

## *Satellite Ortho Suite*

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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 taken into account using these models. The models reflect the physical reality of the complete viewing geometry and correct all distortions generated during the image formation.

### *Module Prerequisites*

The Satellite Ortho Suite is an add-on to Geomatica. It requires Geomatica Core or Geomatica Prime as a pre-requisite.

### *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
- 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 TIFF format (radiometrically corrected)
- Gaofen-1 (GF-1)
  - Read only TIFF or RPC format
- Gaofen-2 (GF-2)
  - Read only TIFF or RPC format
- GeoEye-1 (TIFF or NITF format)
  - GeoEye-1 Basic
  - GeoEye-1 Geo
- Gokturk-1
  - Level 0, 1, 2 data format
- GOSAT
  - Level 1B and 1B+ HDF5 format
- Huanjing (HJ)
  - 1A-CCD1, 1B-CCD1 Level 1 format
  - 1A-CCD2, 1B-CCD2, 1B-IRS, 1C Level 2 format
- Ikonos-2
  - Level 1 GEO product in Geo TIFF format
  - Level 2A Ortho Kit product
- 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
- KazEOSat-1
  - Level 1A
- Kompsat-2:
  - Level 1R TIFF format (highest accuracy)
  - Level 1G GeoTIFF format
  - Level 1G and LR DIMAP format
- Kompsat-3:
  - Level 1R TIFF format (highest accuracy)
  - Level 1G GeoTIFF format
- 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
  - 1A or 1B HDF format
- OrbView-3:
  - Basic Enhanced 1A TIFF format
- Pleiades
  - Level 1A Basic Format
- QuickBird
  - Basic 1B TIFF or NITF format
  - Ortho Ready Standard 2A product in Geo TIFF or NITF format
- RapidEye
  - Basic Level 1B NITF format
  - Level 2A (Geocorrected)
- RASAT
  - Level 1 TIFF format
- Resourcesat-2
  - Level 1G for the following sensors
    - AWIFS
    - LISS-3
    - LISS-4
- Shijian 9A (SJ-9)
  - Level 1A TIFF format
- 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 format
- SPOT 7 (TIFF)
  - Level 1A DIMAP format
- TeLEOS-1
  - Level 1
- TH-01
  - Level 1A and 1B
- Thaichote(THEOS)
  - Level 1A and 2A DIMAP format



- TripleSat
  - Level 1B Geo TIFF format
- WorldView-1
  - Level 1B TIFF and NITF formats
  - Level 2A Standard GeoTIFF format
- WorldView-2
  - Level 1B TIFF and NITF formats
  - Level 2A Standard GeoTIFF format
- Worldview-3
  - Level 1B TIFF and NITF formats
- Yaogan-2, Yaogan-8, Yaogan-14
  - Level 1 Standard Geo TIFF format
- ZY-1-02C
  - Read only TIFF or RPC format
- ZY-3
  - Read only TIFF or RPC format
- ZY3-2
  - Read only TIFF or RPC format

## Satellite Models

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

### Rigorous Math Model

Rigorous math models:

- 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 (GF-1)
- Gaofen-2 (GF-2)
- Gokturk
- IKONOS
- Jilin-1
- Kompsat-2
- Kompsat-3
- NITF
- OrbView-3
- Pleiades
- QuickBird
- RapidEye
- Resourcesat-2
- Shijian-9A (SJ-9)
- SPOT
- TeLEOS-1
- TH
- TripleSat
- WorldView-1
- WorldView-2
- WorldView-3
- Yaogan-2, Yaogan-8, Yaogan-14
- ZY-1-02C
- ZY-3

## 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 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

With manual mosaicking, 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

## 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 Geomatica Focus and the PCI Modeler.

- 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

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