Search ORNL DAAC | 🔍 Search

MASTER: Airborne Science, Southwest US, August 2006

Get Data

Documentation Revision Date: 2023-07-06

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 18 flights aboard a DOE B-200 aircraft over Nevada, California and Colorado, U.S., from 2006-08-21 to 2006-09-06. This data collection focused on mapping geological faults. This deployment was coordinated by the U.S. Department of Energy's Remote Sensing Laboratory (RSL) located at Nellis Air Force Base near Las Vegas, Nevada. 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. MASTER provides data in 50 channels spanning visible to thermal infrared wavelengths (0.4 – 13 μm). Its data have been used to study geological patterns, land covers, ecological disturbances, and other phenomena that affect Earth surface properties.

This dataset includes a total of 474 data files: 183 files in Hierarchical Data Format (HDF-4; *.hdf) format, 72 text (*.txt) files, 18 archives of text files that are zipped (*.zip), 18 flight maps as GIF (*.gif) images, and 183 browse images in JPEG (*.jpg) format.
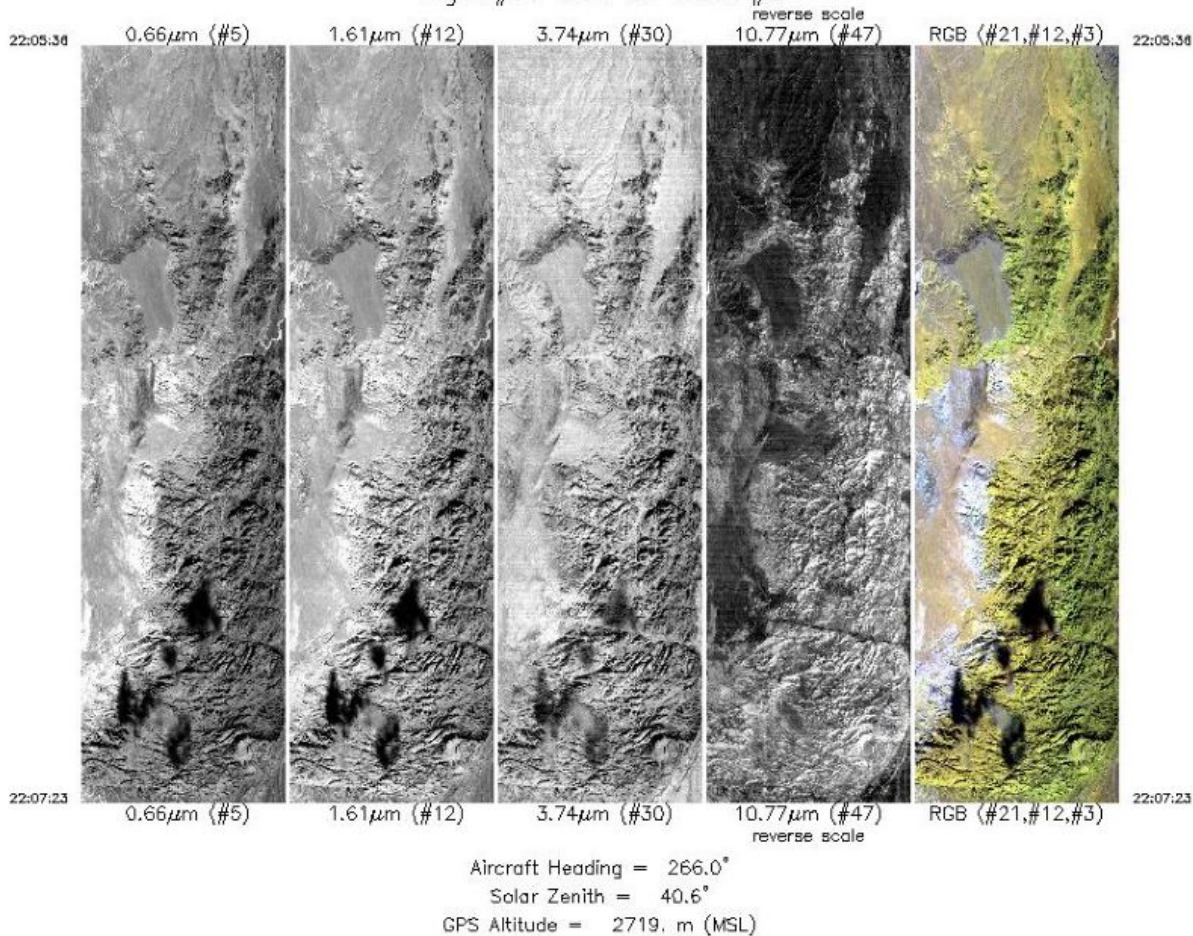
Figure 1. Single-band images and a RGB composite image from flight track 2 acquired on 21 August 2006 over Valley of Fire State Park, south of Glendale, Nevada, U.S. Source: MASTERL1B_0601001_02_20060821_2205_2207_V01.jpg

Citation

Hook, S.J., J.S. Myers, K.J. Thome, M. Fitzgerald, A.B. Kahle, Airborne Sensor Facility NASA Ames Research Center, and G. Peltzer. 2022. MASTER: Airborne Science, Southwest US, August 2006. ORNL DAAC, Oak Ridge, Tennessee, USA. https://doi.org/10.3334/ORNLDAAC/2027

Table of Contents

1. Dataset Overview

This dataset includes Level 1B (L1B) data products from the MODIS/ASTER Airborne Simulator (MASTER) instrument. The spectral data were collected during 18 flights aboard a DOE B-200 aircraft over Nevada, California and Colorado, U.S., from 2006-08-21 to 2006-09-06. This data collection focused on mapping geological faults. This deployment was coordinated by the U.S. Department of Energy's Remote Sensing Laboratory (RSL) located at Nellis Air Force Base near Las Vegas, Nevada. 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. MASTER provides data in 50 channels spanning visible to thermal infrared wavelengths (0.4 – 13 µm). Its data have been used to study geological patterns, land covers, ecological disturbances, and other phenomena that affect Earth surface properties.

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, Colorado and Nevada, U.S.

Spatial Resolution: 5 to 14 m

Temporal Coverage: 2006-08-21 to 2006-09-06

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, Colorado, and Nevada, U.S.	-118.7416	-106.9594	38.9700	32.8201

Data File Information

This dataset includes a total of 474 data files: 183 files in Hierarchical Data Format (HDF-4; *.hdf) format, 72 text (*.txt) files, 18 archives of text files that are zipped (*.zip), 18 flight maps as GIF (*.gif) images, and 183 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 18 flights, including 183 flight tracks (Table 2).
- For each of 183 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_0601001_01_20060821_2157_2159_V01.hdf).

The flight track-level browse images are named MASTERL**AA_BBBBBBBB_CC_YYYYMMDD_EEFF_GGHH_**V0**J**.jpg (e.g., MASTERL1B_0601001_01_20060821_2157_2159_V01.jpg).

The deployment-level auxiliary files are named MASTER**_BBBBBBBB_YYYYMMDD_X.ext** (e.g., MASTER_0601001_20060821_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_*V0J.hdf	L1B	HDF-4	183	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				
MASTERLAA_*BBBBBBBB_CC_YYYYMMDD_EEFF_GGHH_*V0J.jpg	L1B	JPEG	183	Browse figures; one per flight track, multiple tracks per flight.
MASTER_*BBBBBBBB_YYYYMMDD_*ancillary.txt	-	Text	18	Ancillary information about flight including notes on aircraft platform, mission objective, and data evaluation.

File Name	Level	File Type	Total Files	Description
MASTER_*BBBBBBBB_YYYYMMDD*_config.txt	-	Text	18	Instrument configuration information for flight.
MASTER_*BBBBBBBB_YYYYMMDD*_flightpath.gif	-	GIF	18	Map showing flight paths.
MASTER_*BBBBBBBB_YYYYMMDD*_spectral_band_info.txt	-	Text	18	Spectral band information.
MASTER_*BBBBBBBB_YYYYMMDD*_spectral_response_table.zip	-	Text	18	Spectral response tables by band (ZIP archive of 50 text files).
MASTER_*BBBBBBBB_YYYYMMDD*_summary.txt	-	Text	18	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 5 m to 14 m and is a function of aircraft altitude.

Table 2. Number of flight tracks for each MASTER flight during this 2006 deployment over California (CA), Colorado, and Nevada (NV).

Date	Flight Number	Locations (USA)	Flight Tracks
2006-08-21	0601001	Valley of Fire, NV	2
2006-08-22	0601002	Garlock1 Fault, CA	5
2006-08-23	0601004	San Andreas2 Fault, CA	21
2006-08-24	0601005	Garlock1 Fault, CA	6
2006-08-24	0601006	Blue Cut3 Fault, CA	17
2006-08-25	0601007	Banning-Garnet Fault, CA	19
2006-08-25	0601008	Garlock2 Fault, CA	4
2006-08-26	0601009	Pinto Mountain2 Fault, CA	13
2006-08-26	0601010	Garlock2 Fault, CA	11
2006-08-26	0601011	Mt General Fault, CA	12
2006-08-26	0601012	Superstition Mtn Fault, CA	14
2006-08-27	0601013	Blake Ranch Fault, CA	11
2006-08-28	0601014	Lockhart-Helendale Fault, CA	14
2006-08-28	0601015	Blake Ranch Fault, CA	10
2006-08-30	0601016	Superstition Mtn Fault, CA	6
2006-08-30	0601017	Blue Cut2 Fault, CA	5
2006-09-03	0601018	Mt. Emmons, Colarado	11
2006-09-06	0601019	Valley of Fire, NV	2
		Total	183

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, 2016). This data collection focused on mapping earthquake faults.

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 DOE B-200 aircraft at altitude of approximately 2710 m above sea level.
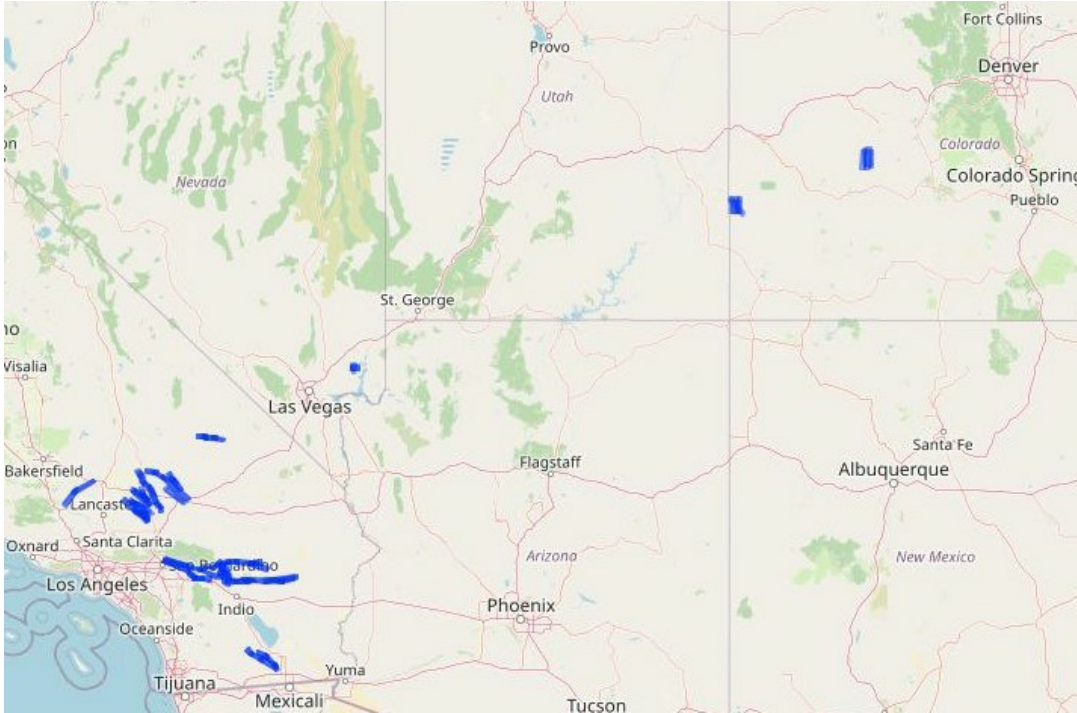

Figure 2. Flight tracks in this dataset represented as blue rectangular polygons. Map shows southwestern United States. Basemap: © OpenStreetMap contributors.
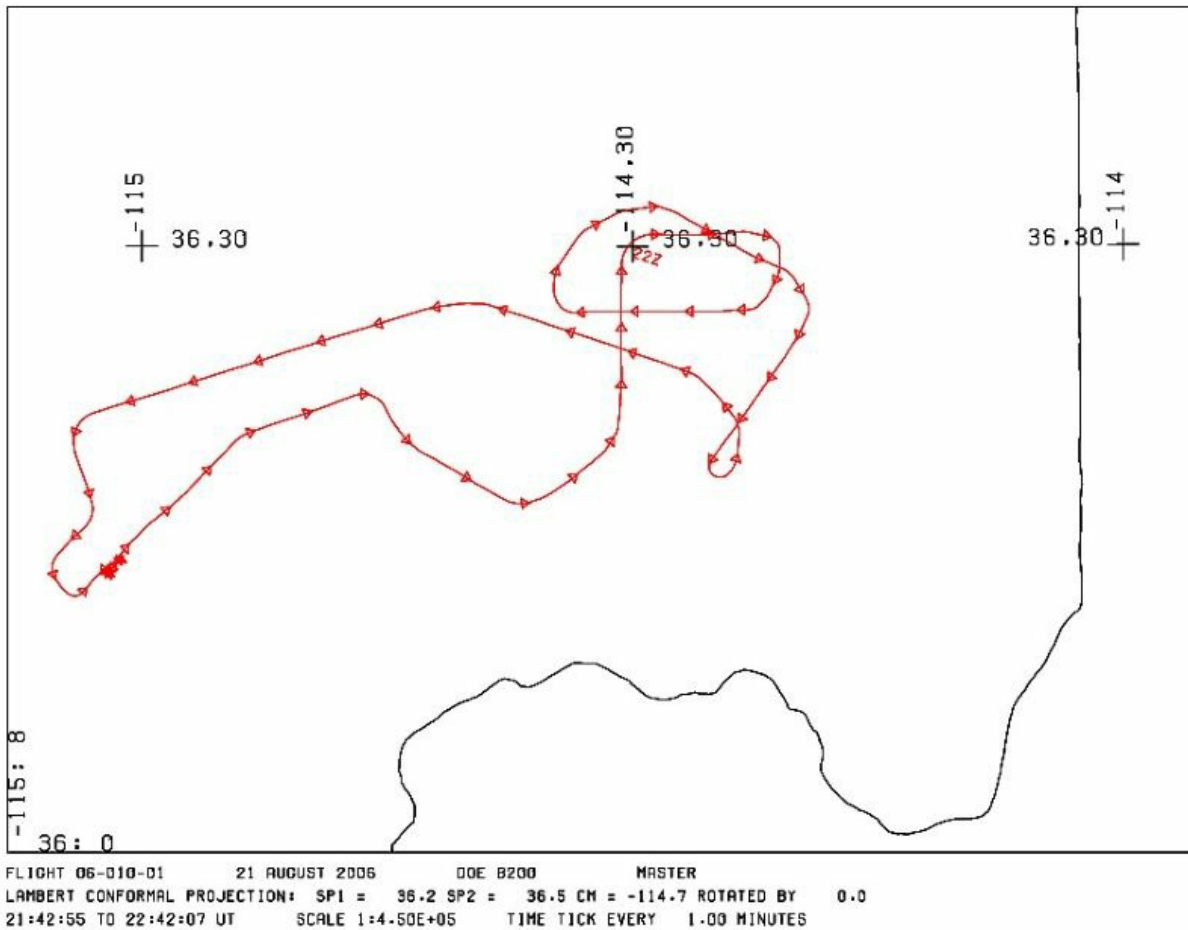
Figure 3. Flight path is shown for 21 August 2006. Flight 0601001 and 2 flight tracks over southern Nevada. Source: MASTER_0601001_20060821_flightpath.gif

6. Data Access

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

MASTER: Airborne Science, Southwest US, August 2006

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. 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