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MASTER: Student Airborne Research Program (SARP) campaign, California, USA, 2016

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Documentation Revision Date: 2024-05-09

Dataset Version: 1.2

Summary

This dataset includes Level 1B (L1B) data products from the MODIS/ASTER Airborne Simulator (MASTER) instrument collected and developed by the Student Airborne Research Program (SARP). The spectral data were collected from flights flown on 2016-06-17 in a NASA ER-2 aircraft over Santa Barbara, California. SARP was an eight-week summer program for junior and senior undergraduate students to acquire hands-on research experience in all aspects of a scientific campaign using airborne science laboratories. The SARP 2016 deployment included one flight with 5 flight tracks. The L1B file format is HDF-4, and L2 products are provided in ENVI and KMZ formats. In addition, the dataset includes flight paths, spectral band information, instrument configuration, ancillary notes, and summary information for each flight, and browse images derived from each L1B data file.

The MASTER instrument is a modified Daedalus Wildfire scanning spectrometer that flies on a variety of multi-altitude research aircraft and provides spectral information similar to that provided by the Moderate Resolution Imaging Spectroradiometer (MODIS) and the Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER), which are aboard two NASA Earth Observing System satellites: Terra and Aqua.

This dataset includes a total of 16 data files: 5 files in Hierarchical Data Format (HDF-4; *.hdf) format, 4 text (*.txt) files, 1 archive of text files that are zipped (*.zip), 1 flight map as a GIF (*.gif) image, and 5 browse images in JPEG (*.jpg) format.

ASTER/MODIS Airborne Simulator Browse Imagery
 HyspIRI_2016 Campaign – 17 Jun 2016
 Santa Barbara
 Flight #16-629-00 Track #16

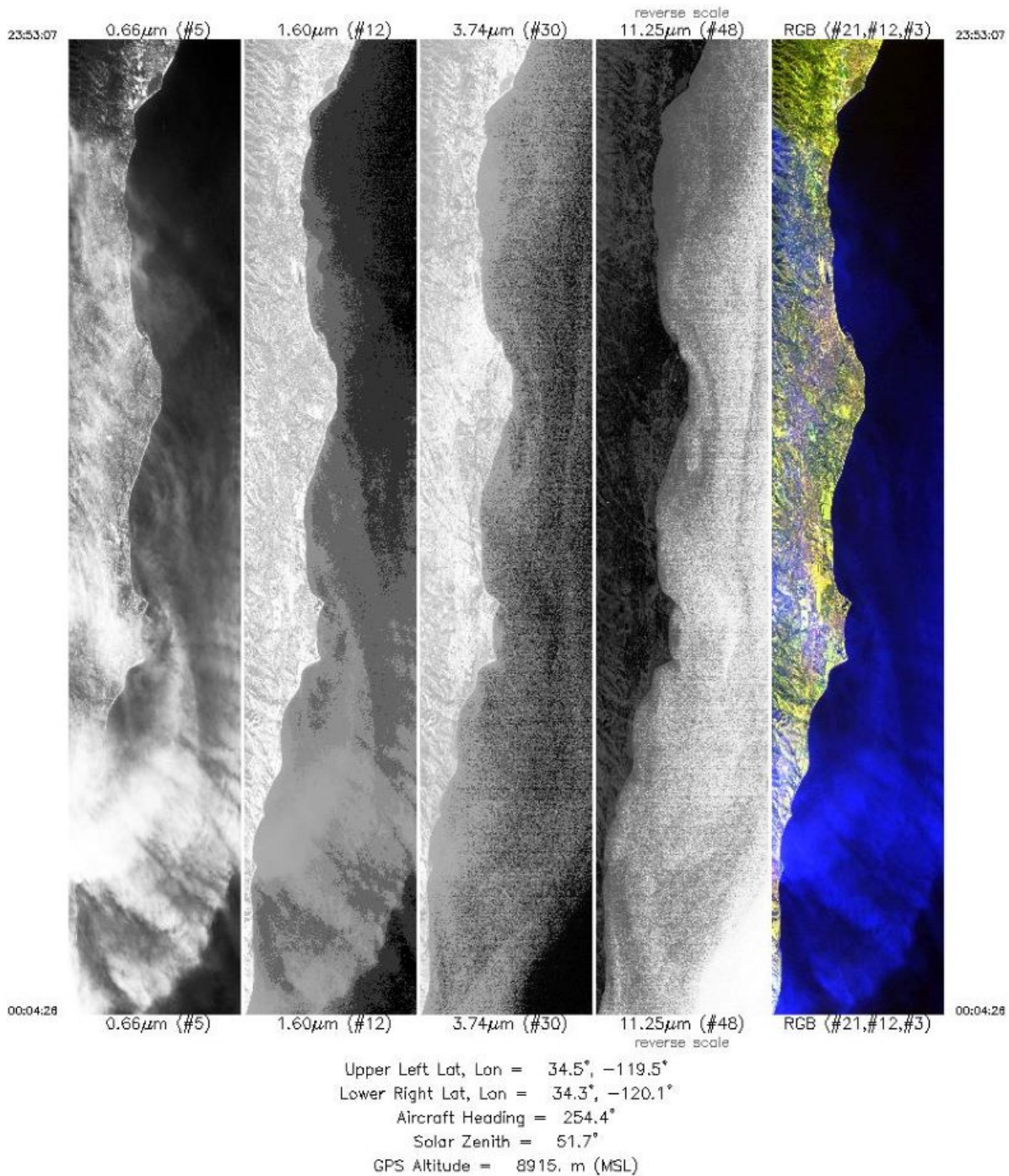


Figure 1. Figure 1. Single-band images and an RGB composite image from flight track 16 as acquired on 17 June 2016 near Santa Barbara, California, U.S. Source: MASTERL1B_1662900_12_20160617_2204_2219_V01.jpg

Citation

Hook, S.J., J.S. Myers, K.J. Thome, M. Fitzgerald, A.B. Kahle, Airborne Sensor Facility NASA Ames Research Center, R.O. Green, and D.A. Roberts. 2021. MASTER: Student Airborne Research Program (SARP) campaign, California, USA, 2016. ORNL DAAC, Oak Ridge, Tennessee, USA. <https://doi.org/10.3334/ORNLDAAC/1912>

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1. Dataset Overview

This dataset includes Level 1B (L1B) data products from the MODIS/ASTER Airborne Simulator (MASTER) instrument collected and developed by the Student Airborne Research Program (SARP). The spectral data were collected from flights flown on 2016-06-17 in a NASA ER-2 aircraft over Santa Barbara, California. SARP was an eight-week summer program for junior and senior undergraduate students to acquire hands-on research experience in all aspects of a scientific campaign using airborne science laboratories. The SARP 2016 deployment included one flight with 5 flight tracks. In addition, the dataset includes flight paths, spectral band information, instrument configuration, ancillary notes, and summary information for each flight, and browse images derived from each L1B data file.

The MASTER instrument is a modified Daedalus Wildfire scanning spectrometer that flies on a variety of multi-altitude research aircraft and provides spectral information similar to that provided by the Moderate Resolution Imaging Spectroradiometer (MODIS) and the Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER), which are aboard two NASA Earth Observing System satellites: Terra and Aqua.

Project: [MODIS/ASTER Airborne Simulator](#)

The MODIS/ASTER Airborne Simulator (MASTER) is a scanning spectrometer which flies on a variety of multi-altitude research aircraft and provides data similar to the Moderate Resolution Imaging Spectroradiometer (MODIS) and the Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER). MASTER first flew in 1998 and has ongoing deployments as a Facility Instrument in the NASA Airborne Science Program (ASP). MASTER is a joint project involving the Airborne Sensor Facility (ASF) at the Ames Research Center, the Jet Propulsion Laboratory (JPL), and the Earth Resources Observation and Science Center (EROS).

Related Publication

Hook, S.J. Myers, J.J., Thome, K.J., Fitzgerald, M. and A.B. Kahle. 2001. The MODIS/ASTER airborne simulator (MASTER) - a new instrument for earth science studies. *Remote Sensing of Environment* 76:93–102. [https://doi.org/10.1016/S0034-4257\(00\)00195-4](https://doi.org/10.1016/S0034-4257(00)00195-4)

Related Dataset

Additional MASTER datasets are available on the ORNL DAAC [MASTER](#) project page.

Acknowledgments

The MASTER instrument is maintained and operated by the Airborne Sensor Facility (ASF) at NASA Ames Research Center in Mountain View, California, under the oversight of the EOS Project Science Office at NASA Goddard. Data processing was conducted at NASA Ames Research Center and the Jet Propulsion Laboratory at the California Institute of Technology in Pasadena, California.

2. Data Characteristics

Spatial Coverage: Vicinity of Santa Barbara, California, U.S.

Spatial Resolution: 19 to 50 m

Temporal Coverage: 2016-06-17

Temporal Resolution: One-time estimate

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

Site	Westernmost Longitude	Easternmost Longitude	Northernmost Latitude	Southernmost Latitude
Santa Barbara, California	-120.882	-118.334	35.846	33.562

Data File Information

This dataset includes a total of 16 data files: 5 files in Hierarchical Data Format (HDF-4; *.hdf) format, 4 text (*.txt) files, 1 archive of text files that are zipped (*.zip), 1 flight map as a GIF (*.gif) image, and 5 browse images in JPEG (*.jpg) format. (Table 1).

There are different numbers of each type of file, which corresponds to the number of "flights" and "flight tracks". A "flight" is flown on a single day, and a "flight track" refers to a segment of a given flight. The number of flight tracks varies among flights and whether L2 data were generated.

- There is one flight: number 1662900 with 5 flight tracks.
- For each of 5 flight tracks, there is one L1B data file in HDF format and one auxiliary browse image (*.jpg).

The primary data files are named MASTERLAA_BBBBBBBB_CC_YYYYMMDD_EEFF_GGHH_V0J-X.ext (e.g., MASTERL1B_1662900_12_20160617_2204_2219_V01.hdf).

The flight track-level browse images are named MASTERLAA_BBBBBBBB_CC_YYYYMMDD_EEFF_GGHH_V0J.jpg (e.g., MASTERL1B_1662900_12_20160617_2204_2219_V01.jpg).

The deployment-level auxiliary files are named MASTER_BBBBBBBB_YYYYMMDD_SARP_X.ext (e.g., MASTER_1662900_20160617_SARP_config.txt).

Elements of file names are described as:

AA = "1B" or "2", indicating L1B or L2, data level,
 BBBBBBBB = "1662900", the flight number,
 CC = flight track,
 YYYYMMDD = date of sampling,
 EEFF = starting time at EE hour and FF minute,
 GGHH = ending time at GG hour and HH minute,
 J = version number for file,
 X = the file content (see Table 1), and
 ext = ".hdf", ".gif", ".jpg", ".txt", or ".zip", indicating the file extension.

Table 1. File names and descriptions. The flight number for all files in this dataset is "1662900".

File Name	Level	File Type	Total Files	Description
Primary Data Files				
MASTERL1B_BBBBBBBB_CC_YYYYmmDD_EEFF_GGHH_V0J.hdf	L1B	HDF-4	5	Multispectral radiance in 50 bands, pixel coordinates, sensor configuration, aircraft platform data, analysis parameters. The "CalibratedData" variable provides estimates of radiance in units of $W\ m^{-2}\ sr^{-1}$ per micron.
Auxiliary Files				
MASTERLAA_BBBBBBBB_CC_YYYYMMDD_EEFF_GGHH_V0J.jpg	L1B	JPEG	5	Browse figures; one per flight track, multiple tracks per flight.
MASTER_1662900_20160617_SARP_ancillary.txt	-	Text	1	Ancillary information about flight including notes on aircraft platform, mission objective, and data evaluation.
MASTER_1662900_20160617_SARP_config.txt	-	Text	1	Instrument configuration information.
MASTER_1662900_20160617_SARP_flightpath.gif	-	GIF	1	Map showing flight paths.
MASTER_1662900_20160617_SARP_spectral_band_info.txt	-	Text	1	Spectral band information for flight.
MASTER_1662900_20160617_SARP_spectral_response_table.zip	-	Text	1	Spectral response tables by band (ZIP archive of 50 text files).
MASTER_1662900_20160617_SARP_summary.txt	-	Text	1	Time and coordinates for start and end of flight tracks along with the number of scan lines, solar and instrument angles, and aircraft altitude. FTLT = flight track number.

Data File Details

The HDF files contain swath trajectory data using longitude, latitude coordinates. The spatial resolution ranges from 19 to 25 m and is a function of aircraft altitude.

3. Application and Derivation

The primary objective of MASTER is to: (a) collect ASTER-like and MODIS-like land datasets to support the validation of the ASTER and MODIS geophysical retrieval algorithms; (b) collect these datasets at a higher resolution than the spaceborne datasets to permit scaling studies and comparisons with in-situ measurements; and (c) under fly the EOS-AM1 ASTER and MODIS sensors to provide an additional radiometric calibration to assist with in-flight instrument performance characterization. Calibration is particularly important for ASTER where on-board calibration is dependent on a single black body in the TIR and only partial aperture illumination in the VNIR.

A secondary objective of MASTER is to: (a) provide both a backup instrument and backup modules for the current MODIS Airborne simulator, which is committed to a program of atmospheric and oceanic measurements; and (b) provide a wider spectral and dynamic range alternative to the use of the Thematic Mapper (TM) airborne simulator and Thermal Infrared Multispectral Scanner (TIMS) airborne scanners (JPL, 2021b).

MASTER imagery has been used for mapping wildfires and their impacts (Veraverbeke et al., 2011), land covers (Li and Moon, 2004), coral reefs (Capolsini et al., 2003), and urban heat islands (Zhao and Wentz, 2016).

4. Quality Assessment

The MASTER instrument channels are calibrated spectrally and radiometrically in the laboratory preflight and postflight. The mid-infrared and thermal infrared channels (26–50) are also radiometrically calibrated in-flight by viewing an internal hot and cold blackbody with each scanline (Hook et al., 2001). Three calibration and validation experiments were conducted in 1998–2001 (Hook et al., 2001; JPL, 2021a). Spectral response information for this deployment is included in the files named MASTER_1662900_20160617_spectral_response_table.zip.

5. Data Acquisition, Materials, and Methods

The MASTER instrument was developed by the NASA Ames Research Center in conjunction with the Jet Propulsion Laboratory. The instrument consists of three key components: the scanning spectrometer, the digitizer, and the storage system. The scanning unit was built by Sensys Technology (formerly Daedalus Enterprises) and the digitizer was a collaborative effort between Berkeley Camera Engineering and the Ames Airborne Sensor Facility (ASF). The data storage system and overall system integration were also provided by the ASF.

The MASTER instrument is similar to the MODIS Airborne Simulator (MAS) developed by the MODIS project (King et al., 1996). However, it has two key differences. First, MASTER supports a variety of scan speeds allowing it to acquire contiguous imagery from a variety of altitudes with different pixel sizes. Second, the channel positions are configured to closely match those of ASTER and MODIS. A detailed description of the instrument and optical system are provided by Hook et al. (2001) and King et al. (1996), respectively.

NASA's Student Airborne Research Program (SARP) is an eight-week summer internship program for rising senior undergraduate students to acquire hands-on research experience in all aspects of a scientific campaign using one or more NASA Airborne Science Program flying science laboratories (aircraft used for SARP have included the DC-8, P-3B, C-23, UC-12B, and ER-2).

For this deployment, the MASTER instrument was flown on NASA's ER-2 aircraft at altitudes of 19,130–20,300 m above sea level. The study area

included a portion of southern California between Bakersfield south and west to Santa Barbara and the Pacific Ocean (Fig. 2).

The L2 data are derived from the L1B files, and the primary L2 products are emissivity in five bands (wavelengths: 8.58, 9.02, 10.62, 11.32, and 12.13 μm) and land surface temperature (LST). Emissivity and LST were corrected using a Temperature and Emissivity Separation (TES) algorithm (Coll et al., 2001).

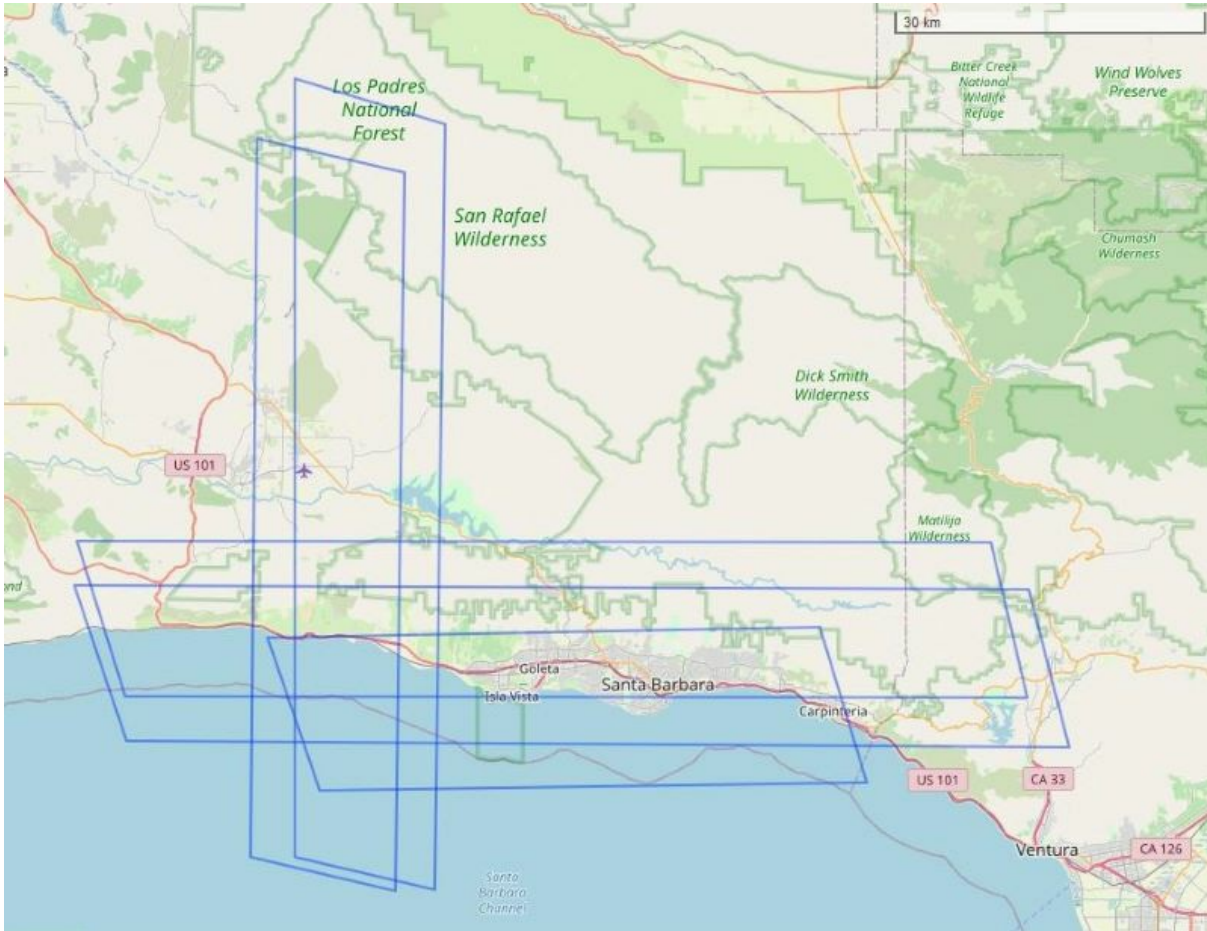


Figure 2. Flight tracks in this dataset represented as blue rectangular polygons. Map shows coast of southern California, U.S., in vicinity of Santa Barbara. Basemap: © OpenStreetMap contributors.

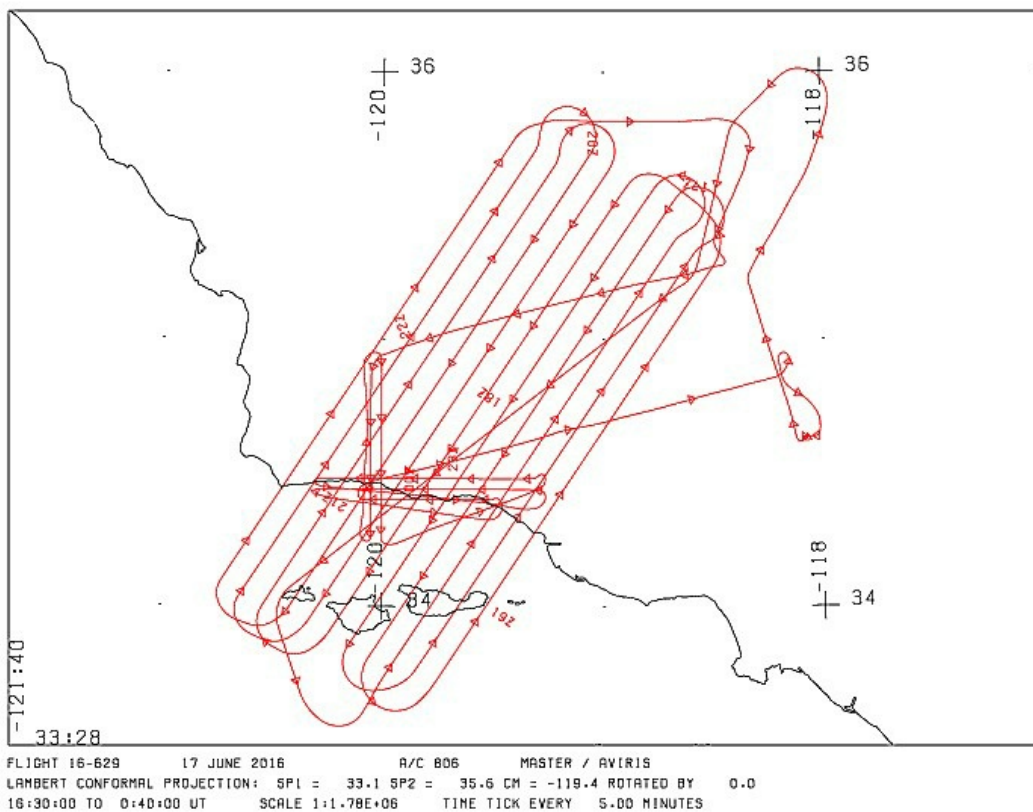


Figure 3. Flight path is shown for June 17, 2016. Flight 1662900 with 16 flight tracks. Source: MASTER_1662900_20160617_flightpath.gif

6. Data Access

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

[MASTER: Student Airborne Research Program \(SARP\) campaign, California, USA, 2016](#)

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	Release Date	Revision Notes
1.2	2024-05-09	Ancillary file names were updated to include the "SARP" label. Content of files was not changed.
1.2	2023-01-26	Flight 162900 included 16 flight lines but only lines 12-16 were for the SARP program and are included herein; the content of those files is unchanged. Data for flight lines 1-11 have been moved to the MASTER: HyspIRI Airborne Campaign, California and Nevada, Summer 2016 dataset.
1.1	2022-06-22	Companion files from the prior release were moved into data. The title was revised, and the User Guide was updated. Content of primary data files is unchanged.
1.0	2021-07-21	Original release under title "MASTER (MODIS-ASTER) Airborne Simulator Campaign, California and Nevada, USA, 2016"



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