

## MODIS Semi-annual Report January-June 2001

Michael D. King<sup>1</sup> and Steven Platnick<sup>1,2</sup>

<sup>1</sup>Goddard Space Flight Center, Greenbelt, MD

<sup>2</sup>University of Maryland Baltimore County, Baltimore, MD

### Abstract

Major efforts over the past six months included: (i) development of an atmospheric correction algorithm for absorbing gas species for use in the Level-2 cloud retrieval code, (ii) development of a new spectral surface albedo map using MODIS land products, (iii) delivery of updated code of the Level-2 cloud retrieval algorithm (version 3.0.1) and MODIS atmosphere Level-3 code for the consistent year processing effort, (iv) continued analysis of MODIS L2 cloud retrieval algorithm and ancillary data sources, (v) initial analysis of data obtained during the SAFARI 2000 dry season campaign in southern Africa, and (vi) continued analysis of MAS and CAR data from the arctic FIRE-ACE experiment.

### I. Task Objectives

With the use of related airborne instrumentation, such as the MODIS Airborne Simulator (MAS) and Cloud Absorption Radiometer (CAR), our primary objective is to extend and expand algorithms for retrieving the optical thickness, effective radius, and water path of liquid and ice clouds using radiation measurements from the Moderate Resolution Imaging Spectroradiometer (MODIS). The secondary objective is to obtain an enhanced knowledge of surface angular and spectral properties that can be inferred from airborne directional radiance measurements.

### II. Work Accomplished

#### a. MODIS Data Analysis, Code and Related Software Development

##### MOD06 Level-2 cloud retrieval code

Mary Gray spent a large part of his effort on debugging several problems with the code. This involved difficulties with the 3.7  $\mu\text{m}$  cloud particle size retrieval, and mismatched array dimensions from an older piece of code. Gray also eliminated all NetCDF calls, replacing them with HDF routines. Steve Platnick wrote a new particle size solution interpolation routine, which was integrated into the production code by Mark Gray. Eric Moody modified the Quality Assurance (QA) implementation to correct the handling of ancillary classifications. In order to facilitate local reprocessing of granules with selected versions of the MOD06 and MOD35 (cloud mask), Eric Moody and Mark Gray wrote scripts to generate process control files (pcf) for running the various "upstream" codes required for cloud retrieval processing. This allowed testing of the latest version codes before

final delivery.

Other specific areas of improvements are discussed below:

**Reflectance Libraries** (Yang, Platnick, Arnold): New cloud ice/water libraries were generated by Ping Yang, with the assistance of Tom Arnold and Steve Platnick. The new water library reflectances are calculated for a different set of particle sizes and include scattering parameters that are correctly integrated over the latest MODIS spectral response functions. Tom Arnold wrote IDL code that plots the reflectance libraries in a number of various ways, including angular interpolation and the incorporation of surface albedo. The plots have been used for validation of the reflectance functions.

**Surface Albedo** (Moody, Platnick, King): a seasonally independent and relatively broadband surface albedo ancillary data product based on the published literature was replaced with a seasonally dependent scheme derived from MODIS data. In both cases, ecosystem is used as a surrogate for spectral surface albedo. The latest algorithm uses a new ecosystem mask with IGBP classifications from MOD12, plus a USGS water mask and a tundra mask carried over from the initial work from the CERES group at LaRC. The MODIS white sky spectral albedo product (MOD43) is then aggregated according to ecosystem to generate statistics based on ecosystem. Results were very encouraging, showing the dispersion for most ecosystems and bands to generally be less than 10%. Examples are shown in [Figs. 1 and 2](#).

**Atmospheric Correction** (Li, Platnick): a look-up table approach to the atmospheric correction of absorbing gas species has been implemented. It is based on *MODTRAN 4* calculations, with scripts written by Jason Li for simulating two-way path transmittances and integrating over the MODIS bands of interest (1, 2, 5, 6, 7, 20, and 30). The approach assumes that absorption of water vapor is primarily due to the column amount of vapor between cloud-top and the top of the atmosphere, and not the details of the vertical distribution. It is also assumed that the temperature profile plays a very minor role for both water vapor and well mixed gas species. The table consists of transmittance calculations for specific cloud top pressures and a variety of profiles (standard and soundings) as water vapor above-cloud precipitable water is varied. The uncertainty in this approach (determined by the standard deviation in transmittance for the different profiles) is found to be quite small compared to uncertainties in water vapor ancillary data (currently from NCEP GDAS). An example is shown in [Fig. 3](#).

**Decision Tree** (Gray, Arnold, King, Platnick): The decision tree part of the retrieval algorithm, which is based on individual 1 km cloud mask tests, is used for two purposes: determine whether a pixel is suitable for a cloud retrieval, and if so, infer the thermodynamic phase of the cloud. It was decided to turn off the branch that relies only on the 1.38  $\mu\text{m}$  band reflectance as it is affected by striping in the calibration as well as retrievals being very sensitive to ancillary information (especially over land). Preliminary analysis also indicates that 1 km sub-

pixel cloud fraction is apparent in some 0.25 km imagery but is passing the decision tree tests. This suggests that spatial variability tests need to be added to our decision tree and should be a priority in future algorithm efforts.

### **Instrument issues:**

Level 1B saturation had been found in bands 2 and 5 (0.86 and 1.24  $\mu\text{m}$ , respectively) over cloud scenes. Band 2 saturation is at the detector level and cannot be fixed (note that this band is expected to saturate at even lower radiances on the Aqua MODIS instrument). Band 5 saturation is due to the A/D converter and can be fixed by reducing programmable gain stages before the converter. Steve Platnick estimated the new  $I_{\text{max}}$  that would be useful, and worked with Jack Xiong of MCST and Roger Drake of SBRS in requesting a 25% reduction in gain. After the gain change, analysis of saturated pixels showed that the fractional saturation of band 5 pixels in equatorial regions is a maximum of about 1%, compared with 5-10% of pixels before the change. The new gain was finalized on 23 April 2001.

Mark Gray, Eric Moody, Steven Platnick, and Michael King continued to examine MODIS Level 2 cloud optical thickness and effective radius retrievals. Example analyzes of ship tracks forming in a region of marine stratocumulus off the coast of California is shown in [Figs. 4 and 5](#). Examination of various liquid water cloud scenes gives results physically realistic and consistent with our understanding of these systems. Ice cloud retrievals also appear consistent with reported in situ measurements.

### MOD08 Level-3 atmosphere code

Paul Hubanks made three redeliveries of the MOD08 atmosphere level-3 code. The initial delivery corrected and/or updated the MOD08 (MODIS Atmosphere Joint Product) Tile, Daily, Eight-Day, and Monthly CDL file specs and corresponding HDF structure files.

Modifications in the second delivery included: correction of the Cloud\_Fraction\_SWIR phase population bug in the MOD08 Tile code, and verification that all the Cloud Fraction parameters were being computed correctly; correction of a bug causing the incorrect population of the Pixel\_Count statistics in the MOD08 Tile code; major modifications to the Tile, Daily, Eight-Day, and Monthly CDL File Specs and HDF Structure Files as requested by Yoram Kaufman of the Atmosphere Aerosol Group (addition of a number of new parameter groups as well as tweaking some existing groups). With the above changes, Hubanks prepared complete delivery packages (FORTRAN90 software, test (populated) HDF files, HDF structure files, CDL file specs, history files, readme files, and PACKINGLIST files) for four PGEs (PGE56, 57, 69, 70) that correspond to the MOD08 Daily, Monthly, Tile, and Eight-Day products, respectively.

In the final delivery (3 June 2001), MOD08 products were updated by redefining

bin-boundary definitions for a number of histogram and joint histogram parameters. These changes were made by an update to the CDL file specs and HDF structure files for each MOD08 product. No changes in the source code were made.

Eric Moody finished porting his high resolution L3 code ( $0.1^\circ$ ) into MODAPS production after scientific SDSs were added. Results have been verified. This high-resolution output will not be an official product but will be pushed to local machines without DAAC archiving.

An example of a joint histogram of cloud optical thickness and effective radius for liquid water clouds off the coast of California on 28 May 2001 is shown in [Fig. 6](#).

### MODIS Atmosphere web site development

Paul Hubanks updated and added numerous items on the MODIS Atmosphere web site. A sampling of some of this work includes:

1. Design: completed a redesign of the Level 1B granule images page (cf [Fig. 7](#)).
2. Browse imagery: Modified the fixed (optimized) scale for all MOD04 Aerosol-related products. The scale was changed from '0 to 2' to '0 to 0.8', which was done to enhance detail in the images. All MOD08\_D3, E3, and M3 images were rerun with the new scale and loaded to the MODIS-Atmosphere web site archive image library. Modified the fixed (optimized) scale for all MOD06 cloud effective radius Ice-related products. The scale was changed from '0 to 80' to '0 to 50', which was done to enhance detail in the images (necessary after the science algorithm was modified such that the upper range in the effective radius retrieval was reduced to 50). All MOD08\_D3, E3, and M3 images were rerun with the new scale and loaded to the MODIS-Atmosphere web site archive image library. Converted the entire MOD08 (Daily, Eight-day, Monthly) web-based Browse Image system from GIF to PNG format when IDL stopped supporting the GIF image format (due to royalty issues) in early 2001.
3. Tools: A new granule locator tool (developed by Rob Levy) was added to the TOOLS page on the MODIS-Atmosphere web site. The tool will locate granules based on the granule metadata files produced by MODAPS. Updated all the Product Analysis Tools pages, from MOD04\_L2 to MOD08\_M3. Added a new tool that extracts and visualizes bit flags from MODIS HDF data. The tool can be downloaded on the BitMapper Tool page.
4. Documentation: Created an algorithm history page for the MOD04 (Aerosol), MOD05 (Water Vapor), and MOD06 (cloud) products. Added "Modification History" and "Known Problems" pages for the Cloud Mask (MOD35\_L2) product. Developed a Data Product Processing and Availability table on the

Products page. Added SDS parameter definitions and derivation information to the MOD08\_D3 Format & Content page. Updated the MOD08\_D3 (Daily Global Product) Parameter List on the MOD08\_D3 Format page. Updated the File Specifications for the Daily (MOD08\_D3), Eight-Day (MOD08\_E3), and Monthly (MOD08\_M3) Global products. Added an updated MODIS Atmosphere Validation Plan on the Validation page and added a link to the EOS Product Validation Site, maintained by the University of Utah on the Validation page. Added the MODIS Atmosphere Data Products and Science Results PowerPoint presentation on the Reference page. Preliminary history information can be found on the MOD05\_L2 History page.

5. Miscellaneous: completed the restoration of the MODIS-Atmosphere web site after a disk drive was lost and the system backup failed.

#### MODIS product visualizations and other software tools

Using the following available tools, Eric Moody, Mark Gray, and Paul Hubanks provided MODIS visualizations for numerous conferences (IGARSS, IAMAS, IGBP), meetings (MODIS, SAFARI), proposals (CRYSTAL-FACE), MODIS brochures, and the new Aqua data products handbook. Specific work included:

- Eric Moody developed global, regional, and seasonal imagery of the new surface albedo ancillary data derived from MODIS land products as described previously.
- Mark Gray and Eric Moody developed imagery of effective radius histograms from the three separate retrievals (using the 1.6, 2.1, and 3.7  $\mu\text{m}$  bands).
- Eric Moody worked with Mike Manyin (NASA GSFC) to create quick time movies of retrievals mapped to a rotating 3-D globe.
- Mark Gray finished an improved version of IDL code for viewing level-1B RGB imagery.
- A new level-3 joint histogram display tool was developed by Paul Hubanks and linked to the MODIS-Atmosphere web site. This tool displays a global image of a specific joint histogram bin. Hubanks also completed work on several IDL tools that make 3-D box plots of any joint histogram SDS for a specified region of 1-degree grid cells (see [Fig. 6](#)), as well as zonal average plots of any simple statistical SDS parameter (masked for ocean or land) from MOD08 related HDF products.

## **b. MODIS-related Instrument Efforts**

### Cloud Absorption Radiometer (CAR)

#### 1. CLAMS

Charles Gatebe coordinated CAR instrument repairs, calibration, and test flights on the University of Washington CV-580 in Seattle (3-13 June 2001). An overview of the CAR instrument is posted at [modis-atmos.gsfc.nasa.gov/car/instrument](http://modis-atmos.gsfc.nasa.gov/car/instrument).

#### 2. CAR Data processing

Jason Li has rewritten the CAR HDF processing code in C++. He included modifications necessitated by changes to raw data format, and by aircraft pitch and roll corrected viewing azimuth and zenith angles. He also undertook a major effort to design an algorithm for finding and correcting bad dark current data (required for HDF processing).

#### 3. CAR web site

Paul Hubanks continued the redesign and re-engineering of the Cloud Absorption Radiometer (CAR) web site. He is currently reformatting the existing pages, editing content, and developing new pages (see [Fig. 8](#)).

### MODIS Airborne Simulator (MAS)

Several MAS upgrades were implemented by NASA Ames Research Center before the SAFARI 2000 deployment, including replacement of old dichroics, primary and secondary mirrors, redesign of the port 4 dewar mounts and pressure release valve, and rewriting of the L1B processing code. Post-deployment calibration at Ames indicated a substantial change in the radiometric calibration compared with the pre-deployment calibration. Use of a field integrating hemisphere to correct for radiometric changes on a flight-by-flight basis was investigated and found to be consistent with a linear calibration degradation (vs. number of ER-2 flights). This calibration strategy, involving the participation of Steve Platnick and Tom Arnold, was implemented by the Ames airborne data facility and used in generating final Level 1B files for all of SAFARI 2000.

Mark Gray and Eric Moody are developing MAS versions of the MODIS cloud retrieval code, including use of the latest routines developed for MODIS version 3 algorithms. The new MAS code will include HDF output of retrieval results, ancillary data including the cloud mask, geolocation, and QA information. Development is expected to continue through July 2001.

### c. MODIS-related Field Campaign and Validation Efforts

#### SAFARI 2000

Steve Platnick and Tom Arnold worked with in situ cloud data received from the University of Washington CV-580 and UK Meteorological Research Flight C-130 during validation efforts off the coast of Namibia. A preliminary analysis of the data is completed and awaiting comparison with MODIS/MAS retrievals using the latest algorithm updates and additions. These comparisons will mark the first validation effort for the MODIS cloud retrieval product. Michael King and Steve Platnick discussed future collaborative efforts on cloud property and aerosol interactions with SAFARI scientists during the SAFARI Science Team Meeting held at GSFC on 30-31 May 2001.

Charles Gatebe, Tom Arnold, and Jason Li worked on various aspects of the CAR SAFARI data, including calibration and generation of Level 1B data.

#### CLAMS (Chesapeake Lighthouse and Aircraft Measurements for Satellites)

Charles Gatebe attended to CLAMS activities, including two science team meetings. Gatebe will participate in the field campaign (9 July - 3 August 2001) along with Tom Arnold and Jason Li.

#### ACE-Asia

Si-Chee Tsay deployed his ground-based instrumentation suite (SMART) at Dunhuang, China during ACE-Asia. Eric Moody helped support the suite during a 2-week period (5-22 May). At the completion of the deployment, Moody flew to Beijing to brief members of the Institute of Atmospheric Physics on MODIS and MODIS-derived cloud products, helping to foster relationships with institute scientists and their research groups.

#### CRYSTAL-FACE

Michael King and Steve Platnick submitted a proposal for the participation of the MAS in the NASA CRYSTAL-FACE field campaign to be held in Florida during summer 2002. In addition, Si-Chee Tsay submitted a proposal for the SMART surface-based radiation platform. This field campaign will provide an excellent opportunity for validation of MODIS ice cloud retrievals.

### d. MODIS-related Services

#### Meetings

1. Steve Platnick participated in the *MODIS Characterization and Support Team Calibration Meeting* held in Greenbelt, MD, 22 January 2001.
2. Michael King organized the *MODIS Atmosphere Discipline Team Meeting* at

NASA GSFC, 23 January 2001; Steve Platnick, Mark Gray, Eric Moody, Paul Hubanks, and Si-Chee Tsay attended.

3. Michael King, Steve Platnick, Mark Gray, Eric Moody, and Paul Hubanks attended the *MODIS Science Team Meeting* in Greenbelt, MD, 24-25 January 2001.
4. Charles Gatebe attended two *CLAMS Science Team Meetings*, 20-22 February 2001 at NASA LaRC and 1 June 2001 at NASA GSFC.
5. Michael King, Steve Platnick, Mark Gray, Tom Arnold, and Si-Chee Tsay participated in the *Terra Cloud Mask Workshop* held at the University of Wisconsin, Madison, 8-9 May 2001.
6. Michael King, Steve Platnick, Charles Gatebe, and Si-Chee Tsay participated in the *SAFARI 2000 Science Team Meeting* held at NASA GSFC, 30-31 May 2001.
7. Michael King, Steve Platnick, and Tom Arnold participated in the *MODIS Airborne Simulator Annual Technical Meeting* held at NASA GSFC, 1 June 2001.
8. Michael King regularly attended weekly *MODIS Technical Team meetings*.
9. Steve Platnick regularly attended weekly *MODIS Sensor Working Group meetings*.
10. Mark Gray, Eric Moody, and Paul Hubanks attend the weekly *MODIS Atmosphere Data Processing meetings*.

#### Presentations

1. Platnick, S., *Overview of the SAFARI field campaign*. Presented at the *MODIS Atmosphere Discipline Team Meeting*, 23 January 2001.
2. King, M. D., et al., *MODIS Atmosphere Summary*. Presented at the *MODIS Science Team Meeting*, Greenbelt, MD, 24 January 2001.
3. Platnick, S., C. C. Moeller, and L. A. Remer, *Summary of MODIS Atmosphere Team Validation Activities*. Presented at the *MODIS Science Team Meeting*, Greenbelt, MD, 25 January 2001.
4. King, M. D., et al., *Early results from the MODIS atmosphere algorithms*. Presented at the *Investigators Working Group Meeting*, Fort Lauderdale, FL, 31 January 2001.
5. King, M. D., et al., *Early results from the MODIS atmosphere algorithms*. Presented at the *CloudSat Meeting*, Ottawa, Canada, 14 February 2001.

6. Gatebe, C. K., *Cloud Absorption Radiometer (CAR)*. Presented at the CLAMS Science Team Meeting, Williamsburg, VA, 22 February 2001.
7. King, M. D., *How NASA's Earth Observing System (EOS) monitors our world environment*. Presented at the GEWEX Coordinated Enhanced Observing Period (CEOP) International Workshop, NASA Goddard Space Flight Center, Greenbelt, MD, 27 February 2001.
8. Gatebe, C. K., *Questions about aerosols: What do we know about aerosols and what don't we know?*. Presented at Howard University, 7 March 2001.
9. King, M. D., et al., *Early results from the MODIS atmosphere algorithms*. Presented at the DoE Atmospheric Radiation Measurements Meeting, Atlanta, GA, 21 March 2001.
10. King, M. D., *Remote sensing of smoke, land, and clouds during SAFARI 2000*. Seminar presented at NASA Goddard Space Flight Center, Greenbelt, MD, 1 May 2001.
11. King, M. D., *Overview of remote sensing science and applications*. Presented at the GEWEX Americas Prediction Project (GAPP) Workshop, Potomac, MD, 2 May 2001.
12. Arnold, G. T., et al., presentation on the MODIS cloud retrieval decision tree at *Terra Cloud Mask Workshop*, 9 Madison, WI, 9 May 2001.
13. Gray, M., et al., presentation on the MODIS cloud retrieval product at *Terra Cloud Mask Workshop*, Madison, WI, 9 May 2001
14. Platnick, S., M. D. King, W. P. Menzel, Y. J. Kaufman, S. A. Ackerman, D. Tanré, B. C. Gao, *MODIS Atmosphere Data Products and Science Results*. Presented at the NASA GSFC Directors Seminar, 21 May 2001.
15. Moody, E., et al., *MODIS and MODIS Cloud Products*. Seminar presentation at the *Institute of Atmospheric Physics* in Beijing, PRC, 23 May 2001.
16. King, M. D., *Introduction of EOS, MODIS, and MODIS atmosphere products*. Presented at the *Workshop for Earth Science Satellite Remote Sensing Data Processing, Analysis and Applications*, George Mason University, Fairfax, VA, 4 June 2001.

### III. Data/Analysis/Interpretation

#### a. FIRE-ACE

Tom Arnold finalized the decision tree logic to be used for FIRE-ACE cloud retrieval processing. MAS retrievals can be performed once modification of the MAS code is updated (cf. II.b). Steve Platnick and Tom Arnold applied a known technique for inferring cloud thermodynamic phase from the shape of the re-

flectance spectrum within the 1.6, 2.1, and 3.7  $\mu\text{m}$  MAS bands. Results are very encouraging and are being compared to the decision tree approach and the 8.5 and 11  $\mu\text{m}$  method used at the University of Wisconsin.

#### **b. Initial SAFARI analysis of Namibian marine stratocumulus**

Several flight days were deemed suitable for cloud retrieval case studies at the SAFARI 2000 science team meeting held at GSFC on 30-31 May 2001. MODIS retrievals for these selected days have been run using the new production code. MAS retrievals are awaiting modification of the MAS retrieval code. The in situ validation will come from the University of Washington Convair CV-580 and the UK C-130 (both platforms flew out over Namibian stratocumulus). A South African Weather Bureau Aerocommander 690A also coordinated with Terra during continental cloud sampling.

#### **c. CAR retrievals**

Charles Gatebe, Oleg Dubovik, Michael King, and Si-Chee Tsay are developing a new inversion scheme to simultaneously retrieve aerosol optical properties and surface BRDF.

### **IV. Problems/Corrective Actions and Status**

In addition to fixing bugs, the main emphasis over this reporting period was to: (a) implement atmospheric corrections for above-cloud gas absorption, (b) improve sea ice/snow and land spectral surface albedos, (c) analyze and refine the decision tree approach for inferring thermodynamic phase, (d) compare cloud particle size retrievals using the three different SWIR/MWIR bands (at 1.6, 2.1, 3.7  $\mu\text{m}$ ), and (e) update reflectance libraries. All items have been completed and the updated cloud retrieval code (version 3.0.1) is currently in production. During the next half-year, all members of the team will be involved in accessing these updates and monitoring the quality of the code.

### **V. Anticipated Future Actions**

1. Monitor performance of the cloud retrieval code in production.
2. Duplicate additions/corrections/features of the MODIS code in the MAS version of the cloud retrieval code.
3. Evaluate anomalous non-monotonic behavior of diffusion domain parameters in reflectance libraries and implement a correction.
4. Continued analysis of SAFARI 2000 dry season campaign (August-September 2000) data, and FIRE-ACE (May-June 1998) data sets.
5. Present status and examples of MODIS cloud products at scientific confer-

ences and meetings.

## VI. Publications

### a. Published

1. Gatebe, C. K., M. D. King, S. C. Tsay, Q. Ji, G. T. Arnold and J. Y. Li, 2001: Sensitivity of off-nadir zenith angles to correlation between visible and infra-red reflectance for use in remote sensing of aerosol over land. *IEEE Trans. Geosci. Remote Sens.*, **39**, 805-819.
2. Tyson, P. D., and C. K. Gatebe, 2001: The atmosphere, aerosols, trace gases and biogeochemical change in southern Africa: A regional integration. *S. Afr. J. Sci.*, **97**, 106-118.

### b. Accepted

1. Platnick, S., J. Y. Li, M. D. King, H. Gerber, and P. V. Hobbs, 2001: A solar reflectance method for retrieving cloud optical thickness and droplet size over snow and ice surfaces. *J. Geophys. Res.*, in press.
2. Marchand, R. T., T. P. Ackerman, M. D. King, C. Moroney and J. P. Muller, 2001: Multiangle observations of arctic stratus clouds. *J. Geophys. Res.*, in press.
3. Arnold, G. T., S. C. Tsay, M. D. King, J. Y. Li and P. F. Soulen, 2001: Airborne spectral measurements of surface-atmosphere anisotropy for Arctic sea ice and tundra. *Int. J. Remote Sens.*, in press.
4. Dubovik, O., B. N. Holben, T. F. Eck, A. Smirnov, Y. J. Kaufman, M. D. King, D. Tanré and I. Slutsker, 2001: Variability of absorption and optical properties of key aerosol types observed in worldwide locations. *J. Atmos. Sci.*, in press.
5. Gatebe, C. K., P. D. Tyson, H. J. Annegarn, G. Helas, A. M. Kinyua, and S. Piketh, 2001: Characterisation and transport of aerosols over equatorial eastern Africa. *Global Biogeochem. Cycles*, in press.

## VII. Awards

Michael King received the NASA Group Achievement Award on behalf of 'The Earth Observatory Web Page Team'.

## VIII. Web sites

The Cloud Retrieval Group, MODIS Atmosphere, MAS, and CAR web sites can be found at:

<http://www.gsfc.nasa.gov/crg>

[modis-atmos.gsfc.nasa.gov](http://modis-atmos.gsfc.nasa.gov)  
<http://www.gsfc.nasa.gov/MAS>  
<http://www.gsfc.nasa.gov/CAR>

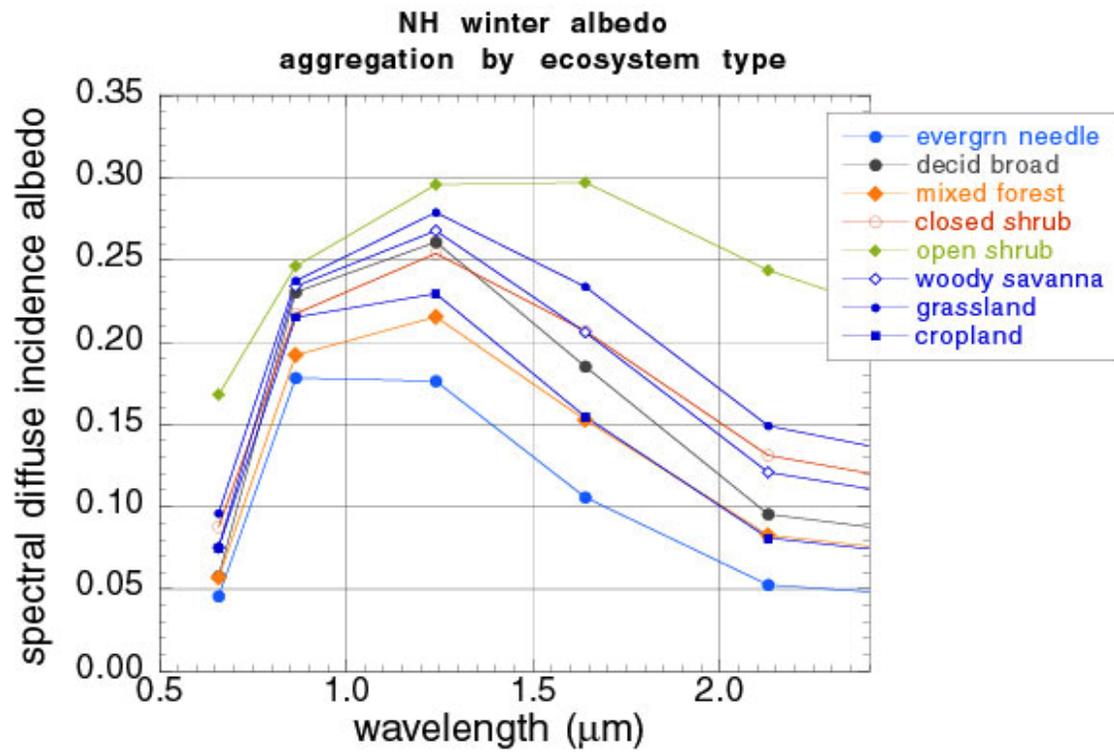
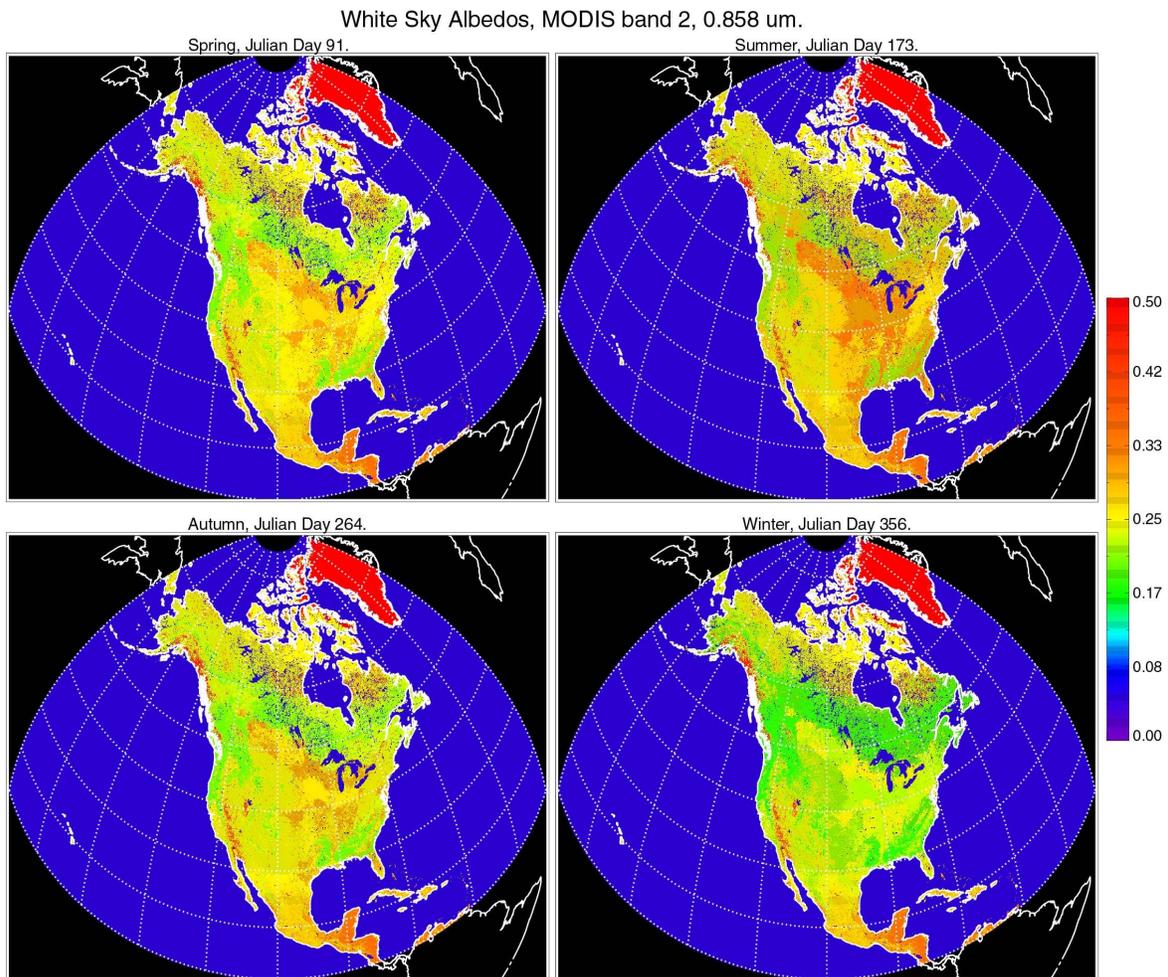
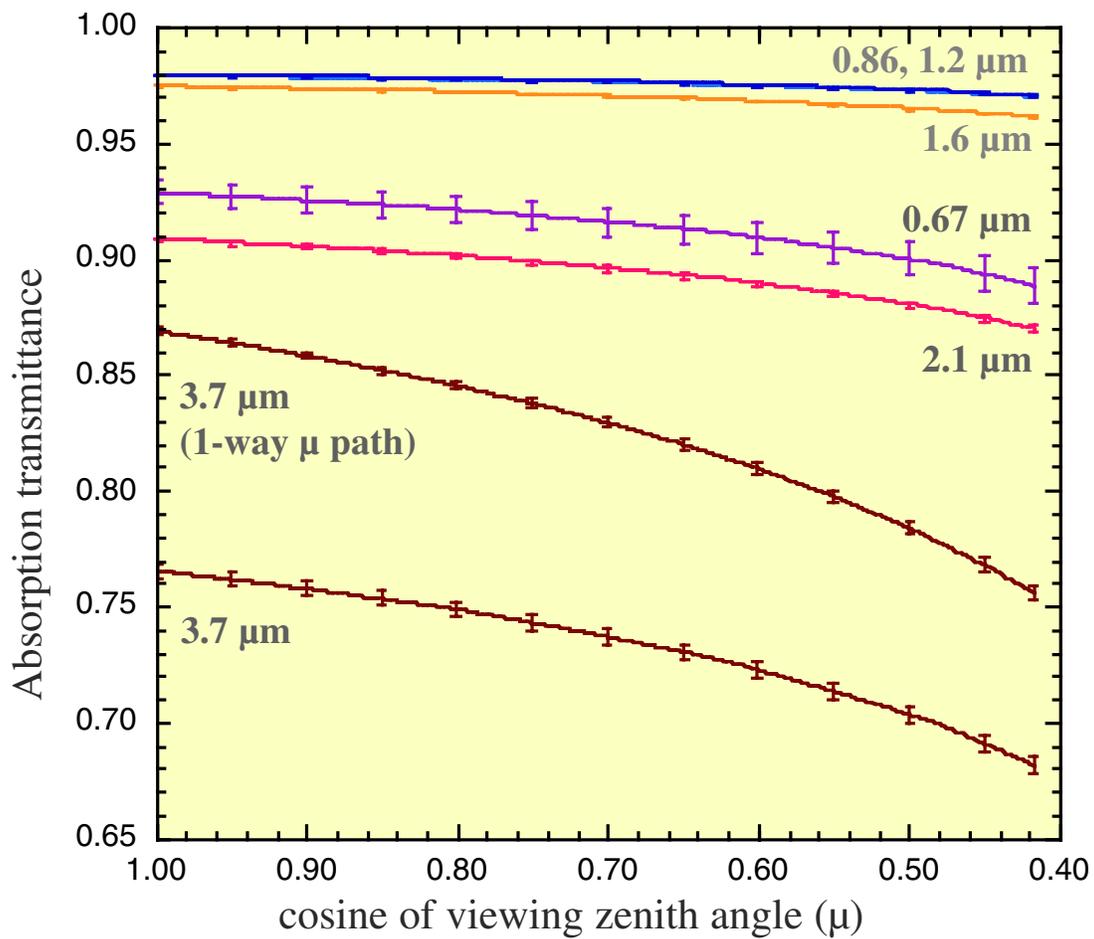


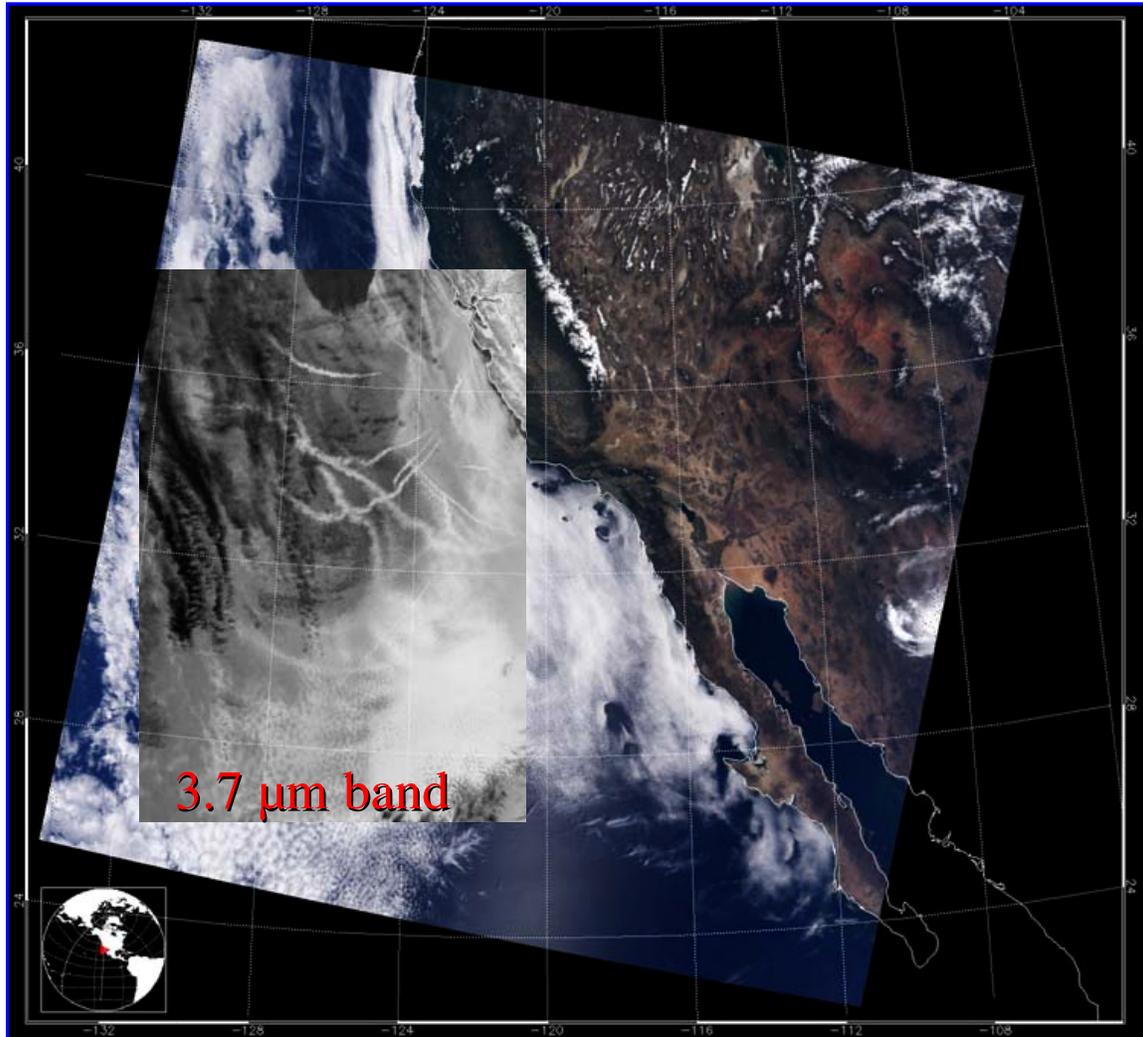
Fig. 1. Spectral albedo derived from MOD12 and MOD43 product aggregation, for selected ecosystems.



**Fig. 2.** Seasonal spectral albedo maps for the Northern hemisphere derived from MOD12 and MOD43 product aggregation.



**Fig. 3.** Atmospheric transmittance in various MODIS bands for a cloud-top at located at a pressure level of 900 mb, with  $2.0 \text{ g}\cdot\text{cm}^{-2}$  of above-cloud water vapor and a cosine of the solar zenith angle of 0.80. A “two-way” path refers to transmittance from the sun to cloud top, and back towards the satellite.



**Fig. 4.** RGB true color composite image of ship tracks off the coast of California on 25 April 2001. An overlay of the 3.7  $\mu\text{m}$  band shows microphysical changes within the tracks (decreased droplet sizes).

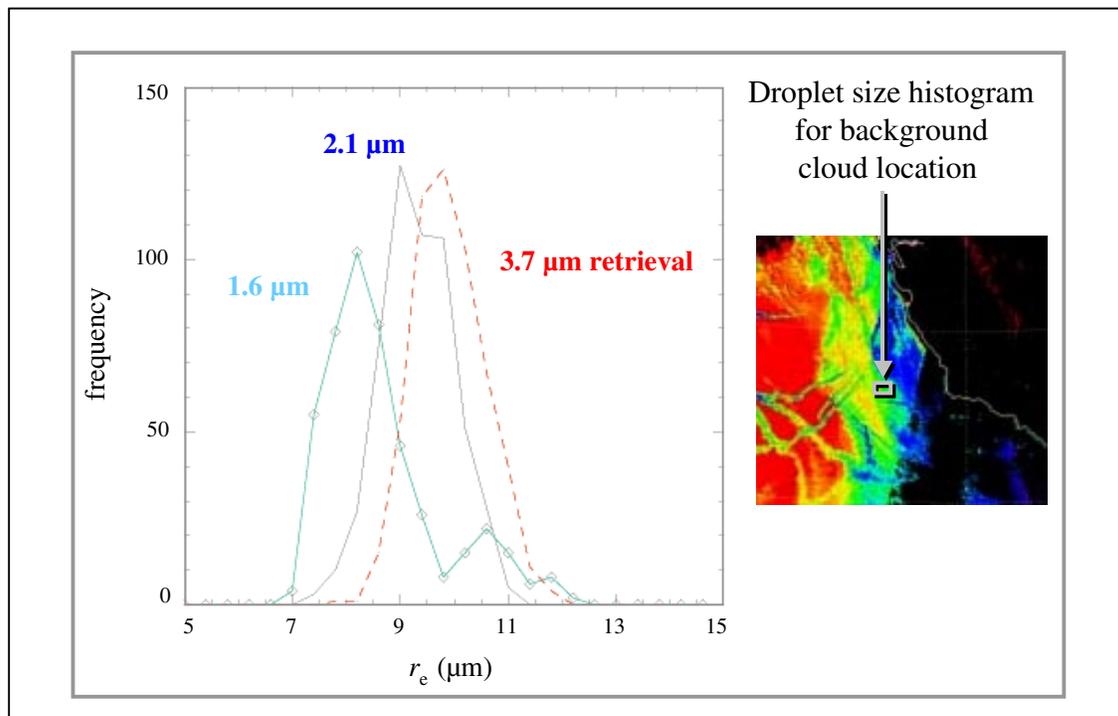
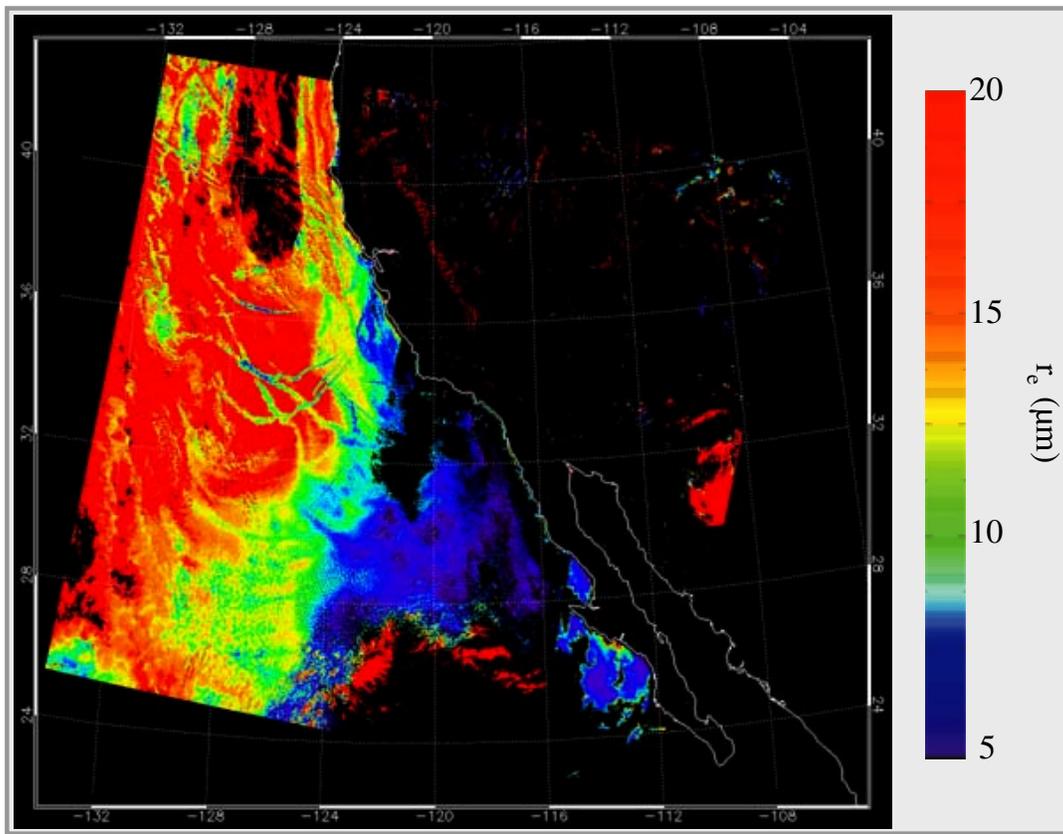


Fig. 5. Cloud effective radius retrievals from the MODIS granule of Fig. 4 (top image). The bottom image shows a histogram of size retrievals corresponding to each of the independent bands used in the retrieval (1.6, 2.1, and 3.7  $\mu\text{m}$  bands).

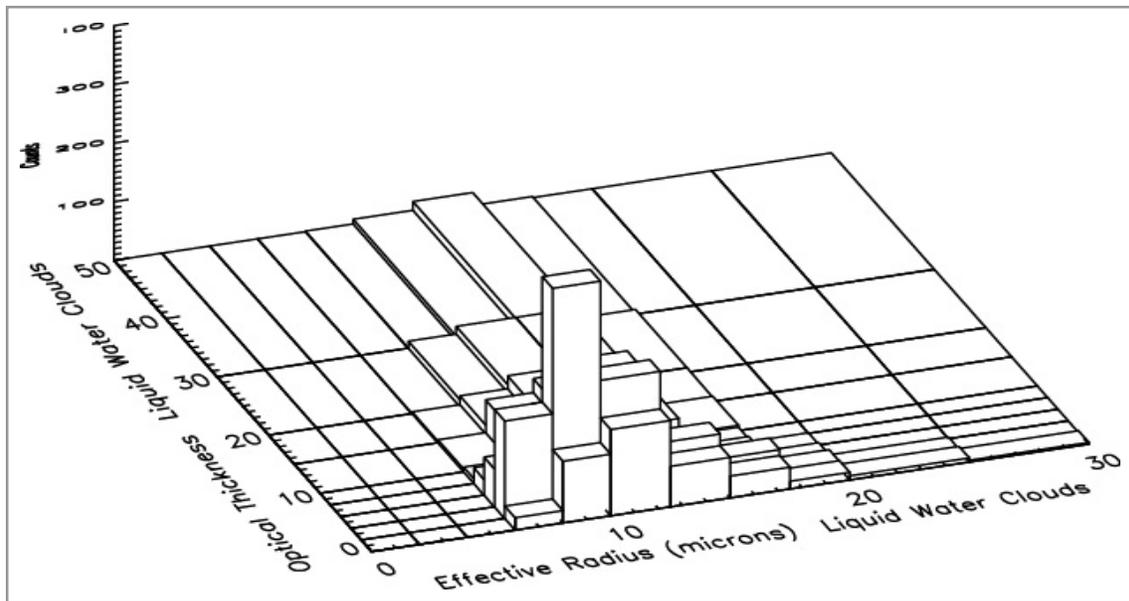


Fig. 6. Example joint histogram of cloud optical thickness and effective radius taken from the production run of the MODIS Atmosphere daily Level-3 product, for an aggregation of liquid water clouds off the coast of California on 28 May 2001 in the region 32-38°N, 117-127°W.

**MODIS Atmosphere**

HOME PRODUCTS IMAGES VALIDATION NEWS STAFF FORUM REFERENCE TOOLS HELP

MOD04\_L2 MOD05\_L2 MOD06\_L2 MOD07\_L2 MOD35\_L2 [Level-2 Products]

MOD08\_D3 MOD08\_E3 MOD08\_M3 [Level-3 Products]

**IMAGES**

Production Images

**L1B GRANULES**

L3 HIGH-RES DAILY

L3 LOW-RES DAILY

L3 LOW-RES EIGHT-DAY

L3 LOW-RES MONTHLY

Show case Images

L1B GRANULES

L1B REGIONAL

L2 REGIONAL

Show case Movies

L2 & L3 GLOBAL

**Menu**  
Select date!

2001

June

- 15th (166)
- 14th (165)
- 13th (164)
- 12th (163)
- 11th (162)
- 10th (161)
- 09th (160)
- 07th (158)
- 06th (157)
- 05th (156)
- 04th (155)
- 03rd (154)
- 02nd (153)
- 01st (152)

May

April

March

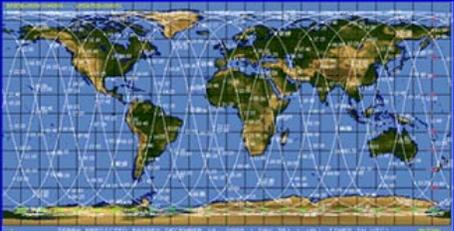
February

January

2000

**15 June 2001 (Day 166)** **HELP**

**MODIS Orbit Track Maps (Predicted)**  
Click on thumbnail map to load full-res version. Maps by UWMisc SSEC.



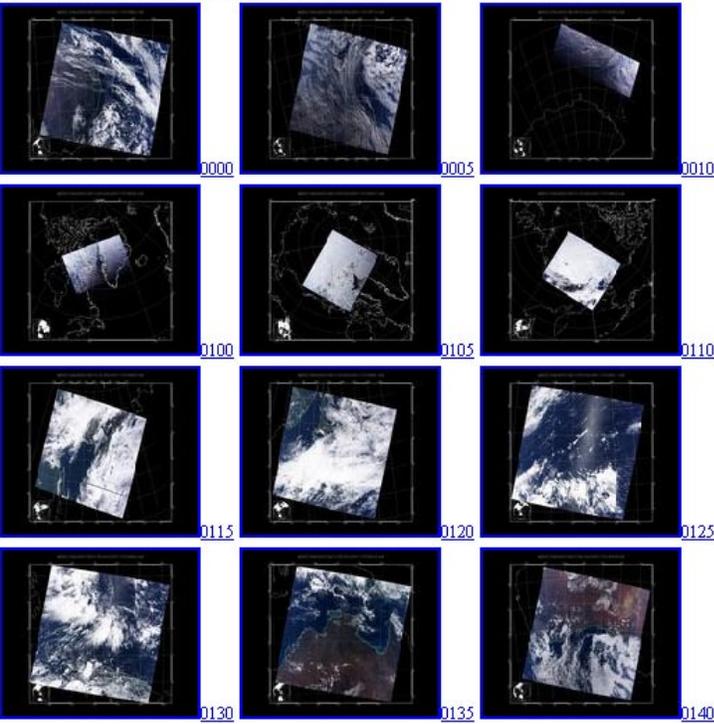
Arc Afr

N.Am Asia

S.Am Aus

Eur Ant

**MODIS L1B Granule Images (RGB=1:4:3)**  
Click on thumbnail image (or UTC time tag) to load full-res version.



0000 0005 0010

0100 0105 0110

0115 0120 0125

0130 0135 0140

Fig. 7. Example of the images section taken from the of the MODIS atmosphere web site.

HOME
INSTRUMENT
APPLICATION
NEWS
DATA
SOFTWARE
REFERENCE
STAFF

# Cloud Absorption Radiometer

**DATA**

OVERVIEW

CLAMS

10 Jul 2001 #1870

12 Jul 2001 #1871

14 Jul 2001 #1872

16 Jul 2001 #1873

17 Jul 2001 #1874

23 Jul 2001 #1875

### CLAMS CAMPAIGN

**17 July 2001 (Flight #1874)**

**Aircraft Flight Summary**

Date: 17 July 2001

Time (Flight): 12:28 to 18:16 UTC

Time (Data): 12:44 to 17:50 UTC

Aircraft Type: [Convair CV-580](#)

Aircraft Flight Scientist: [Prof. Peter Hobbs](#)

Aircraft Flight Number: 1874

Mission Location: [Atlantic Ocean](#)

Lat/Lon Coverage: [36.5-37.9N, 74.8-76.3W](#)

Navigation Statistics: [versus Time](#)

**Flight Track Map**



Map by UJWASH

**CAR Data Summary**

Principal Investigator: [Dr. Michael King](#)

Co-PI: [Dr. Charles Gatebe](#)

Spectral Bands: [Configuration](#)

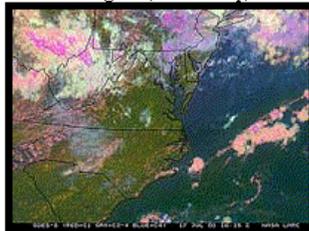
Calibration Type: [Preliminary](#)

**MODIS Image** *(direct broadcast)*



MODIS 7/17/2001 16:05 UTC  
Images by SSEC UW-MADISON

**GOES-8 Images** *(satellite loop)*



GOES-8 7/17/2001 12:45 to 18:15 UTC  
Images by NASA LaRC

**CAR Images** *(quicklook)*

**Imagery from CAR Instrument**  
(RGB = 0.87, 0.68, 0.47 microns)

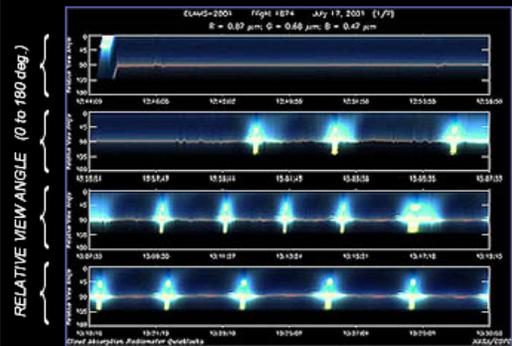
Click browse image thumbnail to load more detailed version.

FLIGHT DIRECTION

→

EURO-2001 Flight 1874 July 17, 2001 (1/7)
R = 0.87 μm; G = 0.68 μm; B = 0.47 μm

RELATIVE VIEW ANGLE (0 to 180 deg.)	GMT TIME
12:44:09	12:44:09 to 12:55:50
12:55:51	12:55:51 to 13:07:32
13:07:33	13:07:33 to 13:19:15
13:19:16	13:19:16 to 13:30:58



Cloud Absorption Radiometer Quicklooks

Fig. 8. Example page taken from the new Cloud Absorption Radiometer web site.