ATCOR Workflow for IMAGINE 2023

Manual

Software version: 3.0

Implementation of ATCOR Algorithms
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Cover: Sentinel-2, Netherlands, acquisition date: 5 August 2015, true color band composite;
top: original image, bottom: result of de-hazing with *ATCOR Workflow for IMAGINE.*

Content

1 Introduction

1.1 Overview

ATCOR stands for **Atmospheric and Topographic Correction**. It eliminates atmospheric and topographic effects in satellite imagery and extracts physical surface properties, such as surface reflectance, emissivity, and temperature.

The ATCOR algorithm was developed by Dr. Rolf Richter from DLR (German Aerospace Center, Oberpfaffenhofen). GEOSYSTEMS GmbH integrated ATCOR into ERDAS IMAGINE in cooperation with *ReSe Applications Schläpfer* and Dr. Rolf Richter.

ATCOR Workflow employs a database containing the result of radiative transfer calculations based on **MODTRAN® 5**.

ATCOR Workflow for IMAGINE includes three **processes**:

- **ATCOR Dehaze**: an optional pre-processing step for removing or reducing haze. If you just need a visually appealing image without being interested in physical quantities, haze removal without any further processing will satisfy your needs. Otherwise, continue with ATCOR-2 or ATCOR-3 (see below).
- **ATCOR-2**: the ATCOR process of choice, if the terrain covered by the imagery to be corrected is almost flat or if a proper Digital Elevation Model (DEM) is not available.
- **ATCOR-3**: the ATCOR process of choice for the correction of satellite imagery acquired over rugged terrain. With ATCOR-3, a combined atmospheric-topographic correction of satellite image data is performed. Thus, for ATCOR-3 a DEM is required.

ATCOR Workflow can be used via a **Dialog** (Section 3) or via the ERDAS IMAGINE **Spatial Modeler** (Section 4).

For getting started, a quick and easy **Step-By-Step Guide** leads you through all processing steps of ATCOR Workflow. The **PDF document** and **example data** can be downloaded from http://www.geosystems.de/en/products/atcor-workflow-for-imagine/download.

1.2 Requirements

ERDAS IMAGINE Level

The ATCOR Workflow Dialog is accessible for users of **IMAGINE Essential** and higher. For using the ATCOR Spatial Modeler operators, **IMAGINE Professional** is required.

ATCOR Workflow License

ATCOR Workflow is a charged add-on for ERDAS IMAGINE.

IDL Runtime License

ATCOR Workflow uses IDL (Interactive Data Language). The free IDL Virtual Machine is included in the ATCOR Workflow Installer. With this free IDL version, an IDL splash screen is displayed the first time an ATCOR Workflow process in a session is run. For disabling the splash screen (e.g. for unattended batch processing), an IDL runtime license has to be purchased. If an IDL runtime license already exists, ATCOR Workflow uses this license by default.

2 About ATCOR Workflow

ATCOR Workflow operates based on projects. For each image to be processed, an individual ATCOR project has to be created. To create a project, a folder has to be specified. In this project folder, ATCOR Workflow stores all files relevant for the project:

- **ATCOR project file** (GEOSYSTEMS_ATCOR.project): it contains the basic information on a project. It must not be modified or deleted by the user.
- **Log file** (<ImageBasename>.log): contains detailed information about the executed process including warnings and error messages.
- **Calibration file** (<ImageBasename>.cal): it contains sensor- and image-specific calibration parameters (Section 7.2).
- **Output files** of the processes ATCOR Dehaze, ATCOR-2, and ATCOR-3, if no output file name was specified.

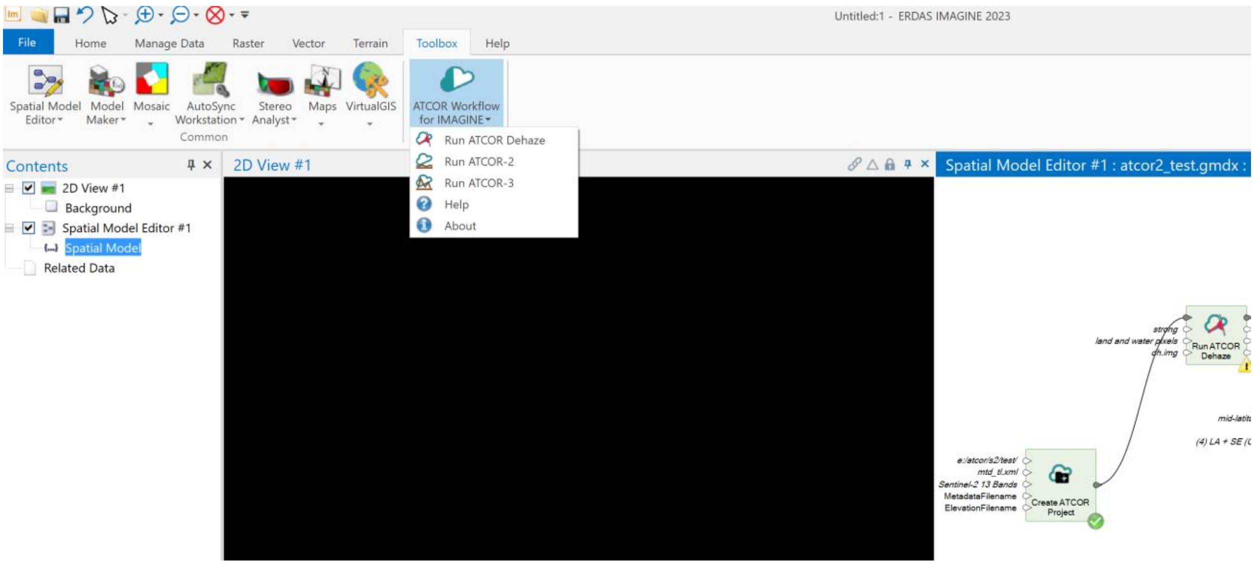
Once a project is created, any ATCOR process, i.e., Dehaze, ATCOR-2, or ATCOR-3, can be executed.

ATCOR Workflow creates also some internal files. These files are written to the ***Repository*** folder, a subfolder in the ATCOR project folder. It must not be modified or deleted by the user.

An ATCOR project can be moved to another location provided that the absolute paths of the image file as well as the metadata file (if specified) and the elevation file (if specified) are still valid.

3 ATCOR Workflow Dialog

The ATCOR Workflow dialog provides access to the full functionality of ATCOR Workflow for IMAGINE via a graphical user interface. It is located in the **ERDAS IMAGINE Toolbox** Tab.



There are three **processes** available,

- **ATCOR Dehaze** for removing or reducing haze,
- **ATCOR-2**, for atmospheric correction of flat terrain, and
- **ATCOR-3**, for atmospheric and topographic correction of mountainous terrain.

Sections 3.1 to 3.3 describe, how to run these processes using the **ATCOR Workflow dialog**.

The dialogs provide the following **buttons**:

Run Click to start the process with the options selected and close the dialog.

Batch	Click to open the *Batch Command Editor* to schedule one or multiple processing jobs. For more information on batch processing see Section 8.
Cancel	Click to cancel this process and close the dialog.
View …	Click to open a graphical model (*.gmdx) serving as an example for this process. The Spatial Model Editor opens. Only available in ERDAS IMAGINE Professional.
Help	Click to open the Help document.

3.1 Run ATCOR Dehaze

3.1.1 Description

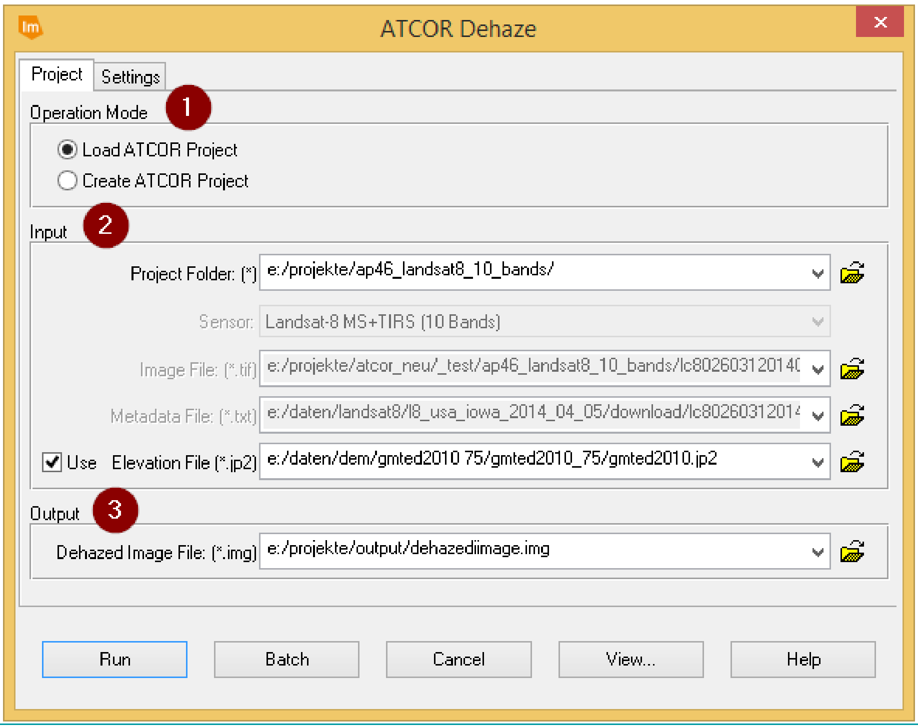
Since version 1.2 of ATCOR for IMAGINE 2020, *ATCOR Dehaze* can optionally be run in standalone mode as before or directly within *ATCOR-2* and *ATCOR-3* such that the dehaze output directly serves as input for *ATCOR-2* or *ATCOR-3*.

The process *ATCOR Dehaze* removes haze and thin clouds from the raw image. In addition to the dehazed image, a map is computed containing the categories haze, cloud, water, land, shadow etc. The haze map categories are listed in Table 1.

The dialog consists of two tabs, the ***Project Tab*** (Section 3.1.2) for specifying input and output parameters as well as the ***Settings Tab*** (Section 3.1.3) for editing metadata and processing parameters. When all mandatory input parameters are specified, the **Run** button becomes active, and you can start the process.

⚠ The process *ATCOR Dehaze* has to be applied to the raw image and NOT to the atmospherically corrected image. So, first run *ATCOR Dehaze* and then *ATCOR-2* or *ATCOR-3* by using the *Run ATCOR-2 / -3* dialog and loading the previously created ATCOR project. Input imagery requires to have a **projected coordinate system** assigned, e.g. UTM, and does not work with geographic coordinate systems!

3.1.2 Project Tab



(1) Operation Mode

Load ATCOR Project	Load an existing ATCOR project.
Create ATCOR Project	Create a new ATCOR project. Once a project is created, any ATCOR process, i.e. ATCOR Dehaze, ATCOR-2, or ATCOR-3, can be executed.

(2) Input

The inputs that can be specified depend on the selected operation mode (*Load ATCOR project* or *Create ATCOR Project*). Mandatory inputs are marked with a *.

Load ATCOR Project

Project Folder *:	Select an existing ATCOR project folder. If a valid ATCOR project folder was chosen, the input fields **Sensor**, **Image File**, and **Metadata File** are filled automatically.
Sensor, **Image File**, and **Metadata File**:	These inputs cannot be modified for an existing project. If you want to update one of these input parameters, a new project has to be created.
Elevation File:	You can either add an elevation file to an existing project or change the specified elevation file. If an elevation file is part of the project, you can use the checkbox to decide if you want to use the elevation file or not. The DEM must be a single band file in either integer, unsigned integer or floating point. 32bit is not supported.

Create ATCOR Project

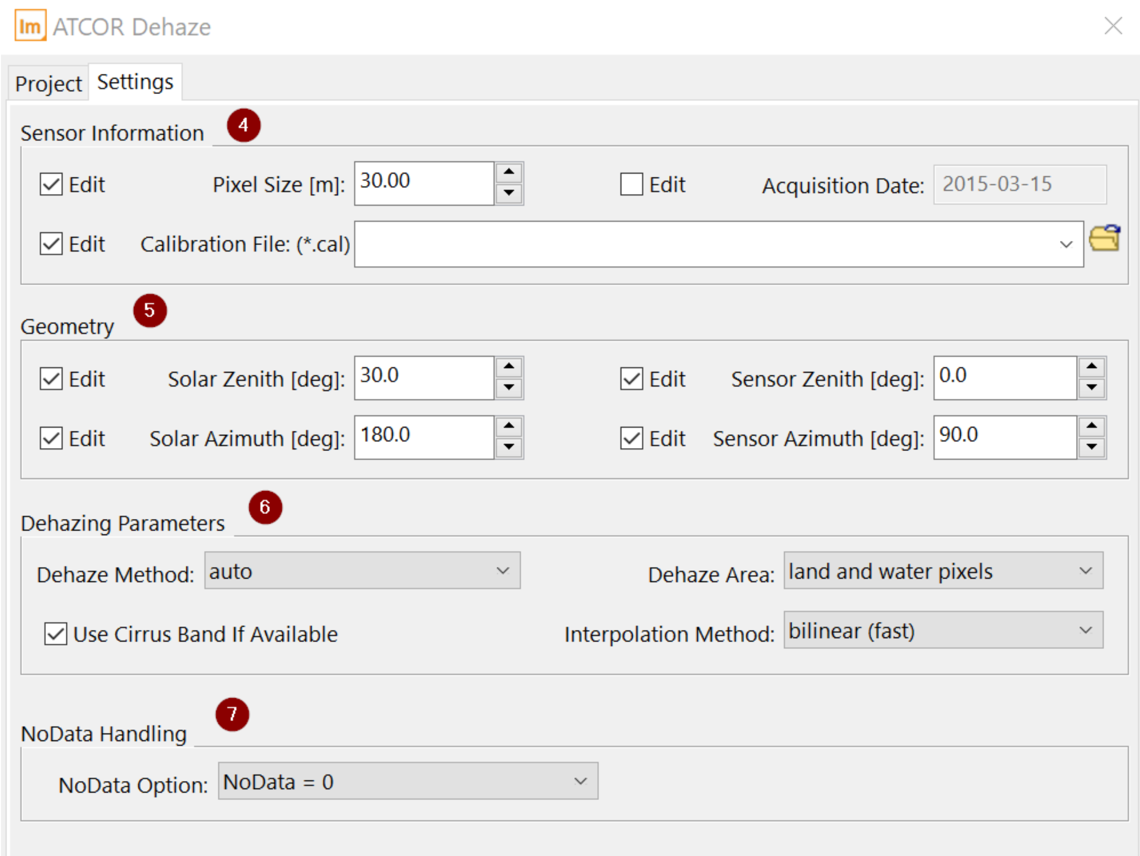
Project folder *:	Select a directory that you want to use as project folder for the new project. It is recommended to choose an empty folder. For each image to be processed, use a separate project folder to avoid that files in the folder are overwritten accidentally.
Sensor *:	Choose a sensor from the provided list.
Image File *:	Specify the image to be processed. All file types that can be directly read in ERDAS IMAGINE (File – Open – Raster Layer) are supported. For sensor specific information on the image file see Section 6.
Metadata File:	Specify the metadata file corresponding to the image file, if the metadata import is supported for the selected sensor (Table 8). Then all metadata relevant for ATCOR are added to the project. The following file extensions are valid: .TXT, .IMD, .XML, .DIM.
Elevation File:	Here you can specify an elevation file. For *ATCOR Dehaze* it is optional. The DEM must be a single band file in either integer, unsigned integer or floating point. 32bit is not supported.

(3) Output

Dehazed Image File:	Specify the name of the output file. Possible image formats are .TIF, .IMG, .JP2, and .ECW.

3.1.3 Settings Tab

⚠ For sensors with automatic metadata import (Table 8), the settings in the ***Sensor Information*** box and in the ***Geometry*** box are set automatically, when a new project is created. They do not have to be entered by the user. For other sensors, the inputs have to be entered manually. For entering the settings on this tab, check the corresponding *Edit* checkbox.



(4) Sensor Information

Pixel Size	Pixel size of the image file.
Acquisition Date	Acquisition date of the image file in ISO format (YYYY-MM-DD).
Calibration File	Select the calibration file. The calibration file is sensor-specific (Section 7.2). For sensors with automatic metadata import (Table 8), the calibration file is created automatically. For other sensors, a calibration file template with default calibration parameters is copied to the project folder. You can use this file as a basis to start from and edit the calibration parameters in this file to optimize your result.

(5) Geometry

Solar Zenith	Solar zenith angle in degree at time of image acquisition.
Solar Azimuth	Solar azimuth angle in degree at time of image acquisition.
Sensor Zenith	Sensor incidence angle in degree.
Sensor Azimuth	Sensor azimuth angle in degree.

(6) Dehaze Parameters

Dehaze Method	Select '*standard'* for removal of thin to medium haze, '*strong'* for removal of thin to moderately thick haze, or '*auto'*. With '*auto'* both options, '*standard'* and '*strong'*, are executed and the better result is kept. The default value is '*auto'*. For more information, please see Section 5.1.1.
Dehaze Area	Select if only land pixels will be dehazed or if both, land and water pixels will be dehazed. The default value is '*land and water pixels*'. For more information, please see Section 5.1.2.
Use Cirrus Band If Available	Specify if you want to use the Cirrus band, if it is available for the selected sensor. The default value is '*TRUE*
Interpolation Method	Select the interpolation method used for bright areas. The default value is '*bilinear'*. For more information, please see Section 5.1.3.

7) NoData Option

NoData = 0	This is the default value. Resulting corrected images will feature 0 as a NoData value.
NoData = 65535	The NoData value of corrected images will be set to 65535 instead of 0.
NoData = 0; recoded to 1 in active image area	The NoData value for inactive image areas of the corrected images will be set to 0, while for active image area 0 values are recoded to 1. For image areas with very low reflectance this avoids NoData values at positions where low values would be physically correct.

3.1.4 Output

There are two outputs, the **dehazed image** and the **haze map**. If the file name for the dehazed image file is *<dehazedImage>.img,* the file name of the haze map is *<dehazedImage>_haze_map.tif*. The haze map contains 21 classes as listed in Table 1 at page 39.

3.2 Run ATCOR-2

3.2.1 Description

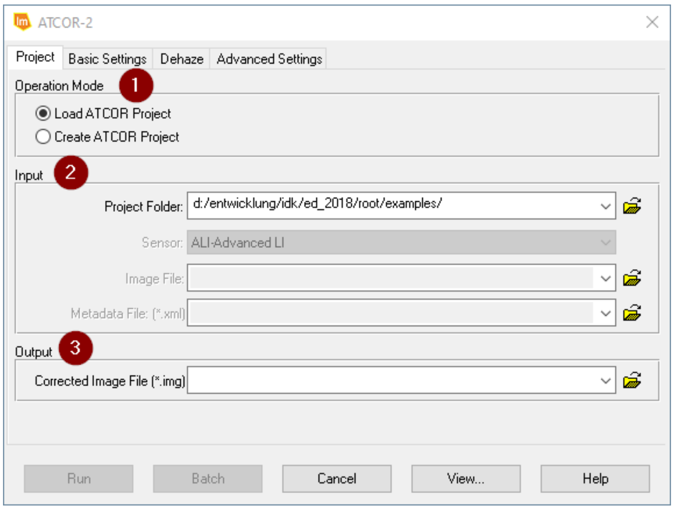
The process *ATCOR-2* applies **atmospheric correction** to the image. The *ATCOR-2* process is intended for **flat terrain**. For mountainous terrain, the *ATCOR-3* process is recommended (see Section 4.5).

The main output of *ATCOR-2* is the **atmospherically corrected image** (surface reflectance, surface temperature). The first bands of the output file represent '*surface reflectance*' corresponding to the reflective input bands. If the input data set also contained thermal bands (e.g. Landsat), the last band of the output file represents '*surface temperature*' in degree Celsius (°C). The scaling factor is per default 4 for 8-bit data and 100 for 16-bit data. It can be set on the *Set ATCOR Parameters* operator.
In addition to the atmospherically corrected image, a set of useful quantities, such as leaf area index (LAI) or albedo, can be calculated. The calculation of the **value-added products** file can be switched on using the 'Set ATCOR Parameters' operator (see Section 4.6, Tab 'Advanced'). The value-added products are stored in a separate file with the file name ending '_flx'. It contains at least six layers (Table 2, layer 1 to 6) and, in case of at least one thermal band, 4 additional layers (layer 7 to 11).

If *ATCOR Dehaze* was executed previously to *ATCOR-2*, the result of *ATCOR Dehaze* is used as input for *ATCOR-2* by default. Additionally, *ATCOR Dehaze* is now available in the *ATCOR-2* workflow as described below.

The dialog consists of three tabs, the ***Project Tab*** (Section 3.2.2) for specifying input and output parameters, as well as the ***Basic Settings Tab*** (Section 3.2.3) and the ***Advanced Settings Tab*** (Section 3.2.4) for editing metadata and processing parameters. When all mandatory input parameters are specified, the **Run** button becomes active and you can start the process.

3.2.2 Project Tab



(1) Operation Mode

Load ATCOR Project	Load an existing ATCOR project.
Create ATCOR Project	Create a new ATCOR project. Once a project is created, any ATCOR process, i.e. *ATCOR Dehaze*, *ATCOR-2*, or *ATCOR-3*, can be executed.

(2) Input

The inputs that can be specified depend on the selected operation mode (*Load ATCOR Project* or *Create ATCOR Project*). Mandatory inputs are marked with a *.

Load ATCOR Project

Project Folder *:	Select an existing ATCOR project folder. If a valid ATCOR project folder was chosen, the input fields **Sensor**, **Image File**, and **Metadata File** are filled automatically.
Sensor, **Image File**, and **Metadata File**:	These inputs cannot be modified for an existing project. If you want to update one of these input parameters, a new project has to be created.

Create ATCOR Project

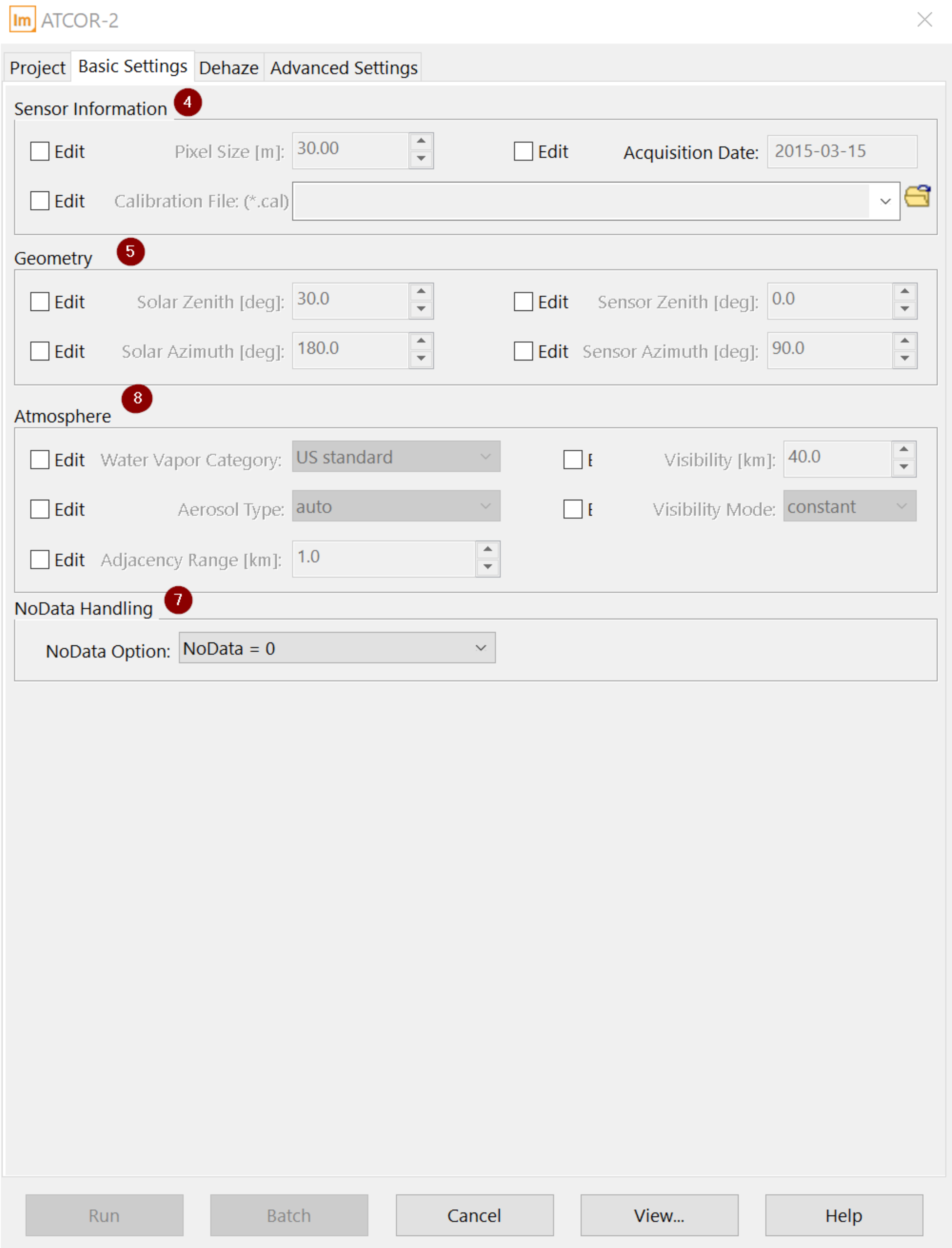
Project folder *:	Select a directory that you want to use as project folder for the new project. It is recommended to choose an empty folder. For each image to be processed use a separate project folder to avoid that files in the folder are overwritten accidentally.
Sensor *:	Choose a sensor from the provided list.
Image File *:	This is the image to be processed. All file types that can be directly read in ERDAS IMAGINE (File – Open – Raster Layer) are supported.
Metadata File:	Specify the metadata file corresponding to the image file, if the metadata import is supported for the selected sensor (Table 8). Then all metadata relevant for ATCOR are added to the project. The following file extensions are valid: .TXT, .IMD, .XML, .DIM.

(3) Output

Corrected Image File:	Specify the name of the output file. Possible image formats are .TIF, .IMG, .JP2, and .ECW.

3.2.3 Basic Settings Tab

⚠ For sensors with automatic metadata import (Table 8), the settings in the ***Sensor Information*** box and in the ***Geometry*** box are set automatically, when a new project is created. They do not have to be entered by the user. For other sensors, the inputs have to be entered manually. For entering the settings on this tab, check the corresponding *Edit* checkbox.



(4) Sensor Information

Pixel Size	Pixel size of the image file.
Acquisition Date	Acquisition date of the image file in ISO format (YYYY-MM-DD).
Calibration File	Select the calibration file. The calibration file is sensor-specific (Section 7.2). For sensors with automatic metadata import (Table 8), the calibration file is created automatically. For other sensors, a calibration file template with default calibration parameters is copied to the project folder. You can use this file as a basis to start from and edit the calibration parameters in this file to optimize your result.

(5) Geometry

Solar Zenith	Solar zenith angle in degree at time of image acquisition.
Solar Azimuth	Solar azimuth angle in degree at time of image acquisition.
Sensor Zenith	Sensor incidence angle in degree.
Sensor Azimuth	Sensor azimuth angle in degree.

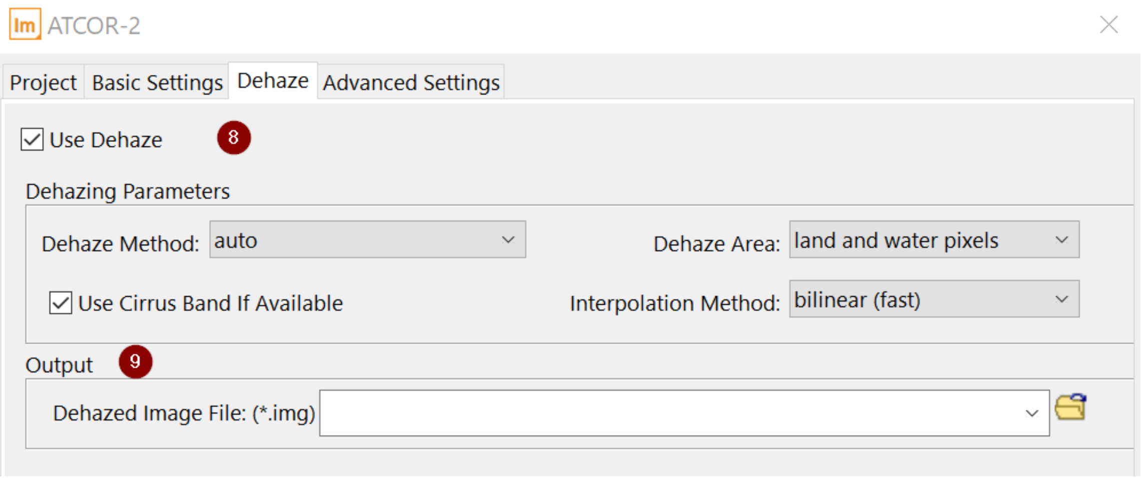
(6) Atmosphere

Water Vapor Category	Select a pre-defined standard atmosphere in terms of water vapor content to roughly characterize water vapor conditions at the time of image acquisition. The default value is '*US-standard*'.
Aerosol Type	Select a pre-defined standard atmosphere in terms of aerosol conditions to roughly characterize aerosol content at the time of image acquisition. The default value is '*rural'*.
Adjacency Range	Specifies the maximum distance in kilometer that is applied to consider **adjacency radiation**. Adjacency radiation is radiation reflected from the neighborhood of a pixel scattered into the viewing direction and consequently blurring reflectance and emissivity information measured for that pixel at the sensor. Thus, atmospheric correction aims for eliminating this radiation component. The default value is 1.0 km.
Visibility	Specify the lower bound of the **visibility** parameter (aerosol optical thickness) in kilometer. If the automatic retrieval of this parameter based on dark reference areas fails, the specified value is used. The default value is 23.0 km.
Visibility Mode	Specifies if a constant value for the **visibility** parameter (aerosol optical thickness) per scene is used or if the visibility is estimated on a pixel-by-pixel basis based on dark reference areas in the scene. The default value is '*variable'*.

(7) NoData Option

NoData = 0	This is the default value. Resulting corrected images will feature 0 as a NoData value.
NoData = 65535	The NoData value of corrected images will be set to 65535 instead of 0.
NoData = 0; recoded to 1 in active image area	The NoData value for inactive image areas of the corrected images will be set to 0, while for active image area 0 values are recoded to 1. For image areas with very low reflectance this avoids NoData values at positions where low values would be physically correct.

3.2.4 Dehaze Tab



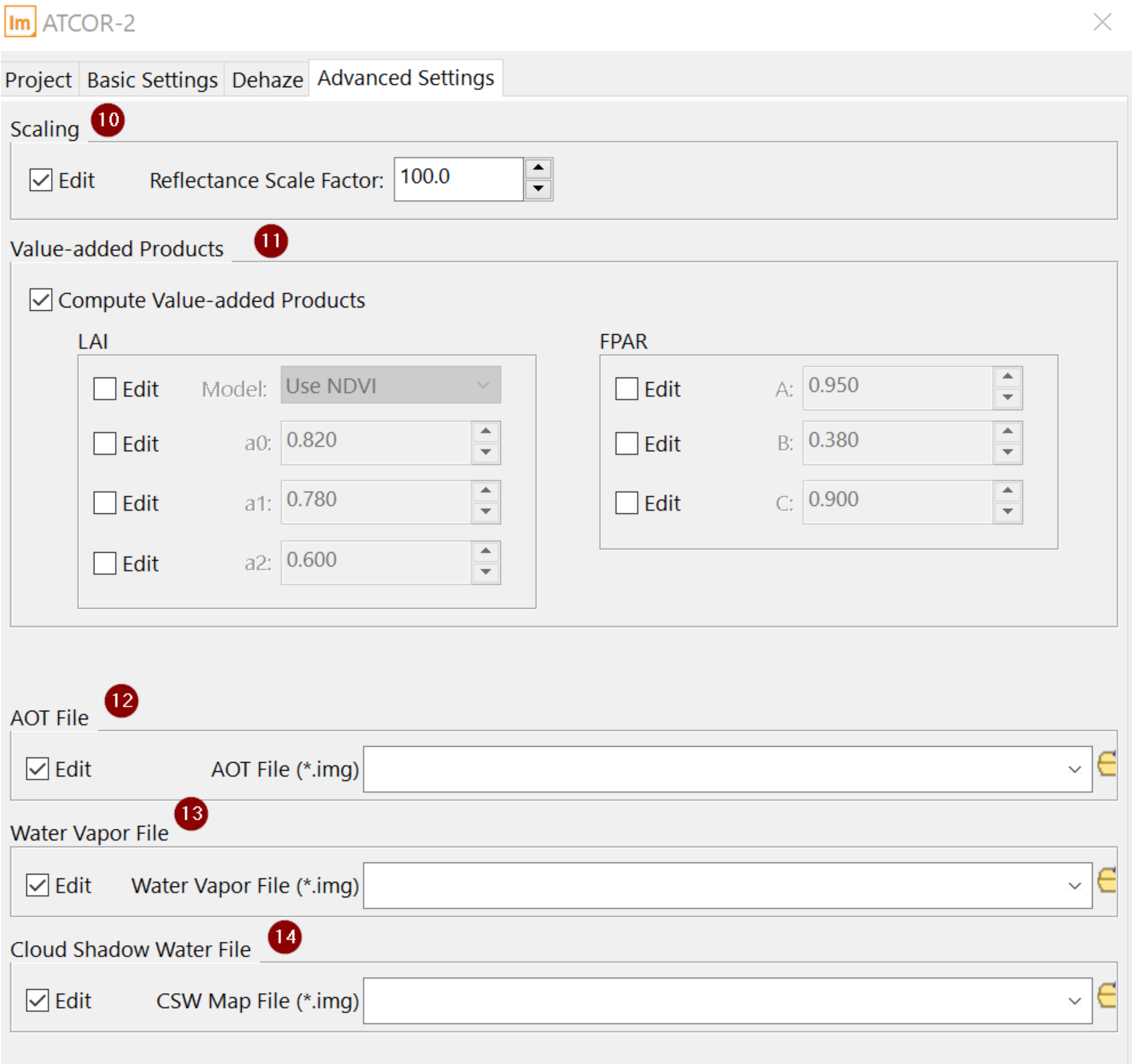
(8) Use Dehaze and Dehazing Parameters

Dehaze Method	Specify the dehaze method (auto, strong, or standard).
Dehaze Area	Define if the scene contains land and water pixels or land pixels only.
Use Cirrus Band if available	If the sensor provides a cirrus band it will be considered if checked.
Interpolation Method	Choose between bilinear interpolation and triangulation.

(9) Output

Dehazed Image File	Specify the name of the output file. Supported image formats are .TIF, .IMG, .JP2, and .ECW.

3.2.5 Advanced Settings Tab



(10) Scaling

Reflectance Scale Factor	Specifies the multiplication factor for surface reflectance (and surface temperature) in the output file of ATCOR-2. A scale factor of 1 yields the output as float data (4 bytes per pixel). If the input data is 16 bit, a scale factor of 100 is recommended (default). So a surface reflectance value of 20.56 % is coded as 2056. If the input data is 8 bit, a scale factor of 4 is recommended (default), i.e. a surface reflectance of 20.56 % is coded as 82.

(11) Value-added Products

Compute Value-added Products	Check this box if you want to compute value-added products as listed in Table 2.
LAI	

Model	Select the vegetation index that you want to use for approximating the LAI (Leaf Area Index). For more information see Section 5.2.10.
a0, a1, a2	Enter values for the LAI model parameters a0, a1 and a2. For more information see Section 5.2.10.
FPAR	
A, B, C	Enter values for the FPAR model parameters A, B, and C. For more information see Section 5.2.11.

(12) Aerosol Optical Thickness File

AOT File	
AOT File	Specifies the filename and format (.ecw, .jp2, .img, .tif) of the exported aerosol optical thickness file. Only supported for multisensors.

(13) Water Vapor File

Water Vapor File	
Water Vapor File	Specifies the filename and format (.ecw, .jp2, .img, .tif) of the exported water vapor file. Only supported for sensors with water vapor bands, e.g. Sentinel-2.

(14) Cloud Shadow Water File

Cloud Shadow Water File	
Cloud Shadow Water File	Specifies the filename and format (.ecw, .jp2, .img, .tif) of the exported cloud shadow water map file.

3.2.6 Output

The main output of the ATCOR-2 process is the **atmospherically corrected image**. The first bands of the output file represent '*surface reflectance*' corresponding to the reflective input bands. If the input data set also contained thermal bands (e.g. Landsat), the last band of the output file represents '*surface temperature*' in degree Celsius (°C). The scaling factor is per default 4 for 8-bit data and 100 for 16-bit data. It can be set on the Advanced Settings Tab.
If specified, also a **value-added products file** (Table 2) is computed. If for the corrected image the file name *<CorrectedImage>.img* was specified, the file name of the value-added products file is *<CorrectedImage> _flx.img*.
On specification of a filename for the AOT file, this will be exported to the specified format. The same applies to the water vapor file.
Additionally, for **multi-channel input imagery** the cloud water shadow (CSW) map is generated if a file name and directory are being provided. It is a thematic raster which contains 7 classes:

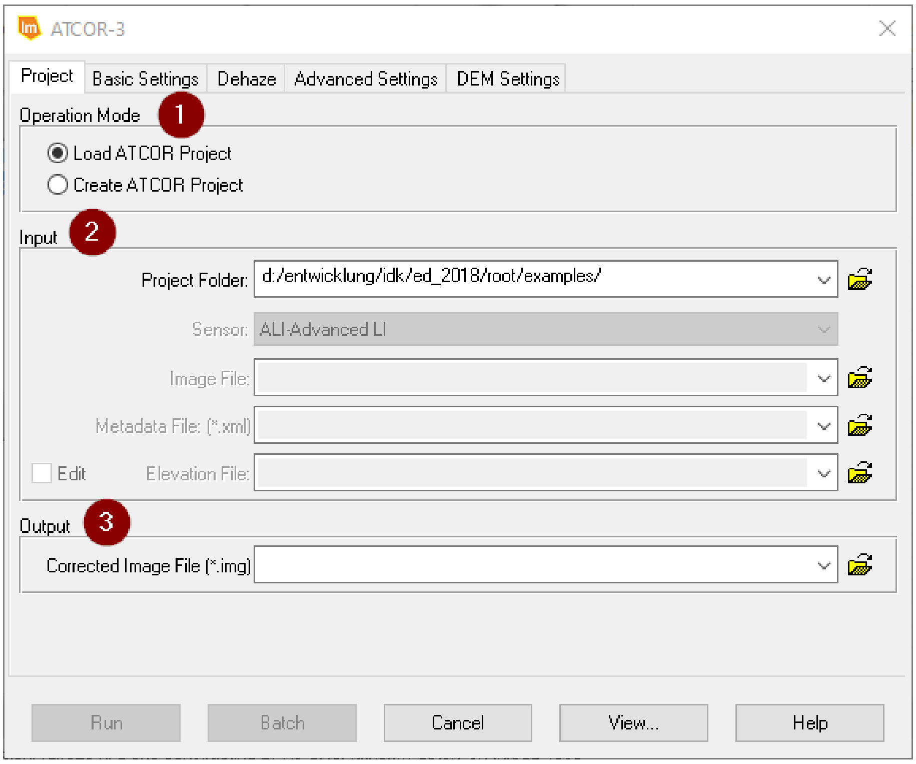
label	definition	color coding
0	geocoded background	grey
1	clear	brown
2	semi-transparent cloud	yellow
3	cloud	bright grey
4	shadow	black
5	water	dark blue
6	snow/ice	white
7	topographic shadow	grey/black

If specified, also the Dehaze products are computed (see 3.1.4).

3.3 Run ATCOR-3

The dialog consists of three tabs, the *Project* Tab for specifying input and output parameters, as well as the *Basic Settings* Tab and the *Advanced Settings* Tab for editing metadata and processing parameters. When all mandatory input parameters are specified, the **Run** button becomes active and you can start the process.

3.3.1 Project Tab



(1) Operation Mode

Load ATCOR Project	Load an existing ATCOR project.
Create ATCOR Project	Create a new ATCOR project. Once a project is created, any ATCOR process, i.e. *ATCOR Dehaze*, *ATCOR-2*, or *ATCOR-3*, can be executed.

(2) Input

The inputs that can be specified depend on the selected operation mode (*Load ATCOR Project* or *Create ATCOR Project*). Mandatory inputs are marked with a *.

Load ATCOR Project

Project Folder *:	Select an existing ATCOR project folder. If a valid ATCOR project folder was chosen, the input fields **Sensor**, **Image File**, and **Metadata File** are filled automatically.
Sensor, **Image File**, and **Metadata File**:	These inputs cannot be modified for an existing project. If you want to update one of these input parameters, a new project has to be created.
Elevation File *:	You can either add an elevation file to an existing project or change the specified elevation file. 32bit is not supported.

Create ATCOR Project

Project folder *:	Select a directory that you want to use as project folder for the new project. It is recommended to choose an empty folder. For each image to be processed, use a separate project folder to avoid that files in the folder are overwritten accidentally.
Sensor *:	Choose a sensor from the provided list.
Image File *:	This is the image to be processed. All file types that can be directly read in ERDAS IMAGINE (File – Open – Raster Layer) are supported. For sensor specific information on the input file see Section 6.

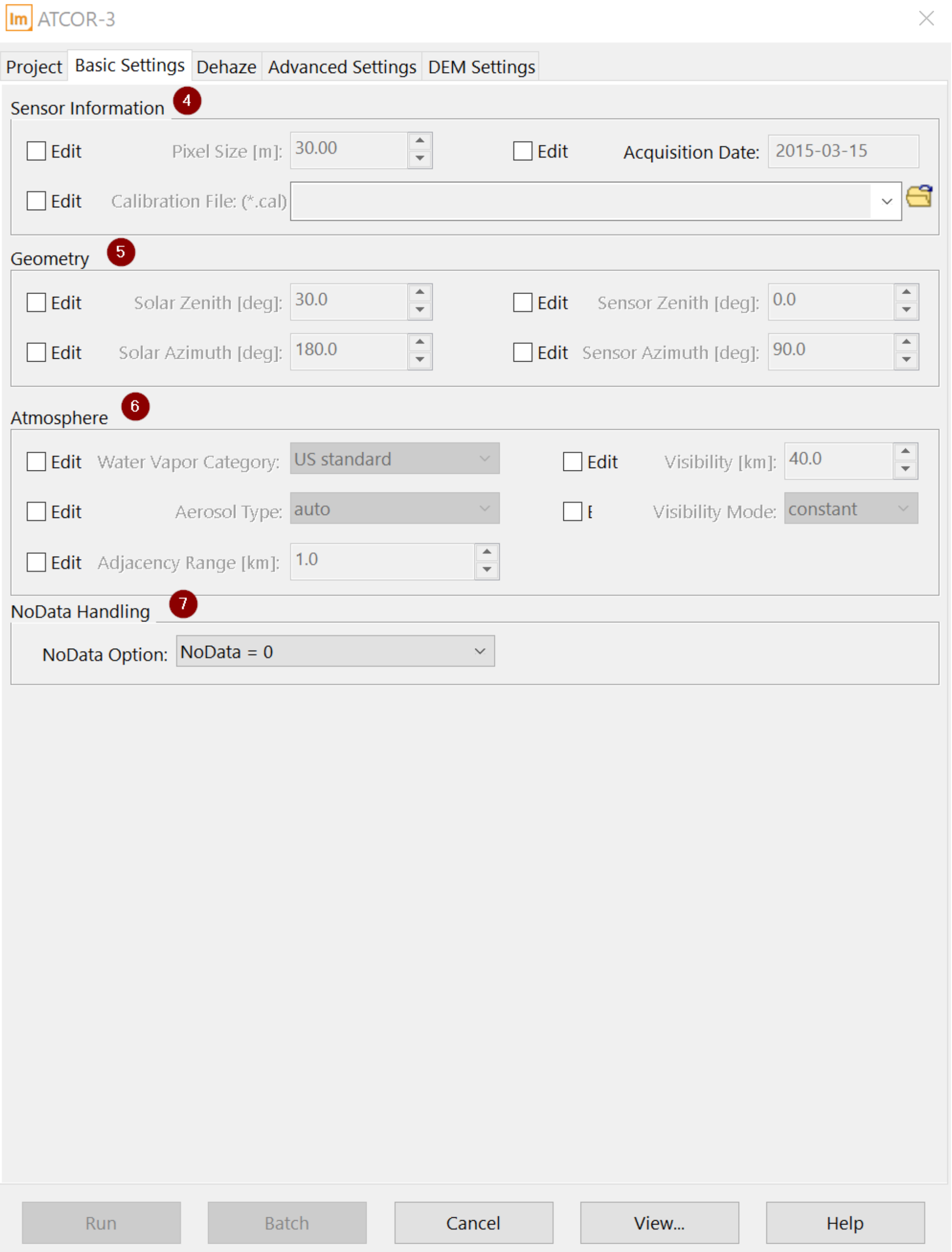
Metadata File:	Specify the metadata file corresponding to the image file, if the metadata import is supported for the selected sensor (Table 8). Then all metadata relevant for ATCOR are added to the project. The following file extensions are valid: .TXT, .IMD, .XML, .DIM. For sensor specific information on the metadata file see Section 6.
Elevation File *:	Specify the elevation file. It is mandatory for the ATCOR-3 process.

(3) Output

Corrected Image File:	Specify the name of the output file. Supported image formats are .TIF, .IMG, .JP2, and .ECW.

3.3.2 Basic Settings Tab

⚠ For sensors with automatic metadata import (Table 8), the settings in the ***Sensor Information*** box and in the ***Geometry*** box are set automatically, when a new project is created. They do not have to be entered by the user. For other sensors, the inputs have to be entered manually. For entering the settings on this tab, check the corresponding *Edit* checkbox.



(4) Sensor Information

Pixel Size	Pixel size of the image file.
Acquisition Date	Acquisition date of the image file in ISO format (YYYY-MM-DD).
Calibration File	Select the calibration file. The calibration file is sensor-specific (Section 7.2). For sensors with automatic metadata import (Table 8), the calibration file is created automatically. For other sensors, a calibration file template with default calibration parameters is copied to the project folder. You can use this file as a basis to start from and edit the calibration parameters in this file to optimize your result.

(5) Geometry

Solar Zenith	Solar zenith angle in degree at time of image acquisition.
Solar Azimuth	Solar azimuth angle in degree at time of image acquisition.
Sensor Zenith	Sensor incidence angle in degree.
Sensor Azimuth	Sensor azimuth angle in degree.

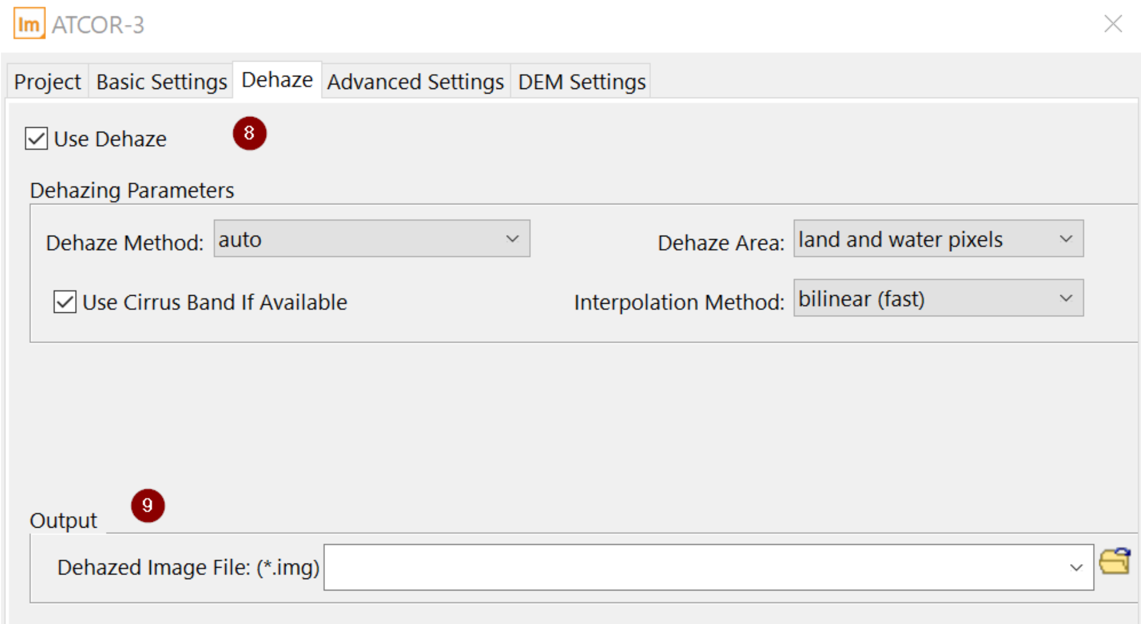
(6) Atmosphere

Water Vapor Category	Select a pre-defined standard atmosphere in terms of water vapor content to roughly characterize water vapor conditions at the time of image acquisition. The default value is '*US-standard*'.
Aerosol Type	Select a pre-defined standard atmosphere in terms of aerosol conditions to roughly characterize aerosol content at the time of image acquisition. The default value is '*rural'*.
Adjacency Range	Specifies the maximum distance in kilometer that is applied to consider **adjacency radiation**. Adjacency radiation is radiation reflected from the neighborhood of a pixel scattered into the viewing direction and consequently blurring reflectance and emissivity information measured for that pixel at the sensor. Thus, atmospheric correction aims for eliminating this radiation component. The default value is 1.0 km.
Visibility	Specify the lower bound of the **visibility** parameter (aerosol optical thickness) in kilometer. If the automatic retrieval of this parameter based on dark reference areas fails, the specified value is used. The default value is 23.0 km.
Visibility Mode	Specifies if a constant value for the **visibility** parameter (aerosol optical thickness) per scene is used or if the visibility is estimated on a pixel-by-pixel basis based on dark reference areas in the scene. The default value is '*variable'*.

7) NoData Option

NoData = 0	This is the default value. Resulting corrected images will feature 0 as a NoData value.
NoData = 65535	The NoData value of corrected images will be set to 65535 instead of 0.
NoData = 0; recoded to 1 in active image area	The NoData value for inactive image areas of the corrected images will be set to 0, while for active image area 0 values are recoded to 1. For image areas with very low reflectance this avoids NoData values at positions where low values would be physically correct.

3.3.3 Dehaze Tab



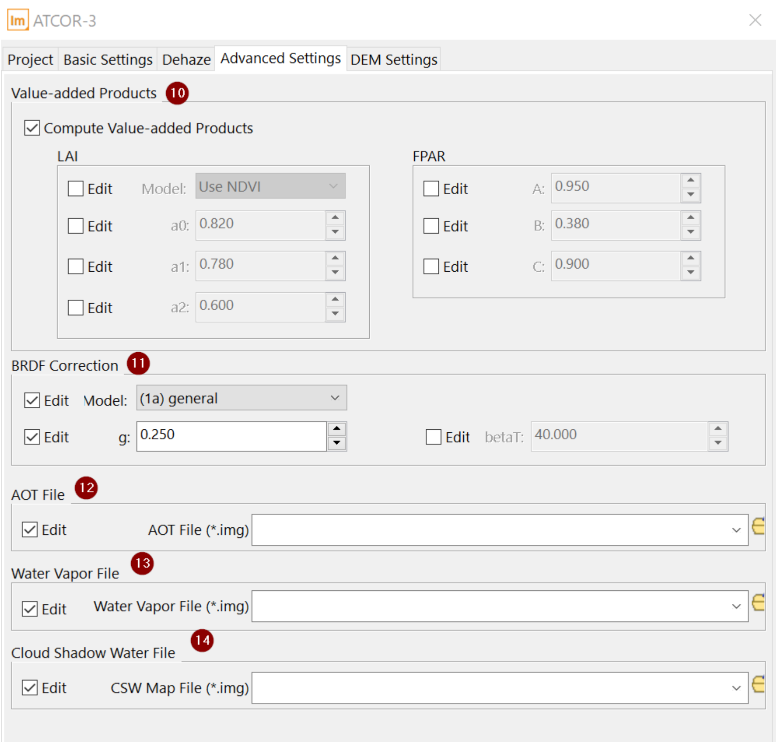
(8) Use Dehaze and Dehazing Parameters

Dehaze Method	Specify the dehaze method (auto, strong, or standard).
Dehaze Area	Define if the scene contains land and water pixels or land pixels only.
Use Cirrus Band if available	If the sensor provides a cirrus band it will be considered if checked.
Interpolation Method	Choose between bilinear interpolation and triangulation.

(9) Output

Dehazed Image File	Specify the name of the output file. Possible image formats are .TIF, .IMG, .JP2, and .ECW.

3.3.4 Advanced Settings Tab



(10) Value-added Products

Compute Value-added Products	Check this box if you want to compute value-added products as listed in Table 2.
LAI	
Model	Select the vegetation index that you want to use for approximating the LAI (Leaf Area Index). For more information, please see Section 5.2.10.
a0, a1, a2	Enter values for the LAI model parameters a0, a1 and a2. For more information, please see Section 5.2.10.
FPAR	
A, B, C	Enter values for the FPAR model parameters A, B, and C. For more information please see Section 5.2.11.

(11) BRDF Correction

Model	Select the BRDF model parametrization in terms of parameter *b* to be used for the BRDF correction. For more information, please see Section 5.2.9.
g	Enter the value for the parameter *g* required for the BRDF correction. For more information, please see Section 5.2.9.
betaT	Enter the value for the parameter *betaT* required for the BRDF correction. For more information, please see Section 5.2.9.

(12) Aerosol Optical Thickness

AOT File	
AOT File	Specifies the filename and format (.ecw, .jp2, .img, .tif) of the exported aerosol optical thickness file. Only supported for multisensors.

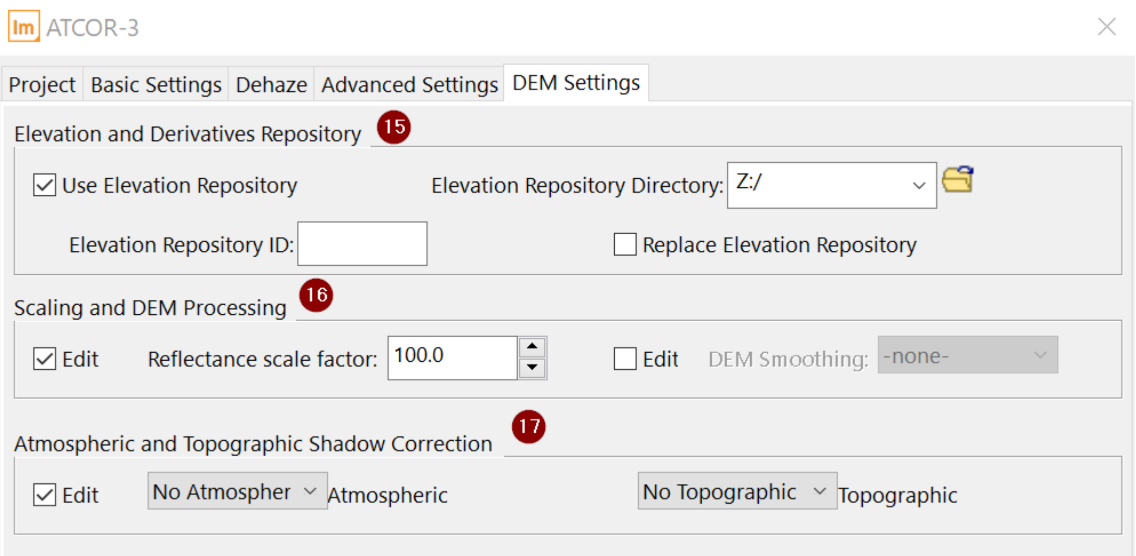
(13) Water Vapor File

Water Vapor File	
Water Vapor File	Specifies the filename and format (.ecw, .jp2, .img, .tif) of the exported water vapor file. Only supported for sensors with water vapor bands, e.g. Sentinel-2.

(14) Cloud Shadow Water File

Cloud Shadow Water File	
Cloud Shadow Water File	Specifies the filename and format (.ecw, .jp2, .img, .tif) of the exported cloud shadow water map file.

3.3.5 DEM Settings Tab



(15) Elevation and Derivatives Repository

Use Elevation Repository	Select if you want to use an elevation repository for recurring processing of the same area. DEM and the aspect, slope and skyview derivatives will be reused. In case the repository does not yet exist, it will be generated.
ElevationRepository Directory	Insert the directory path for the elevation repository.
Elevation Repository ID	Assign an ID to the elevation repository. If the repository already exists, the ID allows ATCOR to use the associated files.
Replace Elevation Repository	Define whether the elevation repository with the according ID should be overwritten or not.
DEM Smoothing	Select a kernel size for smoothing the specified digital elevation model (DEM). If you do not want to smooth the DEM, choose *'-none-'*.

(16) Scaling and DEM Processing

Reflectance Scale Factor	Specifies the multiplication factor for surface reflectance (and surface temperature) in the output file of ATCOR-3. A scale factor of 1 yields the output as float data (4 bytes per pixel). If the input data is 16 bit, a scale factor of 100 is recommended (default). So a surface reflectance value of 20.56 % is coded as 2056. If the input data is 8 bit, a scale factor of 4 is recommended (default), i.e. a surface reflectance of 20.56 % is coded as 82.

(17) Atmospheric and Topographic Correction

Atmospheric Shadow Corr.	Allows to choose whether atmospheric cloud and building shadow correction should be applied or not.
Topographic Shadow Corr.	Allows to choose whether topographic shadow correction should be applied or not.

3.3.6 Output

The main output of the ATCOR-3 process is the **atmospherically and topographically corrected image**. The first bands of the output file represent '*surface reflectance*' corresponding to the reflective input bands. If the input data set also contained thermal bands (e.g. Landsat), the last band of the output file represents '*surface temperature*' in degree Celsius (°C). The scaling factor is per default 4 for 8-bit data and 100 for 16-bit data. It can be set on the Advanced Settings Tab.

If specified, also a **value-added products file** (Table 2) is computed. If for the corrected image the file name *<CorrectedImage>.img* was specified, the file name of the value-added products file is *<CorrectedImage>_flx.img*.

On specification of a filename for the AOT file, this will be exported to the specified format if the sensor supports it. The same applies to the water vapor file, which requires a sensor featuring water vapor bands.

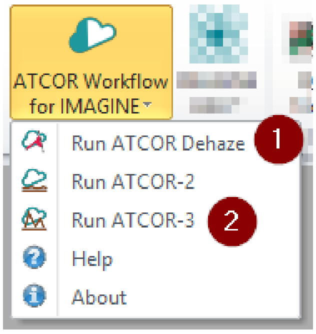
Additionally, for **multi-channel input imagery** the cloud water shadow (CSW) map is generated if a file name and directory are being provided. It is a thematic raster which contains 7 classes:

label	definition	color coding
0	geocoded background	grey
1	clear	brown
2	semi-transparent cloud	yellow
3	cloud	bright grey
4	shadow	black
5	water	dark blue
6	snow/ice	white
7	topographic shadow	grey/black

If specified, also the Dehaze products are computed (see 3.1.4).

3.4 Example

Let us assume that we want to process a **hazy image in mountainous terrain**. A typical workflow for correcting this image using the **ATCOR Workflow Dialog** would be the following:



1. Select '**Run ATCOR Dehaze**'.
   Select '**Create** ATCOR project' on the Project Tab,
   modify settings if necessary,
   and press '**Run'**.

2. Select '**Run ATCOR-3'**.
   Select '**Load** ATCOR Project' on the Project Tab,
   select the project created in Step 1,
   modify settings if necessary,
   and press '**Run'**.

First, we apply the *ATCOR Dehaze* process as the image is affected by haze. The result of Step 1 is the dehazed image (including a haze map).

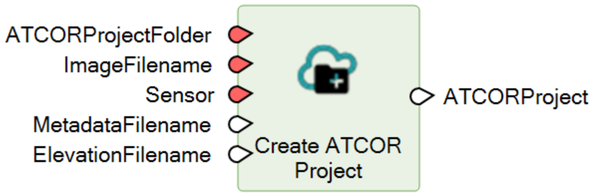
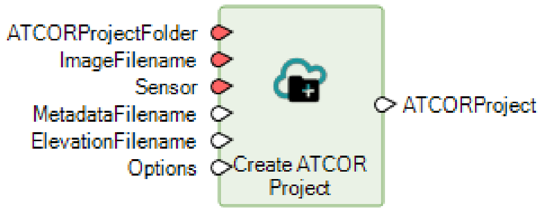
Secondly, we apply the *ATCOR-3* process. With ATCOR-3, better results are expected than with ATCOR-2 because the terrain covered by the image is mountainous. *ATCOR-3* is executed on the result of Step 1 resulting in a dehazed atmospherically and topographically corrected image (surface reflectance).

For detailed examples, please see the **Step-by-Step Guide** (*https://www.geosystems.de/produkte/atcor-workflow-fuer-imagine/download/*).

4 ATCOR Workflow Operators

4.1 Create ATCOR Project

Category: GEOSYSTEMS ATCOR

Default	**Show All Ports**
	

4.1.1 Description

The operator creates a **new ATCOR project** based on the image file specified at the port *ImageFilename*. Once an ATCOR Workflow project is created, any process (*ATCOR Dehaze*, *ATCOR-2*, *ATCOR-3*) can be executed.
For sensors with supported **metadata import** (Table 8),

- the ATCOR-relevant metadata are read from the metadata file specified at the port MetadataFilename,
- the calibration file (.cal) is prepared and written to the project folder, and
- for some sensors (e.g. Sentinel-2) also a layer stack is created, if the image bands are provided as separate files. For more information see Section 6.

If the metadata import is not supported for the selected sensor or if no metadata file is specified, the metadata must be entered manually using the operator *Set ATCOR parameters*. For calibration, a calibration file template is created in the project folder. The calibration parameters (*Gain* and *Offset*) in this text file can be edited by using any standard text editor after creating the project. For more information on preparing the calibration file see Section 7.2.

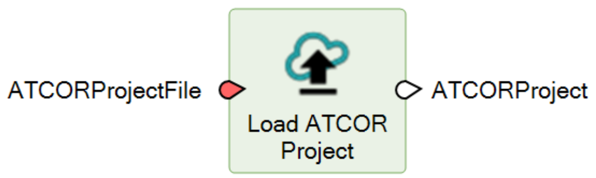
If an **elevation file** is specified at the port *ElevationFilename*, the elevation information is prepared for the project. This step results in an elevation file that matches the input image specified at the port *ImageFilename* in terms of spatial reference system, extent and pixel size. In addition, files for slope, aspect, and skyview are computed. The reprojected, clipped, and resampled elevation file is written to the project folder. The DEM must be a single band file in either integer, unsigned integer or floating point, 32bit is not supported.

4.1.2 Connections

Name	Objects Supported	Description	Required
ATCORProject Folder	Directory	**Directory** that will serve as a container for all ATCOR output files.	✓
ImageFilename	File	Filename of the **input image** to be processed. The image must have projected coordinates (not geographic coordinates). ATCOR Workflow is compatible with most commonly used projections, with a few exceptions, such as *Lambert Conformal Conic* (EPSG 31287). For Landsat-4/5 TM, Landsat-7, Landsat-8, and Sentinel-2 with the spectral bands provided as single files please refer to Section 6.1 for more information.	✓
Sensor	String/Enumeration	Specifies the **sensor** the input image comes from. By double-clicking the port, a list of all supported sensors is shown.	✓
MetadataFilename	File	Filename of the **metadata file** corresponding to the input image. Valid file extensions are .XML, .TXT, .IMD, and .DIM (Section 7.1). For Landsat-4/5 TM, Landsat-7, Landsat-8, and Sentinel-2 with the spectral bands provided as single files please refer to Section 6.1 for more information.	--
ElevationFilename	File	Filename of the **elevation file**.	--
ATCORProject	ATCOR Project	**ATCOR Project** ready for further processing (*ATCOR-2*, *ATCOR-3*, *ATCOR Dehaze*). Connect this port with the *ATCOR Project* input port of other ATCOR operators.	NA

4.2 Load ATCOR project

Category: GEOSYSTEMS ATCOR

Default	Show All Ports
	Same as ‚Default‘ (no hidden ports).

4.2.1 Description

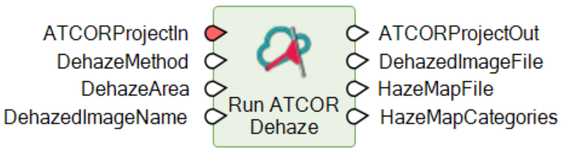
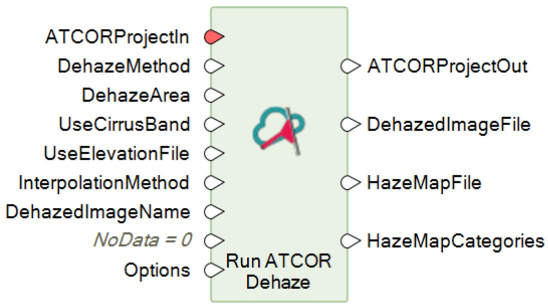
The operator loads an existing ATCOR project.

4.2.2 Connections

Name	Objects Supported	Description	Required
ATCORProjectFile	File	Specifies the ATCOR project file of the ATCOR project to be loaded. The name of this file is always ***GEOSYSTEMS_ATCOR.project***. It is located in the ATCOR project folder.	✓
ATCORProject	ATCOR Project	**ATCOR Project** ready for further processing (*ATCOR-2*, *ATCOR-3*, *ATCOR Dehaze*). Connect this port with the *ATCOR Project* input port of other ATCOR operators.	NA

4.3 Run ATCOR Dehaze

Category: GEOSYSTEMS ATCOR

Default	Show All Ports
	

4.3.1 Description

The operator removes haze and thin clouds from the raw image. In addition to the dehazed image, a map is computed containing the categories haze, cloud, water, land, shadow etc. The haze map categories are listed in Table 1. The category names can be attached to the attribute table of the haze map as demonstrated in Figure 1 (4).

⚠ The process *ATCOR Dehaze* has to be applied to the raw image and NOT to the atmospherically corrected image. So, first run *ATCOR Dehaze* and then *ATCOR-2* or *ATCOR-3* if desired.

4.3.2 Connections

Name	Objects Supported	Description	Required
Input			
ATCORProjectIn	ATCOR Project	An **ATCOR project** that was created using the ‘Create ATCOR project’ operator or loaded from disk using the ‘Load ATCOR project’ operator. Connect this port with the output port of ‘Create ATCOR Project’ or ‘Load ATCOR Project’.	✓
DehazeMethod	String/ Enumeration	Specifies the **level of haze removal** (see Section 5.1.1 for more information). If not	--

Name	Objects Supported	Description	Required
		provided, the default value '*strong'* is used.	
DehazeArea	String/ Enumeration	Specifies if haze removal is applied only over **land** or also over **water** (see Section 5.1.2 for more information). Haze removal over land/water requires clear land/water pixels. The default value is '*land and water pixels*''.	--
UseCirrusBand	Boolean	Specifies if the **cirrus band** (if available) is used or not. The default value is TRUE.	--
UseElevationFile	Boolean	Specifies if the **elevation file** (if available) is used or not. The default value is TRUE.	--
InterpolationMethod	String/ Enumeration	Specifies the **interpolation** method for bright areas (see Section 5.1.3 for more information). If not provided, the default value '*bilinear (fast)*' is used.	--
DehazedImageName	File	Specifies the **output file name** for the dehazed image. If not provided, a default output name is used and the output file is written to the ATCOR project folder. If the output file already exists, it is overwritten.	--
NoDataOption	String/ Enumeration	The user can choose between 3 options: **NoData = 0:** This is the default value. Resulting corrected images will feature 0 as a NoData value. **NoData = 65535:** The NoData value of corrected images will be set to 65535 instead of 0. **NoData = 0; 0 recoded to 1 in active image area:** The NoData value for inactive image areas of the corrected images will be set to 0, while for active image area 0 values are recoded to 1. For image areas with very low reflectance this avoids NoData values at positions where low values would be physically correct.	--
Options	IMAGINE Dictionary	Allows the user to add options to the workflow.	--
Output			
ATCORProjectOut	ATCOR Project	**ATCOR Project** ready for further processing (*ATCOR-2*, *ATCOR-3*). Connect this port with the *ATCOR Project* input port of other ATCOR operators.	NA
DehazedImageFile	File	**Dehazed image** file on disk.	NA
HazeMapFile	File	Created **haze map** file on disk. The file is named automatically and saved in the same directory as the dehazed image.	NA
HazeMapCategories	AttributeTable	Attribute table that contains the **class names of the haze map** (Table 1, page 39). It can be attached to the haze map file as demonstrated in Figure 1.	NA

4.3.3 Example Model

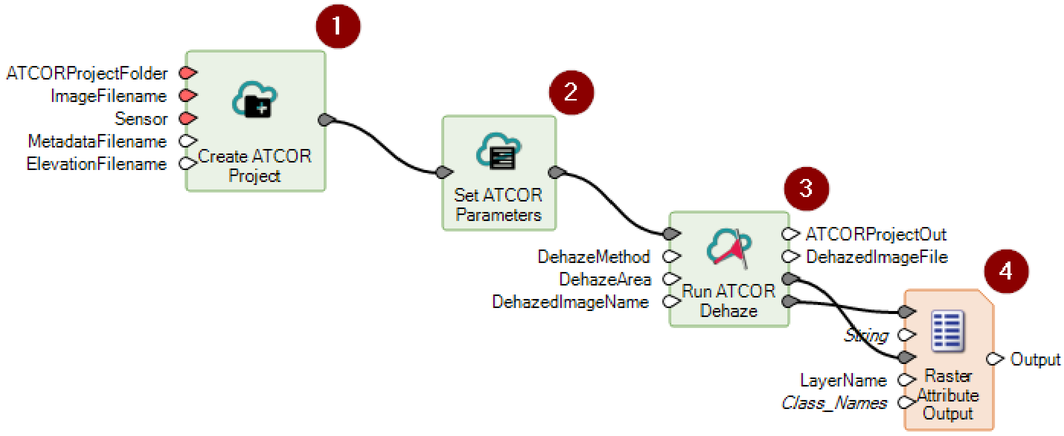
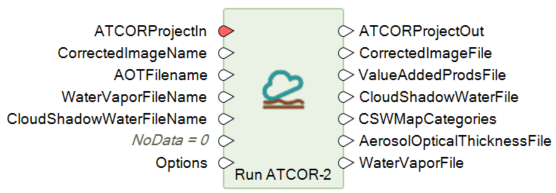


Figure 1: Example model executing *ATCOR Dehaze*. (1) Creates a new ATCOR project. With the second operator (2) you can set image metadata and processing parameters via a dialog or the operator ports. Operator (3) executes *ATCOR Dehaze* using the parameters set with (2). The output files are the dehazed image (`<DehazedImage>.tif`) and the corresponding haze map (`<DehazedImage>_haze_map.tif`). Operator (4) attaches the class names, stored in the auxiliary metadata file of the haze map (`<DehazedImage>_haze_map.tif.aux.xml`) to the attribute table of the dehazed image.

4.4 Run ATCOR-2

Category: GEOSYSTEMS ATCOR

<table>
<tr><th>Default</th><th>Show All Ports</th></tr>
<tr><td>
</td><td>
</td></tr>
</table>

4.4.1 Description

The operator '*Run ATCOR-2*' applies **atmospheric correction** to the image. The *ATCOR-2* process is intended for **flat terrain**. For mountainous terrain, the *ATCOR-3* process is recommended (see Section 4.5).

The main output of the ATCOR-2 operator is the **atmospherically corrected image** (surface reflectance, surface temperature). The first bands of the output file represent '*surface reflectance*' corresponding to the reflective input bands. If the input data set also contained thermal bands (e.g. Landsat), the last band of the output file represents '*surface temperature*' in degree Celsius (°C). The scaling factor is per default 4 for 8-bit data and 100 for 16-bit data. It can be set using the *Set ATCOR Parameters* operator.

In addition to the atmospherically corrected image, a set of useful quantities, such as leaf area index (LAI) or albedo, can be calculated. The calculation of the **value-added products** file can be switched on using the 'Set ATCOR Parameters' operator (see Section 4.6, Tab 'Advanced'). The value-added products are stored in a separate file with the file name ending '_flx'. It contains at least six layers (Table 2, layer 1 to 6) and, in case of at least one thermal band, 4 additional layers (layer 7 to 11).

If *ATCOR Dehaze* was executed previously to *ATCOR-2*, the result of *ATCOR Dehaze* is used as input for *ATCOR-2*.

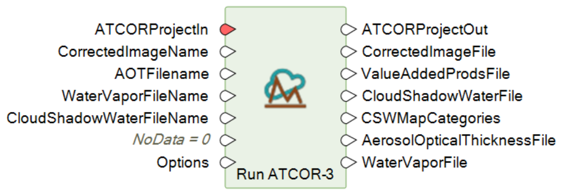
4.4.2 Connections

Name	Objects Supported	Description	Required
Input			
ATCORProjectIn	ATCOR Project	An **ATCOR project** that was created using the ‘Create ATCOR project’ operator or loaded from disk using the ‘Load ATCOR project’ operator. Connect this port with the output port of ‘Create ATCOR Project’ or ‘Load ATCOR Project’.	✓
CorrectedImageName	File	Specifies the file name of the **corrected image**. If not provided, a default output name is used and the output file is written to the ATCOR project folder. If the output file already exists, it will be overwritten.	--
AOTFilename	File	Specifies the directory, format and file name of the **Aerosol Optical Thickness** file. If not specified, the AOT file will not be exported. If the output file already exists, it will be overwritten.	--
WaterVaporFileName	File	Specifies the directory, format and file name of the **Water Vapor** file. If not specified, the Water Vapor file will not be exported. If the output file already exists, it will be overwritten.	--
CloudShadowWaterFileName	File	Specifies the directory, format and file name of the **Cloud Shadow Water** file. If not specified, the Water Vapor file will not be exported. If the output file already exists, it will be overwritten.	--
NoDataOption	String/ Enumeration	The user can choose between 3 options: **NoData = 0:** This is the default value. Resulting corrected images will feature 0 as a NoData value. **NoData = 65535:** The NoData value of corrected images will be set to 65535 instead of 0. **NoData = 0; 0 recoded to 1 in active image area:** The NoData value for inactive image areas of the corrected images will be set to 0, while for active image area 0 values are recoded to 1. For image areas with very low reflectance this avoids NoData values at positions where low values would be physically correct.	--
Options	IMAGINE Dictionary	Allows the user to add options to the workflow.	--
Output			
ATCORProjectOut	ATCOR Project	**ATCOR Project** that can be used for further processing.	NA
CorrectedImageFile	File	**Corrected image file** on disk. For more information see Section 3.2.6.	NA
ValueAddedProdsFile	File	Created **value-added products file** on disk (optional output). The file is named	NA

Name	Objects Supported	Description	Required
		automatically and saved in the same directory as the corrected image.	
CloudShadowWaterFile	File	Created **Cloud-Shadow-Water** file on disk (optional output).	NA
CSWMapCategories	Attribute Table	Attribute table with the class names of the **Cloud-Shadow-Water Map**.	
AerosolOpticalThicknessFile	File	Created **Aerosol Optical Thickness** file on disk (optional output).	NA
WaterVaporFile	File	Created **Water Vapor** file on disk (optional output).	NA

4.5 Run ATCOR-3

Category: GEOSYSTEMS ATCOR

Default	Show All Ports
 	

4.5.1 Description

The operator *Run ATCOR-3*'applies **atmospheric and topographic correction** to the image (surface reflectance, surface temperature). For this process, a **digital elevation model** is required.

The main output of the ATCOR-3 operator is the **atmospherically** and **topographically corrected image**. The first bands of the output file represent '*surface reflectance*' corresponding to the reflective input bands. If the input data set also contained thermal bands (e.g. Landsat), the last band of the output file represents '*surface temperature*' in degree Celsius (°C). The scaling factor is per default 4 for 8-bit data and 100 for 16-bit data. It can be set using the *Set ATCOR Parameters* operator.

In addition to the corrected image, a set of useful quantities, such as leaf area index (LAI) or albedo, can be calculated. The calculation of the **value-added products** file can be switched on using the 'Set ATCOR Parameters' operator (see Section 4.6, Tab 'Advanced'). The value-added products are stored in a separate file with the file name ending '_flx'. It contains at least six layers (Table 2, layer 1 to 6) and, in case of at least one thermal band, 4 additional layers (layer 7 to 11).

If *ATCOR Dehaze* was executed previously to *ATCOR-3*, the result of *ATCOR* Dehaze is used as input for *ATCOR-3*. Additionally, *ATCOR Dehaze* is now available in the *ATCOR-3* workflow as described below.

4.5.2 Connections

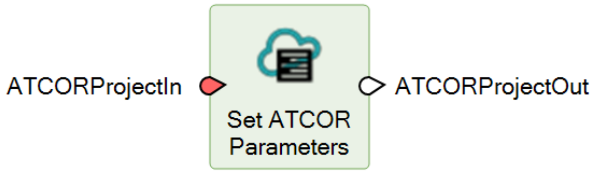
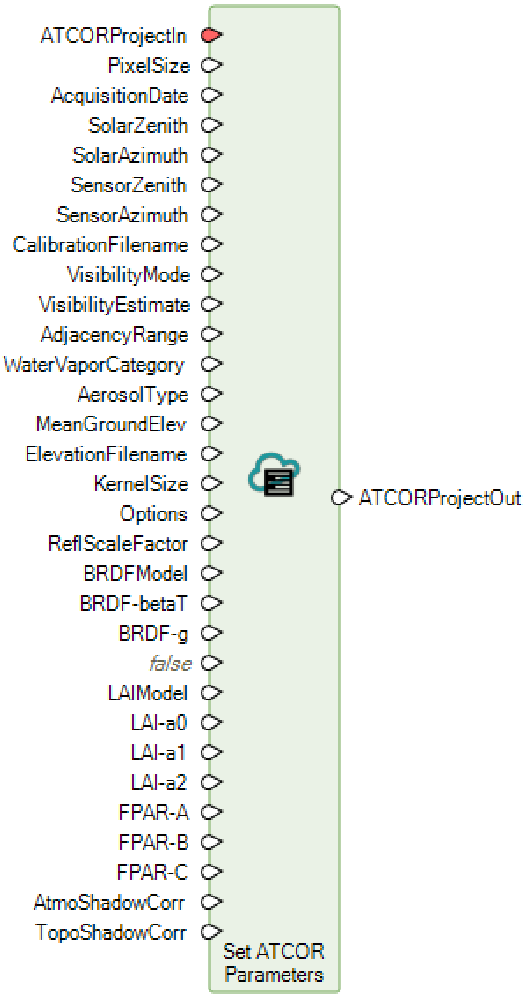
Name	Objects Supported	Description	Required
Input			
ATCORProjectIn	ATCORProject	An **ATCOR project** that was created using the 'Create ATCOR project' operator or loaded from disk using the 'Load ATCOR project' operator. Connect this port with the output port of 'Create	✓

Name	Objects Supported	Description	Required
		ATCOR Project' or 'Load ATCOR Project'.	
CorrectedImageName	File	Specifies the file name of the **corrected image**. If not provided, a default output name is used and the output file is written to the ATCOR project folder. If the output file already exists, it is overwritten.	--
AOTFilename	File	Specifies the directory, format and file name of the **Aerosol Optical Thickness** file. If not specified, the AOT file will not be exported. If the output file already exists, it will be overwritten.	--
WaterVaporFileName	File	Specifies the directory, format and file name of the **Water Vapor** file. If not specified, the Water Vapor file will not be exported. If the output file already exists, it will be overwritten.	--
CloudShadowWaterFileName	File	Specifies the directory, format and file name of the **Cloud Shadow Water** file. If not specified, the Water Vapor file will not be exported. If the output file already exists, it will be overwritten.	--
NoDataOption	String/ Enumeration	The user can choose between 3 options: **NoData = 0:** This is the default value. Resulting corrected images will feature 0 as a NoData value. **NoData = 65535:** The NoData value of corrected images will be set to 65535 instead of 0. **NoData = 0; 0 recoded to 1 in active image area:** The NoData value for inactive image areas of the corrected images will be set to 0, while for active image area 0 values are recoded to 1. For image areas with very low reflectance this avoids NoData values at positions where low values would be physically correct.	--
Options	IMAGINE Dictionary	Allows the user to add options to the workflow.	--
Output			
ATCORProjectOut	ATCORProject	**ATCOR project** that can be used for further processing.	NA
CorrectedImageFile	File	**Corrected image file** on disk. For more information see Section 3.3.5.	NA

Name	Objects Supported	Description	Required
ValueAddedProdsFile	File	Created **value-added products file** on disk (optional output). The file is named automatically and saved in the same directory as the corrected image.	NA
CloudShadowWaterFile	File	Created **Cloud-Shadow-Water** file on disk (optional output).	NA
CSWMapCategories	Attribute Table	Attribute table with the class names of the **Cloud-Shadow-Water Map**.	
AerosolOpticalThicknessFile	File	Created **Aerosol Optical Thickness** file on disk (optional output).	NA
WaterVaporFile	File	Created **Water Vapor** file on disk (optional output).	NA

4.6 Set ATCOR Parameters

Category: GEOSYSTEMS ATCOR

Default	Show All Ports
	

4.6.1 Description

The operator ‘*Set ATCOR Parameters*’ provides access to the project parameters, image metadata, and processing parameters of a project. New values are set via a dialog that opens by double-clicking the operator (Figure 2). Alternatively, you can enter new values via the ports of the operator. By default, the ports are hidden. For showing a port, right-click the operator, select *Properties*, and enable the corresponding port in the ‘*Show*’-column of the *Properties* window. The latter option is recommended when you are going to create a new project.

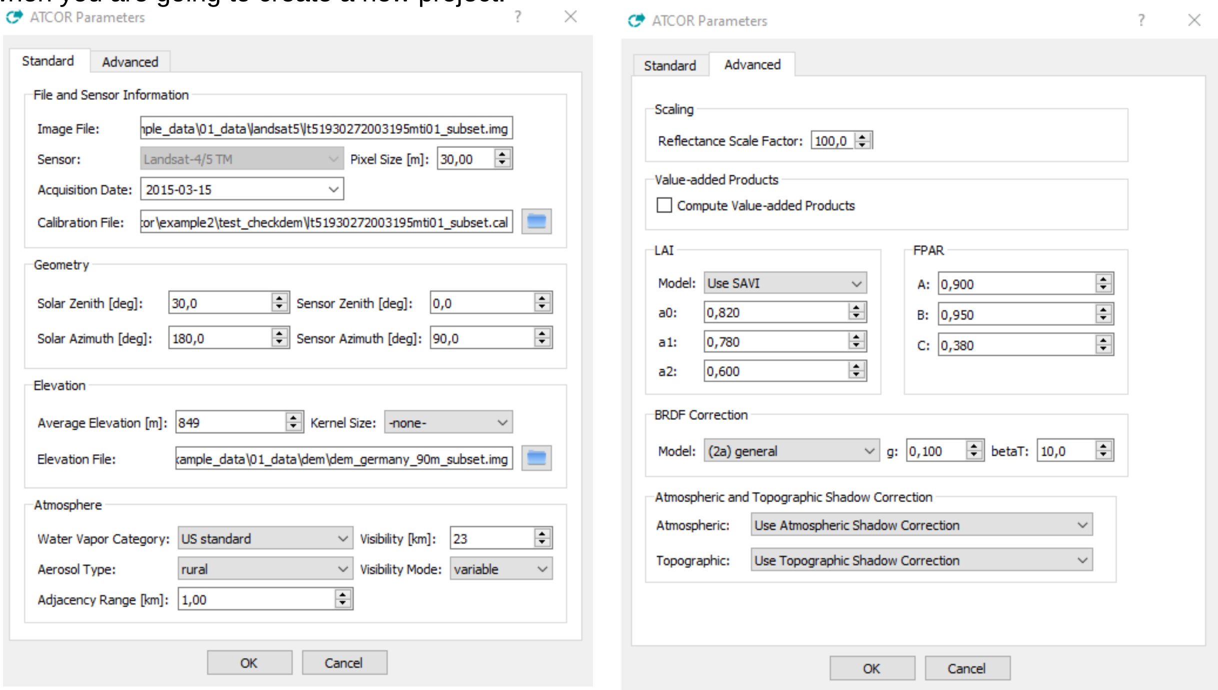


Figure 2: Dialog for setting project parameters, image metadata, and processing parameters for an ATCOR project. You get this dialog by double-clicking the *Set ATCOR Parameters* dialog.

4.6.2 Connections

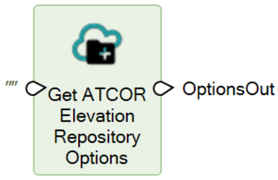
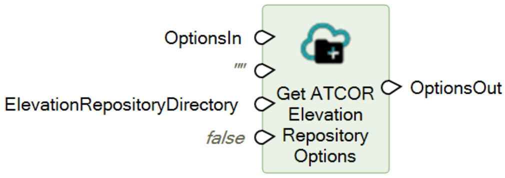
Name	Objects Supported	Description	Required
Input			
ATCORProjectIn	ATCORProject	An **ATCOR project** that was created using the ‘Create ATCOR project’ operator or loaded from disk using the ‘Load ATCOR project’ operator. Connect this port with the output port of ‘Create ATCOR Project’ or ‘Load ATCOR Project’.	✓
PixelSize	Double	Specifies the **pixel size** of the input image in meter. For sensors with supported metadata import (Table 8), this parameter is set, when the project is created. Otherwise, it must be specified by the user. If not provided, the default value is 30.0.	--
AcquisitionDate	String	Specifies the **acquisition date** of the input image in the ISO format YYYY-MM-DD. For sensors with supported metadata import (Table 8), this parameter is set, when the project is created. Otherwise, it must be specified by the user. If not provided, the default value is 2015-03-15.	--
SolarZenith	Double	Specifies the **solar zenith angle** in degree at time of acquisition. For sensors with supported	--

Name	Objects Supported	Description	Required
		metadata import (Table 8), this parameter is set, when the project is created. Otherwise, it must be specified by the user. If not provided, the default value is 30.0. Usually this parameter can be found in the metadata file (if available) or can be calculated from date and time of acquisition.	
SolarAzimuth	Double	Specifies the **solar azimuth angle** in degree at time of acquisition. For sensors with supported metadata import (Table 8), this parameter is set, when the project is created. Otherwise, it must be specified by the user. If not provided, the default value is 180.0. Usually this parameter can be found in the metadata file (if available) or can be calculated from date and time of acquisition.	--
SensorZenith	Double	Specifies the **sensor incidence angle** (= off-nadir angle; Figure 6) in degree. For sensors with supported metadata import (Table 8), this parameter is set, when the project is created. Otherwise, it must be specified by the user. For nadir-looking sensors, this angle is 0.0. For sensors with tilting capability, this parameter can be found in the metadata file (if available).	--
SensorAzimuth	Double	Specifies the **sensor azimuth angle** in degree. For sensors with supported metadata import (Table 8), this parameter is set, when the project is created. Otherwise, it must be specified by the user. If not provided, the default value is 90.0. For sensors with tilting capability, this parameter can be found in the metadata file (if available).	--
CalibrationFile	File	Specifies the name of the calibration file. This file contains the **radiometric calibration parameters** c_0 (*Offset*) and c_1 (*Gain*). For sensors with supported metadata import (Table 8), this file is created in the ATCOR project folder based on the metadata file, when the project is created. Otherwise, a standard sensor-specific calibration file is copied to the project folder that has to be modified by the user. For information on how to get ATCOR compatible calibration parameters from the metadata file see Section 7.2. If you want to test different sets of calibration parameters, you can save them to different files and select them one by one.	--
VisibilityMode	String/ Enumeration	Specifies if a constant value for the **visibility** parameter (aerosol optical thickness) per scene is used or if the visibility is estimated on a pixel-by-pixel basis based on dark reference areas in the scene (see Section 5.2.1 for more information). The default value is '*variable*'.	--

Name	Objects Supported	Description	Required
VisibilityEstimate	Double	Specifies the lower bound of the **visibility** parameter in kilometer. If the automatic retrieval of this parameter based on dark reference areas fails, the specified value is used. See Section 5.2.1 for further information. The default value is 23.0 km.	--
AdjacencyRange	Double	Specifies the maximum distance in kilometer that is applied to consider **adjacency radiation**. Adjacency radiation is radiation reflected from the neighborhood of a pixel scattered into the viewing direction and consequently blurring reflectance and emissivity information measured for that pixel at the sensor. Thus, atmospheric correction aims for eliminating this radiation component. For further information see also Section 5.2.5. The default value is 1.0 km.	--
WaterVaporCategory	String/ Enumeration	Selects a pre-defined standard atmosphere in terms of **water vapor content** to roughly characterize water vapor conditions at the time of image acquisition. See Section 5.2.3 for more information. The default value is '*US-standard*'.	--
AerosolType	String/ Enumeration	Selects a pre-defined standard atmosphere in terms of **aerosol** conditions to roughly characterize aerosol content at the time of image acquisition. See Section 5.2.4 for more information. The default value is '*rural*'.	--
MeanGroundElev	Double	Specifies the **average ground elevation** in meter within the area covered by the scene. It is estimated automatically from the global elevation file that is included in ERDAS IMAGINE, when the project is created. If it fails, the default value is 0.0 which can be overwritten by the user.	--
ElevationFileName	File	Specifies the name of the **elevation file**. It is required for *ATCOR-3,* optional for *ATCOR Dehaze* and not relevant for *ATCOR-2.*	--
KernelSize	String/ Enumeration	Selects the size of the kernel used for **smoothing** the elevation file. See Section 5.2.5 for more information. The default kernel size is '*-none-*', i.e. no smoothing is applied.	--
Options			
ReflScaleFactor	Double	Specifies the **multiplication factor** used to scale surface reflectance in the output file of *ATCOR-2* and *ATCOR-3*. If the input data is 16 bit, a scale factor of 100 is recommended. So a surface reflectance value of 20.56% is coded as 2056. If the input data is 8 bit, a scale factor of 4 is recommended, i.e. a surface reflectance of 20.56% is coded as 82. The default scale factor is 100.	--
BRDFModel	String/ Enumeration	Only relevant for *ATCOR-3*. See Section 5.2.9 for more information.	--
BRDF-betaT	Double	Only relevant for *ATCOR-3*. See Section 5.2.9 for more information.	--

Name	**Objects Supported**	**Description**	**Required**
BRDF-g	Double	Only relevant for *ATCOR-3*. See Section 5.2.9 for more information.	--
ValueAddedProds	Boolean	Specifies if the value-added products file is created by *ATCOR-2* and *ATCOR-3*. See Section 5.2.8 for more information. The default value is FALSE.	--
LAIModel	String/ Enumeration	Selects the vegetation index used for approximating LAI (Leaf Area Index). See Section 5.2.10 for more information. The default value is '*Use SAVI*'.	--
LAI-a0	Double	Specifies parameter a_0 of the empirical three-parameter model that describes the relationship between **LAI** and the selected vegetation index. See Section 5.2.10 for more information.	--
LAI-a1	Double	Specifies parameter a_1 of the empirical three-parameter model that describes the relationship between **LAI** and the selected vegetation index. See Section 5.2.10 for more information.	--
LAI-a2	Double	Specifies parameter a_2 of the empirical three-parameter model that describes the relationship between **LAI** and the selected vegetation index. See Section 5.2.10 for more information.	--
FPAR-A	Double	Specifies parameter ***A*** of the empirical three-parameter model that describes the relationship between **FPAR** and LAI. See Section 5.2.11 for more information.	--
FPAR-B	Double	Specifies parameter ***B*** of the empirical three-parameter model that describes the relationship between **FPAR** and LAI. See Section 5.2.11 for more information.	--
FPAR-C	Double	Specifies parameter ***C*** of the empirical three-parameter model that describes the relationship between **FPAR** and LAI. See Section 5.2.11 for more information.	--
Atmospheric	String/ Enumeration	Allows to choose whether atmospheric cloud and building shadow correction should be applied or not.	--
Topographic	String/ Enumeration	Allows to choose whether topographic shadow correction should be applied or not.	--
Output			
ATCORProjectOut	ATCORProject	**ATCOR Project** that can be used for further processing.	--

4.7 Get ATCOR Elevation Repository Options

Default	Show All Ports
	

4.7.1 Description

The ATCOR Elevation Repository Options is an operator that allows to specify an identifier (RepositoryID) and a directory (ElevationRepositoryDirectory) under which the user can store derivatives of the DEM file (aspect, slope, skyview and elevation) that are used by ATCOR 3. These files can be later used in processing the same geographical area again while saving processing time.
Warning: The user is responsible for the choise of the directory and the identifier, avoid overwriting files that you may need for future processing!

4.7.2 Connections

Name	Objects supported	Description	Required
Input			
RepositoryID	String	Identifier of the elevation repository, will be attached to the filenames in the repository.	✓
OptionsIn	Dictionary	Additional options for input that will be forwarded by the OptionsOut port.	--
ElevationRepositoryDirectory	Directory	The directory in which the DEM files will be stored. A default value can be stored in the IMAGINE preferences in the “GEOSYSTEMS → ATCOR Workflow” section.	--
ReplaceExisting	Boolean	Allows to either	--
Output			
OptionsOut	Dictionary	The output options that will be forwarded to the following operators as dictionary.	✓

4.8 Processing Chains built with ATCOR Workflow Operators - Example

The ATCOR Workflow operators can be embedded in customized processing chains as demonstrated in an example shown below.
The following Spatial Model

- uses two images from the same area from two different dates,
- removes atmospheric and topographic effects from both images,
- computes the NDVI (vegetation index) for each image based on the ATCOR-corrected image, and
- computes the NDVI difference showing land cover changes.

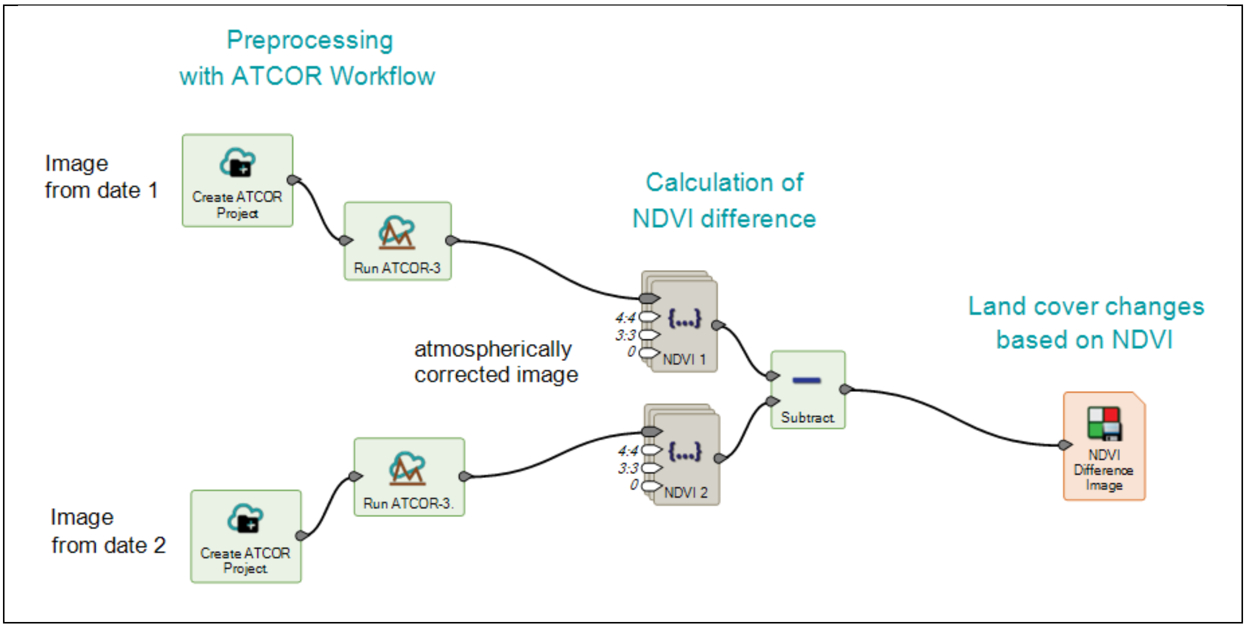


Figure 3: ATCOR Workflow operators embedded in a change detection processing chain.

4.9 Use ATCOR Project Parameter values as Spatial Modeler dictionary items

With version 2020 it is now possible to use selected ATCOR project parameter values in ERDAS IMAGINE 2020 spatial models. The following parameters are available:

- Satellite altitude as “Altitude”
- Sensor name as “SensorName”
- Filename of the Metadata file as “MetaDataFileName”
- Filename of the project file as “ProjectFile”
- Acquisition date as “Date”
- Acquisition day as “Day”
- Acquisition month as “Month”
- Acquisition year as “Year”
- Solar zenith as “SolarZenit”
- Solar azimuth as “SolarAzimuth”
- Visibility as “Visibility”
- Pixel size as “PixelSize”
- Number of bands as “NBands

The following figure shows an example of a spatial model that allows to retrieve the parameter values in a dictionary and export them into a .json file:

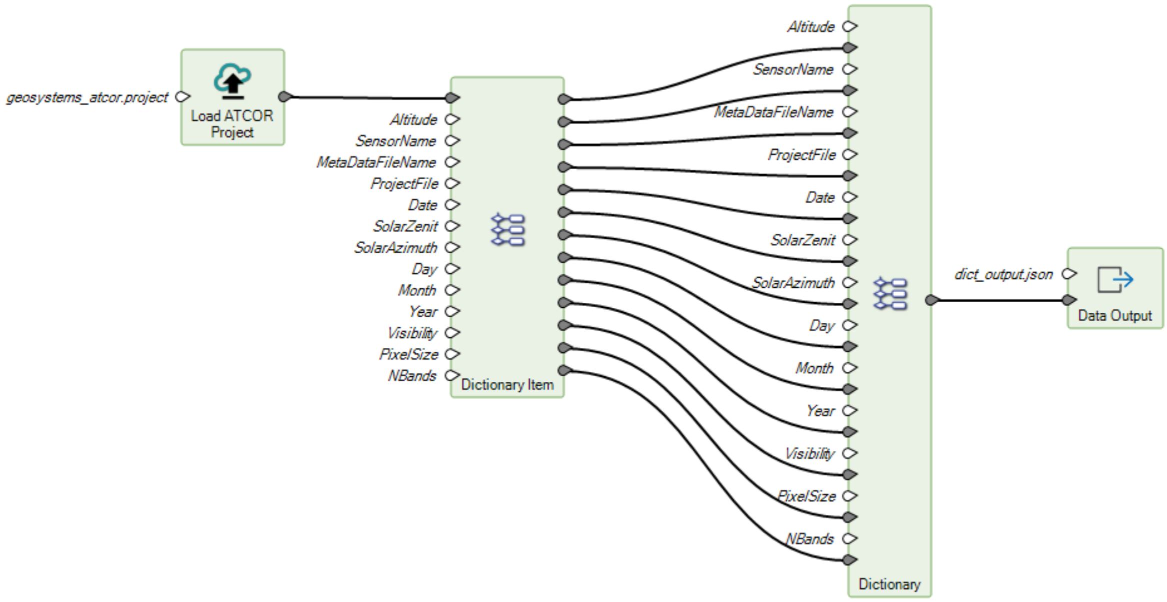


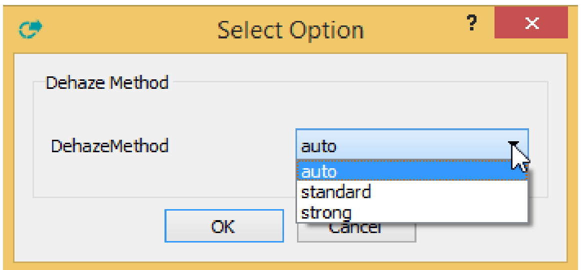
Figure 4: Exemplary usage of attribute values in dictionary

5 ATCOR Workflow Parameters

5.1 Parameters for ATCOR Dehaze

5.1.1 Dehaze Method

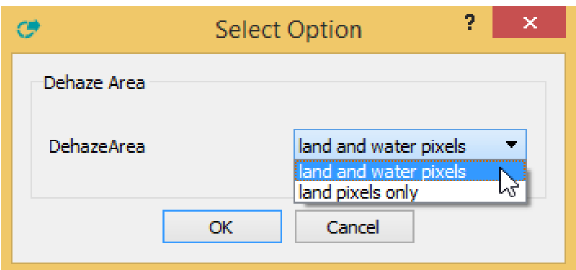
This parameter specifies the level of haze removal.



Value	Description
standard	Removal of thin to medium haze.
strong	Removal of thin to moderately thick haze. [Default]
auto	Both methods, '*standard*' and '*strong*', are applied and the better result is kept.

5.1.2 Dehaze Area

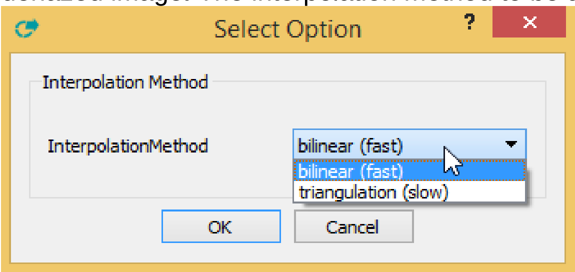
This parameter specifies, if haze removal should be conducted only over land or over land and water.



Value	Description
land pixels	Haze removal over land.
land and water pixels	Haze removal over land and water. [Default]

5.1.3 Interpolation Method

This parameter specifies the interpolation method that is used in very bright areas. In bright areas, it is not possible to separate the contribution of haze and the contribution of the surface to the recorded signal. These areas, coded as “bright areas” in the haze map (Table 1, class 20), have to be interpolated in the dehazed image. The interpolation method to be applied can be selected.



Value	Description
bilinear (fast)	Bright areas are interpolated in the dehazed image using bilinear interpolation. [Default]
triangulation (slow)	Bright areas are interpolated in the dehazed image using triangulation. This method is significantly slower than the interpolation method ‘*bilinear (fast)*’.

5.1.4 Use Cirrus Band If Available

If a narrow **cirrus band** at 1.38 µm exists, the effect of cirrus clouds is also removed by ATCOR Dehaze. Such a band is for example provided by Sentinel-2.
This parameter specifies if the cirrus band (if available), is used or not in the Dehaze process. Accepted values are TRUE and FALSE. The default value is TRUE.

5.1.5 Use Elevation File

This parameter specifies if the **elevation file** (if available) is used or not in the Dehaze process. Accepted values are TRUE and FALSE. The default value is TRUE.

5.1.6 Class label definition of the .hcw file (Haze Map Categories)

Table 1: Haze map categories

Color	Class ID	Class Name	Comment
	0	geocoded background	--
	1	shadow	--
	2	thin cirrus (water)	--
	3	medium cirrus (water)	--
	4	thick cirrus (water)	--
	5	land (clear)	--
	6	saturated	--
	7	snow/ice (ice cloud)	--

	8	thin cirrus (land)	--
	9	medium cirrus (land)	--
	10	thick cirrus (land)	--
	11	haze (land)	--
	12	medium haze (land)	--
	13	haze (water)	--
	14	med. haze/glint (water)	--
	15	cloud (land)	Haze removal limited due to physical reasons.
	16	cloud (water)	Haze removal limited due to physical reasons.
	17	water	--
	18	cirrus cloud	Haze removal maybe limited due to physical reasons.
	19	cirrus cloud (thick)	Haze removal limited due to physical reasons.
	20	bright	--
	21	topographic shadow	--
	22	cloud shadow	--

5.2 Parameters for ATCOR-2 and ATCOR-3

5.2.1 Visibility

The visibility (horizontal meteorological range) is approximately the maximum horizontal distance in kilometer a human eye can recognize a dark object against a bright sky. It is often used in atmospheric correction to characterize the atmosphere at the time of image acquisition.

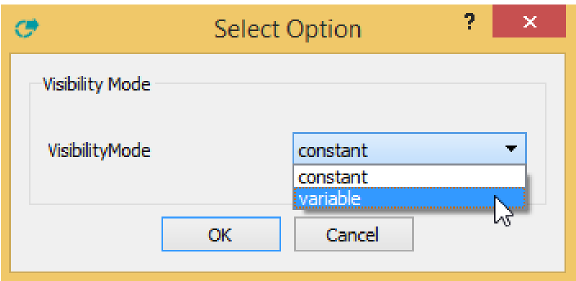
In ATCOR Workflow, the visibility can range from 5 to 120 km. The default value is 23 km corresponding to average clear atmospheric conditions.

For a constant visibility per scene (Section 5.2.2; Visibility Mode = ‘constant’), the specified value is the start value (lower bound) for iteration. In case of a variable scene visibility (Visibility Mode = ‘variable’), the specified value is ignored provided that the scene contains enough dark reference pixels. Otherwise, ATCOR Workflow switches to the constant visibility mode and the specified value is used as a start value for iteration.

In some cases, it may be useful to set Visibility to a fixed value (i.e. no iteration is carried out by ATCOR Workflow). For this option, the Visibility of choice must be specified with a minus-sign (-120 to -5) and the Visibility Mode (Section 5.2.2) must be set to ‘constant’ (e.g. for a fixed Visibility of 45 km choose -45).

5.2.2 Visibility Mode

The visibility is automatically estimated from the scene based on dark reference pixels (dark vegetation, dark soil, water). In *ATCOR-2* and *ATCOR-3* either a constant, i.e. global, value for the whole image or a spatially varying value is applied. If the algorithm for estimating the horizontal visibility from dark reference pixels fails, ATCOR Workflow switches to the constant visibility mode and the specified value is used as a start value for iteration.

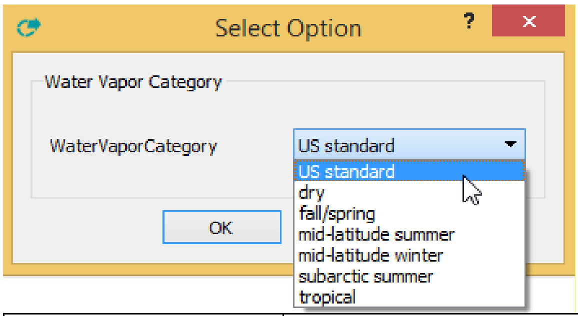


Value	Description
constant	A spatially constant (global) visibility estimate is applied.
variable	A spatially varying visibility estimate is applied. [Default]

5.2.3 Water Vapor Category

The **water vapor content** can be automatically computed if the sensor has spectral bands in water vapor regions (e.g. 920-960 nm). Otherwise, the selection of a water vapor category based on the season and/or the geographical region is usually sufficient. ATCOR Workflow provides several water vapor categories to choose from as listed below.

If a water vapor category is selected for a sensor that has spectral bands in the water vapor regions, this parameter will be ignored.

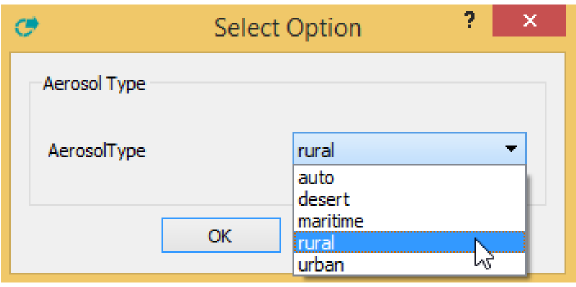


Value	Description
dry	Corresponds to a water vapor column of 0.41 cm at sea level.
fall/spring	Corresponds to a water vapor column of 1.14 cm at sea level.
mid-latitude summer	Corresponds to a water vapor column of 2.92 cm at sea level.
mid-latitude winter	Corresponds to a water vapor column of 0.85 cm at sea level.
subarctic summer	Corresponds to a water vapor column of 2.05 cm at sea level.
tropical	Corresponds to a water vapor column of 4.11 cm at sea level.
US standard	Corresponds to a water vapor column of 1.42 cm for sea level. [Default]

5.2.4 Aerosol Type

The aerosol type describes the absorption and scattering properties of particles in the atmosphere and the wavelength-dependence of the optical properties.

ATCOR Workflow supports several basic aerosol types, as listed below. The user can select one of these types, usually based on the location of the scene. As an example, in areas close to the sea the maritime aerosol type would be a logical choice. If in doubt, the rural (continental) aerosol type is usually a good choice. Alternatively, the aerosol type can be calculated from the image data provided that the scene contains vegetated areas.



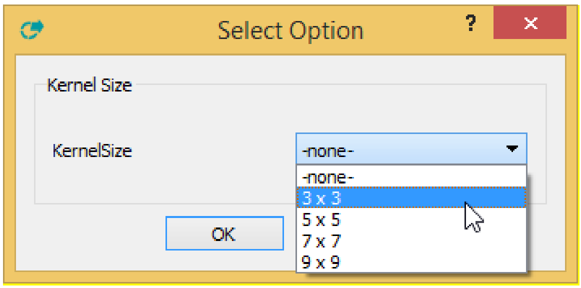
Value	Description
rural	Represents the aerosol conditions in continental areas, which are not influenced by urban and / or industrial aerosol sources. [Default]
urban	Represents the aerosol conditions in urban areas, where a mixture of rural aerosols and aerosols from combustion products and industrial sources occur.
maritime	Represents the aerosol conditions in areas close to the sea. The aerosols are mainly sea-salt particles, which are produced by the evaporation of sea-spray droplets mixed with aerosols of more or less pronounced continental character.
desert	Represents dry sandy aerosol conditions.
auto	The aerosol type is determined automatically from the image data based on dark vegetation pixels. If it fails, the aerosol type '*rural*' is selected. Processing with the '*auto*' option takes longer than with the other options, but it is recommended, for example, for running ATCOR Workflow in batch mode. [For Sentinel-2, the aerosol type is re-set to '*rural*' if '*auto*' is selected. For this sensor, the water vapor content is determined from the image.]

5.2.5 Adjacency Range

ATCOR Workflow accounts for **adjacency effects**, i.e. a scattering effect due to the reflection of upward radiation coming from neighboring pixels. Adjacency effects reduce apparent surface contrast by decreasing TOA radiance over bright pixels and increasing the brightness of dark pixels.
The parameter 'Adjacency Range' specifies the neighborhood in km that is considered to correct for adjacency effects. The default value is 1.0 km.

5.2.6 Kernel Size

This parameter specifies the **size of the low pass filter** used to smooth the elevation file. All related layers (i.e. slope, aspect, and skyview) are automatically smoothed as well. Smoothing can help to remove artifacts in the atmospherically/topographically corrected image.



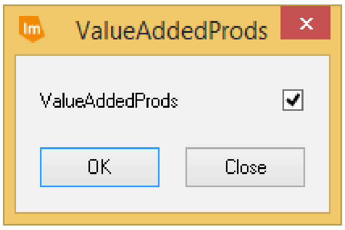
Value	Description
-none-	No smoothing is applied to the elevation file and related layers. [Default]
3 x 3	The elevation file and all related layers are smoothed with a 3 x 3 low pass filter.
5 x 5	The elevation file and all related layers are smoothed with a 5 x 5 low pass filter.
7 x 7	The elevation file and all related layers are smoothed with a 7 x 7 low pass filter.
9 x 9	The elevation file and all related layers are smoothed with a 9 x 9 low pass filter.

5.2.7 Reflectance Scale Factor

This parameter specifies the **multiplication factor** used to scale surface reflectance in the output file of *ATCOR-2* and *ATCOR-3*. If the input data is 16 bit, a scale factor of 100 is recommended. So a surface reflectance value of 20.56% is coded as 2056. If the input data is 8 bit, a scale factor of 4 is recommended, i.e. a surface reflectance of 20.56% is coded as 82. The default scale factor is 100.

5.2.8 Compute Value-Added Products

As a 'by-product' of atmospheric correction a number of useful quantities can be calculated. If the parameter 'Compute Value-added Products' is checked, a separate file (<CorrectedImage>_flx.tif) is generated. It contains at least six layers (Table 2, layer 1 to 6) and, in case of at least one thermal band, 4 additional layers (layer 7 to 11).
The first group of layers (layer 1 to 4) includes vegetation indices (based on surface reflectance instead of at-sensor radiance), simple parametrizations of the leaf area index, and wavelength-integrated reflectance (albedo).
The second group (layer 5 and higher) comprises quantities related to surface energy balance including global radiation on the ground, absorbed solar radiation, net radiation and heat fluxes.



Value	Description
FALSE (box unchecked)	No value-added products are computed.
TRUE (box checked)	The value-added products file is computed. The file name is built from the file name of the corrected image + '_flx' + extension of the corrected image. [Default]

Table 2: Layers of the value-added products file.

Layer	Name
1	Soil adjusted vegetation index (SAVI), range 0 to 1000, scaled with factor 1000. (e.g. scaled SAVI=500 corresponds to SAVI=0.5)
2	Leaf area index (LAI), range 0 to 10000, scaled with factor 1000. (e.g. scaled LAI=5000 corresponds to LAI=5.0)
3	Fraction of photosynthetically active radiation FPAR, range 0 to 1000, scaled with factor 1000. (e.g. scaled FPAR=500 corresponds to FPAR=0.5)
4	Surface albedo (integrated reflectance from 0.3 to 2.5 µm), range 0 to 1000, scaled with factor 10. (e.g. scaled albedo=500 corresponds to albedo=50%)
5	Absorbed solar radiation flux R_{solar} [$W\ m^{-2}$].
6	Global radiation E_g [$W\ m^{-2}$]. (omitted for constant visibility in flat terrain because it is a scalar that is written to the log file (*.log))
7	Thermal air-surface-flux-difference $R_{therm} = R_{atm} - R_{surface}$ [$W\ m^{-2}$].
8	Ground heat flux G [$W\ m^{-2}$].
9	Sensible heat flux H [$W\ m^{-2}$].
10	Latent heat LE [$W\ m^{-2}$].
11	Net radiation R_n [$W\ m^{-2}$].

5.2.9 BRDF Model and Related Parameters

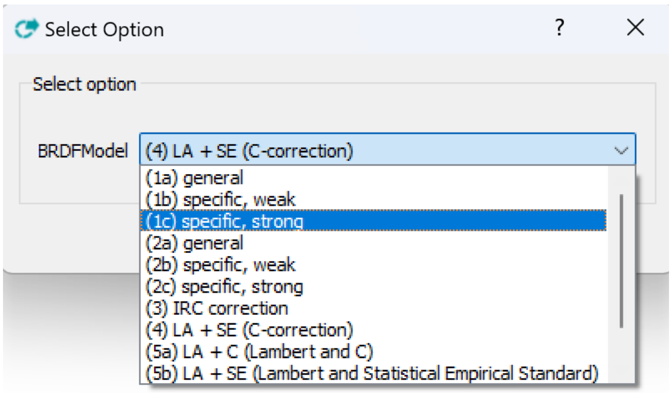
This parameter is only relevant for *ATCOR-3*.

BRDF stands for Bidirectional Reflectance Distribution Function. Several approaches exist to reduce effects caused by the bidirectional (i.e. non-Lambertian) reflectance behavior that is typical for many natural and man-made surfaces.
In ATC
OR Workflow, a simple empirical function is implemented to correct for these effects. The basic function, shown in equation (5-1), has three adjustable parameters (b, β_T, and g).

$$G = \left\{\frac{\cos \beta_i}{\cos \beta_T}\right\}^b \geq g \qquad (5\text{-}1)$$

with β_i denoting the solar incidence angle, β_T the local solar zenith angle threshold, and g the lower bound of the correction function.

BRDF Model
With this parameter, several options for the value of **parameter *b*** can be selected as listed in the table below. The default is model (2b), where for soil/sand pixels a value of 0.5 is applied for b (all spectral bands) and for vegetation pixels a value of 0.75 or 0.33, depending on the spectral band, is applied.



Value	Description		
	soil / sand	vegetation, λ < 720 nm	vegetation, λ ≥ 720 nm
(1a) general	b = 1	b = 1	b = 1
(1b) specific, weak	b = 1	b = ¾	b = $^1/_3$
(1c) specific, strong	b = 1	b = ¾	b = 1
(2a) general	b = ½	b = ½	b = ½
(2b) specific, weak*	**b = ½**	**b = ¾**	**b = $^1/_3$**
(2c) specific, strong	b = ½	b = ¾	b = 1
(3) IRC correction	-	-	-
(4) LA & SE correction (C correction)	-	-	-
(5a) LA & C correction	-	-	-
(5b) LA & SE correction	-	-	-
no correction	No empirical BRDF correction is applied.		

*[Default]

Parameter *betaT*

For the threshold angle ***betaT*****,** denoted as $\boldsymbol{\beta_T}$ in Equation (5-1), a value between 0 and 75 is accepted. Recommended values depending on the solar zenith angle θ_S of the scene are listed in Table 3. These settings are automatically applied, if *betaT* is set to 0.

Table 3: Recommended values for parameter *betaT* depending on the solar zenith angle.

Solar zenith angle (θ_S)	***betaT***
< 45°	θ_S + 20°
45° to 55°	θ_S + 15°
> 45°	θ_S + 10°

Parameter *g*

For **parameter *g***, a value between 0.100 and 0.999 is accepted. Values between 0.200 and 0.250 are adequate in most cases. In case of extreme overcorrection *g*=0.100 should be used.

For detailed information on BRDF correction see https://www.atcor.com.

5.2.10 LAI Model and Parameters

LAI stands for Leaf Area Index. It is computed as a 'by-product' of atmospheric correction, if the option 'Compute Value-added Products' (Section 5.2.8) was selected. The parameter 'LAI Model' specifies the vegetation index (*VI*) to be used to approximate the Leaf Area Index according to equation (5-2).

$$VI = a_0 - a_1 exp(-a_2 LAI) \qquad (5\text{-}2)$$

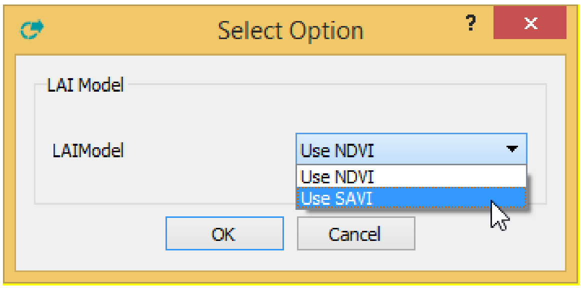
For *VI* either the **NDVI** (Normalized Difference Vegetation Index) or the **SAVI** (Soil-adjusted vegetation index) can be used.

Solving for LAI, we obtain

$$LAI = -\frac{1}{a_2} ln\left(\frac{a_0 - VI}{a_1}\right) \qquad (5\text{-}3)$$

In addition to *VI*, the parameters $\boldsymbol{a_0}$, $\boldsymbol{a_1}$, and $\boldsymbol{a_2}$ can be set.

For detailed information on LAI estimation see https://www.atcor.com.



Value	**Description**
Use NDVI	The LAI is approximated using the Normalized Difference Vegetation Index (NDVI).
Use SAVI	The LAI is approximated using the Soil-adjusted Vegetation Index (SAVI). [Default]

5.2.11 FPAR Model Parameters

FPAR stands for Fraction of absorbed Photosynthetically Active Radiation. It is computed as a 'by-product' of atmospheric correction, if the option 'Compute Value-added Products' was selected. FPAR is associated with green phyto-mass and crop productivity.

A three-parameter model can be employed to approximate FPAR from LAI according to equation (5-4).

$$FPAR = C[1 - A\, exp(-B\, LAI)] \qquad (5\text{-}4)$$

The FPAR parameters '*A*', '*B*', and '*C*' can be selected, if the option 'Compute Value-added Products' was selected. Typical values are *A*=1, *B*=0.4, and *C*=1.

For detailed information on FPAR estimation see https://www.atcor.com.

5.2.12 Topographic and atmospheric shadow correction

These parameters are relevant for ATCOR-3 only.

These parameters set the values for the variables *ishadow* (topographic shadow correction) and *icl_shadow* (atmospheric shadow correction) to either 0 or 1. By default, both values are set to 0. For more information see Section 4.6.

5.2.13 Class label definition of the .csw file (Cloud Shadow Water Map Categories)

Label	Definition	Color Coding
0	Geocoded background	Grey
1	Clear	Brown
2	Semi-transparent cloud	Yellow
3	Cloud	Bright grey
4	Shadow	Black
5	Water	Dark blue
6	Snow / ice	White
7	Topographic shadow	Grey / Black

5.3 Parameter Overview

Table 4 gives an overview of all parameters used in ATCOR Workflow. The accepted values are provided in Section 5.1 (ATCOR Dehaze) and Section 5.2 (ATCOR-2 and ATCOR-3).

Table 4: List of parameters used in ATCOR Workflow with (1) the names used in the ATCOR Workflow Dialog, (2) the port names (Spatial Modeler Operators) and (3) the corresponding variable names in the provided batch list files (*.bls). Required parameters are underlined and in bold type.

Data Field Name (Dialog)	Operator Port Name (Spatial Modeler)	Variable Name (Batch List File *.bls)	Comment
General			
Project Folder	**ATCORProjectFolder**	**prjdir**	always required
--	**ATCORProjectFile**	**prjfile**	
Sensor	**Sensor**	**sensor**	
Image File	**ImageFilename**	**infile**	
Metadata File	MetadataFilename	metafile	Should be specified (if available) for sensors with metadata import.
Elevation File	ElevationFilename	demfile	Required for *ATCOR-3*, optional for *ATCOR Dehaze*, not used for ATCOR-2.
Pixel Size	PixelSize	ps	
Acquisition Date	AcquisitionDate	date	

Data Field Name (Dialog)	Operator Port Name (Spatial Modeler)	Variable Name (Batch List File *.bls)	Comment
Calibration File	CalibrationFilename	calfile	Should be specified for sensors without metadata import.
Solar Zenith	SolarZenith	solzen	
Solar Azimuth	SolarAzimuth	solaz	
Sensor Zenith	SensorZenith	senzen	
Sensor Azimuth	SensorAzimuth	senaz	
ATCOR Dehaze			
Dehazed Image File	DehazedImageName	outfile	
Dehaze Method	DehazeMethod	dhmethod	
Dehaze Area	DehazeArea	dharea	
Interpolation Method	Interpolation Method	intpolmethod	
Use Cirrus Band If Available	UseCirrusBand	usecirrus	
Use Elevation File	UseElevationFile	usedem	
NoData Handling	nodatahandling	nodatahandling	If not provided, default will be used: NoData = 0.
ATCOR-2, ATCOR-3			
Corrected Image File	CorrectedImageName	outfile	
Water Vapor Category	WaterVaporCategory	watvap	
Aerosol Type	AerosolType	aerotype	
Mean Ground Elevation	MeanGroundElev	-	If not provided, ATCOR-2 will use an average elevation value for the AOI derived from a global terrain model.
Adjacency Range	AdjacencyRange	adj	
Visibility	Visibility	visest	
Visibility Mode	VisibilityMode	vismode	
Reflectance Scale Factor	ReflScaleFactor	sclfact	
DEM Smoothing	KernelSize	ks	
Compute Value-added Products	ValueAddedProds	VAprods	
LAI Model	LAIModel	LAImodel	
a0	LAI-a0	a0	
a1	LAI-a1	a1	
a2	LAI-a2	a2	
A	FPAR-A	A	
B	FPAR-B	B	

Data Field Name (Dialog)	Operator Port Name (Spatial Modeler)	Variable Name (Batch List File *.bls)	Comment
C	FPAR-C	C	
BRDF Model	BRDFModel	BRDFmodel	Only relevant for ATCOR-3
g	BRDF-g	g	
betaT	BRDF-betaT	betaT	
Aerosol Optical Thickness File	AOTFilename	AOTFileName	
Water Vapor File	WaterVaporFileName	WaterVaporFileName	
Cloud Shadow Water Map	CloudShadowWaterFile	CloudShadowWaterFile	
Atmospheric cloud shadow correction	AtmoShadowCorr	AtmoShadowCorr	Only relevant for ATCOR-3
Topographic cloud shadow correction	TopoShadowCorr	TopoShadowCorr	Only relevant for ATCOR-3
NoData Handling	nodatahandling	nodatahandling	If not provided, default will be used: NoData = 0.

6 How to Create an ATCOR Workflow Project

An ATCOR Project is created either by using the **ATCOR Workflow Dialog** (Toolbox Tab > ATCOR Workflow for IMAGINE > Run ATCOR Dehaze / ATCOR-2 / ATCOR-3 > Create ATCOR Project) or by using the ***Create ATCOR Project* operator**.

In both cases, an image file and a metadata file can be specified. It depends on the sensor, which inputs are expected by ATCOR Workflow.

6.1 Sensors with Metadata Import

6.1.1 DMC

Input Parameter	Value
Image File	Specify the name of the orthorectified layer stack (3 bands). All file types are accepted that can be directly read in ERDAS IMAGINE (File – Open – Raster Layer). Ensure that the bands are sorted by wavelength in ascending order. ⚠ DMC imagery is usually delivered in the DIMAP format, a TIF file, with the band sequence NIR / Red and Green. For ATCOR Workflow, the band order Green / Red / NIR (i.e. layer stack of band 3, 2, and 1) is required. By default, ATCOR Workflow changes the band order of the specified input image from 1/2/3 to 3/2/1. The image with the modified band order is written into the corresponding ATCOR project folder. If your input image has already the correct band order, uncheck the corresponding checkbox in the Preferences (see Section 9).
Metadata File	Specify the name of the metadata file (*.DIM).

6.1.2 FORMOSAT

Input Parameter	Value
Image File	Specify the name of the orthorectified layer stack (4 bands). All file types are accepted that can be directly read in ERDAS

	IMAGINE (File – Open – Raster Layer). Ensure that the bands are sorted by wavelength in ascending order. ⚠ FORMOSAT imagery is usually delivered in the DIMAP format, a TIF file, with the band sequence NIR / Red / Green and SWIR. For ATCOR Workflow, the band order Green / Red / NIR / SWIR (i.e. layer stack of band 3, 2, 1, and 4) is required. By default, ATCOR Workflow changes the band order of the specified input image from 1/2/3/4 to 3/2/1/4. The image with the modified band order is written into the corresponding ATCOR project folder. If your input image has already the correct band order, uncheck the corresponding checkbox in the Preferences (see Section 9).
Metadata File	Specify the name of the metadata file (*.DIM).

6.1.3 Landsat-4/5 TM, Landsat-7, Landsat-8 and Landsat-9

For creating an ATCOR project based on Landsat L1 data (L2 is not supported), there are two options:

Option 1 – Original Scene: You have a zipped file
containing a TIF file for each band (e.g. *B1.TIF) and the metadata file (*_MTL.TXT).

Unzip (or unzip and untar) the file in order to extract the TIF files (one for each spectral band) and the metadata file (*_MTL.TXT) to a directory.

Input Parameter	**Value**
Image File	Specify the name of the metadata file (*_MTL.TXT). As the file filter is 'All File-based Raster Formats' per default, you have to switch off the filter by entering '*.txt' in the field 'File name' as shown in Figure 5.
Metadata File	--

With 'Run' a layer stack is written to the ATCOR project folder.

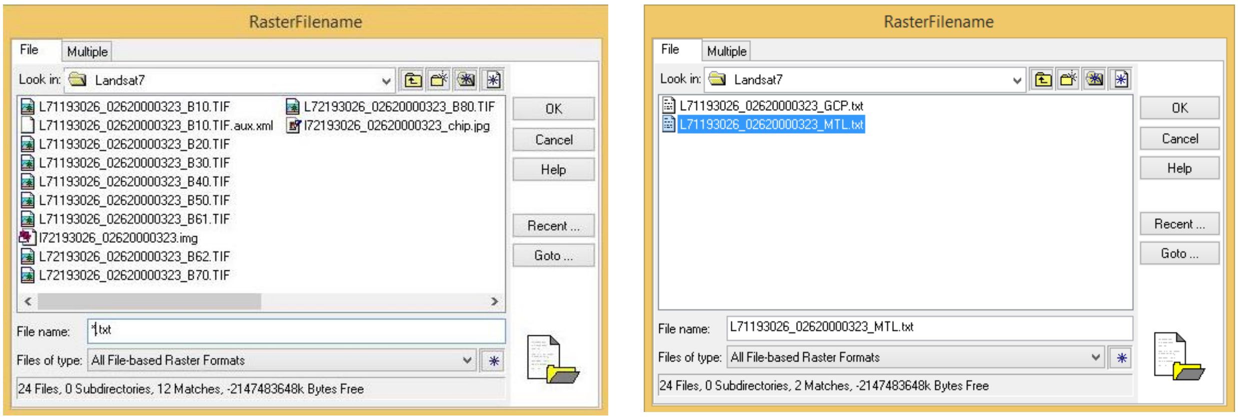


Figure 5: How to switch off the file filter 'All File-based Raster Formats'.

⚠ The ERDAS IMAGINE Import tool for Landsat-4, Landsat-5, Landsat-7 and Landsat-8 unzips the downloaded zip files. It optionally creates several layer stacks, but none of these layer stacks is compatible with ATCOR Workflow in terms of band order and number of bands. We recommend to follow the steps described in option 1.

Option 2 – You want to use a layer stack compatible with ATCOR Workflow, e.g. for processing a subset of a Landsat scene.

Input Parameter	**Value**
Image File	Specify the name of the layer stack. The following image formats are accepted: .IMG, .TIF, .ECW, .JP2, and .VSK. Ensure that the

	number of bands, the band order, and the pixel size are correct (Table 5). If an ATCOR project based on the selected Landsat dataset is already existing, the layer stack located in the corresponding ATCOR project folder or a subset of this image can be used as input.
Metadata File	Specify the name of the metadata file (*_MTL.TXT) if available.

Table 5: Band information for Landsat-4/5, Landsat-7, Landsat-8 and -9 layer stacks as required for ATCOR Workflow.

Sensor	Number of Bands	Bands	Pixel Size
Landsat-4/5 TM	7	B10, B20, … , B50, B60, and B70	30 m
Landsat-7 Multispectral	7	B10, B20, … , B50, B61, and B70	30 m
Landsat-8 MS (8 Bands)	8	B1, B2, …, B5, B9, B6, and B7	30 m
Landsat-8 MS+TIRS (10 Bands)	10	B1, B2, …, B5, B9, B6, B7, B10, and B11	30 m
Landsat-8 Panchromatic	1	B8	15 m
Landsat-9 +TIRS (10 Bands)	10	B1, B2, …, B5, B9, B6, B7, B10, and B11	30 m

6.1.4 PlanetScope

Input Parameter	Value
Image File	Specify the name of the orthorectified layer stack (Level 3B - Analytic Ortho Scene Product) . All file types are accepted that can be directly read in ERDAS IMAGINE (File – Open – Raster Layer). Ensure that the bands are sorted by wavelength in ascending order. The 4 bands, 5 bands and 8 bands products are supported.
Metadata File	Specify the name of the metadata file (DIM_*.XML).

6.1.5 Pléiades

Input Parameter	Value
Image File	Specify the name of the orthorectified layer stack. All file types are accepted that can be directly read in ERDAS IMAGINE (File – Open – Raster Layer). Ensure that the bands are sorted by wavelength in ascending order. ⚠ Pléiades imagery is usually delivered with the band sequence Red / Green / Blue / NIR. For ATCOR Workflow, the band order Blue / Green / Red / NIR is required. By default, ATCOR Workflow changes the band order of the specified input image from 1/2/3/4 to 3/2/1/4. The image with the modified band order is written into the corresponding ATCOR project folder. If your input image has already the correct band order, uncheck the corresponding checkbox in the Preferences (see Section 9).
Metadata File	Specify the name of the metadata file (DIM_*.XML).

6.1.6 Pléiades NEO

Input Parameter	Value
Image File	Specify the name of the Level 1A *RGB*.TIF image file. All file types are accepted that can be directly read in ERDAS IMAGINE (File – Open – Raster Layer). **The 6 bands from the *RGB*.TIF and the *NED*.TIF will be extracted, sorted, stacked, georeferenced based on the RPC-files and reprojected to UTM WGS 84 by ATCOR Workflow.**
Metadata File	Specify the name of the metadata file (DIM_*.XML).

6.1.7 Sentinel-2

Sentinel-2 data are provided as JPEG2000 files (*.JP2), one file for each band. ATCOR Workflow operates based on Sentinel-2 granules and requires Level 1C data. Level 2 data cannot be processed using ATCOR Workflow (and would make no sense…). The pixel values represent scaled TOA (top-of-atmosphere) reflectance data. ATCOR Workflow requires TOA radiance data. Thus, when an ATCOR project based on a Sentinel-2 dataset is created, the following tasks are executed:

- reading information from the metadata file,
- compilation of a layer stack (scaled TOA reflectance), either with 13 bands or with 4 bands, depending on the specified sensor, and
- conversion of pixel values from scaled TOA reflectance to TOA radiance.

Although, ATCOR Workflow only needs the TOA radiance cube, the TOA reflectance cube is kept in a separate folder ('TOA_reflectance') located in the ATCOR project folder. This file can be used, for example, to visually compare the original image and the results of *ATCOR Dehaze*, *ATCOR-2*, and *ATCOR-3*. It is also suitable as input (Image File), when a new project is created based on the same image or on a subset of it (Option 2).

For creating an ATCOR project based on a Sentinel-2 granule, there are two options:

Option 1 – You have the original file structure (.SAFE)

Input Parameter	**Value**
Image File	Specify the name of the metadata file (*.XML) located in the folder of the granule to be processed (see Example below). ATCOR Workflow compiles a layer stack using the JP2 files that are located in the IMG_DATA folder of the granule. The default pixel size is 10 m for the sensor *Sentinel-2 4 Bands* (BGRN) and 20 m for the sensor *Sentinel-2 13 Bands*. For using a different pixel size, change the corresponding settings in the Preferences (see Section 9).
Metadata File	--

With 'Run' a layer stack is written to the ATCOR project folder.

Option 2 - You have a layer stack and the original file structure (.SAFE)

Input Parameter	**Value**
Image File	Specify the name of the layer stack. The following image formats are accepted: .IMG, .TIF, .ECW, .JP2, and .VSK. The layer stack can be either a full granule, compiled from the JP2 files that are located in the IMG_DATA folder (= subfolder of the granule folder), or a subset of it. Ensure that the number of bands, the band order, and the pixel size are correct (Table 6). If an ATCOR project based on the selected Sentinel-2 granule already exists, the layer stack located in the folder 'TOA_reflectance' (= subfolder of the ATCOR project folder) or a subset of this image can be used as input.
Metadata File	Specify the name of the metadata file (*.XML) located in the folder of the granule to be processed (see example below).

Example of a Sentinel-2 metadata file (.XML):

1) for Sentinel-2 data acquired <u>before</u> 2016-12-07:

```
E:\Daten\S2A_OPER_...352.SAFE\GRANULE\
S2A_OPER_MSI_L1C_TL_SGS__20160326T160551_A003966_T31TFJ_N02.01\
S2A_OPER_MTD_L1C_TL_SGS__20160326T160551_A003966_T31TFJ.xml
```

2) for Sentinel-2 data acquired <u>after</u> 2016-12-06:

```
E:\Daten\ S2A_MSI_...2418.SAFE\GRANULE\
L1C_T32UPU_A007641_20161208T102418\
MTD_TL.xml
```

Table 6: Bands for Sentinel-2 layer stacks as required for ATCOR Workflow.

Sensor	Number of Bands	Bands	Pixel Size
Sentinel-2 4 Bands (BGRN)	4	B02, B03, B04, B08	10 m
Sentinel-2 13 Bands	13	B01, B02, … , B08, B8A, B09, … , B12	20 m

⚠ The Sentinel-2 product folder name can be modified in order to shorten path names, but the folder name must end with '.SAFE'. You must not modify the GRANULE folder name or the name of the .XML file!

⚠ Since January 2022, ESA applies a radiometric offset to the pixel values of Sentinel-2 images. This offset is considered by ATCOR's metadata reader, the corrected images are stored **without** the offset.

6.1.8 SPOT-4 and SPOT-5

Input Parameter	**Value**
Image File	Specify the name of the orthorectified layer stack (4 bands). All file types are accepted that can be directly read in ERDAS IMAGINE (File – Open – Raster Layer). Ensure that the bands are sorted by wavelength in ascending order. ⚠ SPOT-4/5 imagery is usually delivered in the DIMAP format, a TIF file, with the band sequence NIR / Red / Green and SWIR. For ATCOR Workflow, the band order Green / Red / NIR / SWIR (i.e. layer stack of band 3, 2, 1, and 4) is required. By default, ATCOR Workflow changes the band order of the specified input image from 1/2/3/4 to 3/2/1/4. The image with the modified band order is written into the corresponding ATCOR project folder. If your input image has already the correct band order, uncheck the corresponding checkbox in the Preferences (see Section 9).
Metadata File	Specify the name of the metadata file (*.DIM).

6.1.9 SPOT-6 and SPOT-7

Input Parameter	**Value**
Image File	Specify the name of the orthorectified layer stack (4 bands). All file types are accepted that can be directly read in ERDAS IMAGINE (File – Open – Raster Layer). Ensure that the bands are sorted by wavelength in ascending order. ⚠ SPOT-6/7 imagery is usually delivered with the band sequence Red / Green / Blue and NIR. For ATCOR Workflow, the band order Blue / Green / Red / NIR (i.e. layer stack of band 3, 2, 1, and 4) is required. By default, ATCOR Workflow changes the band order of the specified input image from 1/2/3/4 to 3/2/1/4. The image with the modified band order is written into the corresponding ATCOR project folder. If your input image has already the correct band order, uncheck the corresponding checkbox in the Preferences (see Section 9).
Metadata File	Specify the name of the metadata file (*.XML).

6.1.10 THEOS

Input Parameter	**Value**

Image File	Specify the name of the orthorectified layer stack (4 bands). All file types are accepted that can be directly read in ERDAS IMAGINE (File – Open – Raster Layer). Ensure that the bands are sorted by wavelength in ascending order. ⚠ THEOS imagery is usually delivered with the band sequence Red / Green / Blue and NIR. For ATCOR Workflow, the band order has to be changed to Blue / Green / Red / NIR (i.e. layer stack of band 3, 2, 1, and 4).
Metadata File	Specify the name of the metadata file (METADATA.DIM).

6.1.11 TripleSat

Input Parameter	**Value**
Image File	Specify the name of the orthorectified layer stack (4 bands). All file types are accepted that can be directly read in ERDAS IMAGINE (File – Open – Raster Layer). Ensure that the bands are sorted by wavelength in ascending order. ⚠ The original TripleSat imagery may have geographic coordinates. In this case, the image has to be reprojected, for example to UTM, before it can be used in ATCOR Workflow.
Metadata File	Specify the name of the metadata file (<scene_name>.XML). ⚠ There may be also another XML file in the data folder with the file name <scene-name>_meta.XML. This file does NOT contain all metadata required by ATCOR Workflow. So for ATCOR Worklflow always use the metadata file <scene_name>.XML.

6.1.12 VENµS

Input Parameter	**Value**
Image File	It is recommended to specify here the name of the *_DBL.TIF file from the original VENµS data structure as delivered by the provider as in put image. It is also possible to rename it or provide a subset, but it needs to be a .TIF.
Metadata File	Specify the name of the metadata file (<scene_name>.HDR). ⚠ There may be also other HDR files in the data folder with the file names <scene-name>_CLA.HDR, <scene-name>_SOL.HDR, <scene-name>_VIE.HDR, VE_*_PDTIMG_*.HDR or VE_*_PDTQLK_*.HDR. These files do NOT contain all metadata required by ATCOR Workflow. So for ATCOR Worklflow always use the metadata file <scene_name>.HDR from the folder above the folder where the .TIF is located.

6.1.13 Other Sensors

Input Parameter	**Value**
Image File	Specify the name of the orthorectified layer stack. All file types are accepted that can be directly read in ERDAS IMAGINE (File – Open – Raster Layer). Ensure that the bands are sorted by wavelength in ascending order.
Metadata File	Specify the name of the metadata file. The expected file type depends on the sensor as listed in Table 8.

6.2 Sensors without Metadata Import

6.2.1 ASTER

ASTER datasets are provided in different data formats (e.g. HDF-EOS, GeoTIFF) and processing levels, as well as with different number of bands. The pixel size is 15 m (VNIR instrument), 30 m (SWIR instrument), and 90 m (TIR instrument). For ATCOR Workflow, all layers of the layer stack must have the same pixel size. The band order must correspond to Table 7.

Input Parameter	Value
Image File	Specify the name of the orthorectified layer stack. All file types are accepted that can be directly read in ERDAS IMAGINE (File – Open – Raster Layer). Ensure that the bands of the layer stack correspond to Table 7.
Metadata File	--

Table 7: Bands for ASTER layer stacks as required for ATCOR Workflow depending on the selected Sensor.

Sensor	Number of Bands	Bands	Pixel Size
ASTER VNIR (3 Bands)	3	1, 2, 3N	15
ASTER VNIR+SWIR (9 Bands)	9	1, 2, 3N, 4, …, 9	15 or 30
ASTER VNIR+SWIR+TIR (14 Bands)	14	1, 2, 3N, 4, …, 9, 10, …, 14	15, 30 (or 90)

6.2.2 Gaofen-7

Input Parameter	Value
Image File	Specify the name of the orthorectified layer stack (4 bands). All file types are accepted that can be directly read in ERDAS IMAGINE (File – Open – Raster Layer). Ensure that the bands are sorted by wavelength in ascending order.
Metadata File	--

6.2.3 PeruSat-1

Input Parameter	Value
Image File	Specify the name of the orthorectified layer stack (4 bands). All file types are accepted that can be directly read in ERDAS IMAGINE (File – Open – Raster Layer). Ensure that the bands are sorted by wavelength in ascending order.
Metadata File	--

6.2.4 Other Sensors

Input Parameter	Value
Image File	Specify the name of the orthorectified layer stack. All file types are accepted that can be directly read in ERDAS IMAGINE (File – Open – Raster Layer). Ensure that the bands are sorted by wavelength in ascending order.
Metadata File	--

7 Sensors in ATCOR Workflow

7.1 Supported Sensors

The sensors supported in ATCOR Workflow are listed in Table 8. Sensors with **automatic metadata import** are highlighted in bold.

Table 8: List of supported sensors

Sensor	Metadata Import	Metadata File	Comment
ALI-Advanced LI	-	-	-
ALOS AVNIR-2	-	-	-
ASTER VNIR (3 Bands)	-	-	See Section 6.2.1.
ASTER VNIR+SWIR (9 Bands)	-	-	See Section 6.2.1.
ASTER VNIR+SWIR+TIR (14 Bands)	-	-	See Section 6.2.1.
Cartosat PAN	-	-	-
Deimos-2	-	-	-
DMC	✓	*.DIM	-
EarthScan	✓	*_meta.XML	-
Formosat-2	✓	*.DIM	-
Formosat-2 PAN	-	-	-
Gaofen1	-	-	-
Gaofen1 PAN	-	-	-
Gaofen2	-	-	-
Gaofen2 PAN	-	-	-
Gaofen7 MS	-	-	-
GEOEYE-1	-	-	-
IKONOS Multispectral	-	-	-
IKONOS Panchromatic	-	-	-
IRS-1A/B LISS-2	-	-	-
IRS-1C/D LISS-3	-	-	-
IRS-1C/D PAN	-	-	-
IRS-P6 AWiFS	-	-	-
IRS-P6 LISS-3	-	-	-
IRS-P6 LISS-4	-	-	-
KOMPSAT-2	-	-	-
KOMPSAT-2 PAN	-	-	-
KOMPSAT-3	✓		-
KOMPSAT-3 PAN	-	-	-
Landsat-4/5 MSS	-	-	-
Landsat-4/5 TM	✓	*_MTL.TXT	⚠ There are two processing systems for Landsat-5 TM, NLABS and LPGS. NLABS has been replaced by LPGS as from 2008-12-08. The metadata import of ATCOR Workflow only supports LPGS processed data. For more information see Section 6.1.3.
Landsat-7 Multispectral	✓	*_MTL.TXT	⚠ There are two processing systems for Landsat-7, NLABS and LPGS. NLABS has been replaced by LPGS as from 2008-12-08. The metadata import of

Sensor	Metadata Import	Metadata File	Comment
			ATCOR Workflow only supports LPGS processed data. For more information see Section 6.1.3.
Landsat-7 Panchromatic	-	-	⚠ There are two processing systems for Landsat-7, NLABS and LPGS. NLABS has been replaced by LPGS as from 2008-12-08. The metadata import of ATCOR Workflow only supports LPGS processed data.
Landsat-8 MS (8 Bands)	✓	*_MTL.TXT	L1T data required. See Section 6.1.3.
Landsat-8 MS+TIRS (10 Bands)	✓	*_MTL.TXT	L1T data required. See Section 6.1.3.
Landsat-8 Panchromatic	✓	*_MTL.TXT	L1T data required. See Section 6.1.3.
Landsat-9 +TIRS	✓	*_MTL.TXT	L1T data required. See Section 6.1.3.
MERIS	-	-	-
NAOMI-1	-	-	-
NAOMI-1 PAN	-	-	-
OrbView-3 Multispectral	-	-	-
OrbView-3 Panchromatic	-	-	-
PeruSat-1 Multispectral	-	-	-
PlanetScope Multispectral (4-Band)	✓	*.XML	First and second generation, Level 3B data required.
PlanetScope 8-Band	✓	*.XML	First and second generation, Level 3B data required.
PlanetScope 5-Band	✓	*.XML	First and second generation, Level 3B data required.
Pléiades Multispectral	✓	DIM_*.XML	See Section 6.1.5.
Pléiades NEO	✓	DIM_*.XML	See Section 6.1.6
QuickBird Multispectral	✓	*.IMD	-
QuickBird Panchromatic	-	-	-
RapidEye	✓	*.XML	-
Resourc2-AWiFS	-	-	-
Resourc2-LISS-3	-	-	-
Resourc2-LISS-4	-	-	-
SAC-C / MMRS	-	-	-
Sentinel-2 4 Bands (BGRN)	✓	*.XML	See Section 6.1.7.
Sentinel-2 13 Bands	✓	*.XML	See Section 6.1.7.
SPOT-1/2/3 Multispectral	-	-	-
SPOT-1/2/3 Panchromatic	-	-	-
SPOT-4 Multispectral	✓	*.DIM	See Section 6.1.8.
SPOT-5 Multispectral	✓	*.DIM	See Section 6.1.8.
SPOT-5 Panchromatic	-	-	-
SPOT-6 Multispectral	✓	DIM_SPOT6_*.XML	See Section 6.1.9.
SPOT-6 Panchromatic	-	-	-
SPOT-7 Multispectral	✓	DIM_SPOT7_*.XML	See Section 6.1.9.
SPOT-7 Panchromatic	-	-	-
THEOS Multispectral	✓	METADATA.DIM	See Section 6.1.10.
THEOS Panchromatic	-	-	-
TripleSat Multispectral	✓	*.XML	See Section 6.1.11.

Sensor	**Metadata Import**	**Metadata File**	**Comment**
VENµS	✓	*.HDR	See Section 6.1.12
WorldView-2 4-Band MS	✓	*.IMD	-
WorldView-2 8-Band MS	✓	*.IMD	-
WorldView-2 Panchromatic	-	-	-
WorldView-3 16-Band MS	✓	*.IMD	-
WorldView-3 4-Band MS	✓	*.IMD	-
WorldView-3 8-Band MS	✓	*.IMD	-
WorldView-3 Panchromatic	-	-	-
WorldView-3 SWIR	✓	*.IMD	-
WorldView-4 Multispectral	✓	*.IMD	-
ZY-3 Multispectral	-	-	-
ZY-3 Panchromatic	-	-	-

7.2 Sensor Geometry and Calibration

This section explains how the information on geometry and radiometry (i.e. sensor calibration) provided in the metadata files has to be interpreted to be used in ATCOR Workflow. This information is only required for sensors without automatic metadata import (Table 8) or if the original metadata file is not available.

In these cases, the **metadata** (date, pixel size, sun and sensor geometry etc.) have to be specified manually, when a new ATCOR project is created.

Additionally, information on the **sensor calibration** are required. The sensor calibration is specified by two parameters, **Offset** (c_0) and **Gain** (c_1).

$$L = c_0 + c_1 * DN \qquad (7\text{-}1)$$

where L is the at-sensor radiance in $mWcm^{-2}sr^{-1}\mu m^{-1}$ (i.e. the physical quantity required as input for ATCOR Workflow) and *DN* is the digital number.

When a new ATCOR project is created for a sensor without automatic metadata import, a sensor-specific **calibration file** template (*.cal) is created in the project folder. This file has to be modified, if the default values differ from the values in the metadata file accompanying the image or if the results of *ATCOR-2* or *ATCOR-3* are not satisfying.

⚠ **Pan-sharpened images** or images modified through **Dynamic Range Adjustment (DRA)** cannot be processed with ATCOR Workflow. These pre-processing steps modify the pixel values in a way that makes it impossible to reconstruct the original pixel values as recorded by the sensor. Only linear transformations of the spectral information with documented transformation parameters are allowed. The transformation parameters have to be considered through the ATCOR calibration file (.cal).

7.2.1 ALOS AVNIR-2

ALOS (Advanced Land Observation Satellite) is the platform for three sensors. One of them is the Advanced Visible and Near Infrared Radiometer type 2 (AVNIR-2) with 4 spectral bands (Blue, Green, Red; Near Infrared) and a nadir spatial resolution of 10 m. The instrument has a +/-44° across-track tilt capability. Different metadata file formats are available.

Radiometry. The calibration coefficients are given in the unit $mWm^{-2}sr^{-1}nm^{-1}$. Thus, they have to be multiplied by 0.1 to convert them to the unit $mWcm^{-2}sr^{-1}\mu m^{-1}$ as used by ATCOR Workflow.

$$c_0 = Offset * 0.1$$

$$c_1 = Gain * 0.1$$

Geometry. The convention for the tilt and orientation angles is similar to SPOT (Section 7.2.11, Figure 7).

7.2.2 ASTER

ASTER data are usually provided as GeoTIFF or HDF-EOS files and a metadata file (.XML). There is no automatic metadata import available for ASTER. So the metadata and the calibration parameters have to be specified manually.

Radiometry. The calibration parameters are calculated according to the Equations (7-2) and (7-3).

$$c_0 = (-1) * c_1 \quad (7\text{-}2)$$

(or approximately $c_0 = 0$)

$$c_1 = ASTERGain \quad (7\text{-}3)$$

with *ASTERGain* according to Table 9.

The actual gain setting ('Low', 'Normal', 'High') for the scene is usually provided in the metadata file. When an ATCOR project is created for a ASTER dataset, a default calibration file is written to the ATCOR project folder. This file should be modified according to the gain settings specified in the metadata file and using the gain values from Table 9.

Table 9: ASTER gain values appropriate for ATCOR Workflow for the gain settings 'high', 'normal', and 'low'.

Instrument	Band	High Gain	Normal Gain	Low Gain 1	Low Gain 2
VNIR	1	0.0676	0.1688	0.225	N/A
	2	0.0708	0.1415	0.189	N/A
	3	0.0423	0.0862	0.115	N/A
SWIR	4	0.01087	0.02174	0.0290	0.0290
	5	0.00348	0.00696	0.00925	0.0409
	6	0.00313	0.00625	0.00830	0.0390
	7	0.00299	0.00597	0.00795	0.0332
	8	0.00209	0.00417	0.00556	0.0245
	9	0.00159	0.00318	0.00424	0.0265
TIR	10	-	6.882E-4	-	-
	11	-	6.780E-4	-	-
	12	-	6.590E-4	-	-
	13	-	5.693E-4	-	-
	14	-	5.225E-4	-	-

E.g., for the gain setting specified in the metadata file *01 HGH, 02 HGH, 3N NOR, 04 NOR, 05 NOR, 06 NOR, 07 NOR, 08 NOR, 09 NOR*, the correct calibration parameters would be as follows:

```
    14    c0        c1     [mW/cm2 sr micron]

1     -0.0000   0.0676
2     -0.0000   0.07080
3     -0.0000   0.08620
4     -0.0000   0.02174
5     -0.0000   0.00696
6     -0.0000   0.00625
7     -0.0000   0.00597
8     0.0000    0.00417
9     0.0000    0.00318
10    0.0000    6.882E-4
11    0.0000    6.780E-4
12    0.0000    6.590E-4
```

13	0.0000	5.693E-4
14	0.0000	5.225E-4

Geometry. ASTER is nadir-looking. So there is no view angle to be considered.

7.2.3 DMC

DMC (*Disaster Monitoring Constellation*) is a constellation of several orbiting satellites with an optical payload intended for rapid disaster monitoring. All DMC sensors have three spectral bands (green, red, NIR) with a spatial resolution of 32 m and a swath of 600 km. The metadata file (*.dim and *.htm formats) of each scene contains information on the solar geometry and the radiometric calibration coefficients.

ATCOR Workflow reads the metadata file (.DIM) and creates the calibration file **automatically**, when an ATCOR project is created. The following section documents how this information on sensor calibration and geometry is compiled for ATCOR Workflow.

Radiometry: The bias and gain specified in the metadata are defined as

$L = bias + DN/gain$

using the radiance unit [W $m^{-2}sr^{-1}\mu m^{-1}$]. Since ATCOR uses the radiance unit [mW $cm^{-2}sr^{-1}\mu m^{-1}$] and the equation

$L = c_0 + c_1 * DN$,

the calibration parameters have to be calculated according to Equations (7-4) and (7-5).

$$c_0 = 0.1 * bias \qquad (7\text{-}4)$$

$$c_1 = 0.1/gain \qquad (7\text{-}5)$$

⚠ Analysis of some DMC data from 2007 indicates that the specified bias in the NIR band is too high, and better results are obtained if bias(NIR) = 0 is employed.

Geometry. The keywords '*SUN_ELEVATION*' and '*SUN_AZIMUTH*' specify the solar elevation and azimuth angle, respectively. The sun zenith angle, as needed for ATCOR Workflow, can be calculated as 90° – '*SUN_ELEVATION*'. DMC is nadir-looking. So there is no view angle to be considered.

7.2.4 Formosat-2

ATCOR Workflow reads the metadata file (.DIM) and creates the calibration file **automatically**, when an ATCOR project is created.

7.2.5 GeoEye-1

GeoEye-1 provides optical data with four multispectral channels in the 480 to 840 µm region with a spatial resolution of about 1.7 m. In addition, panchromatic data with a resolution of about 0.5 m is available. The radiometric encoding is 11 bits per pixel.

Radiometry. The metadata file (*_metadata.txt) for each scene contains the radiometric offset and gain values. These values are given in the same unit as used by ATCOR Workflow, so they can be used for ATCOR Workflow as they are specified in the metadata file.

$$c_0 = 0.0 \qquad (7\text{-}6)$$

$$c_1 = Gain \qquad (7\text{-}7)$$

Geometry. The metadata file (*_metadata.txt) contains the geographic coordinates and the solar elevation and azimuth angles. The sensor geometry as viewed from the scene is specified by

- Nominal Collection Azimuth: absolute azimuth view angle, e.g. 'East' corresponds to 90°
- Nominal Collection Elevation

The incidence angle, as needed for ATCOR Workflow, can be calculated as 90° – *Nominal Collection Elevation*.

7.2.6 Ikonos

Radiometry The calibration parameters c_0 and c_1 for Ikonos are computed according to Equations (7-8) and (7-9).

$$c_0 = 0.0 \quad (7\text{-}8)$$

$$c_1 = 1/(calCoef * bandwidth) \quad (7\text{-}9)$$

where *calCoef* is defined as

$$L = \frac{DN}{calCoef}$$

The parameter *calCoef* depends on the production date and the radiometric resolution of the product as shown in

Table 10 and Table 11.

The calibration parameters c_0 and c_1 resulting from the coefficients in

Table 10 written in bold are stored in the **standard calibration file** that is written to the project folder, when an ATCOR project is created. The values can be modified if needed.

Table 10: Ikonos radiometric calibration coefficients (*calCoef*) for 11-bit products. The values in bold are stored in the calibration file template (default calibration parameters) of ATCOR Workflow.

Production Date	Blue	Green	Red	NIR
Pre 2001-02-22	633	649	840	746
Post 2001-02-22	**728**	**727**	**949**	**843**

Table 11: Ikonos radiometric calibration coefficients (*calCoef*) for 8-bit products.

Production Date	Blue	Green	Red	NIR
Pre 2001-02-22	79	81	105	93
Post 2001-02-22	91	91	119	105

Geometry. The metadata file (*_metadata.txt) contains the geographic coordinates and the solar elevation and azimuth angles. The sensor geometry as viewed from the scene is specified by

- Nominal Collection Azimuth: absolute azimuth view angle, e.g. 'East' corresponds to 90°
- Nominal Collection Elevation

The sensor incidence angle, as needed for ATCOR Workflow, can be calculated as
90° – *Nominal Collection Elevation*.

7.2.7 IRS-1A/B LISS-2

Radiometry. The metadata file includes the radiometric calibration coefficients bias *B* = *Lmin* and gain *G* = *Lmax* in the ATCOR radiance unit $mWcm^{-2}sr^{-1}\mu m^{-1}$. The calibration parameters c_0 and c_1 for ATCOR have to be calculated according to (7-10) and (7-11).

$$c_0 = Lmin \quad (7\text{-}10)$$

$$c_1 = (Lmax - Lmin)/255 \quad (7\text{-}11)$$

7.2.8 IRS-P6

The IRS-P6 platform carries three optical sensors: the AWiFS (Advanced Wide-Field-of-view-Sensor), the LISS-3, and the LISS-4. AWiFS (60 m resolution) and Liss-3 (20 m) have the same spectral bands (Green, Red, NIR, and SWIR at 1.6 µm). The Liss-4 (Red) serves as the high resolution camera (5 m).

Radiometry. The metadata file includes the radiometric calibration coefficients, the bias *B* = *Lmin* and the gain *G* = *Lmax* in the ATCOR radiance unit $mWcm^{-2}sr^{-1}\mu m^{-1}$. The nominal value for *Lmin* is zero. The calibration parameters c_0 and c_1 for ATCOR have to be calculated according to (7-12) and (7-13).

$$c_0 = Lmin \quad (7\text{-}12)$$

$$c_1 = (Lmax - Lmin)/b \quad (7\text{-}13)$$

where b = 1023 for AWiFS (10 bit encoding), and b = 255 for Liss-3 and Liss-4 (8 bit encoding).

⚠ The analysis of a couple of scenes showed that a non-zero bias c_0 is required to obtain reasonable surface reflectance spectra. Therefore, typical average bias values are included in the standard calibration file that is copied to the project folder, when a new ATCOR project is created. A fine tuning of these values may be necessary to obtain better agreement between scene-derived surface reflectance spectra and reference spectra (field measurements, spectral library).

7.2.9 Landsat-5 TM and Landsat-7 Multispectral

Landsat-5 and Landsat-7 data are usually provided as TIF files, one file per band, and a metadata file (*_MTL.txt). There are two processing systems for Landsat-5 TM, NLABS and LPGS. NLABS has been replaced by LPGS as from 2008-12-08. For LPGS processed data, the metadata import and the creation of the calibration file is done automatically, when an ATCOR project is created. The following section documents how this information on sensor calibration and geometry is compiled for ATCOR Workflow.

Radiometry. The metadata file contains the min/max radiance (*L*) for each band and the corresponding max/min digital numbers (*Qmax*, *Qmin*). The general equations to convert the digital number *DN* into at-sensor radiance are given by Equations (7-14) and (7-15).

$$L = B + G * DN \quad (7\text{-}14)$$

$$B = Lmin - \left(\frac{Lmax - Lmin}{Qmax - Qmin}\right) * Qmin \quad (7\text{-}15)$$

$$G = \frac{Lmax - Lmin}{Qmax - Qmin} \quad (7\text{-}16)$$

where *B* = bias, *G* = gain, and *Qmin* = 1, *Qmax* = 255 for the LPGS processing (the former NLAPS used *Qmin* = 0, *Qmax* = 255). The radiance unit in the metadata file is $Wm^{-2}sr^{-1}\mu m^{-1}$. Since ATCOR Workflow employs the unit $mWcm^{-2}sr^{-1}\mu m^{-1}$, the values for *B* and *G* have to be multiplied with the factor 0.1 to get the calibration parameters for the ATCOR calibration file:

$$c_0 = 0.1 * B \quad (7\text{-}17)$$

$$c_1 = 0.1 * G \quad (7\text{-}18)$$

⚠ The standard negative offset values for **Landsat-7** (band 1 to 4) provided in the metadata file can lead to negative surface reflectance for dark targets. In this case, the negative offset values have to be decreased, typically by a factor 2 (e.g. c_0 = -0.6979 → c_0 = -0.3490).

For the thermal band of **Landsat-7** two files are available per scene, B61 (low gain) and B62 (high gain). To be compatible with Landsat-5, only one of them can be included in the layer stack for ATCOR Workflow. Per default, band 61 is considered in the layer stack and in the calibration file. If band B62 is preferred, the layer stack and the calibration file have to be modified. The output of ATCOR-2 and ATCOR-3 has 7 bands, where band 7 is the surface temperature in degree Celsius [°C].

Landsat-7 includes a panchromatic band (B80). It is not included in the automatically created layer stack and calibration file (to be compatible with Landsat-5). This band has to be processed separately, if needed, specifying the sensor 'Landsat-7 Panchromatic'.

Geometry. Landsat is nadir-looking. So there is no view angle to be considered.

7.2.10 Landsat-8

Landsat-8 data are usually provided as TIF files, one file per band, and a metadata file (*_MTL.txt). ATCOR Workflow automatically creates a layer stack, reads the metadata file and creates the calibration file, when an ATCOR project is created. The following section documents how this information on sensor calibration and geometry is compiled for ATCOR Workflow.

Radiometry. For the calculation of the calibration parameters c_0 and c_1, Equations (7-14) to (7-18) apply. As the encoding is 12 bits per pixel, the following values for *Qmax* and *Qmin* have to be used: *Qmax* = 65535, *Qmin* = 1. In the Landsat-8 metadata file, Offset (Bias) and Gain are referred to as *RADIANCE_ADD* and *RADIANCE_MULT*. They can be directly used to calculate the ATCOR calibration parameters c_0 and c_1 according to Equations (7-19) and (7-20).

$$c_0 = 0.1 * RADIANCE\_ADD \qquad (7\text{-}19)$$

$$c_1 = 0.1 * RADIANCE\_MULT \qquad (7\text{-}20)$$

Landsat-8 has two thermal bands (B10 and B11). If the sensor ‘Landsat-8 MS+TIRS (10 Bands)’ is selected, both of them are included in the automatically created layer stack and calibration file. The output of ATCOR-2 and ATCOR-3 has 9 bands, where band 9 is the surface temperature in degree Celsius [°C] (split-window method, assuming an emissivity of 0.98 that is typical for vegetation).

Landsat-8 includes a panchromatic band (B80). It is not included in the automatically created layer stack and calibration file. This band has to be processed separately, if needed, by specifying the sensor ‘Landsat-8 Panchromatic’.

Geometry. Landsat-8 is nadir-looking. So there is no view angle to be considered.

7.2.11 Pléiades

The multispectral Pleiades sensor has 4 bands (blue, green, red, NIR) with a spatial resolution of 2 m. ATCOR Workflow reads the metadata file (DIM_*.XML) and creates the calibration file **automatically**, when an ATCOR project is created. The following section documents how this information on sensor calibration and geometry is compiled for ATCOR Workflow.

Radiometry. The sensor has adjustable gain settings documented in the metadata file for each scene. The radiometric bias and gain are defined as

L = bias + DN/gain

using the radiance unit [$W\ m^{-2} sr^{-1} \mu m^{-1}$]. Since ATCOR uses the radiance unit [$mW\ cm^{-2} sr^{-1} \mu m^{-1}$] and the equation

$L = c_0 + c_1 * DN,$

the calibration parameters have to be calculated according to Equations (7-21) and (7-22).

$$c_0 = 0.1 * bias \qquad (7\text{-}21)$$

$$c_1 = 0.1/gain \qquad (7\text{-}22)$$

⚠ Pleiades imagery is usually distributed with the band sequence Red / Green / Blue / NIR. For ATCOR Workflow, the band sequence Blue / Green / Red / NIR is required. By default, ATCOR Workflow changes the band order of the specified input image from 1/2/3/4 to 3/2/1/4. The image with the modified band order is written into the corresponding ATCOR project folder. If your input image has already the correct band order, uncheck the corresponding checkbox in the Preferences (see Section 9).

Geometry. The keywords ‘*SUN_ELEVATION*’ and ‘*SUN_AZIMUTH*’ specify the solar elevation and azimuth angle, respectively. The satellite geometry is specified by the keywords ‘*AZIMUTH_ANGLE*’ and ‘*INCIDENCE_ANGLE*’.

7.2.12 Pléiades NEO

Geometry. As Pléiades NEO Level 1A imagery is delivered in geographic coordinates and with RPC files for georeferencing, ATCOR Workflow for IMAGINE uses the RPCs for improvement of the georeferenced and subsequently re-stacks the bands according to the band order ATCOR expects. The result will be projected in WGS-84 UTM projection in the according zone.

7.2.13 Quickbird

ATCOR Workflow reads the metadata file (*.IMD) and creates the calibration file **automatically**, when an ATCOR project is created. The following section documents how this information on sensor calibration and geometry is compiled for ATCOR Workflow.

Radiometry. The IMD file contains the absolute calibration factor (*absCalFactor*) for each band in the unit $Wm^{-2}sr^{-1}$. Depending on the processing date, also the effective bandwidth (*effectiveBandwidth*) $\Delta\lambda$ in µm is included. The calibration parameters c_0 and c_1 for ATCOR are calculated according to (7-23) and (7-24).

$$c_0 = 0 \qquad (7\text{-}23)$$

$$c_1 = \frac{absCalFactor * 0.1}{\Delta\lambda} \qquad (7\text{-}24)$$

Geometry. The keywords '*sunEl'* and '*sunAz'* (or '*meanSunEl'* and '*menSunAz'*) specify the solar elevation and azimuth angle, respectively. The sensor can tilt in any direction. The satellite geometry as viewed from the scene center is specified by '*satEl'* or *'meanSatEl'* (satellite elevation angle), and '*satAz'* or *'meanSatAz'* (absolute azimuth angle). ATCOR's incidence angle is calculated as 90 – *satEl*. Depending on the processing date, the tilt angle may be given in the IMD file. It is named '*offNadirViewAngle'* or '*meanOffNadirViewAngle'*. The incidence angle is then obtained by solving Equation (7-29). The orbit altitude of Quickbird is 450 km.

7.2.14 RapidEye

The RapidEye constellation consists of 5 identical instruments in different orbits enabling a high temporal revisit time for any area. The sensor has 5 multispectral bands covering the blue to NIR region, with the specialty of a red-edge band (at 710 nm, bandwidth 40 nm). In addition, the instruments can be tilted in the across-track direction. The nadir spatial resolution is 6.5 m.
ATCOR Workflow reads the metadata file (.XML) and creates the calibration file **automatically**, when an ATCOR project is created. The following section documents how this information on sensor calibration and geometry is compiled for ATCOR Workflow.

Radiometry. For RapidEye data the provided ATCOR calibration file can be used. It is not necessary to build a scene-specific calibration file. The calibration parameters valid for all scenes are given in Equations (7-25) and (7-26).

$$c_0 = 0.0 \qquad (7\text{-}25)$$

$$c_1 = 0.001 \qquad (7\text{-}26)$$

Geometry. The metadata file (.xml) contains information on the solar elevation angle ('illuminationElevationAngle'), the solar azimuth ('illuminationAzimuthAngle'), and the view geometry, i.e. the 'IncidenceAngle' and the view azimuth ('azimuthAngle'). Over the years, different formats of the metadata file were used.

7.2.15 SPOT-1 to SPOT-3

The metadata is specified in two files, i.e. in the VOL_LIST.PDF and in the METADATA.DIM. The first file is intended for a quick overview, the second file contains the complete set of specifications.

Radiometry. The **Gain** values (called *PHYSICAL_GAIN* in the METADATA.DIM) for each band can be taken as they are from either file. The SPOT radiance unit is $1/[Wm^{-2}sr^{-1}\mu m^{-1}]$, but it is automatically converted into the unit used in ATCOR Workflow. The standard **Offset** values are zero. Occasionally, for SPOT-4/5 data a slightly negative offset has to be introduced for band 4 (1.6 µm) when the scene water reflectance is too high (it should be zero).

$$c_0 = 0.0 \qquad (7\text{-}27)$$

$$c_1 = PHYSICAL\_GAIN \qquad (7\text{-}28)$$

Geometry. The geometry of data acquisition is described in the METADATA.DIM file. The solar geometry is specified by the solar elevation and azimuth angle. The sensor view geometry is defined by the incidence angle θ_i at the Earth's surface (Figure 6). Sensor view angle and incidence angle are related as shown in Equation (7-29).

$$\theta_v = \arcsin\left[\frac{R_E}{R_E + h}\sin(\theta_i)\right] 180\,/\pi \qquad (7\text{-}29)$$

where R_E is the Earth radius (6371 km) and h is the orbit altitude (SPOT: 832 km).

In addition to the tilt angle, the view direction with respect to the flight path is specified. Nearly all SPOT data (99.9 %) are recorded in the descending node, i.e. flying from the North Pole to the equator (indicated by a negative value of the velocity vector for the Z component in the METADATA.DIM). Then a positive incidence or tilt angle in METADATA.DIM means the tilt direction is left of the flight direction ("East" for the descending node). This is indicated by an "L" in the incidence angle in VOL_LIST.PDF (e.g. incidence angle L20.6 degree). A negative incidence angle means that the sensor is pointing to the "West" (coded as R=right in the VOL_LIST.PDF, e.g. incidence angle R20.6 degree).

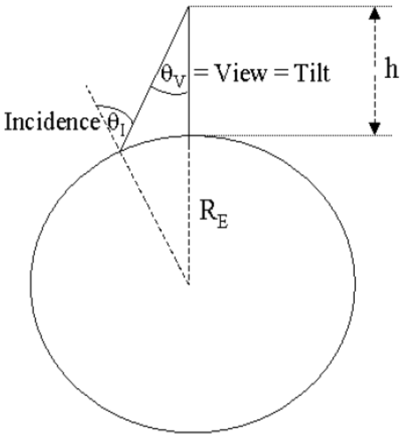


Figure 6: Sensor geometry.

For ATCOR Workflow, the satellite azimuth as seen from the recorded image has to be specified. If α denotes the scene orientation angle with respect to the North (Figure 7), the satellite azimuth angle ϕ_v as viewed from the scene centre is

- $\phi_v = \alpha + 270°$ if incidence (or tilt) angle is positive (L = left case, "East")
- $\phi_v = \alpha + 90°$ if incidence (or tilt) angle is negative (R = right case, "West")

7.2.16 SPOT-4 and SPOT-5

ATCOR Workflow reads the metadata file (.DIM) and creates the calibration file **automatically**, when an ATCOR project is created.

⚠ SPOT-4 and SPOT-5 imagery is usually delivered in the DIMAP format, a TIF file, with the band sequence NIR / Red / Green and SWIR. For ATCOR Workflow the band sequence Green / Red / NIR / SWIR is required. By default, ATCOR Workflow changes the band order of the specified input image from 1/2/3/4 to 3/2/1/4. The image with the modified band order is written into the corresponding ATCOR project folder. If your input image has already the correct band order, uncheck the corresponding checkbox in the Preferences (see Section 9).

7.2.17 SPOT-6 and SPOT-7

ATCOR Workflow reads the metadata file (DIM_SPOT6_*.XML or DIM_SPOT7_*.XML) and creates the calibration file **automatically**, when an ATCOR project is created.

⚠ SPOT-6/7 imagery is usually delivered with the band sequence Red / Green / Blue and NIR. For ATCOR Workflow, the band order Blue / Green / Red / NIR (i.e. layer stack of band 3, 2, 1, and 4) is required. By default, ATCOR Workflow changes the band order of the specified input image from 1/2/3/4 to 3/2/1/4. The image with the modified band order is written into the corresponding ATCOR project folder. If your input image has already the correct band order, uncheck the corresponding checkbox in the Preferences (see Section 9).

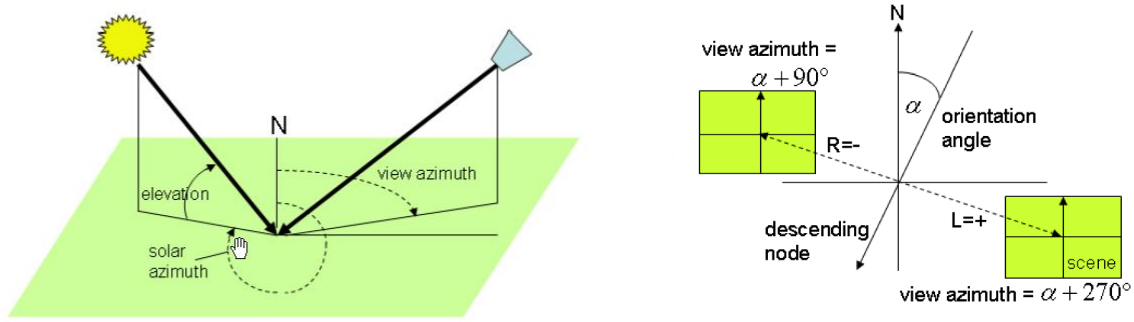


Figure 7: Sun and sensor geometry.

7.2.18 THEOS

THEOS (THailand Earth Observation Satellite) is a satellite mission of Thailand containing a multispectral and a panchromatic instrument. The multispectral sensor has 4 channels in the visible and in the near infrared, similar to the first 4 bands of Landsat-5 TM. The spatial resolution is 15 m and the swath 90 km. The panchromatic instrument has a spectral filter curve similar to Landsat-7 ETM+ panchromatic, but the spatial resolution is 2 m. The orbit altitude is 826 km.

ATCOR Workflow reads the metadata file (.DIM) and creates the calibration file **automatically**, when an ATCOR project is created. The following section documents how this information on sensor calibration and geometry is compiled for ATCOR Workflow.
Radiometry. The data encoding is 8 bits/pixel. The sensor has adjustable gain settings documented in the metadata file for each scene. The gain factor is given in the unit $1/(Wm^{-2}sr^{-1}\mu m^{-1})$. Thus, the calibration parameters for ATCOR are calculated according to Equations (7-30) and (7-31).

$$c_0 = 0.0 \quad (7\text{-}30)$$

$$c_1 = 0.1/PHYSICAL\_GAIN \quad (7\text{-}31)$$

where *PHYSICAL_GAIN* is the gain factor. The factor 0.1 accounts for the unit conversion.

Geometry. The metadata file specifies the satellite incidence angle and the satellite azimuth as required for ATCOR.

7.2.19 VENµS

ATCOR Workflow reads the metadata file (.HDR) selected by the user. Here, it is important to select the metadata file from the top folder of the original data structure. Do not select any of the .HDR files that are located in the folder where the .TIF file is located (see section 6.1.12).

7.2.20 WorldView-2, WorldView-3, and WorldView-4

ATCOR Workflow reads the metadata file (.IMD) and creates the calibration file **automatically**, when an ATCOR project is created. The following section documents how this information on sensor calibration and geometry is compiled for ATCOR Workflow.

Radiometry. The instrument has selectable radiometric gain factors ('*absCalFactor*') specified in the metadata file (*.IMD). The calibration parameters for ATCOR are calculated according to Equations (7-32) and (7-33).

$$c_0 = 0.0 \quad (7\text{-}32)$$

$$c_1 = 0.1 * absCalFactor/FWHM \quad (7\text{-}33)$$

where *FWHM* is the effective bandwidth ('effectiveBandwidth' in µm) as specified in the metadata file.

Geometry. The keywords '*sunEl'* and '*sunAz'* (or '*meanSunEl'* and '*meanSunAz'*) specify the solar elevation and azimuth angle, respectively. The sensor can tilt in any direction. The satellite geometry as viewed from the scene center is specified by '*satEl'* or *'meanSatEl'* (satellite elevation angle), and '*satAz'* or *'meanSatAz'* (absolute azimuth angle). ATCOR's incidence angle is calculated as 90° – *satEl*.

8 ATCOR Workflow in Batch Mode

8.1 Launching ATCOR Workflow in Batch Mode

There are basically three ways to run ATCOR Workflow in batch mode, i.e. via the **ATCOR Workflow Dialog**, the **ERDAS IMAGINE Menu** and with ERDAS IMAGINE Professional also via the **Spatial Model Editor** (Sections 8.1.1 to 0).

8.1.1 ATCOR Workflow Dialog

1. Open the ATCOR Workflow Dialog by clicking **Toolbox Tab** > **ATCOR Workflow for IMAGINE** > **Run ATCOR Dehaze/ATCOR-2/ATCOR-3**.
2. Enter all required inputs in the dialog and click the 'Batch' button. The Batch Command Editor opens (Figure 8).
3. Select '*One or more inputs, one output*' from the field '*Variables*' as shown in Figure 8 (1).
4. Load a prepared **Batch Command File (*.bcf)** (2).
5. Load a prepared **Batch List File (*.bls)** (3) corresponding to the loaded Batch Command File. If necessary, check the box '*Show Full Pathname*' to see the entries of the loaded list.
6. Click '***Run Now***' or '***Submit'*** (4) to launch the batch job. See the ERDAS IMAGINE Help (5) for more information.

8.1.2 ERDAS IMAGINE Menu

1. Click **File** > **Batch** > **Open Batch Command File**. The Batch Command Editor opens (Figure 8).
2. Select a prepared **Batch Command File (*.bcf)** as shown in Figure 8 (2).
3. Load a **Batch List File (*.bls)**, Figure 8 (3), corresponding to the loaded Batch Command File. If necessary check the box '*Show Full Pathname*' to see the entries of the loaded list.
4. Click '***Run Now***' or '***Submit***' (4) to launch the batch job. See the ERDAS IMAGINE Help for more information (5).

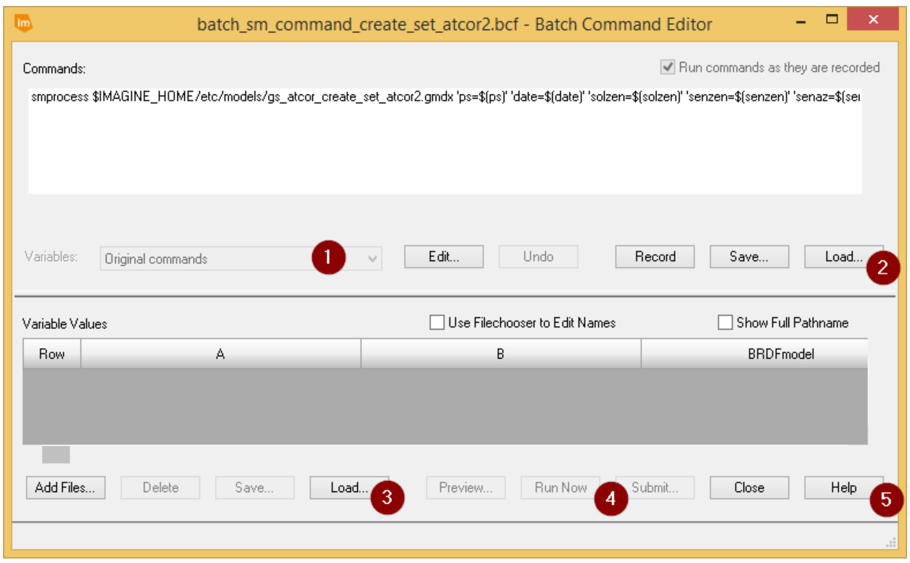


Figure 8: ERDAS IMAGINE Batch Command Editor.

8.1.3 Spatial Model Editor

1. **Create** or **load** the graphical model (*.gmdx) that you want to run in batch.
2. Click ‘***Run in Batch***’ to run the current model in batch mode. See the ERDAS IMAGINE Help for more information.

8.2 Batch Files for ATCOR Workflow

Batch list files (.bls) are tab-delimited text files.

After installation of ATCOR Workflow for IMAGINE, prepared batch command files (*.bcf) and batch list templates (*.bls) for *ATCOR Dehaze*, *ATCOR-2*, and *ATCOR-3* (for ‘Load ATCOR Project’ and ‘Create ATCOR Project’ respectively) are located in

<*Installation path*>\GEOSYSTEMS ATCOR Workflow for IMAGINE 2019 v1.2\tools\

Edit the .bls file using a text editor or spreadsheet (e.g. Microsoft Excel) and load it in the *Batch Command Editor* as explained in Section 8.1.

All ATCOR Workflow variable names are listed in Table 4. Mandatory variables are highlighted. Each input value has to be quoted (e.g. ‘true’, ‘0.250’, ‘strong’, ‘E:/Projekte/GMTED2010.jp2’ etc.). Non-mandatory inputs can be left blank (i.e. empty quotes: ‘’).The values accepted for each variable are provided in Section 5.

9 Preferences

The ATCOR Workflow preferences are located in the group GEOSYSTEMS of the Preference Editor (Figure 9).

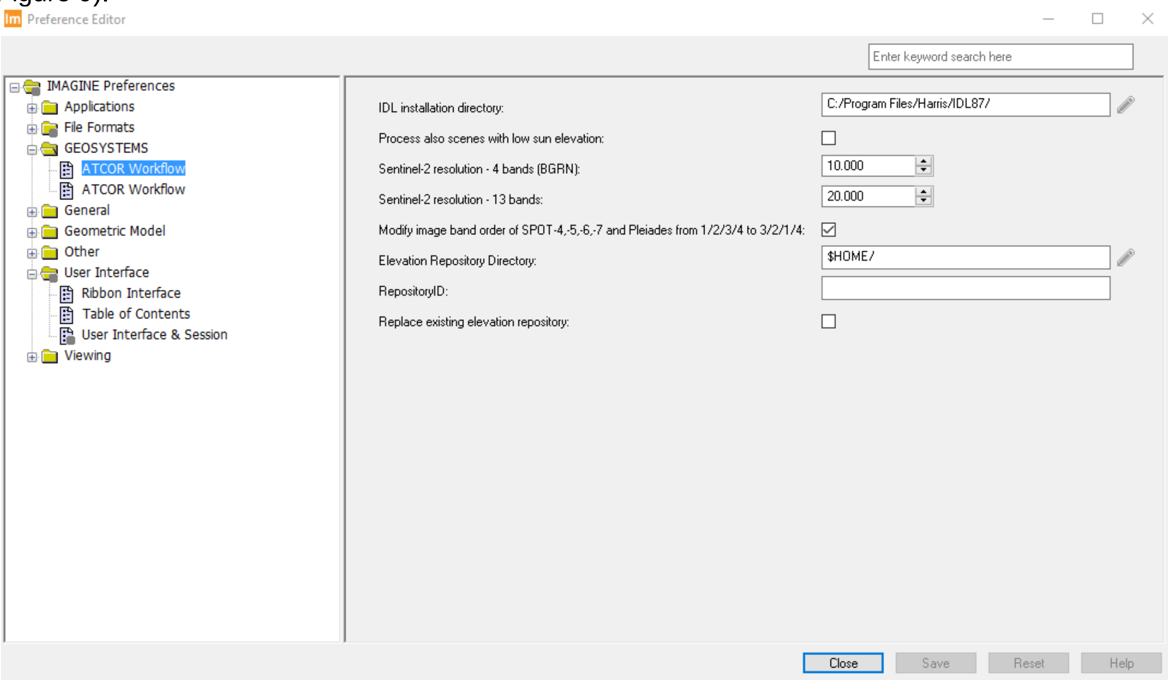


Figure 9: ATCOR Workflow Preferences in the Preferences Editor.

It contains the following entries:

Preference	Description
IDL installation directory	The default directory is C:/Program Files/Haris/IDL87/. This is the expected

Preference	Description
	location of a licensed IDL Version. If this directory does not contain an IDL installation, the internal IDL Version provided by the ATCOR Workflow installer is used.
Process also scenes with low sun elevation	By default, ATCOR Workflow processes only images with a sun elevation angle of at least 20° (or a maximum sun zenith angle of 70°), because low sun elevation may lead to improper results. Check the box to ignore this limit but be aware of the reduced quality of the results.
Sentinel-2 resolution – 4 bands (BGRN)	The default pixel size for processing the 4-band layer stack with the bands B02 (Blue), B03 (Green), B04 (Red), and B08 is 10 m, i.e. the original pixel size of these bands. With this setting you can choose another pixel size, where 10 m is the minimum pixel size.
Sentinel-2 resolution – 13 bands	The default pixel size for processing the 13-band layer stack is 20 m. With this setting you can choose another pixel size, where 10 m is the minimum pixel size.
Modify image band order of SPOT-4/-5/-6/-7 and Pleiades from 1/2/3/4 to 3/2/1/4	For ATCOR Workflow the bands of the input image must be sorted by wavelength in ascending order (e.g. Blue/Green/Red/NIR or Green/Red/NIR/SWIR). **SPOT-4/5** imagery is usually delivered in the DIMAP format, a TIF file, with the band sequence NIR / Red / Green and SWIR. For ATCOR Workflow, the band order has to be changed to Green / Red / NIR / SWIR (i.e. layer stack of band 3, 2, 1, and 4). **SPOT-6/7** imagery is usually delivered with the band sequence Red / Green / Blue and NIR. For ATCOR Workflow, the band order has to be changed to Blue / Green / Red / NIR (i.e. layer stack of band 3, 2, 1, and 4). **Pléiades** imagery is usually delivered with the band sequence Red / Green / Blue / NIR. For ATCOR Workflow, the band order has to be changed to Blue / Green / Red / NIR (i.e. layer stack of band 3, 2, 1, and 4). Check the box, if you want ATCOR Workflow to change the band order as required. The image with the modified band order is written into the corresponding ATCOR project folder.
Elevation Repository Directory	The default directory for the elevation repository.
RepositoryID	Default ID for the repository. Empty per default.
Replace existing elevation repository	Allows to overwrite the existing repository. False by default.

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