MASTER: Student Airborne Research Program (SARP) Campaign, California, 2009

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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 2009-07-22 to 2009-07-24 over southern California, U.S., in a NASA DC-8 aircraft. 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 2009 deployment included two flights with 11 flight tracks. Data products include L1B georeferenced multispectral imagery of calibrated radiance in 50 bands covering wavelengths of 0.460 to 12.879 micrometers at approximately 20-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.

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 30 data files: 11 files in Hierarchical Data Format (HDF-4; *.hdf) format, 7 files in Keyhole Markup Language Zipped (KMZ; *.kmz) format, 8 text (*.txt) files, 2 archives of text files that are zipped (*.zip), and 2 flight maps as GIF (*.gif) images.

Figure 1. RGB composite image from data collected over Pyramid Lake, California, U.S. on 2009-07-24. Image derived from bands 12, 10, 9 spanning visible to near-infrared wavelengths. Source: MASTERL1B_0901100_05_20090724_2125_2126_V01.hdf

Citation

Hook, S.J., J.S. Myers, K.J. Thome, M. Fitzgerald, A.B. Kahle, Airborne Sensor Facility NASA Ames Research Center, S.L. Ustin, and J.P. Ryan. 2022. MASTER: Student Airborne Research Program (SARP) Campaign, California, 2009. ORNL DAAC, Oak Ridge, Tennessee, USA. https://doi.org/10.3334/ORNLDAAC/1990

Table of Contents

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 2009-07-22 to 2009-07-24 over southern California, U.S., in a NASA DC-8 aircraft. 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 2009 deployment included two flights with 11 flight tracks. Data products include L1B georeferenced multispectral imagery of calibrated radiance in 50 bands covering wavelengths of 0.460 to 12.879 micrometers at approximately 20-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.

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., J.J. Myers, K.J. Thome, M. Fitzgerald, 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: southern California, U.S.

Spatial Resolution: 9 to 28 m

Temporal Coverage: 2009-07-22 to 2009-07-24

Temporal Resolution: One-time estimate

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

Site	Westernmost Longitude	Easternmost Longitude	Northernmost Latitude	Southernmost Latitude
southern California	-122.454	-118.476	37.719	34.597

Data File Information

This dataset includes a total of 30 data files: 11 files in Hierarchical Data Format (HDF-4; *.hdf) format, 7 files in Keyhole Markup Language Zipped (KMZ; *.kmz) format, 8 text (*.txt) files, 2 archives of text files that are zipped (*.zip), and 2 flight maps as GIF (*.gif) images (Table 1).

There are different numbers of each type of file, which corresponds to the number of "flights" and "flight tracks". A “flight” is a deployment 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 (Table 2).

- There are 2 flights with 11 flight tracks (Table 2).
- For each of 11 flight tracks, there is one L1B data file in HDF format.
- There are KMZ files for 7 of the 11 flight tracks.
- 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_0901000_01_20090722_2142_2148_V01.hdf).

The deployment-level auxiliary files are named MASTER_**BBBBBBBB_YYYYMMDD_X**.**ext** (e.g., MASTER_0901000_20090722_config.txt).

Elements of file names are described as:

AA = ”1B”, indicating L1B data,
BBBBBBBB = the flight number (see Table 2),
CC = flight track (see 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", "kmz", "gif", "txt", or "zip", indicating the file extension.

Table 1. File names and descriptions.

File Name	Level	File Type	Total Files	Description
Primary Data Files				
MASTERL1B_*BBBBBBBB_CC_YYYYmmDD_EEFF_GGHH*_V0J.hdf	L1B	HDF-4	11	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.
MASTERL1B_*BBBBBBBB_CC_YYYYmmDD_EEFF_GGHH*V0J-RGB.kmz	L1B	KMZ	7	RGB composite browse image (in KMZ format) derived from corresponding bands of RGB wavelengths of L1B data.
Auxiliary Files				
MASTER_*BBBBBBBB_YYYYMMDD*_ancillary.txt	-	Text	2	Ancillary information about flight including notes on aircraft platform, mission objective, and data evaluation.
MASTER_*BBBBBBBB_YYYYMMDD*_config.txt	-	Text	2	Instrument configuration information for flight.
MASTER_*BBBBBBBB_YYYYMMDD*_flightpath.gif	-	GIF	2	Map showing flight paths.
MASTER_*BBBBBBBB_YYYYMMDD*_spectral_band_info.txt	-	Text	2	Spectral band information.
MASTER_*BBBBBBBB_YYYYMMDD*_spectral_response_table.zip	-	Text	2	Spectral response tables by band (ZIP archive of 50 text files).
MASTER_*BBBBBBBB_YYYYMMDD*_summary.txt	-	Text	2	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 and latitude coordinates. The spatial resolution ranges from 9 m to 28 m and is a function of aircraft altitude.

Table 2. Number of flight tracks for each MASTER flight during this 2009 campaign over southern California.

Date	Flight Number	Locations (U.S.)	Flight Tracks
2009-07-22	0901000	Central Valley / Monterey Bay, CA	6
2009-07-24	0901100	Central Valley / Pyramid Lake, CA	5
		Total	11

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 cover (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_*BBBBBBBB_YYYYMMDD*_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, 2021). 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 a NASA DC-8 aircraft at altitudes of 3425–11,217 m above sea level. The study area included portions of southern California (Fig. 2, 3).

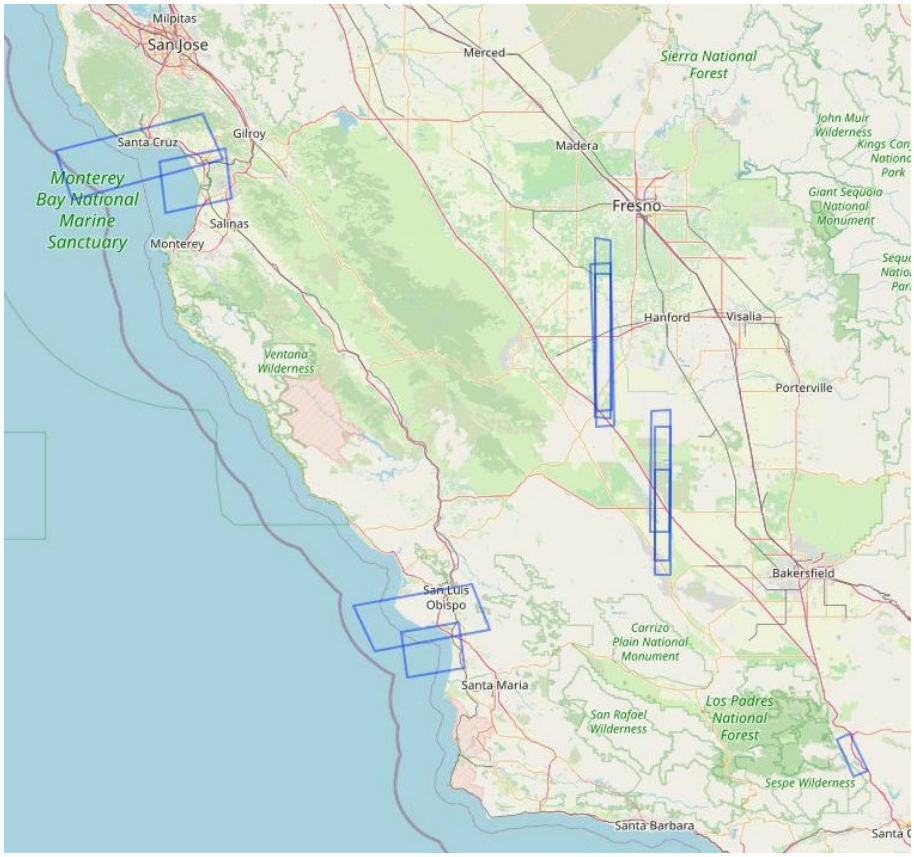

Figure 2. Flight tracks in this dataset represented as rectangular polygons. Map shows a portion of southern California, U.S. Basemap: © OpenStreetMap contributors.

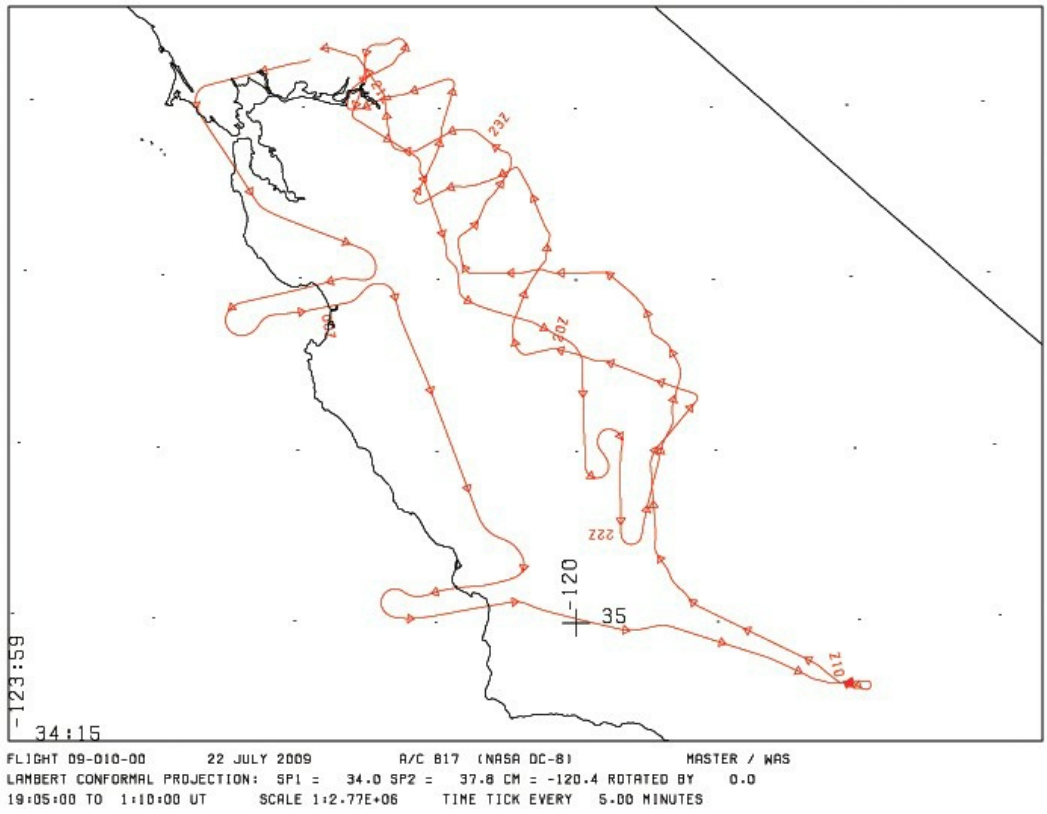

Figure 3. Flight path for Flight 0901000, flown on 22 July 2009. Flight 0901000 and 6 flight tracks occurred over southern California, U.S. Source:

MASTER_0901000_20090722_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, 2009

Contact for Data Center Access Information:

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

7. References

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