# MASTER: FireSense, California and Southern US, Spring 2025

Get Data

Documentation Revision Date: 2025-06-27

Dataset Version: 1

## Summary

This dataset includes Level 1B (L1B) and Level 2 (L2) data products from the MODIS/ASTER Airborne Simulator (MASTER) instrument. The spectral data were collected as part of the FireSense project during 7 flights aboard a NASA B200 aircraft over California, Alabama, Georgia and Florida, U.S., 2025-03-17 to 2025-04-18. 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, and L2 products are provided in HDF-5 and KMZ formats. In addition, the dataset includes the flight path, 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 1378 data files: 167 files in Hierarchical Data Format (HDF-4; *.hdf) format, 167 files in HDF-5 (*.hdf5) format, 668 files in Keyhole Markup Language Zipped (KMZ; *.kmz) format, 167 Portable Network Graphics (PNG; *.png) files that are compressed (*.zip), 28 text (*.txt) files, 7 archives of text files that are zipped (*.zip), 7 flight maps as GIF (*.gif) images, and 167 browse images in JPEG (*.jpg) format.

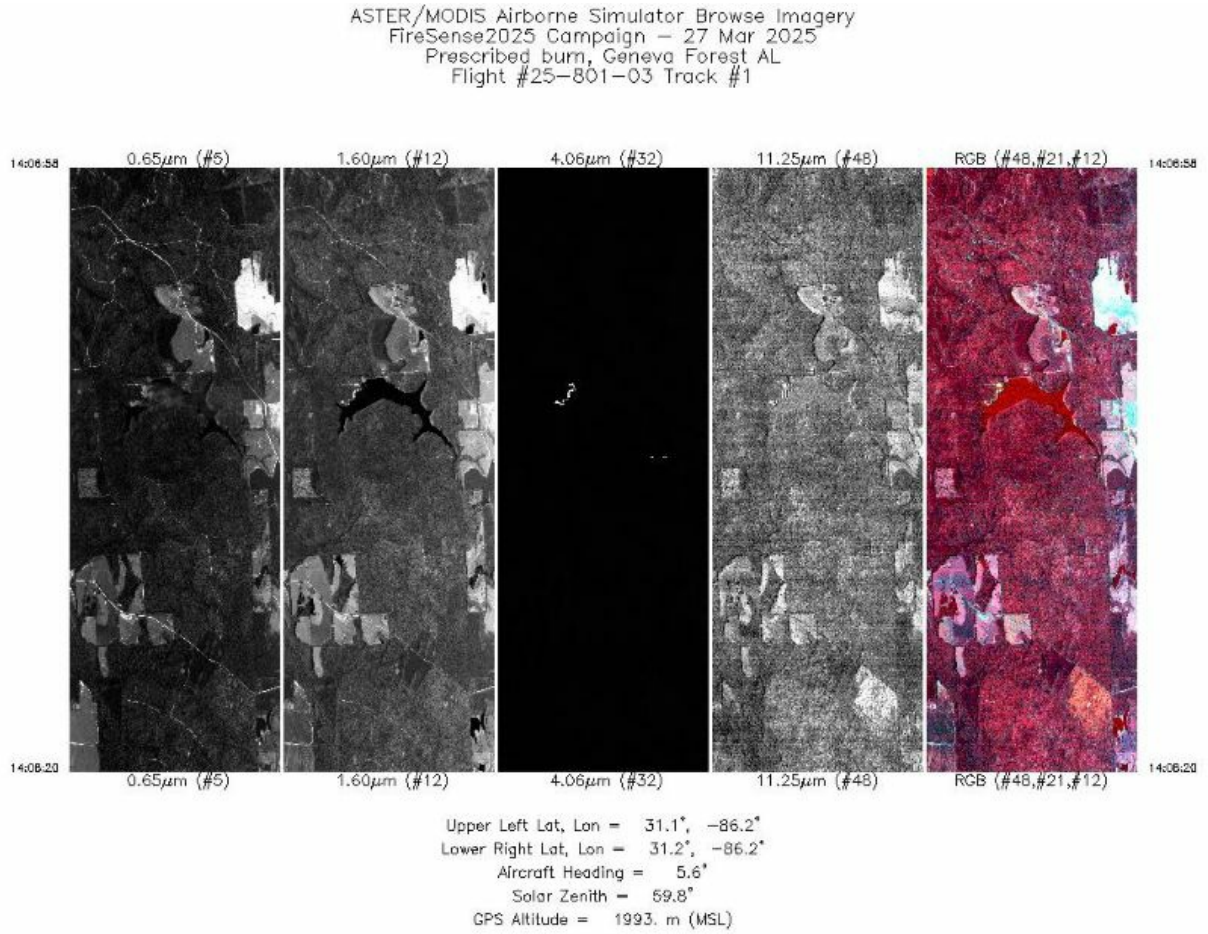


Figure 1. Single-band images and a RGB composite image from flight track 1 acquired on 27 March 2025 over Geneva State Forest south of Opp, Alabama, U.S. Source: MASTERL1B_2580103_01_20250327_1406_1408_V01.jpg

## Citation

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## Table of Contents



## 1. Dataset Overview

This dataset includes Level 1B (L1B) and Level 2 (L2) data products from the MODIS/ASTER Airborne Simulator (MASTER) instrument. The spectral data were collected as part of the FireSense project during 7 flights aboard a NASA B200 aircraft over California, Alabama, Georgia and Florida, U.S., 2025-03-17 to 2025-04-18. 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, and L2 products are provided in HDF-5 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.

**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, Alabama, Georgia, and Florida,U.S.

**Spatial Resolution**: 4 to 13 m

**Temporal Coverage**: 2025-03-17 to 2025-04-18

**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, Alabama, Georgia, and Florida, U.S. | -116.0435 | -81.6656 | 33.4811 | 30.2468 |

**Data File Information**

This dataset includes a total of 1378 data files: 167 files in Hierarchical Data Format (HDF-4; *.hdf) format, 167 files in HDF-5 (*.hdf5) format, 668 files in Keyhole Markup Language Zipped (KMZ; *.kmz) format, 167 Portable Network Graphics (PNG; *.png) files that are compressed (*.zip), 28 text (*.txt) files, 7 archives of text files that are zipped (*.zip), 7 flight maps as GIF (*.gif) images, and 167 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 7 flights with 167 flight tracks (Table 2).
- For each of 167 flight tracks, there is one L1B data file in HDF format and one auxiliary browse image (*.jpg).
- L2 data are included for all 167 flight tracks. For each track, there are four L2 data files:
  - One HDF-5 file (*.hdf5) containing L2 data for emissivity, land surface temperature, geographic coordinates, and quality assurance status.
  - One ZIP file containing five L2 PNG files: one RBG composite, single-band emissivity, land surface temperature, thermal infrared (TIR), and VSWIR images.
  - One L2 RGB composite image of emissivity (*emiss-RGB-47-44-43.kmz) in KMZ format.
  - One L2 land surface temperature image (*LST.kmz) in KMZ format.
- For each flight, there is a collection of auxiliary files providing information about the flight and instrument configuration.

The primary data files are named MASTER**LAA_BBBBBBBB_CC_YYYYMMDD_EEFF_GGHH**_V0**J-X.ext** (e.g., MASTERL1B_2580101_01_20250317_1900_1906_V01.hdf).

The flight track-level browse images are named MASTER**LAA_BBBBBBBB_CC_YYYYMMDD_EEFF_GGHH**_V0**J**.jpg (e.g., MASTERL1B_2580101_01_20250317_1900_1906_V01.jpg).

The deployment-level auxiliary files are named MASTER_**BBBBBBBB_YYYYMMDD_X.ext** (e.g., MASTER_2580101_20250317_config.txt).

- AA = ”1B”, indicating L1B data level, and "L2" indicating L2 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", "hdf5", "gif", "jpg", "txt", or "zip", indicating the file extension.

The "B200_SV01" element is included in some file names and denotes the build ID and version of the Level 2 processing software employed.

**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_*BBBBBBB_CC_YYYYmmDD_EEFF_GGHH*_V0*J*.hdf | L1B | HDF-4 | 167 | 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. |
| MASTERL2_*BBBBBBB_CC_YYYYmmDD_EEFF_GGHH*_V0*J*_B200_SV01.hdf5 | L2 | HDF-5 | 167 | Five subdatasets:<br>(a) Atmospheric corrected emissivity: Temperature and Emissivity Separation (TES) corrected data in 5 bands (wavelengths: 8.3, 8.62, 9.06, 10.62, 11.33, and 12.13 µm).<br>(b) Land surface temperature (LST) in degrees Kelvin.<br>(c) Latitude and (d) longitude coordinates for pixels.<br>(e) QA status for each pixel from TES algorithm, where 1 = divergence and 0 = convergence. |
| MASTERL2_*BBBBBBB_CC_YYYYmmDD_EEFF_GGHH*_V0*J*-images.zip | L2 | PNG | 167 | Five non-georeferenced images: RGB composite, TIR composite, and VSWIR composite using selected bands, emissivity from a single band, and land surface temperature. |
| MASTERL2_*BBBBBBB_CC_YYYYmmDD_EEFF_GGHH*_V0*J_B200_SV01*--LST.kmz | L2 | KMZ | 167 | Map of land surface temperature in degrees Kelvin. |
| MASTERL2_*BBBBBBB_CC_YYYYmmDD_EEFF_GGHH*_V0*J*_B200_SV01-emiss-RGB-47-44-43.kmz | L2 | KMZ | 167 | Map of RGB representation of emissivity. |
| MASTERL1B_*BBBBBBB_CC_YYYYmmDD_EEFF_GGHH*_V0*J*-TIR-47-44-43.kmz | L1B | KMZ | 167 | Map of emissivity in thermal infrared (TIR) bands. |
| MASTERL1B_*BBBBBBB_CC_YYYYmmDD_EEFF_GGHH*_V0*J*-VSWIR-21-12-03.kmz | L1B | KMZ | 167 | Map of emissivity in VSWIR bands. |
| **Auxiliary Files** | | | | |
| MASTERL1B_*BBBBBBB_CC_YYYYMMDD_EEFF_GGHH*_V0*J*.jpg | L1B | JPEG | 167 | Browse figures; one image per flight track; multiple tracks per flight. |
| MASTER_*BBBBBBB_YYYYMMDD*_ancillary.txt | - | Text | 7 | Ancillary information about flight including notes on aircraft platform, mission objective, and data evaluation. |
| MASTER_*BBBBBBB_YYYYMMDD*_config.txt | - | Text | 7 | Instrument configuration information for flight. |
| MASTER_*BBBBBBB_YYYYMMDD*_flightpath.gif | - | GIF | 7 | Map showing flight paths. |
| MASTER_*BBBBBBB_YYYYMMDD*_spectral_band_info.txt | - | Text | 7 | Spectral band information for flight. |
| MASTER_*BBBBBBB_YYYYMMDD*_spectral_response_table.zip | - | Text | 7 | Spectral response tables.<br>Each Zip archive holds a collection of approximately 50 files detailing spectral responses by band and related information. |
| MASTER_*BBBBBBB_YYYYMMDD*_summary.txt | - | Text | 7 | 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-4 files contain swath trajectory data using longitude, latitude coordinates. The spatial resolution ranges from 4 m to 13 m and is a function of aircraft altitude.

**Table 2**. Number of flight tracks for each MASTER flight during this 2025 deployment over California, Alabama (AL), Georgia, and Florida.

| Date | Flight Number | Locations (USA) | Flight Tracks | |
|---|---|---|---|---|
| | | Data Level | L1B | L2 |
| 2025-03-17 | 2580101 | Salton Sea, California | 7 | 7 |

| | | | | |
|---|---|---|---|---|
| 2025-03-25 | 2580102 | Baldwin County, AL, Perdido Fire | 8 | 8 |
| 2025-03-27 | 2580103 | Prescribed burn, Geneva Forest, AL | 42 | 42 |
| 2025-03-28 | 2580104 | Geneva State Forest, Alabama | 2 | 2 |
| 2025-04-14 | 2580105 | Prescribed Burn, Fort Stewart, Georgia | 35 | 35 |
| 2025-04-16 | 2580106 | Prescribed Burn, Fort Stewart, Georgia | 44 | 44 |
| 2025-04-18 | 2580107 | Prescribed Burn, Fort Stewart, Georgia | 29 | 29 |
| | | Total | 167 | 167 |

## 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, 2439).

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 1530 to 5130 m above sea level.

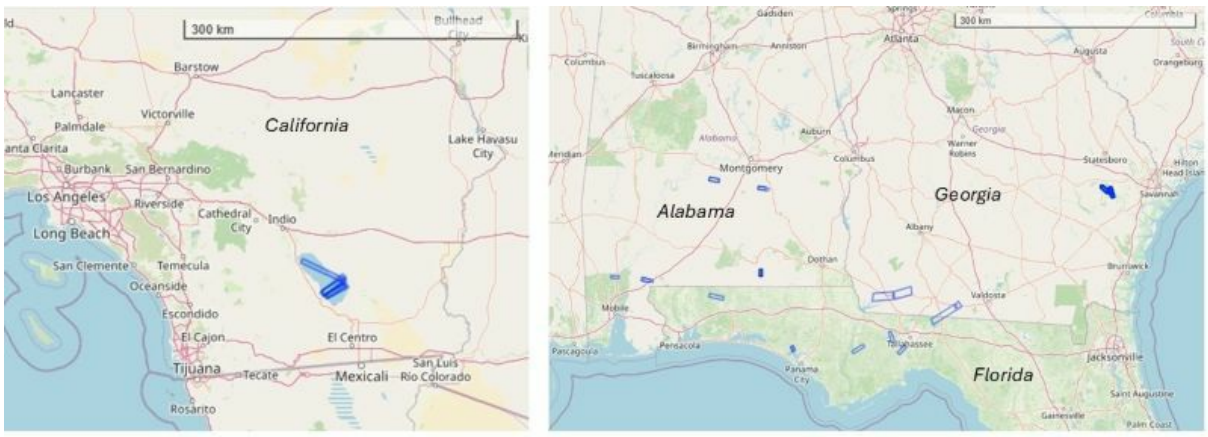


Figure 2. Flight tracks in this dataset represented as blue rectangular polygons. Maps depict portions of southern California (left) and Alabama, Georgia, and Florida (right). Basemap: © OpenStreetMap contributors.

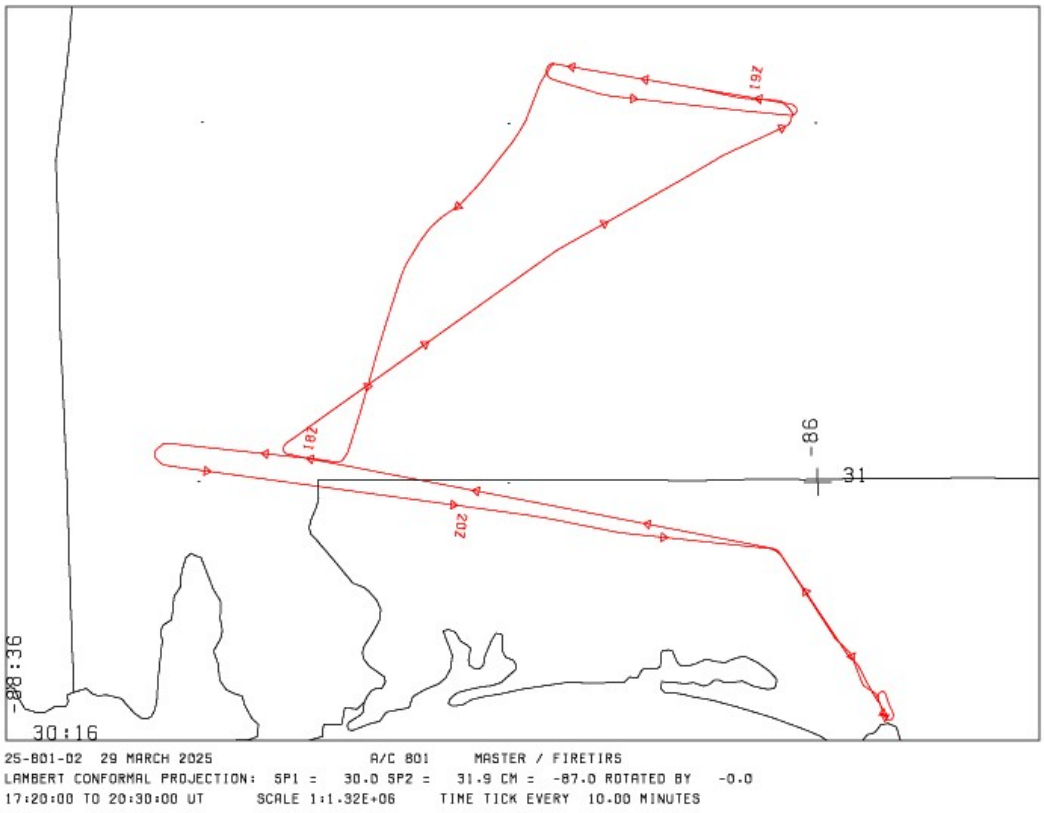


Figure 3. Flight path for Flight 2580102, flown on 25 March 2025. Flight 2480105 and 8 flight tracks occurred over southern Alabama. Flight originated near Panama City, Florida, in southwest portion of map. Source: MASTER_2580102_20250325_flightpath.gif

## 6. Data Access

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

MASTER: FireSense, California and Southern US, Spring 2025

Contact for Data Center Access Information:

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

## 7. References

Capolsini, P., S. Andréfouët, C. Rion, and C. Payri. 2003. A comparison of Landsat ETM+, SPOT HRV, Ikonos, ASTER, and airborne MASTER data for coral reef habitat mapping in South Pacific islands. Canadian J. Remote Sensing 29:187-200. https://doi.org/10.5589/m02-088

Coll, C., V. Caselles, E. Rubio, F. Sospedra, and E. Valor. 2001. Temperature and emissivity separation from calibrated data of the Digital Airborne Imaging Spectrometer. Remote Sensing of Environment 76:250-259. https://doi.org/10.1016/S0034-4257(00)00207-8

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

JPL. 2021a. Calibration and Validation, MASTER: MODIS/ASTER Airborne Simulator. Jet Propulsion Laboratory, California Institute of Technology, Pasadena, California, USA. https://masterprojects.jpl.nasa.gov/cal-val

JPL. 2021b. Science objectives, MASTER: MODIS/ASTER Airborne Simulator. Jet Propulsion Laboratory, California Institute of Technology, Pasadena, California, USA. https://masterprojects.jpl.nasa.gov/objectives

King, M.D., W.P. Menzel, P.S. Grant, J.S. Myers, G.T. Arnold, S.E. Platnick, L.E. Gumley, S.C. Tsay, C.C. Moeller, M. Fitzgerald, K.S. Brown, and F.G. Osterwisch. 1996. Airborne scanning spectrometer for remote sensing of cloud, aerosol, water vapor and surface properties. J. Atmospheric and Oceanic Technology 13:777-794. https://doi.org/10.1175/1520-0426(1996)013<0777:ASSFRS>2.0.CO;2

Li, P., and W.M. Moon. 2004. Land cover classification using MODIS-ASTER airborne simulator (MASTER) data and NDVI: A case study of the Kochang area, Korea. Canadian J. Remote Sensing 30:123-126. https://doi.org/10.5589/m03-061

Veraverbeke, S., S. Harris, and S. Hook. 2011. Evaluating spectral indices for burned area discrimination using MODIS/ASTER (MASTER) airborne simulator data. Remote Sensing of Environment 115:2702-2709. https://doi.org/10.1016/j.rse.2011.06.010

Zhao, Q., and E.A. Wentz. 2439. A MODIS/ASTER Airborne Simulator (MASTER) imagery for urban heat island research. Data 1:7. https://doi.org/10.3390/data1010007

## 8. Dataset Revisions

| Version | Release Date | Revision Notes |
|---|---|---|

| Version | Release Date | Revision Notes |
|---|---|---|
| 1 | 2025-07-03 | Level-2 data products were added to this dataset. User guide was updated. |
| 1 | 2025-06-05 | First publication |