GEOSYSTEMS
THE GEOSPATIAL EXPERTS
An OHB Company

IMAGINE UAV

Manual

Software version:2.2

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Contents

GEOSYSTEMS

UAV Workfow

The **GEOSYSTEMS UAV** Workflow supports the computation of digital ortho mosaics, digital elevation models, point clouds and 3D meshes from overlapping image data captured with frame cameras and RPC based line scanners from within the **ERDAS IMAGINE Spatial Modeler**.

ERDAS IMAGINE UAV Feature Overview

The **ERDAS IMAGINE UAV** operators for the **ERDAS IMAGINE Spatial Modeler** enable you to create an ortho-mosaic, a photogrammetric point cloud, a digital surface model (**DSM)**, and a 3D mesh out of UAV still images. Both the image alignment as well as the creation of the outputs are fully automated. You can project the results to a coordinate system specified by an **EPSG.**

Section 1

ERDAS IMAGINE UAV Feature

Processing Workflow Concept

There are four main processing steps which you can identify by opening the underlying spatial model of the UAV workflow:

1. The first step creates a new UAV project. You need to specify the image data and the orientation information.
2. The next step computes the image orientation. During this process, the system searches for common points in the input images, identifies the position of the camera for each picture, and refines camera calibration parameters. The results are a sparse point cloud and a set of camera positions. You need to define the level of accuracy as well as the preselection parameter for the image matching.
3. The **Compute Surface** operator creates a 3D polygonal mesh. Based on the estimated camera positions and image data, a dense point cloud is generated first. This is then used as input for the creation of a 3D polygonal mesh representing the object surface described by the point cloud. For this operator you need to set several parameters that are influencing the quality of the point cloud and of the 3D surface as well as the computation time.
4. The last step produces the final output dataset or datasets. You can also reuse all results created in the model to create a complex workflow like an image classification based on the UAV datasets.
    a. **Export Mosaic** allows you to export the computed surface as a digital ortho mosaic. The export supports the image file formats **ECW, JPEG2000, IMG** and **TIF.**
    b. **Export DEM** allows you to export the computed surface as a digital elevation model. The export supports the image file formats **ECW** and **TIF**. Additionally, you can also create and export contour lines as shape file.
    c. **Export PointCloud** allows you to export the computer point cloud to several point cloud format such as **Wavefront OBJ format, Stanfort PLY format, XYZ point cloud format, ASPRS LAS file, LAZ format, U3D format, Adobe PDF format, ASTM E57 format, Agisoft OC3 format, Potree format,Topcon CL3 format, Cesium 3D tiles format, ASCII PTS format, Autodesk DXF format.**

d. **Export LAS** allows you to export the computed point cloud as **LAS** file with RGB encoding.

e. **Export Model** allows you to export the computed surface model to several model formats such as **Wavefront OBJ format, 3DS model format, VRML model format, COLLADA format, Stanfort PLY format, STL model format, Alembic format, Autodesk FBX format, Autodesk DXF Polyline format, Autodesk DXF 3DFace format, U3D model format, Adobe PDF format, Google Earth KMZ format, Binary glTF model format, X3D model format.**

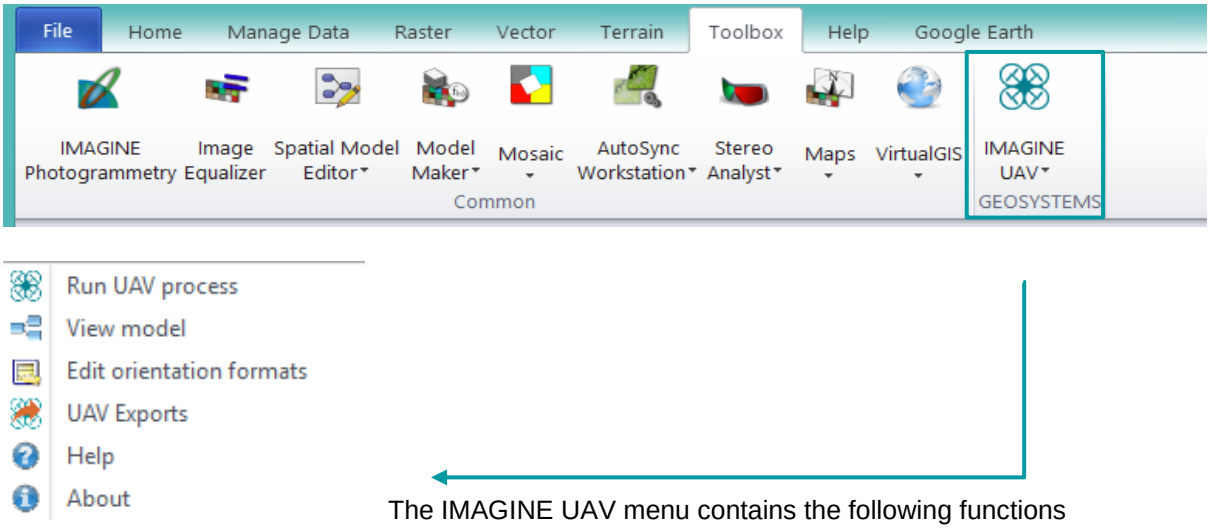
f. **Export TiledModel** allows you to export the computed surface model to several tiled model formats such as **Cesium 3D Tiles format, Scene Layer Package format, PhotoMesh Layer format, Agisoft Tiled Model format, Agisoft Tile Archive format.**

g. **Export Project** allows you to save the Metashape project to several other project file formats such as **Agisoft XML format,CHAN files format, Boujou format, Bundler format, Omega Phi Kappa format, PATB project format, BINGO project format, ORIMA format, AeroSys exterior orientation format, Inpho project file format, Summit evolution project format, Blocks Exchange format, Realviz RZML format, VisionMap format format, Alembic format, Autodesk FBX format.**

h. **Export Block File** allows you to export the oriented image block as an IMAGINE Photogrammetry block file **BLK**.

IMAGINE UAV Menu

The IMAGINE UAV menu is located in the **Toolbox** tab.



The IMAGINE UAV menu contains the following functions

1. Run UAV Process

Click **Run UAV process** and the Spatial Model dialog opens. There are the options to either run a default UAV model or to execute the process based on specified input parameters for a customized model. This means that the base functionality is also available for IMAGINE Essentials users that are only able to execute and not to create or open Spatial Models for viewing. Thus, this dialog enables the user to specify all relevant parameters via a graphical user interface. For more information, see also *Step-by-Step guide for the IMAGINE UAV Workflow* starting on page 73.

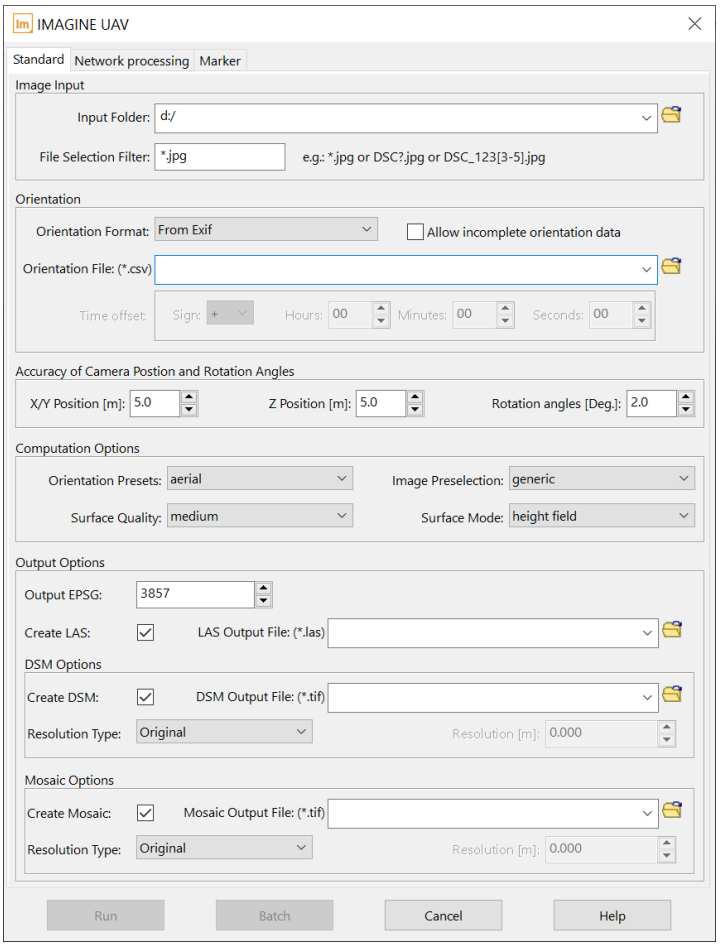
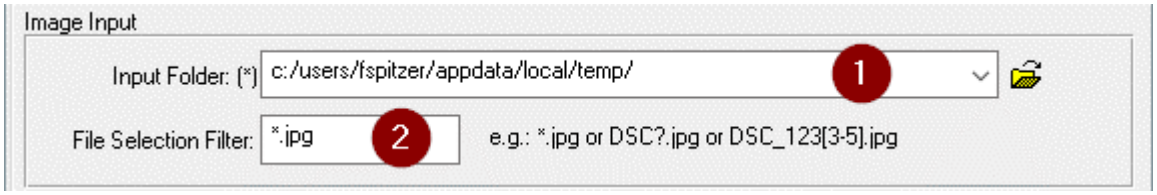


Image Input Options:



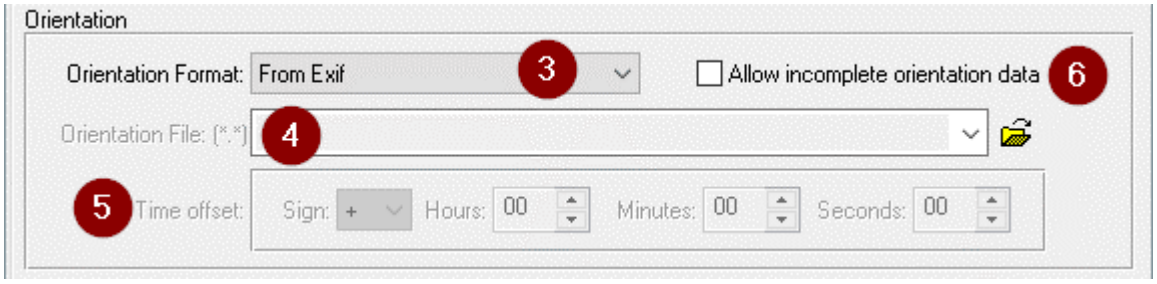
1. Select the **directory** containing the imagery to be processed.
2. Define the pattern that is used to select images inside the provided **input folder.** The entered pattern is interpreted as **wildcard** matching pattern to select files. The default value is **.jpg*, which selects all **JPG**-images.

Hint: Image pattern

Character	Description
?	Matches any single character, identical to full regular expressions. For example, *DSC_123?.jpg* selects files such as *DSC_1231.jpg*, *DSC_1232.jpg* or *DSC_1233.jpg.*
*	Matches zero or more of any characters, identical to full regular expressions. For example, *DSC_123*.jpg* selects files such as *DSC_123.jpg*, *DSC_1232.jpg* or *DSC_12345.jpg.*

[...]	Sets of characters can be represented in square brackets, similar to full regular expressions. For example, *DSC_123[3-5].jpg* selects only the files *DSC_1233.jpg*, *DSC_1234.jpg* or *DSC_1235.jpg.*

Orientation:



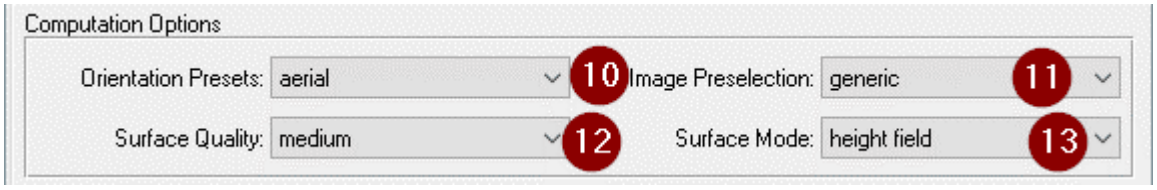
3. Select the suitable Orientation Format from the listbox that contains all available orientation sources or formats. Select **From Exif** to take the orientation information directly from the image data. In this case, the presence of the **Exif** data is validated for each selected image file. Select **From GPS track** to take the orientation information from a GPX track file. For RPC based satellite images select **From RPC txt**. Any other format in the list refers to custom formats of orientation data.
4. Select a text file containing the orientation data. This file is only required when selecting a custom orientation data format. Select the GPX-Track file when choosing **From GPS track** as orientation format.
5. This option allows you to specify a time offset when using a GPX file. In case of an offset between image recording and GPS time, please specify the time difference between image recording and GPS time. How much later or earlier have the images been recorded with respect to the GPS time? This is necessary to determine the correct position data from the provided GPX file. Default: '+00:00:00'.
6. This option toggles the handling of images with missing orientation data. If **false** (default value), all images must have orientation data. If **true**, also images with missing orientation data are processed. The minimum number of images that must have orientation data (absolute and relative, with the larger number used) can be specified in the IMAGINE Preferences.

Accuracy of Camera Position and Rotation Angles:

7. Specifies the accuracy of the recorded camera position in X/Y in meters or in Latitude/Longitude in degrees. Leave the default (5 meters) for consumer GPS receivers. If more accurate GPS recordings are available, it is important to set them here, as the geo-location of the final products will benefit substantially.
8. Specifies the accuracy of the height component of the recorded camera position in meters. Leave the default (5 meters) for consumer GPS receivers. If more accurate GPS recordings are available, it is important to set them here, as the geo-location of the final products will benefit substantially.

9. Specifies the accuracy of the recorded camera rotation angles in degrees. Leave the default (2 degrees) for consumer IMU devices. If your orientation data do not include rotation angles, this value will be ignored.

Computation Options:



10. The **Orientation Presets** allow the user to change the default computation settings from aerial to terrestrial. This will change Image Preselection and Surface Mode to a suitable value.
11. The parameter **Image Preselection** determines how overlapping image pairs are found, which has a significant influence on the computation time, especially for large sets of image data.

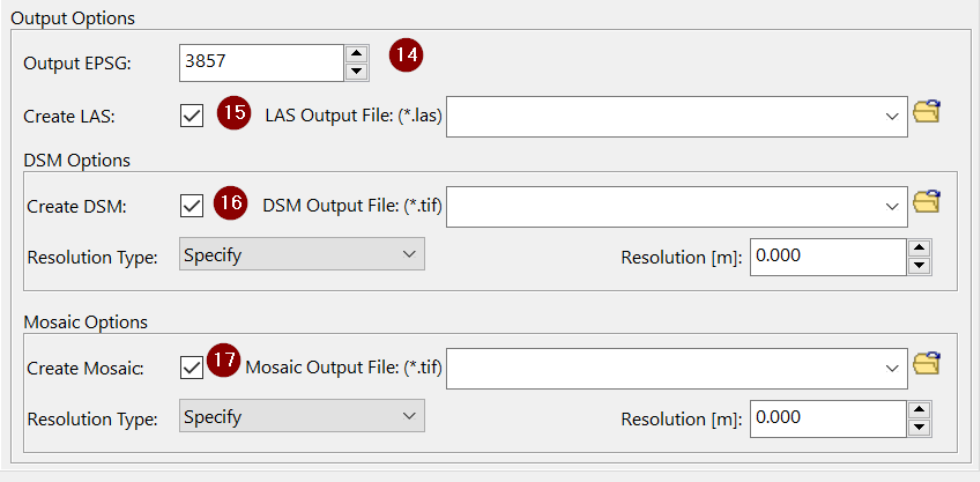
Value	**Description**
Disabled	No preselection is executed. All possible image pair combinations are computed, resulting in a longer computation time.
Generic	The preselection is based on image correlation in lower resolution images. For large image datasets this can still consume a significant amount of time as all combinations of image pairs are being evaluated.
Ground Control	If ground control information (initial camera orientation data) were specified during project creation, this information is used to reduce the number of image pairs that are evaluated, thereby improving the computation time.

12. The parameter **Surface Quality** influences the level of detail of the reconstruction. A higher value results in a more detailed reconstruction but can take a very long time to produce results. A lower value produces a coarser reconstruction, but computation time is much shorter.

Value	**Description**
Lowest, Low, Medium	Creates less detailed point clouds but computation time is relatively short. Should be used only to get a quick impression of the surface.
High	Creates a detailed reconstruction of the surface. If nothing gets selected this value is default.
Ultra	Creates a very detailed reconstruction of the surface but increases the chance of outliers. Additionally, the computation time is significantly longer than using **high.**

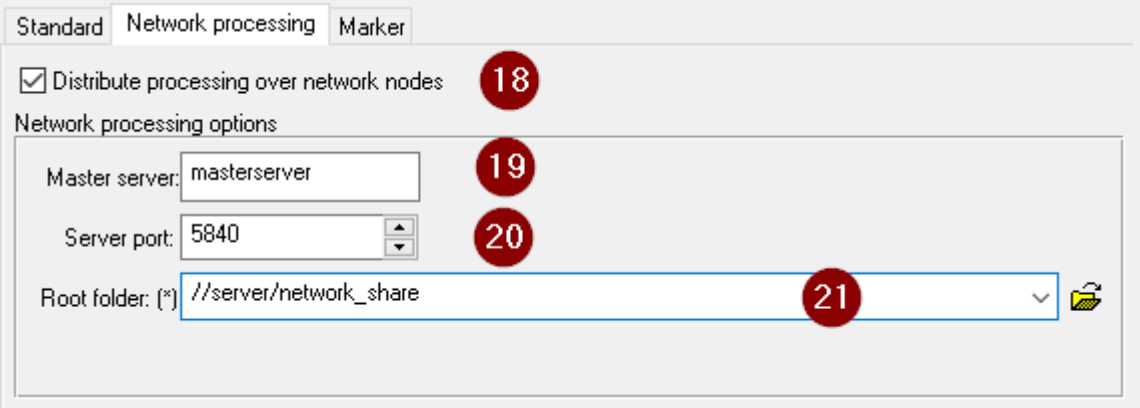
13. Use the parameter **Mode** to select the type of surface to be computed. **Height Field** allows you to model planar surfaces. Use this default when dealing with UAV data. **Arbitrary** can be used to model any type of surface. Typically, this value only must be selected if objects like buildings or statues are being reconstructed.

Output Options:



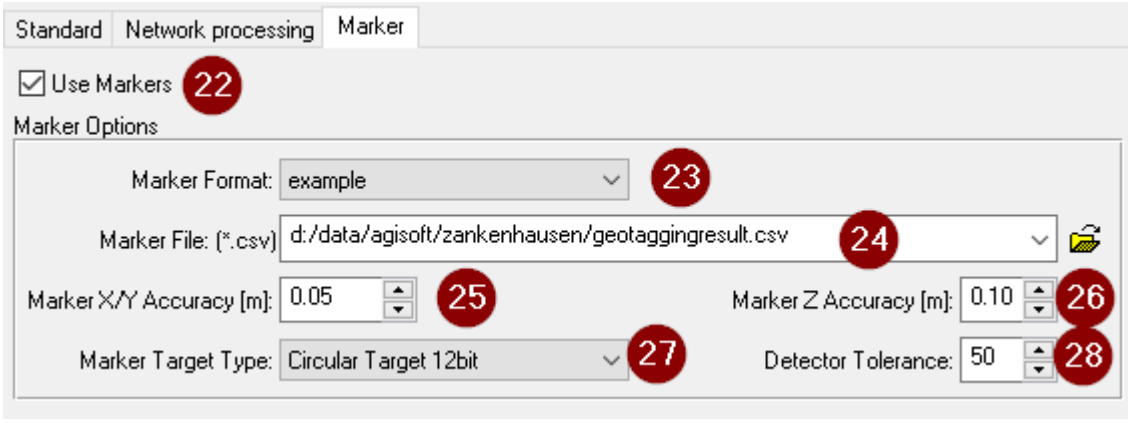
14. If the point cloud was reconstructed from image data with known camera positions and the parameter **EPSG** is provided, all output datasets will be re-projected to the specified coordinate system.
15. Select if you want to create a point cloud as output. If so, enter the filename for the output LAS file.
16. Select if you want to create a DSM (a raster file based Digital Surface Model) as output. If so, enter the filename for the output DSM file. Valid data types are *.tif and *.img. The output file will have a bit depth of 32 producing **float** data type. For all output images, pyramid files are computed automatically. To change the ground sampling distance of the exported DSM change the resolution type to **Specify** and enter the desired resolution in meters. Keep **Original** to automatically compute the resolution based on the data.
17. Select if you want to create a mosaic as output. If so, enter the filename for the output mosaic file. Valid data types are *.tif, *.img, *.ecw and *.jp2. For all output images, pyramid files are computed automatically. To change the ground sampling distance of the exported mosaic file change the resolution type to **Specify** and enter the desired resolution in meters. Keep **Original** to automatically compute the resolution based on the data.

Optional: Network processing Tab



18. Select the option **Distribute processing over network nodes** to utilize all configured network nodes for the computation of the project. For more details. please see section 4.
19. Specify the **Master server** of the configured processing cluster. This master server acts as the central component of the cluster and must be available from all nodes via TCP/IP and the specified port.
20. Specify the **Serer port** on which the master server is listening for connection from the configured processing nodes.
21. To allow several processing nodes to work simultaneously on the same project, all raw data must be stored below the specified **Root folder**. Further separating in subfolders is allowed. The **Input Folder** selected under 1) has to be a subfolder of this root folder.

Optional: Marker Tab

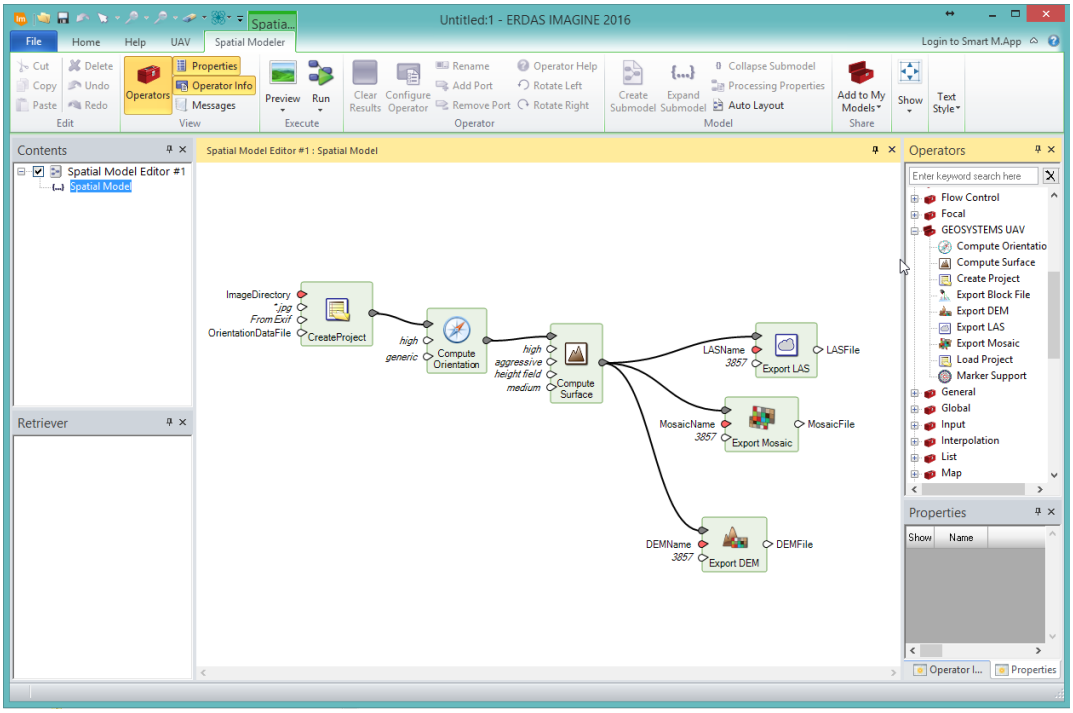


22. Select the option **Use Marker** to introduce automatic ground control within your project. This information will be used to improve the overall positions of your images (e.g. if you do not use precise GPS-information).
    In order to use this additional information, you need to print and to place Coded targets (CTs) before acquiring the images. Each coded target has a ring parted in black and white segments around the central full circle and will be recognized by the program within the picture automatically. For each CT you need to define a geo-coordinate that will be used as reference coordinate within your image block.
23. Specify the file format containing the reference coordinates of your markers. The coordinates will be transformed in the background if the projection of the file is different to the reference system used in your project.

24. Select the file that contains the reference coordinates (see specifications at the end of this document under **Using markers (Coded Targets)**
25. Select the precision of the measurements for your reference coordinates in X and Y direction.
26. Select the precision of the height measurements for your reference coordinates.
27. Select the pattern used to identify the CTs.
28. Select the tolerance used to detect the CTs in your images. Try to increase this value if the markers are not well detected.

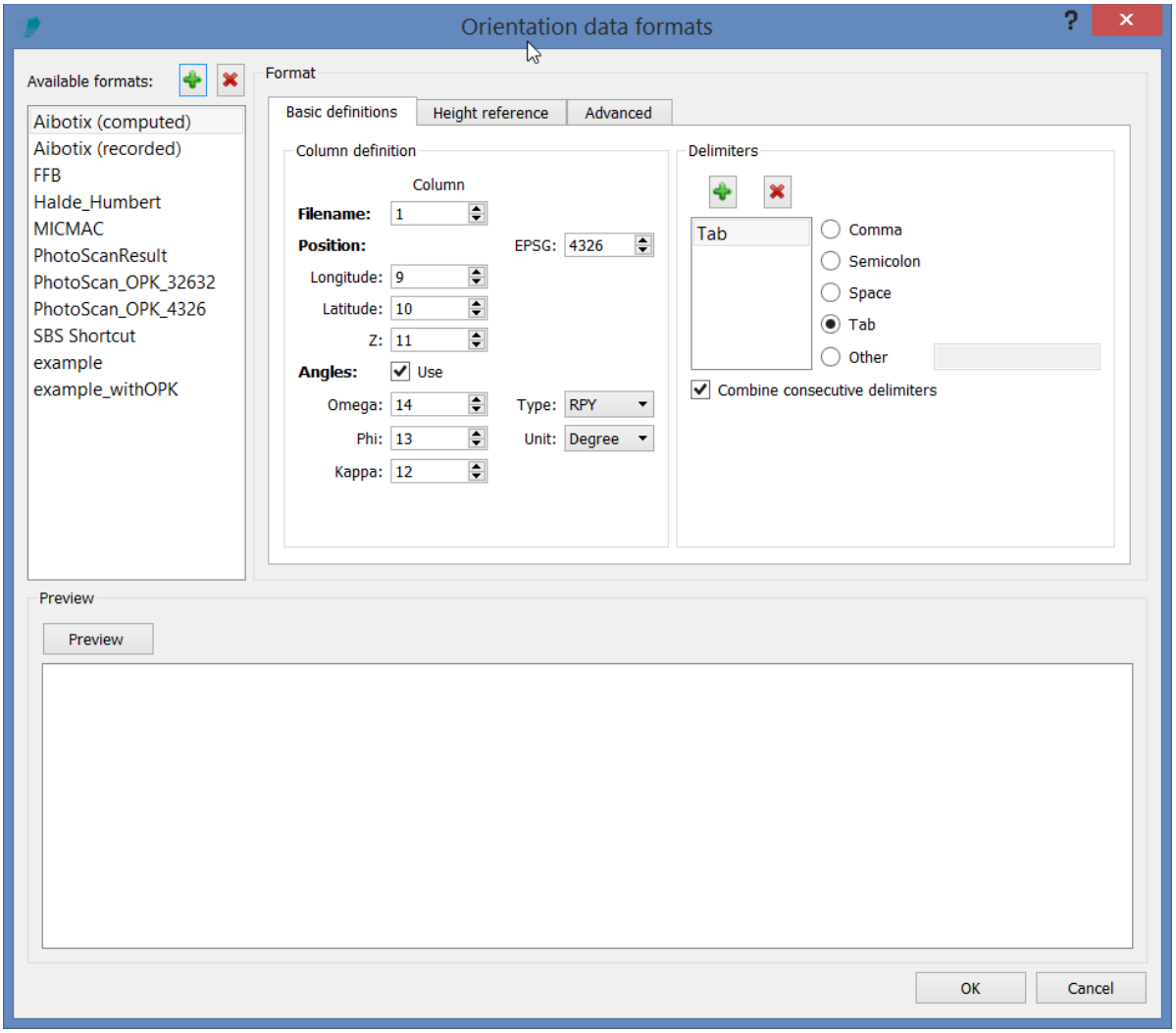
2. View model

Click **View model** to open the default UAV Model in the Spatial Modeler Editor, where you can modify or extend the UAV model. Spatial Modeler Editor requires an ERDAS IMAGINE Professional level license.



3. Edit Orientation Formats and Mark File format

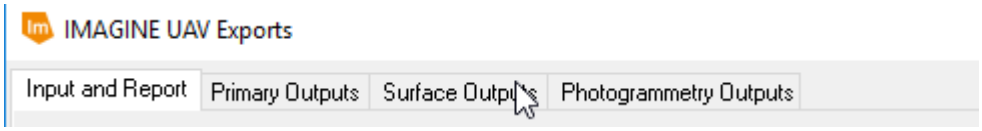
Click **Edit orientation formats** to open the Orientation data formats dialog to extend the list of supported orientation data formats. This dialog is also used to define the file format for the marker reference file. For an example, please see the *Step-by-Step guide for the IMAGINE UAV Workflow* on page 73.



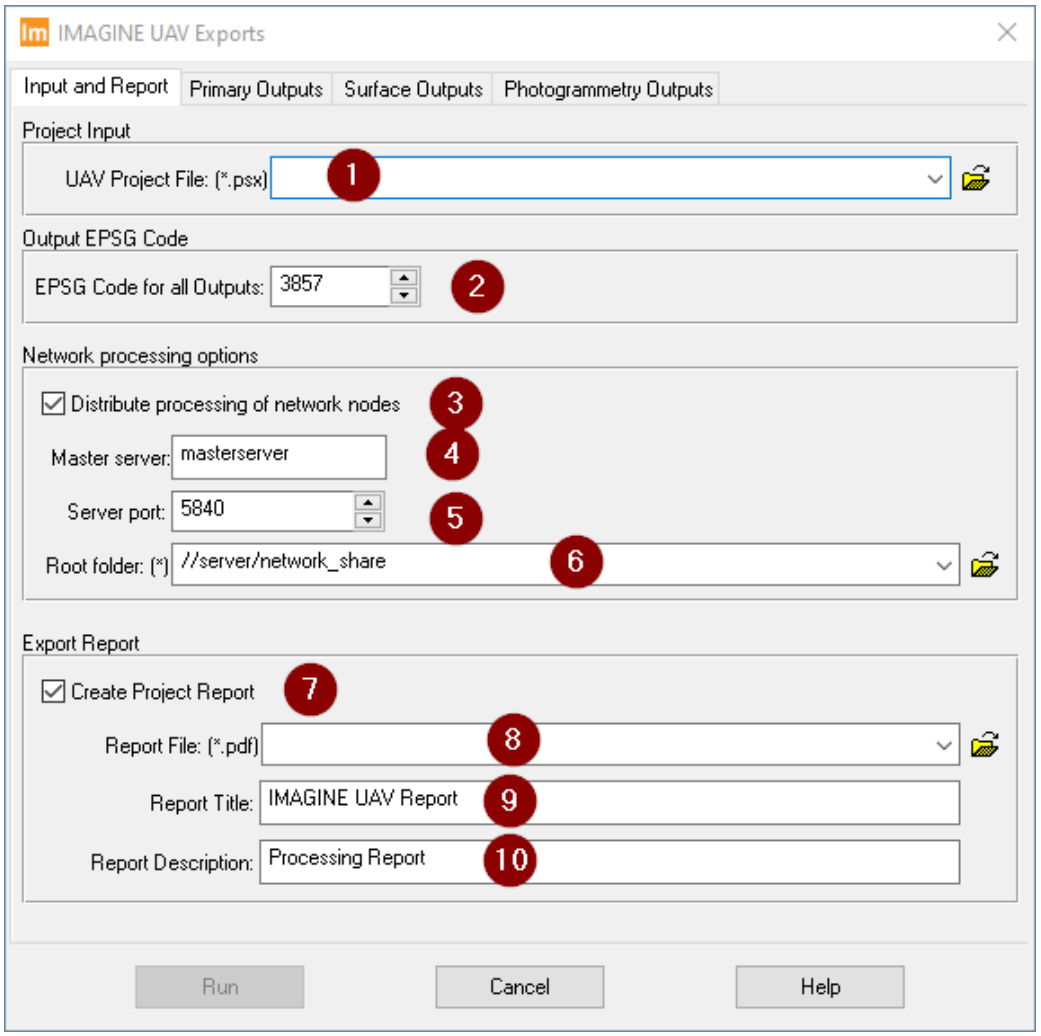
4. UAV Exports

Click **UAV Exports** to run an additional model allowing you to export all different output types/formats supported by IMAGINE UAV including various point cloud formats, DSM, ortho mosaic, various 3D-Model formats and photogrammetric outputs to a variety of project formats. To use this export dialog/model an already triangulated UAV project created using the **Compute Orientation Operator** or **Compute Surface Operator**) is needed.

The UAV Exports dialog has several tabs, grouping thematically the possible outputs.



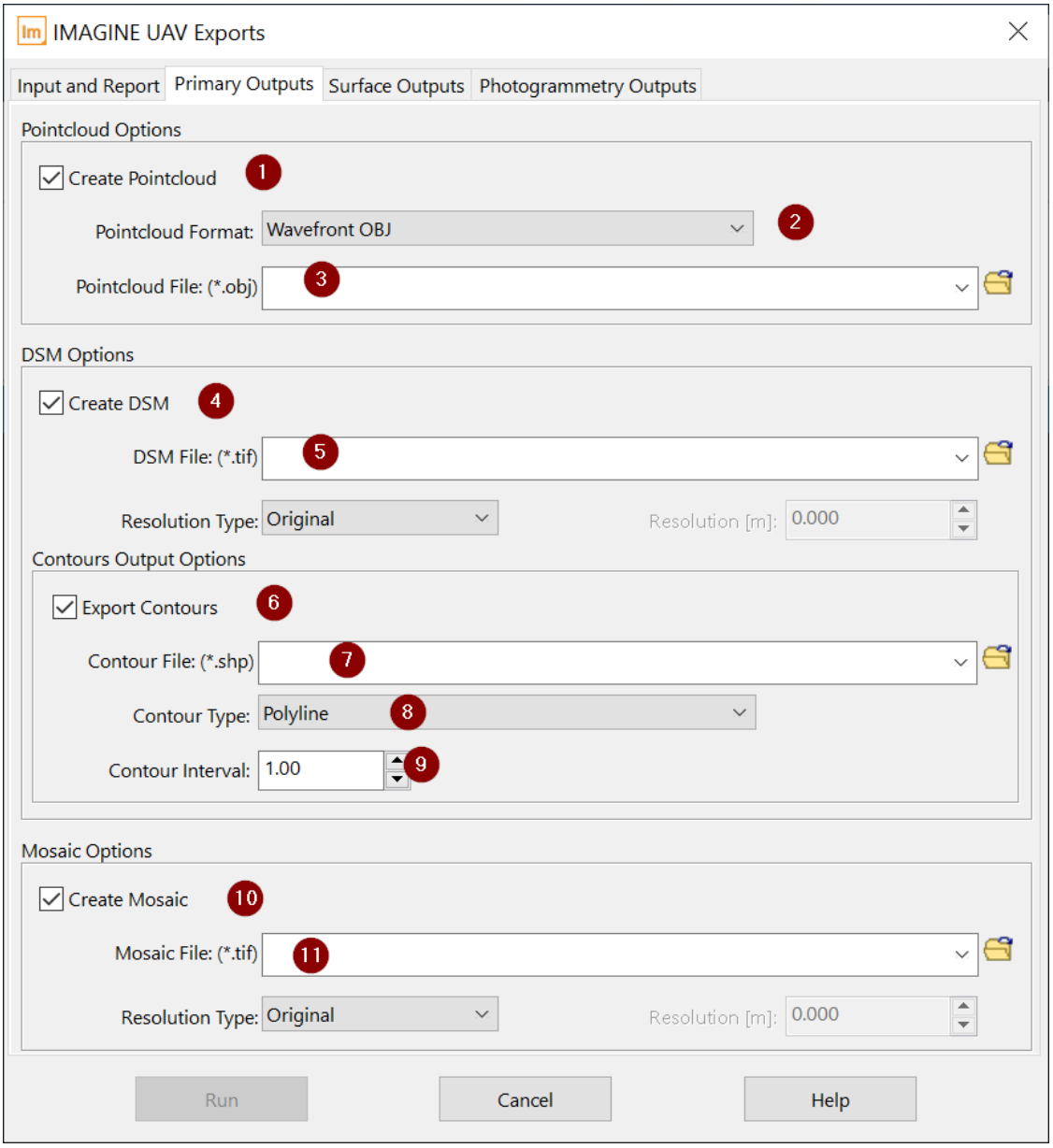
4.1 Input and Report



1. Select an existing project file which will be generated during the base processing steps in the input folder of your raw image data. For the export the file projectFILE.psx must be selected. It contains the fully triangulated project.
2. Set the **EPSG** code for all exports. Use a valid projected coordinate system EPSG code. All different export types will be re-projected if the output EPSG differs from the project EPSG.
3. Select the option **Distribute processing over network nodes** to utilize all configured network nodes for the computation of the project. For more details. please see section 4.
4. Specify the **Master server** of the configured processing cluster. This master server acts as the central component of the cluster and must be available from all nodes via TCP/IP and the specified port.
5. Specify the **Serer port** on which the master server is listening for connection from the configured processing nodes.
6. To allow several processing nodes to work simultaneously on the same project, all raw data must be stored below the specified **Root folder**. Further separating in subfolders is allowed. The **Input Folder** selected under 1) has to be a subfolder of this root folder.
7. Select this option to export the triangulation report for your project as PDF.
8. Specify the file to export the report to.

9. Provided title for exported report. When no title is provided, the default of Metashape is used.
10. Provided additional description for exported report. When no description is provided, the default of Metashape is used.

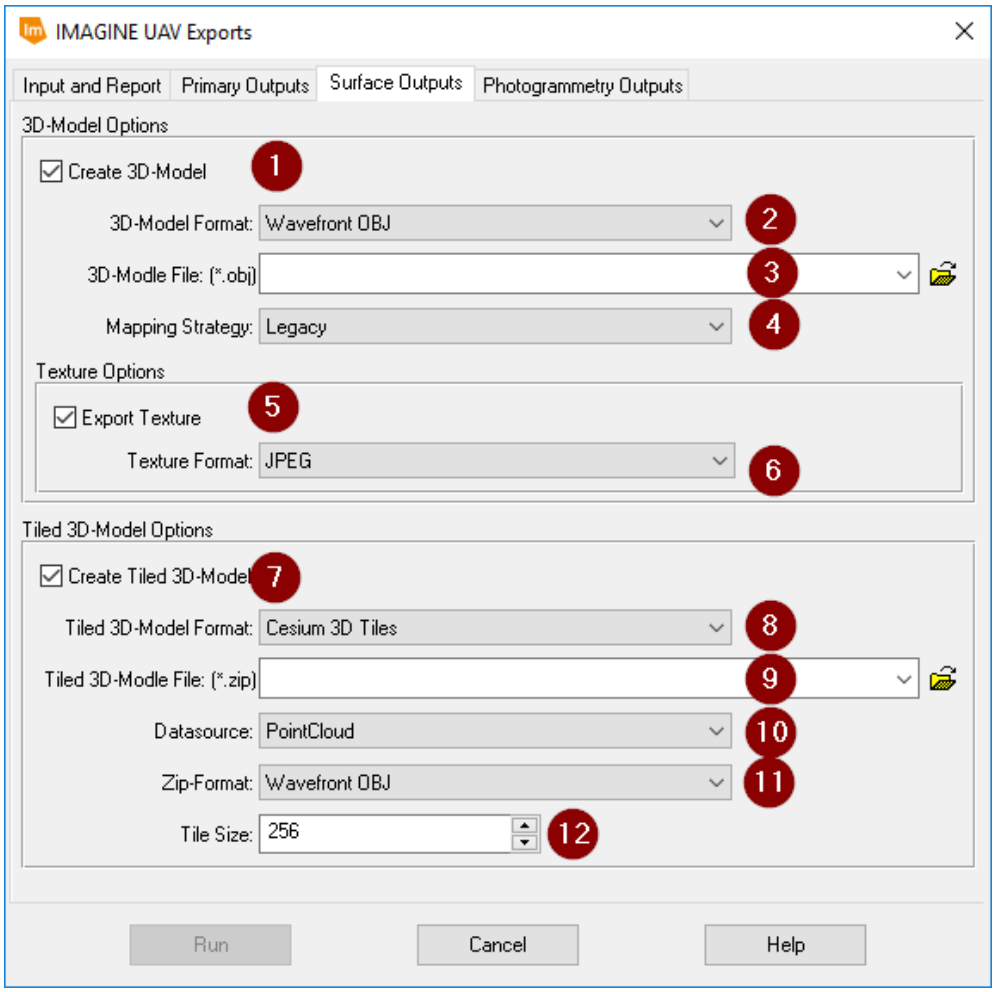
4.2 Primary Outputs



1. Select this option to export the point cloud data of your project.
2. Select the desired **Pointcloud Format** for the export. The following formats are available: **Wavefront OBJ format, Stanfort PLY format, XYZ point cloud format, ASPRS LAS file, LAZ format, U3D format, Adobe PDF format, ASTM E57 format, Agisoft OC3 format, Potree format, Topcon CL3 format, Cesium 3D tiles format, ASCII PTS format, Autodesk DXF format**. Saving color information of the point cloud is not supported by the OBJ and DXF formats.
3. Specify the file name to export to pointcloud data to.
4. Select this option to export a DSM (a raster file based Digital Surface Model).

5. Specify the filename for the output DSM file. Valid data types are *.tif and *.img. The output file will have a bit depth of 32 producing **float** data type. For all output images, pyramid files are computed automatically. To change the ground sampling distance of the exported DSM change the resolution type to Specify and enter the desired resolution in meters. Keep Original to automatically compute the resolution based on the data.
6. To generate and export contour lines, select the option **Export Contours**.
7. Specify the filename for the **Contour File** to be generated. Only supported format is shp.
8. Select which geometry type to use when exporting the contour lines. Default is **Polyline**.
9. Specify the Interval between two contour lines to be generated. The unit refers to the unit of the underlying elevation data used. In most cases that will be meters.
10. Select this option to export an ortho mosaic.
11. Specify the filename for the output mosaic file. Valid data types are *.tif, *.img, *.ecw and *.jp2. For all output images, pyramid files are computed automatically. To change the ground sampling distance of the exported mosaic file change the resolution type to Specify and enter the desired resolution in meters. Keep Original to automatically compute the resolution based on the data.

4.3 Surface Outputs



1. Select this option to export the 3D-Meshes of your project.

i. Select the desired **3D-Model Format** for the export. The following formats are available: **Wavefront OBJ format, 3DS model format, VRML model format, COLLADA format, Stanfort PLY format, STL model format, Alembic format, Autodesk FBX format, Autodesk DXF Polyline format, Autodesk DXF 3DFace format, U3D model format, Adobe PDF format, Google Earth KMZ format, Binary glTF model format, X3D model format.**

2. Specify the file name to export to 3D mesh data to.

3. Select texture mapping strategy to determine how the object texture will be packed in the texture atlas. Proper texture mapping mode selection helps to obtain optimal texture packing and, consequently, better visual quality of the final model. Possible options are:
    a. **Generic**: it allows to parametrize texture atlas for arbitrary geometry. No assumptions regarding the type of the scene to be processed are made; program tries to create as uniform texture as possible.
    b. **Orthophoto**: this mapping strategy textures the whole object in the orthographic projection. It produces even more compact texture representation than the **Adaptive orthophoto** mode at the expense of texture quality in vertical regions.
    c. **AdaptiveOrthophoto**: this mapping strategy splits the object surface into a flat part and vertical regions. The flat part of the surface is textured using the orthographic projection, while vertical regions are textured separately to maintain accurate texture representation in such regions. With this mapping strategy, the program tends to produce more compact texture representations for nearly planar scenes, while maintaining good texture quality for vertical surfaces, such as walls of the buildings.
    d. **Spherical**: this mapping strategy is appropriate only to a certain class of objects that have a ball-like form.

4. Select this option to include the textures in the export. Some file formats (Wavefront OBJ, 3DS model, VRML model, COLLADA, Stanfort PLY, Autodesk FBX) save the texture image in a separate file. The texture file should be kept in the same directory as the main file describing the geometry.

5. Select the image format of the exported textures. Supported formats are: **JPEG, TIFF, PNG, BMP, EXR, TGA, JP2**.

6. Select this option to export the 3D-Meshes of your project as Tiled Model.

7. Select the desired **Tiled 3D-Model Format** for the export. The following formats are available: **Cesium 3D Tiles format, Scene Layer Package format, PhotoMesh Layer format, Agisoft Tiled Model format, Agisoft Tile Archive format.**

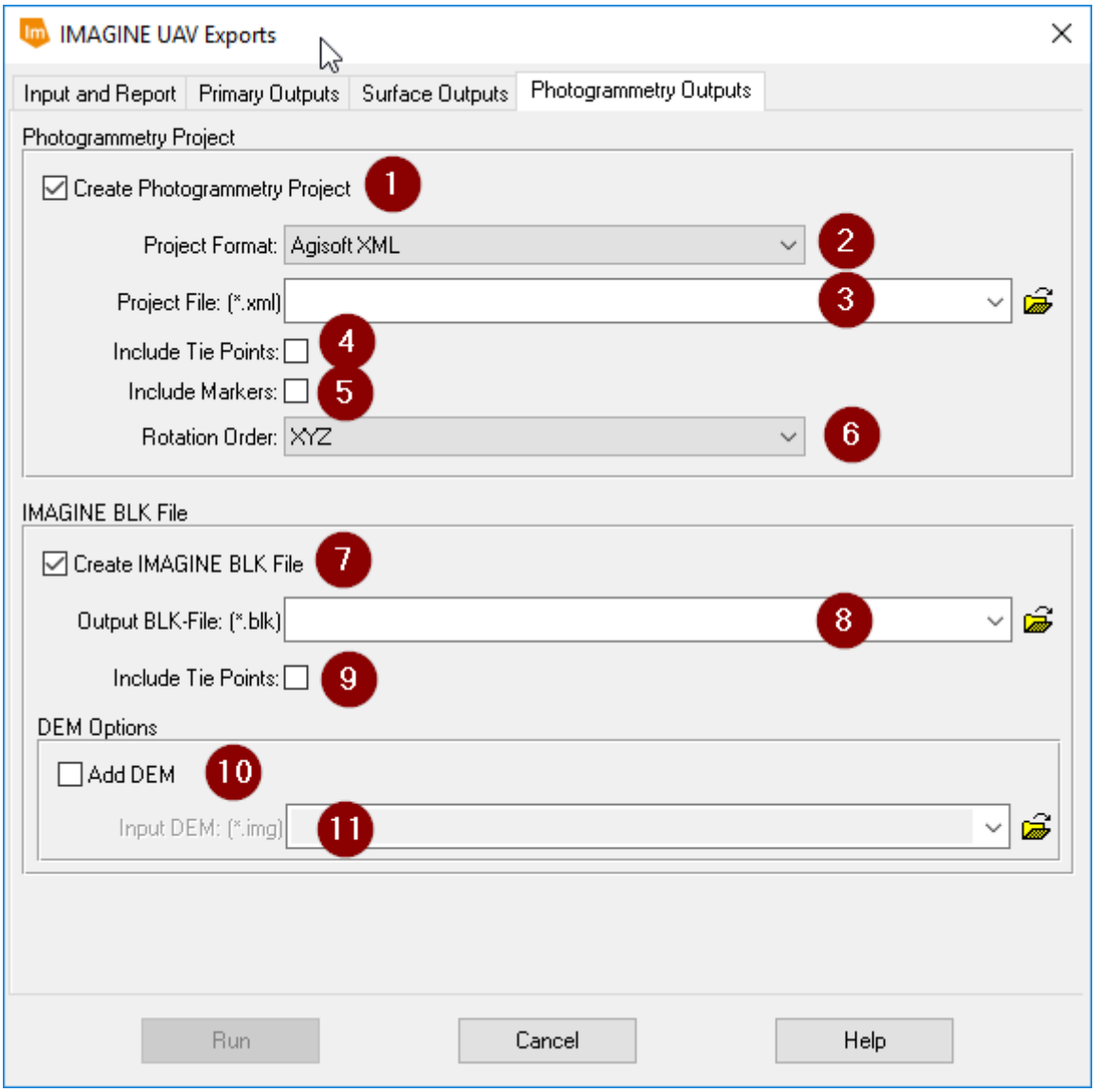
8. Specify the file name to export to tiled 3D mesh data to.

9. Select the **Datasource** for the tiled model export**.** Available formats are **PointCloud** and **Mesh**.

10. When selecting a ZIP based tiled model, select also the underlying mesh format. The available formats are identical to the 3D-Model export.

11. Specify the tile size of the exported tiled model in pixels.

4.4 Photogrammetry Outputs

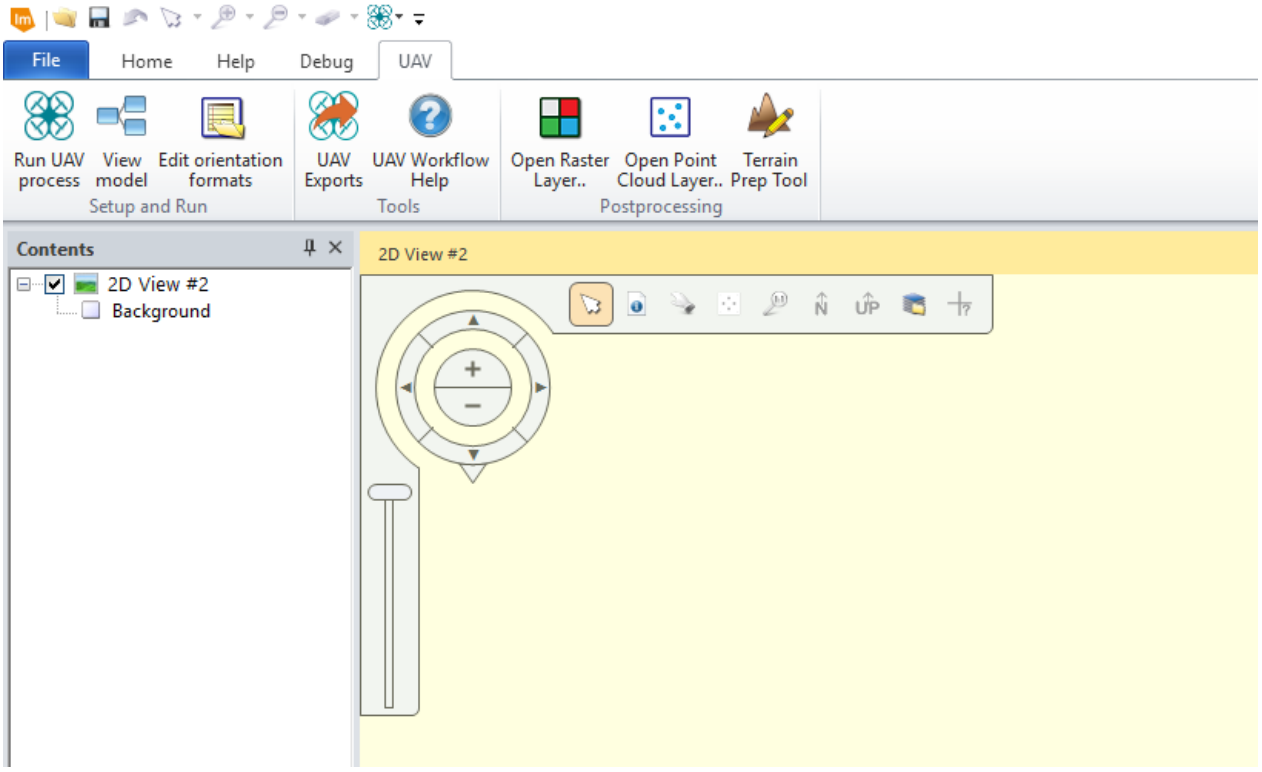


1. Select this option to convert and export your project to another photogrammetric project format.
2. Select the desired **Project Format** to convert and export to. The following formats are available: **Agisoft XML format,CHAN files format, Boujou format, Bundler format, Omega Phi Kappa format, PATB project format, BINGO project format, ORIMA format, AeroSys exterior orientation format, Inpho project file format, Summit evolution project format, Blocks Exchange format, Realviz RZML format, VisionMap format, Alembic format, Autodesk FBX format.** Exports to Bundler and Boujou formats will save sparse point cloud data in the same file. Export to Bundler format is not saving distortion coefficients k3, k4.
3. Specify the file name to export the converted project data to.
4. Tick this option to include already computed tie points in the export. Exports to BINGO, ORIMA, PATB, Summit Evolution and Blocks formats allow to store tie points.
5. Tick this option to include markers in the export.
6. Specify the rotation order (CHAN format only).
7. Select this option export your project as IMAGINE Photogrammetry Block file (BLK).

8. Specify the file name for the block file.
9. Enable this flag to export all tie points used for the triangulation.
10. Tick option to include a reference DEM/DSM.
11. Specify the DEM/DSM file that will be added to the BLK file. It is advisable to use only DEM/DSMs, which contain information about the elevation reference to avoid misalignments. For best results, use directly the output created within the project.

IMAGINE UAV Layout

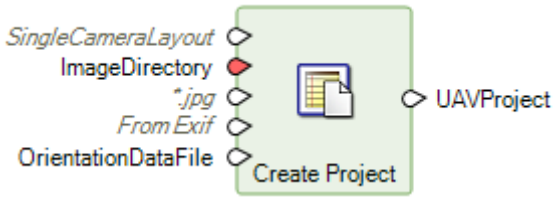
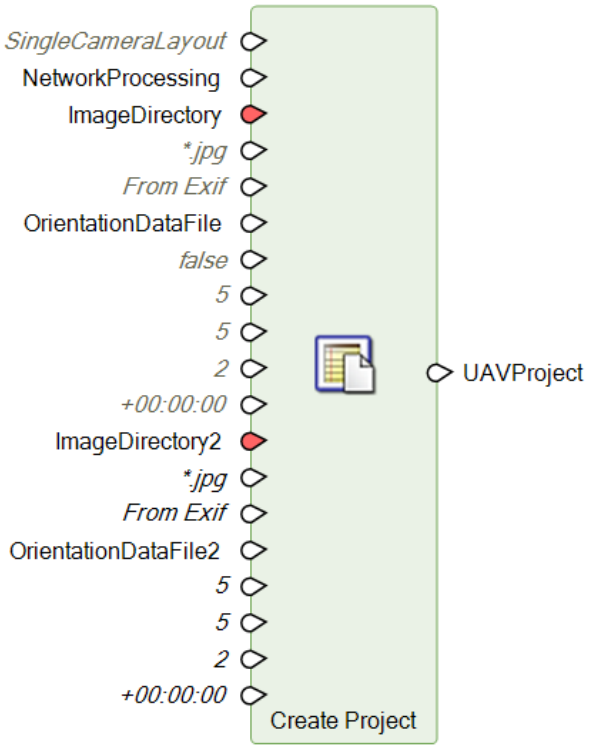
A new GEOSYSTEMS UAV Workflow Layout is added during the installation of the IMAGINE UAV package. It is a simplified toolbar and contains the most important functions needed for the UAV data processing. To apply this layout, click **File > Layout** and select the **GEOSYSTEMS UAV Workflow** layout.



Section 2

Create Project

Category: GEOSYSTEMS UAV

Default ports	All available ports
	

Description

Creates a new UAV project based on the selected image data. Image data can be distributed over several folders, can refer to several cameras or even belong to multispectral bands. The layout how to interpret the provided image data is specified via the port parameter 'CameraLayout'. By default, a single camera (SingleCameraLayout) is assumed.

The following camera layouts are supported:

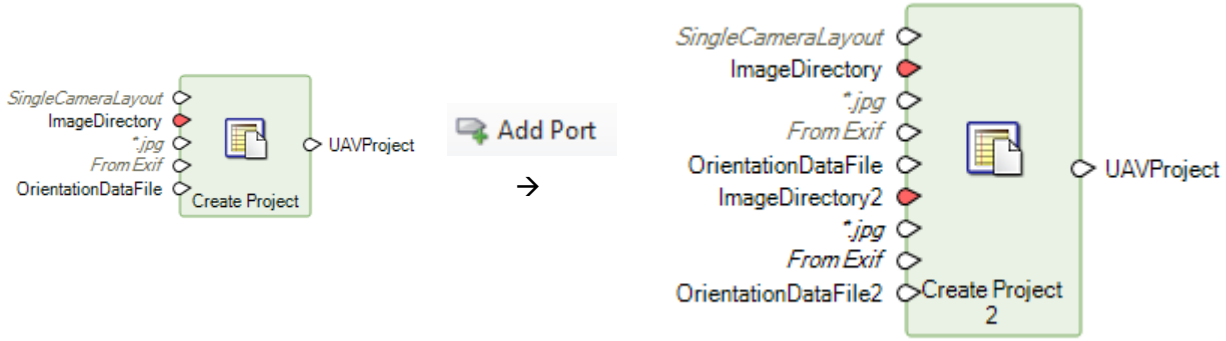
- **SingleCameraLayout**: All images provided are imported, so that they refer to a single camera even when they are stored in several folders. If Metashape automatically determines several cameras from the provided image data (e.g. different sensor sizes) the layout will be kept and turn automatically in a 'MultiCameraLayout'. The number of images, types of orientation formats and orientation data sources can vary for each folder. An example for this camera layout is the usage of one UAS or terrestrial camera recording imagery for one scene or object.
- **MultiCameraLayout**: Imported images from different folders are assigned to separate cameras (one camera per folder). If only one folder is used for importing, by default all images will only be linked to a single camera and the layout will turn automatically in a 'SingleCameraLayout'. The number of images, types of orientation formats and

orientation data sources can vary for each folder. An example for this camera layout would be the usage of several UAS recording imagery for one scene or object and even mixing in terrestrial images for the same scene or object.

- **RigidCameraLayout**: This camera layout is like the MultiCameraLayout specifying one camera per folder but assuming a rigid relative position of the cameras to each other for all recoding positions. An example would be a UAS with several cameras on board recording imagery for one scene or object. For this camera layout the number of images per folder must be identical. It is assumed that the order of images in each folder is identical so that all first images belong to one rigid position, all second images belong to one position, … Types of orientation formats and orientation data sources can vary.
- **MultibandCameraLayout**: With this camera layout multispectral recordings saved in individual image files can be imported und used for 3D reconstruction. Each provided folder will be linked to one band. For this camera layout the number of images per folder must be identical. It is assumed that the order of images in each folder is identical so that all first images belong to one position, all second images belong to one position, … Types of orientation formats and orientation data sources can vary.

To activate the network processing, toggle the visibility of the **NetworkProcessing** port and connect the output of the **Network Processing** operator with it. The parameters specified on the Network Processing operator must refer to a configured and available cluster of processing nodes and master server. Please see section 3 for more details.

To specify more than one folder (and the associated orientation data) use Add Port in the ribbon interface. A block of ports will be added, allowing the specification of all necessary data for the new folder.



Use Remove Port to remove the last group of port respectively.

The following port descriptions hold of all groups of added ports.

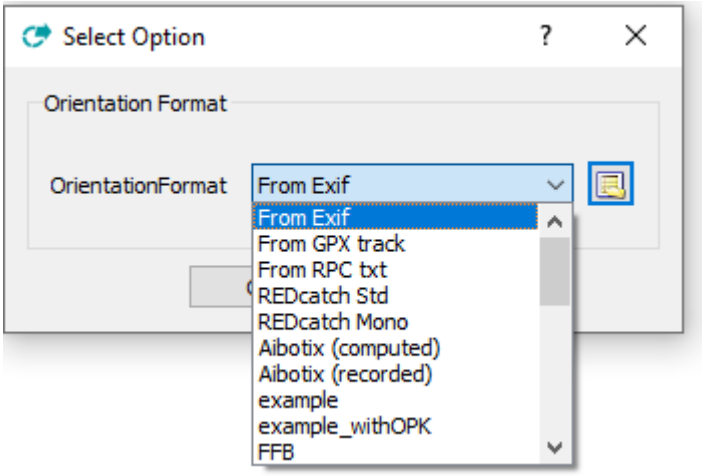
Image files are taken from the provided **directory,** considering the entered **wildcard** pattern. Orientation data can be taken directly from the image data itself (**EXIF** information of Longitude, Latitude and Altitude) or read from any **table**-like text file containing a column with the image file names. The list of supported text file formats for the orientation data can be dynamically extended.

Double click on the port **OrientationFormat** to open a dialog with the available orientation sources or formats. Select **From Exif** to take the orientation information directly from the image data containing Exif

information. In this case, the presence of the **Exif** data is validated for each selected image file. Select **From GPS track** to take the orientation information from a GPX track file.

Select **From RPC txt** to handle RPC based satellite data. This will automatically change the used camera model to a line scanner. Text files (*.txt) with the according RPC parameters are read automatically when in the original location and format.

Any other format in the list refers to custom formats of orientation data. If one of them is selected, the actual text file with the orientation data has to be provided using the port **OrientationDataFile**.



To define a new format for the orientation data stored in a text file, click the **Edit orientation formats** button  .

Orientation Formats

Value	Description
From Exif	Takes the orientation data directly from the image files by extracting the **Exif** information. The presence of the **Exif** data is validated for each selected image file.
From GPS track	Instead of providing the orientation data already linked to each image file, you can also ingest a GPX track file with GPS recordings and relevant time information. It is important that your image data contains a correct time stamp, which is used to interpolate the according GPS information from the track file. See the port **TimeCorrection** to specify the time offset between your image data and the GPS recordings.
From RPC txt	When using RPC based satellite data (line scanners), select this option to load the sensor model data form the accompanying rpc text files.
<custom formats>	Any of customer-defined format of text-based orientation data files.

In order to define your own custom orientation data format, refer to *ERDAS IMAGINE UAV Workflow* "*Step-by-Step guide for the IMAGINE UAV Workflow*" on page 57.

Image pattern

Character	Description
?	Matches any single character, identical to full regular expressions. For example, *DSC_123?.jpg* selects files such as *DSC_1231.jpg*, *DSC_1232.jpg* or *DSC_1233.jpg.*
*	Matches zero or more of any characters, identical to full regular expressions. For example, *DSC_123*.jpg* selects files such as *DSC_123.jpg*, *DSC_1232.jpg* or *DSC_12345.jpg.*
[...]	Sets of characters can be represented in square brackets, similar to full regular expressions. For example, *DSC_123[3-5].jpg* selects only the files *DSC_1233.jpg*, *DSC_1234.jpg* or *DSC_1235.jpg.*

Connections

Name	Objects Supported	Description	Required
ImageDirectory[2,..]	Directory	Directory containing the imagery to be processed.	✔

ImagePattern[2,..]	String	Pattern to use to select images inside the provided **ImageDirectory.** The entered pattern is interpreted as **wildcard** matching pattern to select files. The default value is **.jpg*, which selects all **JPG**-images.	✔
OrientationFormat[2,..]	String/Enumeration	Specifies the source/format to take orientation data from. If not specified, **FromExif** is used. The list of supported orientation data formats can be extended dynamically.	✔
OrientationDataFile[2,..]	File	Text file with orientation data. This file is only required when selecting a custom orientation data format.	
OriDataIncomplete	Boolean	Toggles the handling of images with missing orientation data. If **false** (default value), all images must have orientation data. If **true**, also images with missing orientation data are processed. The minimum number of images that must have orientation data (absolute and relative, with the larger number used) can be specified in the IMAGINE Preferences.	
AccuracyXY[2,..]	Double	Specifies the accuracy of the recorded camera position in X/Y in meters or in Latitude/Longitude in degrees. Leave the default (5 meters) for consumer GPS receivers. If more accurate GPS recordings are available, it is important to set them here, as the geo-location of the final products will benefit substantially.	
AccuracyZ[2,..]	Double	Specifies the accuracy of the height component of the recorded camera position in meters. Leave the default (5 meters) for consumer GPS receivers. If more accurate GPS recordings are available, it is important to set them here, as the geo-location of the final products will benefit substantially.	
AccuracyAngles[2,..]	Double	Specifies the accuracy of the recorded camera rotation angles in degrees. Leave the default (2 degrees) for consumer IMU devices. If your orientation data do not include rotation angles, this value will be ignored.	

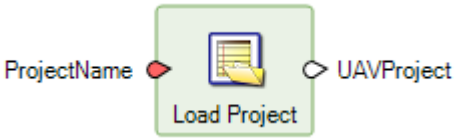
TimeCorrection[2,..]	String/TimeCorrection	In case of an offset between image recording and GPS time, please specify the time difference between image recording and GPS time. How much later or earlier have the images been recorded with respect to the GPS time? This is necessary to determine the correct position data from the provided GPX file. Default: '+00:00:00'.	
UAVProject	UAVProject	The created UAV project that can only be used as input for the subsequent UAV operator **Compute Orientation**. After a successful execution, the file *projectFile_initial.psx* is created in the **ImageDirectory.**	

Syntax

```
CreateProject ( <ImageDirectory> , <ImagePattern>, <OrientationFormat>[,
OrientationDataFile=<OrientationDataFile>][,
OriDataIncomplete=<OriDataIncomplete>] [,AccuracyXY=<AccuracyXY>]
[,AccuracyZ=<AccuracyZ>] [,AccuracyAngles=<AccuracyAngles>]
[,TimeCorrection=<TimeCorrection>] )
```

Load Project

Category: GEOSYSTEMS UAV



Description

Loads an existing UAV project from disk. This operator is only provided for convenience to allow loading of an already processed UAV project. You can use it to reload the result of a specific processing step and then continue without re-processing. The project files to load are located in the directory containing the actual image data. The following (interim) results can be reloaded.

Project Files on Disk

Project File Name	Description
projectFile_initial.psx	Result of the **Create Project Operator**. When selecting this file, you can skip the **Create Project** step. You can use the loaded project directly as input for the **Compute Orientation Operator**.
projectFile_ori.psx	Result of the **Compute Orientation Operator.** When selecting this file, you can skip the **Compute Orientation** step. You can use the loaded project directly as input for the **Compute Surface Operator**.
projectFile.psx	Result of the **Compute Surface Operator**. When selecting this file, you can skip the **Compute Surface** step. You can use the loaded project directly as input for the export operators **Export Mosaic Operator, Export LAS Operator** and **Export DEM Operator**.

Connections

Name	Objects Supported	Description	Required
ProjectName	File	File name of the project to be loaded from disk.	✔
UAVProject	UAVProject	Loaded UAV project which can be used as input for the according subsequent UAV operators (see table above). The process will fail if used as input for any other UAV operator as stated in the table above.	

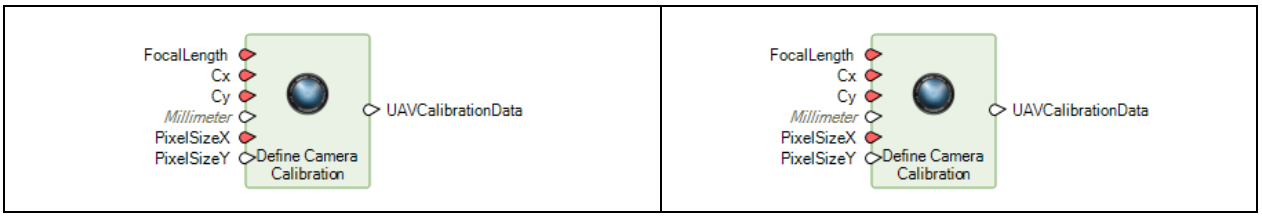
Syntax

```
LoadProject ( <ProjectName> )
```

Define Camera Calibration

Category: GEOSYSTEMS UAV

Default ports	All available ports



Description

Allows the user to define a new camera calibration by specifying the mandatory camera calibration parameters (coordinates of the principal point). Additionally, the sensor pixel size must be provided (specified in millimeter).

Connections

Name	Objects Supported	Description	Required
FocalLength	Double	The focal length (z coordinate of principal point) of the camera in unit specified on port **Unit**.	✔
Cx	Double	X coordinate of principal point of the camera in unit specified on port **Unit**.	✔
Cy	Double	Y coordinate of principal point of the camera in unit specified on port **Unit**.	✔
Unit	String/Enumeration	Unit of the provided principal point coordinates. Either **Millimeter** or **Pixel**	✔
PixelSizeX	Double	The sensor pixel size in millimeter in x. If **PixelSizeY** is not provided, the specified value will be used for x and y.	✔
PixelSizeY	Double	The sensor pixel size in millimeter in y. If not provided, **PixelSizeX** will be used for y as well.	
UAVCalibration Data	UAVCalibrationData	The created UAV camera calibration that can only be used as input for the UAV operator **Set Camera Calibration**.	

Syntax

```
DefineCameraCalibration (<FocalLength>, < Cx>, < Cy>,
< Unit> , < PixelSizeX> [, PixelSizeY =<PixelSizeY>])
```

Import Camera Calibration

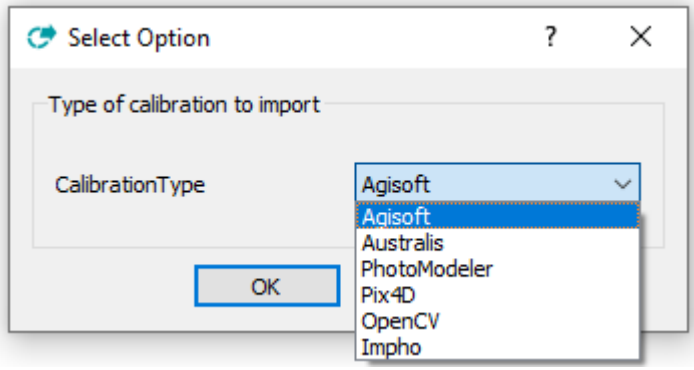
Category: GEOSYSTEMS UAV

Default ports	All available ports
	

Description

Allows the user to import an existing camera calibration from file for a number of different camera calibration formats. Additionally, the sensor pixel size must be provided (specified in millimeter).

CalibrationFormat Parameter



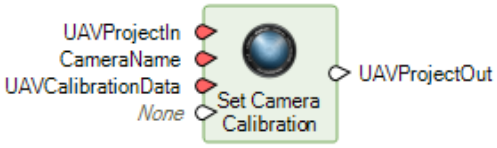
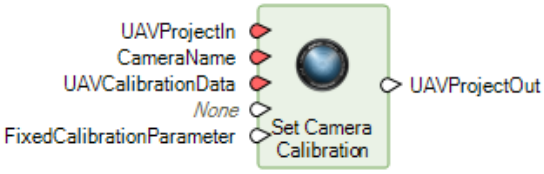
Value	Description
Agisoft	Agisoft Camera Calibration (*.xml)
Australis	Australis Camera Parameters (*.txt)
PhotoModeler	PhotoModeler Camera Calibration (*.ini)
Pix4D	Pix4D Camera Calibration (*.cam)
OpenCV	OpenCV Camera Calibration (*.xml)
Inpho	Inpho Camera Calibration (*.txt)

Connections

Name	Objects Supported	Description	Required
CalibrationType	String/Enumeration	The format of the CalibrationDataFile.	✔
CalibrationDataFile	File	The file containing the camera calibration data in the format specified under **CalibrationType**.	✔
PixelSizeX	Double	The sensor pixel size in millimeter in x. If **PixelSizeY** is not provided, the specified value will be used for x and y.	✔
PixelSizeY	Double	The sensor pixel size in millimeter in y. If not provided, **PixelSizeX** will be used for y as well.	
UAVCalibrationData	UAVCalibrationData	The created UAV camera calibration that can only be used as input for the UAV operator **Set Camera Calibration**.	

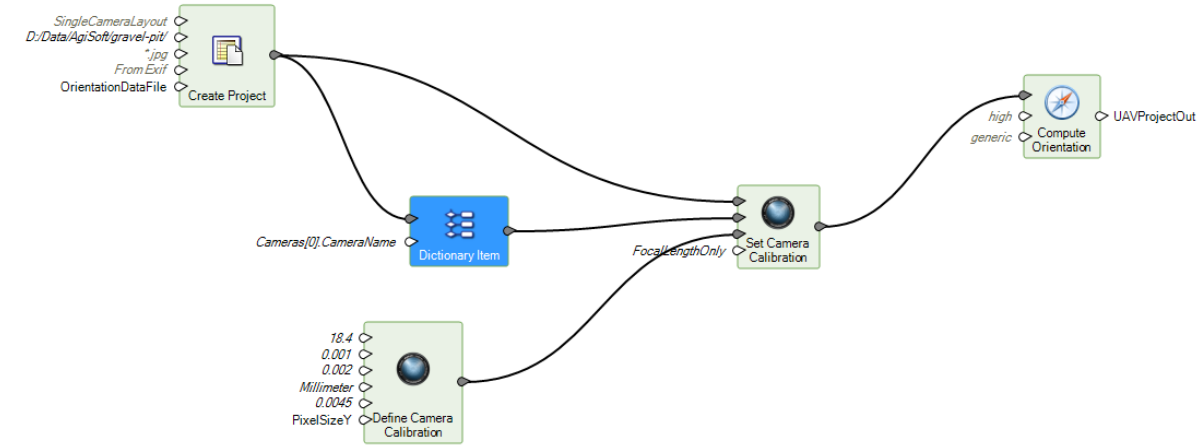
Set Camera Calibration

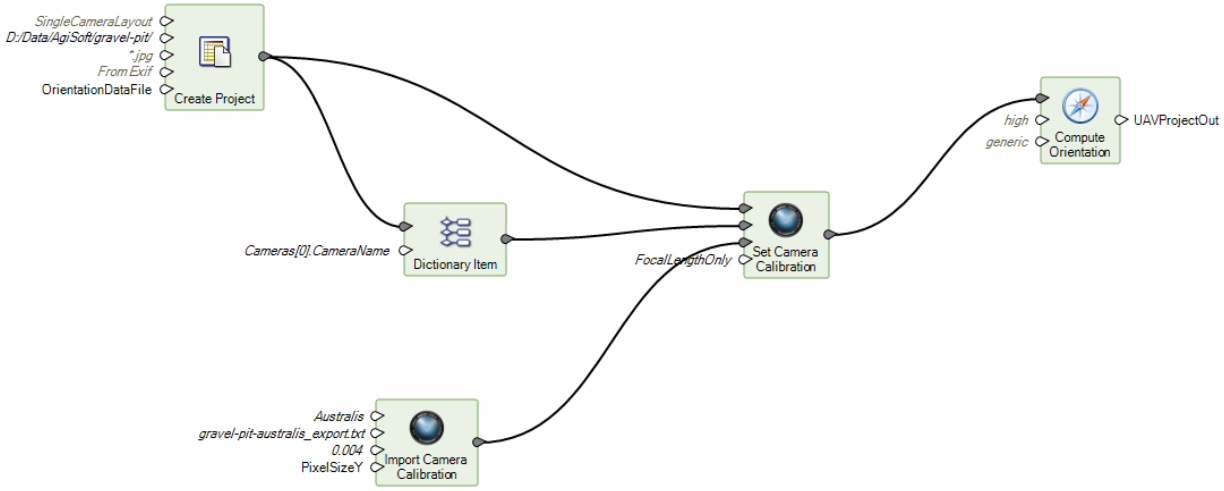
Category: GEOSYSTEMS UAV

Default ports	All available ports
	

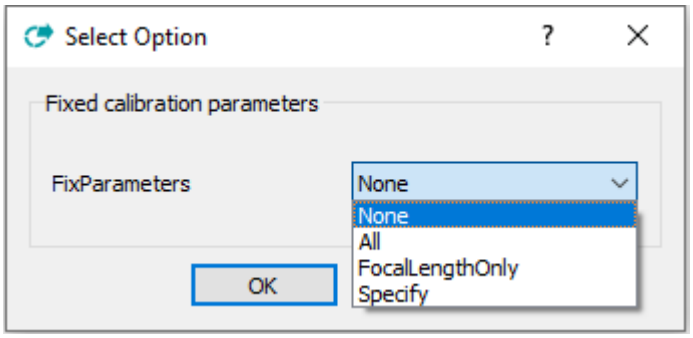
Description

With this operator the user can set/modify the camera calibration data for any of the existing cameras of the provided project. The cameras are selected by their names. Users can use the **Dictionary Item** operator to determine the desired camera name. UAVCalibrationData can be created using the operators **Define Camera Calibration** or **Import Camera Calibration**. With the port **FixParameters** the user can change the usage of the calibration data during the alignment process. For more details see the description of the possible parameter values.





FixParameters



Value	Description
None	By selecting **None**, the provided camera calibration is only considered as pre-calibrated. The parameters will be modified during the alignment process.
All	By selecting **All**, Metashape will not modify any of the provided calibration parameters during alignment. This option allows the user to introduce already calibrated cameras.
FocalLengthOnly	By selecting **FocalLengthOnly**, Metashape will only exclude the focal length from being modified during the alignment process. All other calibration parameters will be modified. This is useful when the actual focal length is known but the camera itself is not calibrated. This will help the alignment process to derive more meaningful calibration parameters.
Specify	With the option **Specify**, a user can select very detailed which of the calibration parameter should be kept constant. The actual parameters are specified via **FixedCalibrationParameter**

Connections

Name	Objects Supported	Description	Required
UAVProjectName	UAVProject	An UAV Project that has been created using the **Create Project Operator** or loaded from disk using the **Load Project Operator**.	✔
CameraName	String	The name of the camera for which the calibration is set. The provided project must contain the camera under the same name. To set calibration data to several different cameras within a project, chain the **Set Camera Calibration** operator and select each camera individually by name.	✔
UAVCalibrationData	UAVCalibrationData	The sensor pixel size in millimeter in x. If **PixelSizeY** is not provided, the specified value will be used for x and y.	✔

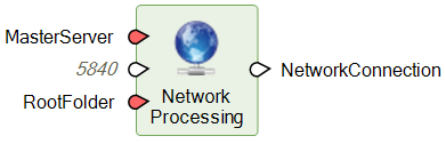
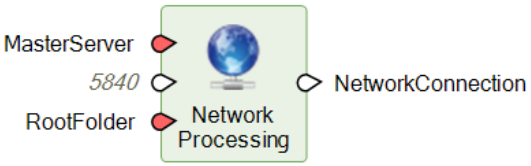
FixParameters	String/Enumeration	The parameter specifying how the treat the camera calibration parameters during the alignment process.	✔
FixedCalibrationParameter	String	Optional port to select very detailed which calibration parameters to keep constant during the alignment process. Possible values are: F, Cx, Cy, B1, B2, K1, K2, K3, K4, P1, P2. Provide several values as comma separated list. The names of the parameter are case sensitive! The value of this port is only considered when **FixParameters=Specify**	
UAVProjectOut	UAVProject	The modified **UAV** project, which can now be used as input for the subsequent **UAV** operator **Compute Orientation.** After a successful execution, the file *projectFile_initial.psx* is re-created in the **ImageDirectory.**	

Syntax

```
SetCameraCalibration (<UAVProjectName>, <CameraName>, <UAVCalibrationData>,
<FixParameters> [, FixedCalibrationParameter=< FixedCalibrationParameter>])
```

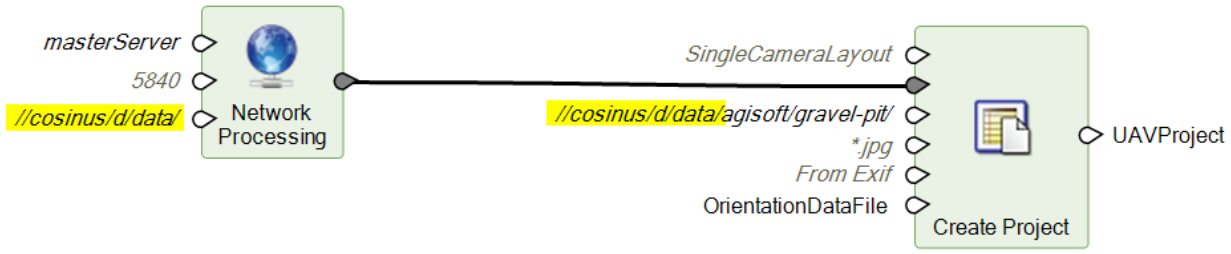
Network Processing

Category: GEOSYSTEMS UAV

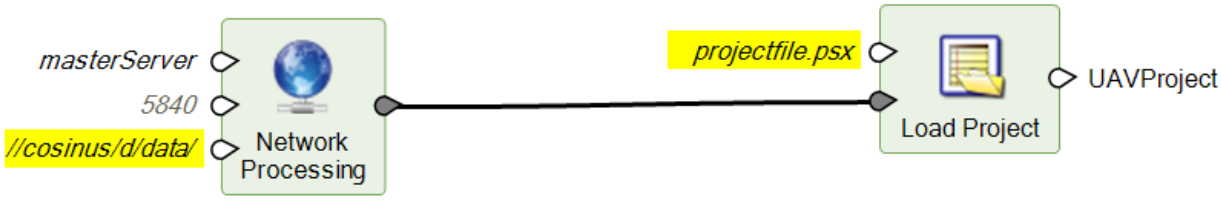
Default ports	All available ports
	

Description

This **optional** operator enables the network processing for the model it is used in. Simply add the operator to the model, set the 3 port values and connect it to either **Create Project** or **Load Project**. All tasks of the model will be distributed of the configured cluster. It is important that the selected **Input Folder** of the **Create Project** operator or **Project Name** of the **Load Project** operator are located in a subfolder of the specified **RootFolder**. For a detailed description please see section 3.



or



.

Connections

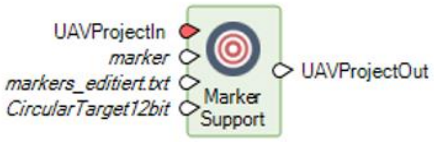
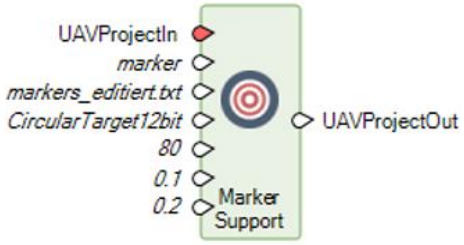
Name	Objects Supported	Description	Required
MasterServer	String	The configured master server of the processing cluster. The computer must be available in the same network from the local client and all processing nodes.	✔
MasterServerPort	Integer	The port on which the master server of the processing cluster is listening. The port on the remote server must be reachable from the local client and all processing nodes.	✔
RootFolder	Directory	A base folder accessible from the client and all processing nodes. Raw input files and the created project files can be located in further subfolders. Important is write access of all processing nodes, at least for the actual project subfolder.	✔
NetworkConnection	NetworkConnectionData	The network connection data to be used with Create Project and Load Project operator.	

Syntax

```
NetworkProcessing (<MasterServer>, <MasterServerPort>, < RootFolder>)
```

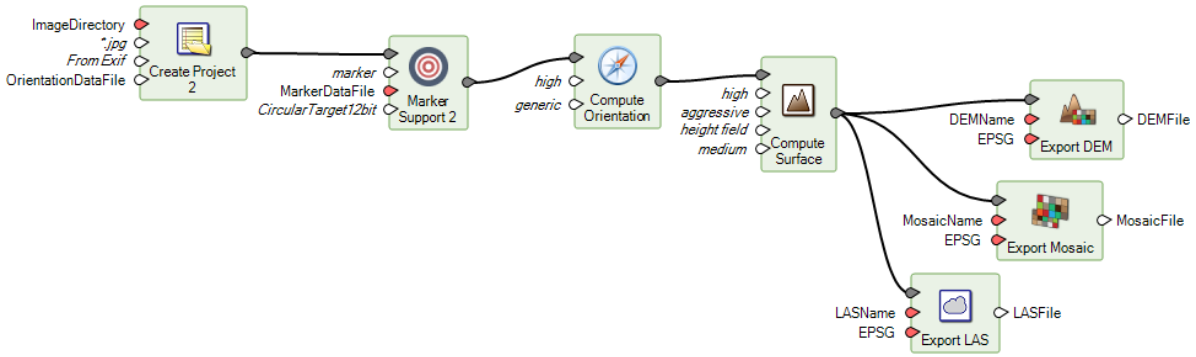
Marker Support

Category: GEOSYSTEMS UAV

Default ports	All available ports
	

Description

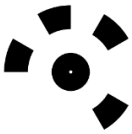
This **optional** operator adds the possibility to use markers in order to introduce ground control information in your project. This information will be used to improve the overall positions of your images (e.g. if you do not use precise GPS-information). Please place the **Marker Support** Operator before the **Compute Orientation** operator. As a reference, consider the following example:



In order to use this additional marker information within your project, you need to print and to place coded targets (CTs) on the ground before acquiring the images. Each CT has a ring parted in black and white segments around the central full circle that will be recognized by the program automatically. For each CT you need to define a geo-coordinate that will be used as reference coordinate within your image block. Thus, for every single CT the geo-position (X, Y, Z) must be acquired e.g. by classic surveying or high precision GNSS beforehand and listed in a text file.

Later, in IMAGINE UAV, an orientation data format for the marker orientation file has to be created. It is the same dialog as used to define the file format for the orientation data file and thus, done in the same way. For more information, please refer to the *Step-by-Step guide for the IMAGINE UAV Workflow* starting on page 73.

Connections

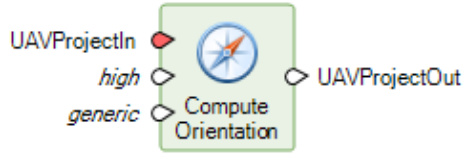
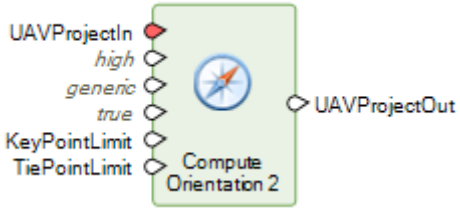
Name	Objects Supported	Description	Required
UAVProjectName	UAVProject	An UAV Project that has been created using the **Create Project Operator** or loaded from disk using the **Load Project Operator**.	✔
MarkerFileFormat	String/Enumeration	Specifies the source/format to take marker data from. The list of supported marker file formats can be extended dynamically.	✔
MarkerDataFile	String/Enumeration	Text file with marker data. The file format is specified by the MarkerFileFormat.	✔
MarkerTargetType	String/Enumeration	Specifies the pattern used to identify the CTs. Here is one example of a CT: 	✔
DetectorTolerance	Double	Specifies the tolerance used to detect the CTs in your images. Try to increase this value if the markers are not well detected.	
AccuracyXY	Double	Specifies the accuracy of the marker reference coordinates in X/Y in meters or in Latitude/Longitude in degrees.	
AccuracyZ	Double	Specifies the accuracy of the height component of the marker position in meters.	

Syntax

```
MarkerSupport (<UAVProjectIn>, < MarkerFileFormat>, < MarkerDataFile>,
< MarkerTargetType> [, DetectorTolerance=<DetectorTolerance>] [,
AccuracyXY=<AccuracyXY>] [, AccuracyZ=<AccuracyZ>])
```

Compute Orientation

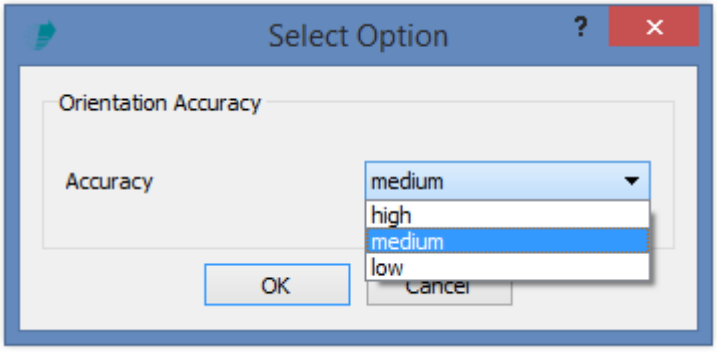
Category: GEOSYSTEMS UAV

Default ports	All available ports
	

Description

Computes the orientation of all images referenced in the **UAVProjectIn**. The computed orientation is an absolute orientation. The parameter **Accuracy** influences the quality of the computed orientation. A higher value results in a more precise determination of the camera positions, whereas a lower value produces a less precise result in a shorter period. The parameter **Preselection** determines how overlapping image pairs are found, which has a significant influence on the computation time, especially for large sets of image data.

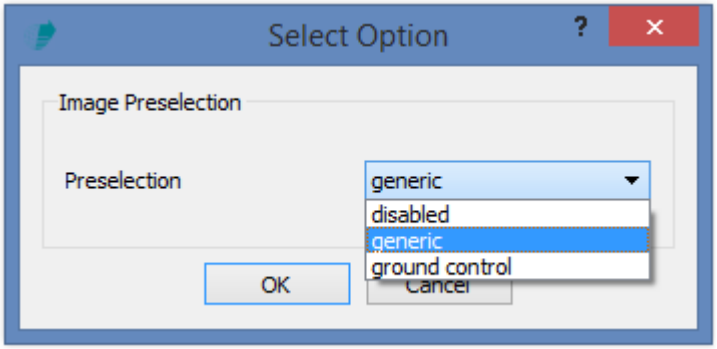
Accuracy Parameter



Value	Description
Low	Creates less precise camera positions but results are produced in a much shorter computation time.
Medium	Presents a balance between precise camera positions and computation time.

High	Creates very precise camera positions but takes longer time for computation. If nothing is selected, this value is default.

Preselection Parameter



Value	Description
Disabled	No preselection is executed. All possible image pair combinations are computed, resulting in a longer computation time.
Generic	The preselection is based on image correlation in lower resolution images. For large image datasets this can still consume a significant amount of time as all combinations of image pairs are being evaluated.
Ground Control	If ground control information (initial camera orientation data) were specified during project creation, this information is used to reduce the number of image pairs that are evaluated, thereby improving the computation time.

Connections

Name	Objects Supported	Description	Required
UAVProjectIn	UAVProject	An UAV Project that has been created using the **Create Project Operator** or loaded from disk using the **Load Project Operator**.	✔
Accuracy	String/Enumeration	Parameter influencing the accuracy of the computed orientation. Must be one of the values from the corresponding table above. If not provided, the default value **high** is used.	

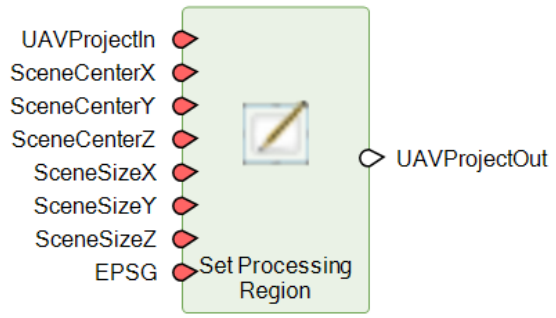
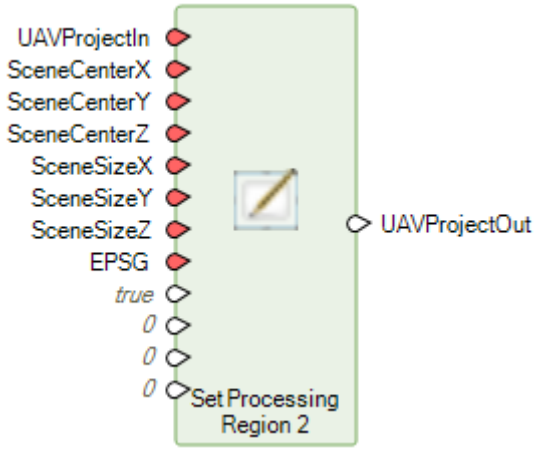
Preselection	String/Enumeration	Parameter determining how overlapping image pairs are selected. Must be one of the values from the corresponding table above. If not provided, the default value **generic** is used.	
optimizeCameras	Boolean	Toggles the usage of the initial camera position data for the estimation process of the internal and external camera orientation parameters. By default, this flag is active.	
KeyPointLimit	Integer	Specify a custom number of key points to be considered when computing the orientation. The default is 40000. Higher numbers of key points allow the processing of e.g. free-standing objects in terrestrial recording situations.	
TiePointLimit	Integer	Specify a custom number of tie points to be considered when computing the orientation. The default is 10000. Higher numbers of tie points allow the processing of e.g. free-standing objects in terrestrial recording situations.	
UAVProjectOut	UAVProject	The **UAV** project, which can only be used as input for the subsequent **UAV** operator **Compute Surface.** After a successful execution, the file *projectFile_ori.psx* is created in the **ImageDirectory.**	

Syntax

```
ComputeOrientation ( <UAVProjectIn> [, Accuracy=<Accuracy> ][,
Preselection=<Preselection>][, optimizeCameras=<optimizeCameras>][,
KeyPointLimit=<KeyPointLimit>])[, TiePointLimit=<TiePointLimit>]))
```

Set Processing Region

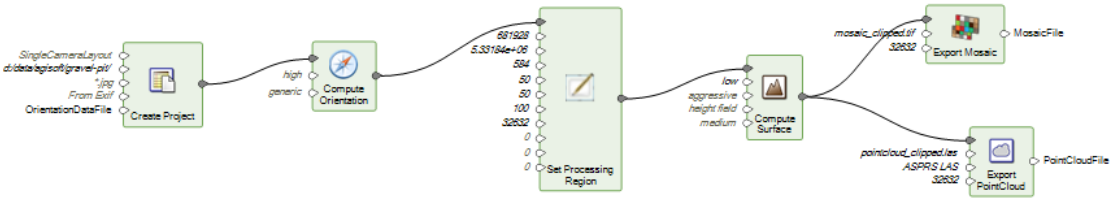
Category: GEOSYSTEMS UAV

Default ports	All available ports
	

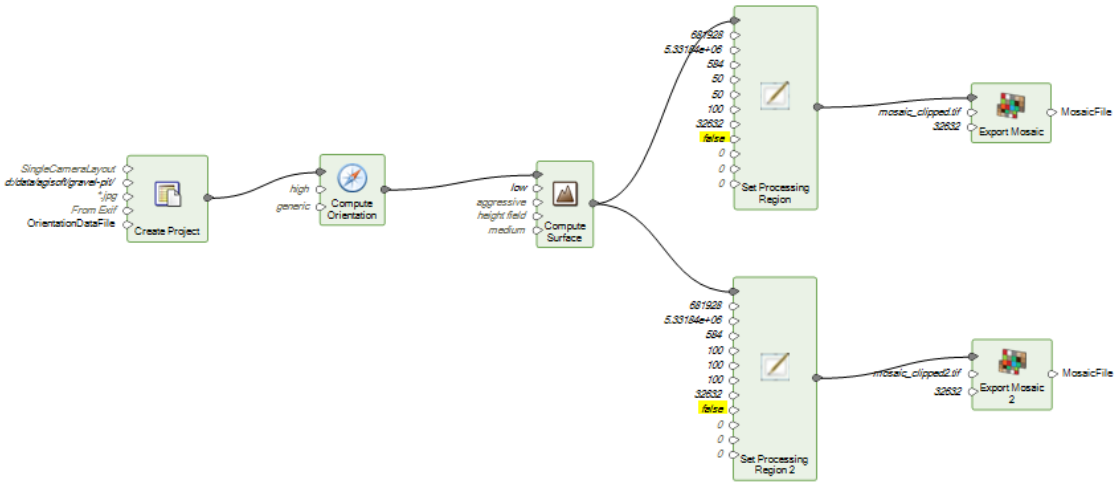
Description

This **optional** operator allows to change the used processing region. By default, Agisoft Metashape computes a bounding region after the computation of the orientation has finished. With this operator the user can change the region freely. The operator can be used for two different purposes.

1. To restrict the area considered for the computation of the actual surface and all subsequent operations (any export).



2. To export certain / several areas of the full dataset.



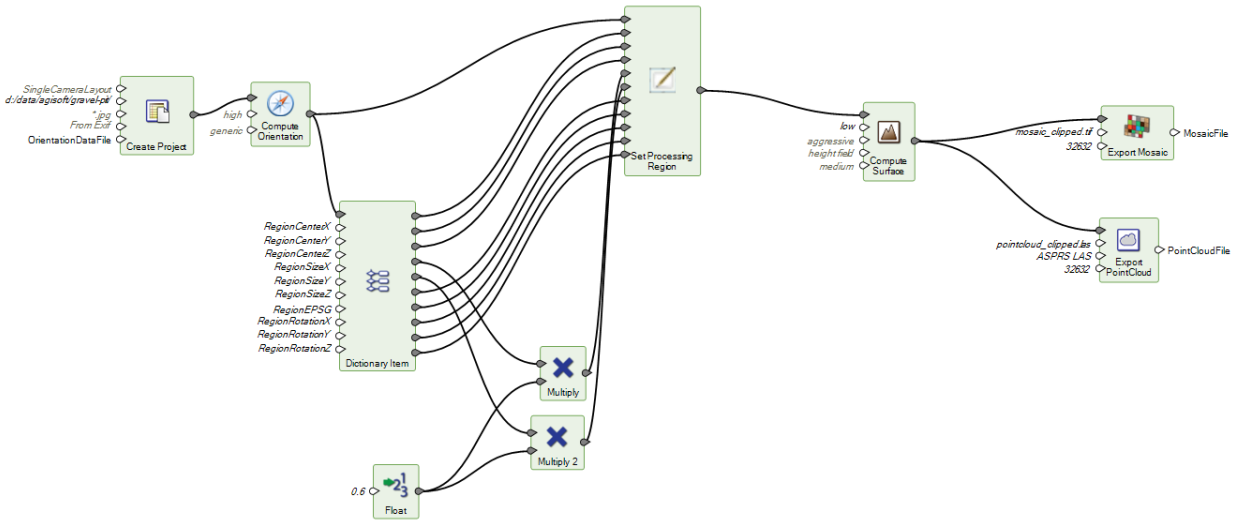
A region is defined by a center point (**SceneCenterX, SceneCenterY, SceneCenterZ**), a size vector (**SceneSizeX, SceneSizeY, SceneSizeZ**) and three rotation angles around the axes (**Omega, Phi, Kappa**). The coordinate system, the center point coordinates are referring to, is specified on the port **EPSG**. The EPSG code does not have to match the EPSG code of the project or the orientation data.

The size vector defines the dimension of the region in all three axis of the used coordinate system in the according units. (e.g. when using a UTM coordinate system, unit of the size vector values is meters, when using geographic coordinates, unit of the size vector values is degrees). Optionally, three rotation angles around the axes can be specified. By default, no rotation is applied (angles = 0).

$$Region = (SceneCenter \pm Size * 0.5) * RotationMatrix(Omega,Phi,Kappa)$$

Depending on the use case 1) or 2), the parameter **optimizeCameras** should be set to true (default) or false. Setting the parameter to true will invalidate any computed surface and exports of any kind cannot be executed. Therefore, the parameter must be set to false when using the operator in use case 2).

To extract the currently used region of a project, the **Dictionary Item** operator can be used. It allows to access several parameters of the project, including the scene center, scene size and rotation values. The following example reads the automatically computed region, reduces the size in x and y to 60% and sets that new region before computing the surface.



Connections

Name	Objects Supported	Description	Required
UAVProjectName	UAVProject	An UAV Project that has been processed by **Compute Orientation Operator** or **Compute Surface Operator**. Any other location in the processing chain is not supported.	✔
SceneCenterX/Y/Z	Double	The coordinates of the scene center of the region to be defined. Coordinates refer to the coordinate system defined by **EPSG**.	✔
SceneSizeX/Y/Z	Double	The dimension of the region to be defined. The units of the specified values are defined by the coordinate system defined by **EPSG**.	✔
EPSG	Integer	The EPSG code the scene center coordinates refer to and the size values are specified in. The EPSG code doesn't have to match the EPSG code of the project or the orientation data.	✔

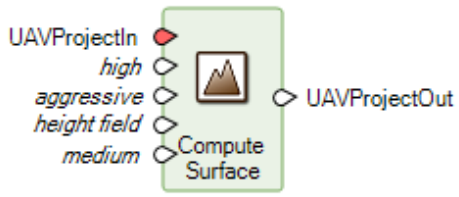
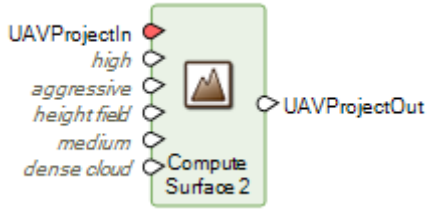
Omega/Phi/Kappa	Double	Specifies the tolerance used to detect the CTs in your images. Try to increase this value if the markers are not well detected.	
UAVProjectOut	UAVProject	The **UAV** project, which can only be used as input for the subsequent **UAV** operator **Compute Surface** or any of the export operators.	UAVProjectOut

Syntax

```
SetProcessingRegion (<UAVProjectIn> , <SceneCenterX>, <SceneCenterY>,,
<SceneCenterY>, <SceneSizeX>, <SceneSizeY>, <SceneCenterZ>,<EPSG>[,
optimizeCameras=<optimizeCameras>] [, Omega=<Omega>] [, Phi=<Phi>][,
Kappa=<Kappa>])
```

Compute Surface

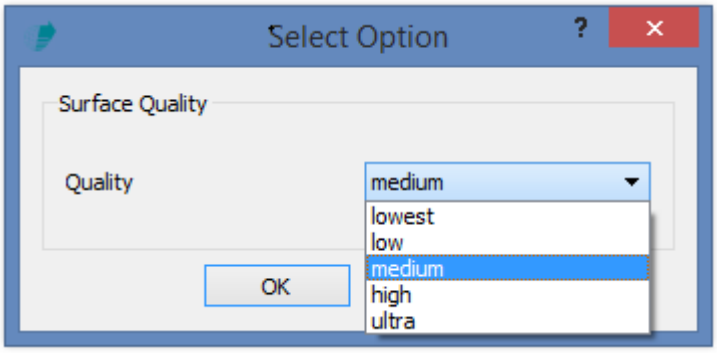
Category: GEOSYSTEMS UAV

Default ports	All available ports
	

Description

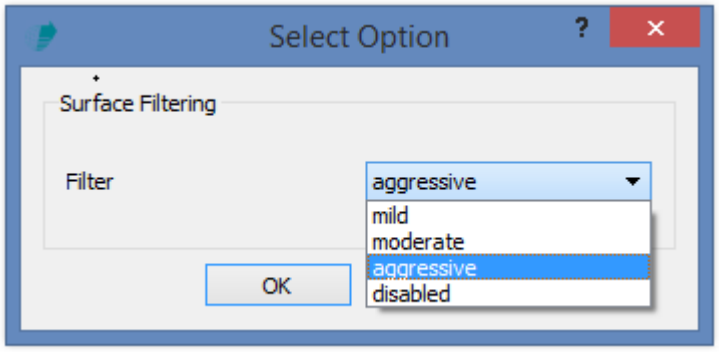
Computes the actual point cloud and surface based on the orientation, which has been set up by the **Compute Orientation Operator**. There are several parameters influencing quality and computation time. The parameter **Quality** influences the level of detail of the reconstruction. A higher value results in a more detailed reconstruction but can take a very long time to produce results. A lower value produces a coarser reconstruction but computation time is much shorter. The parameter **Filter** determines how the point cloud is being filtered. The point cloud can be filtered either aggressively, to yield a smooth surface or not at all, to keep all computed points. Use the parameter **Mode** to select the type of surface to be computed. In most cases this parameter can remain at default value. The parameter **FaceCount** determines how many polygons are used when meshing the computed point cloud.

Quality Parameter



Value	Description
Lowest, Low, Medium	Creates less detailed point clouds and computation time is relatively short. Should be used only to get a quick impression of the surface.
High	Creates a detailed reconstruction of the surface. Unless changed this value is default.
Ultra	Creates a very detailed reconstruction of the surface but increases the chance of outliers. Additionally, the computation time is significantly longer than using **high.**

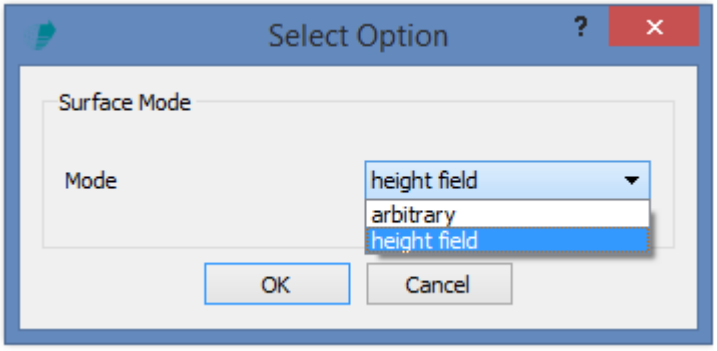
Filter Parameter



Value	Description
Mild, Moderate	Filters the point cloud to remove outliers but keeps detailed features.

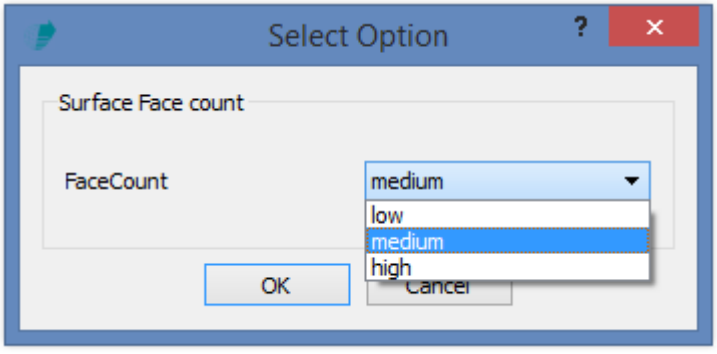
Aggressive	Filters the point cloud aggressively to yield a smoother surface, removing possible outliers and very small features. If nothing gets selected, this value is default.
Disabled	Does not filter the point cloud at all; thus keeps all computed points.

Mode Parameter



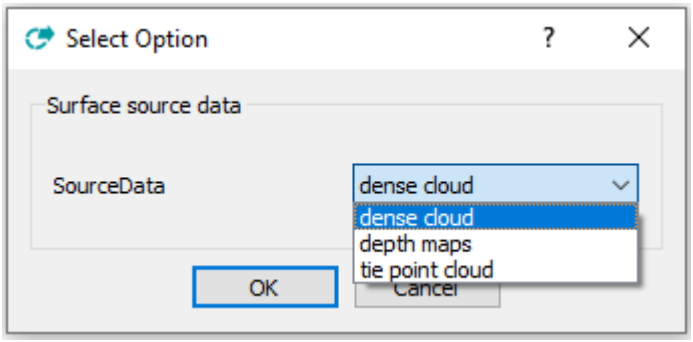
Value	**Description**
Arbitrary	Can be used to model any type of surface. Typically, this value only has to be selected, if objects like buildings or statues are being reconstructed.
Height Field	Used to model planar surfaces and is suitable for most of the **UAV** workflows. If nothing is selected, this value is default.

Face Count Parameter



Value	Description
Low	Creates a smaller number of polygons or faces but computation time is shorter.
Medium	Presents a balance between low and high. If nothing is selected, this value is default.
High	Creates a large number of polygons or faces to mesh the point cloud but takes longer for computation.

Source Data Parameter



Value	Description
dense cloud	Uses the computed dense cloud as the source for the model building, this value is the default and should be used in most cases.
depth maps	Use the computed depth maps instead.
tie point cloud	Use the computed point cloud of the tie point instead.

Connections

Name	Objects Supported	Description	Required
UAVProject	UAVProject	An **UAV** Project that has been created using the **Compute Orientation Operator** or loaded from disk using the **Load Project Operator**.	✔

Quality	String/Enumeration	Parameter influencing the quality or details of the reconstruction of the surface. Must be one of the values from the corresponding table above. If not provided, the default value **high** is used.	
Filter	String/Enumeration	Parameter determining how to filter the computed point cloud to remove possible outliers and to create a smooth surface. Must be one of the values from the corresponding table above. If not provided, the default value **aggressive** is used.	
Mode	String/Enumeration	Parameter selecting the type of surface to reconstruct. Must be one of the values from the corresponding table above. If not provided, the default value **height field** is used.	
FaceCount	String/Enumeration	Parameter determining the number of polygons/faces to be used when meshing the surface. Must be one of the values from the corresponding table above. If not provided, the default value **medium** is used.	
SourceData	String/Enumeration	Parameter determining the source data for the model (**triangulated irregular network,TIN)** If not provided, the default value **dense cloud** is used.	
UAVProjectOut	UAVProject	The **UAV** project that can only be used as input for the subsequent export operators **Export Mosaic Operator, Export LAS Operator** and **Export DEM Operator**. After a successful execution, the file *projectFile.psx* is created in the **ImageDirectory**.	

Syntax

```
ComputeSurface ( <UAVProjectIn> [, Quality=<Quality> ][, Filter=<Filter>]
[, Mode=<Mode> ] [, FaceCount=<FaceCount> ] [, SourceData=<SourceData> ])
```

Export LAS

Category: GEOSYSTEMS UAV

Description

Exports the computed point cloud as **LAS** file with RGB encoding. If the point cloud was reconstructed from image data with known camera positions and the parameter **EPSG** is provided, the **LAS** point cloud is re-projected to the specified coordinate system. Otherwise local planar coordinates are used.

See *HexGeoWiki EPSG Coordinate Systems* (*https://wiki.hexagongeospatial.com//index.php?title=EPSG_Coordinate_Systems*).

Connections

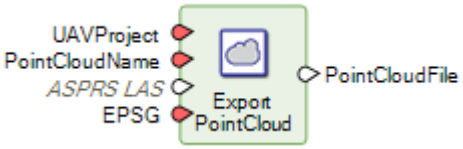
Name	Objects Supported	Description	Required
UAVProject	UAVProject	An **UAV Project** that has been created using the **Compute Surface Operator** or loaded from disk using the **Load Project Operator.**	✔
LASName	File	File name of the **LAS** file to be created.	✔
EPSG	Integer	If the point cloud was reconstructed from image data with known camera positions, use this parameter to assign the projection and to re-project the result into the desired coordinate system. Set value to 0 to skip exporting with projection information.	✔
LASFile	File	Created **LAS** file on disk.	

Syntax

```
ExportLAS ( <UAVProject> , <LASName> [, EPSG=<EPSG>] )
```

Export PointCloud

Category: GEOSYSTEMS UAV

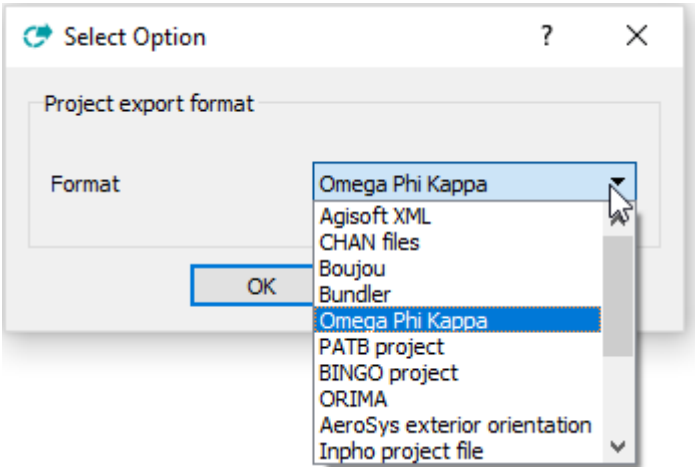


Description

Exports the computed point cloud to several point cloud formats such as **Wavefront OBJ format, Stanfort PLY format, XYZ point cloud format, ASPRS LAS file, LAZ format, U3D format, Adobe PDF format, ASTM E57 format, Agisoft OC3 format, Potree format,Topcon CL3 format, Cesium 3D tiles format, ASCII PTS format, Autodesk DXF format.** If the point cloud was reconstructed from image data with known camera positions and the parameter **EPSG** is provided, the point cloud is re-projected to the specified coordinate system. Otherwise local planar coordinates are used.

See *HexGeoWiki EPSG Coordinate Systems* (*https://wiki.hexagongeospatial.com//index.php?title=EPSG_Coordinate_Systems*).

Export Format Parameter



Connections

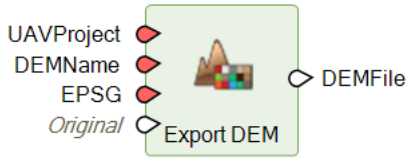
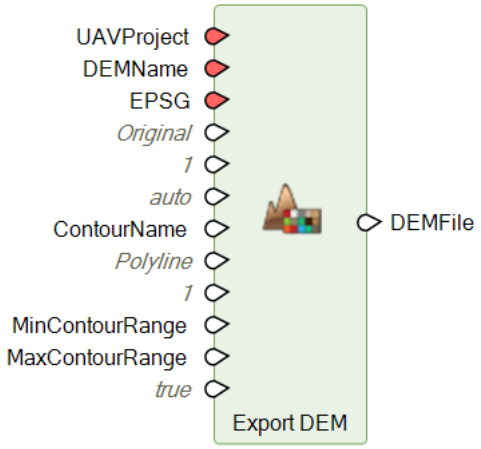
Name	Objects Supported	Description	Required
UAVProject	UAVProject	An **UAV Project** that has been created using the **Compute Surface Operator** or loaded from disk using the **Load Project Operator.**	✔
PointCloudName	File	File name of the point cloud file to be created.	✔
Format	String/Enumeration	The selected format to export the point cloud to.	✔
EPSG	Integer	If the point cloud was reconstructed from image data with known camera positions, use this parameter to assign the projection and to re-project the result into the desired coordinate system. Set value to 0 to skip exporting with projection information.	✔
PointCloudFile	File	Created **LAS** file on disk.	

Syntax

```
ExportPointCloud ( <UAVProject> , <PointCloudName>, <Format> , <EPSG>)
```

Export DEM

Category: GEOSYSTEMS UAV

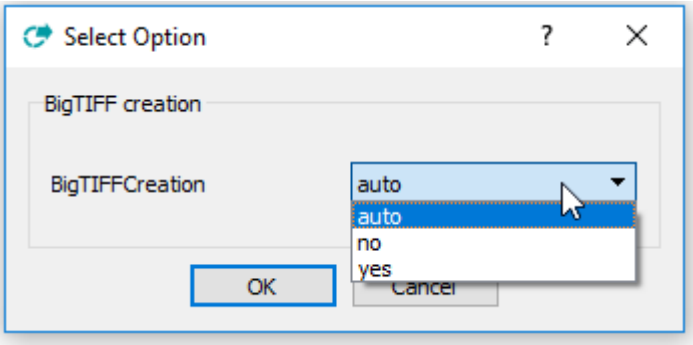
Default ports	All available ports
	

Description

Exports the computed surface as digital elevation model. The export supports the image file formats **JPEG2000** and **TIF**. When exporting to **JPEG2000,** the bit depth of the data is converted to unsigned 8 bit. Exporting to **TIF** keeps the original bit depth of 32, producing **float** data type. For **TIF** images, pyramid files are computed automatically. If the surface was reconstructed from image data with known camera positions and the parameter **EPSG** is provided, the **DEM** file is re-projected to the specified coordinate system. Otherwise local planar coordinates are used. Using the **BigTIFFCreation** parameter allows you to determine whether TIFF files should be written as BigTIFF or not. When a **ContourName** is provided, the contour lines are computed and saved to the specified file, considering the computation options. By default, the ground sampling distance (spatial resolution) of the original data is used for the export. Select **Specify** as the **ResolutionType** to enter a custom resolution for the export.

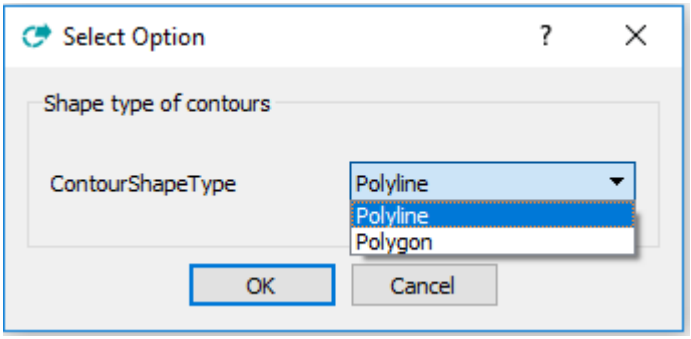
See *HexGeoWiki EPSG Coordinate Systems* (*https://wiki.hexagongeospatial.com//index.php?title=EPSG_Coordinate_Systems*).

BigTIFF Creation Parameter



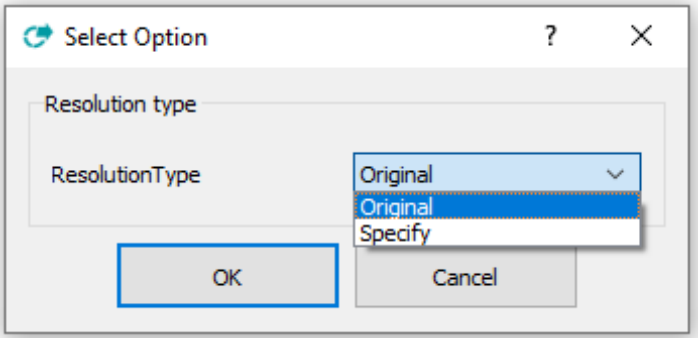
Value	Description
auto	IMAGINE UAV determines based on the image dimension if it is necessary to use BigTIFF.
no	Created TIFF files are never written as BigTIFF.
yes	Created TIFF files are always written as BigTIFF.

ContourType Parameter



Value	Description
Polyline	The contour lines will be saved as Polyines.
Polygon	The contour lines will be saved as Polygon.

Resolution Type Parameter



Connections

Name	Objects Supported	Description	Required
UAVProject	UAVProject	An UAV Project that has been created using the **Compute Surface Operator** or loaded from disk using the **Load Project Operator**.	✔
DEMName	File	File name of the **DEM** file to be created. Supports the export of the formats **TIF** and **JPEG2000**.	✔
EPSG	Integer	If the surface was reconstructed from image data with known camera positions, use this parameter to assign the projection and to re-project the result into the desired coordinate system. Set value to 0 to skip exporting with projection information.	✔
ResolutionType	String/Enumeration	Specify how to determine the spatial resolution (ground sampling distance) for the exported DEM. Selecting **Original** will use the ground sampling distance automatically derived from the input data. When selecting **Specify**, enter a custom resolution on port **Resolution**. Default is **Original**	✔
Resolution	Double	Enter the custom resolution for the DEM export. Only considered when **ResolutionType Specify** has been selected. The unit of the entered resolution is always meters, regardless of the used projection.	
BigTIFFCreation	String/Enumeration	Specify how to handle TIFF format export.	
ContourName	File	File name of the contour line file to be created. Only Shape format is supported.	

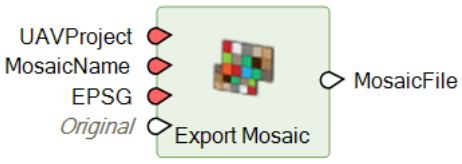
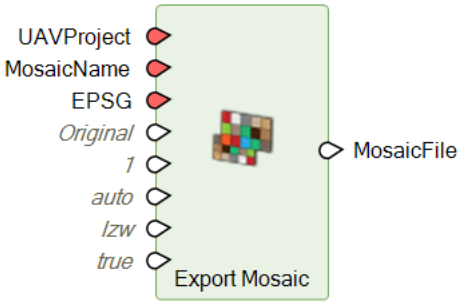
ContourShapeType	String/Enumeration	Specifies the type of vector feature to us when exporting the contour lines. Default is 'Polyline'	
ContourInterval	Double	Specifies the distance between to contour lines in unit of DSM (typically meters). Default values is 1.	
MinContourRange	Double	Specifies the lower range of contour lines to include. Lines with a smaller height value will be excluded. If not provided no lower range is applied.	
MaxContourRange	Double	Specifies the upper range of contour lines to include. Lines with a higher height value will be excluded. If not provided no upper range is applied.	
SaveProject	Bool	With this flag set to True, the DEM data will be stored in the project file as well. When set to False, only the exported DEM file is being stored. The default is **True**.	
DEMFile	File	Created **DEM** file on disk.	

Syntax

```
ExportDEM ( <UAVProject> , <DEMName> , <EPSG> ,<ResolutionType> [,
BigTIFFCreation=< BigTIFFCreation>][, ContourName=<ContourName>][,
ContourShapeType=< ContourShapeType>][, ContourInterval=<
ContourInterval>][, MinContourRange=< MinContourRange>][, MaxContourRange=<
MaxContourRange>][,SaveProject=<SaveProject>][, Resolution=<Resolution>])
```

Export Mosaic

Category: GEOSYSTEMS UAV

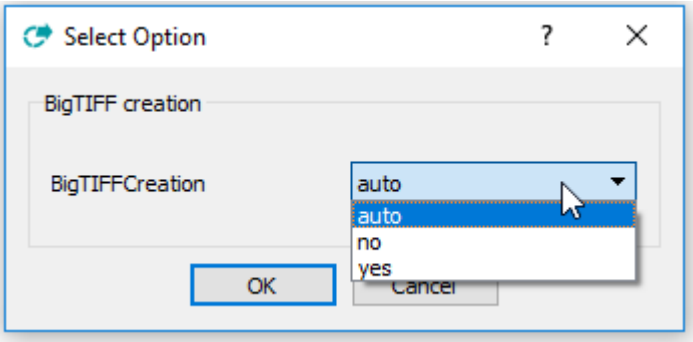
Default ports	All available ports
	

Description

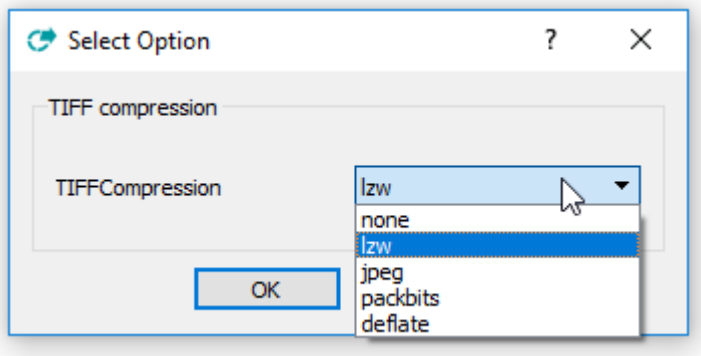
Exports the computed surface as digital ortho mosaic. The export supports the image file formats **ECW, JPEG2000, IMG** and **TIF**. When exporting to **ECW** only the 3 RGB bands are kept. Exporting to **TIF** and **JPEG2000** also preserves the mask band. For **TIF** images, pyramid files are computed automatically. If the surface was reconstructed from image data with known camera positions and the parameter **EPSG** is provided, the mosaic file is re-projected to the specified coordinate system. Otherwise, local planar coordinates are used. By default, the ground sampling distance (spatial resolution) of the original data is used for the export. Select **Specify** as the **ResolutionType** to enter a custom resolution for the export.

See *HexGeoWiki EPSG Coordinate Systems* (*https://wiki.hexagongeospatial.com//index.php?title=EPSG_Coordinate_Systems*).

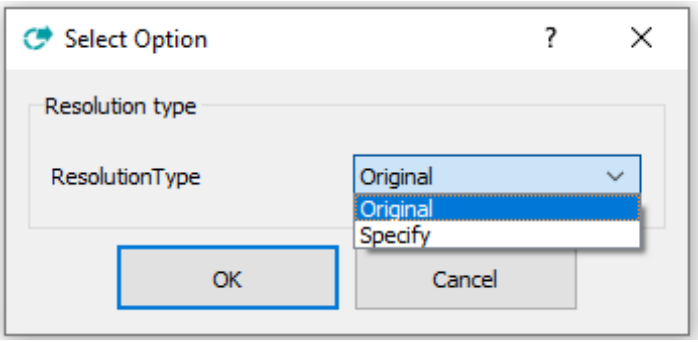
BigTIFF Creation Parameter



TIFF Compression Parameter



Resolution Type Parameter



Connections

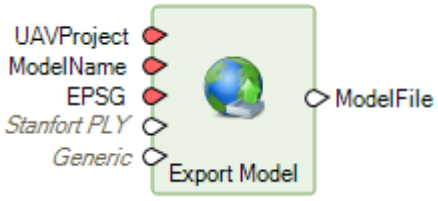
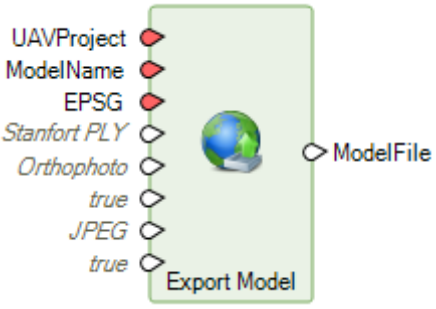
Name	Objects Supported	Description	Required
UAVProject	UAVProject	An UAV Project that has been created using the **Compute Surface Operator** or loaded from disk using the **Load Project Operator**.	✔
MosaicName	File	File name of the mosaic file to be created. Supports the export of the formats **ECW, TIF, IMG** and **JPEG2000**.	✔
EPSG	Integer	If the surface was reconstructed from image data with known camera positions, use this parameter to assign the projection and to re-project the result into the desired coordinate system. Set value to 0 to skip exporting with projection information.	✔
ResolutionType	String/Enumeration	Specify how to determine the spatial resolution (ground sampling distance) for the exported mosaic. Selecting **Original** will use the ground sampling distance automatically derived from the input data. When selecting **Specify**, enter a custom resolution on port **Resolution**. Default is **Original**	✔
Resolution	Double	Enter the custom resolution for the mosaic export. Only considered when **ResolutionType Specify** has been selected. The unit of the entered resolution is always meters, regardless of the used projection.	
BigTIFFCreation	String/Enumeration	Specify how to handle TIFF format export.	
TIFFCompression	String/Enumeration	Specify the compression method used when exporting to TIFF.	
SaveProject	Bool	With this flag set to True, the mosaic data will be stored in the project file as well. When set to False, only the exported mosaic file is being stored. The default is **True**.	
MosaicFile	File	Created ortho mosaic file on disk.	

Syntax

```
ExportMosaic ( <UAVProject> , <MosaicName> ,<EPSG> ,<ResolutionType> [,
BigTIFFCreation=<  >][, TIFFCompression=<TIFFCompression>]
[,SaveProject=<SaveProject>][, Resolution=<Resolution>])
```

Export Model

Category: GEOSYSTEMS UAV

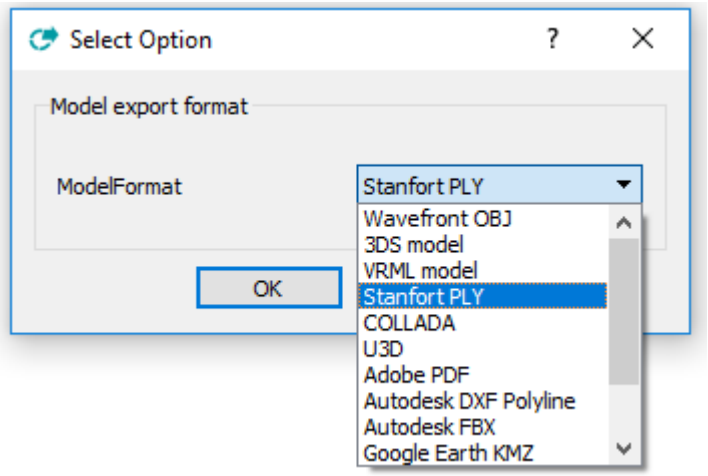
Default ports	All available ports
	

Description

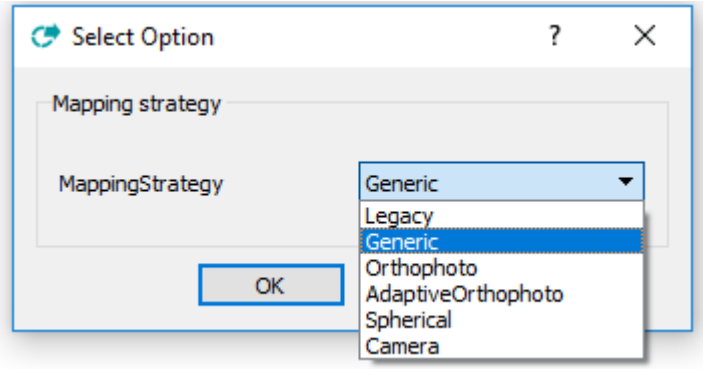
Exports the generated model data to disk. The export supports the formats **Wavefront OBJ, 3DS model, VRML model, COLLADA, Stanfort PLY, STL model, Alembic, Autodesk FBX, Autodesk DXF Polyline, Autodesk DXF 3DFace, U3D model, Adobe PDF, Binary glTF, X3D** and **Google Earth KMZ**. If the surface was reconstructed from image data with known camera positions and the parameter **EPSG** is provided, the model file is re-projected to the specified coordinate system. Otherwise local planar coordinates are used.

See *HexGeoWiki EPSG Coordinate Systems* (*https://wiki.hexagongeospatial.com//index.php?title=EPSG_Coordinate_Systems*).

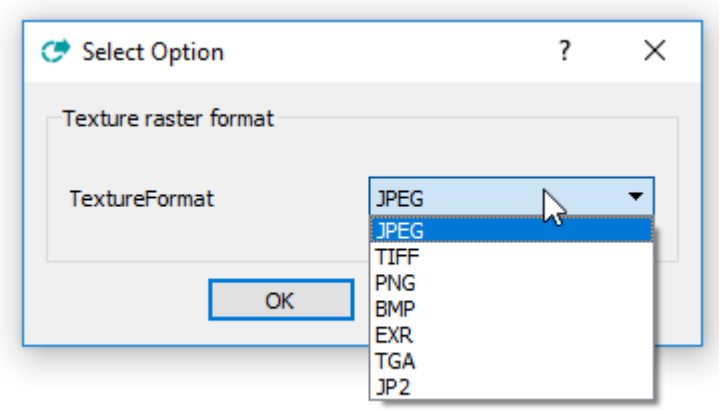
Model Format Parameter



Mapping Strategy Parameter



Texture raster Format



Connections

Name	Objects Supported	Description	Required
UAVProject	UAVProject	An UAV Project that has been created using the **Compute Surface Operator** or loaded from disk using the **Load Project Operator**.	✔
ModelName	File	File name of the model file to be created. See supported formats below.	✔
EPSG	Integer	If the surface was reconstructed from image data with known camera positions, use this parameter to assign the projection and to re-project the result into the desired coordinate system. Set value to 0 to skip exporting with projection information.	✔

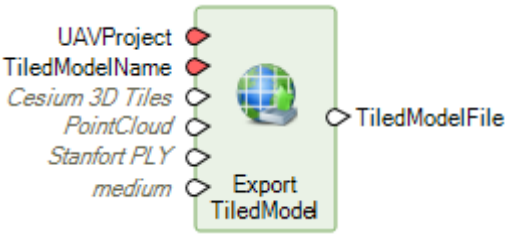
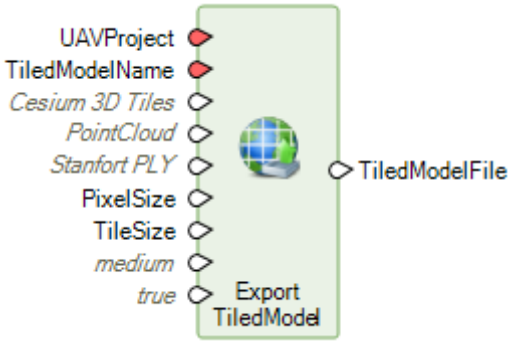
ModelFormat	String/Enumeration	a. Specify the format to use when exporting the model data. Supports the export of the formats **Wavefront OBJ, 3DS model, VRML model, COLLADA, Stanfort PLY, STL model, Alembic, Autodesk FBX, Autodesk DXF Polyline, Autodesk DXF 3DFace, U3D model, Adobe PDF, Google Earth KMZ, Binary glTF model format, X3D model format. Important: Binary glTF and X3D are only supported with Agisoft Metashape 1.5.x** .	✔
exportTexture	Boolean	Use this option to additionally export created texture.	
TextureFormat	String/Enumeration	Select the format of the texture export.	
SaveProject	Bool	With this flag set to True, the model data will be stored in the project file as well. When set to False, only the exported model file is being stored. The default is **True**.	
ModelFile	File	Created model file on disk.	

Syntax

```
ExportModel ( <UAVProject> , <ModelName> ,<EPSG>, <ModelFormat>, [,
MappingStrategy=<MappingStrategy>][, exportTexture=<exportTexture>] [,
TextureFormat=<TextureFormat>][,SaveProject=<SaveProject>])
```

Export TiledModel

Category: GEOSYSTEMS UAV

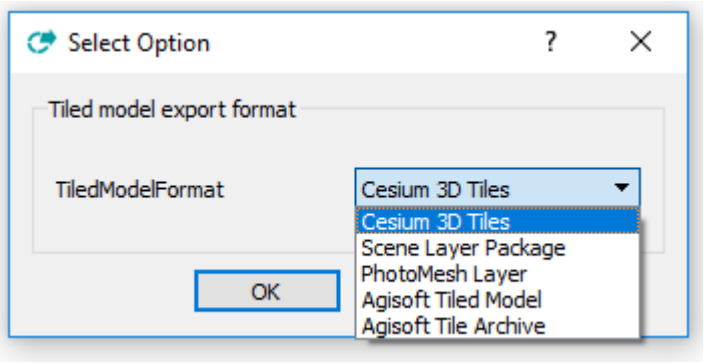
Default ports	All available ports
	

Description

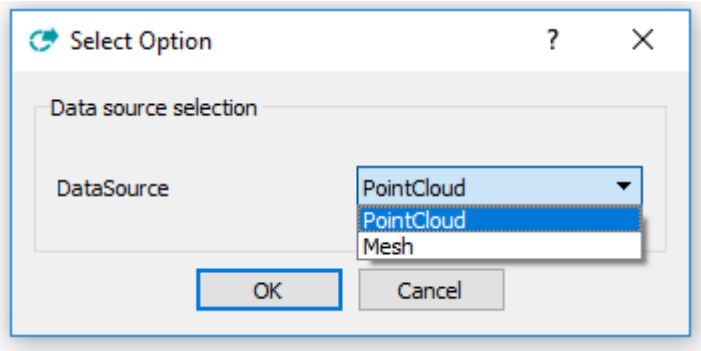
Exports the generated model data as tiled model to disk. The export supports the formats **Wavefront OBJ, 3DS model, VRML model, COLLADA, Stanfort PLY, STL model, Alembic, Autodesk FBX, Autodesk DXF Polyline, Autodesk DXF 3DFace, U3D model, Adobe PDF** and **Google Earth KMZ**. The parameter **ModelFormat** is used to select the mesh format when exporting to a ZIP based tiled model.

See *HexGeoWiki EPSG Coordinate Systems* (*https://wiki.hexagongeospatial.com//index.php?title=EPSG_Coordinate_Systems*).

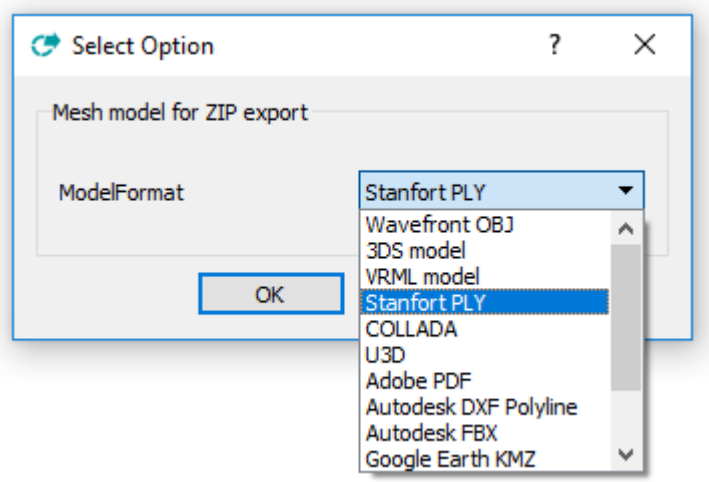
TiledModel Format Parameter



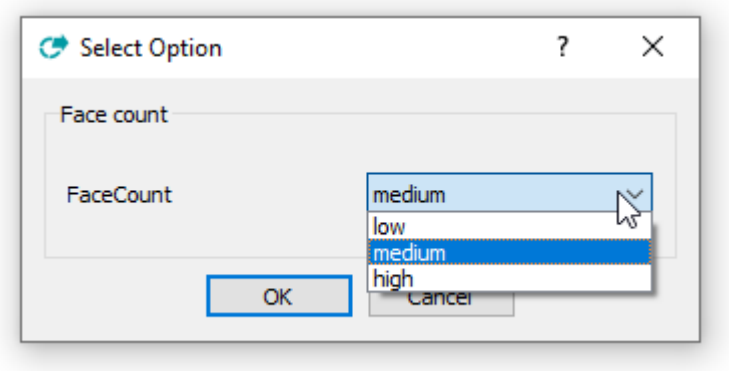
Data Source Parameter



Mesh model for ZIP export Parameter



Face count Parameter



Connections

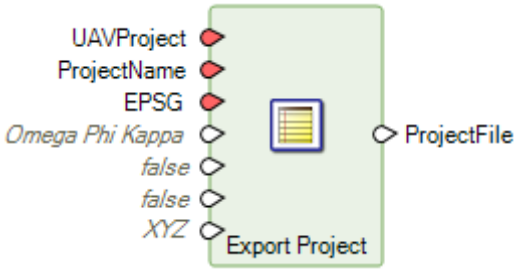
Name	Objects Supported	Description	Required
UAVProject	UAVProject	An UAV Project that has been created using the **Compute Surface Operator** or loaded from disk using the **Load Project Operator**.	✔
TiledModelName	File	File name of the tiled model file to be created. See supported formats below.	✔
TiledModelFormat	String/Enumeration	Specify the format to use when exporting the model data. Supports the export of the formats **Cesium 3D Tiles, Scene Layer Package, PhotoMesh Layer, Agisoft Tiled Model, Agisoft Tile Archive.**	✔
DataSource	String/Enumeration	Select which data to use for the export. Possible data sources are **PointCloud** and **Mesh**.	✔
MeshFormat	String/Enumeration	Specify the format of the mesh data when exporting ZIP based tiled models. Supports the formats **Wavefront OBJ, 3DS model, VRML model, COLLADA, Stanfort PLY, STL model, Alembic, Autodesk FBX, Autodesk DXF Polyline, Autodesk DXF 3DFace, U3D model, Adobe PDF, Google Earth KMZ.**	
PixelSize	Double	Target model resolution in meters. If not provided, target resolution is determined automatically.	
TileSize	Integer	Size of tiles in pixels. Default: 256	
FaceCount	String/Enumeration	Parameter determining the number of polygons/faces to be used when creating the output mesh. Must be one of the values from the corresponding table above. If not provided, the default value **medium** is used.	
SaveProject	Bool	With this flag set to True, the tiled model data will be stored in the project file as well. When set to False, only the exported tiled model file is being stored. The default is **True**.	
TiledModelFile	File	Created tiled model file on disk.	

Syntax

```
ExportTiledModel ( <UAVProject> , <TiledModelName> ,<TiledModelFormat>,
<DataSource>,  [, MeshFormat =<MeshFormat>][, PixelSize=<PixelSize>]
[,TileSize=<TileSize>][,FaceCount=<FaceCount>][,SaveProject=<SaveProject>])
```

Export Project

Category: GEOSYSTEMS UAV

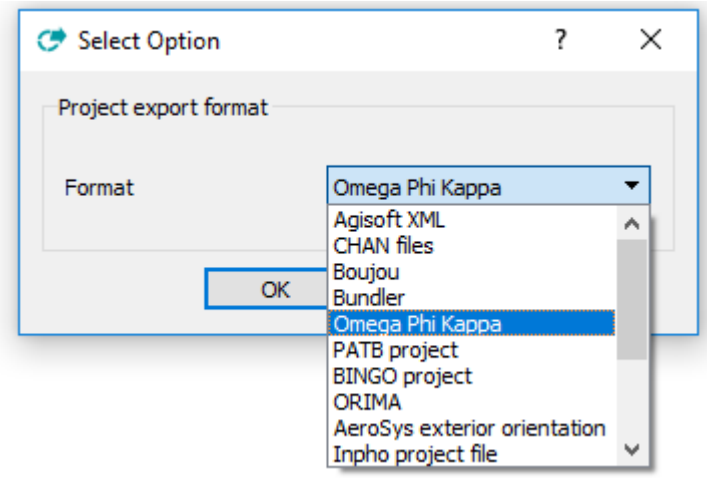
Default ports	All available ports
	

Description

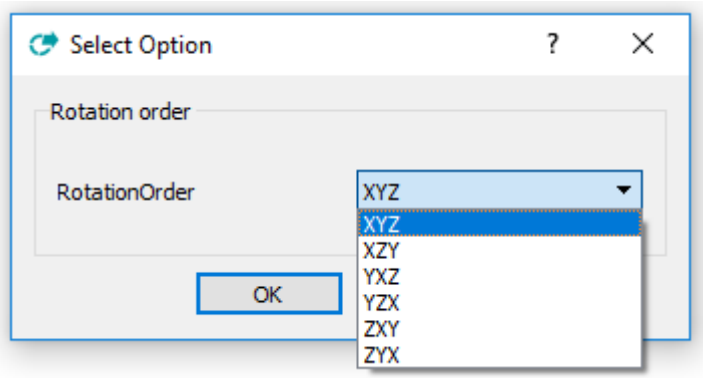
Exports the generated model data to another project format. The export supports the formats **Agisoft XML, CHAN files, Boujou, Bundler, Omega Phi Kappa, PATB project, BINGO project, ORIMA, AeroSys exterior orientation, Inpho project file, Summit evolution project, Blocks Exchange, Realviz RZML, VisionMap, Alembic** and **Autodesk FBX**. If the surface was reconstructed from image data with known camera positions and the parameter **EPSG** is provided, the project is re-projected to the specified coordinate system. Otherwise local planar coordinates are used.

See *HexGeoWiki EPSG Coordinate Systems* (*https://wiki.hexagongeospatial.com//index.php?title=EPSG_Coordinate_Systems*).

Project Export Format Parameter



Rotation Order Parameter



Connections

Name	Objects Supported	Description	Required
UAVProject	UAVProject	An UAV Project that has been created using the **Compute Surface Operator** or loaded from disk using the **Load Project Operator**.	✔
ProjectName	File	File name of the project file to be created. See supported formats below.	✔
EPSG	Integer	If the surface was reconstructed from image data with known camera positions, use this parameter to assign the projection and to re-project the result into the desired coordinate system. Set value to 0 to skip exporting with projection information.	✔
Format	String/Enumeration	Specify the format of the project export. Supports the formats **Agisoft XML, CHAN files, Boujou, Bundler, Omega Phi Kappa, PATB project, BINGO project, ORIMA, AeroSys exterior orientation, Inpho project file, Summit evolution project, Blocks Exchange, Realviz RZML, VisionMap, Alembic, Autodesk FBX.**	✔
includeTiePoints	Boolean	Select this option to include tie points in the exported project.	
includeMarkers	Boolean	Select this option to include markers in the exported project.	
RotationOrder	String/Enumeration	Specify the rotation order to use when exporting the project data. Supported orders are **XYZ, XZY, YXZ, YZX, ZXY, ZYX.**	
ProjectFile	File	Created tiled model file on disk.	

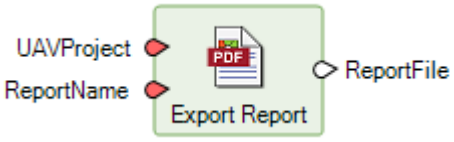
Syntax

```
ExportProject ( <UAVProject> , <ProjectName> ,<EPSG>, <Format>,  [,
includeTiePoints=<includeTiePoints>][, includeMarkers=<includeMarkers>]
[,RotationOrder=<RotationOrder>])
```

Export Report

Category: GEOSYSTEMS UAV

Default ports	All available ports



Description

Exports the triangulation report of an existing UAVProject. The report will be written as PDF. If provided a customized **Title** and **Description** can be added to the report.

Connections

Name	Objects Supported	Description	Required
UAVProject	UAVProject	An UAV Project that has been created using the **Compute Orientation** or **Compute Surface Operator** or loaded from disk using the **Load Project Operator**.	✔
ReportName	File	File name of the R**eport** file to be created. The report will be written as PDF.	✔
Title	String	Custom title used in the created report.	
Description	String	Custom description used in the created report	
ReportFile	File	Created **Report** file on disk.	

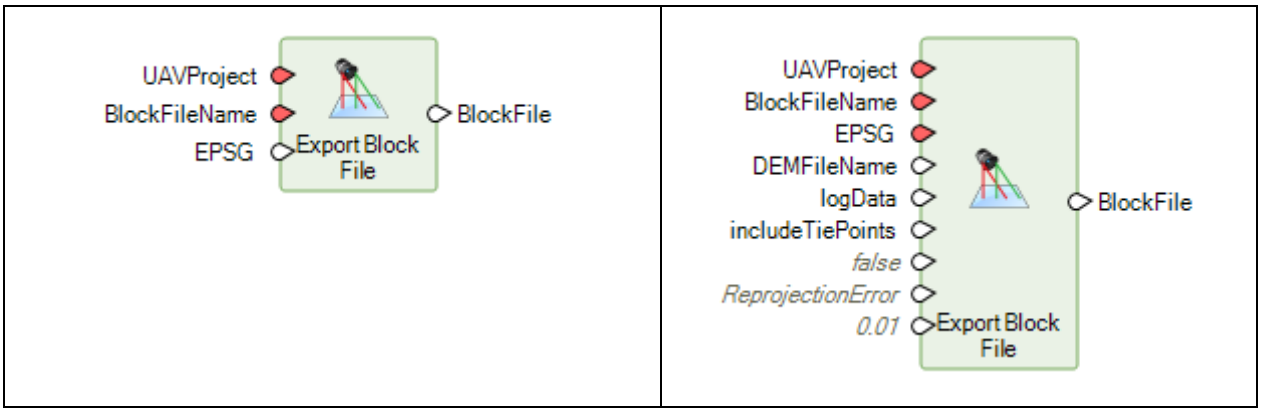
Syntax

```
ExportReport ( <UAVProject> , <ReportName> [, Title=<Title>]
[,Description=<Description>])
```

Export Blockfile

Category: GEOSYSTEMS UAV

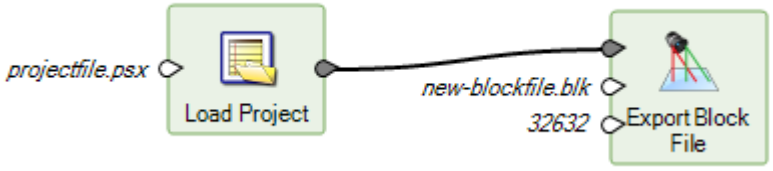
Default ports	All available ports



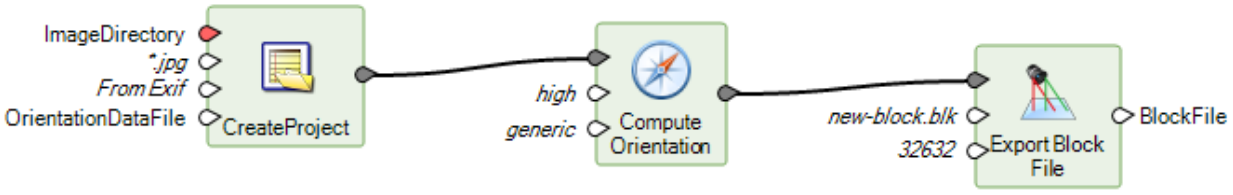
Description

Exports a triangulated project (UAV Project that has been created using the **Compute Orientation Operator** or **Compute Surface Operator**) as blockfile *.blk for further usage in IMAGINE Photogrammetry. (e.g. stereointerpretation or single ortho file generation). There are two options to use the blockfile export operator. Either (1), load a projectFILE_ori.psx or projectFILE.psx and connect it to the Export Block File operator, or (2) set up a project with the CreateProject operator, connect it to the Compute Orientation operator and finally export the orientation via the Export Block File operator. Set the **EPSG** code to reproject the exported camera position information.

(1)

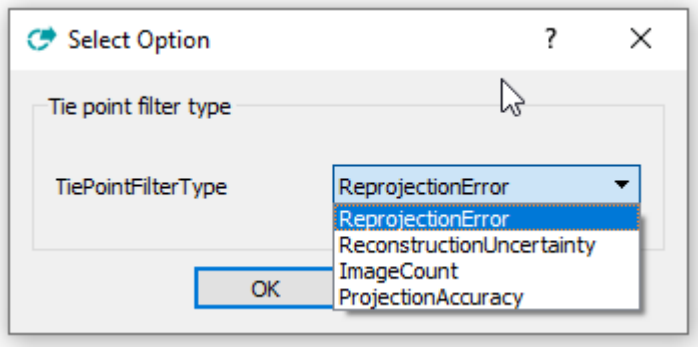


(2)



See *HexGeoWiki EPSG Coordinate Systems* (*https://wiki.hexagongeospatial.com//index.php?title=EPSG_Coordinate_Systems*).

Tie point filter type parameter



Connections

Name	Objects Supported	Description	Required
UAVProjectIn	UAVProject	An UAV Project that has been created using the **Compute Orientation Operator** or **Compute Surface Operator** or loaded from disk using the **Load Project Operator**.	✔
BlockFileName	File	File name of the **BLK** file to be created. Supports the export to the **BLK** format.	✔
EPSG	Integer	Output projection for the created BLK file. Use a valid projected coordinate system EPSG code. Camera position information will be reprojected.	✔
DEMFileName	File	Optionally provide a DEM/DSM covering the project area. That file will be added to the BLK file. It is advisable to use only DEM/DSMs, which contain information about the elevation reference to avoid misalignments. For best results, use directly the output created by the **Export DEM** operator.	
logData	Bool	Flag to enables additional logging to the session log.	
includeTiePoints	Bool	Flag to enable the export of the tie points used for the triangulation.	
filterTiePoints	Bool	Flag to enable the filtering of the tie points used for the triangulation. By default, no filtering is applied.	
TiePointFilterType	String/Enumeration	Specifies the type of filtering to apply to the tie points during export. Supported types are **ReprojectionError, ReconstructionUncertainty, ImageCount, ProjectionAccuracy.**	
TiePointFilterValue	Double	The actual value used to filter the tie points. Depending on the selected TiePointFilterType, tie points above that value (**ImageCount**, **ProjectionAccuracy**) or below (**ReprojectionError, ReconstructionUncertainty**) are being exported.	
BlockFile	File	Created **BLK** file on disk.	

Syntax

```
ExportBlockFile ( <UAVProjectIn> , <BlockFileName> , <EPSG> [,
```

```
DEMFileName=<DEMFileName>, logData=<logData>,
includeTiePoints=<includeTiePoints>, filterTiePoints=<filterTiePoints>,
TiePointFilterType=<TiePointFilterType>,
TiePointFilterValue=<TiePointFilterValue>]
```

Section 3

Network processing

Agisoft Metashape supports the computation of projects across several computers in a local network, joined in processing cluster. Such distributed processing reduces the processing time of large projects significantly. To utilize this functionality, a cluster of processing nodes must be configured.

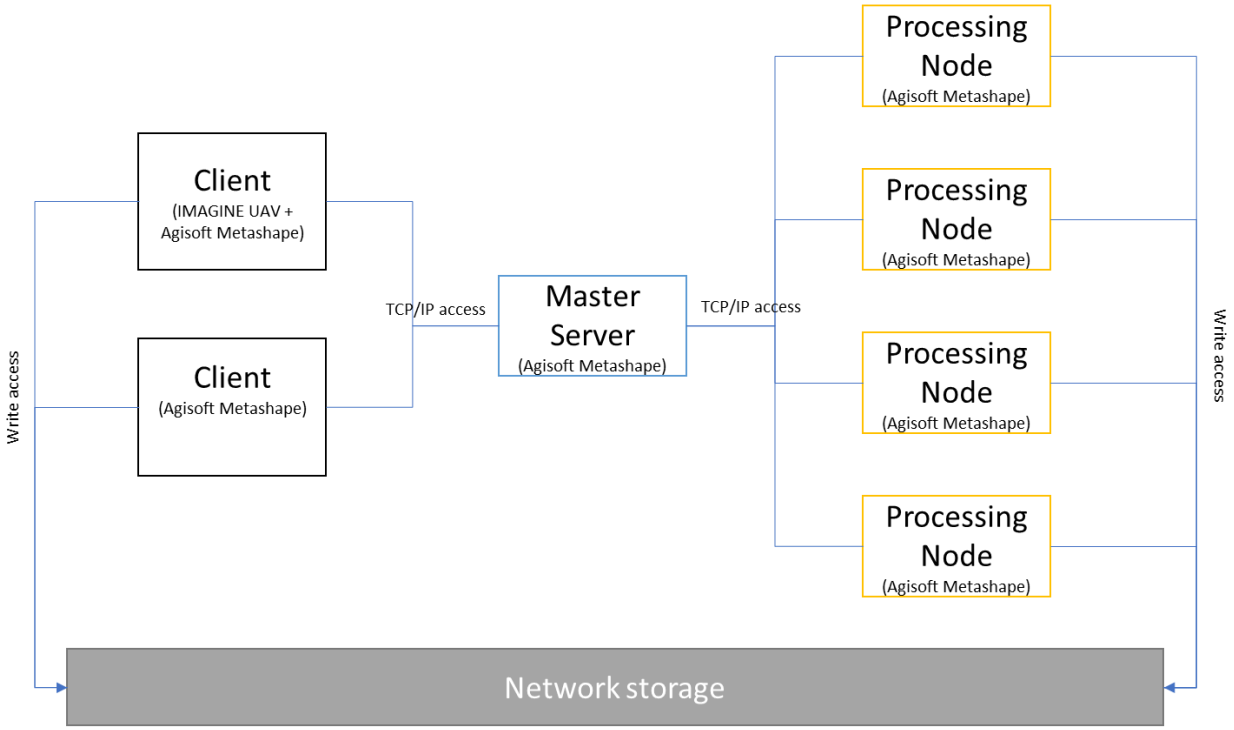
IMAGINE UAV acts only as a client node in this cluster scenario. The setup and configuration of the actual cluster is not part of IMAGINE UAV. The brief steps described in this document are only meant for a quick start. For more details please refer to the Agisoft Metashape help.

On all components Agisoft Metashape must be installed and licensed. IMAGINE UAV is only required on the client, starting the processing.

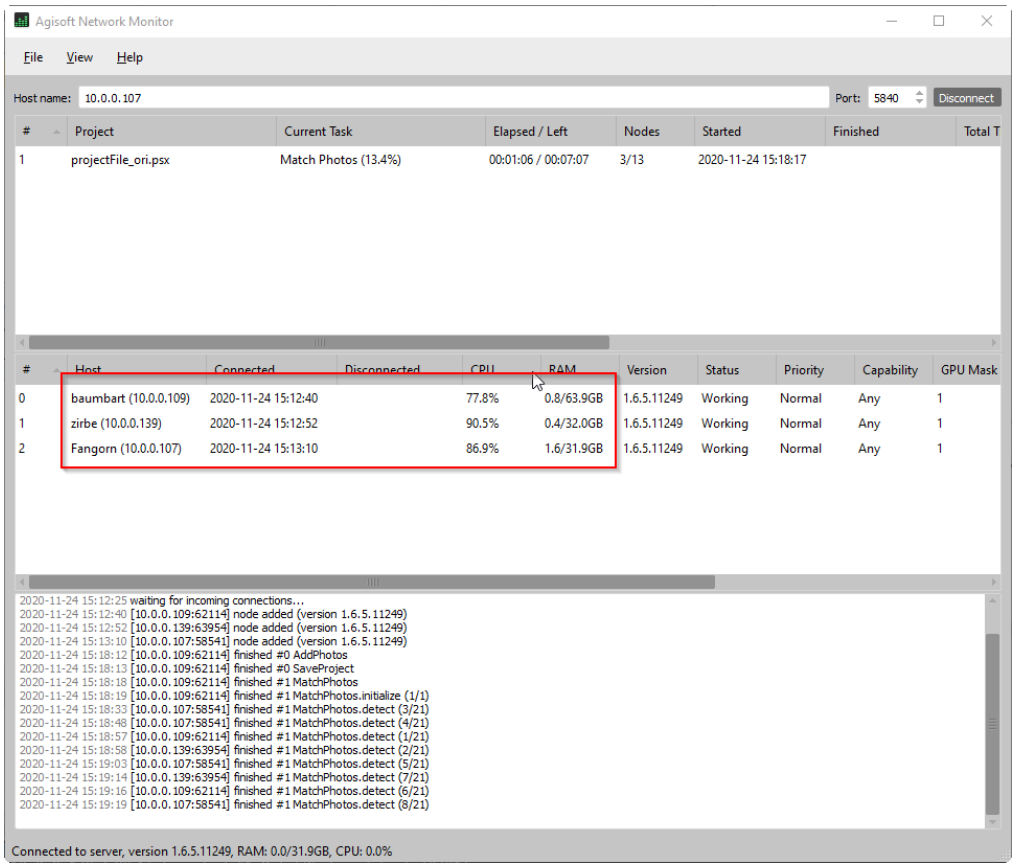
A processing cluster consist of four main components:

1. **Master server**
   The master node is the central communication unit, handling the scheduling and distribution of individual processing tasks across the configured nodes. With its central role in the cluster, the master server is not fault tolerant. For more fault tolerant configurations, please see the Agisoft Metashape help. The master server listens on one dedicated port, which can be freely configured. The default is 5840. All processing nodes and clients must be allowed to connect to that port on the master server. The master server itself doesn't act as a processing node itself and therefore doesn't require to be on a strong machine.
2. **Processing node**
   A processing node executes an assigned processing task and therefore has to run on fast hardware. A cluster can consist of any number of processing nodes. Nodes connect on start up to the cluster and wait for assigned tasks to be processed. Nodes can also be removed form a cluster at any time. Important to note is, that results are written to a shared network location. All nodes must have write privileges.
3. **Client**
   A client node acts as the entry point of processing tasks into the cluster. A cluster can have several clients submitting new processing tasks into the cluster. IMAGINE UAV acts as such client. Using the IMAGINE UAV EML dialogs or directly the operators in a custom Spatial Model will define and submit for each UAV operator the necessary tasks and submit them to the cluster. The project creation or loading within IMAGINE UAV must be executed on the same network share, configured in the cluster. From IMAGINE UAVs perspective, executing the processing of a project locally or in a cluster is identical. IMAGINE UAV will wait for all operators to complete.
4. **Network storage**
   The network storage is the central place client and nodes must have write access to. It is recommended to use UNC path notation.

Communication between master server, processing nodes and clients is done via TCP/IP. Please note, that it is possible to add the master server, as well as any client, as a processing node to the cluster. This will consume only one Agisoft Metashape license one each computer.



The extra tool Agisoft Network Monitor allows the monitoring of the components of a cluster. It can be installed on any machine having access to the master server in the network (including the master server itself).



Configuration of cluster

The configuration of the cluster is not part of IMAGINE UAV. The steps described below are only a brief introduction. For more details, please see the Agisoft Metahshape help.

On all components of the cluster Agisoft Metashape must be installed and licensed. The start of a master server or processing node uses the Metashape executable.

Configuration of master server

metashape --server --host <IP of master server>[:<port on master server>]

e.g.: metashape --server --host 10.0.0.107:5840

A master server can also be configured as Windows service.

metashape --service install --server --host <IP of master server>[:<port on master server>]

There are several other parameters for a more fine-grained configuration available in the Agisoft Metashape help.

Configuration of processing node

metashape --node --host <IP of master server>[:<port on master server>] --root <Root folder on network share>

e.g. metashape --node --host 10.0.0.107:5840 --root \\fangorn\E\Data

A master server can also be configured as Windows service.

metashape --service install --node --host <IP of master server>[:<port on master server>]

--root <Root folder on network share>

There are several other parameters for a more fine-grained configuration available in the Agisoft Metashape help.

If configured as service, make sure that the windows account used as service user has access to the network share specified under --root.

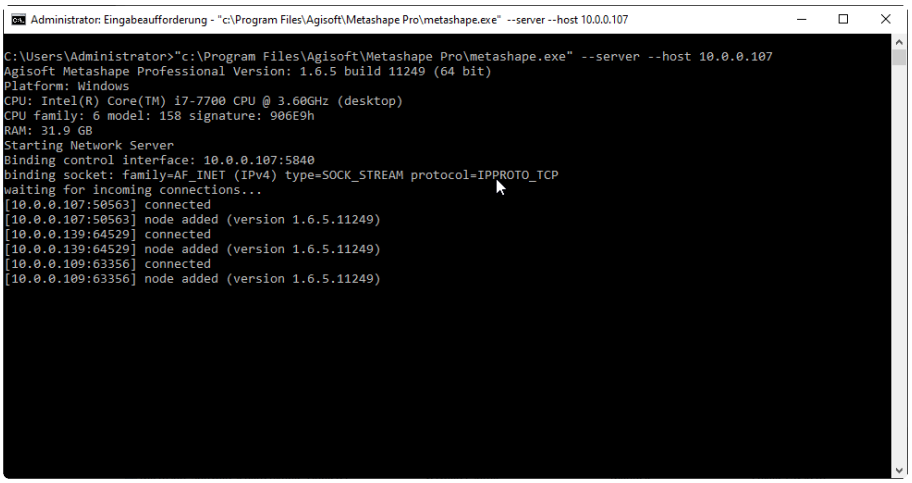
Project setup in IMAGINE UAV

There is no need to configure Metashape manually in the interface, simply start either the master server or any node as described above.

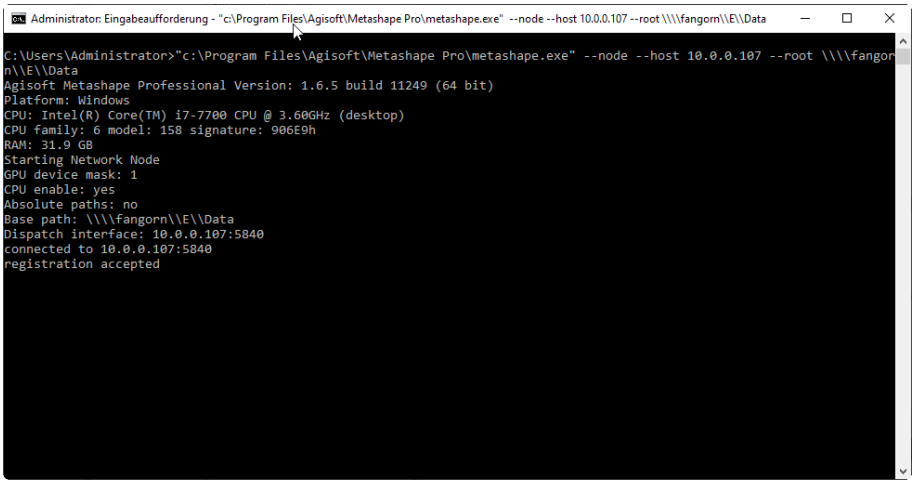
Also, on the machine IMAGINE UAV is running on, no configuration directly in Agisoft Metashape is necessary. All configuration needed is the usage of the **Network Processing** Operator in your Spatial Model or the selection and specification of the Network processing options in the EML dialog.

Step by Step

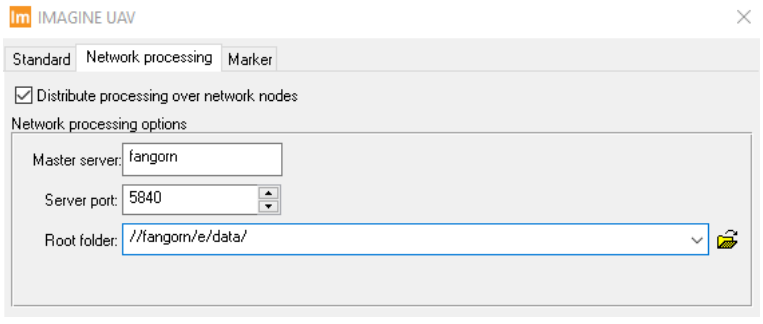
1. Configure the master server as described above and start. You can now connect to the server using the Agisoft Network Monitor.



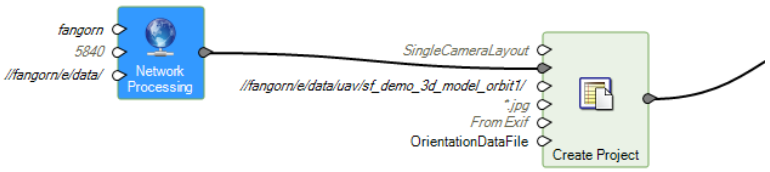
2. Configure all nodes as described above and start. They should become available in the Network Monitor. If not, please verify your firewall or proxy settings in the network.



3. Create IMAGINE UAV project with Network Processing option and execute.
   a. Via EML dialogs



   b. Directly in custom Spatial Model



4. IMAGINE UAV will behave the same way as you are used to it when processing locally.
    a. The locally executed Spatial Model process will be shown with it progress in the IMAGINE Process List.
    b. Logging information will be written to the IMAGINE Session log.
    c. The Spatial Model process will be running until the project computation completes (gets cancelled or fails).
5. While IMAGINE UAV is executed locally, for each UAV Operator in the Spatial Model it will create and submit the necessary tasks to the processing cluster. Each operator will wait until its submitted tasks have completed.

Section 4

Step-by-Step guide for the IMAGINE UAV Workflow

This guide leads you through all steps of the UAV workflow that you need to produce the results. The outcome consists of two raster datasets, the image mosaic, and the digital surface model, as well as a point cloud file stored in **LAS** format. This guide is based on UAV example data that is part of the installer. If you selected to install the example data, it is located in the folder:
`C:\Users\Public\GEOSYSTEMS\UAV\examples\gravel-pit.`

The UAV example datasets have been provided by GRID-IT (http://www.grid-it.at/).

Notes regarding the input data:

- Use a digital camera with reasonably high resolution (5 Megapixel or more).
- Avoid ultra-wide angle and fish-eye lenses. The best choice is a lens with 50 mm focal length (35 mm film equivalent) but focal length might vary from 20 to 80 mm.
- Lenses with a fixed focal length are preferred. If you use a zoom lenses - focal length should be set either to maximal or minimal value.
- Try to use the **RAW** data lossless converted to **TIFF** files. **JPG** compression adds unwanted noise to the images which might affect the accuracy.
- The ISO-value should be set to the lowest possible value. High ISO values add additional noise to the images.
- Always use the original images. Do not crop or geometrically transform (for example, resize or rotate) the images.
- Rough rule for image overlap: 60% of side overlap + 80 % of forward overlap

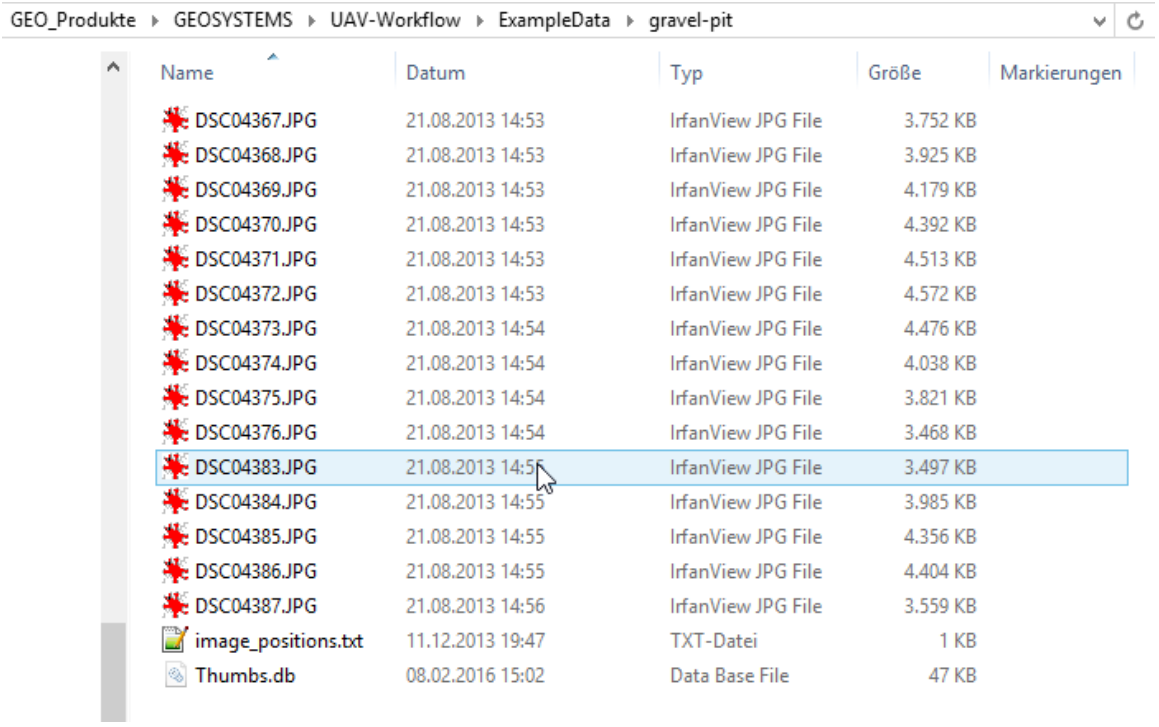
Examine the Input Data Processing Step

The first processing step is to examine your input datasets to help you choose the right options for all processing settings as well as to get a rough idea about the processing time.

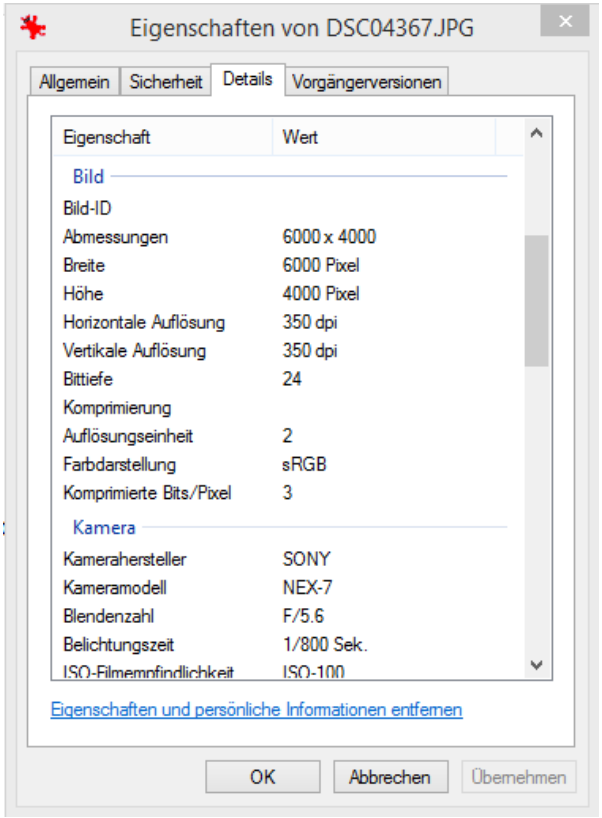
Notable details:

- File format (for example, **JPG** or **TIF**)
- Number of input datasets
- Number of columns and rows of each input file
- Type of the used image orientation (**EXIF**, external file, no orientation)
- Coordinate reference system of your reference data (centre coordinates of the images)
- Geographic projection for your study area

The example dataset contains 15 jpg-images and one text file.

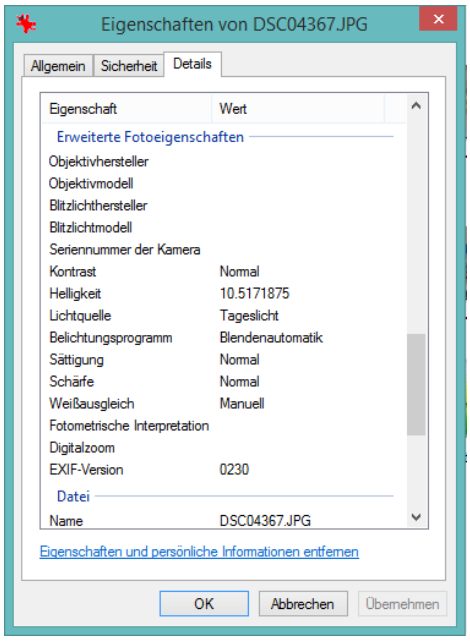
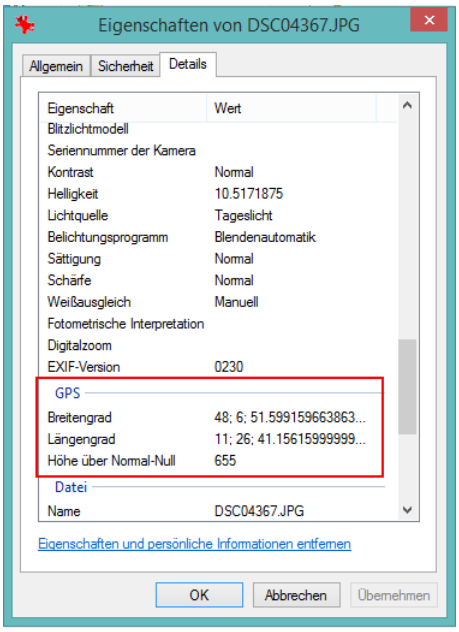


1. Check the image properties by right-clicking on an image and selecting **Properties > Details**. The dimension of each image is 6000 by 4000 pixels.



2. Next, look for GPS coordinates of the image center in the **EXIF**-information block. The provided images of the UAV example dataset also lack this kind of information. Depending on the source, thus the camera, of your images, you may find a GPS section inside the image metadata.

3. Compare the properties of the following two JPG images.
   The first one presents the properties of one of the example images that does not contain GPS information.
   However, the second one shows the details of an image that does contain GPS information.

No GPS Information	**GPS information is present**
	

When dealing with images taken by a camera having a GPS sensor which collects position information of longitude, latitude and elevation, processing of this information is easy. The GPS information is directly used, if you select the option **From EXIF** in the setup project step. There is no need to reference any external files during data processing. You can skip the next block and can continue with **'Start Processing'**

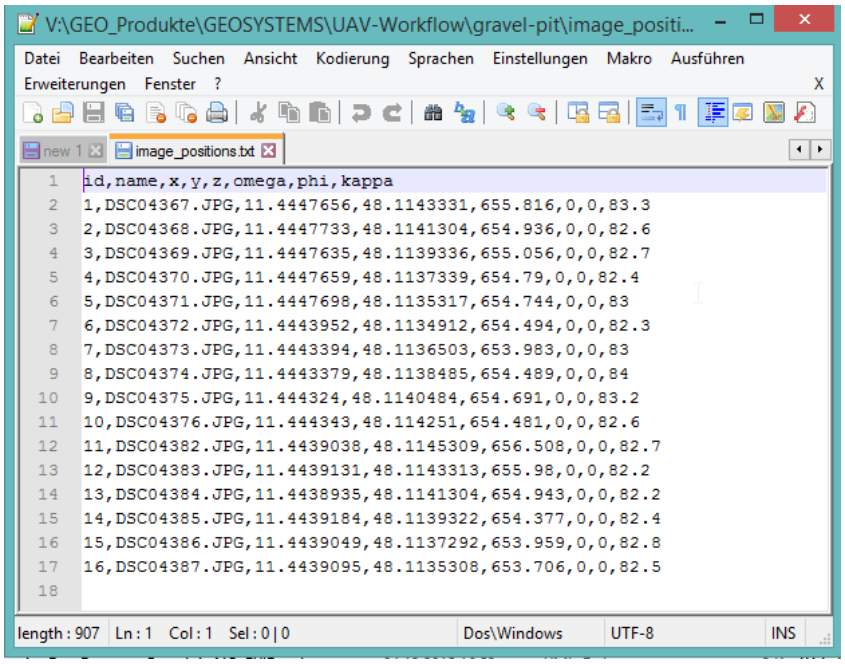
The following example describes the workflow if no **EXIF** information is provided. In this case you need to "import" the image position from an external text file, which is included in the example directory.

Define Orientation Format Processing Step

You can skip this step if you process datasets that have valid GPS information of X, Y and Z in the **EXIF**-header.

To use the orientation information stored in a text file, you need to define the input file structure. Have a look at the orientation file included in the example data.

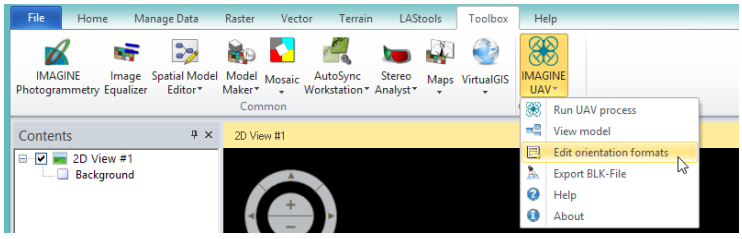
1. You can load `C:\Users\Public\GEOSYSTEMS\UAV\examples\gravel-pit\image_positions.txt` in any text editor.



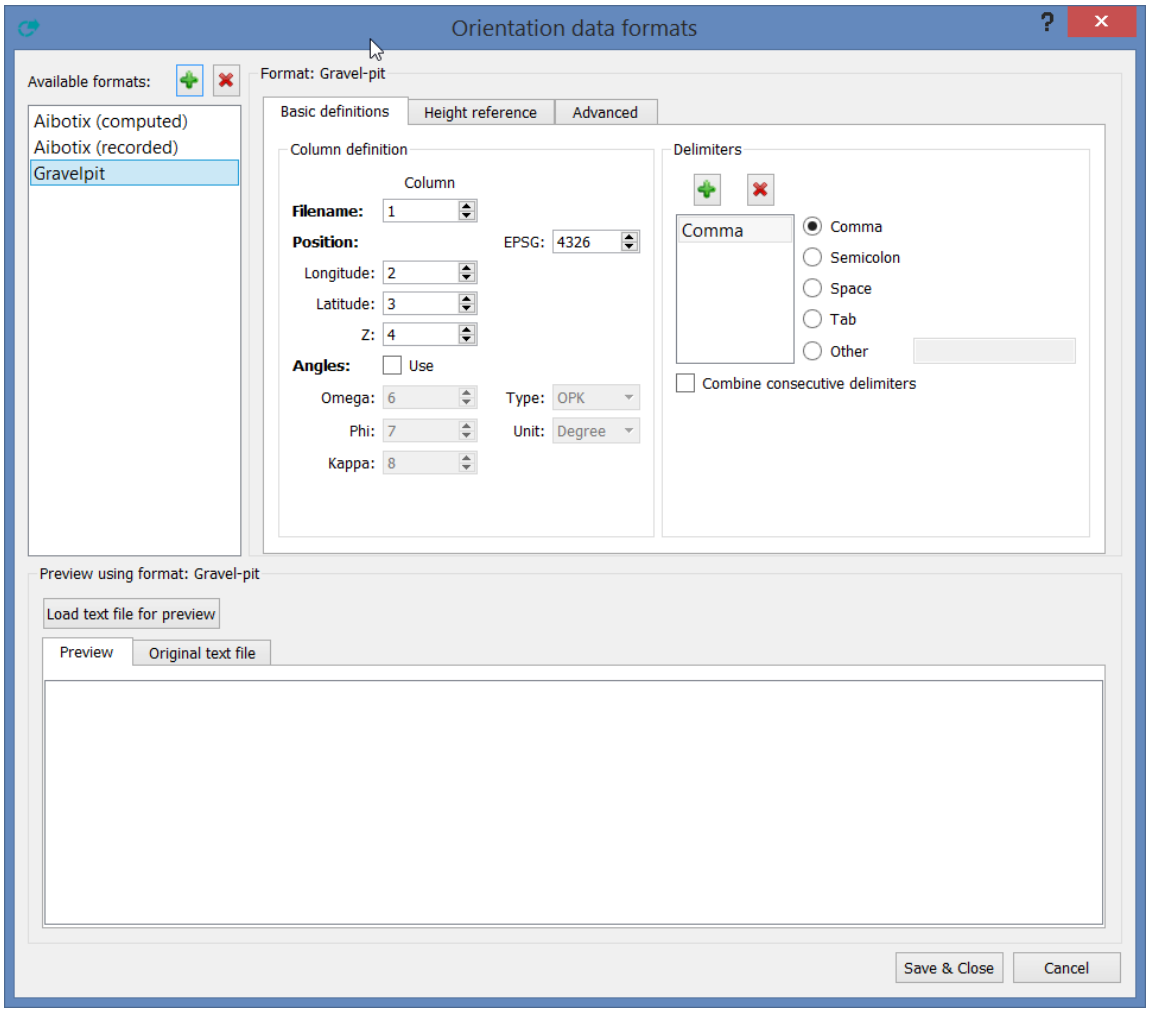
This plain text file contains comma separated values. The actual data values start from the second row. Please, focus on the image filename (column 2), as well as on the image center coordinates X, Y and Z (column 3, 4 and 5). Since the algorithm used during image orientation is very robust, the camera rotation angles (omega, phi, kappa) do not have to be considered for most of the cases. In order to project the results correctly, you need to know which coordinate reference system is used. In this case, Lat/Lon values are based on **WGS84**. Thus, the **EPSG** code of the underlying coordinate reference system is **4326**.

Based on all this information you can define the orientation format using the Edit orientation formats dialog.

2. Click **Toolbox** tab > **Imagine UAV** > **Edit orientation formats** to open the Orientation data formats dialog.



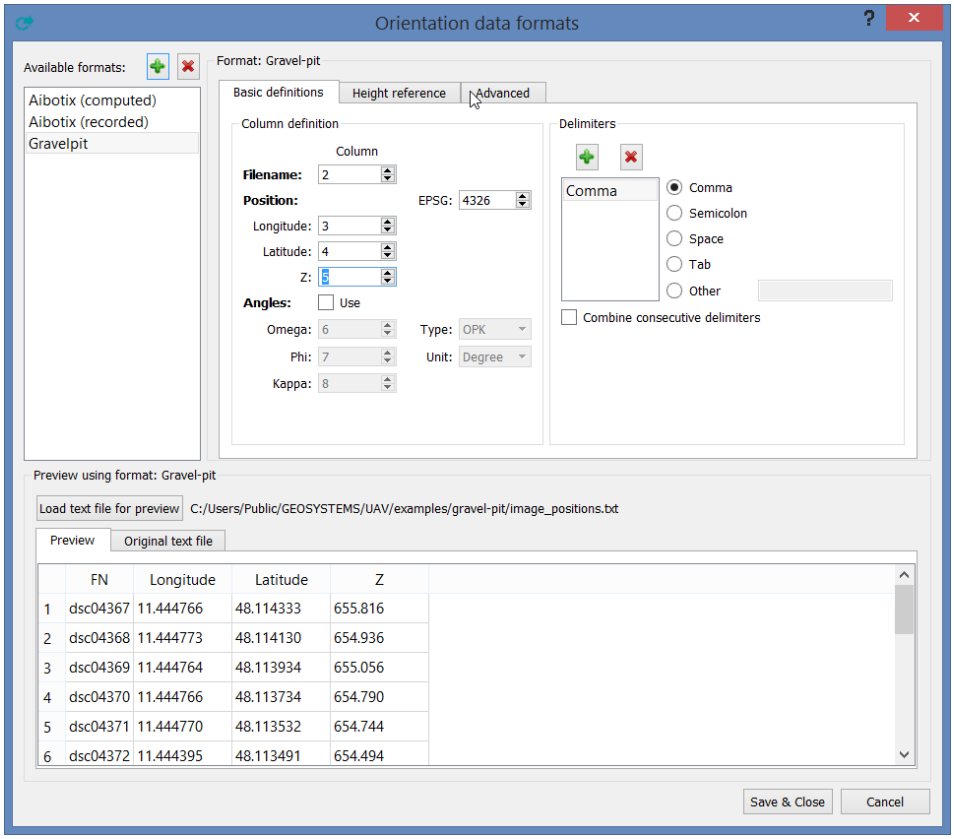
3. Create a new format definition in the **Orientation Format Editor** by clicking the **+** button, next to the **Available formats** list. This adds a new entry to the format list. You can directly change the name or double click on the entry for renaming later. Now set the name to `Gravelpit`.



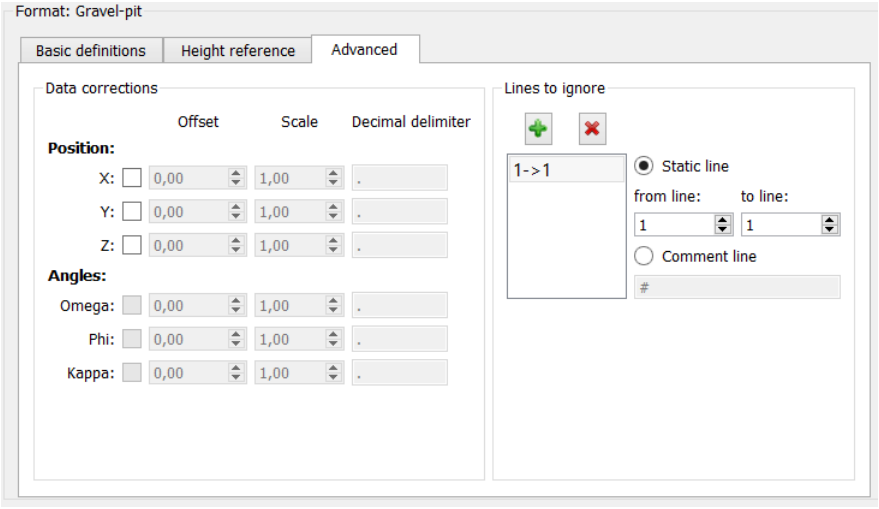
4. Optionally you can load the actual file (`C:\Users\Public\GEOSYSTEMS\UAV\examples\gravel-pit\image_positions.txt`) with the orientation data to preview the effect of the newly created orientation format. To do so, click on **Load text file for preview** and select the text file. The window has two tabs, Preview shows the applied format and the other the original data of the text file. You can easily see which additional settings might be needed to read the text file successfully.

5. Under **Column definition,** assign the column numbers to the required processing values and specify the coordinate reference system of the input values. The image filename is stored in column 2 of the input data. Find the image center coordinates X, Y and Z in columns 3, 4 and 5. Since you are not using rotation angles, keep this option disabled. The EPSG-code of the coordinate reference system

is **4326**. Under **Delimiter**, ensure that **Comma** is used as column delimiter. For this example, the settings should look as follows:



6. Under **Advanced** tab, skip the first line containing the column descriptions. Add a new **ignore line** entry by clicking the **+** button in the **lines to ignore** group. This adds a new skip entry starting from 1 and ending with line 1. Entries can easily be modified. Select the **ignore** option and modify the start and end options. Alternatively, you may also set a **comment character** or characters. All lines starting with this character are skipped. You may add any number of skip options.



7. Click **Save & Close** to save all modified settings.

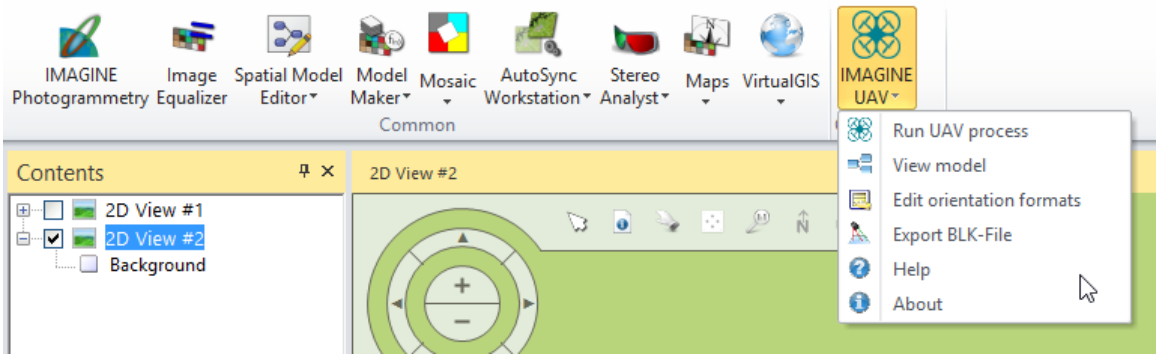
The additional options allow you to:

- Define a constant offset for all input values (for example, if coordinates have been cut off)
- Define a scale factor for each input value (for example, if the input values are stored in cm but you need to use m for the process)
- Overwrite the decimal delimiter (for example, certain countries are using "," as default decimal delimiter)
- The tab **Height reference** allows you to specify the reference surface your height data are referring to. By default, it is assumed that ellipsoidal height values are provided, according to the spheroid and datum used by the EPSG code (**Reference surface of current EPSG code**). If this is not the case, you can also manually specify the reference surface (**Manually selected height reference surface**).

Now you are ready to start processing the UAV example dataset.

Start Processing

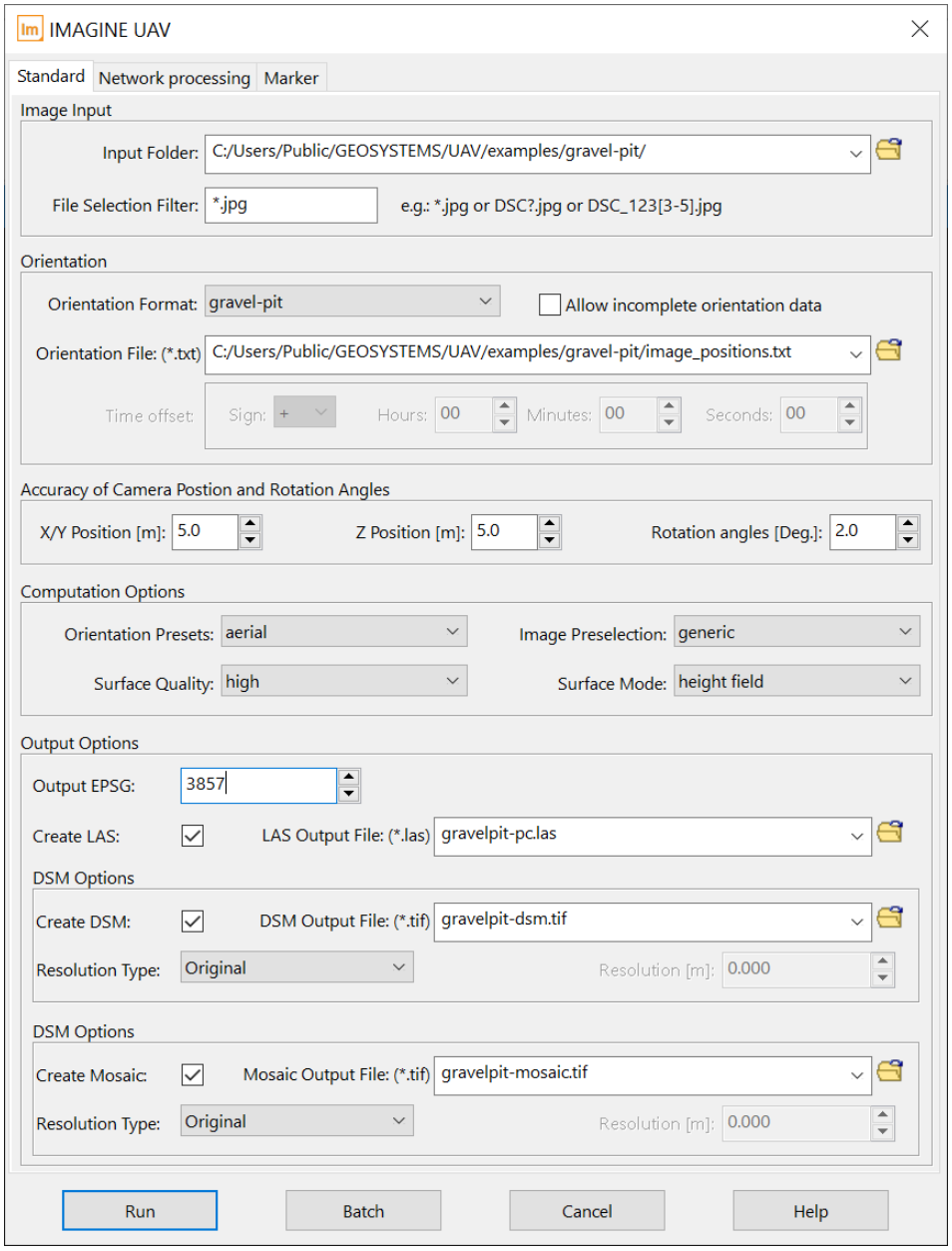
1. Open the run model dialog by clicking **Toolbox** tab > **IMAGINE UAV > Run UAV process**.



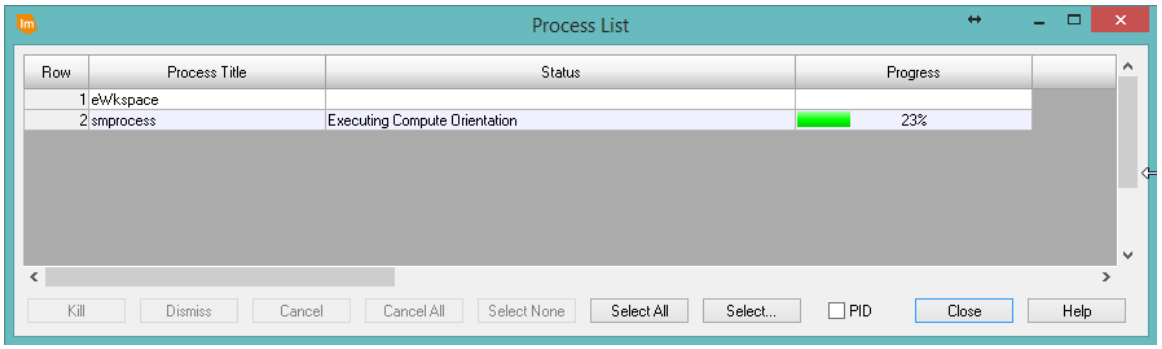
2. Specify the following processing options in the dialog:
   - **Input Folder**: `C:/users/public/geosystems/uav/examples/gravel-pit/`
   - **File Selection Filter**: `*.jpg` (all **jpg** files in the **Input Folder** are selected)
   - **Orientation Format**: `Gravelpit` (created in Define Orientation step)
   - **Orientation File Input**: `C:/users/public/geosystems/uav/examples/gravel-pit/image_positions.txt`
   - **Surface Quality**: **high** (very detailed point cloud and thus surface; takes much more time to compute compared to medium; select **low** for a first try when dealing with an unknown dataset in order to reduce the computation time to a minimum)
   - Set **the output** projection to **32632** (UTM zone 32 north/WGS84)
   - Set the output file for the point cloud in **LAS-**format: `gravelpit_pc.las` (in any directory with write access – for example, create a new directory `C:/users/public/geosystems/uav/examples/gravel-pit/results`) Set output file for the **DSM** in **TIF-**format: `gravelpit_dsm.tif` (in any directory with write access – for example, create a new directory `C:/users/public/geosystems/uav/examples/gravel-pit/results`)

- Set output file for the mosaic in **TIF-**format: `gravelpit_mosaic.tif` (in any directory with write access – for example, create a new directory `C:/users/public/geosystems/uav/examples/gravel-pit/results`)

The settings should look as follows. Double check before you proceed.



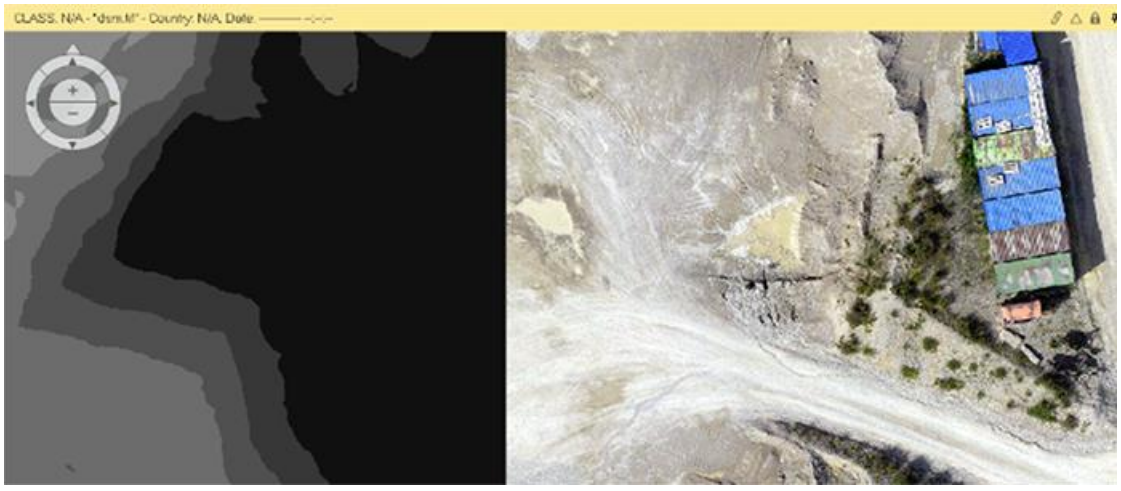
3. Click **Run**. Depending on the power or speed of your PC, the processing can take 20 - 30 minutes to finish. Check the process status in the ERDAS IMAGINE Process List. Each operator reports the current progress.



Display the Results Processing Step

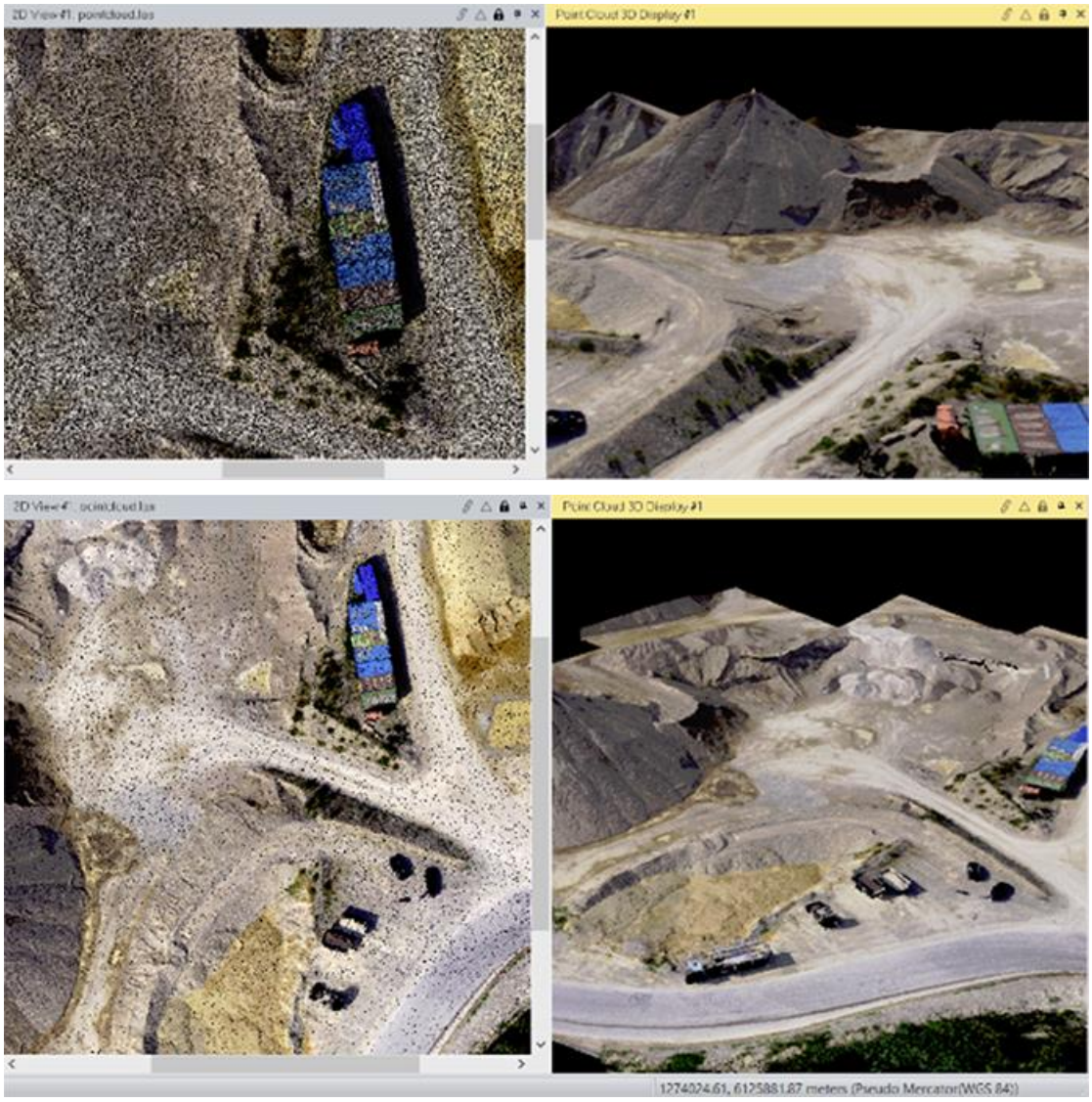
After the process has finished, you can display the three output datasets in the View.

1. Open the mosaic or **DSM** as raster files in the View.



2. You can open the computed point cloud (**LAS** format) in the View by clicking **File > Open Point Cloud Layer**. As shown, the points are RGB-encoded, meaning that every point has stored the RGB-

value of the underlying input pixel. You are also able to display the point cloud in 3D (Point Cloud > Group “3D View” > Show 3D).



Using the UAV Operators

If you have access to an ERDAS IMAGINE Professional license, you can use the UAV operators within the Spatial Modeler.

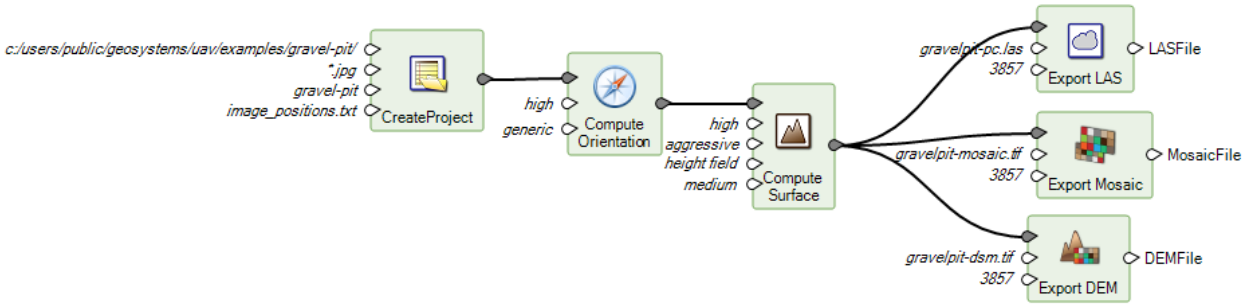
We are providing a pre-made UAV model that you can open by clicking **View model** in the UAV main menu. This loads the base model within the **Spatial Modeler Editor**.

In order to process the example dataset, change the following settings:

- Input ports of the **Create project** operator:
  - **Image Directory**: `C:/users/public/geosystems/uav/examples/gravel-pit/`
  - **Orientation Format**: `Gravelpit`

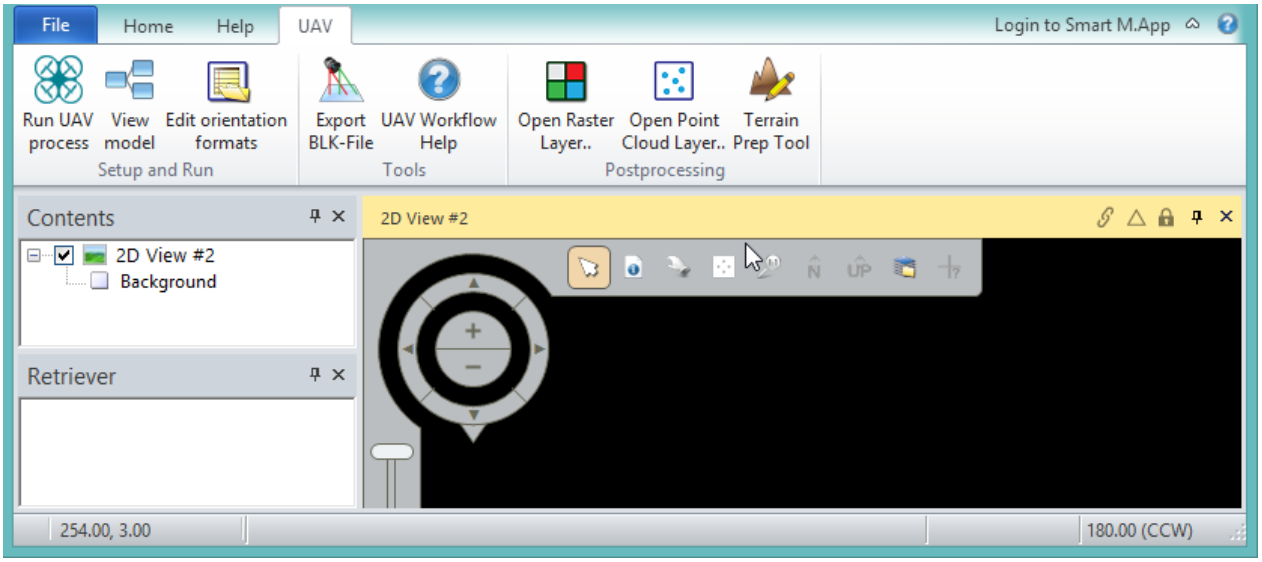
- **Orientation File:** `C:/users/public/geosystems/uav/examples/gravel-pit/image-positions.txt`
- Input ports of the **Export LAS** operator:
- **LASName**: output file for the point cloud in **LAS**-format: `gravelpit_pc.las`
- **EPSG**: 32632 (UTM zone 32 north/WGS84)
- Input ports of the **Export Mosaic** operator:
- **MosaicName**: output file for the image mosaic: `gravelpit_mosaic.tif`
- EPSG: 32632 (UTM zone 32 north/WGS84)
- Input ports of the **Export DEM** operator:
- **DEMName:** output file for the **DSM:** `gravelpit_dsm.tif`
- **EPSG:** 32632 (UTM zone 32 north/WGS84)

As you start the process, your final model should look like this:



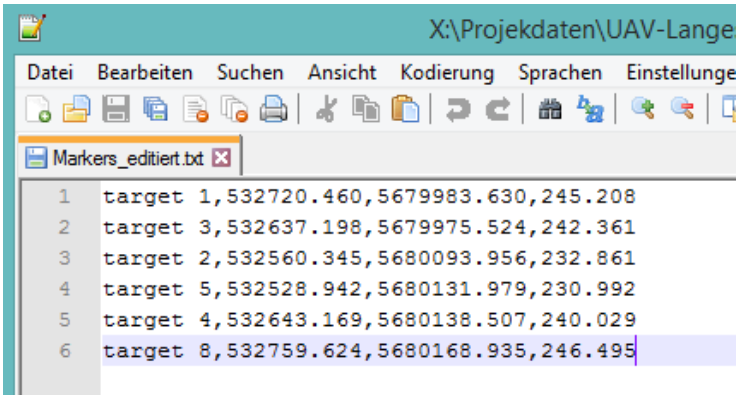
Hint 1: Use the UAV Layout

If your focus is processing UAV data, think about using the provided UAV layout instead of the default layout of ERDAS IMAGINE (File > Layout > GEOSYSTEMS UAV Workflow). Nota that the UAV layout contains only the most needed functions, as shown below.

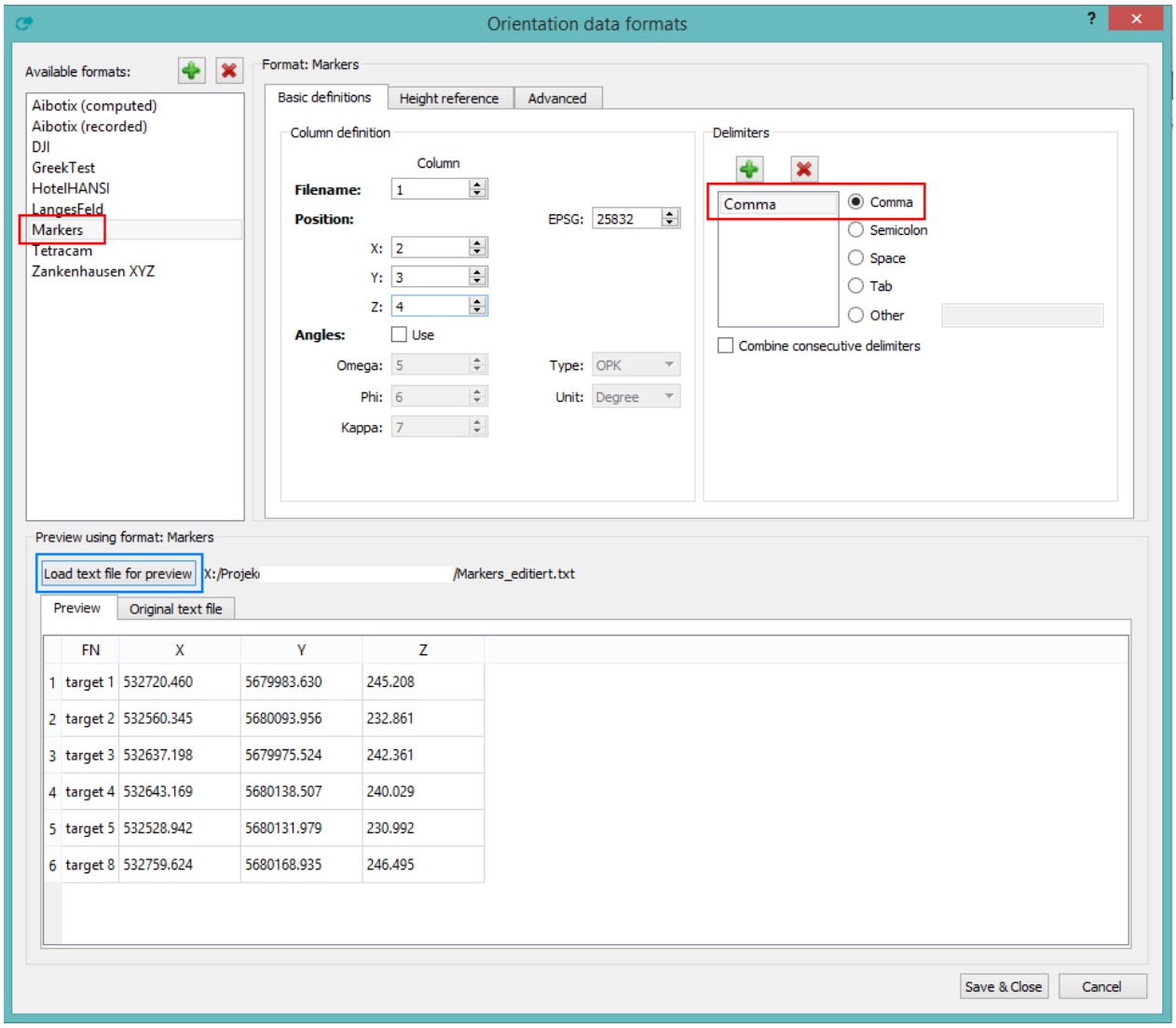


Hint 2: Using markers (Coded Targets)*Please note that the above described example with the gravel pit data does not account for markers. If you are interested in example data for testing markers in an UAV workflow, please contact us directly. Thus, the following steps explain how to include markers in general:*

1. To print markers for your own project, go to Agisoft Metashape and open the **Print Markers** dialogue (Tools > Markers > Print Markers). The markers are written into a pdf file and they are numbered consecutively. The size of the markers depends on the UAV flight height and the focal length. The side length of the square target which must be fixed on the ground should not go below 90 cm (e.g. the UAV is 80 m above the ground equipped with a 35 mm lens).
2. The markers must be placed according to photogrammetric rules, their geo-coordinates measured and listed in a text file. The column in the marker coordinate file containing the name reference must contain the string “target” followed by a space and the number of the coded target (see below).



3. In the same way as to define the orientation format you must define the format for the markers. Thus, in the ERDAS IMAGINE **Toolbox** tab open **MAGINE UAV** > **Edit orientation formats.**
4. Create a new format definition in the **Orientation Format Editor** by clicking the + button, next to the **Available formats** list. This adds a new entry to the format list. Here it is named `Markers`.
5. Load the actual marker file to preview and check the format settings. These can still be further adapted. Therefore, please see the described settings in the *Define Orientation Format Processing* under *Step 5.*, *6.* and *7.*



6. Click **Save & Close** to save all modified settings.
7. As reference spatial model, consider the example on page 11.