Delta-X: UAVSAR L1B Interferometric Products, MRD, Louisiana, 2021

Get Data

Documentation Revision Date: 2024-07-23

Dataset Version: 1.1

Summary

This dataset contains UAVSAR Level 1B (L1B) interferometric products for Delta-X flight lines acquired during the 2021 Spring (2021-03-27 to 2021-04-18) and Fall (2021-09-03 to 2021-09-13) deployments. The data were collected by Uninhabited Aerial Vehicle Synthetic Aperture Radar (UAVSAR), a polarimetric L-band synthetic aperture radar flown on the NASA Gulfstream-III (C20) aircraft as part of the Delta-X campaign. The study area includes the Atchafalaya Basin, in Southern Louisiana, USA, within the Mississippi River Delta (MRD) floodplain. Repeat pass interferometric synthetic aperture (InSAR) data are a standard UAVSAR product delivered by the UAVSAR processing team. For this dataset, a set of nearest-neighbor (NN), NN+1, and NN+2 co-registered VV-polarization interferograms were generated from the quad-polarization SLC stack level-1 (L1) product using a combination of the InSAR Scientific Computing Environment (ISCE), the statistical-cost, network-flow algorithm for phase unwrapping (SNAPHU), and previously developed python code. Data quality was assessed by comparing water elevation estimates with data from in situ water level gauges throughout the study area. The data are provided in non-georeferenced ENVI file format and include interferometric amplitude, wrapped interferometric phase, interferometric coherence, and unwrapped interferometric phase products. Geometry files for each flight line per field campaign with latitude, longitude, height and incidence angle information are also included. The goal of this campaign was to measure water-level changes throughout wetlands, and these data may be used to generate time series of water levels. The data are provided in ENVI format.

Delta-X was a joint airborne and field campaign in the Mississippi River Delta that took place during Spring and Fall 2021. The Delta-X campaign conducted airborne (remote sensing) and field (in situ) measurements to observe hydrology, water quality (e.g., total suspended solids (TSS), and vegetation structure. This data serves for the continued development of algorithms and models. The Delta-X algorithms are used to convert remote sensing observables to geophysical parameters, and to develop numerical, hydrodynamic and ecological models.

This dataset includes a total of 1,972 files in ENVI binary image and associated header file format: 481 interferogram phase, 481 interferogram amplitude, 481 coherence, 481 unwrapped interferogram phase, and 48 geometry files.

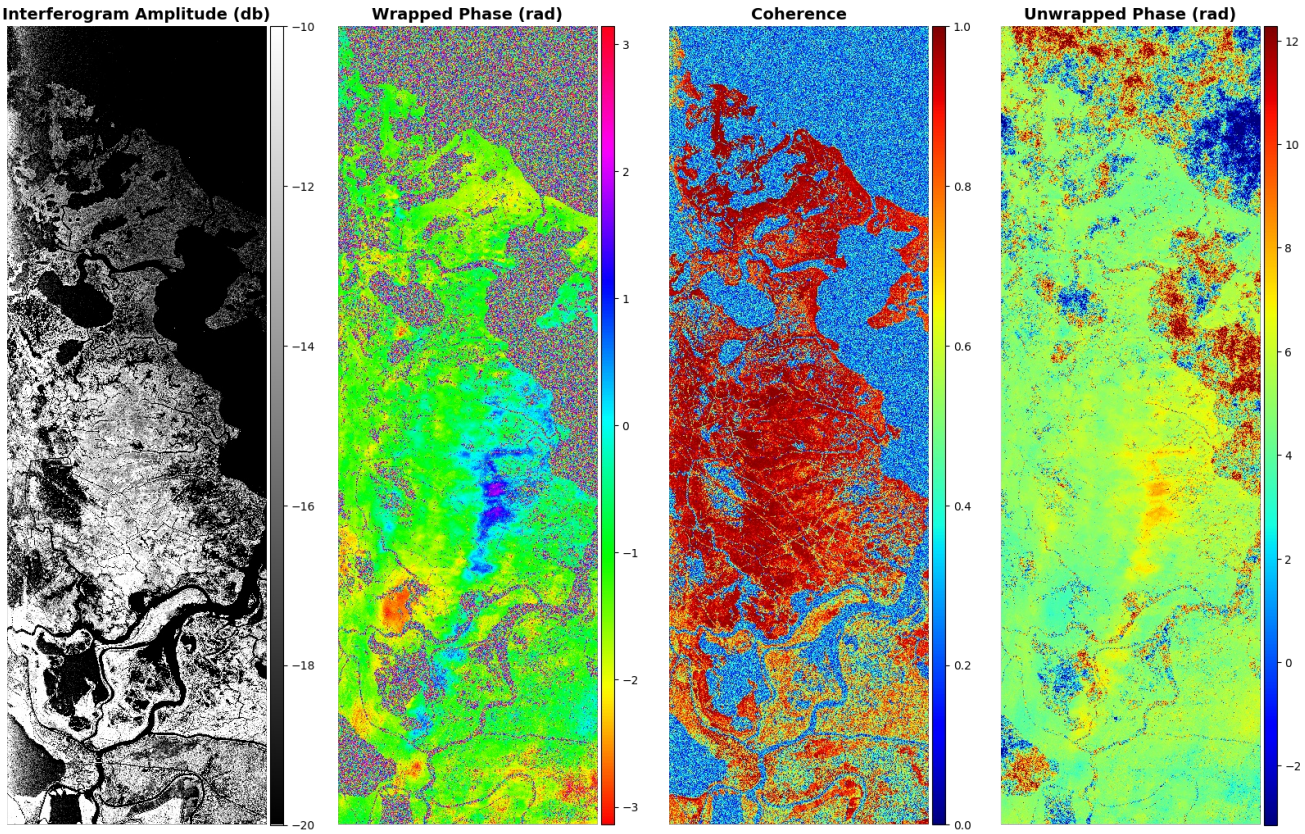

Figure 1. UAVSAR interferometric product example. From left to right: Interferometric amplitude (displayed in decibel scale), wrapped interferometric phase, interferometric coherence and unwrapped interferometric phase, generated using acquisitions from flight-line wterre_34202 on 2021-04-06 at 20:32 and 21:02 (UTC).

Citation

Jones, C., T. Oliver-Cabrera, M. Simard, and Y. Lou. 2022. Delta-X: UAVSAR L1B Interferometric Products, MRD, Louisiana, 2021. ORNL DAAC, Oak Ridge, Tennessee, USA. https://doi.org/10.3334/ORNLDAAC/1979

Table of Contents

1. Dataset Overview

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For this dataset, a set of nearest-neighbor (NN), NN+1, and NN+2 co-registered VV-polarization interferograms were generated from the quad-polarization SLC stack level-1 (L1) product (Jones et al., 2021) using a combination of the InSAR Scientific Computing Environment (ISCE), the statistical-cost, network-flow algorithm for phase unwrapping (SNAPHU) (Chen et al., 2000 and 2001), and previously developed python code as described in Oliver-Cabrera et al. (2022). Data quality was assessed by comparing water elevation estimates with data from in situ water level gauges throughout the study area. The data are provided in non-georeferenced ENVI file format and include interferometric amplitude, wrapped interferometric phase, interferometric coherence, and unwrapped interferometric phase products. Geometry files for each flight line per field campaign with latitude, longitude, height and incidence angle information are also included.

Delta-X was a joint airborne and field campaign in the Mississippi River Delta that took place during Spring and Fall 2021. The Delta-X campaign conducted airborne (remote sensing) and field (in situ) measurements to observe hydrology, water quality (e.g., total suspended solids (TSS), and vegetation structure. This data serves for the continued development of algorithms and models. The Delta-X algorithms are used to convert remote sensing observables to geophysical parameters, and to develop numerical, hydrodynamic and ecological models.

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 Publications

Jensen, D., K.C. Cavanaugh, M. Simard, G.S. Okin, E. Castañeda-Moya, A. McCall, and R. R. Twilley. 2019. Integrating imaging spectrometer and synthetic aperture radar data for estimating wetland vegetation aboveground biomass in coastal Louisiana. Remote Sensing 11:2533. https://doi.org/10.3390/rs11212533

Oliver-Cabrera, T., C.E. Jones, Z. Yunjun, and M. Simard. 2022. InSAR phase unwrapping error correction for rapid repeat measurements of water level change in wetlands. IEEE Transactions on Geoscience and Remote Sensing 60:5215115. https://doi.org/10.1109/TGRS.2021.3108751

Related Datasets

Jones, C., M. Simard, Y. Lou, and T. Oliver. 2021. Delta-X: UAVSAR Single Look Complex (SLC) Stack L1 Products, Louisiana, USA, 2021. ORNL DAAC, Oak Ridge, Tennessee, USA. https://doi.org/10.3334/ORNLDAAC/1984

- The UAVSAR L1 products used to generate this L1B dataset.

Jones, C., T. Oliver-Cabrera, M. Simard, and Y. Lou. 2022. Delta-X: UAVSAR Level 2 Geocoded Interferometric Products, LA, USA, 2021. ORNL DAAC, Oak Ridge, Tennessee, USA. https://doi.org/10.3334/ORNLDAAC/2057

- L2 interferometric products generated from this L1B dataset.

Jones, C., T. Oliver-Cabrera, M. Simard, and Y. Lou. 2022. Delta-X: UAVSAR Level 3 Geocoded InSAR Derived Water Level Changes, LA,USA, 2021. ORNL DAAC, Oak Ridge, Tennessee, USA. https://doi.org/10.3334/ORNLDAAC/2058

- L3 water-level change products generated from the L2 products.

Jones, C., M. Simard, Y. Lou, and T. Oliver. 2021. Pre-Delta-X: L1 UAVSAR Single Look Complex and Interferograms, MRD, LA, USA, 2016. ORNL DAAC, Oak Ridge, Tennessee, USA. https://doi.org/10.3334/ORNLDAAC/1816

Simard, M., M.W. Denbina, D.J. Jensen, and R. Lane. 2020. Pre-Delta-X: Water Levels across Wax Lake Outlet, Atchafalaya Basin, LA, USA, 2016. ORNL DAAC, Oak Ridge, Tennessee, USA. https://doi.org/10.3334/ORNLDAAC/1801

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, southern coast of Louisiana, USA

Spatial Resolution: approximately 6 m

Temporal Coverage: 2021-03-27 to 2021-04-18 and 2021-09-03 to 2021-09-13

Temporal Resolution: Repeated samples at 30-minute intervals

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

Site	Westernmost Longitude	Easternmost Longitude	Northernmost Latitude	Southernmost Latitude
Atchafalaya and Terrebonne Basins	-91.6574	-90.1334	29.7857	28.9827

Data File Information

This dataset includes a total of 1,924 files in ENVI binary image and associated header file format: 481 interferogram phase, 481 interferogram amplitude, 481 coherence, 481 unwrapped interferogram phase and 48 geometry files. Each ENVI consist of a binary data file (*.dat) plus a metadata header file (*.hdr); the data file and its associated header are provided in a zip archive (*.zip).

The main interferometric product files are named ***ssssss_aaaaa_YYLLDDHHMM_yyllddhhmm_vv_product*.zip** (e.g., atchaf_06309_2103271342_2103271413_01_coh.zip), where

- ***ssssss***: "atchaf", "eterre" or "wterre"; 6-character alphanumeric site name assigned to the UAVSAR flight line .
- ***aaaaa***: 5-character flight line ID assigned to the UAVSAR flight line (Table 1, Fig 3). The first 3 characters are the aircraft heading in degrees from North, and the last 2 characters are an alphanumeric counter chosen to ensure uniqueness of the ID.
- ***YYLLDDHHMM***: starting time of first acquisition, encoded as YY = the last two digits of the year, LL = month, DD = day of month, HH = hour, and MM = minute, in UTC.
- ***yyllddhhmm***: start time of second acquisition, encoded as yy = the last two digits of the year, ll = month, dd = day of month, hh = hour, and mm = minute, in UTC.
- ***vv***: version number.
- ***product***: interferometric file type as "coh" = coherence, "intamp" = amplitude, "intphase" = phase, and "unwphase" = unwrapped phase.

These L1B Interferometric products are provided as real Float32 data type. The ENVI header files contain the names of the products from which the product was derived (Table 2), the data format, along with the number of samples and lines in the raster. The no data value is NaN.

The geometry files are named ***ssssss_aaaaa_vv_season.geom*.rdr.zip** (e.g., atchaf_06309_01_fall.hgt.rdr.zip), where

- ***season***: "spring" or "fall"
- ***geom***: geometry product: "hgt" = topographic height relative to the WGS-84 ellipsoid, "inc" = incidence angle, "lat" = pixel latitude, or

"lon" = pixel longitude.

The geometry files contain the information used for georeferencing each pixel acquisition. The horizontal datum used was WGS-84. Topographic elevation ("hgt") in meters was recorded at the location where the pixel was projected using Shuttle Radar Topography Mission (SRTM) 1 Arc-Second digital elevation model (DEM; EROS 2017); surface elevations were adjusted to reference the WGS-84 ellipsoid. The incidence angle ("inc") is the angle in degrees between the radar line of sight and surface normal.

3. Application and Derivation

The UAVSAR interferometric products serve as maps of water surface levels throughout the wetland regions. These data were used to produce Level 2 (Jones et al., 2022a) and Level 3 (Jones et al., 2022b) products that provide water level change time series measurements. These measurements were used to evaluate hydrodynamic models and compare their performance.

The geometry information can be useful for users who want to do their own geocoding of the images or want to extract information that requires projecting the pixel information into a specific direction.

4. Quality Assessment

Data quality was assessed by comparing water elevation estimates with data from in situ water level gauges throughout the study area. Residual errors were assessed through a scene-wide comparison of elevation estimates for sites above the high-water level. Pixels that lack data or which failed quality tests were marked with a “no data” value (NaN).

5. Data Acquisition, Materials, and Methods

UAVSAR is a polarimetric L-band synthetic aperture radar operating with 80 MHz bandwidth from 1217.5–1297.5 GHz designed for interferometry (InSAR) (Hensley et al., 2009). UAVSAR’s swath width is 22 km, which illuminates an area from 22°–67° incidence angle, with 3 m (cross-track average) by 1 m (along-track) single look ground resolution. The instrument was flown on a Gulfstream-III (C20) aircraft with the radar electronics and antenna housed in a pod mounted below the fuselage (Fig. 2). Table 1 summarizes the acquisitions used to generate the interferometric products.

Figure 2. UAVSAR is flown on a Gulfstream-III aircraft, mounted in a pod hung below the fuselage.

During the Delta-X campaign, the UAVSAR instrument was operated in its standard acquisition configuration, operating at an altitude of 12.5 km in quad-polarization mode, transmitting horizontally and vertically polarized radiation on alternate pulses and receiving both co-polarized (HH or VV) and cross-polarized (HV or VH) returns for each pulse.

The Level 1 (L1) UAVSAR single look complex (SLC) VV-polarization co-registered stack products (Jones et al., 2021) were used as the underlying data for these L1B products (Table 2). These L1B products are not georeferenced; the spatial coverage of all flight lines is shown in Figure 2.

Table 1. Summary of all UAVSAR flight lines, number of acquisitions and interferograms produced from the data collected during the 2021 Delta-X deployments. Detailed information about these flights is available from https://uavsar.jpl.nasa.gov/ by searching on the flight line name.

UAVSAR flight line	Date	Number of acquisitions	Interferograms produced
atchaf_06309	2021-03-27	8	18
	2021-04-01	7	15
	2021-04-02	9	21
	2021-09-05	9	21
	2021-09-13	2	1
atchaf_19809	2021-03-23	9	21
	2021-04-01	9	21
	2021-04-02	9	21
	2021-09-05	9	21
	2021-09-13	4	6

wterre_16300	2021-04-05	8	18
	2021-04-06	7	15
	2021-04-07	7	15
	2021-09-03	6	12
	2021-09-12	7	15
wterre_34202	2021-04-05	8	18
	2021-04-06	6	12
	2021-04-07	8	18
	2021-09-03	7	15
	2021-09-12	8	18
eterre_08705	2021-04-12	8	18
	2021-04-16	6	12
	2021-04-18	7	15
	2021-09-04	8	18
	2021-09-07	8	18
eterre_27309	2021-04-12	7	15
	2021-04-16	7	15
	2021-04-18	7	15
	2021-09-04	8	18
	2021-09-07	7	15

Figure 3. Spatial coverage of each UAVSAR flight line acquired during the 2021 Delta-X deployments. Map shows the Atchafalaya and Terrebone Basins, a portion of the Mississippi River Delta, along the southern coast of Louisiana, USA.

Table 2. Level 1 (L1) co-registered single look complex (SLC) stack products used to generate these L1B products. The L1 SLC's are quad-polarization stacks, and the VV-polarization data was used.

UAVSAR flight line	Baseline L0 SLC Product
atchaf_06309	atchaf_06309_02
	atchaf_06309_03
atchaf_19809	atchaf_19809_02
	atchaf_19809_03
wterre_16300	wterre_16300_02
	wterre_16300_03
wterre_34202	wterre_34202_02
	wterre_34202_03
eterre_08705	eterre_08705_02
	eterre_08705_03
eterre_27309	eterre_27309_01
	eterre_27309_02

The wrapped InSAR interferograms and interferometric coherence products were generated for nearest-neighbor (NN), NN+1, and NN+2 pairs for data acquired within a single flight (one day) for all flight lines. A segment concatenation was performed for flight lines that were divided into segments, forming only one interferogram for the complete flight line. Many standard InSAR processing packages (e.g., ISCE https://github.com/isce-framework/isce2) can be used for generating these products. The unwrapped interferograms were processed using the SNAPHU phase unwrapping software (Chen et al., 2000 and 2001) as described in Oliver-Cabrera et al. (2022).

6. Data Access

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

Delta-X: UAVSAR L1B Interferometric Products, MRD, Louisiana, 2021

Contact for Data Center Access Information:

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

7. References

Chen, C. W., and H. A. Zebker. 2000. Network approaches to two-dimensional phase unwrapping: intractability and two new algorithms. Journal of the Optical Society of America A 17:401. https://doi.org/10.1364/JOSAA.17.000401

Chen, C. W., and H. A. Zebker. 2001. Network approaches to two-dimensional phase unwrapping: intractability and two new algorithms: erratum. Journal of the Optical Society of America A 18:1192. https://doi.org/10.1364/josaa.18.001192

EROS. 2017. Shuttle Radar Topography Mission (SRTM) 1 Arc-Second Global. U.S. Geological Survey, Earth Resources Observation And Science (EROS) Center. https://doi.org/10.5066/F7PR7TFT

Hensley, S., H. Zebker, C. Jones, T. Michel, R. Muellerschoen, and B. Chapman. 2009. First deformation results using the NASA/JPL UAVSAR instrument. 2009 2nd Asian-Pacific Conference on Synthetic Aperture Radar. https://doi.org/10.1109/APSAR.2009.5374246

Jensen, D., K.C. Cavanaugh, M. Simard, G.S. Okin, E. Castañeda-Moya, A. McCall, and R. R. Twilley. 2019. Integrating imaging spectrometer and synthetic aperture radar data for estimating wetland vegetation aboveground biomass in coastal Louisiana. Remote Sensing 11:2533. https://doi.org/10.3390/rs11212533

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Jones, C., T. Oliver-Cabrera, M. Simard, and Y. Lou. 2022a. Delta-X: UAVSAR Level 2 Geocoded Interferometric Products, LA, USA, 2021. ORNL DAAC, Oak Ridge, Tennessee, USA. https://doi.org/10.3334/ORNLDAAC/2057

Jones, C., T. Oliver-Cabrera, M. Simard, and Y. Lou. 2022b. Delta-X: UAVSAR Level 3 Geocoded InSAR Derived Water Level Changes, LA,USA, 2021. ORNL DAAC, Oak Ridge, Tennessee, USA. https://doi.org/10.3334/ORNLDAAC/2058

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8. Dataset Revisions

Release Date	Version	Revision Notes

2024-07-19	1.1	Added 48 geometry files to version 1.1 and updated the User Guide. Existing data files were not changed. Dataset version number was kept unchanged.
2022-04-28	1.1	Added data from Fall 2021 acquisitions. Updated User Guide
2022-04-21	1.0	Original release with Spring 2021 data.