



CATALYST
PROFESSIONAL

Satellite Ortho Suite Module: Description

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

The Satellite Ortho Suite includes rigorous and rational function models developed to compensate for distortions and produce orthorectified satellite images for high resolution and low resolution sensors. 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 cartographic projection (ellipsoid and cartographic) are all considered 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 Satellite Ortho Suite is an add-on to CATALYST Professional Essentials bundle and comes included with the following bundles: Satellite bundle, Complete bundle, Developer bundle.

Supported Satellite Formats

The Satellite Ortho Suite supports a wide range of high and low-resolution optical satellite sensors.

- ALOS:
 - AVNIR-2: Level 1A, 1B1, and 1B2R format
 - PRISM: Level 1A, 1B1 and 1B2R format (1A and 1B1 provide the highest accuracy)
- ASTER:
 - Level 1A and 1B HDF format (1A recommended for the highest accuracy)
- AVHRR
 - Level 1b 8-bit/10-bit/16-bit HRPT/LAC
 - Level 1b 8-bit/10-bit/16-bit GAC
 - Dartcom 16-bit HRPT
 - Satlantic 16-bit HRPT
 - Quorum Qtrack 16-bit HRPT
 - 16-bit HRPT Minor Frame
 - Dundee 16-bit HRPT
 - AVHRR CEOS (Raw AVHRR CCT Image Format)
- CARTOSAT-1:
 - CARTOSAT L1 (radiometrically corrected) format
- CBERS 1 and 2B
 - Level 1A support
- CBERS-4
 - Level 2 IRS, MUX, P5M, P10, and WF1
- DEIMOS-1
 - L1R, L1T, DIMAP format
- DEIMOS-2
 - L1B, DIMAP format
- Disaster Monitoring Constellation (DMC)
 - L0R and L1R TIFF file format
- Dubaisat-2
 - Level 1R data format
- EROS A/B:
 - Level 1A data format
- FASat Charlie
 - Level 1A SSOT format
- FORMOSAT-2
 - Level 1A DIMAP data
- FORMOSAT-5

- L1A and L4TWD97 data
- Gaofen-1 (GF1)
 - Level 1A standard
- Gaofen-2 (GF2)
 - Level 1A standard
- Gaofen-4 (GF4)
 - Level 1A standard
- Gaofen-6 (GF6)
 - Level 1A standard
- Gaofen-7 (GF7)
 - Earth-observation satellite in the Gaofen series of Chinese civilian remote-sensing satellites. The data includes 2.5m resolution multi-spectral and 0.8m stereo panchromatic data.
- GeoEye-1 (TIFF or NITF format)
 - GeoEye-1 Basic
 - GeoEye-1 Geo
- Gokturk-1
 - Level 0, or Level 1 data
- Gokturk-2
 - Level 0, or Level 1 data
- GOSAT
 - Level 1B (First version)
- Huanjing (HJ)
 - 1A-CCD1, 1B-CCD1 Level 1 format
 - 1A-CCD2, 1B-CCD2, 1B-IRS, 1C Level 2 format
- Hyperion
 - Level 1R, 1T and 1GST
- Ikonos
 - IKONOS provides various levels of processing. The following formats are recommended:
 - GEO product in UTM WGS84 GeoTiff format
 - NITF format with or without rational function
 - For color data stored in separate files, you can point to any TIFF file. Channels 1, 2, 3, and 4 correspond to red, green (grn), blue (blu), and near infrared (nir) data.
- IRS
 - Level 0 (raw) and Level 1 (radiometrically corrected) Super Structure format (recommended for the highest accuracy)
 - Full-scene data Orbit-oriented or Map-oriented EOSAT format
- Jilin-1
 - Level 1 with RPC data
- Jilin-1 07b
 - Level 1 with RPC data

- Kanopus-V
 - Level 2A and 3A Pan, MS and PSH data
- KazEOSat-1
 - Level 1A, Level 2 with RPC
- KazEOSat-2
 - Level 1G data
- Khalifasat
 - Support added for RADIO and GEO products for this optical sensor which features 3m multi-spectral and 0.7m panchromatic data
- Kompsat-2:
 - Level 1R (highest accuracy)
 - Level 1G
- Kompsat-3/3A:
 - Level 1R (highest accuracy)
 - Level 1G
- LANDSAT 1/2/3/4/5 MSS
 - LMTX Data with .txt and .tif files
- LANDSAT 5 (Brazilian):
 - Full-scene data with level 4 or 5 processing levels
- LANDSAT 5 (EOSAT):
 - LANDSAT 5 image full-scene data
 - ORBIT-ORIENTED or MAP-ORIENTED product
 - SYSTEMATIC geodetic processing
- LANDSAT 5/7 (LSGOWG) Canadian CDs:
 - LANDSAT full-scene or sub-scene image data
 - Level-4 processing (bulk, radiometric, and along-scan-line geometric corrections applied)
 - Level-5 processing (georeferenced) CD
- LANDSAT 5/7 (LSGOWG) ESA CDs:
 - Level 5 full-scene or quad-scene data
- LANDSAT 5 (NLAPS, TIFF):
 - NLAPS full-scene data with level-8 processing levels
 - TIFF full-scene data with systematic correction
- LANDSAT 7 (HDF, TIFF, FAST, NLAPS):
 - Full-scene data with 1G processing in HDF, TIFF, FAST, or NLAPS format
 - 0R or 1R is not recommended because of discontinuity on the image
- LANDSAT 8
 - L1GT and L1T products in Geo TIFF format
- MERIS (ENVISAT)
 - 1B format
- MODIS
 - MCD43A2 and MCD43A4 products
- Orbita

- Level 1B OHS-2A, OHS-2C, and OHS-2D
- OrbView-3:
 - Orbview Basic product
- PeruSat-1
 - Level 2A, Sensor product Level 3, Ortho product
- Pleiades
 - Level 1A and Level 2
- QuickBird
 - Basic 1B TIFF or NITF format
 - Ortho Ready Standard 2A product in Geo TIFF or NITF format
- RapidEye
 - Level 1B Basic
- RASAT
 - Level 1 TIFF format
- Resourcesat-2
 - Level 1G for the following sensors
 - AWIFS
 - LISS-3
 - LISS-4
- Sentinel-2
 - Level L1C format (S2MSI1C products)
- Shijian 9A (SJ-9)
 - Level 1A TIFF format
- Skysat
 - Basic scene products
- SPOT 1 to 3 (LGWOWG) Canadian formats, Level 1
- SPOT 1 to 4 (SPOTIMAGE)
 - Level 0
 - 1A (recommended)
 - 1B
 - Old SPOTIMAGE LGSOWG format and the new CAP-T format
- SPOT 5
 - Level 1A and 1B DIMAP and CAP formats
- SPOT 6 (TIFF)
 - Level 1A DIMAP
- SPOT 7 (TIFF)
 - Level 1A DIMAP
- SuperView-1
 - Level 1B or 2A data
- TeLEOS-1
 - Level 1 and 2
- Thaichote (THEOS)
 - Level 1 /1A

- TH-01
 - Level 1A, 1B, 2, 3A, 3B
- TripleSat
 - Level 1B Geo TIFF format
- WorldView-1
 - Basic (1B) TIFF and NITF formats
 - Ortho-ready (2A) Standard GeoTIFF format
- WorldView-2
 - Basic (1B) TIFF and NITF formats
 - Ortho-ready (2A) Standard GeoTIFF format
- Worldview-3
 - System-ready (Basic), Viewready (Standard), or Mapready (Ortho) products
- Worldview-4
 - System-ready (Basic), Viewready (Standard) products
- Yaogan-2, Yaogan-8, Yaogan-14
 - Level 1 Standard Geo TIFF format
- ZY-1-02C
 - TIFF or RPC format
- ZY-3
 - TIFF or RPC format
- ZY3-2
 - TIFF or RPC format

Satellite Models

Two methods of model calculation are included in the Satellite Ortho Suite:

Rigorous Math Model

- Calculate the position and orientation of the sensor when an image is taken
- Accurately account for known distortions in an image
- Use ground control points (GCPs) and tie points (TPs), combined with the knowledge of rigorous geometry of sensors, to calculate best fit for all images in a project

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
 - Zero- or first-order GCP refinement available

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

- ALOS

- AVNIR-2
- PRISM
- CARTOSAT (completed 6 Level certification by ANTRIX)
- DEIMOS
- DMC
- Dubaisat-2
- EROS
- GeoEye-1
- Gaofen-1 (GF1)
- Gaofen-2 (GF2)
- Gaofen-4 (GF4)
- Gaofen-6 (GF6)
- Gokturk
- IKONOS
- Jilin-1
- Kompsat-2
- Kompsat-3/3A
- NITF
- OrbView-3
- PeruSat-1
- Pleiades
- QuickBird
- RapidEye
- Resourcesat-2
- Shijian-9A (SJ-9)
- SPOT
- SuperView-1
- TeLEOS-1
- TH
- TripleSat
- WorldView-1
- WorldView-2
- WorldView-3
- WorldView-4
- Yaogan-2, Yaogan-8, Yaogan-14
- ZY-1-02C
- ZY-3
- ZY3-2

Ground Control

The satellite models support GCP and tie-point ground controls as follows:

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 (and multi-way) GCP collection
- Conversion of GCPs to check points to exclude from model calculation
- Display of individual and overall RMS error for GCPs

Depending on the sensor, the following minimum number of GCPs is required:

- SPOT 1-4: 4 per image, depending on GCP quality
- SPOT 5: 6 per image, depending on GCP quality
- IRS, ASTER, EOC: 6 per image (6-8 recommended)
- LANDSAT: 6 per image (10-12 recommended)
- Rational functions computed from GCPs: 5 per image (19 per image is recommended)
- Rational functions extracted from image files: None required (accuracy is improved with 1 or more GCPs)

Tie Point Collection

- Extends ground control over areas without GCPs
- Identifies how images in a project relate to each other
- Ensures the best fit for all the images in the project
- Imports and exports tie point locations
- Allows entry of tie point elevations manually or extracts them from a DEM automatically
- Show individual and overall RMS errors

Residual Report

Using residual reports, you can:

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

Project Summary Information

Raw Image Summary Table

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.

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 ground control points (GCPs), tie points (TPs), and check points (CPs)
- Image-specific information, including image ID, GCPs, TPs, CPs, root mean square (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

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. You can choose to display image centers, geocoded vector footprints, and/or thumbnails of the imagery. You can also toggle the display of ground control points, tie points, and check points, 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

- Can run as a batch process
- Utilizes a DEM for terrain correction
- Can increase the size of the working cache for faster processing
- Can increase the sampling interval for faster processing
- Offers 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
- Clips the image size upon orthorectification
- Can use a scheduled start time
- Provides approximately one-third of a pixel accuracy for VIR satellite images, and approximately one pixel for radar images when quality ground-control coordinates are used

Manual Mosaicking

Mosaicking is available using the Mosaic Tool. Using this you can:

- Define a mosaic area
- Collect cutlines manually, including:
 - Import and export of cutlines
 - Specified blend width along seams
- 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 the mosaicking process, the Mosaic Tool New Project Wizard will lead you through the setup of a mosaic project.

Functions

With a license for the Satellite 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.

- AVMODEL – calculates model for orthorectifying AVHRR data
- CDCARTOSAT – reads Cartosat imagery
- CDSPOTRPC – reads SPOT DIMAP and CAP format data for orthorectification using the Rational Function model
- MERGEBAND – merges and recombines multiple bands in separate files into a single file
- MODEL2RPC – converts a math model to a RPC model
- QBASMBLE – assembles QuickBird tiles into a single image with the associated RPC model information
- RFMODEL – computes the math model of one or more images using the rational function math modeling method
- SATMODEL – calculates the math model for one or more images using the rigorous math modeling method
- STITCH – merges the different tiles, which are obtained from the same orbit on the same day, into one complete scene