MASTER: Airborne Science, Western US, September 2004

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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 during 11 flights aboard a Cessna Caravan aircraft over California, Oregon, Washington, and Colorado, U.S., from 2004-09-15 to 2004-10-14. A focus of this deployment involved mapping volcanic landforms. Data products include L1B georeferenced multispectral imagery of calibrated radiance in 50 bands covering wavelengths of 0.460 to 12.879 micrometers at approximately 10-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. The primary goal of this airborne campaign was to demonstrate important science and applications research that is uniquely enabled by HyspIRI-like data, taking advantage of the full suite of MASTER thermal infrared bands as well as the contiguous spectroscopic measurements of the AVIRIS (also flown in the HyspIRI campaign), or combinations of measurements from both instruments.

This dataset includes a total of 218 data files: 76 files in Hierarchical Data Format (HDF-4; *.hdf) format, 44 text (*.txt) files, 11 archives of text files that are zipped (*.zip), 11 flight maps as GIF (*.gif) images, and 76 browse images in JPEG (*.jpg) format.

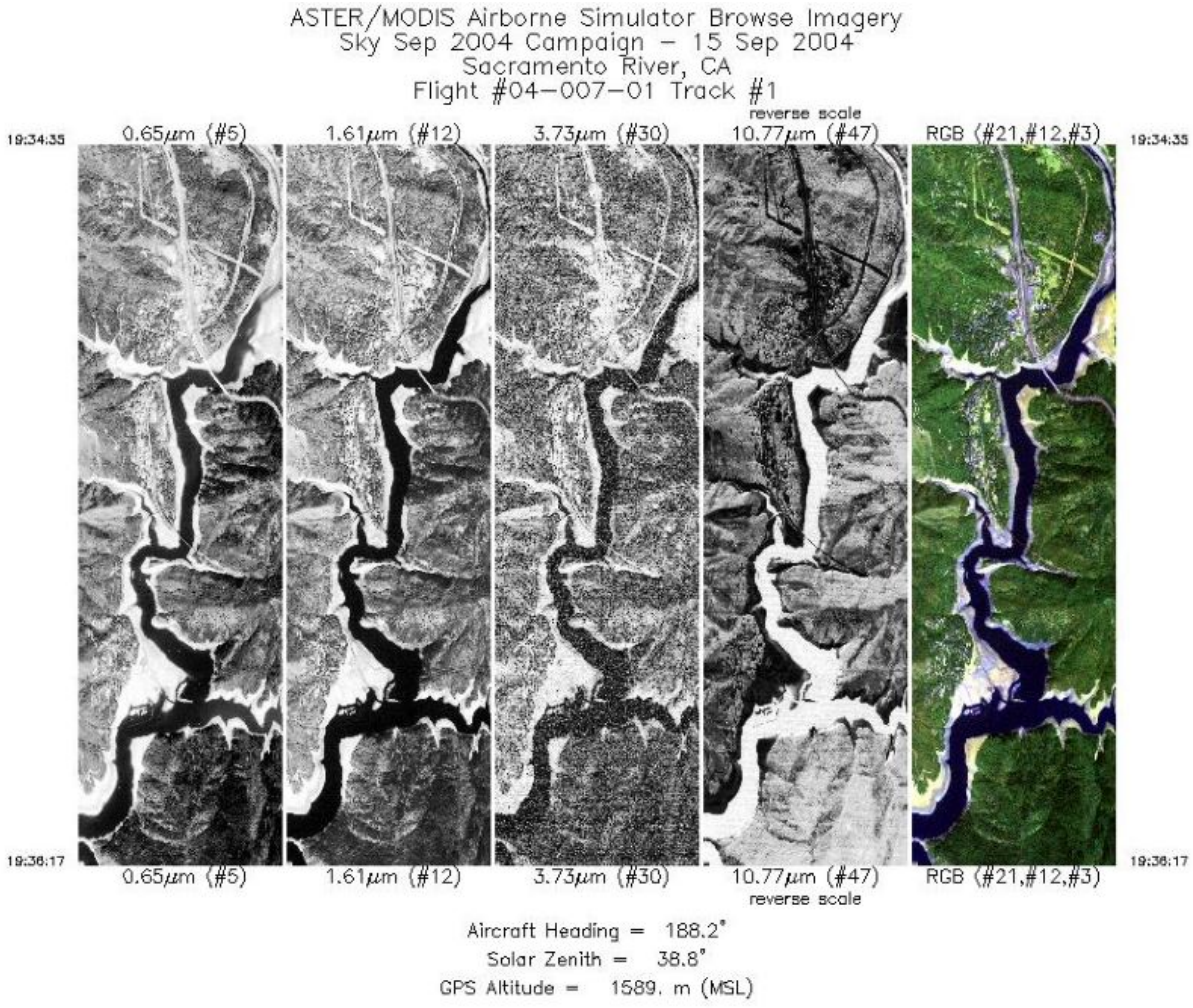

Figure 1. Single-band images and a RGB composite image from flight track 1 acquired on 15 September 2004 over Sacramento River, California, U.S. Source: MASTERL1B_0400701_01_20040915_1934_1936_V01.jpg

Citation

Hook, S.J., J.S. Myers, K.J. Thome, M. Fitzgerald, A.B. Kahle, Airborne Sensor Facility NASA Ames Research Center, E.A. Abbott, A. Gillespie, and J.E. Robinson. 2022. MASTER: Airborne Science, Western US, September 2004. ORNL DAAC, Oak Ridge, Tennessee, USA. https://doi.org/10.3334/ORNLDAAC/2035

Table of Contents

1. Dataset Overview

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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. The primary goal of this airborne campaign was to demonstrate important science and applications research that is uniquely enabled by HyspIRI-like data, taking advantage of the full suite of MASTER thermal infrared bands as well as the contiguous spectroscopic measurements of the AVIRIS (also flown in the HyspIRI campaign), or combinations of measurements from both instruments.

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, Washington, Oregon and Colorado, U.S.

Spatial Resolution: 4 to 11 m

Temporal Coverage: 2004-09-15 to 2004-10-14

Temporal Resolution: One-time estimate

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

Sites	Westernmost Longitude	Easternmost Longitude	Northernmost Latitude	Southernmost Latitude
Washington	-122.2671	-122.1171	46.3328	46.1024
Oregon	-122.7249	-122.5993	42.2362	42.1505
California	-123.7796	-122.2985	41.7082	40.7026
Colorado	-103.7490	-103.6124	37.7025	37.6601

Data File Information

This dataset includes a total of 218 data files: 76 files in Hierarchical Data Format (HDF-4; *.hdf) format, 44 text (*.txt) files, 11 archives of text files that are zipped (*.zip), 11 flight maps as GIF (*.gif) images, and 76 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 11 flights, including 76 flight tracks (Table 2).
- For each of 76 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_0400701_01_20040915_1934_1936_V01..hdf).

The flight track-level browse images are named MASTERL**AA_BBBBBBBB_CC_YYYYMMDD_EEFF_GGHH**_V0**J**.jpg (e.g., MASTERL1B_0400701_01_20040915_1934_1936_V01..jpg).

The deployment-level auxiliary files are named MASTER_**BBBBBBBB_YYYYMMDD_X**.**ext** (e.g., MASTER_0400701_20040915_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				
MASTERL1B_*BBBBBBBB_CC_YYYYmmDD_EEFF_GGHH*_V0*J*.hdf	L1B	HDF-4	76	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				

File Name	Level	File Type	Total Files	Description
MASTERLAA_*BBBBBBBB_CC_YYYYMMDD_EEFF_GGHH*_V0J.jpg	L1B	JPEG	76	Browse figures; one per flight track, multiple tracks per flight.
MASTER_*BBBBBBBB_YYYYMMDD*_ancillary.txt	-	Text	11	Ancillary information about flight including notes on aircraft platform, mission objective, and data evaluation.
MASTER_*BBBBBBBB_YYYYMMDD*_config.txt	-	Text	11	Instrument configuration information for flight.
MASTER_*BBBBBBBB_YYYYMMDD*_flightpath.gif	-	GIF	11	Map showing flight paths.
MASTER_*BBBBBBBB_YYYYMMDD*_spectral_band_info.txt	-	Text	11	Spectral band information.
MASTER_*BBBBBBBB_YYYYMMDD*_spectral_response_table.zip	-	Text	11	Spectral response tables by band (ZIP archive of 50 text files).
MASTER_*BBBBBBBB_YYYYMMDD*_summary.txt	-	Text	11	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 4 m to 11 m and is a function of aircraft altitude.

The file *MASTER_0500103_20041014_config.txt* includes two sets of instrument configuration information: Set A pertains to flight tracks 01 to 03, and set B is for flight tracks 04 to 06. These sets differ in calibration parameters for channels 20-21 and 40-41.

Table 2. Number of flight tracks for each MASTER flight during this 2004 deployment over portions of California (CA), Colorado (CO), Oregon (OR), and Washington (WA), U.S.

Date	Flight Number	Locations (USA)	Flight Tracks
2004-09-15	0400701	Sacramento River, CA	5
2004-09-23	0400702	La Junta, CO	3
2004-09-24	0400703	Mount St. Helens, WA	4
2004-09-25	0400704	Ashland, OR	23
2004-09-25	0400705	Ashland, OR	17
2004-09-28	0400706	Bluff Creek, CA	2
2004-09-28	0400707	Bluff Creek, CA	2
2004-09-30	0400708	Mount St. Helens, WA	5
2004-10-12	0500101	Mount St. Helens, WA	5
2004-10-14	0500102	Mount St. Helens, WA	4
2004-10-14	0500103	Mount St. Helens, WA	6
		Total	76

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).

A focus of this deployment included mapping volcanic land forms.

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 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 Cessna Caravan (Sky Research) aircraft at altitude of 1570 to 2009 m above sea level.

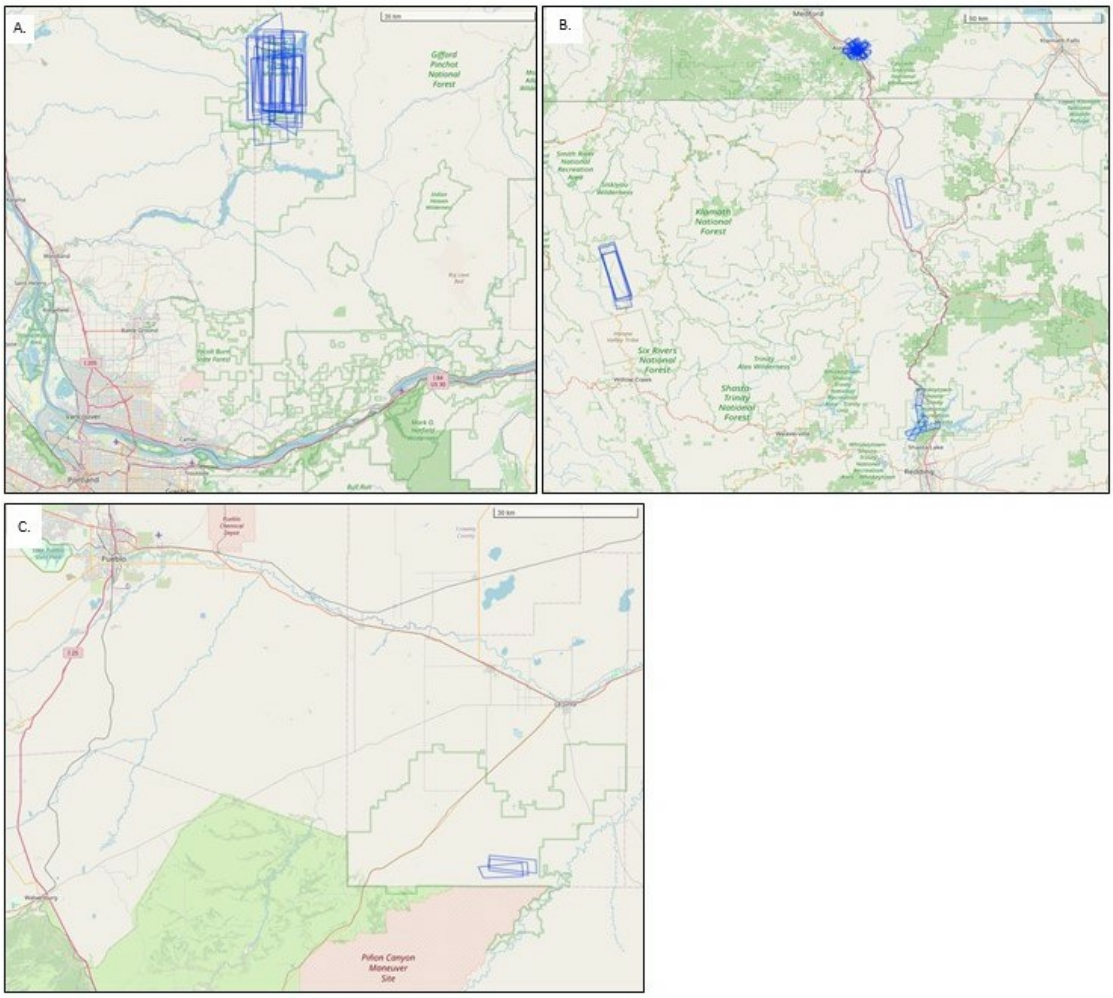

Figure 2. Flight tracks in this dataset shown as blue rectangles (A) over Mount St. Helens, Washington, north of Portland, Oregon; (B) in southern Oregon and northern California north of Redding, California; and (C) southeast of Pueblo, Colorado, U.S. Basemap: © OpenStreetMap contributors.

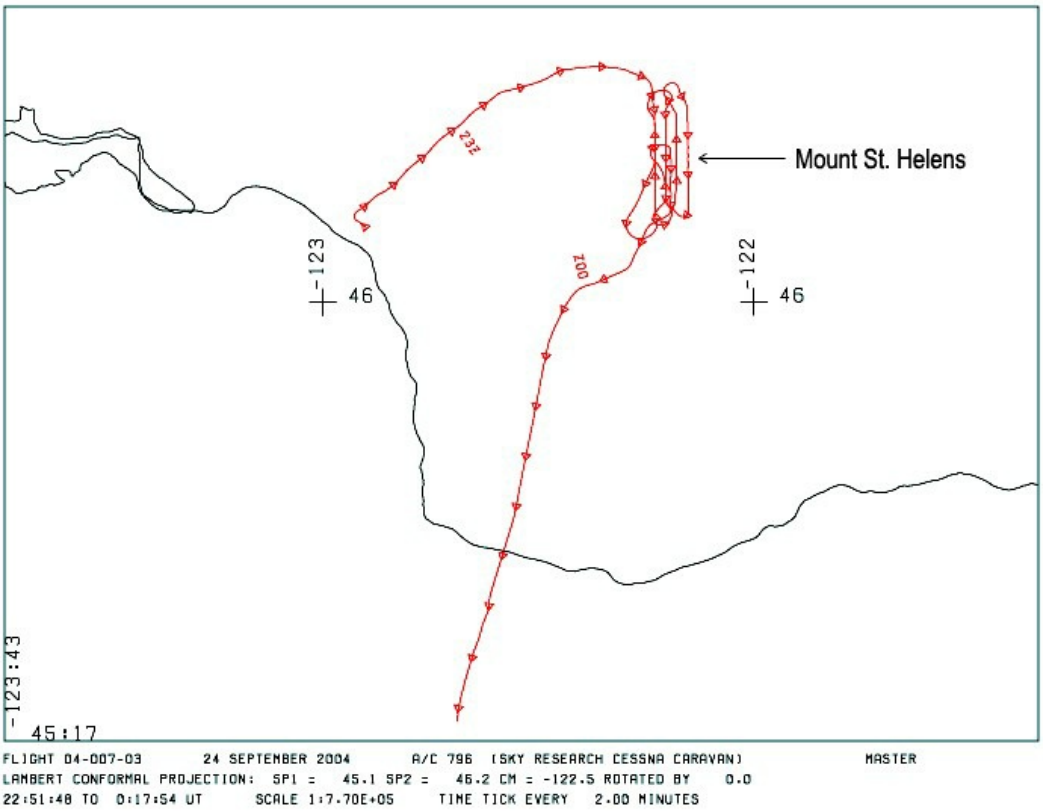

Figure 3. Flight path is shown for 24 September 2004. Flight 0400703 and 4 flight tracks over Mount St. Helens in southeastern Washington, U.S. Source: MASTER_0400703_20040924_flightpath.gif

6. Data Access

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

MASTER: Airborne Science, Western US, September 2004

Contact for Data Center Access Information:

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

7. References

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