MASTER: Jornada Experiment-Airborne Science, Southwest US, October 2008

Get Data

Documentation Revision Date: 2023-04-11

Dataset Version: 1

Summary

This dataset includes Level 1B (L1B) data products from the MODIS/ASTER Airborne Simulator (MASTER) instrument. The spectral data were collected as part of the Hyperspectral Infrared Imager (HyspIRI) mission's preparatory airborne campaign during four flights aboard a DOE B-200 and a NASA ER-2 aircraft over California and New Mexico, U.S., 2008-10-20 to 2008-10-29. A focus of this data collection was the USDA Jornada Experimental Range (Jornada) in southern New Mexico. To complement the programs of ground measurements, JORNEX (JORNada EXperiment) began in 1995 to collect remotely sensed data from aircraft and satellite platforms to provide spatial and temporal data on physical and biological states of the Jornada rangeland. JORNEX uses remote sensing techniques to study arid rangeland and the responses of vegetation to changing hydrologic fluxes and atmospheric driving forces. This deployment was coordinated by NASA's Dryden Flight Research Center (DRFC), renamed Armstrong Flight Research Center in 2014, located in Edwards, California, and the U.S. Department of Energy's Remote Sensing Laboratory (RSL) located at Nellis Air Force Base near Las Vegas, Nevada. Data products include L1B georeferenced multispectral imagery of calibrated radiance in 50 bands covering wavelengths of 0.460 to 12.879 micrometers at approximately 30-meter spatial resolution. The L1B file format is HDF-4. 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. MASTER provides data in 50 channels spanning visible to thermal infrared wavelengths (0.4 – 13 µm). Its data have been used to study geological patterns, land covers, ecological disturbances, and other phenomena that affect Earth surface properties.

This dataset includes a total of 60 data files: 21 files in Hierarchical Data Format (HDF-4; *.hdf) format, 12 text (*.txt) files, 3 archives of text files that are zipped (*.zip), 3 flight maps as GIF (*.gif) images, and 21 browse images in JPEG (*.jpg) format.

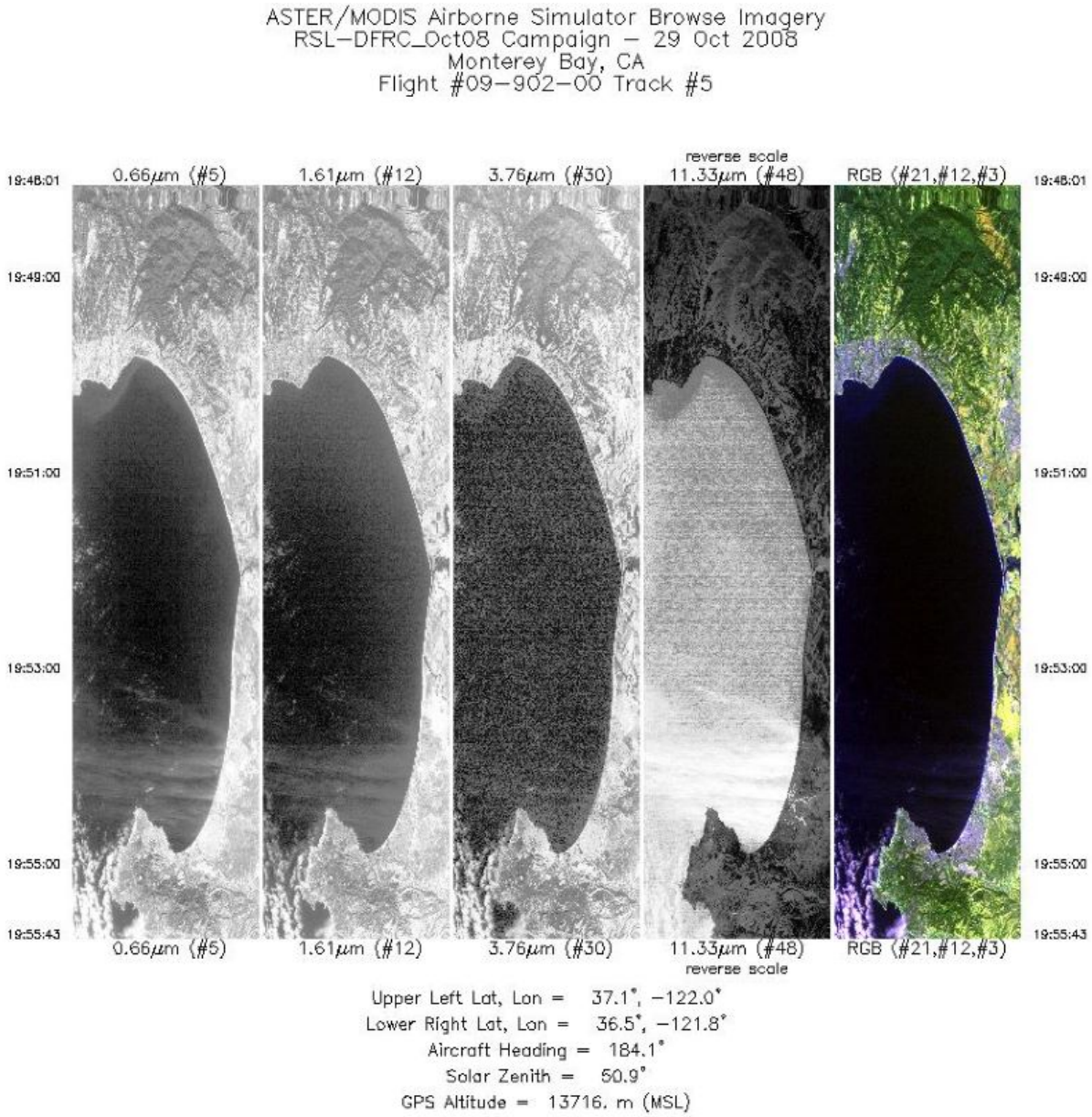

Figure 1. Single-band images and a RGB composite image from flight track 5 as acquired on 29 October 2008 over Monterey Bay, California, U.S. Source: MASTERL1B_0990200_05_20081029_1948_1955_V01.jpg

Citation

Hook, S.J., J.S. Myers, K.J. Thome, M. Fitzgerald, A.B. Kahle, Airborne Sensor Facility NASA Ames Research Center, A.N. French, and J.P. Ryan. 2022. MASTER: Jornada Experiment-Airborne Science, Southwest US, October 2008. ORNL DAAC, Oak Ridge, Tennessee, USA. https://doi.org/10.3334/ORNLDAAC/2014

Table of Contents

1. Dataset Overview

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Data products include L1B georeferenced multispectral imagery of calibrated radiance in 50 bands covering wavelengths of 0.460 to 12.879 micrometers at approximately 30-meter spatial resolution. The L1B file format is HDF-4. 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. MASTER provides data in 50 channels spanning visible to thermal infrared wavelengths (0.4 – 13 µm). Its data have been used to study geological patterns, land covers, ecological disturbances, and other phenomena that affect Earth surface properties.

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

Related Datasets

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: Portions of California and New Mexico, U.S.

Spatial Resolution: 5 to 50 m

Temporal Coverage: 2008-10-20 to 2008-10-29

Temporal Resolution: One-time estimate

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

Site	Westernmost Longitude	Easternmost Longitude	Northernmost Latitude	Southernmost Latitude
California and New Mexico, U.S.	-122.337	-106.582	37.720	32.450

Data File Information

This dataset includes a total of 60 data files: 21 files in Hierarchical Data Format (HDF-4; *.hdf) format, 12 text (*.txt) files, 3 archives of text files that are zipped (*.zip), 3 flight maps as GIF (*.gif) images, and 21 browse images in JPEG (*.jpg) format.

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" typically refers to a segment of a given flight. The number of flight tracks varies among flights (Table 2).

- There are three flights with 21 flight tracks (Table 2).
- For each of 21 flight tracks, there is one L1B data file in HDF format and one auxiliary browse image (*.jpg).
- For each flight, there is a collection of auxiliary files providing information about the flight and instrument configuration.

The primary data files are named MASTERL **AA_BBBBBBBB_CC_YYYYMMDD_EEFF_GGHH**_V0**J**-**X**.**ext** (e.g., "MASTERL1B_0900101_01_20081020_2019_2024_V01.hdf).

The flight track-level browse images are named MASTERL **AA_BBBBBBBB_CC_YYYYMMDD_EEFF_GGHH**_V0**J**.jpg (e.g., "MASTERL1B_0900101_01_20081020_2019_2024_V01.jpg).

The deployment-level auxiliary files are named MASTER_**BBBBBBBB_YYYYMMDD_X**.**ext** (e.g., MASTER_0900101_20081020_config.txt).

- AA = "1B",indicating L1B data level,
- BBBBBBBB = flight number (Table 2),
- CC = flight track (Table 2),
- 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.

File Name	Level	File Type	Total Files	Description
Primary Data Files				

File Name	Level	File Type	Total Files	Description
MASTERL1B_*BBBBBBBB_CC_YYYYmmDD_EEFF_GGHH*_V0*J*.hdf	L1B	HDF-4	21	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*_V0*J*.jpg	L1B	JPEG	21	Browse figures; one per flight track, multiple tracks per flight.
MASTER_*BBBBBBBB_YYYYMMDD*_ancillary.txt	-	Text	3	Ancillary information about flight including notes on aircraft platform, mission objective, and data evaluation.
MASTER_*BBBBBBBB_YYYYMMDD*_config.txt	-	Text	3	Instrument configuration information for flight.
MASTER_*BBBBBBBB_YYYYMMDD*_flightpath.gif	-	GIF	3	Map showing flight paths.
MASTER_*BBBBBBBB_YYYYMMDD*_spectral_band_info.txt	-	Text	3	Spectral band information.
MASTER_*BBBBBBBB_YYYYMMDD*_spectral_response_table.zip	-	Text	3	Spectral response tables by band (ZIP archive of 50 text files).
MASTER_*BBBBBBBB_YYYYMMDD*_summary.txt	-	Text	3	Time and coordinates for start and end of flight tracks along with the number of scan lines, solar and instrument angles, aircraft altitude, and additional information. FTLT = flight track number.

Data File Details

The HDF-4 files contain swath trajectory data using longitude, latitude coordinates. The spatial resolution ranges from 5 m to 50 m and is a function of aircraft altitude.

Table 2. Number of flight tracks for each MASTER flight during this 2008 deployment over California (CA) and New Mexico (NM).

Date	Flight Number	Locations (USA)	Platform	Flight Tracks
2008-10-20	0900101	San Francisco Bay, CA	DOE B-200	2
2008-10-22	0900102	Sevilleta, NM	DOE B-200	11
2008-10-29	0990200	Lake Isabella, CA	NASA ER-2	8
			Total	21

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).

A focus of the data collection on 2008-10-22 was the USDA Jornada Experimental Range (Jornada) in southern New Mexico. To complement the programs of ground measurements, JORNEX (JORNada EXperiment) began in 1995 to collect remotely sensed data from aircraft and satellite platforms to provide spatial and temporal data on physical and biological states of the Jornada rangeland. JORNEX uses remote sensing techniques to study arid rangeland and the responses of vegetation to changing hydrologic fluxes and atmospheric driving forces.

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 MASTER_BBBBBBBB_YYYYMMDD_spectral_response_table.zip files.

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.

For this deployment, the MASTER instrument was flown on DOE B-200 and NASA ER-2 aircraft (Table 2) at altitudes of 1980 m to 6600 m (DOE B-200) and approximately 13,700 m (NASA ER-2) above sea level.

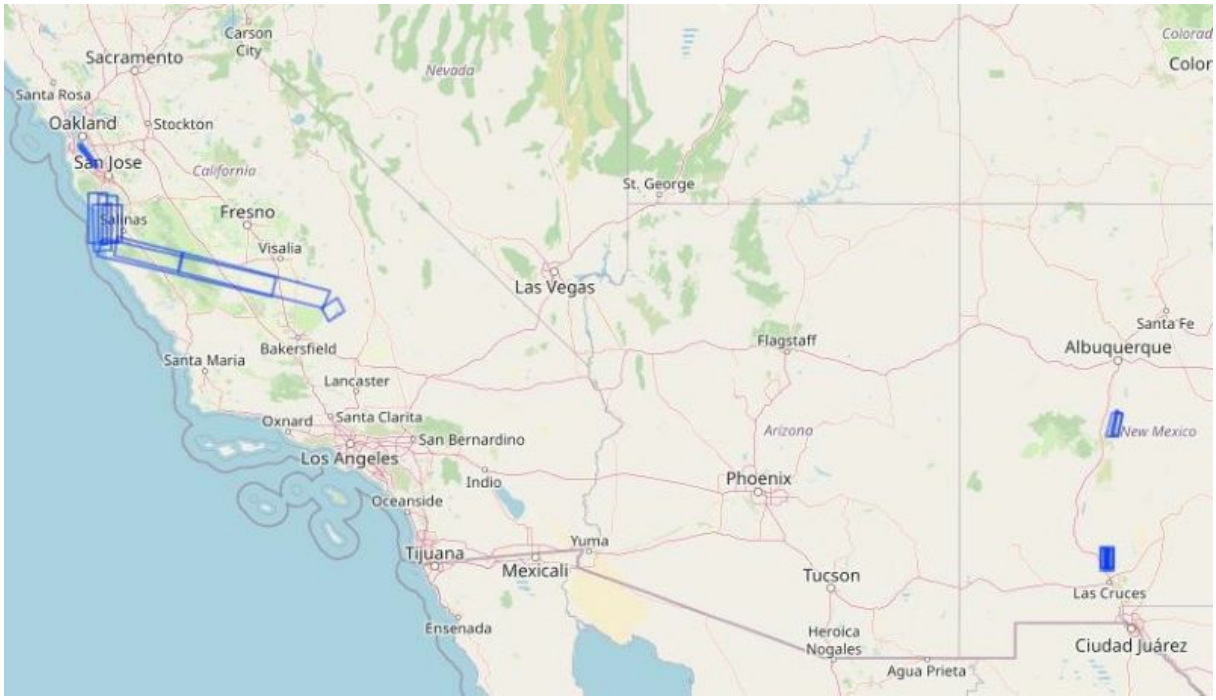

Figure 2. Flight tracks in this dataset represented as blue rectangular polygons. Basemap: © OpenStreetMap contributors.

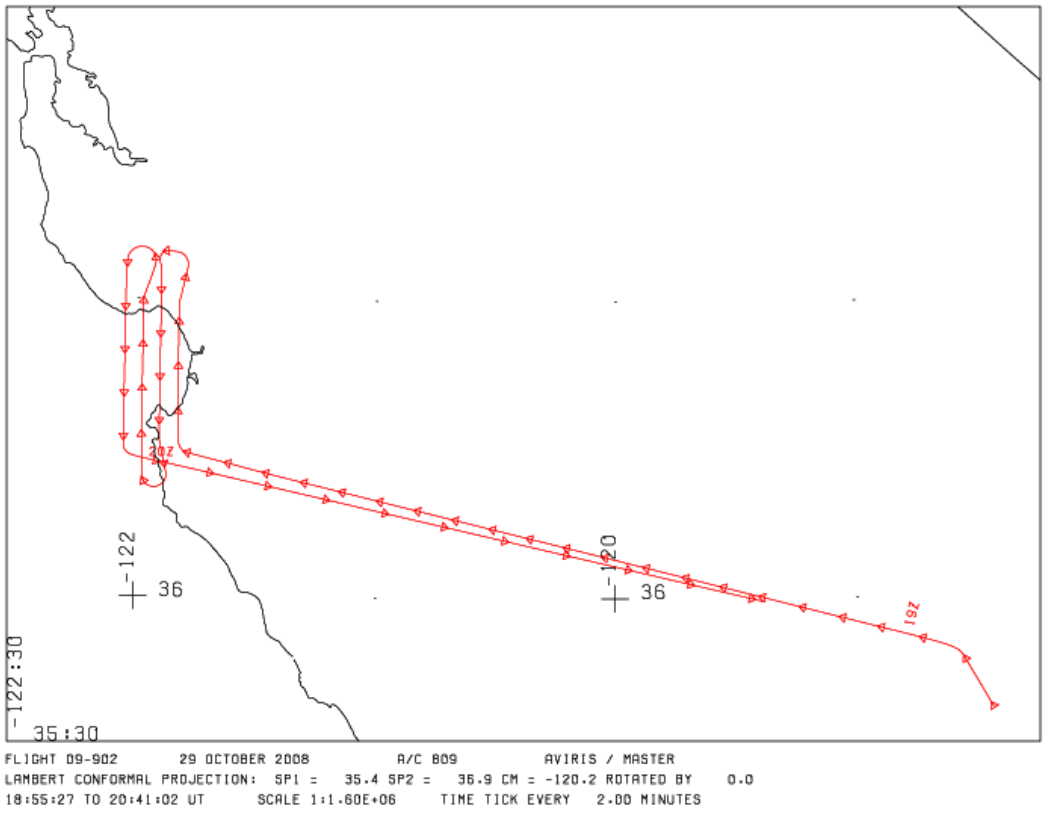

Figure 3. Typical flight path is shown for August 26, 2018. Flight 0800509 and 13 flight tracks. Source: MASTER_0800509_20080826_flightpath.gif

6. Data Access

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

MASTER: Jornada Experiment-Airborne Science, Southwest US, October 2008

Contact for Data Center Access Information:

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

7. References

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