MASTER: Student Airborne Research Program (SARP) Campaign, California, 2010

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 collected and developed by the Student Airborne Research Program (SARP). The spectral data were collected from flights flown on 2010-06-28 to 2010-07-01 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 2010 deployment included three flights with 21 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 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.

This dataset includes a total of 70 data files: 21 files in Hierarchical Data Format (HDF-4; *.hdf) format, 10 files in Keyhole Markup Language Zipped (KMZ; *.kmz) 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.

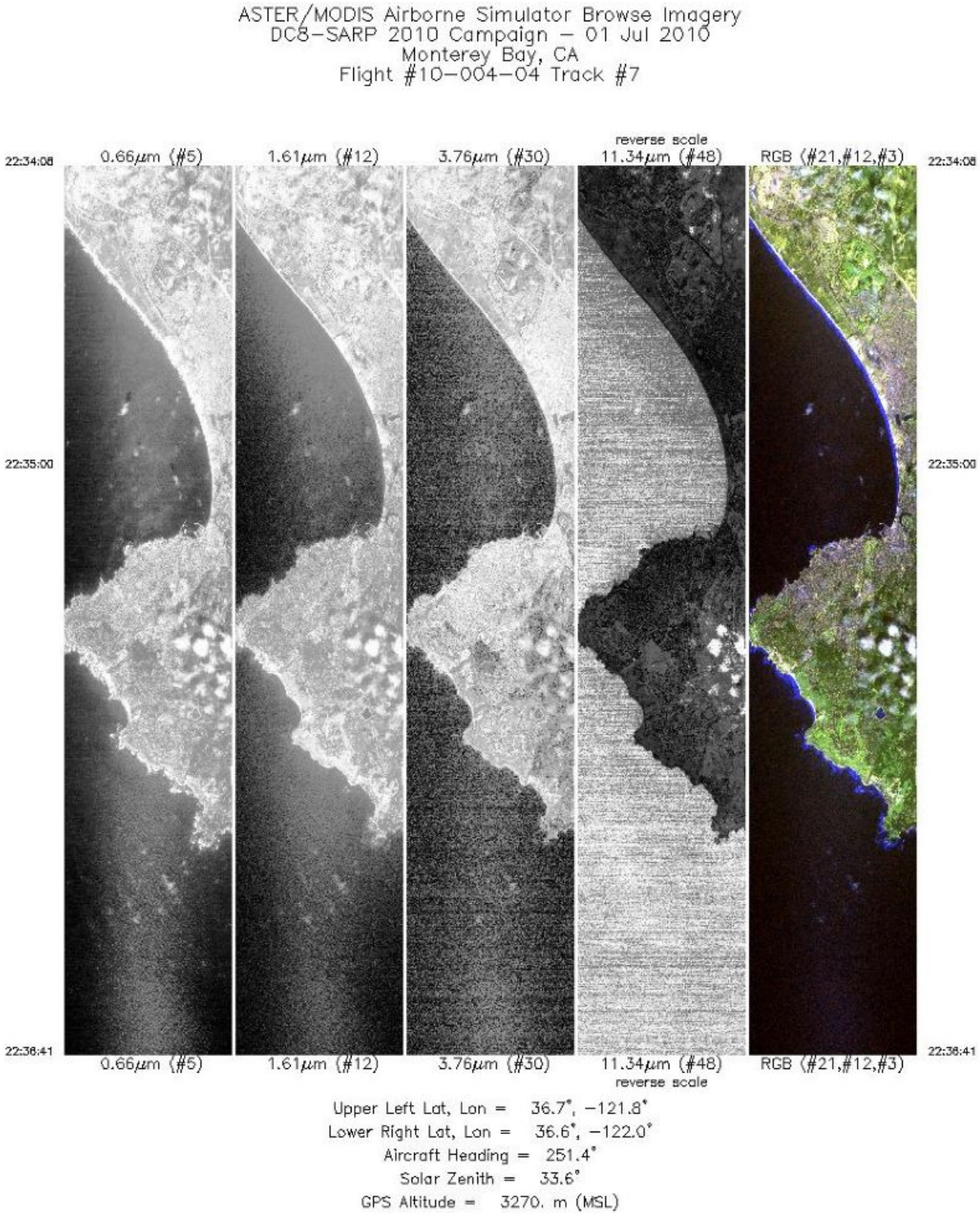

Figure 1. Single band images and an RGB composite image from flight track 7 acquired on 01 July 2010 over Monterey Bay, California, U.S. Source: MASTERL1B_1000404_07_20100701_2234_2236_V02.jpg

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, 2010. ORNL DAAC, Oak Ridge, Tennessee, USA. https://doi.org/10.3334/ORNLDAAC/1989

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 2010-06-28 to 2010-07-01 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 2010 deployment included three flights with 21 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 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., 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: 8 to 11 m

Temporal Coverage: 2010-06-28 to 2010-07-01

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	-122.344	-115.542	37.161	33.022

Data File Information

This dataset includes a total of 70 data files: 21 files in Hierarchical Data Format (HDF-4; *.hdf) format, 10 files in Keyhole Markup Language Zipped (KMZ; *.kmz) 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 (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 3 flights with 21 flight tracks (Table 2).
- For each of 21 flight tracks, there is one L1B data file in HDF format and an auxiliary browse image (*.jpg).
- There are KMZ files for 10 of the 21 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_1000402_01_20100628_2002_2007_V02.hdf).

The flight track-level browse images are named MASTERL**AA_BBBBBBBB_CC_YYYYMMDD_EEFF_GGHH**_V0**J**.jpg (e.g., MASTERL1B_1000402_01_20100628_2002_2007_V02.jpg).

The deployment-level auxiliary files are named MASTER_**BBBBBBBB_YYYYMMDD_X**.**ext** (e.g., MASTER_1000402_20100628_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", "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	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.
MASTERL1B_*BBBBBBBB_CC_YYYYmmDD_EEFF_GGHH*V0*J*-RGB.kmz	L1B	KMZ	10	RGB composite browse image (in KMZ format) derived from corresponding bands of RGB wavelengths of L1B data.
Auxiliary Files				
MASTER*LAA_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, 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 8 m to 11 m and is a function of aircraft altitude.

Table 2. Number of flight tracks for each MASTER flight during this 2010 deployment over southern California.

Date	Flight Number	Locations (U.S.)	Flight Tracks
2010-06-28	1000402	Salton Sea, CA	3
2010-06-29	1000403	Central Valley / Monterey Bay, CA	8
2010-07-01	1000404	Santa Barbara / Central Valley / Monterey Bay, CA	10
		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 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 3271–4212 m above sea level. The study area included portions of southern California (Fig. 2–3).

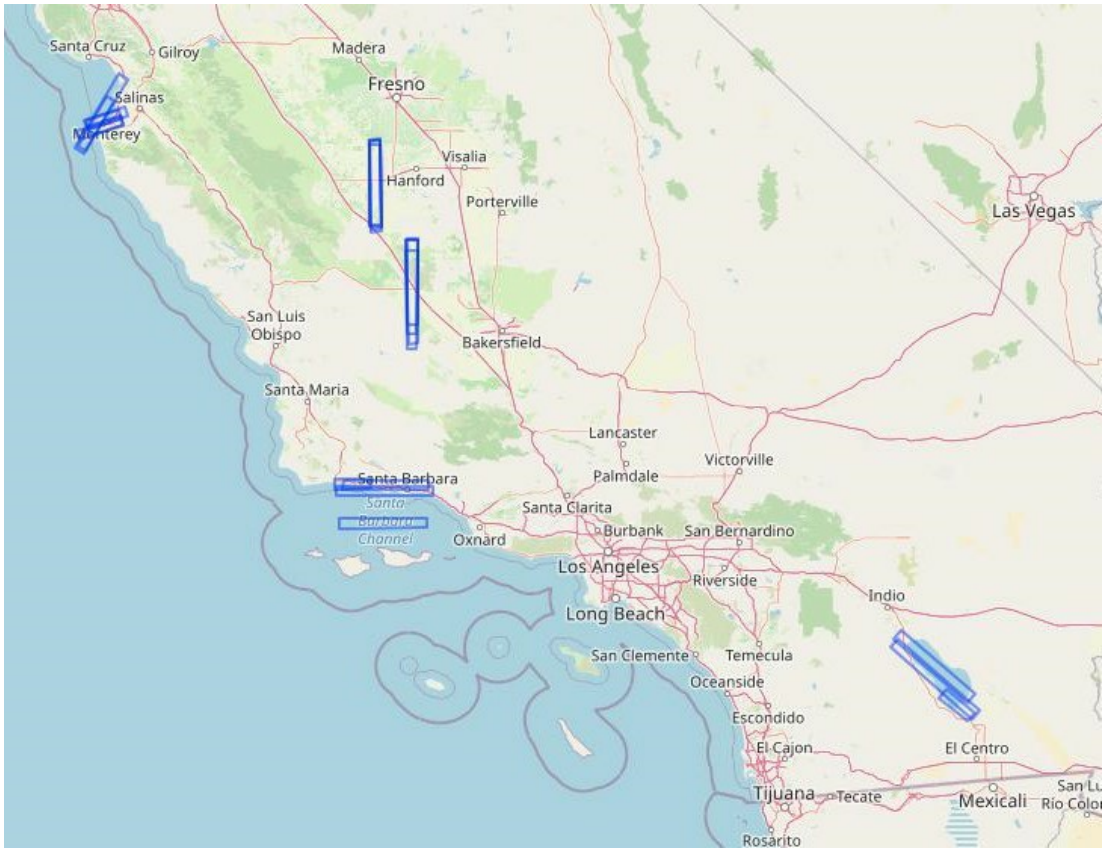

Figure 2. Flight tracks in this dataset represented as rectangular polygons. Map shows a portion of southern California, U.S.. Basemap: © OpenStreetMap contributors.

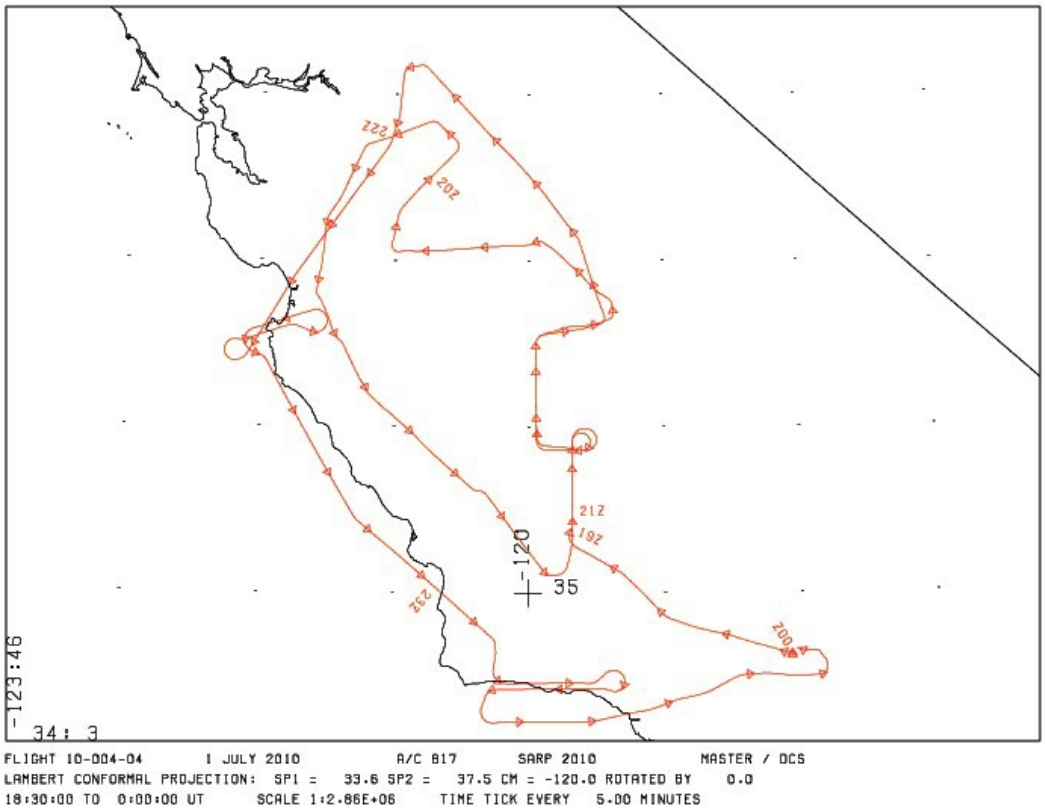

Figure 3. Flight path for Flight 1000404, flown on 01 July 2010. Flight 1000404 and 10 flight tracks occurred over southern California, U.S. Source: MASTER_1000404_20100701_flightpath.gif

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, 2010

Contact for Data Center Access Information:

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

7. References

ASF. 2021. Campaign summary information: HyspIRI / WDTS Airborne Campaign. Airborne Sensor Facility, Airborne Science Program, NASA Ames Research Center, Moffett Field, California. https://asapdata.arc.nasa.gov/sensors/master/data/deploy_html/hyspiri_home.html

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. 2016. A MODIS/ASTER Airborne Simulator (MASTER) imagery for urban heat island research. Data 1:7. https://doi.org/10.3390/data1010007





Home

About Us
- Mission
- Data Use and Citation Policy
- User Working Group
- Partners

Get Data
- Science Themes
- NASA Projects
- All Datasets

Submit Data
- Submit Data Form
- Data Scope and Acceptance
- Data Authorship Policy
- Data Publication Timeline
- Detailed Submission Guidelines

Tools
- MODIS
- THREDDS
- SDAT
- Daymet
- Airborne Data Visualizer
- Soil Moisture Visualizer
- Land - Water Checker

Resources
- Learning
- Data Management
- News
- Earthdata Forum

Contact Us