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MASTER: Pacific Rim Campaign, July-October, 2000

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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 46 flights aboard a NASA DC-8 aircraft over sites encompassing the Pacific Rim, including Alaska, California, Hawaii, islands of the south and western Pacific Ocean, New Zealand, Australia, Polynesia, southeast Asia, South Korea, and Japan. Flights took place on 2000-07-21 to 2000-10-23. The Pacific Rim 2000 (PacRim II) Campaign gathered geographic and atmospheric data for coastal analysis, oceanography, forestry, geology, hydrology and archaeology of various regions using data from the Airborne Synthetic Aperture Radar (AirSAR) and MODIS/ASTER Airborne Simulator (MASTER) instruments. This was the first campaign to operate both the AIRSAR and MASTER instruments simultaneously, providing scientists with additional insight on how topography affects the vegetation and land surface temperature as seen in the MASTER data. Data products include L1B georeferenced multispectral imagery of calibrated radiance in 50 bands covering wavelengths of 0.460 to 12.879 micrometers at approximately 25-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 1098 data files: 411 files in Hierarchical Data Format (HDF-4; *.hdf) format, 184 text (*.txt) files, 46 archives of text files that are zipped (*.zip), 46 flight maps as GIF (*.gif) images, and 411 browse images in JPEG (*.jpg) format.
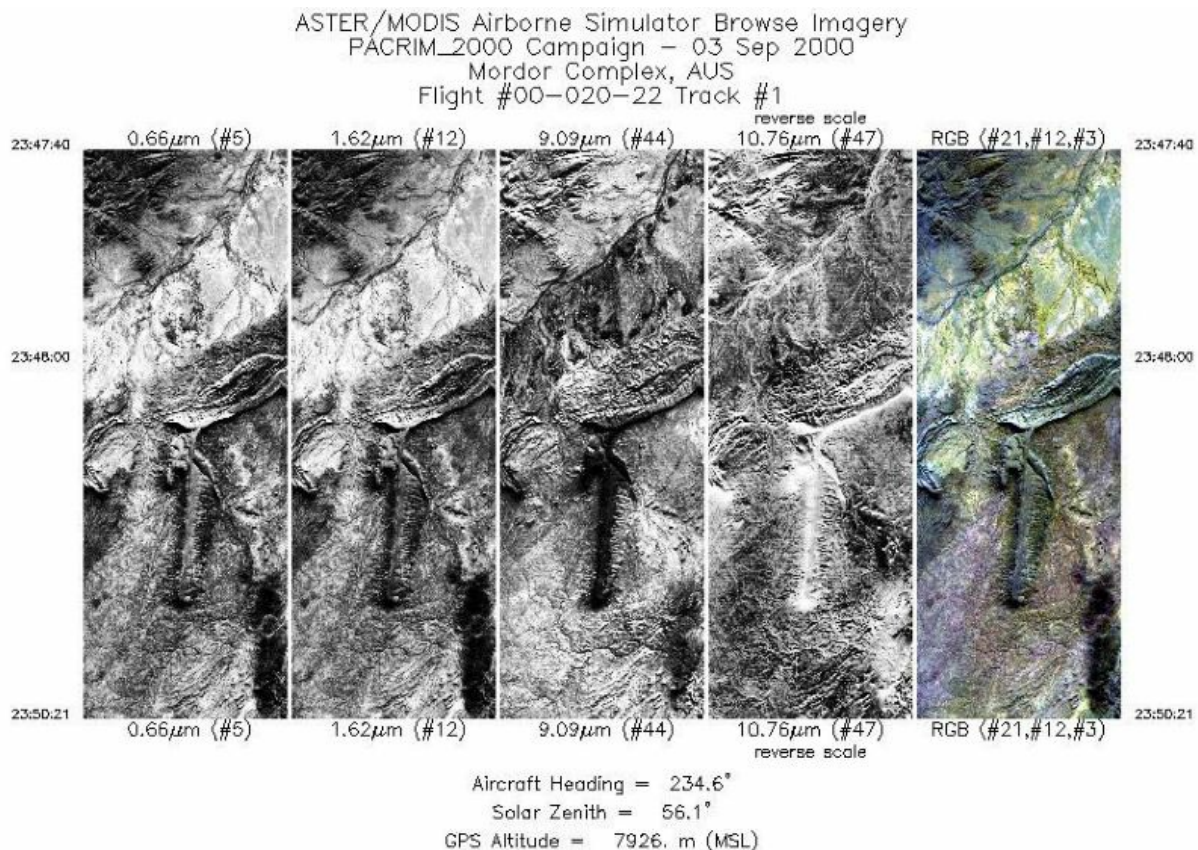

Figure 1. Single-band images and a RGB composite image from flight track 1 acquired on 3 September 2000 over the Mordor Complex east of Alice Springs, Northern Territory, Australia (lat -23.5, lon 134.42). Source: MASTERL1B_0002022_01_20000903_2347_2350_V02.jpg

Citation

Hook, S.J., J.S. Myers, K.J. Thome, M. Fitzgerald, A.B. Kahle, Airborne Sensor Facility NASA Ames Research Center, and F.A. Kruse. 2022. MASTER: Pacific Rim Campaign, July-October, 2000. ORNL DAAC, Oak Ridge, Tennessee, USA. https://doi.org/10.3334/ORNLDAAC/2093

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 46 flights aboard a NASA DC-8 aircraft over sites encompassing the Pacific Rim, including Alaska, California, Hawaii, islands of the south and western Pacific Ocean, New Zealand, Australia, Polynesia, southeast Asia, South Korea, and Japan. Flights took place on 2000-07-21 to 2000-10-23. Data products include L1B georeferenced multispectral imagery of calibrated radiance in 50 bands covering wavelengths of 0.460 to 12.879 micrometers at approximately 25-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 Pacific Rim 2000 (PacRim II) Campaign gathered geographic and atmospheric data for coastal analysis, oceanography, forestry, geology, hydrology and archaeology of various regions using data from the Airborne Synthetic Aperture Radar (AirSAR) and MODIS/ASTER Airborne Simulator (MASTER) instruments. This was the first campaign to operate both the AIRSAR and MASTER instruments simultaneously, providing scientists with additional insight on how topography affects the vegetation and land surface temperature as seen in the MASTER data (Tapley et al. 2001).

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 Publications

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

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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: Selected islands of the Pacific Ocean; portions of Australia, eastern Asia; Alaska, and California, U.S.

Spatial Resolution: 2 to 30 m

Temporal Coverage: 2000-07-21 to 2000-10-23

Temporal Resolution: One-time estimate

Study Area: All latitudes and longitudes given in decimal degrees. Note that this study area crosses the Antimeridian.

Site	Westernmost Longitude	Easternmost Longitude	Northernmost Latitude	Southernmost Latitude
Islands of Pacific Ocean and Pacific Rim sites	101.363	-119.778	65.199	-55.379

Data File Information

This dataset includes a total of 1098 data files: 411 files in Hierarchical Data Format (HDF-4; *.hdf) format, 184 text (*.txt) files, 46 archives of text files that

are zipped (*.zip), 46 flight maps as GIF (*.gif) images, and 411 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 46 flights, which include 411 flight tracks.
- For each flight track, there is one L1B data file in HDF format. There is one auxiliary browse image (*.jpg) for 152 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_0002002_01_20000721_1750_1753_V02.hdf).

The flight track-level browse images are named MASTERL**AA_BBBBBBBB_CC_YYYYMMDD_EEFF_GGHH_**V0**J**.jpg (e.g., MASTERL1B_0002002_01_20000721_1750_1753_V02.jpg).

The deployment-level auxiliary files are named MASTER**_BBBBBBBB_YYYYMMDD_X**.**ext** (e.g., MASTER_0002002_20000721_config.txt).

- AA = "1B" , indicating L1B data level,
- BBBBBBBB = flight number (Table 2),
- CC = flight track (Table 2)
- YYYYMMDD = date of sampling in UTC,
- EEFF = starting time at EE hour and FF minute in UTC,
- GGHH = ending time at GG hour and HH minute in UTC,
- 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	411	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				
MASTERL1B_*BBBBBBBB_CC_YYYYMMDD_EEFF_GGHH_*V0J.jpg	L1B	JPEG	411	Browse figures; one per flight track, multiple tracks per flight.
MASTER_*BBBBBBBB_YYYYMMDD_*ancillary.txt	-	Text	46	Ancillary information about flight including notes on aircraft platform, mission objective, and data evaluation.
MASTER_*BBBBBBBB_YYYYMMDD_*config.txt	-	Text	46	Instrument configuration information for flight.
MASTER_*BBBBBBBB_YYYYMMDD_*flightpath.gif	-	GIF	46	Map showing flight paths.
MASTER_*BBBBBBBB_YYYYMMDD_*spectral_band_info.txt	-	Text	46	Spectral band information.
MASTER_*BBBBBBBB_YYYYMMDD_*spectral_response_table.zip	-	Text	46	Spectral response tables by band (ZIP archive of 50 text files).
MASTER_*BBBBBBBB_YYYYMMDD_*summary.txt	-	Text	46	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 2 to 30 m and is a function of aircraft altitude.

Table 2. Number of flight tracks for each MASTER flight during this 2000 deployment over Pacific Rim sites, including sites in French Polynesia (PYF), American Samoa (ASM), New Zeeland (NZL), Australia (AUS), Indonesia (IDN), Malaysia (MYS), Philippines (PHL), Japan (JPN), Northern Mariana Islands (MNP), and United States (US) (Figure 2).

Date	Flight Number	Locations	Flight Tracks
2000-07-21	0002002	Lake Tahoe, California-Nevada, US	12
2000-07-22	0002003	Ivanpah, California, US	12
2000-07-27	0002005	Montezuma Hills, California, US	12
2000-07-31	0002006	Pacific Ocean Equatorial Crossing	4
2000-08-04	0002007	Makatea, PYF	18
2000-08-05	0002008	Makatea, PYF	3
2000-08-06	0002009	Rurutu, PYF	4

2000-08-08	0002010	Manua, ASM	4
2000-08-10	0002011	Savusavu Bay, FJI (Fiji)	4
2000-08-12	0002012	South Island, NZL	7
2000-08-14	0002013	White Island reef, NZL	7
2000-08-16	0002014	Macquarie Island, AUS	9
2000-08-17	0002015	Uardry, AUS	9
2000-08-18	0002016	Bagobucc, AUS	11
2000-08-19	0002017	Mt. Fitton, AUS	4
2000-08-24	0002018	Hunter Region, AUS	11
2000-08-26	0002019	Strickland River, PNG	4
2000-08-28	0002020	Bougainville, PNG (Papua New Guinea)	8
2000-08-30	0002021	Palm Island, AUS	16
2000-09-03	0002022	Mordor Complex, AUS	12
2000-09-06	0002023	Finke River, AUS	9
2000-09-09	0002024	Cervantes, AUS	17
2000-09-13	0002025	E. Alligator River, AUS	3
2000-09-15	0002026	S. Alligator River, AUS	14
2000-09-15	0002027	Sungai Wain, IDN	1
2000-09-17	0002028	Kinabalu coast, MYS	8
2000-09-19	0002029	Pekan, MYS	13
2000-09-20	0002030	Angkor, KHM (Cambodia)	2
2000-09-23	0002031	Parker Volcano, PHL	8
2000-09-24	0002032	Balayan Bay, PHL	20
2000-09-27	0002033	Polollio Is., PHL	12
2000-09-30	0002034	Jeju Island, ROK (South Korea)	3
2000-10-02	0002035	Tsukuba, JPN	1
2000-10-04	0002036	Nara, JPN	22
2000-10-06	0002037	Farallonde de Pajaros, MNP	6
2000-10-07	0002038	Palau Islands	9
2000-10-09	0002039	Saipan, MNP	2
2000-10-11	0002040	Pu'u O'o, Hawaii, US	24
2000-10-13	0002041	Barbers Point, Hawaii, US	14
2000-10-14	0002042	Molokai, Hawaii, US	9
2000-10-16	0002043	Pu'u O'o, Hawaii, US	14
2000-10-17	0002044	Okmok, Alaska, US	6
2000-10-19	0002045	Ladue, Alaska, US	6
2000-10-21	0002046	Richardson, Alaska, US	13
2000-10-22	0002047	Dot Lake, Alaska, US	3
2000-10-23	0002048	Lake Tahoe, California, US	1
		Total	411

User Notes:

- Dates and times are provided in UTC. Many flights begin shortly before midnight (UTC) on the date listed in Table 2 and end in early hours of the following day. Files for flight *tracks* beginning after midnight will have the following day encoded in their file name.
- There are missing latitude and longitude coordinates in MASTERL1B_0002040_13_20001012_0108_0117_V02..hdf. Missing values are indicated by -999 and -639 for latitude and longitude, respectively.

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 Pacific Rim 2000 (PacRim II) Campaign gathered geographic and atmospheric data for coastal analysis, oceanography, forestry, geology, hydrology and archaeology of various regions using data from the Airborne Synthetic Aperture Radar (AirSAR) and MODIS/ASTER Airborne Simulator (MASTER) instruments. This was the first campaign to operate both the AIRSAR and MASTER instruments simultaneously, providing scientists with additional insight on how topography affects the vegetation and land surface temperature as seen in the MASTER data (Tapley et al. 2001).

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 DC-8 aircraft at altitudes of 5800 to 11,900 m above sea level.
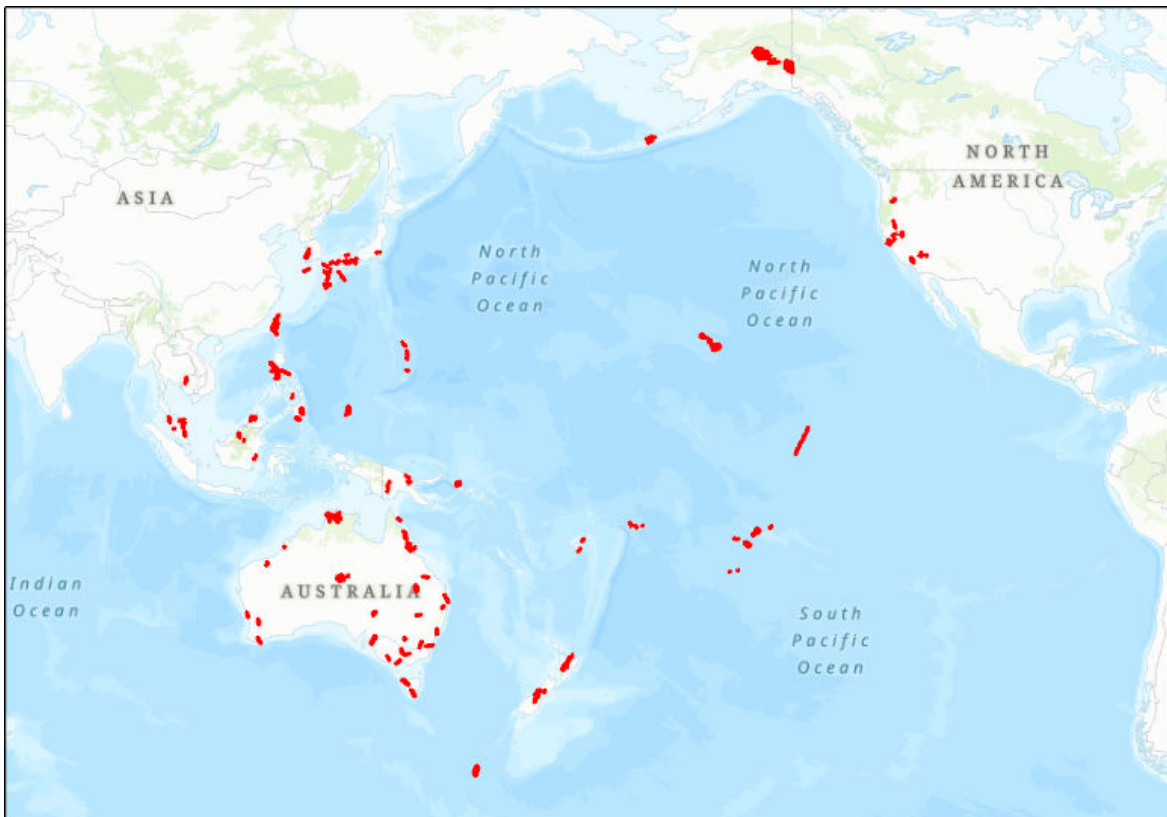

Figure 2. Study areas in this dataset represented as red polygons. Basemap: © OpenStreetMap contributors.
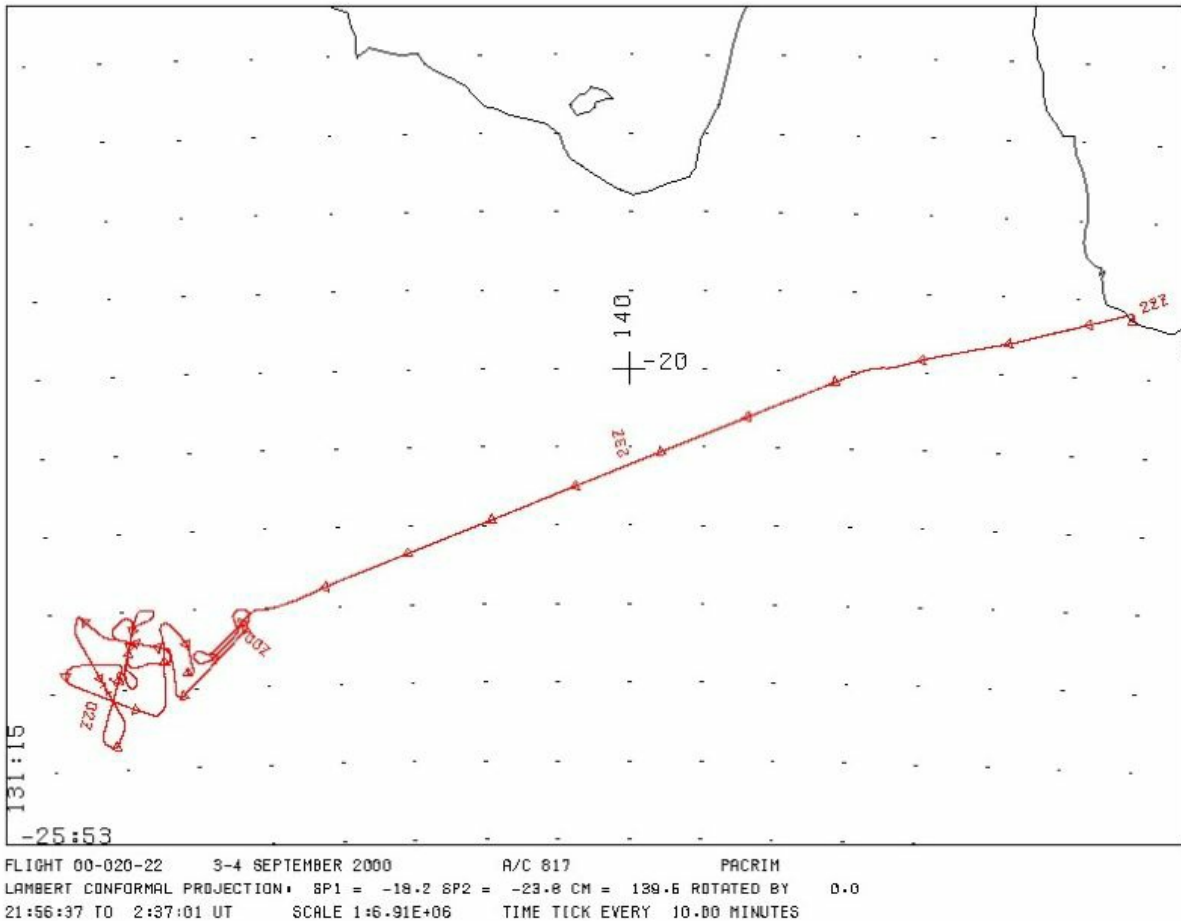
Figure 3. Flight path is shown for 03 September 2000. Flight 0002022 and 12 flight tracks. Map shows flight path from temporary base in Queensland, Australia, to study area in southern Northern Territory, Australia. Source: MASTER_0002022_20000903_flightpath.gif

6. Data Access

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

MASTER: Pacific Rim Campaign, July-October, 2000

Contact for Data Center Access Information:

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

7. References

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