CATALYST

PROFESSIONAL

Atmospheric Correction Module: Description

The Atmospheric Correction module is an add-on module to CATALYST Professional Essentials.

The data obtained by optical satellite sensors with high spatial resolution has become an invaluable tool for many groups interested in studying, managing, developing, and protecting our population, environment, and resources. Unfortunately, satellite images are often obscured by atmospheric effects like haze as a result of conditions in the atmosphere at the time the image was captured.

The objective of atmospheric correction is the elimination of atmospheric and terrain effects to retrieve physical parameters of the earth's surface, including surface reflectance, ground visibility and temperature. Such correction is especially important in cases where multi-temporal, multi-sensor or multi-condition images are to be compared and analyzed.

CATALYST is a PCI Geomatics Enterprises Inc. brand, which has been introduced to put our leading-edge technology into the hands of decision makers. CATALYST provides proven algorithms rooted in photogrammetry and remote sensing to offer engineers, environmental management, and geospatial professionals access to leading edge and scalable software solutions and platforms.

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Module Prerequisites

The Atmospheric Correction (including ATCOR) module is an add-on to CATALYST Professional's Essential bundle or comes included with the following bundles: Satellite bundle, Complete bundle, Developer bundle.

Workflows

The Atmospheric Correction module provides several workflows that allow you to perform various types of atmospheric correction and includes ATCOR technology from DLR:

Top-of-the-Atmosphere reflectance

The Top of the Atmosphere Reflectance workflow is the most basic of the atmospheric correction workflows. The workflow converts pixel values to physical reflectance, as measured above the atmosphere. It normalizes images based on radiance values and image acquisition times, using only the required image information.

Haze removal and cloud masking

The Haze Removal workflow allows you to calculate water and cloud masks for the input scene, and remove haze from images before performing atmospheric correction, thematic classification, or creating a mosaic.

This workflow generates an image containing raw DN values (scaled radiance) that have been corrected for haze. The output also includes all the pre-classification masks (haze, cloud, and water.

Ground reflectance atmospheric correction

The ATCOR Ground Reflectance workflow allows you to calculate the reflectance values at ground level to remove atmospheric effects in satellite imagery, preparing the images for analysis under different atmospheric conditions. The workflow generates a reflectance image at ground level, corrected by atmospheric (aerosol type and water vapor) and terrain effects.

When running the ground reflectance workflow, users also have the ability to output value-added products, including:

- Soil-Adjusted Vegetation Index (SAVI): uses the red and near-infrared bands to measure the density and vigor of green vegetation by attempting to eliminate the reflectivity of the ground beneath the canopy

- Leaf-Area Index (LAI): calculates the green-leaf density

- Fraction of Absorbed Radiation (FPAR): calculates the amount of photosynthetically active radiation absorbed by plant canopy

- Surface Albedo: calculates wavelength-integrated surface reflectance

- Absorbed Solar Radiation: calculates the shortwave solar radiation absorbed by the surface

Surface temperature atmospheric correction

The ATCOR Surface Temperature workflow takes an input thermal band in scaled radiance (raw DN values), a DEM and terrain derivatives, and, optionally, a visibility map to generate a surface temperature map of the thermal image. This workflow currently supports only and Landsat 4 TM, Landsat 5 TM, and Landsat 7 sensors.

When running the Surface temperature workflow, users have the ability to optionally output the following energy balance components:

- Thermal flux difference: calculates the difference between the emitted atmospheric radiation and the emitted surface radiation

- Ground heat flux: calculates the exchange rate of energy between the Earth's surface and the underground

- Latent heat: calculates the exchange rate of stored heat energy between the air and the Earth's surface. Latent heat flux is measures the amount of energy needed to change matter from one state to another (from solid to liquid to gas).

- Sensible heat: calculates the exchange rate of excess heat energy between the air and the Earth's surface. Sensible heat flux measures the amount of energy needed to change air temperature.

- Net radiation: calculates the difference between absorbed and emitted shortwave and longwave radiations

Supported Sensors

- ALOS AVNIR-2
- ASTER
- CBERS-4
- DEIMOS-1
- DEIMOS -2
- DMC (Disaster Monitoring Constellation)
- FASat-Charlie
- FORMOSAT-2
- FORMOSAT-5
- Gaofen-1
- Gaofen-2
- Gaofen-4
- Gaofen-6
- Geoeye-1
- Gokturk-1
- IKONOS
- IRS-1A / 1B / 1C / 1D / P6
- Kazeosat-2
- KOMPSAT-2
- KOMPSAT-3 / 3A
- Landsat-4 MSS
- Landsat-5 MSS
- Landsat-4 TM
- Landsat-5 TM
- Landsat-7 ETM+- Data
- Landsat-8
- OrbView-3
- PeruSAT-1
- PlanetScope
- Pléiades
- QuickBird
- RapidEye
- RASAT
- Resourcesat-2
- Sentinel-2
- SPOT-1
- SPOT-2
- SPOT-3
- SPOT-4
- SPOT-5
- SPOT 6
- SPOT 7
- SuperView-1
- Thaichote (THEOS)
- Triplesat
- Worldview-2
- Worldview-3
- Worldview-4
- ZY-3
- ZY3-2

Atmospheric Correction in CATALYST Professional's Focus Application

The Atmospheric Correction workflows in Focus, accessed from the **Analysis** menu, allow you to perform each of the available operations using the minimum amount of information required. They also allowing you to execute further radiometric corrections, such as calculating ground reflectance or surface temperature. Each workflow runs independently; information provided in one workflow is automatically applied to the other workflows.

The atmospheric correction window provides access to several workflows:
- The TOA Reflectance workflow: computes a Top-of-Atmosphere reflectance image
- The Haze Removal workflow: creates coarse classification masks for cloud and water masking, and performs haze removal
- The ATCOR Ground Reflectance workflow: performs atmospheric correction of satellite images
- The ATCOR Surface Temperature workflow: performs atmospheric correction of thermal images

Focus - Spectra Reflectance Plot
In the Spectra Reflectance Plot window, found under the **Layer** menu in Focus, you can view, analyze, and configure a detailed graph that plots reflectance and wavelength. You can create or import spectra from several sources that include one or more points, lines, or polygons drawn in the view pane or imported from spectra signatures from spectra-library files.
You can also collect and examine both target and reference spectra. The target and reference spectra can be compared from regression statistics to aid in determining the suitability of an atmospheric correction with a known sample in a spectra library or a control dataset.
You can zoom in or out on any part of the graph or export the spectra for additional examination in statistical-analysis software or a spreadsheet program.

Spectral plotting with ATCOR
The ATCOR Spectra Plotting window is linked to the image you select in the first step of the ATCOR - Ground Reflectance wizard.
With ATCOR spectra plotting you can apply various atmospheric settings to compare the reflectance signature produced by each variation of the settings for a given spectra. A spectrum can be composed of a single pixel or a weighted average of several pixels. Comparisons of similar features can be made between the target image and library signatures or to a reference reflectance image. By comparing the target image and reference data, you can deduce the most accurate atmospheric model and condition so that you can

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adjust the atmospheric settings that give the closest match between the image signature and the corresponding library signature or reference reflectance image.

Atmospheric Correction Functions

With a license for the Atmospheric Correction the following functions can be executed either independently or sequentially via an EASI™ or Python™ script. They may also be available in the Algorithm Librarian in CATALYST Professional Focus and Modeler applications.

- ATCOR – Calculates atmospheric and terrain correction
- ATCOR_T – Atmospheric correction for thermal imagery
- DN2TOA – Calculates top of atmosphere reflectance
- FPAR – Calculates fraction of absorbed photosynthetically active radiation
- HAZEREM – Removes haze from satellite imagery
- LAI – Calculates leaf area index model value
- MASKING – Creates cloud, haze and water masks from satellite imagery
- SAVI – Calculates Soil Adjusted Vegetation Index
- TERSEUP – Generates terrain derivatives, in preparation for atmospheric correction

Note: The ATCOR models are incorporated into the CATALYST Professional product under license from Deutsches Zentrum fur Luft-und Raumfahrt e.V. (German Aerospace Center). These models are covered by German Patent P 41 02 579.2.