MODIS Science Team Member

Semi-Annual Report

(July-Dec, 1997)

Eric Vermote (University of Maryland) - Team Member

Nazmi El Saleous (UMD), Paul Fisher (SSAI), Damianos Karakos (UMD),

James Ray (SSAI), Anne Vermeulen (UMD)

Contract: NAS5-96062

A. FOCUS ACTIVITIES DURING THE REPORTING

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

1. Version 2.0 algorithm development and delivery
2. Development of a QA plan and some QA tools
3. Aerosols retrieval and transport from AVHRR data
4. Analysis of AVHRR data
5. Analysis of SeaWiFS data
6. Radiative transfer code: 6S
7. Validation activities

Some other activities, mainly related to the installation and management of the SCF hardware and software holdings, were performed but will not be detailed in this report.

1. Version 2.0 Algorithm

Version 2.0 of the surface reflectance code was delivered and accepted. In addition to the science algorithm, this version includes the interface to read all input and ancillary data expected at launch. It also writes the appropriate meta data in accordance with ECS requirements and file specifications.

Intensive testing of the code with MODIS simulated data was performed at the SCF prior to delivery. This exercise allowed us to refine some aspects of the algorithm and to create new lookup tables needed for atmospheric correction.

2. QA Plan

The development of a surface reflectance QA plan was begun. This work will continue in the next reporting period when the plan is expected to be completed.

An activity to develop product specific QA tools was initiated. The prototype tool developed allows to extract pixels that meet predefined criteria from the surface reflectance product. It has been tested with the already existing synthetic data set to study the variation of the output product as a function of given input parameters.

3. Aerosols Retrieval and Transport

In preparation for the evaluation of MODIS aerosol product used as an input in the surface reflectance code, an effort has been undertaken to derive a global aerosol optical thickness product from available AVHRR data. The generated product will be compared to ground measurements (sunphotometer) and will constitute, upon validation, a reference database to which we can compare the MODIS aerosol product. The approach used is as follows:

- Correct AVHRR top of the atmosphere reflectance for Rayleigh scattering, ozone and water vapor effect using DAO and TOMS data.
- Over clear ocean outside of the sun glint and over clear dense and dark vegetated areas where the surface reflectance can be assumed to be known, the signal is inverted using lookup tables (derived using 6S) to compute the aerosol optical thickness in the red band.

Work was also started on the implementation of a transport model that uses DAO wind speed fields to help in filling the gaps where aerosol retrieval in not possible by the method currently used. This will work will continue over the next reporting period.

4. Analysis of AVHRR Data

One year of global AVHRR GAC data (1989) was processed using our in-house AVHRR processing system. This system uses an atmospheric correction scheme similar to the one we used to generate MODIS surface reflectance products. The products are stored in a simplified Level 2G format (no coverage percentage is carried for either the grid cell or the AVHRR pixel). The goals achieved in this activity are as follows:

- Becoming familiar with a data format similar to the one used to store the surface reflectance intermediate products. This included the use and the refinement of already existing AVHRR tools to suit our needs.

- Producing Level 3 surface reflectance from Level 2G using different compositing approaches. Unfortunately, the limited capabilities of AVHRR do not allow the exploration all of the possible approaches for MODIS data. But this activity still constitutes a prototyping exercise with real data that pointed out some of the issues we will have to deal with for MODIS data (cloud contamination and cloud shadow for example).

- Using global Level 3 products generated in this activity to examine the spectral properties of some test sites distributed over the globe for different seasons. This is the basis for a test site library that will be part of the post launch QA and validation activities where spectral response of some test sites will be compared to responses from heritage systems.

Figure 1: False RGB composite (R=3.75 μm, G=0.87 μm, B=0.670 μm) - January 1989

- Applying the aerosol inversion approach described earlier to compute aerosol optical thickness globally. The results are binned to a 1 degree x 1 degree grid as shown in figure 2.

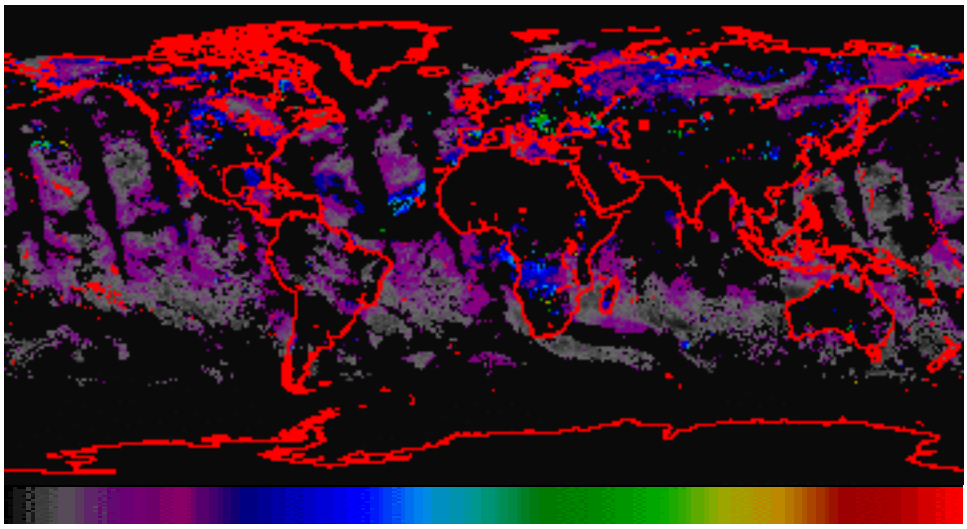

Figure 2: Aerosol optical thickness derived from AVHRR for July 1, 1989

5. Analysis of SeaWiFS Data

The SeaWiFS instrument has more bands in the visible and NIR region than AVHRR. It is also a new instrument that does not have a historical data record like the one held for AVHRR. These reasons make this instrument a perfect candidate to (1) prototype the SCF activity with MODIS data, (2) to test more in depth the MODIS surface reflectance algorithms and (3) to use a data source for QA purposes.

Approximately one month of SeaWiFS data was processed to derive Level 3 surface reflectance at all wavelengths (412, 443, 490, 510, 555, 670, 765 and 865 nanometers) (Figure 3). This data set was used to:

- Examine surface spectral response for different land cover types.
- Derive aerosol optical thickness using a more elaborate algorithm, taking advantage of the numerous visible and NIR bands. The products generated will then be used in conjunction with AVHRR products for QA of inputs to the surface reflectance code.
- Derive a new index sensitive to the presence of smoke. This constitutes a prototype for generating new products with MODIS data.
- Compare the different vegetation indices that will be produced from MODIS data.

Figure 3: RGB composite of Sept.-Oct. 1997 SEAWIFS surface reflectance data (R=0.670 μm, G=0.555 μm, B=0.430 μm)

6. Radiative Transfer Code: 6S

The 6S radiative transfer code is an important element in our QA procedure. A fair amount of time was spent on the implementation of features needed for our evaluation activity. This includes the addition of the spectral response of some MODIS and SeaWiFS bands. Some time was also devoted to the analysis and integration of the users community input and comments to improve the performance of this model.

7. Validation

Preliminary analysis of data gathered during the PROVE experiment was conducted. The lack of good calibration data requires more investigation and use of data from instruments that were operating prior to the experiment. A more thorough analysis in collaboration with Dr. Jeff Privette has begun, and will continue over the next reporting period.

B. MEETINGS ATTENDED

- Third Workshop on Desktop Computing in the EOS Era, July 29-30, Oregon
- SeaDAS workshop, Oct 21, NASA/GSFC
- MODIS Science Team meeting, Oct 22 - 24, College Park, MD
- EOS SWAMP Land Validation Coordination Meeting, Dec 3-5, College Park, MD

C. PUBLICATIONS

Vermote E.F., El Saleous N.Z., Justice C.O., Kaufman Y.J., Privette J., Remer L., Roger J.C., and Tanré D., 1997, Atmospheric correction of visible to middle infrared EOS-MODIS data over land surface, background, operational algorithm and validation, *Journal of Geophysical Research*, Vol 102, d14, pp. 17,131-17,141.

Vermote E.F., Tanre D., Deuze J.L., Herman M., and Morcrette J.J., 1997, Second Simulation of the Satellite Signal in the Solar Spectrum: an overview, *IEEE Transactions on Geoscience and Remote Sensing*, Vol. 35, p.3.

Vermote E.F., Vermeulen A., Ouaidrari H., and Roger J.C., 1997, Atmospheric correction for shortwave sensors (MODIS, ASTER, MISR, POLDER, SEAWIFS, MERIS, VEGETATION), *Proceedings of the 7th International Symposium on physical measurements and signatures in remote sensing*, 6-11 April 1997, Courchevel, France.

Ouidrari H., Vermote E.F., El Saleous N.Z., and Roy D., 1997, AVHRR Pathfinder II data set: Evaluation and improvements, *Proceedings of the 7th International Symposium on physical measurements and signature in remote sensing*, 6-11 April, 1997, Couchevel, France.

Kaufman Y.J., Tanré D., Remer L., Vermote E.F., and Holben B.N., 1997, Operational Remote Sensing of Tropospheric Aerosol Over the Land from EOS-MODIS, *Journal of Geophysical Research*, Vol 102, d14, pp. 17,051-17,068.

Devaux, C., Vermeulen A., Deuzé J.L., Herman M., Santer R., and Verbrugghe M., 1997, Retrieval of the single scattering albedo of atmospheric aerosols from ground-based measurements, Application to observational data, Revised version accepted by the *Journal of Geophysical Research.*

Plana Fattori, A., Legrand M., Devaux, C., Tanré D., Vermeulen A., and Dubuisson P., 1997, Estimating the atmospheric water vapor content from sun-photometric measurements, accepted by the *Journal of Applied Meteorology.*

D. NEW HIRES

- Nazmi El Saleous - SCF manager
- James Ray - Programmer
- Damianos Karakos - Graduate student to help with data management and programming