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## MASTER: FireSense, western US, October 2023

### Get Data

Documentation Revision Date: 2024-04-25

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 FireSense project during 11 flights aboard a NASA B200 aircraft over California, Nevada, Utah, and Arizona, U.S., 2023-10-16 to 2023-10-26. The FireSense project is focused on delivering NASA's unique Earth science and technological capabilities to operational agencies, striving towards measurable improvement in US wildland fire management. 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 [FireSense project](#) collects data to support decisions before, during, and after wildland fires. The measurements include pre-fire fuel conditions, active fire dynamics, post fire impacts and threats, as well as air quality forecasting. Data priorities were developed with stakeholders in wildland fire management agencies.

This dataset includes a total of 586 data files: 174 files in Hierarchical Data Format (HDF-4; \*.hdf) format, 172 files in Keyhole Markup Language Zipped (KMZ; \*.kmz) format, 44 text (\*.txt) files, 11 archives of text files that are zipped (\*.zip), 11 flight maps as GIF (\*.gif) images, and 174 browse images in JPEG (\*.jpg) format.

ASTER/MODIS Airborne Simulator Browse Imagery  
FireSense2023 Campaign – 20 Oct 2023  
USFS Blowdown Prescribed Burn, Kaibab Plateau AZ  
Flight #24-801-06 Track #2

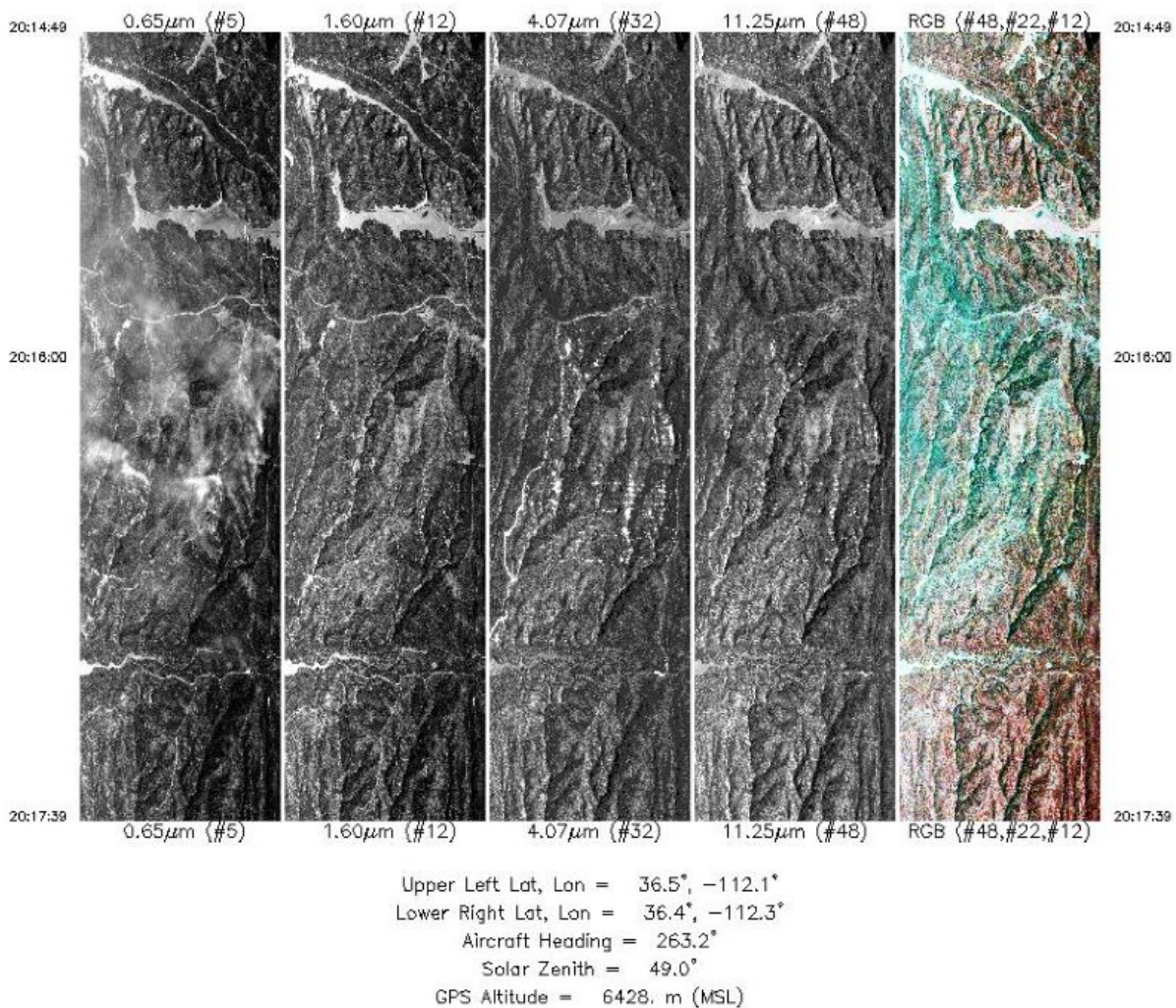


Figure 1. Single-band images and a RGB composite image from flight track 2 acquired on 20 October 2023 over US Forest Service lands on Kaibab Plateau in northern Arizona, California, U.S. Source: MASTERL1B\_2480106\_02\_20231020\_2014\_2017\_V01.jpg

## Citation

Hook, S.J., J.S. Myers, K.J. Thome, M. Fitzgerald, A.B. Kahle, Airborne Sensor Facility NASA Ames Research Center, J.K. Shuman, and J.D. Jacobson. 2024. MASTER: FireSense, western US, October 2023. ORNL DAAC, Oak Ridge, Tennessee, USA. <https://doi.org/10.3334/ORNLDAAC/2330>

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## 1. Dataset Overview

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 [FireSense project](#) during 11 flights aboard a NASA B200 aircraft over California, Nevada, Utah, and Arizona, U.S., 2023-10-16 to 2023-10-26. The FireSense project is focused on delivering NASA's unique Earth science and technological capabilities to operational agencies, striving towards measurable improvement in US wildland fire management. 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.

**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 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, Nevada, Utah, and Arizona, U.S.

**Spatial Resolution:** 8 to 20 m

**Temporal Coverage:** 2023-10-16 to 2023-10-26

**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, U.S.	-120.169	-112.052	39.206	33.019

**Data File Information**

This dataset includes a total of 586 data files: 174 files in Hierarchical Data Format (HDF-4; \*.hdf) format, 172 files in Keyhole Markup Language Zipped (KMZ; \*.kmz) format, 44 text (\*.txt) files, 11 archives of text files that are zipped (\*.zip), 11 flight maps as GIF (\*.gif) images, and 174 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 8 flights with 98 flight tracks (Table 2).
- For each of 98 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 MASTERLAA\_BBBBBBBB\_CC\_YYYYMMDD\_EEFF\_GGHH\_V0J-X.ext (e.g., MASTERL1B\_0800301\_01\_20080414\_2226\_2228\_V01.hdf).

The flight track-level browse images are named MASTERLAA\_BBBBBBBB\_CC\_YYYYMMDD\_EEFF\_GGHH\_V0J.jpg (e.g., MASTERL1B\_0800301\_01\_20080414\_2226\_2228\_V01.jpg).

The deployment-level auxiliary files are named MASTER\_BBBBBBBB\_YYYYMMDD\_X.ext (e.g., MASTER\_0800301\_20080414\_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", ".kmz" or ".zip", indicating the file extension.

**Table 1.** File names and descriptions.

File Name	Level	File Type	Total Files	Description
<b>Primary Data Files</b>				
MASTERL1B_BBBBBBBB_CC_YYYYmmDD_EEFF_GGHH_V0J.hdf	L1B	HDF-4	174	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 <sup>-2</sup> sr <sup>-1</sup> per micron.

File Name	Level	File Type	Total Files	Description
MASTERL1B_BBBBBBBB_CC_YYYYmmDD_EEFF_GGHHV0J-RGB.kmz	L1B	KMZ	172	RGB composite browse image (in KMZ format) derived from corresponding bands of RGB wavelengths of L1B data.
<b>Auxiliary files</b>				
MASTERLAA_BBBBBBBB_CC_YYYYMMDD_EEFF_GGHH_V0J.jpg	L1B	JPEG	174	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 8 m to 20 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).

Date	Flight Number	Locations (USA)	Flight Tracks	
			Data Level	L1B
2023-10-16	2480101	Salton Sea California		2
2023-10-16	2480102	Las Vegas Nevada		5
2023-10-18	2480103	Kaibab Plateau AZ PreBurn		9
2023-10-19	2480104	USFS Blowdown Prescribed Burn, Kaibab Plateau AZ		40
2023-10-20	2480105	USFS Lakes Unit Prescribed Burn, Kaibab Plateau AZ		16
2023-10-20	2480106	USFS Blowdown Prescribed Burn, Kaibab Plateau AZ		18
2023-10-21	2480107	USFS Blowdown Prescribed Burn, Kaibab Plateau AZ		32
2023-10-21	2480108	Southwestern Utah		3
2023-10-21	2480109	Flat Top Mesa Nevada		6
2023-10-24	2480110	Lake Eleanor / Cherry Lake, California		29
2023-10-26	2480111	Lake Tahoe (JPL Buoys 1 and 4)		14
			Total	174

### 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, 2330).

The [FireSense project](#) collects data to support decisions before, during, and after wildland fires. The measurements include *pre-fire fuel conditions*, *active fire dynamics*, *post fire impacts* and threats, as well as *air quality forecasting*. Data priorities were developed with stakeholders in wildland fire management agencies.

### 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 a NASA B200 aircraft at altitudes of 3030 to 8090 m above sea level.

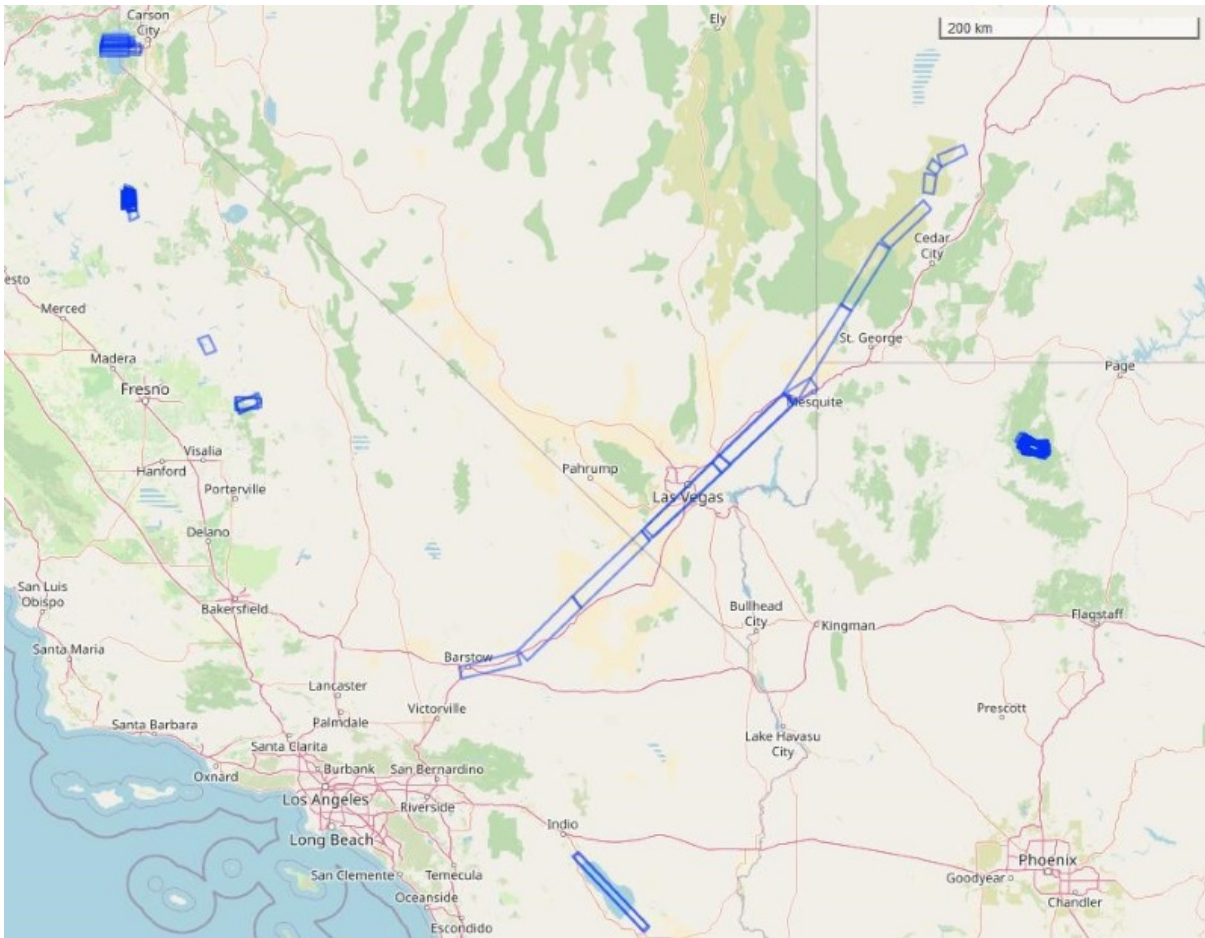


Figure 2. Flight tracks in this dataset represented as rectangular polygons. Map depicts portions of California, Nevada, Utah, and Arizona. Basemap: © OpenStreetMap contributors.





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