MODIS Science Team Member

Semi-annual Report

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A. FOCUS ACTIVITIES DURING THE REPORTING PERIOD

The most important activities undertaken during this reporting period are the following:

1. Versions 2.1 and 2.2 surface reflectance L2/L3 DAAC/SDST delivery
2. Version 2.0 1km and 250m VI product delivery (assist Arizona)
3. Version 2.1 surface reflectance L2 testing
4. Land Synthetic data set generator improvements
5. QA
6. Surface reflectance error budget generation (SWAMP request)
7. SCF Hardware
8. Aerosol transport modeling
9. Aerosol optical depth retrieval from AVHRR data
10. Aerosol characteristics retrieval from SeaWiFS/AVHRR fusioned data
11. Validation activities
12. Aerosol climatology
13. 6S code

1. Versions 2.1 and 2.2 Surface Reflectance L2/L3 DAAC/SDST Delivery

Version 2.1 of MODIS L2 and L3 surface reflectance algorithm was delivered to SDST and the DAAC. After this version passed the DAAC integration tests, it was replaced by the next version.

Version 2.2 of the MODIS L2 surface reflectance algorithm (MOD09) was delivered to both MODIS Science Data Support Team (SDST) and the Goddard Data Active Archive Center (GDAAC). This version of the code is launch-ready, and includes patches to fix the errors identified in version 2.1. As for the earlier

version, version 2.2 of MOD09 was directly chaperoned into the DAAC processing system.

Version 2.3 of the MOD09 algorithm development was initiated. Currently, this version can provide a Lambertian surface reflectance correction in ~6 minutes for a 5 minute input data granule, correct the surface reflectance product from BRDF effects using the "Montana" LUT methodology by ingesting the MODIS L3 land cover product.

Version 2.2 of MODIS L3 surface reflectance algorithm (MOD09A) is being developed. The new version resolves some optimisation issues and improves the code speed by 28 %.

Some other activities related to code delivery and interface with SDST were undertaken including:

- Work with Paul Shehadi (MODIS SDST/GSC/Code 922) on developing methods that may improve the code delivery process to the MODIS Science Data Support Team and, ultimately to the DAACs.

- Creation of an error message/operator action lists for the MODIS L2 surface reflectance product and delivered these lists to MODIS SDST.

- Putting together the first cut ODL production rules for the MODIS L2 surface reflectance algorithm at the request of SDST. In doing this work, major deficiencies in the ECS specified production rules were noted. They must be rectified in order to correctly run the code. These deficiencies were passed on to SDST and GDAAC.

- Work with Robert Wolfe (RSTX/Code 922) to specify exactly which MODIS tiles will be utilized for land global processing.

- Identification of some problems in the MODIS simulated L1B data format. They were passed along to the MODIS Calibration Support Team.

- Review of the MODIS Emergency Backup System (MEBS)-Land Data Operational Product Evaluation (LDOPE) Interface Control Document(ICD).

2. Version 2.0 1km and 250m VI Product Delivery (assist Arizona)

Two major problems were fixed in the MODIS 250m L3 VI code to enable HDF-EOS support and 16-day composites (see last Jan-March report).

Kamel Didan, the new programmer hired by the University of Arizona to support the VI code, was invited to spend a month at our SCF where he received extensive instructions and training from Paul Fisher on the VI code. Kamel will handle future maintenance and new development for the MODIS Vegetation Index algorithms working from the University of Arizona.

Work was conducted with MODIS SDST to change the ECS system design for the at-launch MODIS 1km L3 vegetation index algorithm (MOD13A). The earlier system design was left over from V1 and was completely inefficient for running the V2.x algorithm.

3. Version 2.1 Surface Reflectance L2 Testing vs 6S

Extensive testing of the atmospheric correction part of the algorithm with the improved synthetic datasets was conducted, as well as a comparison of each correction step with the 6S reference code. Slight changes and refinements have been made to the algorithm: notably the computation of the spherical albedo for elevated target, the interpolation of the ancillary water vapor and surface pressure data, and the absorption by half the water vapor content in the aerosol layer (WV was considered under the aerosol layer). A range of acceptable values for water vapor, ozone, and surface pressure has also been added. The algorithm accuracy is overall satisfactory as it is, but further improvement could probably be made. Example: some error sources (systematic errors of small magnitude) are well identified and come from correction for surface elevation. A draft report has been generated documenting all the tests done on the code and will be used by the SDST land test team effort as a prototype.

4. Land Synthetic Data Set Generator Improvements

The computation of top of the atmosphere (TOA) radiance's in the L1B data produced by the synthetic data generator was significantly improved. A

better modeling and accounting for atmospheric components, in particular aerosols, was included. Some errors that existed in the SDST code were also fixed and some code enhancements were made to fulfill the land community requirements for simulated data set including adding noise to the data. A 16-day period of synthetic Level 1B data covering the US and Canada test areas were produced using the improved code.

The improved version of the synthetic data generator code was delivered back to SDST along with the appropriate support to integrate the improved code in SDST's current version. The new version is currently being used by SDST.

5. Quality Assurance Activities

Development of the at-launch Quality Assurance approach and QA analyses tools are in progress. The purpose of these tools is to detect any problems that can affect the quality of the surface reflectance product. A QA plan document describing the approach will soon be available at the SCF. In addition and in collaboration with LDOPE, Version 2.1 of the surface reflectance algorithm has been implemented at the LDOPE facility, as well as a new set of simulated data over the LDOPE test area (USA-Canada) and over a test area covering South Africa. This data set was used at LDOPE by running the surface reflectance algorithm and other MODIS algorithms in order to update the test data set used by LDOPE to prototype its QA activities. New QA tools dedicated to the intercomparison of MODIS-SeaWiFS-AVHRR data have been developed. These tools support various input/output projections and enable the use of the CIA World Databank II to generate a high resolution coastline map in the test data set geometry. These tools also support the re-projection of some ancillary data (e.g. land-sea mask, land cover).

6. Surface Reflectance Error Budget Generation (SWAMP request)

Documentation of uncertainty sources in the SR retrieval and product accuracy were provided based on the set of simulation done for 6 generic cases in the ATBD.

7. SCF Hardware

The SCF major computer systems are now installed in Building 32. They are interconnected with a high speed ATM link. With the help of the CNE, all systems are now configured appropriately to take advantage of that link in both on and off campus communications.

The on-line storage capabilities were augmented with a network file system from Auspex which is configured to serve data over ethernet and ATM.

A 2 TB near line storage from ATL has been installed and is now completely operational. Ominstorage, a Hierarchical System Management software from HP is used to manage data migration to and from this library as needed. In-house software utilities were developed to enhance and facilitate the use of this library.

8. Aerosols Transport Modeling

Work continued on the process of debugging the algorithm for calculating mass fluxes from wind speed ancillary data (DAO). This will be used with an adapted version of the GISS aerosol transport code. The GISS model was adapted to handle the DAO surface pressure ancillary data and to ingest aerosol optical thickness AOT data and output AOT data. This was done to interface with the Pathfinder II products.

Work was performed on the preliminary modeling of the Mt. Pinatubo eruption's injection of tracer in the atmosphere and subsequent aerosol transport. Our adaptation of the aerosol transport program td90n9s shows the aerosol cloud extending primarily southward, while the aerosols from the eruption itself extending southwesterly, with a strong western component (e. g., Volon et al., SPIE, v. 2309, 318-326). Tests were conducted on the effect of different PU/PV data (from GISS vs. calculated from DAO U/V wind data) on the modeled aerosol plume.

S. J. Lin (GSFC Data Assimilation Office - DAO) provided us with the aerosol transport subroutine "tpcore" (versions 4.0 and 4.5). This is part of the DAO's chemistry transport model/general circulation model. We developed a software which (1) reads DAO surface pressure, temperature and horizontal wind files, (2) calculates aerosol mixing ratios, and (3) calls “tpcore” to compute aerosol transport. This software was tested using a point-source of

aerosols (a Pinatubo-like simulation) for 30 simulated days at different resolutions (2 by 2.5 degrees, 4 by 5 degrees) to address implementation and performance issues.

Work was done to develope a new set of horizontal winds (UWND, VWND) and temperature (TMPU) data from the DAO for 1991. This dataset will be used as input to the transport model described above in order to test it in a similar way to the GISS model.

9. Aerosol Optical Depth Retrieval from AVHRR

Work was done on validation of AVHRR optical thickness retrieval using AERONET sunphotometer measurements for the September-December 1997 period. The 1 deg x 1 deg statistics database described in the July-Dec 97 report was used in concert with 6S and coincident sunphotometer observations to improve the retrieval algorithm over land. The main improvement to the algorithm consisted of including larger land areas where it can be applied by estimating the surface reflectance in the red band (0.67 mic) from the middle infrared band (3.75 mic). Figure 1, shows the empirical relation between the red and mid-infrared reflectances derived from AVHRR data for November 97.

The new algorithm was used to derive optical thickness in AVHRR red band over land, the results were compared with the sunphotometer measurements and are presented in Figure 2.

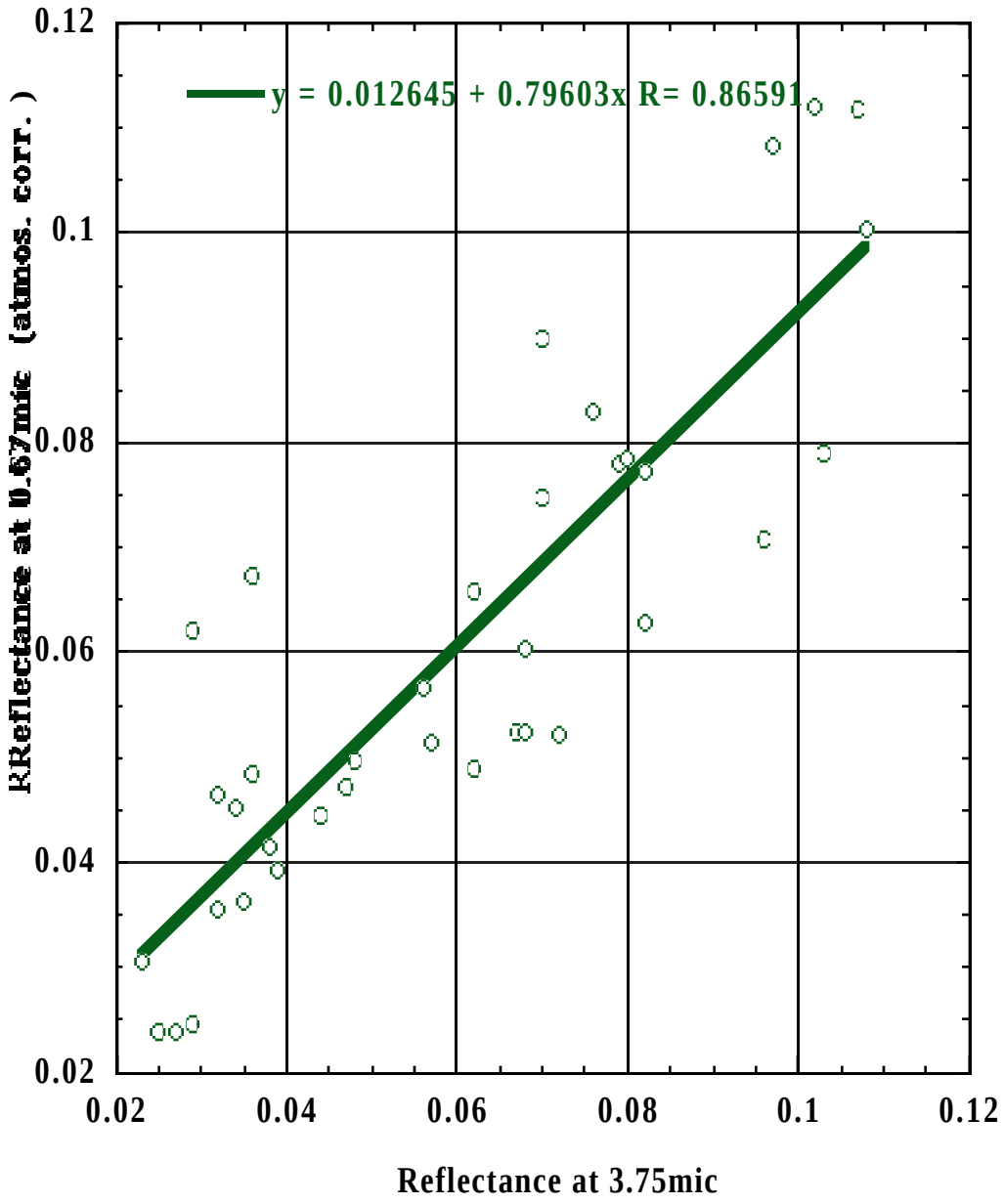

Figure 1: Relationship between the visible and mid-infrared reflectance derived from AVHRR clear acquisitions over AERONET sites for November 97

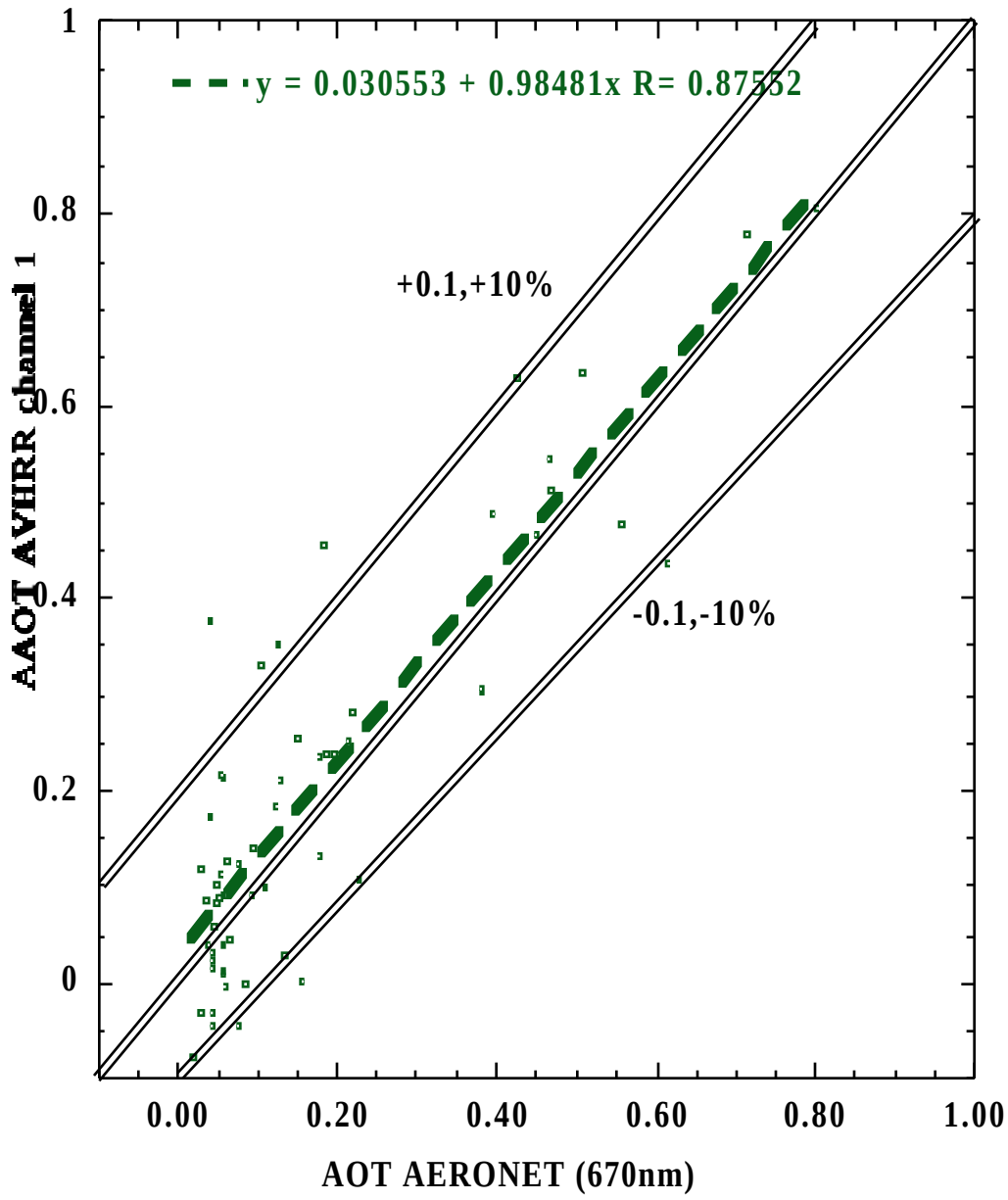

Figure 2: Retrieved versus measured aerosols optical thickness over land for October 97

10. Aerosol Characteristics Retrieval from SeaWiFS/AVHRR Fusioned Data

A software to process SeaWiFS level 1A data was developed. It produces atmospherically corrected bands (or top of the atmosphere) over land and ocean as well as the smoke and aerosol index product which is a prototype for the aerosol product. This software will be modified and used for the development of an enhanced aerosol retrieval software which combines

AVHRR and SeaWiFS data to produce optical depth and size parameters over land and ocean. Three months of Seawifs data were processed using this software and are currently being evaluated by comparison to AVHRR retrievals and sunphotometer measurements. An example of aerosols optical thickness retrieved over land from AVHRR and Seawifs data for Sept. 27, 1997 is presented in Figure 3.

The availability of multiple visible bands in Seawifs makes it appropriate for aerosol characteristics determination by retrieving the optical thickness at different wavelengths. We initiated an effort where optical thickness retrieval from Seawifs data is performed in the red and blue bands as shown in Figure 4.

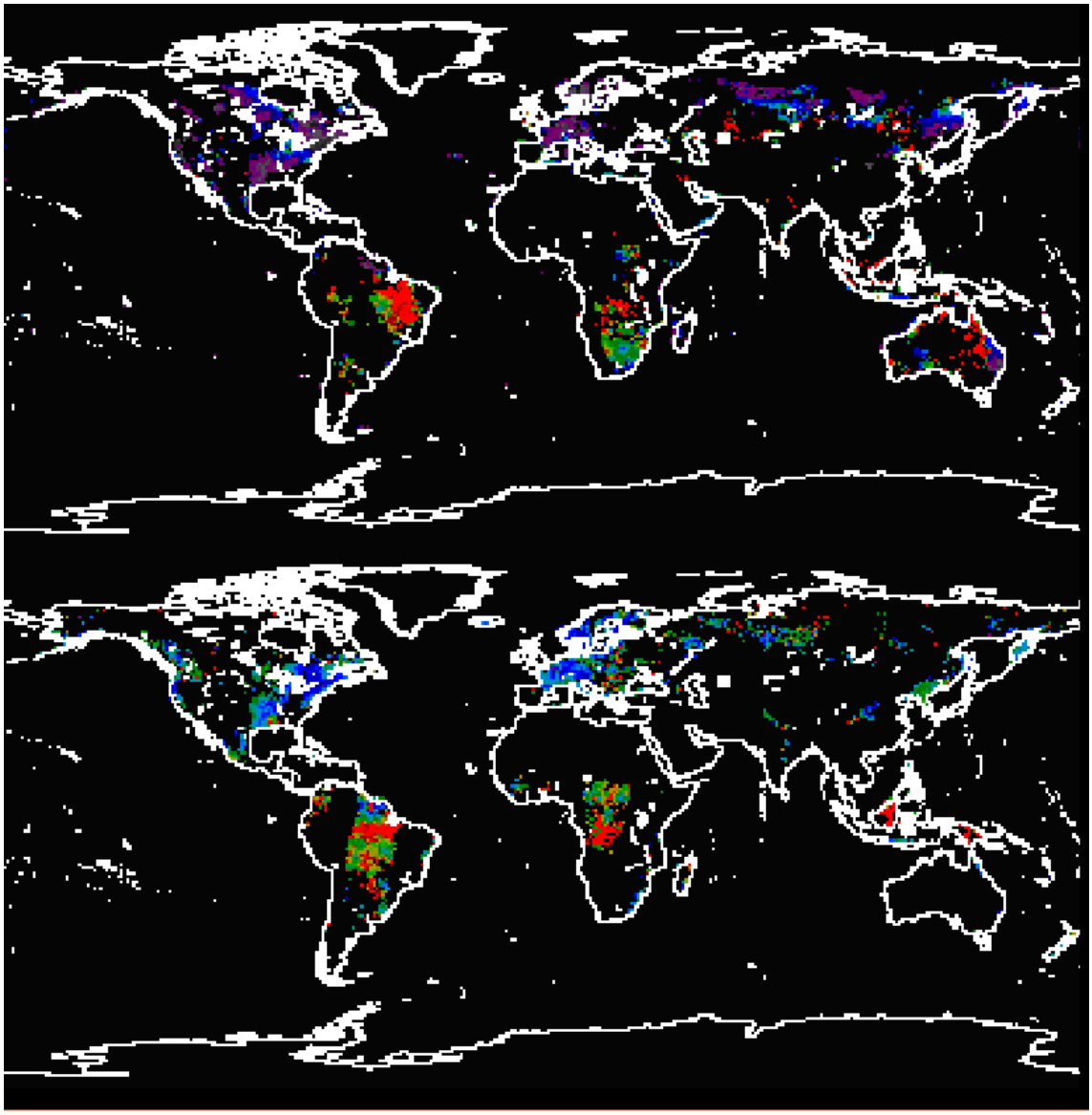

Figure 3: Aerosols optical thickness at 0.67 mm for 27-Sept.-97 derived from AVHRR (upper image) and SeaWiFS (lower image) data

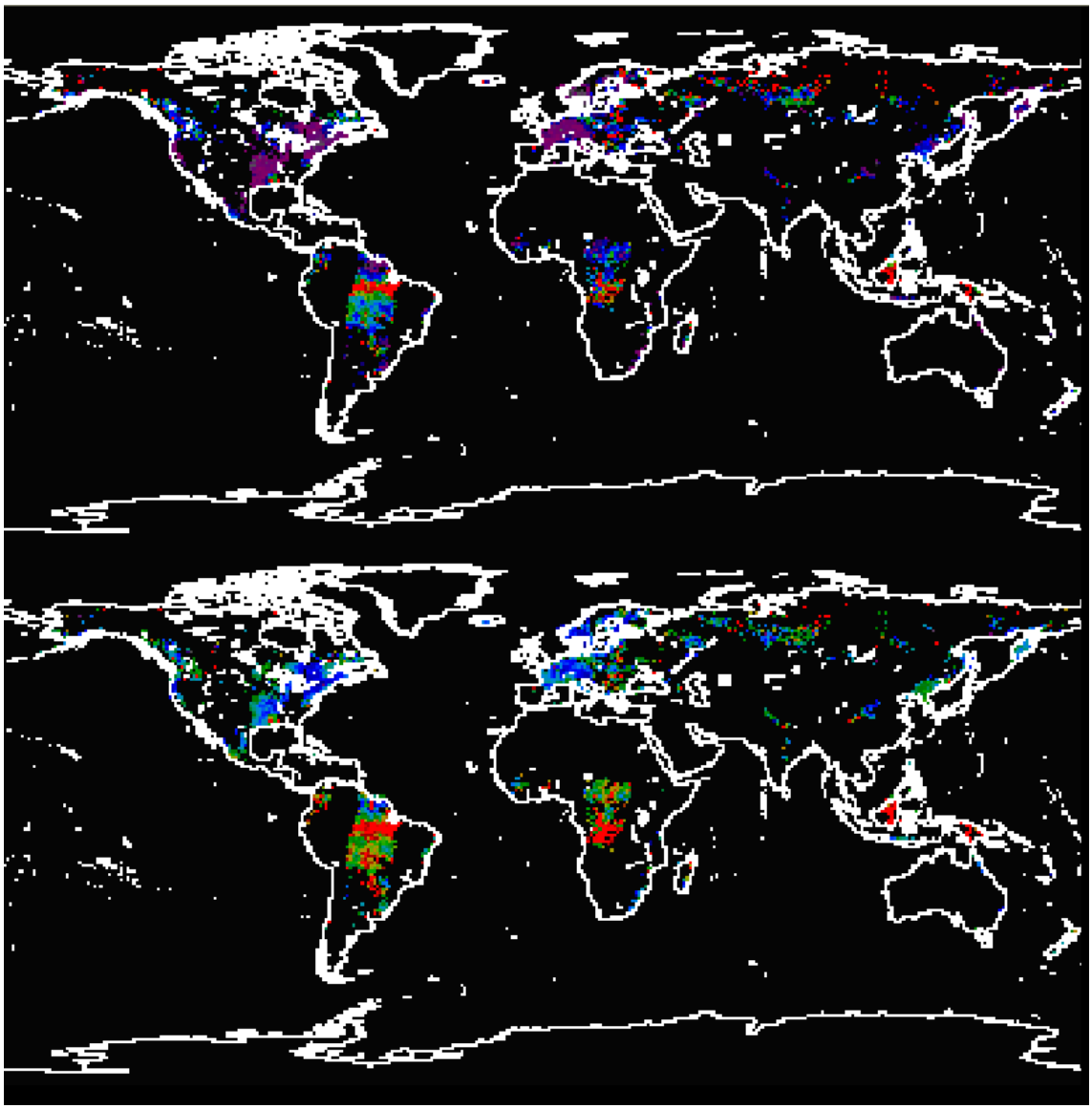

Figure 4: Aerosols optical thickness derived from SeaWiFS data for 27-Sept.-97 at 0.443 mm (upper image) and 0.67 mm (lower image)

11. Validation

A meeting was held at USDA with Surface Reflectance Validation PI's (S. Liang (UMD), J. Privette (GSFC)) and Co-PI's (January 13, 1998). Points covered during the meeting: (1) discussion of instruments involved, (2) plans for directional reflectance's measurements, (3) soil/vegetation and atmosphere characterization, (4) short-term/mobile and/or long-term towers and airborne measurements have been considered, (5) description of sites of validation.

12. Aerosol Climatology

An effort to produce an aerosol climatology that can be used in MODIS data atmospheric correction was initiated. Instantaneous sunphotometer measurements are retrieved on a regular basis from the AERONET database and used to compute monthly mean values of aerosol optical thickness in the visible bands and of Angstrom coefficient.

13. 6S code

New improvements related to spectral computation and polarization were made to the 6S radiative transfer code. It was also adapted to perform atmospheric correction and account for the atmosphere-BRDF coupling effect.

B. MEETINGS ATTENDED

- Surface Reflectance Validation Coordination Meeting, January 13, 1998, USDA
- MIT course: Lecture on AVHRR and SeaWiFS global product (January 29, 1998)
- MIT course: Lecture on radiative transfer modeling, and computer exercises with the 6S Radiative Transfer Code (GSFC, January 30, 1998)
- EDC DAAC Science Advisory Panel Meeting, February 3, 1998, Raytheon, Landover
- MODLAND / SDST, GSFC, February 11-13. Presentation of the preliminary approach for MOD09 Quality Assurance Analyses.
- SeaWiFS Science Team Meeting, January 6-9,1998: Presentation on aerosol product from SeaWiFS data.
- MODLAND / SDST, GSFC, February 11-13, 1998.
- ECS V0 ordering tool demo, March 3.
- Aerosol Working group meeting,GSFC, February 19 and March 17,1998.
- MEBS demo and MEBS scheduler training, March 11 and March 18, 1998.
- ECS briefing regarding the implementation of MODIS Land Tiling within the ESDIS system, May 7.

- MODIS 1-on-1 meeting with ECS and GDAAC, GSFC, May 19, 1998.
- MODIS MCST calibration workshop, Greenbelt, MD, June 23, 1998.
- MODIS Science Team meeting, Greenbelt, MD, June 24-26, 1998.
- SAFARI 2000 planning meeting, UMCP, June 29-30, 1998
- Weekly SCF status meetings.
- Weekly Technical Team meetings.
- Weekly MODIS SDST transfer group meetings.

C. PUBLICATIONS

Ouaidrari H., Vermote E.F. “LANDSAT TM Software for Atmospheric Correction”, submitted to Remote Sensing of Environment.

Justice C., Vermote E., Townshend J.R.G., Defries R., Roy D. P., Hall D., Salomonson V., Privette J, Riggs G., (RDC), Strahler A., Lucht W., Myneni R., Knjazihhin Y., Running S., and Nemani R., Wan Z, Huete A.R., Van Leeuwen W., , Wolfe R.E., Giglio L., Muller J-P., Lewis P., Barnsley M.J., 1998, ”The Moderate Resolution Imaging Spectroradiometer (MODIS): land remote sensing for global change research”, ***IEEE Transaction on Geoscience and Remote Sensing***, 36,4,1228-1249.

Wolfe R.E., Roy D.P., Vermote E.F.,1998, “MODIS Land Data Storage, Gridding and Compositing Methodology: Level 2 Grid”, ***IEEE Transaction on Geoscience and Remote Sensing***, 36,4,1324-1338.

Asner G.P., Bateson C.A., Privette J.L., El Saleous N.Z. and Wessman C.A., “Vegetation Structural Effects on Ecosystem Carbon Flux from Multi-satellite Data Fusion and Inverse Modeling”, accepted for J.G.R.

Devaux, C., A. Vermeulen, J.L. Deuzé, P. Dubuisson, M. Herman, R. Santer and M. Verbrugghe, 1998 : "Retrieval of aerosol single-scattering albedo from ground-based measurements : Application to observational data", ***Journal of Geophysical Research,*** Vol 103, D8, pp. 8753-8761

Plana Fattori, A., M. Legrand, C. Devaux, D. Tanré, A. Vermeulen and P. Dubuisson, 1998 : "Estimating the atmospheric water vapor content from sun-photometric measurements", ***Journal of Applied Meteorology***, in press