap (QPSI)
 - Wide quad-pol stripmap (QPSII)
 - Wave (WAV)
- ICEYE
 - Level 1B:
 - Single Look Complex (SLC)
 - Ground Range Detected (GRD)
- Huanjing (HJ-1C)
 - 1C Level 2 format

- JERS1 (LGSOWG)
 - JERS-1 CD provides different levels of processing. We recommend that you use a georeferenced level or equivalent for highest accuracy. OrthoEngine only works for descending order images.
- KOMPSAT-5
 - L1A SCS_U: Single Look Complex Slant Un-balanced
 - L1A SCS_B: Single Look Complex Slant Balanced
 - L1B DSM_U: Detected, Slant Range, Multi-look Un-equalized
 - L1B DSM_U: Detected, Slant Range, Multi-look
 - L1B DGM_B: Detected, Ground projected, Multi-look Balanced
- PAZ
 - Level 1B
 - Multi-look ground range detected (MGD)
 - Single-look slant range complex (SSC)
 - Geocoded ellipsoid corrected (GEC)
 - Enhanced ellipsoid corrected (EEC)
- RADARSAT-1 (CEOS)
 - SGC (SAR Georeferenced Coarse Resolution)
 - SGF (SAR Georeferenced Fine Resolution)
 - SGX (SAR Georeferenced Extra Fine Resolution)
 - SLC (Single Look Complex)
 - SCN (ScanSAR Narrow Beam Product)
 - SCW (ScanSAR Wide Beam Product)
- RADARSAT-2 (CEOS)
 - Level 1.1 SLC (Spotlight, Ultra Fine, Multi-look Fine, Fine, Standard, Fine-Quad-Pol, Standard Quad-Pol, Wide, ScanSAR Wide, ScanSAR Narrow)
 - Level 1.5 SGF (Fine, Standard, Fine-Quad-Pol, Standard Quad-Pol)
 - Level 1.5 SGX (Fine, Standard, Fine-Quad-Pol, Standard Quad-Pol, ScanSAR Wide, ScanSAR Narrow)
- RADARSAT Constellation (RCM)
 - SLC (Single-look complex, slant range)
 - GRC (Multi-look complex, ground range)
 - GRD (Multi-look detected data in ground range)
- RISAT-1
 - High resolution spotlight (HRS)
 - Fine resolution stripmap (FRS-1)
 - Fine resolution alternate stripmap (FRS-2)
 - Medium resolution ScanSAR (MRS)
 - Coarse resolution ScanSAR (CRS)
- SAOCOM
 - Level 1A, Single-look, slant range, complex (SLC)
 - Level 1B, Multi-look, ground range, detected (GRD)
- Sentinel-1

- Level 1 ground range detected (GRD) products
 - Stripmap (SM)
 - Interferometric wide swath (IW)
 - Extra-wide swath (EW)
 - Wave (WV)
- SIR-C
 - Single-Look Complex, Standard Quad Polarization (SLC-Q)
 - Single-Look Complex, Standard Dual Polarization (SLC-D)
 - Multi-Look Complex, Quad Polarization (MLC-Q)
 - Multi-Look Complex, Dual Polarization (MLC-D)
- TerraSAR-X / TanDEM-X
 - Level 1b MGD products
 - Level 1b SSC products
- UAVSAR Polarimetric
 - Calibrated single-look complex (SLC) products, Polarimetric mode
 - Calibrated multi-look complex (MLC) products, Polarimetric mode
 - Calibrated complex cross-products projected to the ground in simple geometric coordinates (GRD), Polarimetric mode
 - Compressed Stokes matrix products (DAT), Polarimetric mode

Radar Specific Model

The Radar Specific Model uses the additional parameters in the orbit data to diminish amount of ground control points (GCPs) required. The extra parameters maintain the positional accuracy and high levels of detail in the model, but the number of GCPs needed is reduced to few or none. This math model does not use tie points (TPs) since each scene is computed using the GCPs of that scene only.

The radar-specific model is available for the following types of imagery:

- ALOS-1 PALSAR
- ALOS-2 PALSAR
- ASAR
- COSMO-SkyMed
- KOMPSAT-5
- RADARSAT
- RISAT-1
- TanDEM-X
- TerraSAR-X

RPC Models

The Rational Function is a simple math model that:

- Builds a correlation between the pixels and their ground locations

- Obtains RPC data with images and imports coefficients automatically
- Calculates the polynomial coefficients from GCPs
- Refines RPC data with one or more GCPs
- Refines zero- or first-order GCPs

RPC-based corrections are available for the following types of imagery:

- Capella Space
- COSMO-SkyMed
- Gaofen-3 (GF3)
- ICEYE
- KOMPSAT-5
- PAZ
- RADARSAT-2
- RADARSAT Constellation (RCM)
- TerraSAR-X

Ground Control

The OrthoEngine Satellite Models support GCP and TP ground controls.

GCP Collection

GCPs can be collected manually or by using:

- A geocoded image
- Geocoded vectors
- A chip database
- A digitizing tablet
- An imported text file

Other features include:

- Stereo-GCP collection
- Conversion of GCPs to check points (CPs) to exclude from model calculation
- Display of individual and overall root mean square (RMS) error for GCPs

The following minimum number of GCPs is required:

- RADARSAT, ERS, JERS, ASAR, EROS:
 - 8 per image (10-12 recommended)
- RADARSAT with RADARSAT-specific model:
 - GCPs are optional (8 recommended)
- ASAR:
 - GCPs are optional

- Rational Functions Computed from GCPs:
 - 5 per image (19 per image is recommended)
- Rational Functions Extracted from Image File:
 - None required (accuracy is improved with 1 or more GCPs)

Tie Point Collection

Tie point (TP) collection allows a user to:

- Extend ground control over areas without GCPs
- Identify how images in a project relate to each other
- Ensure the best fit for all images in a project
- Enter the elevations of TPs manually or extract them from a DEM
- Import and export TPs
- Show individual and overall RMS errors

Residual Report

Using residual reports, a user can:

- Show GCP, CP, TP, and Stereo-GCP error information in one report
- Edit points in a residual report and update bundle adjustments
- View error information in ground units or pixel units
- Print the report to a file

Project Summary Information

Raw Image Summary Table

A summary of information about all of the images in your OrthoEngine project can be viewed in the Raw Image Summary Table window. This window provides information about the following:

- Total number of images in the project
- Total number of GCPs, TPs, and CPs
- Image-specific information, including image ID, GCPs, TPs, CPs, RMS error, number of overlapping pairs connected by TPs, number of potential overlapping pairs that could be connected by TPs, and the percentage of all overlaps connected by TPs

The Raw Image Summary Table provides you with a dynamic view of your project, allowing you to better target your quality assurance efforts to achieve your desired project requirements.

Image-specific information is displayed in tabular format. The tabular contents can be sorted, making it easier for you to analyze the data in your project and identify areas on which to focus your quality assurance activities.

The Raw Image Summary Table window displays both active and inactive images in your project. You can activate and deactivate one or more of the images in your project using the check box column. An active image is included in any processing you want to do on your project. When you deactivate an image, it is still in your project, but is excluded from processing. You can also activate and deactivate images in the Project Overview window.

Project Overview

The Project Overview window provides a graphical display of the raw images in your project, while the Raw Image Summary Table lists all pertinent information in table format. You can use both windows together to gather relevant information about each image in your project, allowing you to better target your quality control efforts and manage your project.

By default, the Project Overview window displays centers of each raw image in the project. Users can choose to display image centers, geocoded vector footprints, and/or thumbnails of the imagery. One can also toggle the display of GCPs, TPs, and CPs, as well as Image and Point IDs, for all images or for selected images only.

Note: When the Raw Image Summary Table is open, the Project Overview window displays the current image with a yellow border and its image ID.

This viewer helps users to better assess their project using a graphical overview. It also includes some simple tools to assist in project management like:

- Ability to display reference imagery or vectors
- Rotating the kappa of the input imagery
- Measurement tools

Orthorectification

The orthorectification process enables a user to:

- Perform batch processes
- Utilize a DEM for terrain correction
- Increase working cache for processing
- Increase sampling interval for faster processing
- Utilize the following resampling methods:
 - Nearest Neighbor
 - Bilinear Interpolation
 - Cubic Convolution
 - 8-pt Sin X/X
 - 16-pt Sin X/X
 - Average filter
 - Median filter
 - Gaussian filter

- User-defined filter
- Clip the image size upon orthorectification
- Set a starting time for processing
- Achieve approximately one-third of a pixel accuracy for VIR satellite images, and approximately one pixel for radar images when quality GCPs are used

Mosaicking

The mosaicking process, using the Mosaic Tool, enables a user to:

- Define a mosaic area
- Collect cutlines manually by:
 - Importing and exporting cutlines
 - Blending seams using Blend Width
- Perform manual color balancing:
 - Based on samples identified in overlap between images
 - By using samples (match areas) to compute look-up tables (LUTs) to adjust new images to match an existing mosaic
 - By adjusting the dark end or light end
 - By importing and exporting LUTs for color balancing
- Mosaic unreferenced images

When you initiate mosaicking OrthoEngine opens the Mosaic Tool application, in which you can perform all the tasks necessary to create the mosaic. When you initiate the mosaicking process, the Mosaic Tool New Project Wizard will lead you through the setup of a mosaic project.

If the images in your project are orthorectified, the Mosaic Tool New Project Wizard appears, and the images appear in the Source file box on the Source Images page of the wizard; otherwise, a message appears, prompting you to create the orthorectified images.

Mosaic Tool

Mosaic Tool features a wizard to make creating your mosaic project quick and easy. The wizard walks you through the following steps to ensure you have everything set up to create your mosaic:

- Source files to use
- Key details, such as size and extents
- Applying color balancing, normalization, or both to the input images
- Selecting how to create cutlines and mask layers
- Previewing the mosaic

Functions

With a license for the Radar Ortho Suite, the following functions can be executed either independently or sequentially via an EASI™ or Python™ script. They may also be available in the Algorithm Librarian in CATALYST Professional's Focus and Modeler applications.

- MODEL2RPC – Lets users convert a math model to an RPC model
- RFMODEL – computes the math model of one or more images using the rational function math modeling method
- RSMODEL – computes the math model of one or more images using the radar-specific modeling method
- SATMODEL – calculates the math model for one or more images using the Rigorous math modeling method