GEOSYSTEMS
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# ATCOR Workflow for IMAGINE 2023

## Step-By-Step Guide

Software version: 3.0

HEXAGON
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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 Overview

This guide leads you through the major processing steps of ATCOR Workflow. All example data sets are processed using both, the **ATCOR Workflow Dialog** and the **ATCOR Workflow Operators** (Spatial Modeler).

## 1.1 Before you start

**Make sure that**

- **ERDAS IMAGINE** Essential 2022 Update 2 (for ATCOR Workflow Dialog) or ERDAS IMAGINE Professional 2022 Update 2 (for ATCOR Workflow Dialog and access to the ATCOR Workflow operators) is installed and licensed,
- **During installation of ATCOR Workflow,** the option to download the GMTED 30m DEM was checked. If not, it can be downloaded afterwards under https://cloud.geosystems.de/s/3wiAqqjzW9PKjG4/download/GMTED2010.zip,
- **ATCOR Workflow for IMAGINE 2022 Update 2** is installed and licensed, and that
- you have access to the **internet** for downloading the demo datasets (Example 1: ~840 MB, Example 2: ~50 MB, Example 3: ~750 MB).
- ⚠ ATCOR Workflow for IMAGINE is based on 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. Just click on the splash screen to remove it. 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.

## 1.2 Download Example data

The example data required for the Step-By-Step Guide can be downloaded here: https://www.geosystems.de/produkte/atcor-workflow-fuer-imagine/download.

# 2 Example 1 – Landsat-8 with Dehaze, ATCOR-2/3

## 2.1 What You Will Learn

Based on a **Landsat-8** image (Figure 1 and 2), the following processing steps are demonstrated:

- automatic metadata import,
- haze reduction (*ATCOR Dehaze*), and
- atmospheric correction in flat terrain (*ATCOR-2*).
- atmospheric correction in terrain (*ATCOR-3*).

The example data set is processed using the **ATCOR Workflow Dialog** (Section 2.3) and the **ATCOR Workflow Operators** (Spatial Modeler) (Section 2.4).

## 2.2 Data Preparation

1. **Download** the file `ATCOR_Workflow_Step_by_Step_Guide_Example1.zip` from http://www.geosystems.de/en/products/atcor-workflow-for-imagine/download and **extract** it to the folder `<My_ATCOR_Workflow_Demo_Folder>\Example1\01_L8_data`.

2. **Open the multispectral image** by importing Bands 2,3 and 4 as Virtual Stack: **File Tab > Open > Raster Layer…**. Choose TIFF in the "Files of type" option and select `LC81990262013104LGN01_B2.TIF`, `LC81990262013104LGN01_B3.TIF` and `LC81990262013104LGN01_B2.TIF`.

Navigate to the “Multiple” tab in the “Select Layer To Add:” dialogue and select “Virtual Stack”. Click OK. The virtual stack is opened in the 2D View window.
Choose the band combination Layer 3 (red) - Layer 2 (green) - Layer 1 (blue) in the **Multispectral Tab > Bands**.

3. **Examine the multispectral image**: The image (Figure 2) shows haze and cirrus clouds, so we will apply ATCOR Dehaze prior to atmospheric correction. As the area is rather flat, we will use ATCOR-2 for atmospheric correction. Additionally, we want to compute the LAI (Leaf Area Index) based on the Soil-adjusted Vegetation Index (SAVI).

### 1.2.1 Landsat-8 image

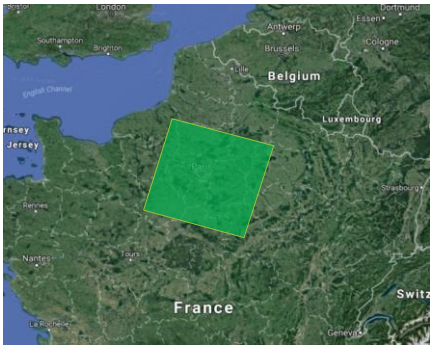



Figure 1: Footprint of the Landsat-8 demo data set (Example 1), path/row: 199/026, date: 2013-04-14.

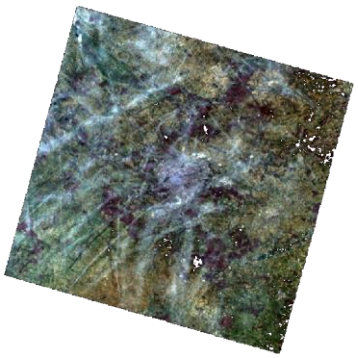


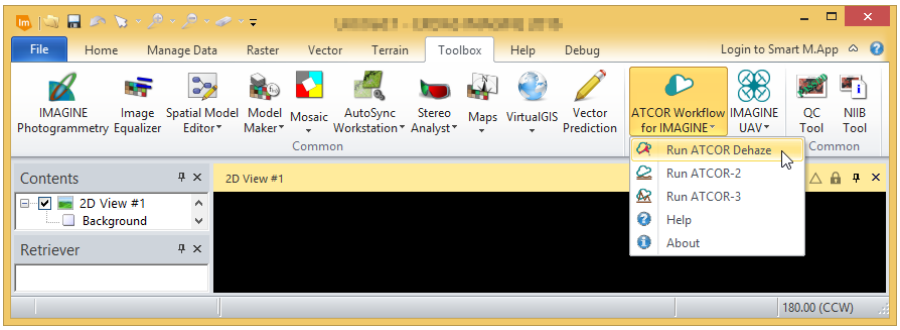
Figure 2: True color quicklook of the Landsat-8 demo data set (after import in ERDAS IMAGINE).
[Image courtesy of the U.S. Geological Survey]

## 2.3 Data Processing Using the ATCOR Workflow Dialog

1. **Create** the following folders (**do not move the project data afterwards to other folders!**):

```
<My_ATCOR_Workflow_Demo_Folder>\Example1\02_atcor_project
<My_ATCOR_Workflow_Demo_Folder>\Example1\03_output
```

2. Click **Toolbox Tab** > **ATCOR Workflow for IMAGINE** > **Run ATCOR Dehaze** to open the ATCOR Dehaze dialog.



3. Select the Operation Mode **Create ATCOR Project**.
4. Specify the following options on the **Project Tab** of the dialog (Figure 3):
    - Project folder: navigate into the folder `<My_ATCOR_Workflow_Demo_Folder>\Example1\02_atcor_project`
    - Sensor: Landsat-8 MS + TIRS (10 Bands)
    - Image File: switch off the file filter 'All File-based Raster Formats' by entering '*.txt' in the field 'Image File' and select the file `<My_ATCOR_Workflow_Demo_Folder>\Example1\01_L8_data\temp\lc81990262013104lgn01\LC81990262013104LGN01_MTL.txt`
    - Metadata File: [no input required]
    - Elevation File: `Documents\gmted2010\GMTED2010.jp2`
    - Dehazed Image File: specify the name for the output file (new file) `<My_ATCOR_Workflow_Demo_Folder>\Example1\03_output\LC81990262013104LGN01_dh.tif`
5. Navigate from the Project Tab to the **Settings Tab** (Figure 4).

   The input values in the **Sensor Information** box and in the **Geometry** box will be set automatically for Landsat-8, as ATCOR Workflow provides metadata import for this sensor. Therefore, you do not have to edit these settings.
6. In the **Dehaze Parameters** box specify the following options:
    - Dehaze Method: *standard*
    - Dehaze Area: land pixels only
    - Use Cirrus Band If Available: ✓
    - Interpolation Method: *bilinear (fast)*

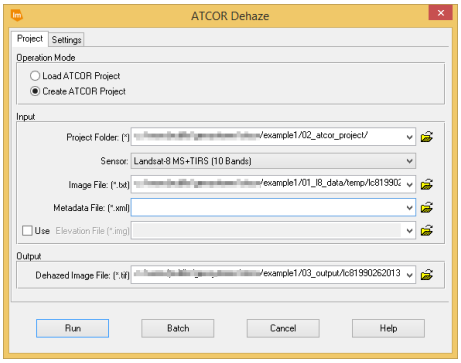



Figure 3: ATCOR Dehaze Project Tab.

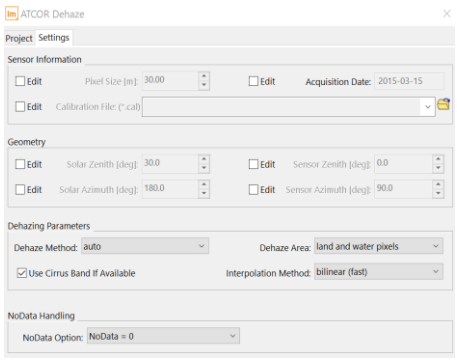



Figure 4: ATCOR Dehaze Settings Tab.

7. Click **Run**. Depending on your PC, processing can take about 5 minutes to finish. Check the process status in the ERDAS IMAGINE Process List.
8. Examine the **Session Log**. Here you find some basic information about the executed process as well as warnings or error messages if a problem occurred.
9. Examine the **project folder**: `<My_ATCOR_Workflow_Demo_Folder>\Example1\02_atcor_project`

   Here you find the following files:
    - `GEOSYSTEMS_ATCOR.project`, the ATCOR project file, a text file containing some basic information on the project,

- `lc819902620131041gn01.tif`, the layer stack of the original image with the band order and pixel size as required by ATCOR Workflow,
- `lc819902620131041gn01.log`, the log file (during processing, ATCOR shows a message that describes the required band order, within our example this can be ignored), and
- `lc819902620131041gn01.cal`, the calibration file.

**10.** Examine the **log file**. Here you can find detailed information about the executed process.

**11.** **Open** the original image and the dehazed image in the Viewer and compare (Figure 12: Results of ATCOR Dehaze and ATCOR-2 for Example 1 (detail): original image (top left), dehazed and atmospherically corrected image (top right), haze map (bottom left; yellowish colors indicate haze contaminated pixels, see Table 1 for haze map categories), Leaf Area Index Index (LAI) (bottom right; brown: low LAI, green: high LAI).

**Original image**: `<My_ATCOR_Workflow_Demo_Folder>\Example1\02_atcor_project\lc819902620131041gn01.tif`

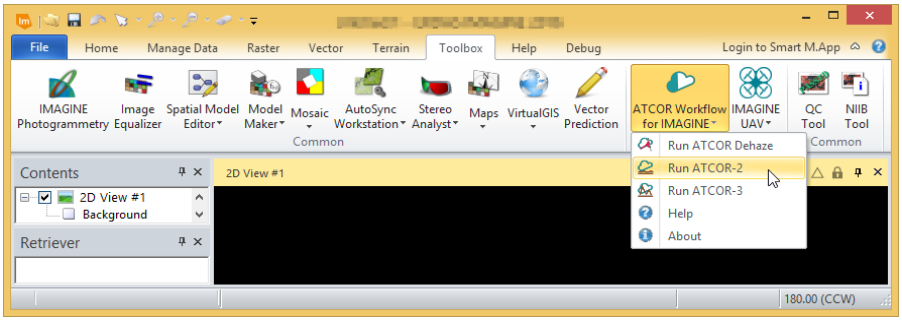
**Dehazed image**:`<My_ATCOR_Workflow_Demo_Folder>\Example1\03_output\LC819902620131041LGN01_dh.tif`

Now load the haze map into the viewer and compare with the original / dehazed image.

**Haze map**: `<My_ATCOR_Workflow_Demo_Folder>\Example1\03_output\LC819902620131041LGN01_haze_map.tif`

Next, we atmospherically correct the dehazed image using the ATCOR-2 process.

**12.** Click **Toolbox Tab** > **ATCOR Workflow for IMAGINE** > **Run ATCOR-2** to open the ATCOR-2 dialog.




**13.** Select the Operation Mode **Load ATCOR Project**.

**14.** Specify the following options on the **Project Tab** of the dialog:

- Project Folder:
  `<My_ATCOR_Workflow_Demo_Folder>\Example1\02_atcor_project`
- Corrected Image File: specify the name for the output file (new file)
  `<My_ATCOR_Workflow_Demo_Folder>\Example1\03_output\LC819902620131041LGN01_atcor2.tif`

**15.** Navigate from the Project Tab to the **Basic Settings Tab** (Figure 5).

In the **Sensor Information** box and in the **Geometry** box the metadata values are shown as they were read from the metadata file, when the project was created. Do not edit these values!

**16.** In the **Atmosphere** box specify the following options after checking the corresponding Edit box:

- Water Vapor Category: *fall/spring*
- Aerosol Type: *rural*

17. Navigate from the Basic Settings Tab to the **Advanced Settings Tab** (Figure 6). Check the checkbox **Compute Value-added Products** and select the **LAI Model** *Use SAVI*.
18. Click **Run**. Depending on your PC, processing can take about 5 minutes to finish. Check the process status in the ERDAS IMAGINE Process List.
19. Examine the **Session Log** (**File Tab > Session > View Session Log**). Here you can find basic information about the executed process as well as warnings or error messages if a problem occurred.
20. Examine the **log file**. Entries referring to the process ATCOR-2 were added to the file providing detailed information about the executed process.
21. **Display** the result and compare the atmospherically corrected image with the original image, e.g. by using the Inquire Curser. The corrected image provides surface reflectance spectra. You get surface reflectance in % by dividing the pixel value by 100 (= applied reflectance scale factor). E.g. a pixel value of 2150 corresponds to a reflectance of 21.5%.

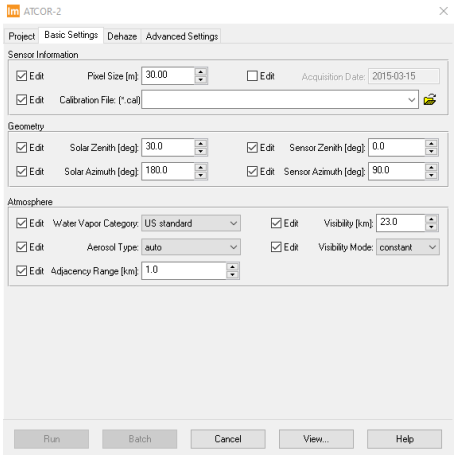


Figure 5: ATCOR-2 Basic Settings Tab.

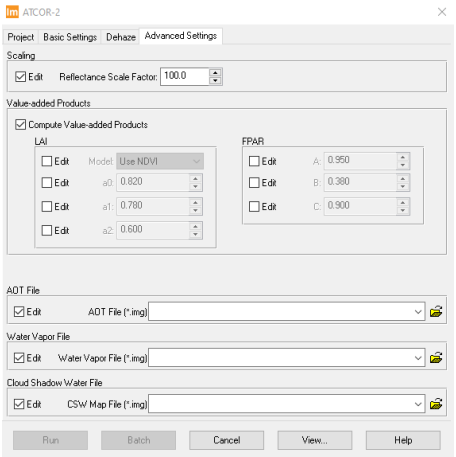
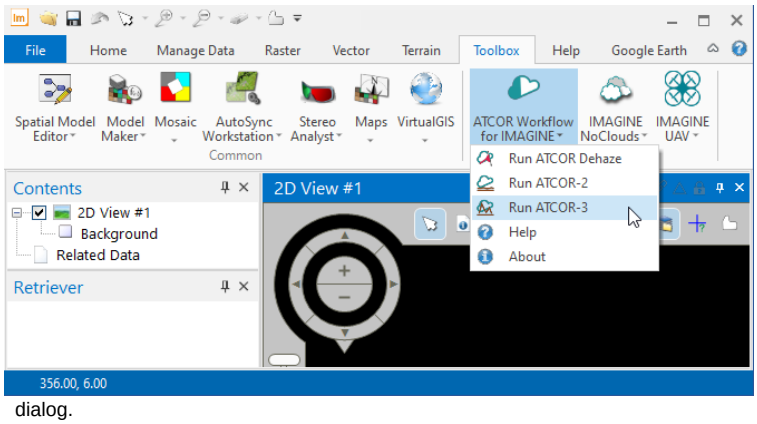


Figure 6: ATCOR-2 Advanced Settings Tab.

22. Click **Toolbox Tab** > **ATCOR Workflow for IMAGINE** > **Run ATCOR-3** to open the ATCOR-3



dialog.

23. Select the Operation Mode **Create ATCOR Project**.

**24.** Specify the following options on the **Project Tab** of the dialog (Figure 3):

- Project folder: navigate into the folder
  `<My_ATCOR_Workflow_Demo_Folder>\Example1\04_atcor3_project`
- Sensor: Landsat-8 MS + TIRS (10 Bands)
- Image File: switch off the file filter 'All File-based Raster Formats' by entering '*.txt' in the field 'Image File' and select the file
  `<My_ATCOR_Workflow_Demo_Folder>\Example1\01_L8_data\lc81990262013104lgn01.tar\LC81990262013104LGN01_MTL.txt`
- Metadata File: [no input required]
- Elevation File: `Documents\gmted2010\GMTED2010.jp2`
- Corrected Image File: specify the name for the output file (new file)
  `<My_ATCOR_Workflow_Demo_Folder>\Example1\03_output\LC81990262013104LGN01_atcor3.tif`

**25.** Navigate from the Project Tab to the **Basic Settings** (Figure 4).

The input values in the **Sensor Information** box and in the **Geometry** box will be set automatically for Landsat-8, as ATCOR Workflow provides metadata import for this sensor. Therefore, you do not have to edit these settings.

**26.** In the **Dehaze Parameters** box specify the following options:

- Use Dehaze: ✓ (optional
- Dehaze Method: *standard*
- Dehaze Area: land pixels only
- Use Cirrus Band If Available: ✓
- Interpolation Method: *bilinear (fast)*

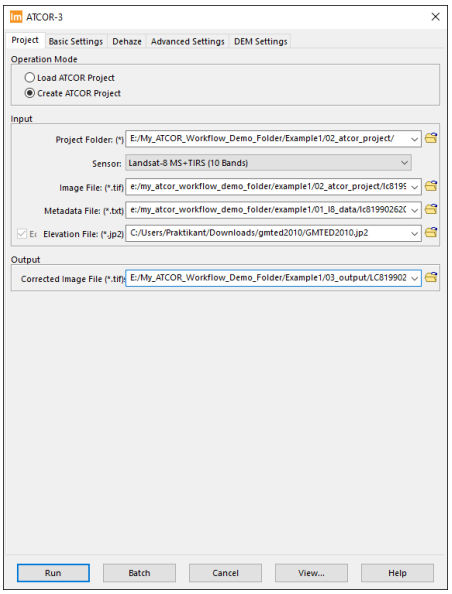


Figure 7: ATCOR3 Project Tab.

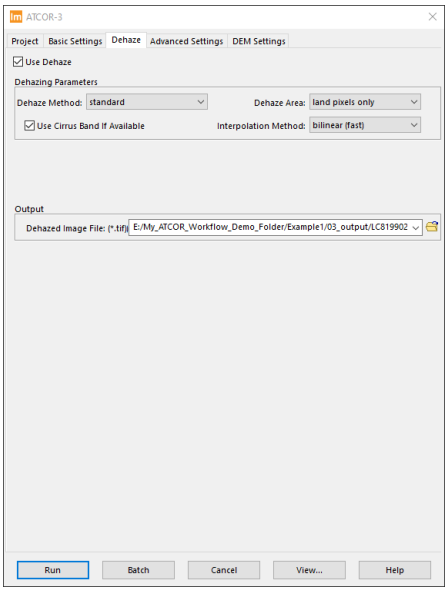


Figure 8: ATCOR Dehaze Settings Tab.

27. Click **Run**. Depending on your PC, processing can take about 5 minutes to finish. Check the process status in the ERDAS IMAGINE Process List.
28. Examine the **Session Log**. Here you find some basic information about the executed process as well as warnings or error messages if a problem occurred.
29. Examine the **project folder**:
    `<My_ATCOR_Workflow_Demo_Folder>\Example1\04_atcor3_project`

    Here you find the following files:

    - `GEOSYSTEMS_ATCOR.project`, the ATCOR project file, a text file containing some basic information on the project,
    - `lc819902620131041gn01.tif`, the layer stack of the original image with the band order and pixel size as required by ATCOR Workflow,
    - `lc819902620131041gn01.log`, the log file (during processing, ATCOR shows a message that describes the required band order, within our example this can be ignored), and
    - `lc819902620131041gn01.cal`, the calibration file.
30. Examine the **log file**. Here you can find detailed information about the executed process.
31. **Open** the original image and the dehazed image in the Viewer and compare (Figure 12: Results of ATCOR Dehaze and ATCOR-2 for Example 1 (detail): original image (top left), dehazed and atmospherically corrected image (top right), haze map (bottom left; yellowish colors indicate haze contaminated pixels, see Table 1 for haze map categories), Leaf Area Index Index (LAI) (bottom right; brown: low LAI, green: high LAI).

**Original image**: `<My_ATCOR_Workflow_Demo_Folder>\Example1\04_atcor3_project\lc819902620131041gn01.tif`

**Dehazed image**:`<My_ATCOR_Workflow_Demo_Folder>\Example1\03_output\LC81990262013104LGN01_dh.tif`

Now load the haze map into the viewer and compare with the original / dehazed image.

**Haze map**: `<My_ATCOR_Workflow_Demo_Folder>\Example1\03_output\LC81990262013104LGN01_haze_map.tif`

**Corrected image**:`<My_ATCOR_Workflow_Demo_Folder>\Example1\03_output\LC81990262013104LGN01_atcor3.tif`

## 2.4 Data Processing Using the ATCOR Workflow Operators

1. **Create** the following folders:

   `<My_ATCOR_Workflow_Demo_Folder>\Example1\02_atcor_project_SM`
   `<My_ATCOR_Workflow_Demo_Folder>\Example1\03_output_SM`

2. Click **Toolbox Tab** > **Spatial Model Editor** to open the Spatial Modeler.

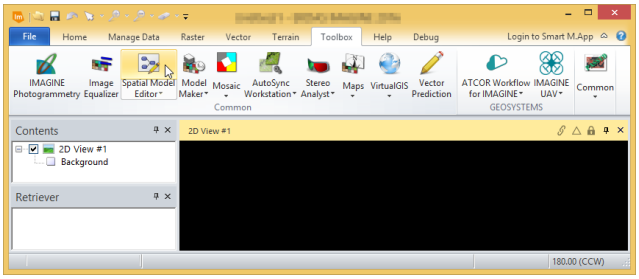


Figure 9: ATCOR Workflow for IMAGINE button.

3. Navigate to the **Operators** window, open the group ***GEOSYSTEMS ATCOR***, and add the operators *Create ATCOR Project*, *Run ATCOR Dehaze*, *Set ATCOR Parameters*, and *Run ATCOR-2* by drag-and-drop to the Spatial Model Editor. Connect the operators as shown in Figure 10.

4. **Set** the operator ports as follows (see also Figure 10) by double-clicking the corresponding ports:

   **Create ATCOR Project:**

   - ATCORProjectFolder: navigate into the folder `<My_ATCOR_Workflow_Demo_Folder>\Example1\02_atcor_project_SM`
   - ImageFilename: switch off the file filter 'All File-based Raster Formats' by entering '*.txt' in the field 'Image File' and select the file `<My_ATCOR_Workflow_Demo_Folder>\Example1\01_L8_data\temp\lc81990262013104lgn01\LC81990262013104LGN01_MTL.txt`
   - Sensor: Landsat-8 MS + TIRS (10 Bands)

   **Run ATCOR Dehaze:**

   - DehazeMethod: *standard*
   - DehazeArea: land and water pixels
   - DehazedImageName: `<My_ATCOR_Workflow_Demo_Folder>\Example1\03_output_SM\LC81990262013104LGN01_dh.tif`

   **Set ATCOR Parameters:** Enable the ports by right-clicking the operator, select **Properties.** The Properties window is now located in the lower right corner of your screen. Enable the ports by checking the port in the 'Show' column. To set the port, double-click the port (not the operator) and select the following values:

   - Water Vapor Category: *fall/spring*
   - Aerosol Type: *rural*
   - ValueAddedProds: *true*

     ⚠ The computation of the value-added products file could also be enabled (not recommended here!) by using the 'Set ATCOR Parameters' GUI that can be opened by double-clicking the operator. The processing parameter **Compute Value-added Products** is located on the **Advanced Settings Tab** of the GUI. Before the GUI opens, the *Create ATCOR Project* operator is executed. Thus, it is recommended to enter the parameters via the ports and not via the GUI, when the project has not been created yet. However, you might find the GUI useful in combination with the 'Load ATCOR Project' operator.

   **Run ATCOR-2:**

   - CorrectedImageName: `<My_ATCOR_Workflow_Demo_Folder>\Example1\03_output_SM\LC81990262013104LGN01_atcor2.tif`

     ⚠ The atmospheric correction (ATCOR-2) is executed on the dehazed image.

5. **Save** the Spatial Model, for example to the file `<My_ATCOR_Workflow_Demo_Folder>\Example1\03_output_SM\Create_dehaze_atcor2.gmdx`

6. Click **Run** in the **Spatial Modeler Tab**. Depending on your PC, the processing will take about 10 minutes to finish. Check the process status in the ERDAS IMAGINE Process List.

When the process finished successfully, you can see a **warning icon** at the 'Run ATCOR Dehaze' operator and an **info icon** at the 'Run ATCOR-2' operator. See the Spatial Modeler Messages window for

more information. You can open this window by clicking the 'Messages' button in the Spatial Modeler ribbon (group 'View').

7. Examine the **Session Log**.
8. Examine the **project folder**.

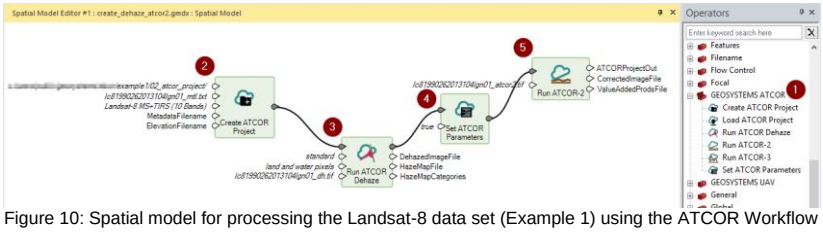


Figure 10: Spatial model for processing the Landsat-8 data set (Example 1) using the ATCOR Workflow operators (1). The model creates a new ATCOR project (2), executes ATCOR Dehaze (3), sets parameters relevant for ATCOR-2 (4), and executes ATCOR-2 (5).

**Open** the original image and the dehazed image in the Viewer and compare (Figure 12: Results of ATCOR Dehaze and ATCOR-2 for Example 1 (detail): original image (top left), dehazed and atmospherically corrected image (top right), haze map (bottom left; yellowish colors indicate haze contaminated pixels, see Table 1 for haze map categories), Leaf Area Index Index (LAI) (bottom right; brown: low LAI, green: high LAI).

**Original image**: `My_ATCOR_Workflow_Demo_Folder>\Example1\02_atcor_project_SM\lc81990262013104lgn01.tif`

**Dehazed image**: `<My_ATCOR_Workflow_Demo_Folder>\Example1\03_output_SM\LC81990262013104LGN01_dh.tif`

Then load the haze map in the viewer and compare with the original / dehazed image.

**Haze map**: `<My_ATCOR_Workflow_Demo_Folder>\Example1\03_output_SM\LC81990262013104LGN01_haze_map.tif`

Use the Inquire Cursor to examine the pixel values of the haze map. You get the class IDs but not the names of the map categories (class names). To add the class names, continue with step 9.

9. Remove the haze map from the Viewer.
10. Navigate to the Spatial Modeler window 'Operators', open the group ***Attributes***, and add the operator ***Raster Attribute Output*** by drag-and-drop to the Spatial Modeler Editor. Connect the operator with the *Run ATCOR Dehaze* operator as follows and as shown in Figure 11 (6):
    - HazeMapFile → Filename
    - HazeMapCategories → TableIn
11. **Set** the operator ports (via double-click) as follows:
    - TableType: *String*
    - Attribute: *Class_Names*

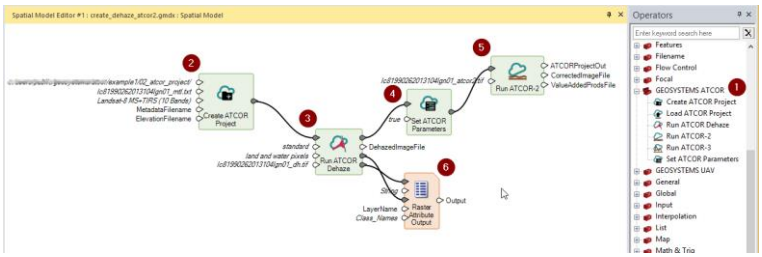


Figure 11: Spatial model for processing the Landsat-8 data set (Example 1). The model creates a new ATCOR project (2), executes ATCOR Dehaze (3), sets parameters relevant for ATCOR-2 (4), executes ATCOR-2 (5), and adds the class names of the haze map to its attribute table (6).

**12.** Again, **save** the Spatial Model to the file

`<My_ATCOR_Workflow_Demo_Folder>\Example1\03_output_SM\Create_dehaze_atcor2.gmdx`

**13.** Right-click the *Raster Attribute Output* operator and select ***Run Just This***.

**14.** **Display** the **haze map**: add the file to the viewer and use the Inquire Cursor to get the pixel values. Now the class IDs are displayed.

**15.** **Display** the dehazed and **atmospherically corrected image**

`<My_ATCOR_Workflow_Demo_Folder>\Example1\03_output_SM\lc819902620131041gn01_atcor2.tif`

and the **value-added products file**

`<My_ATCOR_Workflow_Demo_Folder>\Example1\03_output_SM\lc819902620131041gn01_atcor2_flx.tif`.

By default, the file is located in the same directory as the atmospherically corrected image.

**Display** layer 2 (Leaf Area Index;

**16.** Table 2) of the value-added products file (*`_flx.tif`) with *File – Open – Raster as Image Chain.* Navigate to the **Multispectral Tab,** click the button *Image Chain* (Group *Settings*), select *Pseudocolor* and select Layer 2 (Group *View*). Click the button *Color Table* (Group *Color*) and select *NDVI Natural.*

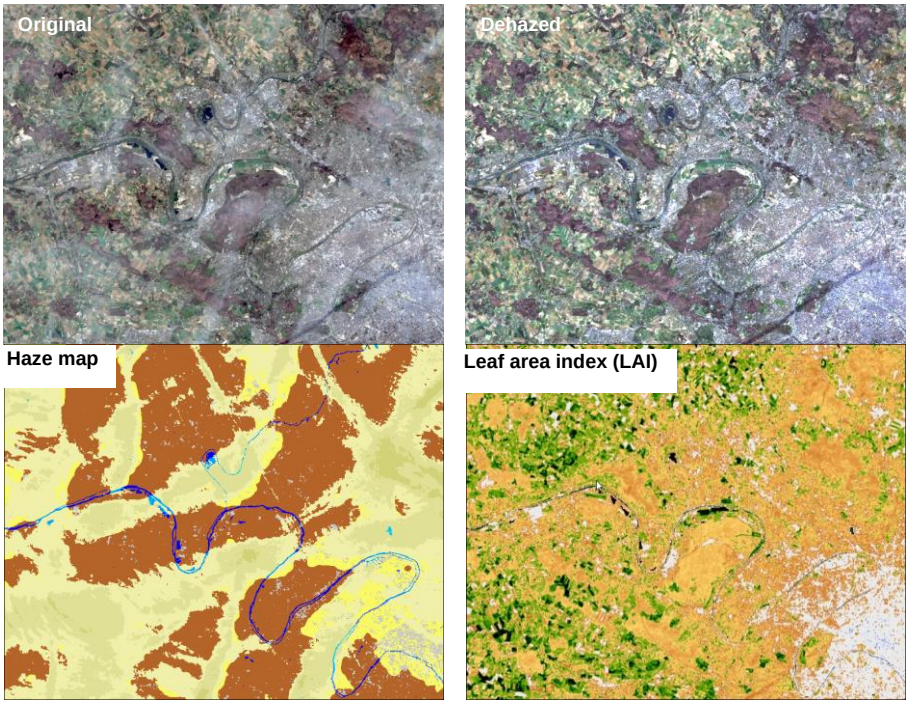



Figure 12: Results of ATCOR Dehaze and ATCOR-2 for Example 1 (detail): original image (top left), dehazed and atmospherically corrected image (top right), haze map (bottom left; yellowish colors indicate haze contaminated pixels, see Table 1 for haze map categories), Leaf Area Index Index (LAI) (bottom right; brown: low LAI, green: high LAI).

**Run ATCOR-3:**

**17.** Replace the Run ATCOR-2 operator by the Run ATCOR-3 operator.

**18.** Activate the port ElevationFile in the **Set ATCOR Parameters** operator and choose

```
Documents\gmted2010\GMTED2010.jp2
```

Kommentiert [MG1]: DEM ändern

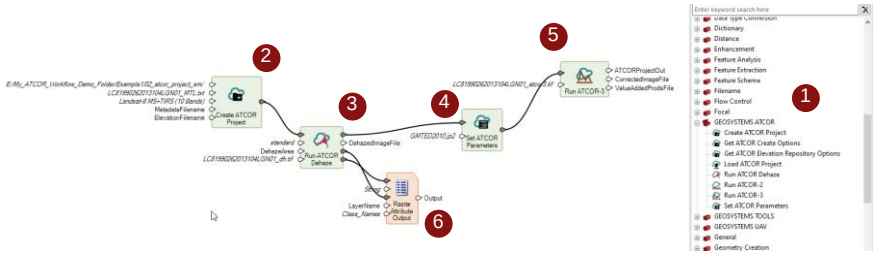
**19.** Set the **CorrectedImageName** in **(5)** to

```
<My_ATCOR_Workflow_Demo_Folder>\Example1\03_output_SM\
lc8199026201310 4lgn01_atcor3.tif
```

**20. Save** the Spatial Model to the file

```
<My_ATCOR_Workflow_Demo_Folder>\Example1\03_output_SM\
Create_dehaze_atcor3.gmdx
```

**21.** Right-click the *Raster Attribute Output* operator and select ***Run Just This***.




# 3 Example 2 – Landsat-5 with ATCOR-3 and ATCOR-2 and manual metadata input

## 3.1 What You Will Learn

Based on a **Landsat-5 TM dataset (subset)**, the following processing steps are demonstrated:

- manual metadata input,
- calibration coefficients adjustment, and
- atmospheric and topographic correction in rugged terrain (ATCOR-3).

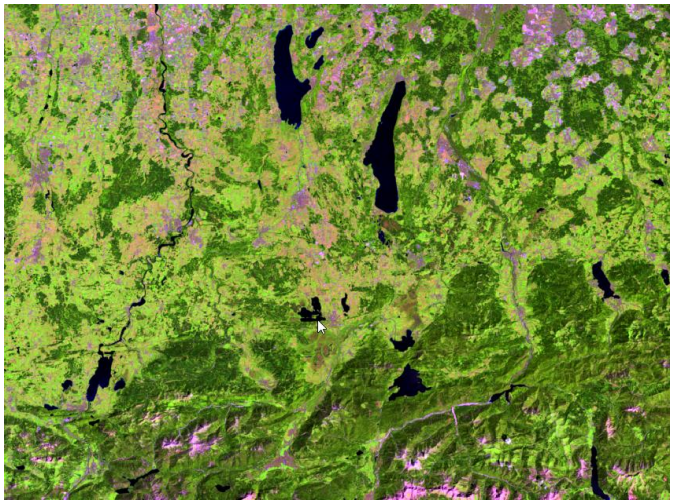
**Note**: For Landsat-5 TM data, *ATCOR Workflow* can import metadata information automatically from the corresponding metadata file. For demonstration purposes, this example shows how metadata can be entered manually. This is useful if the original metadata file is missing as well as for sensors without automatic metadata import (e.g. GEOEYE-1).
The example data set is processed using the **ATCOR Workflow Dialog** (Section 3.3) and the **ATCOR Workflow Operators** (Spatial Modeler) (Section 3.4).

## 3.2 Data Description

In this example we will use the subset of a Landsat-5 TM scene (Section 3.2.1) and the corresponding SRTM subset (Section 3.2.2). The example data can be downloaded under https://www.geosystems.de/fileadmin/redaktion/Software/ATCOR_Workflow/ATCOR_Workflow_Step_by_Step_Guide_Example2.zip.

### 3.2.1 Landsat-5 TM Image

Quicklook:
(Band 5–4–3)



| | | |
|---|---|---|
| Sensor: | Landsat-5 TM | |
| Acknowledgement: | Landsat 5 TM image courtesy of the U.S. Geological Survey | |
| Extent: | Subset of scene 193/027 (path/row),<br>UL: X 616260.0 Y 5330130.0, LR: X 715290.0 Y 5256210.0,<br>UTM, Zone 32 (EPSG: 32632) | |
| Band order: | B10 - B20 - B30 - B40 - B50 - B60 - B70 | |
| Pixel size: | 30 m (band B60 was resampled from 60 m to 30 m) | |
| Data type: | Unsigned 8-bit | |
| Acquisition date: | 2003-07-14 | |
| Sun azimuth: | 132.91° | |
| Sun elevation: | 57.21° | |
| Radiometric rescaling: [$Wm^{-2}sr^{-1}\mu m^{-1}$] | RADIANCE_ADD_BAND_1 = -2.28583 | RADIANCE_MULT_BAND_1 = 0.7658 |
| | RADIANCE_ADD_BAND_2 = -4.28819 | RADIANCE_MULT_BAND_2 = 1.4482 |
| | RADIANCE_ADD_BAND_3 = -2.21398 | RADIANCE_MULT_BAND_3 = 1.0440 |
| | RADIANCE_ADD_BAND_4 = -2.38602 | RADIANCE_MULT_BAND_4 = 0.8760 |
| | RADIANCE_ADD_BAND_5 = -0.49035 | RADIANCE_MULT_BAND_5 = 0.1204 |
| | RADIANCE_ADD_BAND_6 = 1.18243 | RADIANCE_MULT_BAND_6 = 0.0554 |
| | RADIANCE_ADD_BAND_7 = -0. 21555 | RADIANCE_MULT_BAND_7 = 0.0656 |

### 3.2.2 Digital Elevation Model

| | |
|---|---|
| DEM: | SRTM (Shuttle Radar Topography Mission) |
| Pixel size: | 90 m |
| Acknowledgement: | USGS (2006), Shuttle Radar Topography Mission, 3 Arc Second scene, Global Land Cover Facility, University of Maryland, College Park, Maryland. |

## 3.3 Data Processing Using the ATCOR Workflow Dialog

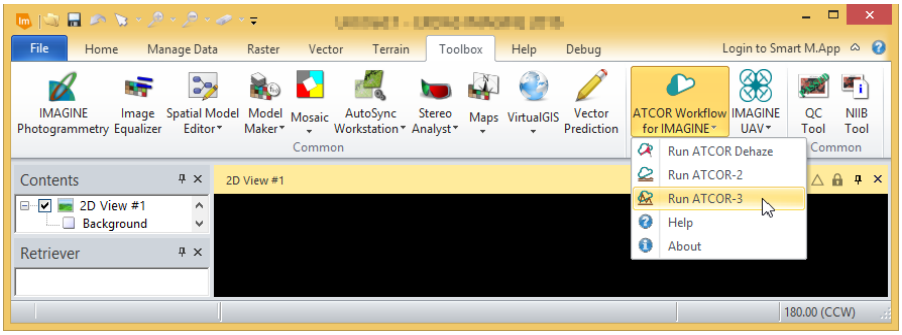
1. **Download** the file `ATCOR_Workflow_Step_by_Step_Guide_Example2.zip` from http://www.geosystems.de/en/products/atcor-workflow-for-imagine/download and extract it to the folder `<My_ATCOR_Workflow_Demo_Folder>\Example2`.

2. **Create** the following folders:

   ```
   <My_ATCOR_Workflow_Demo_Folder>\Example2\02_atcor_project
   <My_ATCOR_Workflow_Demo_Folder>\Example2\03_output
   ```

```
<My ATCOR Workflow Demo Folder>\Example2\04_elevation_repository_SM
```

3. Click **Toolbox Tab** > **ATCOR Workflow for IMAGINE** > **Run ATCOR-3** to open the ATCOR-3 dialog.




4. Select the Operation Mode **Create ATCOR Project**.
5. Specify the following options on the **Project Tab** of the dialog:
   - Project folder: navigate into the folder `<My_ATCOR_Workflow_Demo_Folder>\Example2\02_atcor_project`
   - Sensor: Landsat-4/5 TM
   - Image File: `<My_ATCOR_Workflow_Demo_Folder>\Example2\01_data\Landsat5\lt51930272003195mti01_subset.img`
   - Metadata File: [no input, as we do not have a metadata file]
   - Elevation File:
   - `<My_ATCOR_Workflow_Demo_Folder>\Example2\01_data\DEM\dem_germany_90m_subset.img`
   - Corrected Image File: specify the name for the output file (new file) `<My_ATCOR_Workflow_Demo_Folder>\Example2\03_output\lt51930272003195mti01_subset_atcor3.img`
6. Navigate from the Project Tab to the **Basic Settings Tab** (Figure 13).

   In the **Sensor Information** box and in the **Geometry** box default metadata values are shown. They have to be modified according to the data description in Section 3.2:
   - Pixel Size: *30*
   - Acquisition date: *2003-07-14*
   - Solar Zenith: *32.8* (= 90° - Sun Elevation)
   - Solar Azimuth: *132.9*

   In the **Atmosphere** box specify the following parameters after checking the corresponding Edit box:
   - Water Vapor Category: *mid-latitude summer*
   - Aerosol Type: *rural*
7. Navigate from the Basic Settings Tab to the **Advanced Settings Tab** (Figure 14) and edit the following parameters:

   **Value-added Products Box:**
   - Compute Value-added Products: not checked

**BRDF Correction Box:**

- BRDF Model: (2b) specific, weak
- g: 0.200
- betaT: 0.0

  We set ***betaT*** to 0.0 in order to get this parameter as a function of the solar zenith angle. More details are provided in the User Manual (*ATCOR_Workflow_for_IMAGINE_Help.pdf*).

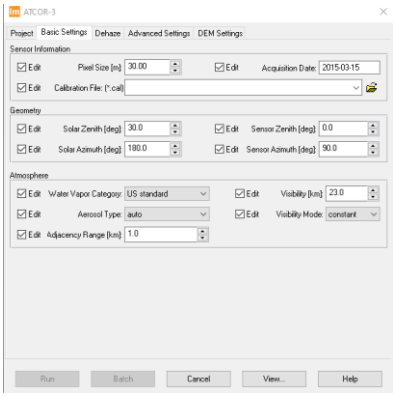



Figure 13: Basic Settings Tab of ATCOR-3.

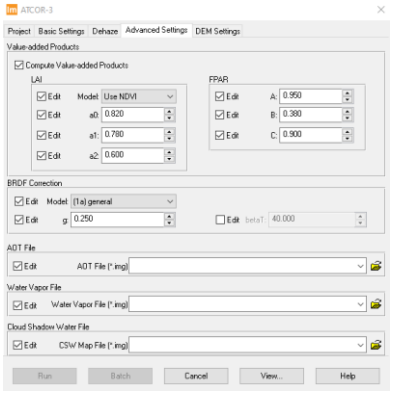



Figure 14: Advanced Settings Tab of ATCOR-3.

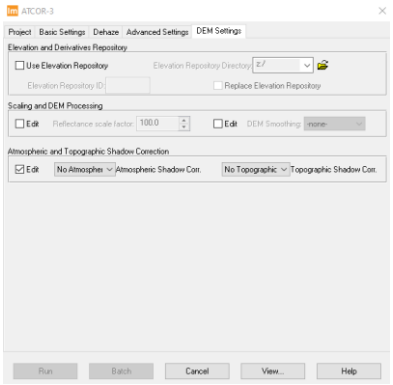



Figure 15: DEM Settings Tab of ATCOR-3.

**8.** Navigate from the **Advanced Settings Tab** to the **DEM Settings Tab** (Figure 14).

The elevation repository (new since ATCOR Workflow for IMAGINE 2020) allows to store the derivatives of the DEM to be stored permanently under a user-defined ID. If the same area is processed later on using ATCOR 3, these files can be re-used, which saves a significant amount of processing time.
**Elevation and Derivatives Repository** Box:

- Use Elevation Repository: checked.

- Elevation Repository Directory: `<My ATCOR Workflow Demo Folder>\Example2\04_elevation_repository_SM`
- Elevation Repository ID: landsat_001
- Replace Existing Repository: checked.

**Scaling and DEM Processing** Box:

- Reflectance Scale Factor: 4
  - The output data type will be Unsigned 8-bit (same as input), i.e. values from 0 to 255 can be stored. Considering the expected range of surface reflectance values, a **reflectance scale factor** of 4 would be suitable. With this scaling factor, a surface reflectance of 20.56%, for example, is coded as 82.
- DEM Smoothing: -none-

**9.** Click **Run**. Depending on your PC, processing will take about 5 minutes to finish. Check the process status in the ERDAS IMAGINE Process List.

**10.** Examine the **Session Log**. Here you find some basic information about the executed process as well as warnings or error messages if a problem occurred.

**11.** Examine the **project folder**:
`<My_ATCOR_Workflow_Demo_Folder>\Example2\02_atcor_project`

Here you find the following files:

- `GEOSYSTEMS_ATCOR.project`, the ATCOR project file, a text file containing some basic information on the project,
- `lt51930272003195mti01_subset_ele.tif`, the elevation file prepared from the specified elevation file to satisfy the ATCOR-specific requirements,
- `lt51930272003195mti01_subset.log`, the log file, and
- `lt51930272003195mti01_subset.cal`, the calibration file.
- Folder `_Repository` with some temporary results.

**12.** Examine the **log file**. Here you can find detailed information about the executed process.

**13.** Examine the **Elevation Repository** folder.

`<My ATCOR Workflow Demo Folder>\Example2\04_elevation_repository_SM`
Here you find the following files:

- asp_landsat_001.bsq / .hdr, the aspect file in .bsq format and the according header file derived from the DEM
- ele_landsat_001.bsq /.hdr, the elevation file in .bsq format and the according header file converted from the elevation file.
- sky_landsat_001.bsq /.hdr, the skyview file in .bsq format and the according header file derived from the DEM
- slp_landsat_001.bsq /.hdr, the slope file in .bsq format and the according header file derived from the DEM

For subsequent processing of this dataset, you can re-use these files by entering the same **ElevationRepositoryDirectory** and **RepositoryID** again in order to save processing time.

**14.** **Open** the original image and the atmospherically/topographically corrected image in the Viewer and compare (Figure 17), using for example the band composition 5 (Red) – 4 (Green) – 3 (Blue).

**Original image**: `<My_ATCOR_Workflow_Demo_Folder>\Example2\01_data\Landsat5\lt51930272003195mti01_subset.img`
**Corrected image**: `<My_ATCOR_Workflow_Demo_Folder>\Example2\03_output\lt51930272003195mti01_subset_atcor3.img`

15. Finally, we want to **adjust the calibration parameters $c_0$ (*Offset*) and $c_1$ (*Gain*)**. Many sensors are recalibrated from time to time. The actual calibration parameters are usually provided together with the image or can be downloaded from the web. It is recommended to use the image-specific parameters if available.

    For the first run, we used default calibration parameters. So now let us replace them by the values provided in Section 3.2 (Radiometric rescaling). For each spectral band, there are two values, i.e. **RADIANCE_ADD** corresponding to the *Offset* and **RADIANCE_MULT** corresponding to the *Gain*. It is important to pay attention to the unit. The values provided in Section 3.2 are based on the radiance unit $Wm^{-2}sr^{-1}\mu m^{-1}$, while ATCOR Workflow employs the unit $mWcm^{-2}sr^{-1}\mu m^{-1}$. Thus, the values have to be multiplied by the **conversion factor 0.1**, before they can be used in ATCOR Workflow.
    Open the **calibration file**
    `<My_ATCOR_Workflow_Demo_Folder>\Example2\02_atcor_project\lt51930272003195mti01_subset.cal`
    in a text editor, edit the values as explained, and save them to a new text file:
    `<My_ATCOR_Workflow_Demo_Folder>\Example2\02_atcor_project\lt51930272003195mti01_subset_V2.cal`
    The new calibration file will look like the text file shown in Figure 16. More information on the calibration procedure is provided in the User Manual (*ATCOR_Workflow_for_IMAGINE_Help.pdf*).

```
7       c0        c1   [mW/cm2 sr micron]
1   -0.228583   0.07658
2   -0.428819   0.14482
3   -0.221398   0.1044
4   -0.238602   0.0876
5   -0.049035   0.01204
6   0.118243    0.00554
7   -0.021555   0.00656
```

    Figure 16: Calibration file according to the image-specific calibration parameters.

16. Click **Toolbox Tab** > **ATCOR Workflow for IMAGINE** > **Run ATCOR-3** to open the ATCOR-3 dialog.
17. Select the Operation Mode **Load ATCOR Project**.
18. Specify the following options on the **Project Tab** of the dialog:
    - Project folder: select the folder
      `<My_ATCOR_Workflow_Demo_Folder>\Example2\02_atcor_project`
    - Corrected Image File: specify the name for the output file (new file)
      `<My_ATCOR_Workflow_Demo_Folder>\Example2\03_output\lt51930272003195mti01_subset_atcor3_V2.img`
19. Navigate from the Project Tab to the **Basic Settings Tab,** check the **Edit** box of the **calibration file** and select the new calibration file:
    `<My_ATCOR_Workflow_Demo_Folder>\Example2\02_atcor_project\lt51930272003195mti01_subset_V2.cal`
20. Navigate from the Basic Settings Tab to the **Advanced Settings Tab**. All settings are preserved from the previous run. So you do not have to set them again.
21. Click **Run**. Depending on your PC, processing will take again a few minutes to finish. Check the process status in the ERDAS IMAGINE Process List.
22. **Display** the result and compare the new output file with the first result. The new output file appears slightly brighter than the first result. However, as the image-specific calibration parameters (V2) are quite similar to the default parameters the difference is not significant.

    **Note**: Adjusting the calibration parameters can also be useful, if the result of atmospheric correction is not satisfying, e.g. if there are many pixels in the resulting image with a value of zero.

**23.** For comparison, repeat the steps 1-22 by using the **Run ATCOR-2** dialog instead of the **Run ATCOR-3 dialog**. Make sure to use different output filenames in order to not overwrite your ATCOR-3 results. Compare the results in the ERDAS IMAGINE viewer.

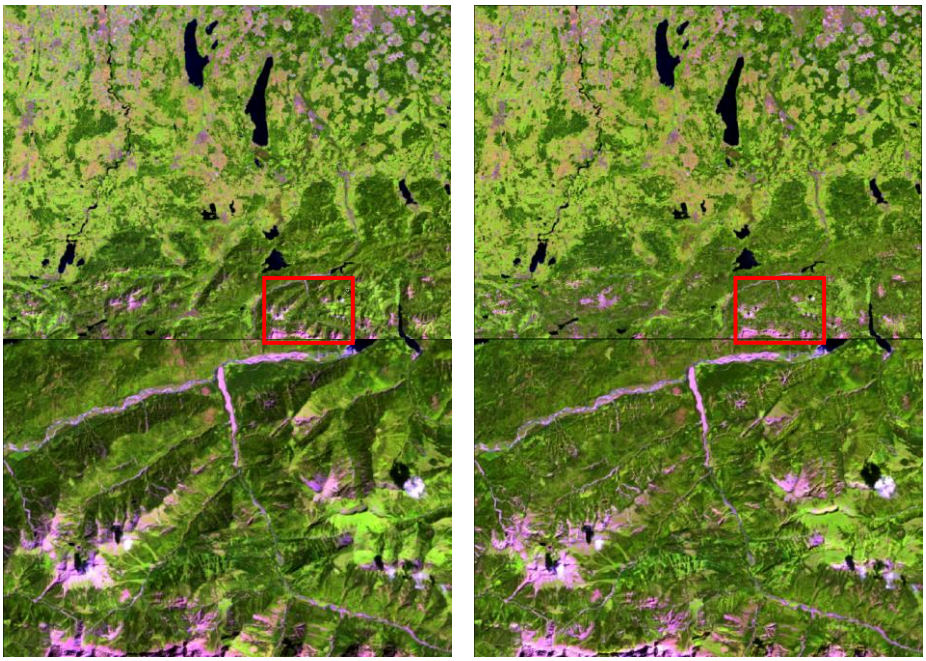


Figure 17: Comparison of the original (left) and the image corrected with ATCOR-3 (right) for the full image (top) and a detail taken from the mountainous part in the south of the image (bottom). Band composition 5-4-3.

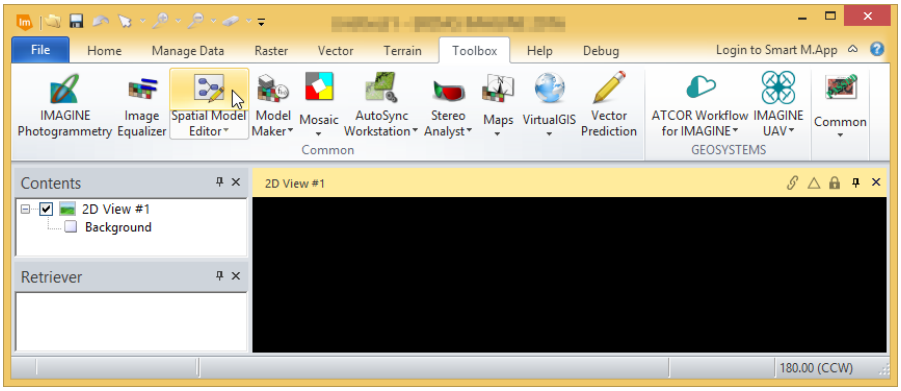
## 3.4 Data Processing Using the ATCOR Workflow Operators

**1.** **Download** (if not done already following the instructions in Section 3.3) the file `ATCOR_Workflow_Step_by_Step_Guide_Example2.zip` from http://www.geosystems.de/en/products/atcor-workflow-for-imagine/download and extract it to the folder `<My_ATCOR_Workflow_Demo_Folder>\Example2\`.

**2.** **Create** the following folders:

```
<My_ATCOR_Workflow_Demo_Folder>\Example2\02_atcor_project_SM
<My_ATCOR_Workflow_Demo_Folder>\Example2\03_output_SM
<My ATCOR Workflow Demo Folder>\Example2\04_elevation_repository_SM
```

**3.** Click **Toolbox Tab** > **Spatial Model Editor** to open the Spatial Modeler.




4. Navigate to the **Operators** window of the Spatial Modeler, open the group ***GEOSYSTEMS ATCOR*** (Figure 18a, (1)), and add the operators *Create ATCOR Project*, *Get ATCOR Elevation Repository Options, Set ATCOR Parameters*, and *Run ATCOR-3* by drag-and-drop to the Spatial Model Editor. Connect the operators as shown in Figure 18a.

5. **Set** the operator ports by double-clicking the ports as follows (see also Figure 18b):

   **Create ATCOR Project:**

   - ATCORProjectFolder: navigate into the folder `<My_ATCOR_Workflow_Demo_Folder>\Example2\02_atcor_project_SM`
   - ImageFilename: `<My_ATCOR_Workflow_Demo_Folder>\Example2\01_data\Landsat5\lt51930272003195mti01_subset.img`
   - Sensor: Landsat-4/5 TM
   - ElevationFilename: `<My_ATCOR_Workflow_Demo_Folder>\Example2\01_data\DEM\srtm_germany_90m_subset.img`

   **Get ATCOR Elevation Repository Options:** To enable the ports, right-click the operator, select **Properties,** and enable the ports **RepositoryID, ElevationRepositoryDirectory** and **ReplaceExisting** in the Properties window located in the lower right corner of your screen. Again, to set the ports, double-click the ports (not the operator) and select the following values:

   - RepositoyID: landsat_001
   - ElevationRepositoryDirectory: `<My ATCOR Workflow Demo Folder>\Example2\04_elevation_repository_SM`
   - ReplaceExisting: true

   **Set ATCOR Parameters:** To enable the ports, right-click the operator, select **Properties**, and enable the ports in the Properties window located in the lower right corner of your screen. Again, to set the ports, double-click the ports (not the operator) and select the following values according to Section 3.2.1:

   - PixelSize: *30*
   - AcquisitionDate: *2003-07-14*
   - SolarZenith: *32.8* (= 90°- Sun Elevation)
   - SolarAzimuth: *132.9*
   - Water Vapor Category: *mid-latitude summer*

- Aerosol Type: *rural*
- ReflScaleFactor: *4*
- BRDFModel: (2b) specific, weak
- BRDF-betaT: *0.0*
- BRDF-g: *0.200*

Additionally, enable the port "Options", which later needs to be connected with the output port of the **Get ATCOR Elevation Repository Options** operator (Figure 18: Spatial model for processing the Landsat-5 data set (Example 2). The model involves four operators from the group *GEOSYSTEMS ATCOR* (1). It creates a new ATCOR project (2), sets options for the elevation repository (3), sets metadata and processing parameters (4), and executes ATCOR-3 (5). Figure (a) shows the operators before setting the ports, in Figure (b) the ports are set as required to process the dataset..
The output data type will be Unsigned 8-bit (same as input), i.e. values from 0 to 255 can be stored. Considering the expected range of surface reflectance values, a **reflectance scale factor** of 4 would be suitable. With this scaling factor, a surface reflectance of 20.56%, for example, is coded as 82.
We set ***BRDF-betaT*** to 0.0 in order to get this parameter as a function of the solar zenith angle. The applied rules are given in the User Manual (*ATCOR_Workflow_for_IMAGINE_Help.pdf*).

**Run ATCOR-3:**

- CorrectedImageName: specify the name of the output file (new file)
  `<My_ATCOR_Workflow_Demo_Folder>\Example2\03_output_SM\lt51930272003195mti01_subset_atcor3.img`

6. **Save** the Spatial Model, for example to the file
   `<My_ATCOR_Workflow_Demo_Folder>\Example2\03_output_SM\Create_atcor3.gmdx`
7. Click **Run** in the **Spatial Modeler Tab**. Depending on your PC, the processing will take about 5 minutes to finish. Check the process status in the ERDAS IMAGINE Process List.
8. Examine the **Session Log**.
9. Examine the **project folder**.
   `<My_ATCOR_Workflow_Demo_Folder>\Example2\02_atcor_project_SM`

   Here you find the following files:
   - `GEOSYSTEMS_ATCOR.project`, the ATCOR project file, a text file containing some basic information on the project,
   - `lt51930272003195mti01_subset_ele.tif`, the elevation file prepared from the specified elevation file to satisfy the ATCOR-specific requirements,
   - `lt51930272003195mti01_subset.log`, the log file, and
   - `lt51930272003195mti01_subset.cal`, the calibration file.
10. Examine the **Elevation Repository** folder.

    `<My ATCOR Workflow Demo Folder>\Example2\04_elevation_repository_SM`
    Here you find the following files:
    - asp_landsat_001.bsq
    - asp_landsat_001.hdr
    - ele_landsat_001.bsq
    - ele_landsat_001.hdr
    - sky_landsat_001.bsq
    - sky_landsat_001.hdr

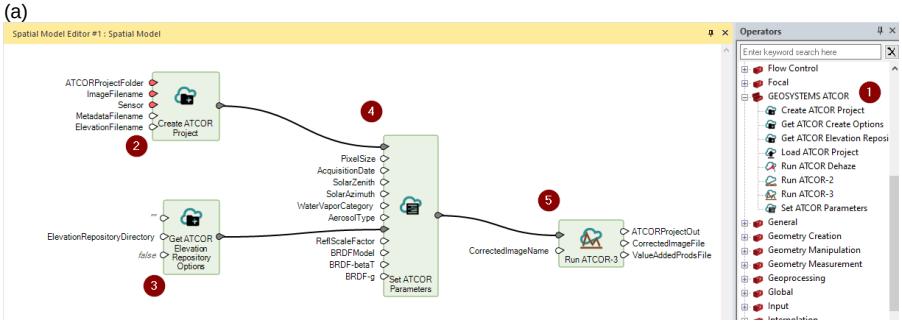
- slp_landsat_001.bsq
- slp_landsat_001.hdr

These files are aspect, slope, skyview and elevation files as required by ATCOR3.
For subsequent processing of this dataset, you can re-use these files by entering the same **ElevationRepositoryDirectory** and **RepositoryID** again in order to save processing time.

**11.** **Open** the original image and the corrected image in the Viewer and compare (Figure 17).

**Original image**: `<My_ATCOR_Workflow_Demo_Folder>\Example2\01_data\Landsat5\lt51930272003195mti01_subset.img`
**Corrected image**: `<My_ATCOR_Workflow_Demo_Folder>\Example2\03_output_SM\lt51930272003195mti01_subset_atcor3.img`

(a)




(b)

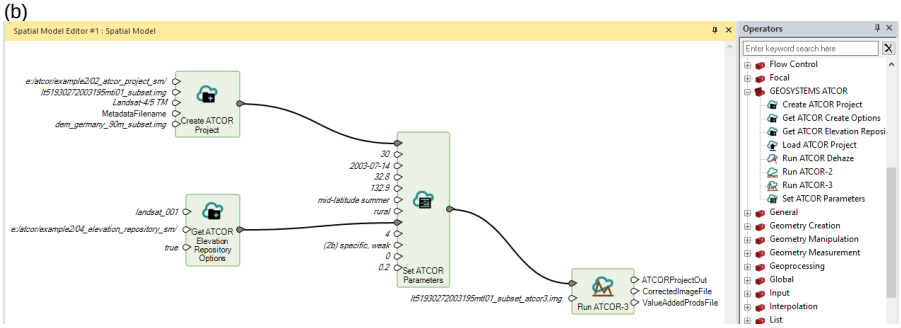



Figure 18: Spatial model for processing the Landsat-5 data set (Example 2). The model involves four operators from the group *GEOSYSTEMS ATCOR* (1). It creates a new ATCOR project (2), sets options for the elevation repository (3), sets metadata and processing parameters (4), and executes ATCOR-3 (5). Figure (a) shows the operators before setting the ports, in Figure (b) the ports are set as required to process the dataset.

**12.** Finally, we want to **adjust the calibration parameters $c_0$ (*Offset*) and $c_1$ (*Gain*)**. Many sensors are recalibrated from time to time. The actual calibration parameters are usually provided together with the image or can be downloaded from the web. It is recommended to use the image-specific parameters if available.

For the first run, we used default calibration parameters. So now let us replace them by the values provided in Section 3.2 (Radiometric rescaling). For each spectral band, there are two values, i.e. **RADIANCE_ADD** corresponding to the *Offset* and **RADIANCE_MULT** corresponding to the *Gain*. It is important to pay attention to the unit. The values provided in Section 3.2 are based on the radiance unit $Wm^{-2}sr^{-1}\mu m^{-1}$, while ATCOR Workflow employs the unit $mWcm^{-2}sr^{-1}\mu m^{-1}$. Thus, the values have to be multiplied by the **conversion factor 0.1**, before they can be used in ATCOR Workflow.
Open the **calibration file**

<My_ATCOR_Workflow_Demo_Folder>\Example2\02_atcor_project_SM\
lt51930272003195mti01_subset.cal

in a text editor, edit the values as explained, and **save** them to a new text file:

<My_ATCOR_Workflow_Demo_Folder>\Example2\02_atcor_project_SM\
lt51930272003195mti01_subset_V2.cal

The new calibration file will look like the text file shown in Figure 19. More information on the calibration issue is provided in the User Manual (*ATCOR_Workflow_for_IMAGINE_Help.pdf*).

```
7       c0        c1  [mW/cm2 sr micron]
1   -0.228583   0.07658
2   -0.428819   0.14482
3   -0.221398   0.1044
4   -0.238602   0.0876
5   -0.049035   0.01204
6   0.118243    0.00554
7   -0.021555   0.00656
```

Figure 19: Calibration file according to the image-specific calibration parameters.

13. **Enable** the port 'CalibrationFilename' of the '**Set ATCOR Parameters**' operator and select the new calibration file
    <My_ATCOR_Workflow_Demo_Folder>\Example2\02_atcor_project_SM\
    lt51930272003195mti01_subset_V2.cal

    Alternatively, you can double-click the 'Set ATCOR Parameters' operator. A **dialog** opens. Select the Standard Tab. In the box 'File and Sensor Information' you can select the new calibration file.

14. **Modify** the output file name specified at the port 'CorrectedImageName' of the operator '**Run ATCOR-3**' to avoid that the previous output file is replaced:

    <My_ATCOR_Workflow_Demo_Folder>\Example2\03_output_SM\
    lt51930272003195mti01_subset_atcor3_V2.img

15. Click **Run** in the **Spatial Modeler Tab**. As now only the processes 'Set ATCOR Parameters' and 'Run ATCOR-3' are executed, the processing will be much faster than the first time you executed the model.

16. **Display** the result and compare the new output file with the first result. The new output file appears slightly brighter than the first result. However, as the image-specific calibration parameters (V2) are quite similar to the default parameters, the difference is not significant in this example.

    **Note**: Adjusting the calibration parameters can also be useful, if the result of atmospheric correction is not satisfying, e.g. if there are many pixels in the resulting image with a value of zero.

17. **For comparison**, repeat the steps 1-16 by using the **Run ATCOR-2 operator instead of the Run ATCOR-3 operator.** Make sure to change the output filenames in order not to overwrite your ATCOR-3 results. After completion, compare the corrected images in the ERDAS IMAGINE viewer.

# 4 Example 3 – Sentinel-2 with Dehaze and ATCOR-2

## 4.1 What you Will learn

Based on a **Sentinel-2** image, the following processing steps are demonstrated:

- Automatic metadata import,
- Haze reduction (*ATCOR Dehaze*), and
- Atmospheric correction in flat terrain (*ATCOR-2*)

The example data set (Figure 20 and Figure 21) is processed using the **ATCOR Workflow Dialog** (Section 4.2) and the **ATCOR Workflow Operators** (Spatial Modeler) (Section 4.3). Please note that the example consists of a Level 1C dataset, it makes no sense to process Level 2 data using ATCOR Workflow, this would throw an error.


Figure 20: Footprint of the Sentinel-2 demo data set (Example 3), Product URI: S2A_MSIL1C_20170319T095021_N0204_R079_T33TWF_20170319T095021.SAFE.

Figure 21: True color quicklook of the Sentinel-2 demo data set.

## 4.2 Data processing Using the ATCOR Workflow Dialog

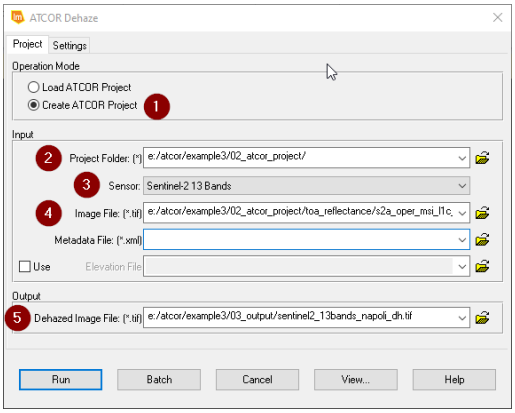
**Run ATCOR Dehaze:**
From the **Toolbox** menu in IMAGINE 2022 open the **ATCOR Workflow for IMAGINE** menu and start **Run ATCOR Dehaze**.

1. **Create** the following folders:

```
<My_ATCOR_Workflow_Demo_Folder>\Example3\02_atcor_project
<My_ATCOR_Workflow_Demo_Folder>\Example3\03_output
```

In Tab **Project** choose **Create ATCOR Project** insert the following:

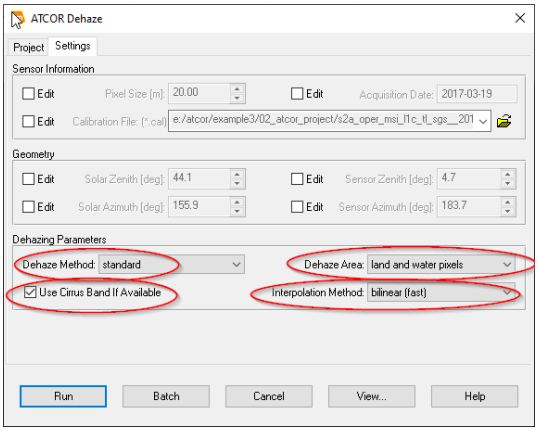
- **Input:**
  - **Project Folder:**
    `<My_ATCOR_Workflow_Demo_Folder>\Example3\02_atcor_project`
  - **Sensor:** Sentinel-2 13 bands
  - **Image File (do not use the manifest.safe file!):**
    `<My_ATCOR_Workflow_Demo_Folder>\Example3\01_S2_data\S2A_MSIL1C_20170319T095021_N0204_R079_T33TWF_20170319T095021.SAFE\GRANULE\L1C_T33TWF_A009085_20170319T095021\MTD_TL.xml`




- **Output:**
  - **Dehazed Image:** `<My_ATCOR_Workflow_Demo_Folder>\Example3\03_output\Sentinel2_13Bands_Napoli_dh.tif`

In Tab **Settings** set:

- **Dehazing Parameters:**
  - DehazeMethod: *standard*
  - DehazeArea: land and water pixels
  - Check **Use Cirrus Band If Available**
  - Interpolation Method: bilinear (fast)

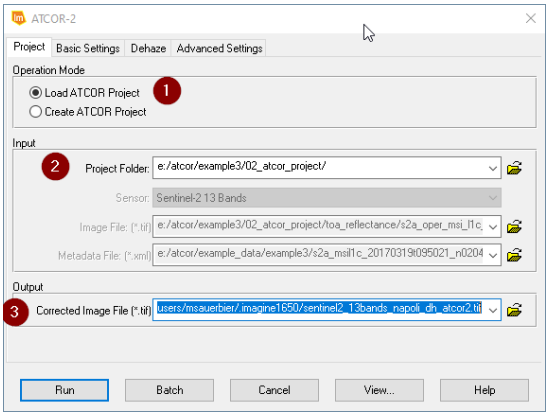



Then click the **Run** button.

**Run ATCOR 2:**
From the **Toolbox** menu in IMAGINE 2022 open the **ATCOR Workflow for IMAGINE** menu and start **Run ATCOR 2**.
In Tab **Project** choose **Load ATCOR Project** insert the following:

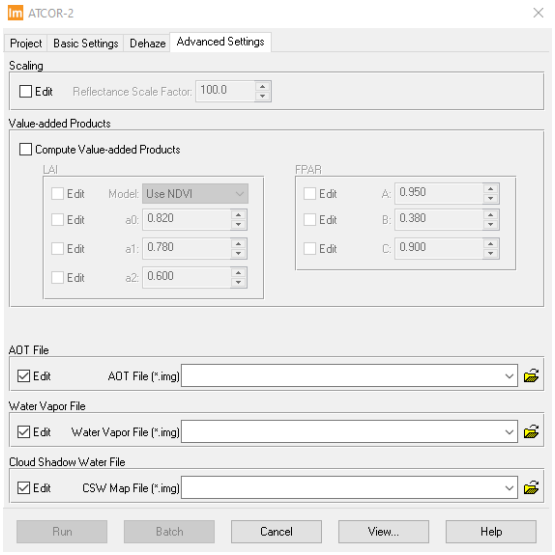
- **Project Folder:** `<My_ATCOR_Workflow_Demo_Folder>\Example3\02_atcor_project`

- **Corrected Image:** `<My_ATCOR_Workflow_Demo_Folder>\Example3\03_output\Sentinel2_13Bands_Napoli_dh_atcor2.tif`




In Tab **Advanced Settings** check boxes **Edit** in the **AOT File** group and in the Water Vapor File group and insert:

- **AOT File:** `<My ATCOR Workflow Demo Folder>\Example3\03_output\Sentinel2_13Bands_Napoli_dh_atcor2_aot.tif`
- **Water Vapor File:** `<My ATCOR Workflow Demo Folder>\Example3\03_output\Sentinel2_13Bands_Napoli_dh_atcor2_wv.tif`
- **Cloud Shadow Water File:** `<My ATCOR Workflow Demo Folder>\Example3\03_output\Sentinel2_13Bands_Napoli_dh_atcor2_csw.tif`



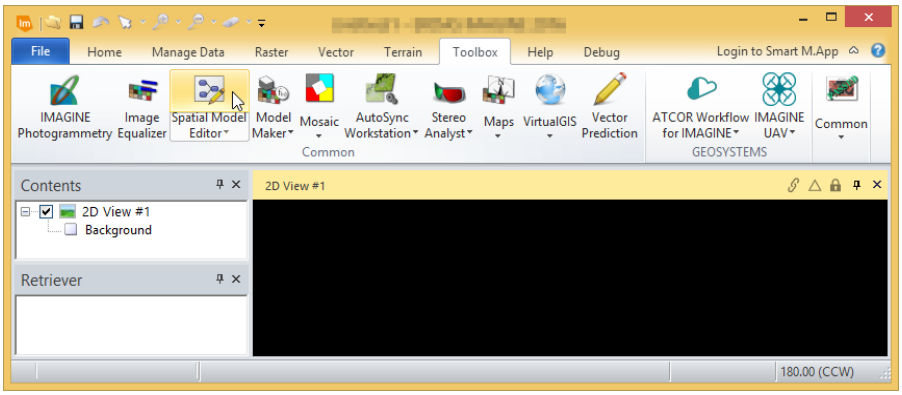

Click **Run** and examine the results according to 4.3 (see below).

## 4.3 Data processing Using the ATCOR Workflow Operators

2. **Create** the following folders:

```
<My_ATCOR_Workflow_Demo_Folder>\Example3\02_atcor_project_SM
<My_ATCOR_Workflow_Demo_Folder>\Example3\03_output_SM
```

3. Click **Toolbox Tab** > **Spatial Model Editor** to open the Spatial Modeler.




4. Navigate to the **Operators** window, open the group ***GEOSYSTEMS ATCOR***, and add the operators *Create ATCOR Project*, *Run ATCOR Dehaze*, *Set ATCOR Parameters*, and *Run ATCOR-2* by drag-and-drop to the Spatial Model Editor. Connect the operators as shown in Figure 22.

5. **Set** the operator ports as follows (see also Figure 22) by double-clicking the corresponding ports:

   **Create ATCOR Project:**

   - ATCORProjectFolder: navigate into the folder `<My_ATCOR_Workflow_Demo_Folder>\Example3\02_atcor_project_SM`
   - ImageFilename: switch off the file filter 'All File-based Raster Formats' by entering '*.xml' in the field 'Image File' and select the file `<My_ATCOR_Workflow_Demo_Folder>\Example3\01_S2_data\S2A_MSIL1C_20170319T095021_N0204_R079_T33TWF_20170319T095021.SAFE\GRANULE\L1C_T33TWF_A009085_20170319T095021\MTD_TL.xml`
   - Sensor: Sentinel-2 13 Bands

   **Run ATCOR Dehaze:**

   - DehazeMethod: *standard*
   - DehazeArea: land and water pixels
   - DehazedImageName: `<My_ATCOR_Workflow_Demo_Folder>\Example3\03_output_SM\Sentinel2_13Bands_Napoli_dh.tif`

   **Set ATCOR Parameters:** Enable the ports by right-clicking the operator, select **Properties.** The Properties window is now located in the lower right corner of your screen. Enable the ports by checking the port in the 'Show' column. To set the port, double-click the port (not the operator) and select the following values:

   - Water Vapor Category: *fall/spring*
   - Aerosol Type: *rural*

- ValueAddedProds: *true*

  ⚠ The computation of the value-added products file can also be enabled (not recommended here!) by using the 'Set ATCOR Parameters' GUI. It is opened by double-clicking the operator. The processing parameter **Compute Value-added Products** is located on the **Advanced Settings Tab** of the GUI. Before the GUI opens, the *Create ATCOR Project* operator is executed. Thus, it is recommended to enter the parameters via the ports and not via the GUI, when the project has not been created yet. However, you might find the GUI useful in combination with the 'Load ATCOR Project' operator.

**Run ATCOR-2:**

- CorrectedImageName: `<My_ATCOR_Workflow_Demo_Folder>\Example3\03_output_SM\Sentinel2_13Bands_Napoli_dh_atcor2.tif`

  ⚠ The atmospheric correction (ATCOR-2) is executed on the dehazed image.

- AOTFilename: `<My ATCOR Workflow Demo Folder>\Example3\03_output\Sentinel2_13Bands_Napoli_dh_atcor2_aot.tif`
- WaterVaporFileName: `<My ATCOR Workflow Demo Folder>\Example3\03_output\Sentinel2_13Bands_Napoli_dh_atcor2_wv.tif`
- CloudShadowWaterFile: `<My ATCOR Workflow Demo Folder>\Example3\03_output\Sentinel2_13Bands_Napoli_dh_atcor2_csw.tif`

6. **Save** the Spatial Model, for example to the file `<My_ATCOR_Workflow_Demo_Folder>\Example3\03_output_SM\Create_dehaze_atcor2.gmdx`
7. Click **Run** in the **Spatial Modeler Tab**. Depending on your PC, the processing will take about 10 minutes to finish. Check the process status in the ERDAS IMAGINE Process List.

When the process finished successfully, you can see a **warning icon** at the 'Run ATCOR Dehaze' operator and an **info icon** at the 'Run ATCOR-2' operator. See the Spatial Modeler Messages window for more information. You can open this window by clicking the 'Messages' button in the Spatial Modeler ribbon (group 'View').

8. Examine the **Session Log**.
9. Examine the **project folder**.

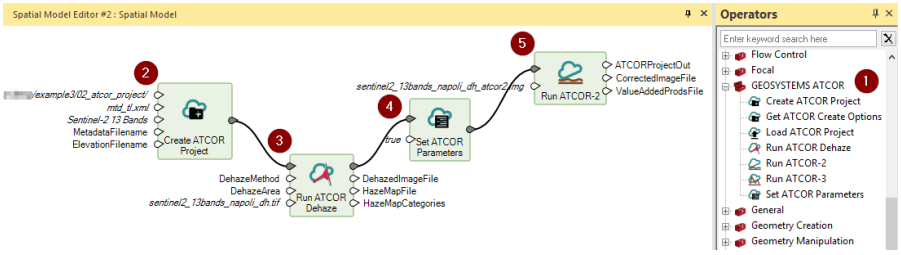



Figure 22: Spatial model for processing the Sentinel-2 data set (Example 3) using the ATCOR Workflow operators (1). The model creates a new ATCOR project (2), executes ATCOR Dehaze (3), sets parameters relevant for ATCOR-2 (4), and executes ATCOR-2 (5).

10. **Open** the original image and the dehazed image in the Viewer and compare (Figure 24). Use a proper LUT stretch function to improve the contrast of the image.

**Original image**: `My_ATCOR_Workflow_Demo_Folder>\Example3\02_atcor_project_SM\TOA_reflectance\S2A_OPER_MSI_L1C_TL_SGS__20170319T133044_A009085_T33TWF_N02_04.tif`

**Dehazed image**: `<My_ATCOR_Workflow_Demo_Folder>\Example1\03_output_SM\Sentinel2_13Bands_Napoli_dh.tif`

Now load the haze map into the viewer and compare with the original / dehazed image.

**Haze map**: `<My_ATCOR_Workflow_Demo_Folder>\Example3\03_output_SM\Sentinel2_13Bands_Napoli_haze_map.tif`

Use the Inquire Cursor to examine the pixel values of the haze map. You get the class IDs but not the names of the map categories (class names). To add the class names, continue with step 9.

**11.** Remove the haze map from the Viewer.

**12.** Navigate to the Spatial Modeler window 'Operators', open the group ***Attributes***, and add the operator ***Raster Attribute Output*** by drag-and-drop to the Spatial Modeler Editor. Connect the operator with the *Run ATCOR Dehaze* operator as follows and as shown in Figure 11 (6):

- HazeMapFile → Filename
- HazeMapCategories → TableIn

**13.** **Set** the operator ports (via double-click) as follows:

- TableType: *String*
- Attribute: *Class_Names*

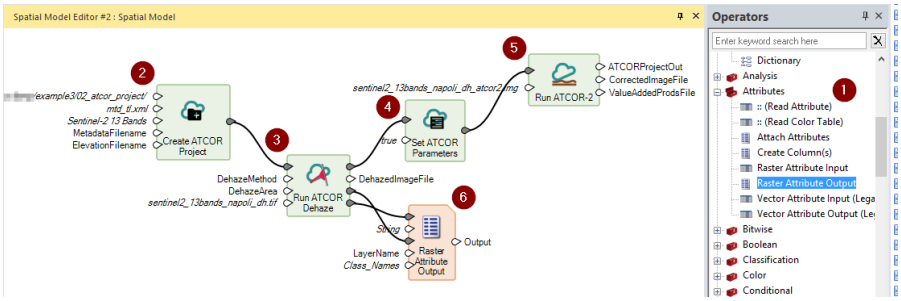



Figure 23: Spatial model for processing the Sentinel-2 data set (Example 3). The model creates a new ATCOR project (2), executes ATCOR Dehaze (3), sets parameters relevant for ATCOR-2 (4), executes ATCOR-2 (5), and adds the class names of the haze map to its attribute table (6).

**14.** Again, **save** the Spatial Model to the file

`<My_ATCOR_Workflow_Demo_Folder>\Example3\03_output_SM\Create_dehaze_atcor2.gmdx`

**15.** Right-click the *Raster Attribute Output* operator and select ***Run Just This***.

**16.** **Display** the **haze map**: add the file to the viewer and use the Inquire Cursor to get the pixel values. Now the class names are displayed together with the class IDs.

**17.** **Display** the dehazed and **atmospherically corrected image**

`<My_ATCOR_Workflow_Demo_Folder>\Example3\03_output_SM\Sentinel2_13Bands_Napoli_dh_atcor2.tif`

and the **value-added products file**

`<My_ATCOR_Workflow_Demo_Folder>\Example3\03_output_SM\Sentinel2_13Bands_Napoli_dh_atcor2_flx.tif`.

By default, the value-added products file is located in the same directory as the atmospherically corrected image.

**Display** layer 1 (Soil-adjusted Vegetation Index;

18. Table 2) of the value-added products file (*`_flx.tif`) with *File – Open – Raster as Image Chain.* Navigate to the **Multispectral Tab,** click the button *Image Chain* (Group *Settings*), select *Pseudocolor* and select Layer 1 (Group *View*). Click the button *Color Table* (Group *Color*) and select *NDVI Natural.*

19. **Display** the **aerosol optical thickness file** `<My ATCOR Workflow Demo Folder>\Example3\03_output\Sentinel2_13Bands_Napoli_dh_atcor2_aot.tif` and inspect the values using the **Inquire** tool.

20. **Display** the **water vapor file** `<My ATCOR Workflow Demo Folder>\Example3\03_output\Sentinel2_13Bands_Napoli_dh_atcor2_wv.tif` and inspect the values using the **Inquire** tool.

21. **Display** the **Cloud-Shadow-Water Map** (CSW-Map) `<My ATCOR Workflow Demo Folder>\Example3\03_output\ Sentinel2_13Bands_Napoli_dh_atcor2_out_csw.tif` and compare it visually to the Haze Map. The class names of the CSW-Map can be attached to the raster similar as for the Haze Map, described above (Figure 23).

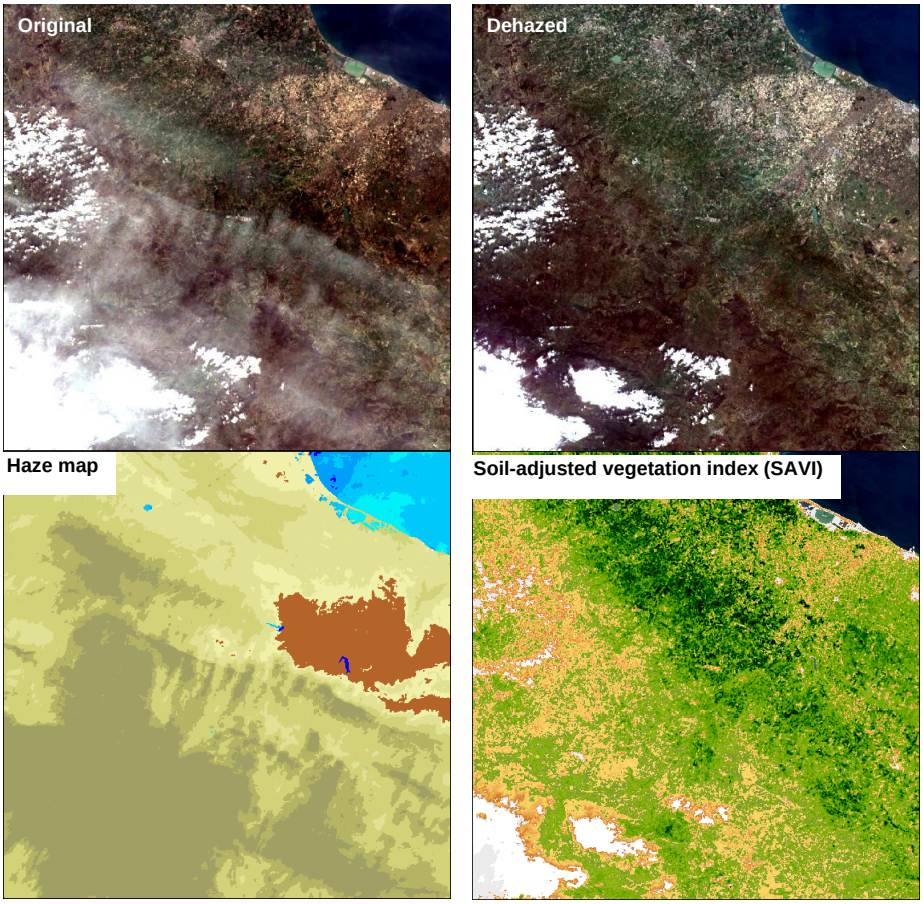



Figure 24: Results of ATCOR Dehaze and ATCOR-2 for Example 3 (detail): original image (top left), dehazed and atmospherically corrected image (top right), haze map (bottom left; yellowish colors indicate haze contaminated pixels, see Table 1 for haze map categories), Leaf Area Index Index (LAI) (bottom right; brown: low LAI, green: high LAI).

# 5 Appendix

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 | -- |

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.<br>(e.g. scaled SAVI=500 corresponds to SAVI=0.5) |
| 2 | Leaf area index (LAI), range 0 to 10000, scaled with factor 1000.<br>(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.<br>(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.<br>(e.g. scaled albedo=500 corresponds to albedo=50%) |
| 5 | Absorbed solar radiation flux $R_{solar}$ [$W\ m^{-2}$]. |
| 6 | Global radiation $E_g$ [$W\ m^{-2}$].<br>(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 $R_n$ [$W\ m^{-2}$]. |