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# MASTER: Costa Rica Airborne Research and Technology Applications (CARTA), 2005

## Get Data

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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 23 flights aboard a NASA WB-57 aircraft over Costa Rica on 2005-03-01 to 2005-04-06. The CARTA-2005 project was a collaborative effort between the Centro Nacional de Alta Tecnología (CENAT) of Costa Rica and NASA. 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  $\mu\text{m}$ ). 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 612 data files: 237 files in Hierarchical Data Format (HDF-4; \*.hdf) format, 92 text (\*.txt) files, 23 archives of text files that are zipped (\*.zip), 23 flight maps as GIF (\*.gif) images, and 237 browse images in JPEG (\*.jpg) format.

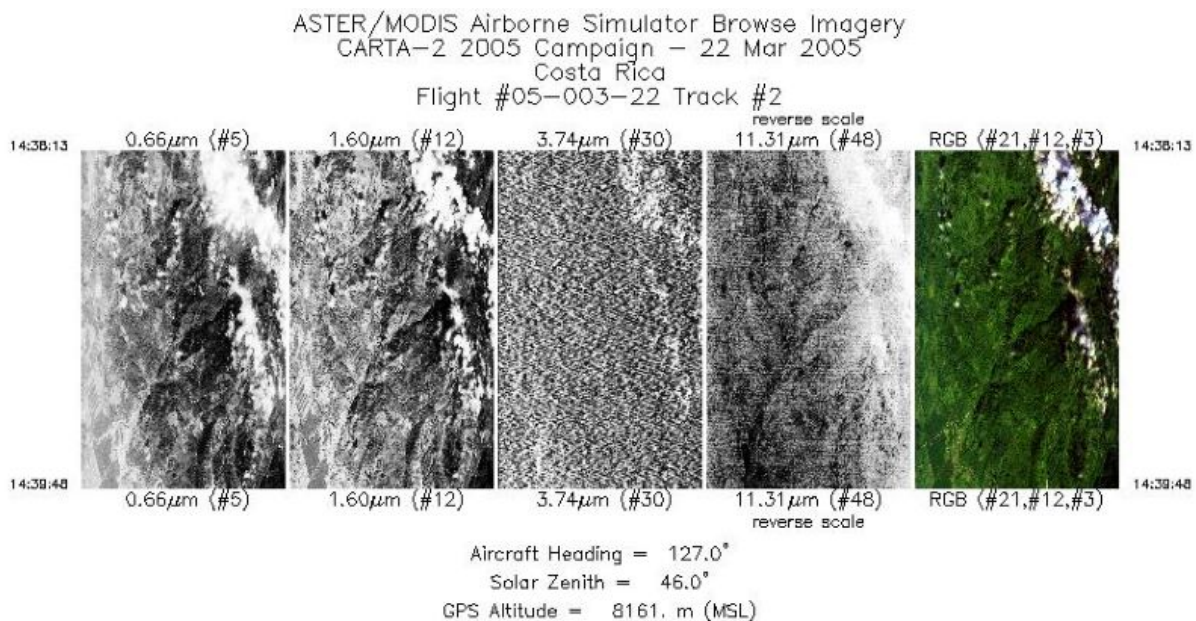


Figure 1. Single-band images and a RGB composite image from flight track 2 acquired on 22 March 2005 over Costa Rica. U.S. Source: MASTERL1B\_0500322\_02\_20050322\_1438\_1439\_V01.jpg

## Citation

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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 during 23 flights aboard a NASA WB-57 aircraft over Costa Rica on 2005-03-01 to 2005-04-06. The CARTA-2005 project was a collaborative effort between the Centro Nacional de Alta Tecnologia (CENAT) of Costa Rica and NASA. 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  $\mu\text{m}$ ). 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](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. The CARTA-2005 project was a collaborative effort between the Centro Nacional de Alta Tecnologia (CENAT) of Costa Rica and NASA. The USGS National Wetlands Research Laboratory and the DOE Remote Sensing Laboratory also provided collaboration and support.

## 2. Data Characteristics

**Spatial Coverage:** Costa Rica

**Spatial Resolution:** 7 to 24 m

**Temporal Coverage:** 2005-03-01 to 2005-04-06

**Temporal Resolution:** One-time estimate

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

Site	Westernmost Longitude	Easternmost Longitude	Northernmost Latitude	Southernmost Latitude
Costa Rica	-86.078	-82.536	11.280	7.903

### Data File Information

This dataset includes a total of 612 data files: 237 files in Hierarchical Data Format (HDF-4; \*.hdf) format, 92 text (\*.txt) files, 23 archives of text files that are zipped (\*.zip), 23 flight maps as GIF (\*.gif) images, and 237 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.

- There are 23 flights, which include 237 flight tracks.
- For each flight track, 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\_0500306\_01\_20050301\_1432\_1440\_V01.hdf).

The flight track-level browse images are named MASTERLAA\_BBBBBBBB\_CC\_YYYYMMDD\_EEFF\_GGHH\_V0J.jpg (e.g., MASTERL1B\_0500306\_01\_20050301\_1432\_1440\_V01.jpg).

The deployment-level auxiliary files are named MASTER\_BBBBBBBB\_YYYYMMDD\_X.ext (e.g., MASTER\_0500306\_20050301\_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
<b>Primary Data Files</b>				
MASTERL1B_BBBBBBBB_CC_YYYYMMDD_EEFF_GGHH_V0J.hdf	L1B	HDF-4	237	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.
<b>Auxiliary files</b>				
MASTERL1B_BBBBBBBB_CC_YYYYMMDD_EEFF_GGHH_V0J.jpg	L1B	JPEG	237	Browse figures; one per flight track, multiple tracks per flight.
MASTER_BBBBBBBB_YYYYMMDD_ancillary.txt	-	Text	23	Ancillary information about flight including notes on aircraft platform, mission objective, and data evaluation.
MASTER_BBBBBBBB_YYYYMMDD_config.txt	-	Text	23	Instrument configuration information for flight.
MASTER_BBBBBBBB_YYYYMMDD_flightpath.gif	-	GIF	23	Map showing flight paths.
MASTER_BBBBBBBB_YYYYMMDD_spectral_band_info.txt	-	Text	23	Spectral band information.
MASTER_BBBBBBBB_YYYYMMDD_spectral_response_table.zip	-	Text	23	Spectral response tables by band (ZIP archive of 50 text files).
MASTER_BBBBBBBB_YYYYMMDD_summary.txt	-	Text	23	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 is 7 to 24 m and is a function of aircraft altitude.

**Table 2.** Number of flight tracks for each MASTER flight during this 2005 deployment over Costa Rica.

Date	Flight Number	Locations	Flight Tracks
2005-03-01	0500306	Costa Rica	13
2005-03-03	0500307	Costa Rica	8
2005-03-04	0500308	Costa Rica	13
2005-03-05	0500309	Costa Rica	9
2005-03-06	0500310	Costa Rica	12
2005-03-07	0500311	Costa Rica	9
2005-03-08	0500312	Costa Rica	5
2005-03-10	0500313	Costa Rica	15
2005-03-14	0500316	Costa Rica	8
2005-03-15	0500317	Costa Rica	9
2005-03-18	0500319	Costa Rica	2
2005-03-19	0500320	Costa Rica	6
2005-03-21	0500321	Costa Rica	10
2005-03-22	0500322	Costa Rica	12
2005-03-23	0500323	Costa Rica	6
2005-03-25	0500324	Costa Rica	11
2005-03-27	0500325	Costa Rica	14
2005-03-29	0500326	Costa Rica	12

2005-03-30	0500327	Costa Rica	14
2005-04-01	0500329	Costa Rica	11
2005-04-02	0500330	Costa Rica	14
2005-04-04	0500331	Costa Rica	8
2005-04-06	0500332	Costa Rica	16
Total			237

### 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).

The CARTA-2005 project's objectives were to acquire airborne multispectral digital imagery and photographic data over Costa Rica for various scientific and national objectives.

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 a NASA WB-57 aircraft at altitudes of 7545 to 8850 m above sea level.



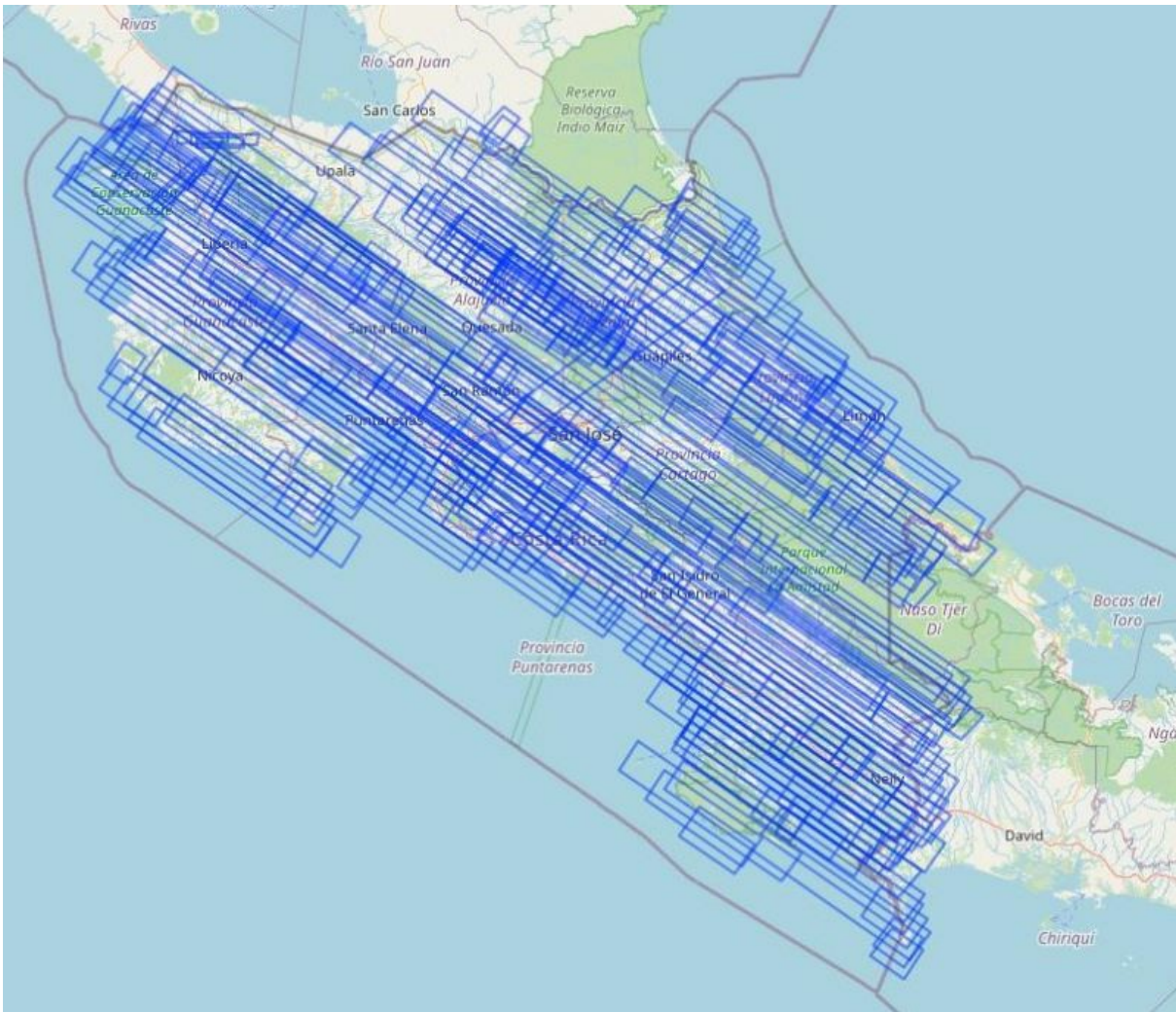


Figure 2. Flight tracks in this dataset represented as blue rectangular polygons. Map shows Costa Rica and adjacent countries. Basemap: © OpenStreetMap contributors.

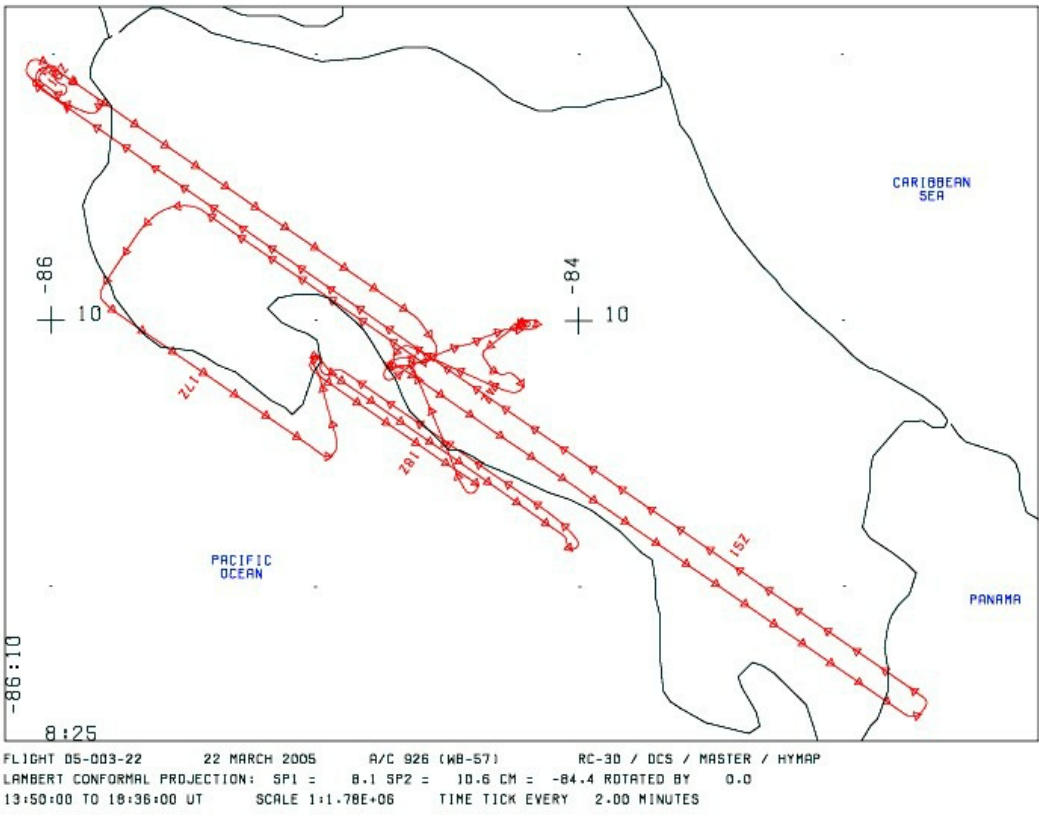


Figure 3. Flight path is shown for 22 March 2005. Flight 0500322 and 12 flight tracks over Costa Rica. Source: MASTER\_0500322\_20050322\_flightpath.gif

## 6. Data Access

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

[MASTER: Costa Rica Airborne Research and Technology Applications \(CARTA\), 2005](#)

Contact for Data Center Access Information:

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

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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>

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