Global Hydrology Resource Center

Data User Guide

GOES-R PLT Airborne Visible/Infrared Imaging Spectrometer (AVIRIS)

Introduction

The GOES-R PLT Airborne Visible/Infrared Imaging Spectrometer (AVIRIS) dataset consists of radiance, reflectance, water phase, and navigation data delivered by the Airborne Visible/Infrared Imaging Spectrometer (AVIRIS) flown aboard the NASA ER-2 high-altitude aircraft during the GOES-R PLT field campaign. This field campaign took place from March through May 2017 in support of post-launch L1B and L2+ product validation of the Advanced Baseline Imager (ABI) and the Geostationary Lightning Mapper (GLM) satellite instruments. The GOES-R PLT AVIRIS data files are available from April 11, 2017 through May 14, 2017 in ASCII and binary formats along with browse imagery files in JPG format.

Notice:
The ER-2 aircraft did not operate each day of the campaign; therefore, AVIRIS data are only available on aircraft flight days. Also, flights during the beginning of the campaign were either test flights or flights taking place at night. Because of this, no AVIRIS data are available for the initial parts of the campaign.

Citation

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Keywords:

NASA, NOAA, GHRC, GOES-R PLT, GLM, ABI, AVIRIS, radiance, surface reflectance, spectrometer

Campaign

The Geostationary Operational Environmental Satellites - R series (GOES-R) is a geostationary satellite program comprised of a four-satellite fleet including GOES-R, GOES-S, GOES-T, and GOES-U. The GOES-R Series Program is a collaborative development and acquisition effort between the National Oceanic and Atmospheric Administration (NOAA) and the National Aeronautics and Space Administration (NASA) to develop, launch and operate the satellites. The first satellite in the GOES-R series, GOES-R, launched on November 19, 2016 and became GOES-16 when it reached geostationary orbit. GOES-16 replaced GOES-13 as NOAA's operational GOES East satellite at 75.2 degrees west longitude on December 18, 2017. GOES-16 observes North and South America, as well as the Atlantic Ocean all the way to the west coast of Africa. GOES-16 provides high spatial and temporal resolution imagery of the Earth using its Advanced Baseline Imager (ABI). GOES-16's Geostationary Lightning Mapper (GLM) is the first operational lightning mapper flown in geostationary orbit. GOES-16 also includes four other scientific instruments for monitoring space weather and the Sun. More information about the GOES-R mission can be found at the GOES-R website.

The GOES-R Post Launch Test (PLT) field campaign took place between March 21 and May 17, 2017 in support of the post-launch validation of NOAA's new generation of geostationary Earth-observing instruments: ABI and GLM. The campaign was comprised of two phases: the first centered on the U.S. west coast, providing tests primarily for the ABI instrument, and the second focused on the central and eastern U.S. with tests primarily for the GLM instrument (Figure 1). The validation effort included targeted data collections from the NASA ER-2 high-altitude aircraft integrated with nine payloads (both passive and active instruments) coordinated with ground-based and low earth-orbit referenced data from several operational and research satellite missions. Sixteen ER-2 aircraft validation missions, totaling 105.1 mission flight hours, were conducted over ideal Earth validation targets, such as deserts and oceans, thunderstorms, active wildfires, and an expansive set of cloud and moisture phenomenology. Dedicated ABI 30-second mesoscale (MESO) imagery collections were conducted concurrently with the ER-2 high-altitude aircraft based sensors during each GLM mission. The GOES-R PLT field campaign provided critical reference data and new insights into the performance NOAA's new generation of geostationary Earth-observing instrument products. More information about the GOES-R PLT field campaign is available on the GOES-16 Field Campaign webpage.

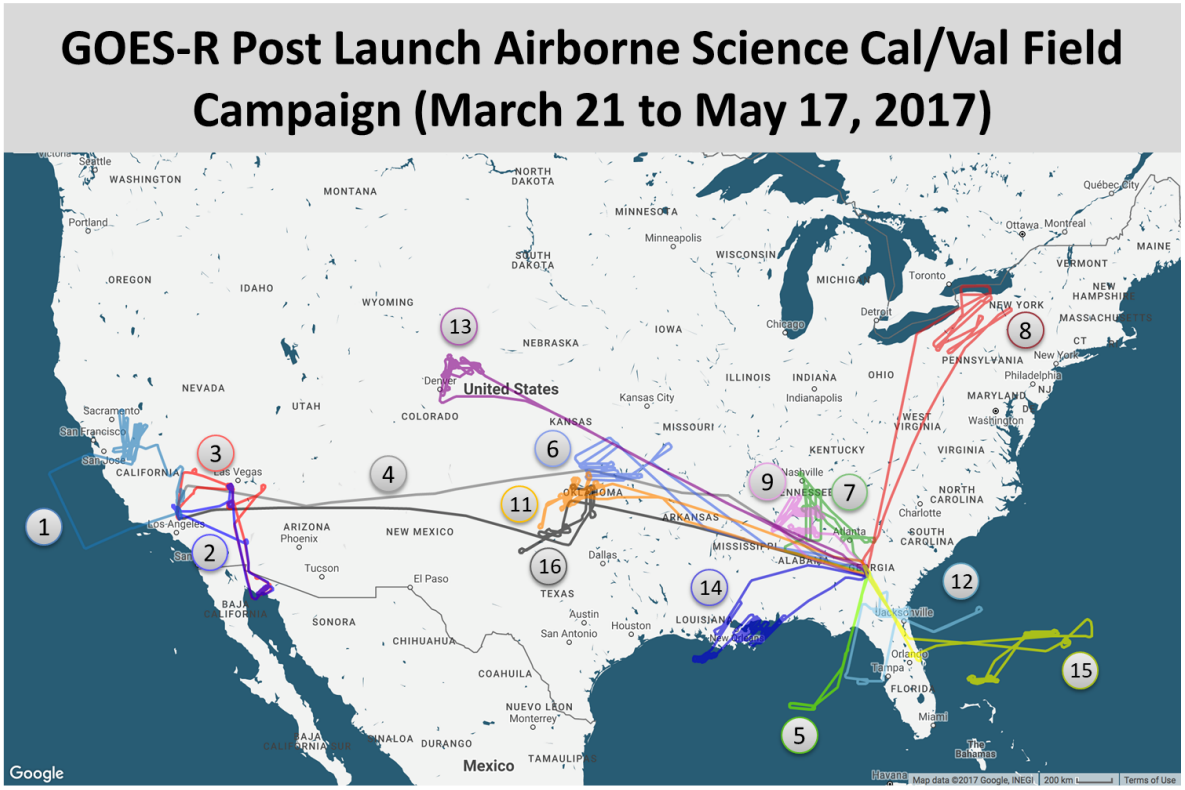

Figure 1: The GOES-R PLT Field Campaign study area
(Image source: Frank Padula)

Instrument Description

The Airborne Visible/Infrared Imaging Spectrometer (AVIRIS) is a passive remote sensing instrument that takes spectral measurements of the earth and atmosphere to extract information about surface and atmospheric features (Figure 2). It was flown aboard the NASA ER-2 high-altitude research aircraft during the GOES-R PLT field campaign. AVIRIS measures spectral radiance in 224 channels with wavelengths ranging from 400 to 2,500 nm, within the visible and infrared portions of the electromagnetic spectrum. The AVIRIS data from each channel reveal a spectrum of radiation. Each type of feature reflects a specific spectrum depending on its molecular composition. Analysis of the spectrum can reveal the type of feature and its characteristics. For example, the spectrum reflected by vegetation differs from that reflected by soil. AVIRIS's scanning ability allows images to be constructed from these measurements. This information can be applied in various fields including environmental science, oceanography, land and water management, and agriculture. More information about the AVIRIS instrument can be found at the NASA JPL AVIRIS website and on the NASA Airborne Science Program AVIRIS webpage. More information about remote sensing instruments and how they work can be found on the EOSDIS Remote Sensors webpage.

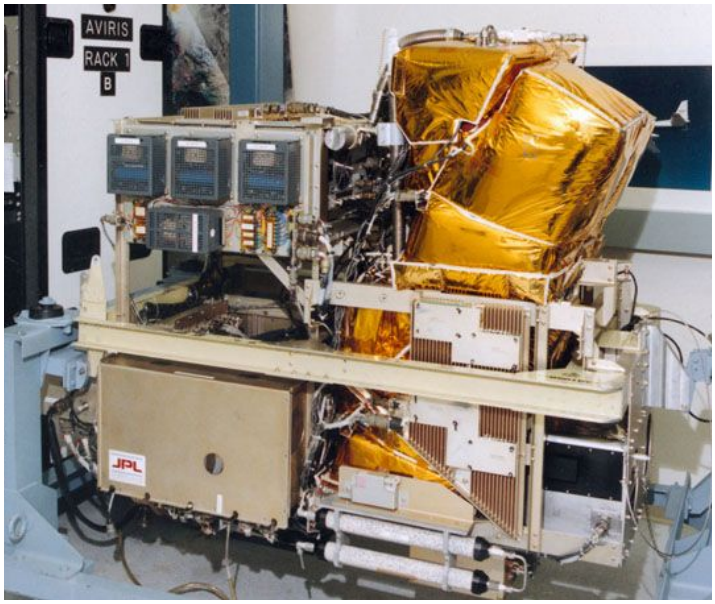

Figure 2: The AVIRIS instrument
(Image source: NASA Airborne Science AVIRIS webpage)

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Data Characteristics

The GOES-R PLT Airborne Visible/Infrared Imaging Spectrometer (AVIRIS) dataset consists of ASCII and binary files containing radiance, surface reflectance, water phase, and navigation data. These data are available at a Level 1B (L1B) and Level 2 (L2) processing level. More information about the NASA data processing levels is available on the EOSDIS Data Processing Levels webpage. The files are organized by processing level, flight date, and flight 'run' number. The characteristics of this dataset are listed in Table 1 below.

Table 1: Data Characteristics

Characteristic	Description
Platform	NASA Earth Resources 2 (ER-2)
Instrument	Airborne Visible/Infrared Imaging Spectrometer (AVIRIS)
Spatial Coverage	N: 43.57 , S: 26.45, E: -72.20 , W: -118.20 (United States of America)
Spatial Resolution	20m diameter pixel size
Temporal Coverage	April 11, 2017 - May 14, 2017
Temporal Resolution	1 run (flight line) per file
Sampling Frequency	12 Hz scanning rate

Parameter	Radiance
Version	1
Processing Level	1B and 2

File Naming Convention

The GOES-R PLT Airborne Visible/Infrared Imaging Spectrometer (AVIRIS) dataset files are named using the following convention:

L1B Data folders: f<yy><mm><dd><tnn><pnn><rnn>rdn_e/
L1B Data files: goesrplt_aviris_f<YYYY><mm><dd>_<tnn><pnn><rnn>rdn_e_[type]

L2 Data folders: f<yy><mm><dd><tnn><pnn><rnn>_rfl_v1f5/
L2 Data files: goesrplt_aviris_f<YYYY><mm><dd>_<tnn><pnn><rnn>_[type]

Browse files: goesrplt_aviris_f<YYYY><mm><dd>_<tnn><pnn><rnn>_geo.jpg

Table 2: File naming convention variables

Variable	Description
yy	Two-digit year
YYYY	Four-digit year
mm	Two-digit month
dd	Two-digit day
tnn	Legacy naming convention when AVIRIS data recorded onto VLDS tapes (static number of 01; *i.e. t01*)
pnn	Power cycle number (static number of 00; *i.e. p00*)
rnn	Airborne flight run number (where *nn* is the two-digit run number)
[type]	File type (see Table 3)
.jpg	JPG image file

Table 3: AVIRIS file type extensions

Type	Description
*gain.txt	Multiplication factors, radiance to 16-bit integer
*rccf17.txt	Radiometric calibration coefficients
*spc.txt	Spectral calibration file
*eph	Position data in a WGS-84/NAD83 UTM x,y,z coordinate system
*lonlat_eph	Position in WGS-84 longitude, latitude, and elevation
*obs_hdr.txt	**obs* image header file
*obs	Parameters relating to the geometry of the observation and illumination conditions in raw spatial format
*obs_ort_hdr.txt	**obs_ort* image header file

*obs_ort	Parameters relating to the geometry of the observation and illumination conditions rendered using the **_ort_glt* lookup table
*ort.plog	Generic data processing info
*ort_glt_hdr.txt	**ort_glt* image header file
*ort_glt	Geometric look-up table
*ort_igm_hdr.txt	**ort_igm* image header file
*ort_igm	Input geometry file
*sc01_img.hdr	**sc01_img* image header file
*sc01_img	Scaled radiance image file
*img.plog	Generic data processing info
*sc01_ort_img_hdr.txt	**sc01_ort_img* image header file
*sc01_ort_img	Ortho-corrected, scaled radiance image file
*corr_v1f5_hdr.txt	**corr_v1f5_img* image header file
*corr_v1f5_img	Ortho-corrected and atmospherically corrected reflectance data
*h2o_v1f5_img_hdr.txt	**h2o_v1f5_img* image header file
*h2o_v1f5_img	Retrieved column water vapor and optical absorption paths for liquid H_2O and ice

Note: The **sc01_img.hdr, *sc01_img,* and **img.plog* files are only included for the 04/16/17 and 04/18/17 flight dates. Files with the ending *.txt* are ASCII text files.

Data Format and Parameters

The GOES-R PLT Airborne Visible/Infrared Imaging Spectrometer (AVIRIS) dataset files are separated by processing level: L1B and L2. The files are organized into folders for each date and flight run. For each flight run there are a total of 16 to 19 file types for the L1B data and 4 file types for the L2 data; with the file type denoted by the file extension. Files are in ASCII and binary format. Each file type is detailed below:

L1B Data Files

Multiplication Factors for Radiance (*gain.txt)

This ASCII file contains the multiplication factors used to store the radiance values as 16-bit integers and retrieve the radiance in units of *microwatts/cm^2/nm/sr*. There are two columns of data; the first for 'multiplication factor' and the second for 'channel number'.

Radiometric Calibration Coefficients (*rccf17.txt)

This ASCII file contains the AVIRIS radiometric calibration coefficients and laboratory calibration uncertainty. The file is organized into 2 columns: 'radiometric calibration coefficient' and 'uncertainty in radiometric calibration coefficient'.

Spectral Calibration File (*spc.txt)

This ASCII file contains the AVIRIS spectral calibration data. The file contains information about the wavelength in 5 columns including: wavelength center position, full width at half

maximum (FWHM) equivalent gaussian, uncertainty in wavelength center position, uncertainty in FWHM for equivalent gaussian, and channel number.

UTM Position Data (*eph)
This binary file contains the position data of the ER-2 aircraft in Universal Transverse Mercator (UTM) coordinates, including aircraft roll, pitch, heading, and sensor position.

Lat/Lon Position Data (*lonlat_eph)
This binary file contains the position data of the ER-2 aircraft in latitude, longitude, and elevation coordinates.

Observation Parameter Header File(*obs_hdr.txt)
This is the ASCII header file for the **obs* file. It contains number of lines, samples, channel, and other information.

Observation Parameter File (*obs)
This is an observation parameter file that contains information on the sensor path length, solar azimuth and zenith, solar phase, and other related information. These are raw spatial data in binary format. The parameters are listed in Table 4 below.

Table 4: Observation Parameters

Name	Description	Units
path length	Sensor-to-ground	meters
to-sensor-azimuth	0 to 360 degrees clockwise from North	degrees
to-sensor-zenith	0 to 90 degrees from zenith	degrees
to-sun-azimuth	0 to 360 degrees clockwise from North	degrees
to-sun-zenith	0 to 90 degrees from zenith	degrees
solar phase	Degrees between to-sensor and to-sun vectors in principal plane	degrees
slope	Local surface slope as derived from a digital elevation model (DEM)	degrees
aspect	Local surface aspect 0 to 360 degrees clockwise from North	degrees
cosine i	Apparent local illumination factor based on DEM slope and aspect, and to-sun vector (range -1 to 1)	-
UTC time	Decimal hours for mid-line pixels	-

Ortho-Corrected Observation Parameter Header File (*obs_ort_hdr.txt)
This is the ASCII header file describing the format for the *obs_ort file. It contains number of lines, samples, channel, and other information.

Ortho-Corrected Observation Parameter File (*obs_ort)

This is the observation parameter file that has been rendered using the GLT lookup tables. These ortho-corrected data include the same parameters as the **obs* file and are in binary format. The parameters are listed again in Table 5 below.

Table 5: Ortho-Corrected Observation Parameters

Name	Description	Units
path length	Sensor-to-ground	meters
to-sensor-azimuth	0 to 360 degrees clockwise from North	degrees
to-sensor-zenith	0 to 90 degrees from zenith	degrees
to-sun-azimuth	0 to 360 degrees clockwise from North	degrees
to-sun-zenith	0 to 90 degrees from zenith	degrees
solar phase	Degrees between to-sensor and to-sun vectors in principal plane	degrees
slope	Local surface slope as derived from DEM	degrees
aspect	Local surface aspect 0 to 360 degrees clockwise from North	degrees
cosine i	Apparent local illumination factor based on DEM slope and aspect, and to-sun vector (range -1 to 1)	-
UTC time	Decimal hours for mid-line pixels	-

Processing Information for Ortho-corrected Files (*ort.plog)
This binary file contains generic data processing information.

Geometric Lookup Table Header File (*ort_glt_hdr.txt)
This is the ASCII header file for the **ort_glt* data file. This file contains the number of lines, samples, channel, integer format, pixel size, scene elevation, and other information.

Geometric Lookup Table (*ort_glt)
This binary file contains ortho-corrected product with a fixed pixel size projected into a rotated UTM system that describes which original pixel occupies which output pixel in the final product. Positive values indicate that an output pixel is real while negative values indicate a nearest-neighbor infill pixel. This file contains two parameters: 'sample number' and 'original line number'.

Input Geometry Header File (*ort_igm_hdr.txt)
This is the ASCII header file for the **ort_igm* file. It contains the number of lines, samples, the channel, integer format, and other information.

Input Geometry File (*ort_igm)
This is a binary input geometry file. It contains pixel location data for each radiance image cube including longitude, latitude, and estimated ground elevation for each pixel. No map correction or resampling is applied to the radiance image pixels. The input parameters are listed in Table 6 below.

Table 6: Input Geometry Parameters

Name	Units
WGS-84 longitude	degrees
WGS-84 latitude	degrees
Estimated ground elevation at each pixel center	meters

AVIRIS Radiance Data Header File (*sc01_img.hdr)
This is the ASCII header file containing format information for the **sc01_img* file as well as the number of lines, samples, the channel, and other information about the file.

AVIRIS Radiance Data File (*sc01_img)
This binary file contains the AVIRIS radiance image data. The radiance is multiplied by the gain and stored as 16-bit integers.

Processing Information for Image Data File (*img.plog)
This binary file contains generic data processing information.

Ortho-corrected AVIRIS Radiance Data Header File (*sc01_ort_img_hdr.txt)
This is the ASCII header file for the **sc01_ort_img* file containing the format information along with the number of lines, samples, channel, integer format, and other information.

Ortho-corrected AVIRIS Radiance Data (*sc01_ort_img)
This binary file contains the calibrated ortho-corrected AVIRIS radiance image data. The ortho-corrected radiance in multiplied by the gain and stored as 16-bit integers.

L2 Data Files

Atmospherically Corrected Reflectance Data Header File (*corr_v1f5_img_hdr.txt)
This is the ASCII header file for the **corr_v1f5_img* file containing format information, the number of lines, samples, channel, integer format, and other information.

Atmospherically Corrected Reflectance Data (*corr_v1f5_img)
This binary file contains atmospherically corrected reflectance image data. The AVIRIS apparent surface reflectance ranges from 0 to 1 and is scaled by a factor of 1000.

Water Absorption Path Data Header File (*h2o_v1f5_img_hdr.txt)
This is the ASCII header file containing format information for the **h2o_v1f5_img* file along with the number of lines, samples, channel, integer format, and other information.

Water Absorption Path Data (*h2o_v1f5_img)
This binary file contains water absorption path image data. This includes the retrieved column water vapor and optical absorption paths for liquid H_2O and ice.

Browse Imagery
The dataset browse files contain aerial images of AVIRIS scanned spectral measurements. The image files are in JPEG format.

Additional details about the AVIRIS dataset files are available in the AVIRIS Distribution Document.

Algorithm

The radiance values collected by AVIRIS are converted into surface reflectance using methods from the Atmosphere Removal Algorithm (Gao, Heidebrecht, & Goetz, 1993). This algorithm models absorption by various atmospheric constituents (water vapor, CO_2, oxygen, etc.) to determine surface reflectance and estimates atmospheric transmittance (the fraction of electromagnetic radiation transmitted through the atmosphere) by combining the absorption models with observation geometry . More information about the AVIRIS data processing is available in the AVIRIS Surface Reflectance Processing and Products documentation.

Quality Assessment

The AVIRIS image data were ortho-corrected to remove distortions caused by the viewing point of the sensor, terrain, and other factors. This correction was performed using three-dimensional ray tracing and a 30m resolution DEM. This process gives the best estimate for the location and altitude of each image pixel. More information on the AVIRIS pixel correction procedure can be found in the AVIRIS Ortho-correction Processing and Production documentation.

Software

No software is required to view the AVIRIS ASCII data files. They can be viewed in a text editor or in a spreadsheet software, such as Microsoft Excel or Notepad++. Special software is required to read the binary data files.

Known Issues or Missing Data

The ER-2 aircraft did not operate each day of the campaign; therefore, AVIRIS data are only available on aircraft flight days. Also, flights during the beginning of the campaign were either test flights or flights taking placing at night. Because of this, no AVIRIS data are available for the initial parts of the campaign.

References

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Related Data

All data collected by other instruments during GOES-R PLT are considered related datasets. They can be located using the GHRC HyDRO2.0 search tool and entering the term 'GOES-R PLT' in the search box.

Contact Information

To order these data or for further information, please contact:

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