Delta-X: AVIRIS-NG L2 Surface Reflectance, MRD Louisiana, 2021

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Documentation Revision Date: 2022-08-29

Dataset Version: 1

Summary

This dataset provides Level 2 (L2) atmospherically corrected surface reflectance data acquired from NASA's Airborne Visible-Infrared Imaging Spectrometer-Next Generation (AVIRIS-NG) over regions of interest in the Atchafalaya and Terrebonne basins on the southern coast of Louisiana, United States. Data were collected as part of the Delta-X Spring and Fall 2021 deployments that occurred from 2021-03-27 to 2021-04-06 and from 2021-08-18 to 2021-08-25. Additionally, L2 data from flights flown specifically to capture the Significant Event of Hurricane Ida are provided. This includes 56 files from flights conducted following Hurricane Ida from 2021-09-23 to 2021-09-25. Hurricane Ida made landfall over this region on 2021-08-29. AVIRIS-NG is a pushbroom spectral mapping system with a high signal-to-noise ratio (SNR) designed for high performance imaging spectroscopy. AVIRIS-NG measures the wavelength range from 380 nm to 2510 nm with 5-nm sampling resolution. For this dataset, spatial resolution varies from 3.8-5.4 meters. For this campaign, the AVIRIS-NG instrument was deployed on the Dynamic Aviation King Air B200 platform. This dataset represents one part of a multisensor airborne sampling campaign conducted by different aircraft teams for the Delta-X Campaign. Data are provided in ENVI file format.

This dataset contains 200 compressed (*.zip) files each containing an ENVI binary file and an associated header (*.hdr) file.

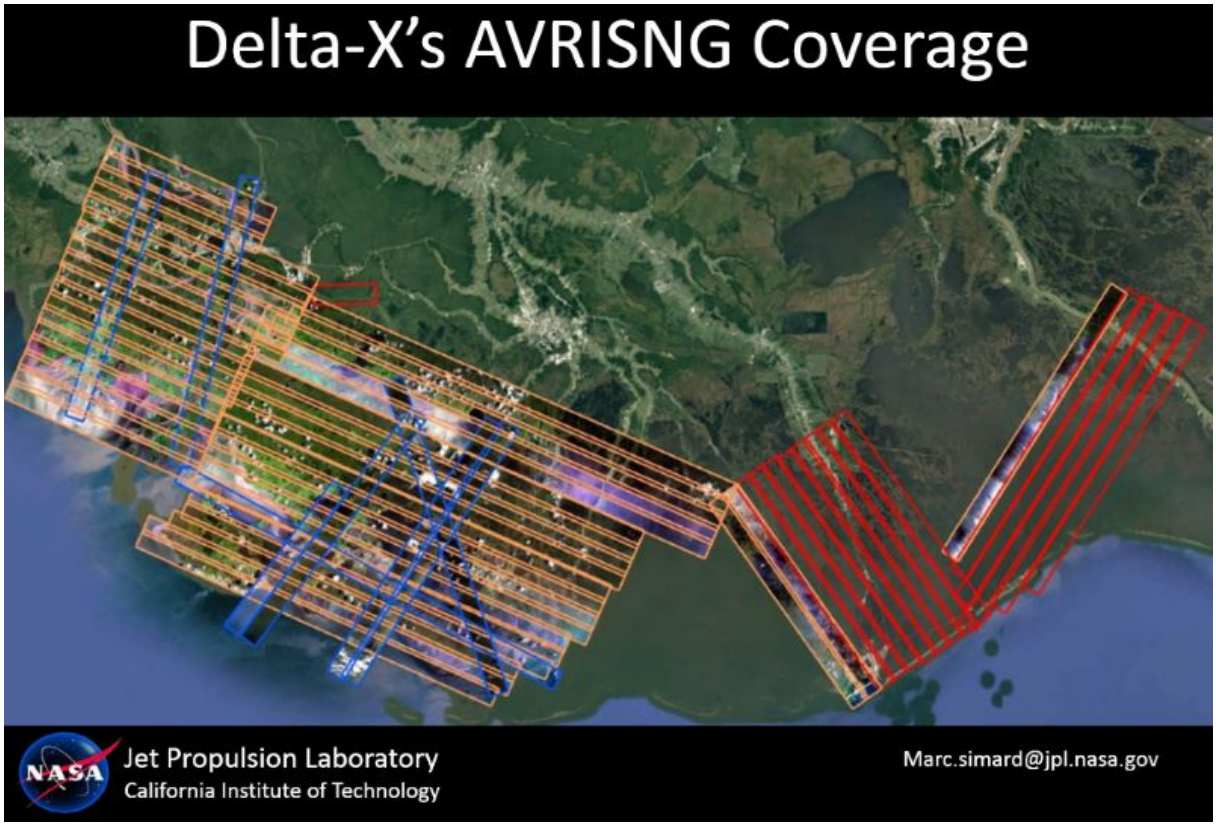

Figure 1. The Delta-X study region on the coast of Louisiana, U.S. Polygons show AVIRIS-NG Flight Lines.

Citation

Thompson, D.R., D.J. Jensen, J.W. Chapman, E. Greenberg, and M. Simard. 2022. Delta-X: AVIRIS-NG L2 Surface Reflectance, MRD Louisiana, 2021. ORNL DAAC, Oak Ridge, Tennessee, USA. https://doi.org/10.3334/ORNLDAAC/1988

Table of Contents

1. Dataset Overview

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Project: Delta-X

The Delta-X mission is a NASA Earth Venture Suborbital-3 mission to study the Mississippi River Delta in the United States, which is growing and sinking in different areas. River deltas and their wetlands are drowning as a result of sea level rise and reduced sediment inputs. The Delta-X mission will determine which parts will survive and continue to grow, and which parts will be lost. Delta-X begins with airborne and in situ data acquisition and carries through data analysis, model integration, and validation to predict the extent and spatial patterns of future deltaic land loss or gain.

Related datasets:

Fichot, C.G., and J. Harringmeyer. 2021. Delta-X: In Situ Spectral Reflectance of Water Surface at MRD, LA, USA, Spring 2021. ORNL DAAC, Oak Ridge, Tennessee, USA. https://doi.org/10.3334/ORNLDAAC/1994

Jensen, D.J., D.R. Thompson, I.B. Mccubbin, and M. Simard. 2021. Pre-Delta-X: L2 AVIRIS-NG Surface Spectral Reflectance across MRD, LA, USA, 2015-2016. ORNL DAAC, Oak Ridge, Tennessee, USA. https://doi.org/10.3334/ORNLDAAC/1826

Thompson, D.R., D.J. Jensen, J. Chapman, M. Simard, and E. Greenberg. 2022. Delta-X AVIRIS-NG L2A BRDF-Adjusted Surface Reflectance, 2021. ORNL DAAC, Oak Ridge, Tennessee, USA. https://doi.org/10.3334/ORNLDAAC/2025

Thompson, D.R., D.J. Jensen, J. Chapman, E. Greenberg, and M. Simard. 2021. Delta-X: AVIRIS-NG L1B Spectral Radiance Products, MRD, LA, 2021. ORNL DAAC, Oak Ridge, Tennessee, USA. https://doi.org/10.3334/ORNLDAAC/1987

Acknowledgements:

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2. Data Characteristics

Spatial Coverage: Atchafalaya and Terrebonne basins**,** Louisiana, US

Spatial Resolution: 3.8 to 5.4 m

Temporal Coverage: 2021-03-27 to 2021-09-25

Temporal Resolution: Multiple overpasses at irregular intervals

Spectral Parameters: 425 bands at 5-nm resolution with a range between 380-2500 nm

Study Area: Latitude and longitude are given in decimal degrees.

Site	Westernmost Longitude	Easternmost Longitude	Northernmost Latitude	Southernmost Latitude
Atchafalaya and Terrebonne basins**,** Louisiana	-91.64	-89.58	29.85	29.02

Data File Information

There are 200 multiband ENVI files provided in separate compressed archive (*.zip) files. Each zip file contains a multiband reflectance file in ENVI binary file format and an associated header (*.hdr) file. The data file naming convention is described below.

File Naming Conventions

The archives holding the reflectance files have the naming convention **angYYYYMMDDtHHMMSS_rfl_v2z1.zip**, where

- YYYYMMDDtHHMMSS = the date and time of data acquisition in UTC format, and
- rfl = reflectance
- v2z1= the file version number

Data File Details

ENVI file characteristics:

- 425 bands at 5-nm spectral resolution covering wavelengths from 380-2500 nm
- UTM coordinate system, zone 15N, EPSG 32615

- Gridded horizontal spatial resolution of 3.8 - 5.4 meters
- The range of valid surface reflectance values is 0.0 - 1.0
- No data values are indicated by -9999

Table 1. Information contained in ENVI header (*.hdr) files

Variable	Description
samples	number of columns in image file
lines	number of rows in the image file
data ignore value	no data value
wavelength units	units for band wavelengths
correction factors	a vector of parameters, one per band, used in BRDF
wavelength	a vector of wavelength values, one per band
fwhm	full width at half maximum, a vector of values, one for each band, measuring spectral resolution
smoothing factors	a vector of values, one for each band, used for reducing noise in reflectance values
map info	geographic information with coordinates/projection system

Companion File

This dataset has one companion file, *Hurricane_Ida_file_list.txt*, containing a list of 56 files included in this dataset from Hurricane Ida Significant Event flights. Hurricane Ida made landfall over this region on 2021-08-29, and flight dates occurred from 2021-09-23 to 2021-09-25.

3. Application and Derivation

Surface reflectance spectra are commonly used to measure properties of the surface composition. They can indicate water column constituents, soil composition, vegetation functional traits, and more. See a recent survey by Cawse-Nicholson et al. (2021) for a more complete description of spectroscopy measurement and its applications to different Earth science disciplines.

4. Quality Assessment

Data quality was monitored at several steps during acquisition and analysis. First, operators performed a preliminary real-time assessment using a real-time display in the cabin and assessed images and spectra in a scrolling “waterfall” plot. This allowed identification of impinging clouds, instrument artifacts, or other issues that would require adjustment or (in the worst case) immediate reacquisition. Second, representative spectra were used to assess the performance of science data algorithms at each stage. These could be matched to in-situ reference data for validation, calibration, and calculating uncertainty predictions, following procedures outlined in Thompson et. al. (2019a, 2019b). In general, the campaign data from spring 2021 have superior surface reflectance estimation due to the better atmospheric conditions encountered during those flights. Fall 2021 overflights encountered higher atmospheric haze, higher water vapor loadings, and a larger number of clouds.

Bad data flags (-9999, noted in header information) were embedded in the spectroscopic data. These flags serve mainly to mark the periphery of an orthorectified image where no spectra were acquired. Clouds and other valid but unusable regions were still considered bona fide scene content and not altered. However, for surface studies we recommend ignoring a large margin of data (1 km or more) around any visible clouds, to avoid their disruption to the downwelling incident light field and corresponding increase in atmospheric correction error.

5. Data Acquisition, Materials, and Methods

AVIRIS-NG is a pushbroom spectral mapping system with a high signal-to-noise ratio (SNR) designed for high performance spectroscopy. AVIRIS-NG was developed as a successor to the Classic Airborne Visible Infrared Imaging Spectrometer (AVIRIS-C) (Green et al., 1998). The instrument covers the entire solar reflected spectrum from 380-2510 nm with a single Focal Plane Array (FPA), at a spectral sampling of approximately 5 nm. The AVIRIS- NG sensor has a 1 milliradian instantaneous field of view, providing altitude-dependent ground sampling distance ranging from sub-meter to 20 m scales. Its detector has a 640×480- pixel array, from which standard products are generated using the sensor’s 600 cross-track spatial samples and 425 spectral samples. Each acquisition is a “flight line” forming a continuous strip of pushbroom data that typically takes 1-10 minutes to acquire. Multiple aircraft overflights cover the region of interest in these strips, accumulating a combined map of the target area. For this campaign, AVIRIS-NG was implemented on a Dynamic Aviation King Air B200. The instrument has four components: 1) a sensor with its mount and camera glass mounted at a nadir port; 2) an onboard calibrator (OBC), mounted in the cabin next to the sensor; 3) a forward operator electronics rack, and 4) an aft thermal-control electronics rack.

AVIRIS-NG acquired data in its standard operating mode over regions of interest in the Atchafalaya and Terrebonne basins. The area was provisionally split into multiple mosaics— a large “survey” covering the entire domain—which required multiple days to accomplish. Planning flight lines to have a 15% overlap area at their margins accommodates position and geometric sampling uncertainty. The precise direction of flight lines was adjusted to accommodate local time and weather conditions and to ameliorate sun glint effects. Because AVIRIS-NG’s data collection was impeded when clouds are present below or above the aircraft, the team typically decided which days to fly based on an early morning “go/no-go” decision from the daily weather forecast.

The AVIRIS-NG radiance data (Level 1) were derived by calibrating incident radiance spectra measured by the sensor using the techniques described in Thompson et al. (2018a, 2018b) and Chapman et al., (2019). These radiances were then analyzed to estimate atmospheric state and surface reflectance (Level 2) using the method of Thompson et al. (2018a, 2018b, 2018c, 2019a). During this stage, a vicarious radiometric correction on the order of 1% is applied which evens out minor discrepancies between the laboratory calibration and flight conditions. This vicarious adjustment uses an in-situ reference from the Delta-X flight campaign, and a correction procedure detailed in Bruegge et al. (2021). The observed reflectance signal is influenced by the bi-directional reflectance distribution function (BRDF) resulting from variation in solar and instrument viewing angles, which creates differences in illumination intensity across various surface cover types within each scene.

6. Data Access

These data are available through the Oak Ridge National Laboratory (ORNL) Distributed Active Archive Center (DAAC).

Delta-X: AVIRIS-NG L2 Surface Reflectance, MRD Louisiana, 2021

Contact for Data Center Access Information:

- E-mail: uso@daac.ornl.gov
- Telephone: +1 (865) 241-3952

7. References

Bruegge, C.J., G.T. Arnold, J. Czapla-Myers, R. Dominguez, M.C. Helmlinger, D.R. Thompson, J.V. den Bosch, and B.N. Wenny. 2021. Vicarious Calibration of eMAS, AirMSPI, and AVIRIS Sensors During FIREX-AQ. IEEE Transactions on Geoscience and Remote Sensing 59:10286–10297. https://doi.org/10.1109/TGRS.2021.3066997

Cawse-Nicholson, K., P.A. Townsend, D. Schimel, A.M. Assiri, P.L. Blake, M.F. Buongiorno, P. Campbell, N. Carmon, K.A. Casey, R.E. Correa-Pabón, K.M. Dahlin, H. Dashti, P.E. Dennison, H. Dierssen, A. Erickson, J.B. Fisher, R. Frouin, C.K. Gatebe, H. Gholizadeh, M. Gierach, N.F. Glenn, J.A. Goodman, D.M. Griffith, L. Guild, C.R. Hakkenberg, E.J. Hochberg, T.R. H. Holmes, C. Hu, G. Hulley, K.F. Huemmrich, R.M. Kudela, R.F. Kokaly, C.M. Lee, R. Martin, C.E. Miller, W.J. Moses, F.E. Muller-Karger, J.D. Ortiz, D.B. Otis, N. Pahlevan, T.H. Painter, R. Pavlick, B. Poulter, Y. Qi, V.J. Realmuto, D. Roberts, M.E. Schaepman, F.D. Schneider, F.M. Schwandner, S.P. Serbin, A.N. Shiklomanov, E.N. Stavros, D.R. Thompson, J.L. Torres-Perez, K.R. Turpie, M. Tzortziou, S. Ustin, Q. Yu, Y. Yusup, and Q. Zhang. 2021. NASA's surface biology and geology designated observable: A perspective on surface imaging algorithms. Remote Sensing of Environment 257:112349. https://doi.org/10.1016/j.rse.2021.112349

Chapman, J.W., D.R. Thompson, M.C. Helmlinger, B.D. Bue, R.O. Green, M.L. Eastwood, S. Geier, W. Olson-Duvall, and S.R. Lundeen. 2019. Spectral and Radiometric Calibration of the Next Generation Airborne Visible Infrared Spectrometer (AVIRIS-NG). Remote Sensing 11:2129. https://doi.org/10.3390/rs11182129

Fichot, C.G., and J. Harringmeyer. 2021. Delta-X: In Situ Spectral Reflectance of Water Surface at MRD, LA, Spring 2021. ORNL DAAC, Oak Ridge, Tennessee, USA. https://doi.org/10.3334/ORNLDAAC/1994

Green, R.O., M.L. Eastwood, C.M. Sarture, T.G. Chrien, M. Aronsson, B.J. Chippendale, J.A. Faust, B.E. Pavri, C.J. Chovit, M. Solis, M.R. Olah, and O. Williams. 1998. Imaging Spectroscopy and the Airborne Visible/Infrared Imaging Spectrometer (AVIRIS). Remote Sensing of Environment 65:227–248. https://doi.org/10.1016/S0034-4257(98)00064-9

Jensen, D.J., D.R. Thompson, I.B. Mccubbin, and M. Simard. 2021. Pre-Delta-X: L2 AVIRIS-NG Surface Spectral Reflectance across MRD, LA, USA, 2015-2016. ORNL DAAC, Oak Ridge, Tennessee, USA. https://doi.org/10.3334/ORNLDAAC/1826

Thompson, D.R., K. Cawse-Nicholson, Z. Erickson, C.G. Fichot, C. Frankenberg, B.-C. Gao, M.M. Gierach, R.O. Green, D. Jensen, V. Natraj, and A. Thompson. 2019a. A unified approach to estimate land and water reflectances with uncertainties for coastal imaging spectroscopy. Remote Sensing of Environment 231:111198. https://doi.org/10.1016/j.rse.2019.05.017

Thompson, D.R., L. Guanter, A. Berk, B.-C. Gao, R. Richter, D. Schläpfer, and K.J. Thome. 2018c. Retrieval of Atmospheric Parameters and Surface Reflectance from Visible and Shortwave Infrared Imaging Spectroscopy Data. Surveys in Geophysics 40:333–360. https://doi.org/10.1007/s10712-018-9488-9

Thompson, D.R., L. Guanter, A. Berk, B.-C. Gao, R. Richter, D. Schläpfer, and K.J. Thome. 2019b. Retrieval of Atmospheric Parameters and Surface Reflectance from Visible and Shortwave Infrared Imaging Spectroscopy Data. Surveys in Geophysics 40:333–360. https://doi.org/10.1007/s10712-018-9488-9

Thompson, D.R., J.W. Boardman, M.L. Eastwood, R.O. Green, J.M. Haag, P. Mouroulis, and B. Van Gorp. 2018a. Imaging spectrometer stray spectral response: In-flight characterization, correction, and validation. Remote Sensing of Environment 204:850–860. https://doi.org/10.1016/j.rse.2017.09.015

Thompson, D.R., V. Natraj, R.O. Green, M.C. Helmlinger, B.-C. Gao, and M.L. Eastwood. 2018b. Optimal estimation for imaging spectrometer atmospheric correction. Remote Sensing of Environment 216:355–373. https://doi.org/10.1016/j.rse.2018.07.003

Thompson, D.R., D.J. Jensen, J. Chapman, M. Simard, and E. Greenberg. 2022. Delta-X AVIRIS-NG L2A BRDF-Adjusted Surface Reflectance, 2021. ORNL DAAC, Oak Ridge, Tennessee, USA. https://doi.org/10.3334/ORNLDAAC/2025

Thompson, D.R., D.J. Jensen, J. Chapman, E. Greenberg, and M. Simard. 2021. Delta-X: AVIRIS-NG L1B Spectral Radiance Products, MRD, LA, 2021. ORNL DAAC, Oak Ridge, Tennessee, USA. https://doi.org/10.3334/ORNLDAAC/1987