Delta-X: AirSWOT L2 Geocoded Water Surface Elevation, MRD, Louisiana, 2021, Version 2

Get Data

Documentation Revision Date: 2023-02-23

Dataset Version: 2

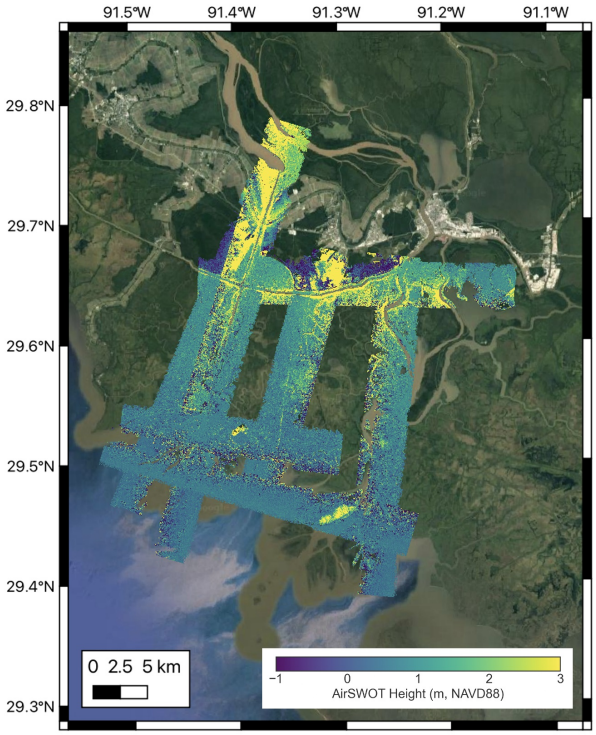
Summary

This dataset contains Level 2 (L2) AirSWOT geocoded products, including estimated water surface elevation. The AirSWOT instrument is a Ka-band interferometer and for this study is flown on the King Air B200 platform. Data were collected during the DeltaX airborne campaign over the Atchafalaya and Terrebonne basins of the Mississippi River Delta, Louisiana, USA. Flights occurred during the Delta-X Spring 2021 deployment from 2021-03-26 to 2021-04-18 and the Delta-X Fall 2021 deployment from 2021-08-21 to 2021-09-12. AirSWOT is capable of producing high resolution (3.6 m) digital elevation models over land and water bodies using near-nadir wide-swath Ka-band radar interferometry to measure water-surface elevation and produce continuous gridded elevation data. The instrument includes six antennas that form multiple baseline pairs for along-track and across-track interferometry. AirSWOT elevation data is useful for calibrating elevation and slopes along the main channels, as well as tying observations to open ocean tidal conditions and is an airborne calibration and validation instrument for the Surface Water and Ocean Topography (SWOT) satellite. In this Version 2, datafiles from the Delta-X Spring 2021 Campaign released in Version 1 were reprocessed using an improved calibration. This version also contains the initial release of data from the Delta-X Fall 2021 Campaign. Note that data acquired on September 1 and September 5, 2021 do not meet the expected MAE in-situ comparison and should be used with caution. This AirSWOT Level 2 dataset contains Cloud Optimized GeoTIFF rasters in UTM map coordinates for each flight line. In addition, a text file provides basic metadata, including flight line ID, start and end UTC times of data acquisition, processor version number, and the date and time of different processing stages.

For additional details, see Section 8: Dataset Revisions.

Note: Data for 2021-09-01 to 2021-09-05 were impacted by poor flight conditions and has a higher noise level and other anomalous errors compared to the data collected on other dates. As part of AirSWOT L2 validation, water levels as measured by AirSWOT are compared to in situ station data with expected mean absolute error around 10 cm or less. However, the data acquired on September 1 and September 5, 2021, did not meet these criteria. Users should therefore be cautioned when using the data from these dates.

This dataset contains 3,699 files.There are 411 flightlines with nine files associated with each flightline: eight Cloud Optimized GeoTIFF (*.tif) files and one plain text annotation (*.ann) file containing basic metadata such as the flight line ID, start and end UTC times of data acquisition, processor version number, and the date and time of different processing stages.



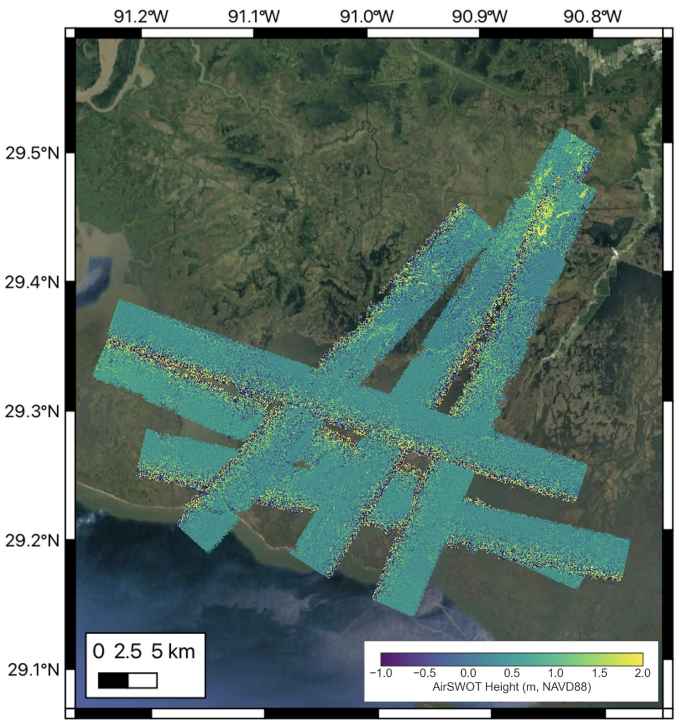


Figure 1: AirSWOT L2 geocoded UTM height maps collected on April 1, 2021 over the Atchafalaya Basin (left), and April 5, 2021 over the Western Terrebonne basin (right).

Citation

Denbina, M.W., M. Simard, and E. Rodriguez. 2023. Delta-X: AirSWOT L2 Geocoded Water Surface Elevation, MRD, Louisiana, 2021, Version 2. ORNL DAAC, Oak Ridge, Tennessee, USA. https://doi.org/10.3334/ORNLDAAC/2128

Table of Contents

1. Dataset Overview

This dataset contains Level 2 (L2) AirSWOT geocoded products, including estimated water surface elevation. The AirSWOT instrument is a Ka-band interferometer and for this study is flown on the King Air B200 platform. Data were collected during the DeltaX airborne campaign over the Atchafalaya and Terrebonne basins of the Mississippi River Delta, Louisiana, USA. Flights occurred during the Delta-X Spring 2021 deployment from 2021-03-26 to 2021-04-18 and the Delta-X Fall 2021 deployment from 2021-08-21 to 2021-09-12. AirSWOT is capable of producing high resolution (3.6 m) digital elevation models over land and water bodies using near-nadir wide-swath Ka-band radar interferometry to measure water-surface elevation and produce continuous gridded elevation data. The instrument includes six antennas that form multiple baseline pairs for along-track and across-track interferometry. AirSWOT elevation data is useful for calibrating elevation and slopes along the main channels, as well as tying observations to open ocean tidal conditions and is an airborne calibration and validation instrument for the Surface Water and Ocean Topography (SWOT) satellite. In this Version 2, datafiles from the Delta-X Spring 2021 Campaign released in Version 1 were reprocessed using an improved calibration. This version also contains the initial release of data from the Delta-X Fall 2021 Campaign. Note that data acquired on September 1 and September 5, 2021 do not meet the expected MAE in-situ comparison and should be used with caution. This AirSWOT Level 2 dataset contains Cloud Optimized GeoTIFF rasters in UTM map coordinates for each flight line. In addition, a text file provides basic metadata, including flight line ID, start and end UTC times of data acquisition, processor version number, and the date and time of different processing stages.

Project: Delta-X

The Delta-X mission is a 5-year 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

Denbina, M.W., M. Simard, and E. Rodriguez. 2022. Delta-X: AirSWOT L2 Geocoded Water Surface Elevation, MRD, Louisiana, 2021. ORNL DAAC, Oak Ridge, Tennessee, USA. https://doi.org/10.3334/ORNLDAAC/2070

- Version 1 of this dataset. It is now superseded.

Denbina, M.W., M. Simard, E. Rodriguez, X. Wu, and C. Michailovsky. 2021. Pre-Delta-X: L2 AirSWOT Water Surface Elevations, Atchafalaya Basin, LA, USA, 2016. ORNL DAAC, Oak Ridge, Tennessee, USA. https://doi.org/10.3334/ORNLDAAC/1818.

- Contains L2 AirSWOT products from the Pre-Delta-X Spring 2015 deployment.

Denbina, M.W., M. Simard, and E. Rodriguez. 2021. Delta-X: AirSWOT Level 1b Interferogram Products across MRD, LA, USA, 2021. ORNL DAAC, Oak Ridge, Tennessee, USA. https://doi.org/10.3334/ORNLDAAC/1996.

- Contains L1b AirSWOT products from the Delta-X 2021 deployment

Denbina, M.W., M. Simard, and E. Rodriguez. 2022. Delta-X: AirSWOT L3 Water Surface Elevation Versus Time, MRD, Louisiana, 2021. ORNL DAAC, Oak Ridge, Tennessee, USA. https://doi.org/10.3334/ORNLDAAC/2133

- Contains L3 AirSWOT water elevation products from the Delta-X 2021 Spring and Fall Campaigns

Christensen, A.L., J.M. Mallard, M. Simard, T.M. Pavelsky, and A. Rovai. 2022. Delta-X: In-situ Water Surface Elevation, MRD, Louisiana, USA, 2021. ORNL DAAC, Oak Ridge, Tennessee, USA. https://doi.org/10.3334/ORNLDAAC/2086

- In-situ water surface elevation validation measurements

Acknowledgments

This work was supported by NASA Earth Venture Suborbital-3 (EVS-3) program (grant NNH17ZDA001N-EVS3).

2. Data Characteristics

Spatial Coverage: Atchafalaya and Terrebonne Basins, LA, USA

Spatial Resolution: 3.6 m

Temporal Coverage: Spring- 2021-03-26 to 2021-04-18. Fall- 2021-08-21 to 2021-09-12

Temporal Resolution: Measurements taken at irregular intervals.

Spring Flights: 2021-03-26, 2021-03-27, 2021-04-01, 2021-04-02, 2021-04-05, 2021-04-06, 2021-04-07, 2021-04-12, 2021-04-16, and 2021-04-18.

Fall Flights: 2021-08-21, 2021-08-22, 2021-08-23, 2021-08-24, 2021-09-01, 2021-09-03, 2021-09-04, 2021-09-05, 2021-09-07, 2021-09-11, and 2021-09-12

Site Boundaries: Latitude and longitude are given in decimal degrees.

Site	Westernmost Longitude	Easternmost Longitude	Northernmost Latitude	Southernmost Latitude
Atchafalaya and Terrebonne basins, Louisiana, US	-91.60	-90.21	29.86	29.98

Data File Information

This dataset contains 3,699 files. There are 411 flightlines with nine files associated with each flightline: eight Cloud Optimized GeoTIFF (*.tif) files containing high resolution elevation data and related variables and one annotation (*.ann) file containing basic metadata such as the flight line ID, start and end UTC times of data acquisition, processor version number, and the date and time of different processing stages.

Data File Details

CRS: "WGS 84 / UTM zone 15N" (EPSG: 32615)

Bands: 1

Missing data value: -10000

File Naming Convention

Files are named utm_m0m_*flightline*.*variable*.tif (e.g., utm_m0m_20210401144714.dhdphi.tif), where:

utm = represents the Universal Transverse Mercator map units .

m0m = represents 'mode 0 with motion compensation', the AirSWOT output product

flightline = identifies the specific AirSWOT flightline in YYYYMMDDHHMMSS format in UTC time indicating the start of the flight line. Note: The flight line start time and the data start time, used to create the data products (available in the annotation companion files), are not identical.

variable = indicates the type of data product (i.e. the variable represented in the data file), see Table 1.

Annotation files are named: o5release_*flightline*.ann (see File Naming Convention above for a description of *flightline*.

Table 1. Data dictionary for utm_m0m_*flightline*.*variable*.tif files.

Variable	Units	Description
corr		Interferometric correlation (values between 0 and 1).
dhdphi	m radian-1	Height sensitivity expressed as the conversion factor between interferometric phase and vertical height.
err	m	Estimated height error (1-sigma standard deviation).
hgt	m, referenced to WGS-84	Estimated water surface elevation in respect to the WGS84 ellipsoid surface.
ghgt	m, referenced to NAVD88 (GEOID12B)	Estimated height above the NAVD88 (GEOID12B) vertical datum.
inc	radians	Incidence angle estimated from the reference DEM.
mag	m	Backscatter magnitude product. Equal to the square root of the geometric mean of the reference and secondary channel sigma-nought. The file contains values in linear units of magnitude, but can be converted to sigma-nought in dB using the equation: sigma0_in_db = 20*log10(.mag)
mag_ns	m	Backscatter magnitude product after the estimated noise-equivalent sigma-nought has been subtracted from the data. Equal to the square root of the geometric mean of the reference and secondary channel sigma-nought after noise subtraction. The file contains values in linear units of magnitude, but can be converted to sigma-nought in dB using the equation: sigma0_in_db = 20*log10(.mag).

3. Application and Derivation

AirSWOT uses airborne radar interferometry to measure open water surface elevation. It was developed in collaboration with NASA's Surface Water and Ocean Topography (SWOT) project and has supported multiple ocean and hydrology campaigns including Tanana River, Yukon Flats Basin, and Willamette River. AirSWOT's elevation measurements can be used to calibrate and validate hydrodynamic models and estimate river discharge.

4. Quality Assessment

Data quality of the AirSWOT water level products was assessed by comparison with data from in situ water level gauges at locations throughout the study area (Christensen et al., 2022). The calibration and global adjustment analysis estimated phase drift rate to make global calibration adjustments based on cross-over flight lines.

In addition, an estimated height uncertainty product is included in this L2 product (utm_m0m_*flightline*_err.tif). This product provides an estimated 1-sigma standard deviation of the AirSWOT height for each image pixel.

AirSWOT produces continuous gridded elevation data. On a pixel basis, elevation error was dominated by random noise, and contiguous pixels along a river channel were averaged to reduce measurement noise. Assuming a total averaging area of 1 km^2, the height noise was less than 10 cm for the Pre-Delta-X L2 products after final phase calibration.

NOTE: The data for September 1 and September 5, 2021 was impacted by poor flight conditions and has a higher noise level and other anomalous errors compared to the data collected on other dates. As part of AirSWOT L2 validation, water levels as measured by AirSWOT are compared to in situ station data with expected mean absolute error around 10 cm or less. However, the data acquired on September 1 and September 5, 2021, did not meet these criteria. Users should therefore be cautioned when using the data from these dates.

5. Data Acquisition, Materials, and Methods

AirSWOT used near-nadir wide-swath radar interferometry (Rodriguez et al., 2017; Altenau et al., 2017) to measure water-surface elevation. The instrument was operated at Ka-band (35.75 GHz) and included six antennas that formed multiple baseline pairs for along-track and across-track interferometry. These antenna combinations provided contiguous coverage from about 500 m to 4 km from nadir, which removed water-motion-induced geolocation and height errors. The instrument was coupled with a high-precision Applanix GPS/IMU system to compensate for the effects of aircraft motion and attitude. AirSWOT was flown on a Langley Research Center (LaRC) King Air aircraftt. There are three components to the overall instrument suite: (1) radar mounted in the nadir forward port of the aircraft, (2) Avcon electronics rack in the main cabin, and (3) Welch power distribution rack in the rear of the aircraft. Radiometric calibration data was acquired prior to deployment by imaging a corner reflector array in Rosamond, CA.

AirSWOT produces data products in multiple modes and employs cross-track and along-track interferometry to both estimate the height of the water surface and to compensate for the motion of water scatterers. The delivered products were from mode “m0m (mode 0 with motion compensation) and represent the standard output product for the AirSWOT outer swath mode. Data from this mode has also been used in the pre-Delta-X campaign (Denbina et al., 2019), as well as other previous studies to measure water surface elevation and slope (e.g., Altenau et al., 2017; Altenau et al., 2019; Pitcher et al., 2019; Tuozzolo et al., 2019).

AirSWOT performance in the floodplain was limited by the presence of vegetation and by the very shallow slopes characteristic of floodplain discharge. Therefore, the bulk of the AirSWOT data collections were targeted at larger channels. Channel discharge supplies water for potential overflow to islands and floodplains. In situ data were incorporated in the phase calibration procedure because the standard AirSWOT phase calibration could be adversely affected by wetland vegetation, which covers a significant portion of this study area (Section 5 of Denbina, 2018). The AirSWOT instrument suffered from small phase drifts creating potential slope artifacts in the cross-track direction. To correct the phase-drift artifacts, the flight pattern was designed to include crossovers that were used to make global adjustments and estimate phase drifts when producing the L2 products.

In addition to the raster files, a plain text annotation file is included with basic metadata, including flight line ID, start and end UTC times of data acquisition, processor version number, and the date and time of different processing stages.

6. Data Access

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

Delta-X: AirSWOT L2 Geocoded Water Surface Elevation, MRD, Louisiana, 2021, Version 2

Contact for Data Center Access Information:

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

7. References

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8. Dataset Revisions

Version	ReleaseDate	Description
2.0	2023-02-23	Datafiles released in Version 1 (from the Delta-X Spring 2021 Campaign) were reprocessed using improved calibrations. The authors estimate this recalibration may have changed previous WGS84 elevation estimates (*.hgt.tif files) by +/- 3-5 cm on average and potentially up to +/- 20 cm in rare cases. This is the initial release of files from the Delta-X Fall 2021 Campaign and for NAVD88 (GEOID12B) vertical datum water elevation estimates (*.ghgt.tif files).
1.0	2022-11-10	Initial release of 1776 data files.