AVIRIS-NG L1B and L2A data for ARCSIX

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Dataset Version: 1

Summary

This dataset contains Level 1B (L1B) calibrated radiance and Level 2A (L2A) orthocorrected surface reflectance products from the Airborne Visible / Infrared Imaging Spectrometer-Next Generation (AVIRIS-NG) instrument acquired between 2024-05-30 and 2024-08-16 for the Arctic Radiation-Cloud Aerosol-Surface Interaction Experiment (ARCSIX) project. ARCSIX was a NASA field investigation aimed at quantifying the contributions of surface properties, clouds, aerosol particles, and precipitation to the Arctic summer surface radiation budget and to sea ice melting during the early melt season. The L1B files include calibrated radiance. These data are georeferenced but not orthorectified; the L1B files include orthocorrected pixel locations in geographic coordinates and a geometric lookup table, which provides projected coordinates in a UTM grid. The L2A files hold orthocorrected surface hemispherical directional reflectance derived from calibrated radiance using an optimal estimation algorithm. These files include estimates of atmospheric aerosol optical thickness (AOT) and column water vapor. The L2A data are projected in a UTM coordinate system. The NASA AVIRIS-NG instrument is a pushbroom spectral mapping system with high signal-to-noise ratio (SNR), designed and toleranced for high-performance spectroscopy. AVIRIS-NG measures reflected radiance at 5-nm intervals in the Visible to Shortwave Infrared (VSWIR) spectral range from 380-2510 nm. The AVIRIS-NG sensor has a 1 milliradian instantaneous field of view, providing altitude dependent ground sampling distances from 20 m to sub meter range. AVIRIS-NG was flown on a NASA Gulfstream III aircraft. These AVIRIS-NG L1B and L2A data are provided in NetCDF format.

This dataset holds 3855 NetCDF files.

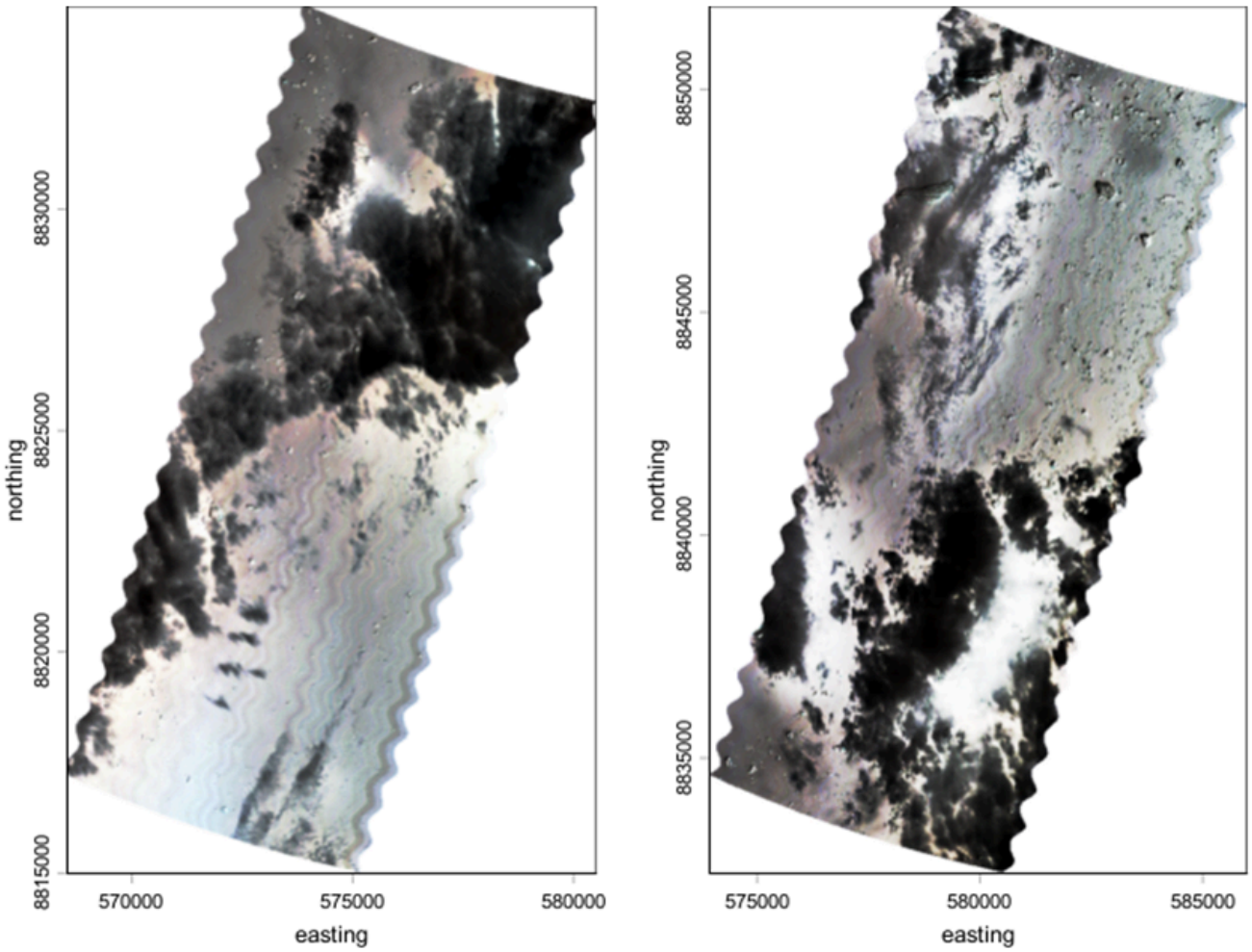


Figure 1. RGB image of surface reflectance for scene 000 (left) and 001 (right) from flight line ang20240530t131312 on May 30, 2024 over Greenland (approx -65.180 longitude, 79.546 latitude). Reflectance wavelengths: R 677.72, G 532.47, B 472.36 nm. Easting and northing coordinates in UTM zone 19N (EPSG:32619).

Citation

Chapman, J.W., N. Bohn, A.M. Chlus, H. Bender, L.M. Rios, R. Eckert, M. Eastwood, S. Geier, S.R. Lundeen, W. Olson-Duvall, E.D. Brunner, D.J. Jensen, P. Sullivan, D.R. Thompson, B.A. Wilder, and R.O. Green. 2026. AVIRIS-NG L1B and L2A data for ARCSIX. ORNL DAAC, Oak Ridge, Tennessee, USA. https://doi.org/10.3334/ORNLDAAC/2535

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1. Dataset Overview

This dataset contains Level 1B (L1B) calibrated radiance and Level 2A (L2A) orthocorrected surface reflectance products from the Airborne Visible / Infrared Imaging Spectrometer-Next Generation (AVIRIS-NG) instrument acquired between 2024-05-30 and 2024-08-16 for the Arctic Radiation-Cloud Aerosol-Surface Interaction Experiment (ARCSIX) project.

The L1B files include calibrated radiance. These data are georeferenced but not orthorectified; the L1B files include orthocorrected pixel locations in geographic coordinates and a geometric lookup table, which provides projected coordinates in a UTM grid.

The L2A files hold orthocorrected surface hemispherical directional reflectance derived from calibrated radiance using an optimal estimation algorithm. These files include estimates of atmospheric aerosol optical thickness (AOT) and column water vapor. The L2A data are projected in a UTM coordinate system. The NASA AVIRIS-NG instrument is a pushbroom spectral mapping system with high signal-to-noise ratio (SNR), designed and toleranced for high-performance spectroscopy. AVIRIS-NG measures reflected radiance at 5-nm intervals in the Visible to Shortwave Infrared (VSWIR) spectral range from 380-2510 nm. The AVIRIS-NG sensor has a 1 milliradian instantaneous field of view, providing altitude dependent ground sampling distances from 20 m to sub meter range. AVIRIS-NG was flown on a NASA Gulfstream III aircraft.

Project: Arctic Radiation-Cloud-Aerosol-Surface Interaction Experiment (ARCSIX)

The Arctic Radiation-Cloud-Aerosol-Surface Interaction Experiment (ARCSIX) was a NASA field investigation aimed at quantifying the contributions of surface properties, clouds, aerosol particles, and precipitation to the Arctic summer surface radiation budget and to sea ice melting during the early melt season. Based out of Pituffik SFB in Greenland, the ARCSIX research team completed deployments from May to June 2024 and from July to August 2024 using the NASA P-3B, NASA G-III, and SPEC-Learjet aircraft. The P-3B was equipped with *in situ* and remote sensing payloads to acquire measurements of aerosols, clouds, and radiation properties. The high-flying G-III was equipped with remote sensing instrumentation (including HALO and AVIRIS-NG), along with the AVAPS dropsonde system. The SPEC-Learjet acquired measurements of cloud microphysics. Data were also collected at the Thule High Arctic Atmospheric Observatory (THAAO) in Pituffik, Greenland.

Related Datasets

Green, R.O., P.G. Brodrick, J.W. Chapman, M. Eastwood, S. Geier, M. Helmlinger, S.R. Lundeen, W. Olson-Duvall, R. Pavlick, L.M. Rios, D.R. Thompson, and A.K. Thorpe. 2023. AVIRIS-NG L1B Calibrated Radiance, Facility Instrument Collection, V1 (Version 1). ORNL Distributed Active Archive Center. https://doi.org/10.3334/ORNLDAAC/2095

Green, R.O., P.G. Brodrick, J.W. Chapman, M. Eastwood, S. Geier, M. Helmlinger, S.R. Lundeen, W. Olson-Duvall, R. Pavlick, L.M. Rios, D.R. Thompson, and A.K. Thorpe. 2023. AVIRIS-NG L2 Surface Reflectance, Facility Instrument Collection, V1. ORNL DAAC, Oak Ridge, Tennessee, USA. https://doi.org/10.3334/ORNLDAAC/2110

See Earthdata's ARCSIX Project page and AVIRIS Project Page for related information and datasets.

2. Data Characteristics

Spatial Coverage: Greenland

Spatial Resolution: 11 to 12 m

Temporal Coverage: 2024-05-30 to 2024-08-16

Temporal Resolution: Daily, weather permitting, during deployment

Study Areas: All latitudes and longitudes given in decimal degrees.

Site	Westernmost Longitude	Easternmost Longitude	Northernmost Latitude	Southernmost Latitude
Greenland	-108.3376	1.6907	85.7889	36.6947

Data File Information

This dataset holds 3855 NetCDF files: 2031 L1B radiance files and 1824 L2A surface reflectance products.

The naming convention for the files is *<fid>_<scene>_<product1>_<ver>_<product2>.nc*, where

- *<fid>* = flight line identifier, *angYYYMMDDthhmmss*, encoding the date and time by year (YYYY), month (MM), day (DD), hour (hh), minute (mm), and second (ss) of the flight (e.g., ang20231126t114819)
- *<scene>* = three digit scene-id from within a flight line (e.g., 000, 001, …, 017)
- *<product1>* = “L1B_RDN” for radiance or “L2A_OE” for surface reflectance from optimal estimation algorithm
- *<ver>* = unique eight-character identifier of full heritage versioning
- *<product2>* = “RDN" for calibrated radiance or “RFL_ORT” for orthocorrected surface reflectance

Example file names for one flight line are:
ang20240530t131312_001_L1B_RDN_cc451d4a_RDN.nc, *ang20240530t131312_001_L2A_OE_0033e1d5_RFL_ORT.nc*

The radiance (RDN) files hold calibrated radiance in raw spatial format (not orthocorrected). However, these files include the geometric lookup table (GLT), which provides a georeferenced location for each pixel in the raw image (Table 1). The GLT is an orthocorrected product with a fixed pixel size projected into a UTM coordinate system that contains the information about which original pixel occupies which output pixel in the final product. Orthocorrected pixels are referenced back to the raw image by the *line* and *sample* variables. The line and sample values are sign-coded to indicate if it is a real measurement (indicated by a positive value) or a nearest-neighbor infill (indicated by negative values). The UTM coordinates are based on WGS 84 datum, and the UTM zone is specified in the *transverse_mercator* variable.

The surface reflectance (RFL_ORT) files hold orthocorrected data projected into the UTM coordinate system using WGS-84 datum (Table 2). Projection information is included with attributes of the *transverse_mercator* variable in these files.

Table 1. Variables in Level 1B calibrated radiance (RDN) NetCDF files.

Group	Variable	Description	Units
/	lon	Longitude for center of grid cell; EPSG 4326	degrees east
	lat	Latitude for center of grid cell; EPSG 4326	degrees north
	elev	Elevation for center of grid cell in height above mean sea level (surface elevation)	m
	transverse_mercator	Details about the projected UTM coordinate system	-
radiance	radiance	Calibrated radiances in 425 bands covering wavelengths between 380 nm to 2510 nm in approximately 5-nm intervals. Image cube dimensions = lines x 598 samples x 425 bands	uW nm^{-1} cm^{-2} sr^{-1}
	wavelength	Center wavelength for each spectral band (n = 425)	nm
	fwhm	Full width at half maximum for band (n = 425)	nm
geolocation_lookup_table	easting	UTM easting coordinate for center of grid cell for orthocorrected pixel location	m
	northing	UTM northing coordinate for center of grid cell for orthocorrected pixel location	m
	line	Pixel identifier in the along-track (flight path) direction, indicating the row location of a pixel from the uncorrected sensor image within the orthocorrected grid	1
	sample	Pixel identifier in the across-track direction, indicating the column location of a pixel from the uncorrected sensor image within the orthocorrected grid	1

Table 2. Variables in L2A orthocorrected surface reflectance (RFL_ORT) files.

Group	Variable	Description	Units
/	easting	UTM easting coordinate for center of grid cell for orthocorrected pixel location	m
	northing	UTM northing coordinate for center of grid cell for orthocorrected pixel location	m
	transverse_mercator	Details about the projected UTM coordinate system	-
reflectance	reflectance	Surface hemispherical directional reflectance factor in 425 bands covering wavelengths between 380 nm to 2510 nm in approximately 5-nm intervals, estimated using an optimal estimation based atmospheric correction algorithm.	1
	wavelength	Center wavelength for each spectral band (n = 425)	nm
	fwhm	Full width at half maximum for band (n = 425)	nm
aerosol_optical_thickness	aerosol_optical_thickness	Factor measuring optical pathlength of aerosol absorption level of aerosols in atmosphere	1
water_vapor	water_vapor	Column concentration of water vapor in the atmosphere between sensor and surface measured in linear units of condensed liquid.	cm

On NASA's Earthdata, the files are organized as multifile granules. Each granule represents a scene and includes both related NetCDF files. The granule naming convention is *<fid>_<scene>_<product1>_<ver2>* , where *<ver2>* is the production version number (e.g., "001").

Example granule names: *ang20240530t131312_000_L1B_RDN_001*, *ang20240530t131312_000_L2A_RFL_001*

3. Application and Derivation

The Arctic Radiation-Cloud-Aerosol-Surface Interaction Experiment (ARCSIX) was a NASA field investigation aimed at quantifying the contributions of surface properties, clouds, aerosol particles, and precipitation to the Arctic summer surface radiation budget and to sea ice melting during the early melt season.

The primary objective of ARCSIX was to enhance long-term space-based monitoring and predictive capabilities of Arctic sea ice, cloud, and aerosols by validating and improving remote sensing algorithms and model parameterizations. The science questions focused on:

- Examining the impact of the predominant summer Arctic cloud types on the radiative surface energy budget;
- Investigating which processes control the evolution and maintenance of the predominant cloud types in the summertime Arctic;
- Studying how the two-way interactions between surface properties and atmospheric forcings affect sea ice evolution.

The AVIRIS-NG sensor collects data that can be used for characterization of the Earth's surface and atmosphere from geometrically coherent spectroradiometric measurements. This data can be applied to studies in the fields of oceanography, environmental science, snow hydrology, geology, volcanology, soil and land management, atmospheric and aerosol studies, agriculture, and limnology. Applications under development include the assessment and monitoring of environmental hazards such as toxic waste, oil spills, and land/air/water pollution. With proper calibration and correction for atmospheric effects, the measurements can be converted to ground reflectance data which can then be used for quantitative characterization of surface features.

The line of NASA Airborne Visible/Infrared Imaging Spectrometers (AVIRIS-Classic/-NG/-3/-5) has been in operation since 1986 acquiring contiguous spectral measurements between 380 and 2510 nm for use by a range of terrestrial ecology science investigations related to: (1) pattern and spatial distribution of ecosystems and their components, (2) ecosystem function, physiology and seasonal activity, (3) biogeochemical cycles, (3) changes in disturbance activity, and (4) ecosystems and human health. These instruments have been useful in developing techniques for atmospheric corrections needed to estimate surface reflectance using hyperspectral data (Gao et al., 1993; Thompson et al., 2015; Thompson et al., 2016; Thompson et al., 2018).

4. Quality Assessment

The AVIRIS-NG calibration procedure addresses electronic effects involving radiometric responses of each detector, optical effects involving the spatial and spectral view of each detector, and radiometric calibration. Detector responsiveness is measured at the beginning of each deployment and mid-flight for particularly long deployments. Instrument artifacts in the spectrometer data, such as striping, are removed statistically by minimizing a Markov Random Field model. Likewise, bad pixels are identified and corrected using statistical methods followed by laboratory and field protocols to evaluate effectiveness. Details of calibration methods are available in Chapman et al. (2019).

5. Data Acquisition, Materials, and Methods

The overarching goal of the ARCSIX Project was to quantify the contributions of surface properties, clouds, aerosol particles, and precipitation to the Arctic summer surface radiation budget and sea ice melt during the early melt season. ARCSIX included two aircraft deployment periods. Flights during the spring deployment took place between 28 May and 14 June 2024. The summer deployment flights took place between 25 July and 16 August 2024 (Figure 2).

The Airborne Visible-Infrared Imaging Spectrometer (AVIRIS-NG) was developed to provide continued access to high signal-to-noise ratio imaging spectroscopy measurements in the solar reflected spectral range (Green et al., 1998). AVIRIS-NG measures the wavelength range from 380 nm to 2510 nm with 5-nm sampling. Spectra are measured as images with 598 cross-track elements and, depending on flight altitude, spatial sampling from 0.3 m to 12.0 m. AVIRIS-NG has better than 95% cross-track spectral uniformity and >= 95% spectral instantaneous field of view (IFOV) uniformity. AVIRIS-NG was flown at a flight altitude of 40,000 ft on a Gulfstream III aircraft for the ARCSIX campaign, resulting in a spatial sampling of approx. 11.2 m.

AVIRIS-NG instrument data were processed to L1B radiance using AVIRIS-NG calibration software, followed by atmospheric correction to Hemispherical Directional Reflectance Factor (HDRF) through the ISOFIT (https://github.com/isofit/isofit) surface and atmospheric modeling package, by NASA's Jet Propulsion Laboratory. The L1B data were used to generate the L2A surface reflectance products. Examples of the methods employed are available in Thompson et al. (2018). The NetCDF files list the band wavelengths and full width half maximum (fwhm) values for each band.

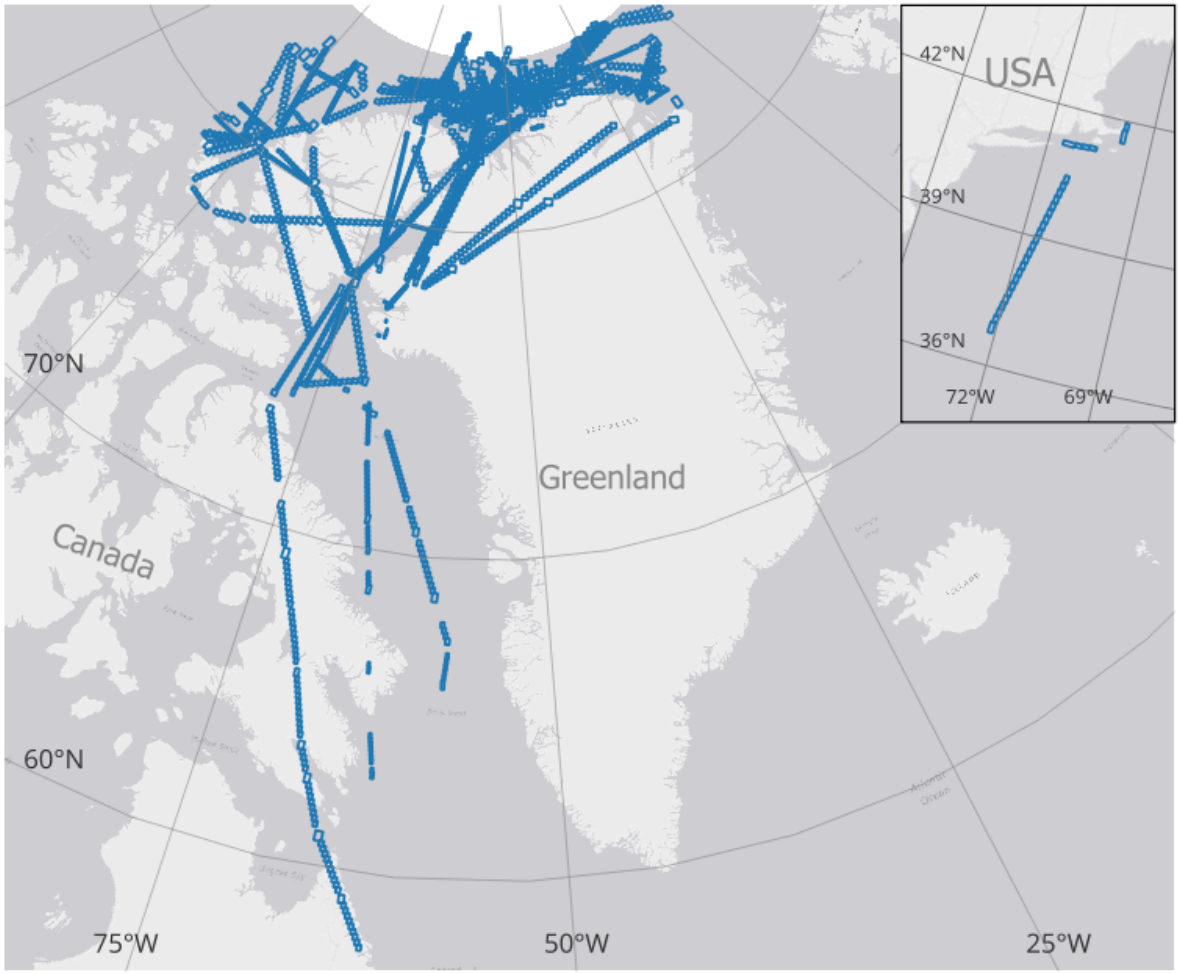


Figure 2. Distribution of AVIRIS-NG scenes (blue rectangles) in 2024 over Greenland, Canada, and the Atlantic Ocean off the eastern United States (inset). Basemap: ESRI.

6. References

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