# Semi-annual Report, January to June 2002
# University of Arizona/ NAS5-31364

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## 1. TASK OBJECTIVES

During the first half of 2002, our MODIS efforts were mostly concentrated in the following areas:

1) MODIS Vegetation Index algorithm development for collection 4 reprocessing,
2) Adoption of a weighted average scheme for the VI compositing algorithm,
3) Continued development of the MODIS Aggregation algorithm with changes aimed at reducing disk volume,
4) MODIS VI product public outreach and preparation for the MODIS Vegetation community outreach workshop, Missoula, Montana,
5) MODIS Vegetation Index CD-ROM data sampler,
6) Evaluation of reprocessed MODSI VI products,
7) MODIS VI product quality assurance processing and application
8) MODIS VI product validation within LBA and U.S. sites,
9) In-house production system, code development, maintenances/upgrades.
10) Investigation of artifacts and anomalies in MOD13Q1, MOD13A1, and MOD13A2,

## 2. WORK ACCOMPLISHED

### *2.1 Algorithm and Code development, maintenance, and enhancements*

The specific accomplishments during the first half of 2002 were:

- MODIS VI 1km, 500m, and 250m algorithms changed to meet the new requirements of Collection 4,
- Science changes made to the compositing algorithm to improve the spatial integrity and consistency of the data,
- Adoption of the ‘dominant quality assurance’ parameter when aggregating data,
- Designed a proposal for QA data assimilation,
- Addressed spatial artifacts and anomalies encountered in MOD13Q1 and MOD13A1.

In June 2002, we delivered new versions of all the MODIS VI Algorithms, including

a. MOD13A1, MOD13A2, and MOD13A3 Version 2.3.0
b. MODAGG Version 2.3.0
a. MOD13Q1 Version 2.3.0

In response to upstream product changes, we made major changes to our MODIS VI algorithm in order to accommodate these changes and be ready for the Collection 4 requirements. This required modifications to both the filtering and compositing schemes in the MODIS VI algorithms. The most important change implemented in our newest algorithm version is the use of a weighted average scheme to handle the orbital data to enhance the spatial integrity and continuity of the data. This scheme was analyzed and we expect to have it implemented fully during collection 4 reprocessing. Figure 1 compares both the old approach of not weighing observations to the new weighted average approach.

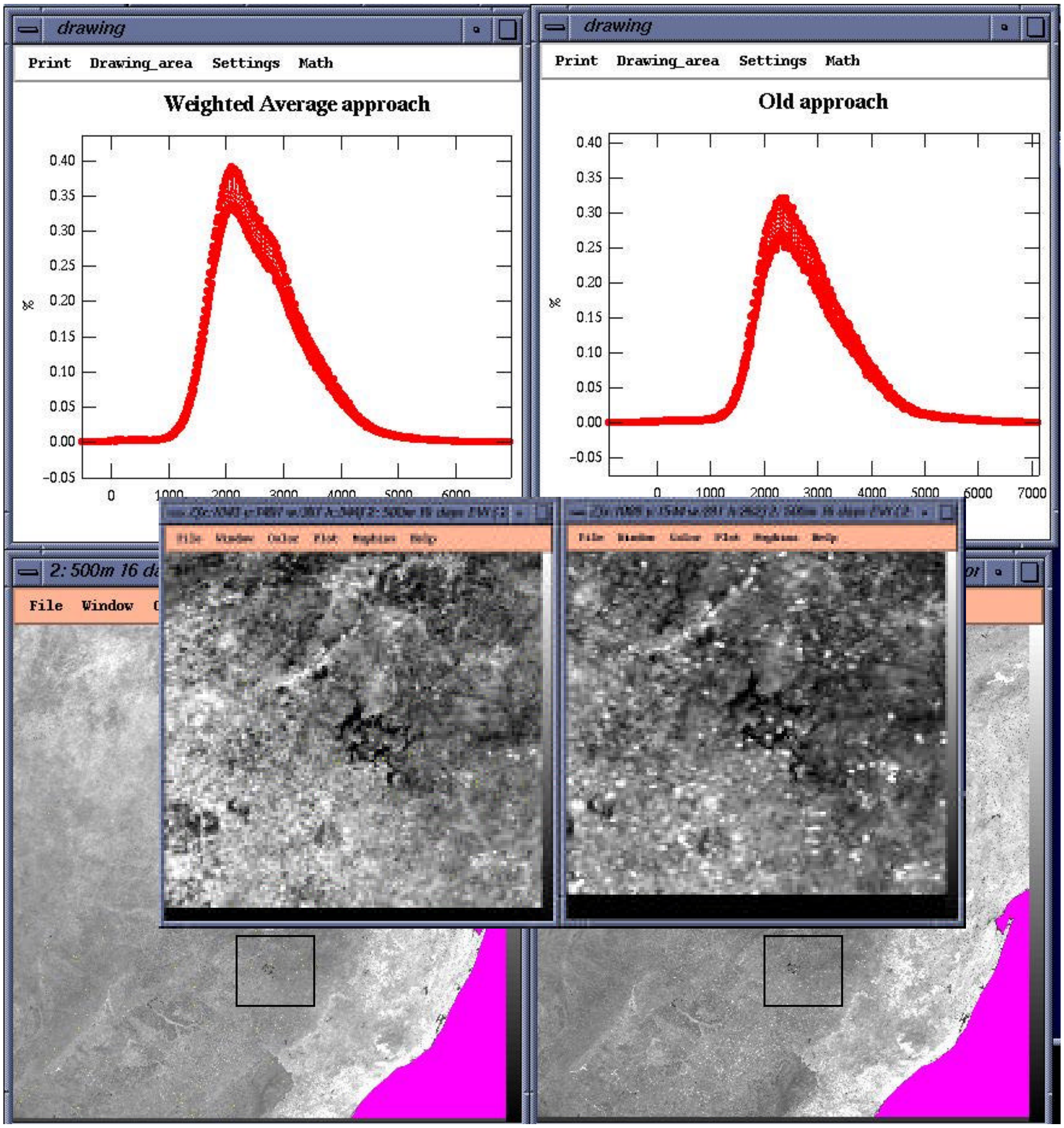



*Figure 1: Spatial consistency of VI data before and after weighted average implementation. The inset shows the spatially degraded quality of the 500m data when observations from each orbit are treated as separate representation of each grid cell. The weighted average scheme combines all observations from the same orbit into one value to represent the grid cell. The result is an improved spatial continuity and less clustering (right inset).*

The histogram of the old method shows more scatter due to reduced spatial consistency as opposed to the histogram from the new approach where the data has greater spatial integrity. Along with this averaging scheme we also implemented a dominant quality assurance assignment procedure for input and output data. All algorithms are now consistent and use the same data filtering procedures.

We conducted an evaluation of the algorithm handling of aerosol quantity (previous report) and found that the new filtering rules are robust and eliminated most of the problems we were encountering and that were associated with the aerosol variable. The MODIS Surface Reflectance aggregation algorithm, which currently uses a form of the weighted average scheme, also needed some adjustment to the quality assurance assignment similar to those of the MODIS VI algorithm. We also worked on coordinating our SCF effort with that of the larger MODLAND group. The usual biweekly MODLAND telecom still serves as a good place to discuss these changes and planned changes and the necessary requirements to respond to them.

## *2.2 SCF Maintenance*

We strove to maintain our SCF maintenance and processing needs through upgrades and additional storage purchases, including;

a. System upgrade and maintenance so that our SGI system can now run IRIX 6.5.16,
b. Upgraded the SCF disk storage capabilities to 1TB, with and additional 3 TB soon to be available to the SCF soon,
c. In-house code development to serve several MODIS VI applications and research purposes. We modified the "Mosaicking code" to work with the MODIS Reprojection Tool (MRT). Currently this tool enables us to stitch L3 tiles, which are then projected using the MRT. We also installed multiple shareware tools for MODIS data analysis,
d. Purchase of a LINUX/Win2000 desktop system and laptop computer.

## *2.3 MODIS Vegetation Workshop*

As part of our effort for public outreach, we participated in the MODIS Community Outreach Workshop on Vegetation Variables (VI/LAI/FPAR/NPP), held at the University of Montana in Missoula, July 15-19$^{th}$ 2002. This workshop was open to the at-large science community interested in MODIS vegetation variables (VI/LAI/FPAR/NPP). The workshop focused on year 2001 results and validation, current status of our products, and user issues. The workshop also included details about data availability and ordering, data quality, formats, validation status, software tools, documents, answers to frequently asked questions and tutorials. Each team showcased their products, the science algorithms behind them, and presented ongoing research and validation using MODIS data. The workshop was very successful in terms of introducing and showcasing the potential of MODIS products as well as in familiarizing ourselves with the potential users and uses of MODIS data.

Each team made presentations on the status of the products and examples of ongoing research using MODIS data. In particular, our team made available to participants a CD-ROM containing global, regional, and local MODIS VI data sets covering the year 2001 to 2002. The CD also covered detailed information in response to users request. We also presented four posters focusing on various MODIS VI aspects. An introduction poster was meant to present the MODIS Vegetation Index product series, along with specific information regarding VI dynamic range, production coverage, and data structure. Another poster on the innovative approach of MODIS per pixel quality assurance (QA) data, its meaning, use and possible applications. Validation status, and our internal data management plan were also presented in separate posters.

Workshop posters and presentations are summarized at the following web site:
http://www.forestry.umt.edu/ntsg/MODISCon/

### *2.3.1 MODIS VI CD-ROM data sampler*

We produced a CD-ROM containing one year of 1km MODIS VI data from the US Southwest, four seasonal data sets at 500m, and a wet and dry season 250m data sets. Time series profiles were included for multiple sites of interest, representing different land cover types and biomes. Yearly 1km global VI animations and regional 500m animations were also included to showcase the dynamic MODIS VI capabilities, specifically that of EVI. In all, the CD-ROM was very appreciated by the participants and we're in the process of producing a second version with more data, and focus on validation and science findings (Fig. 2).


*Figure 2: MODIS Vegetation Index CD-ROM front page*

This CD will be made available on the internet through one of MODIS web sites and as mentioned earlier plans are being made for version 2 of this CD.

### *2.3.2 Presentations and Posters at the Vegetation Outreach Workshop*

Huete, A., et al., 2002, “MODIS Vegetation Indices (MOD13)”, Introduction Presentation on VI’s.

Didan, K., 2002, “MODIS Vegetation Index Production Algorithms”, Presentation of Production aspects of the VI.

Huete, A., 2002, “Global Validation of EOS Vegetation Indices”, Presentation of Validation Activities.

Didan K., Huete, A., and Miura, T., 2002, “MODIS Vegetation Index Product series” (Poster).

Didan, K., Gao, X., and Huete, A., 2002, “MODIS Vegetation Index Quality Assurance Processing and Application” (Poster).

Yin, Y., Didan, K., and Huete, A., 2002, “MODIS VI Data Management in TBRS” (Poster).

Gao, X., Huete, A., Schaub, D., Ferreira, L., Miura, T., Didan, K., 2002, “Global Validation of EOS-MODIS Vegetation Indices” (Poster).

Rodriguez, E.P., Huete, A.R., Schaub, D., Didan, K., Miura, T., Glenn, E., and Nagler, P., 2002, “Application of MODIS Vegetation Indices to Monitor Seasonal Responses and Water Use Impacts over the Colorado River Delta Area, Mexico” (Poster).

Morisette, J., Vermote, E., Huete, A., Privette, J., and Roy, D., 2002, “Validation Analysis, Continuous Land Product Example: NDVI” (Poster).

## *2.4 Science research*

The compositing algorithm was assessed using a long-term data set with the goal of establishing the performance of the data filtering. In this analysis we came to the conclusion that data filtering is the most valuable step in compositing. Due to the nature of the constrained view angle – maximum value composite (CV-MVC), which is adopted in the MODIS VI algorithm, if low quality data is used in this step, it will bias the output and result in poor quality VI data. In addressing the above issues, we opted for a stricter approach, by which all data is filtered and ranked based on its quality assurance (hence the importance of MODIS QA data) and only the best quality data is used. This process resulted in an improved performance of the algorithm with improved quality. Figures 3, 4, and 5 illustrate the performance of the current data-filtering scheme used in the algorithm.

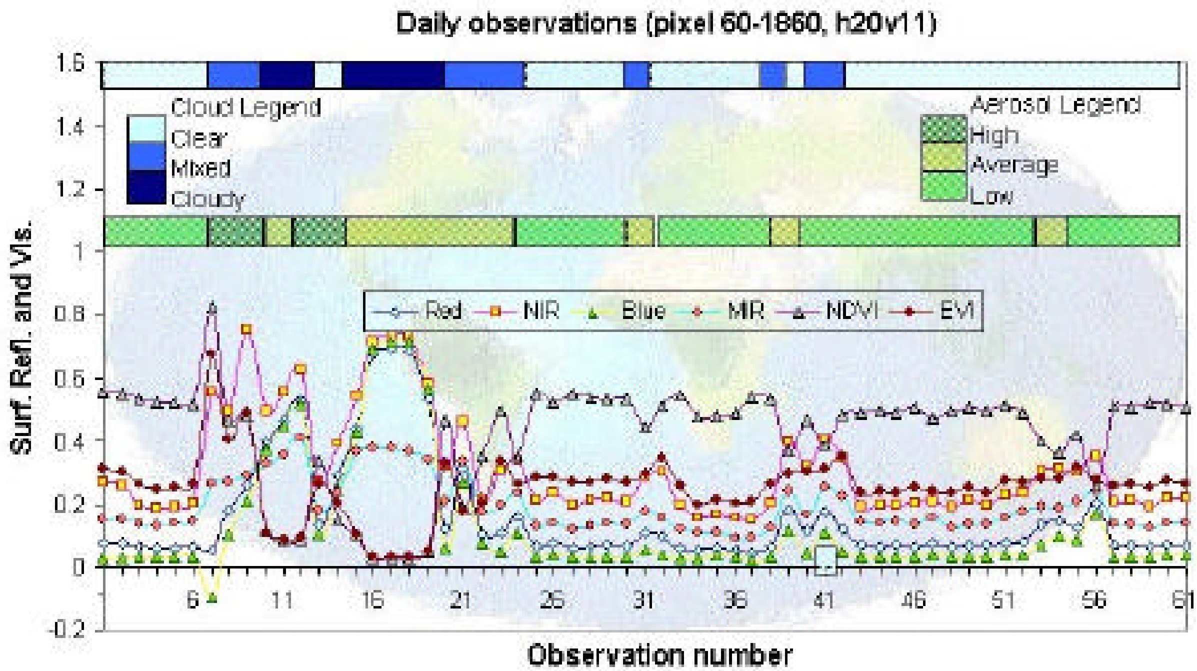



*Figure 3: Daily input data with quality flags. This daily data shows the day-to-day variations in the surface reflectance due to aerosol, clouds, etc…*

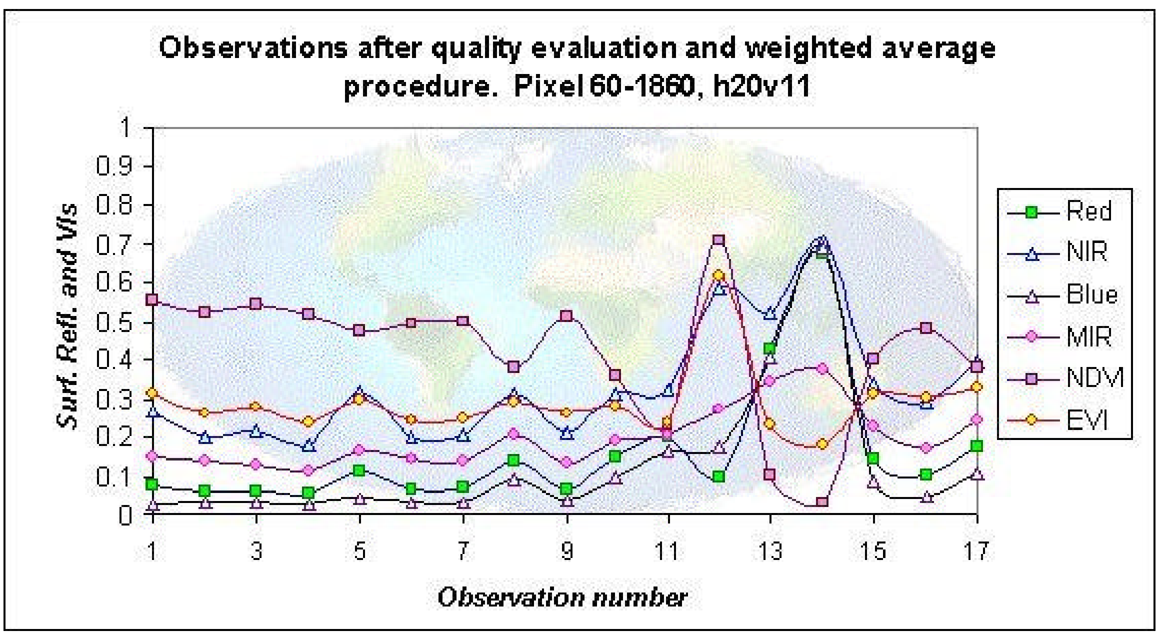



*Figure 4: Daily data after weighted average and quality ranking. Data on the left represent the highest quality (stable signal) and to the right represent lower quality (more variations).*

*The filtering process ranked the data based on its quality, resulting in this graph, were data with same quality is behaves similarly.*

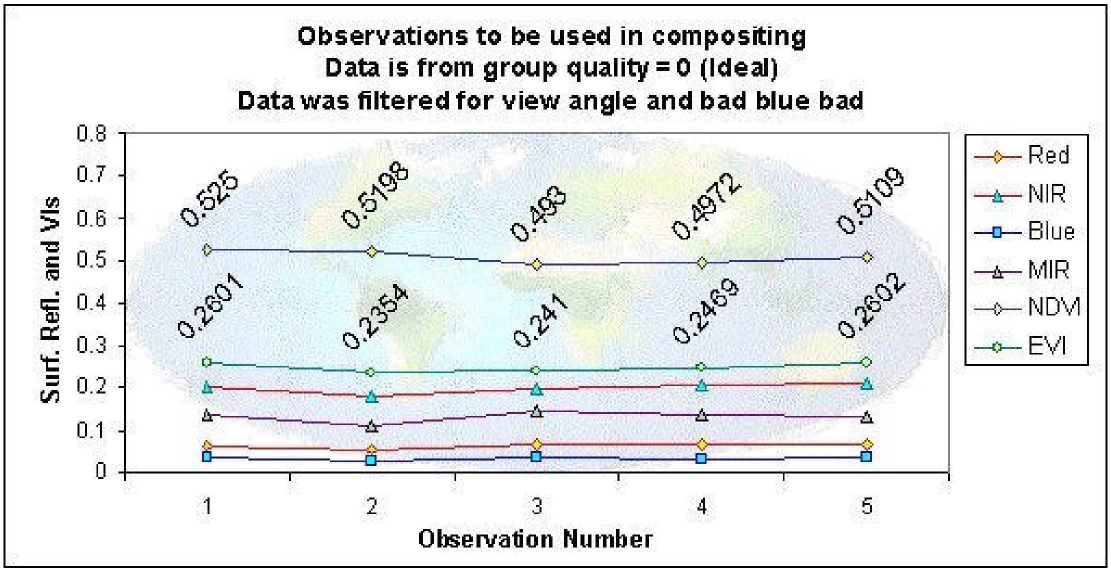



*Figure 5: Only data with highest quality is used in compositing.*

This research indicates that filtering is of major importance and is critical to successful compositing. The MODIS VI Collection 4 algorithms adopted this scheme of stricter data filtering and we expect results to improve, leading to a more stable data set useful for time series analysis.

## *2.5 MODIS VI quality assurance applications*

The MODIS Vegetation Index (VI) production algorithm series benefited from the approach of per pixel quality assurance (QA) information adopted by the MODIS science team. This quality assurance information is generated by each product, and is intended to provide information on the quality of the processing and input data, which establishes a reliability measure of each pixel in a product. The VI algorithms rely heavily on the input quality information to assess, separate, and composite the daily data.

Although simple in concept, this quality assurance information was found to be very intricate and difficult to understand, making it inadequate for use. Its structure and the various types of information being conveyed along with the lack of a definite and unique quality characterization made it difficult to implement as stated by many MODIS data users. We proposed a simple and practical mechanism to simplify this quality information and make it more accessible to users. Using all available quality information for a pixel, this mechanism will transparently assess and establish a unique quality and reliability factor.  Users would be able to directly use this quality measure with no further quality inspection.

To help understand the meaning and make use of this QA output, we proposed a simple procedure (figure 6) that combines these numerous quality indicators based on their specific significance, and generates a unique quality measure for each pixel.  It is important to realize that this unique measure, although useful in itself, will need to be interpreted and used in conjunction with the actual data.  This approach was evaluated on a set of MODIS VI time series profiles, and was found to be very useful in capturing the quality of the VI data.  It does also show that quality information is instrumental to establishing the reliability of the data.  This approach, was applied to a time series data set (Fig. 7).

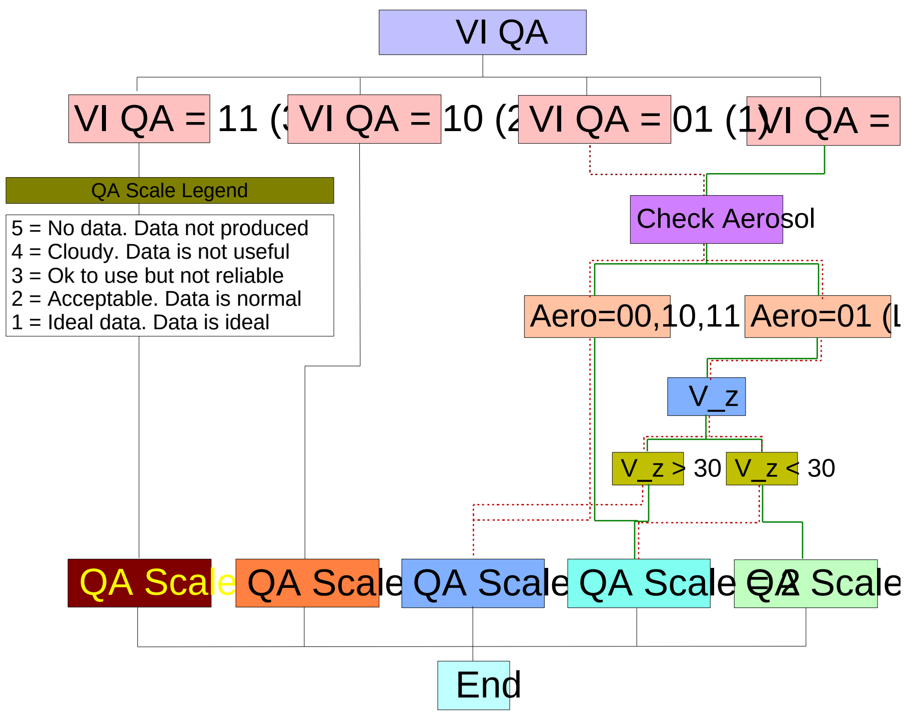



Figure 6:  Unique quality measure generation.

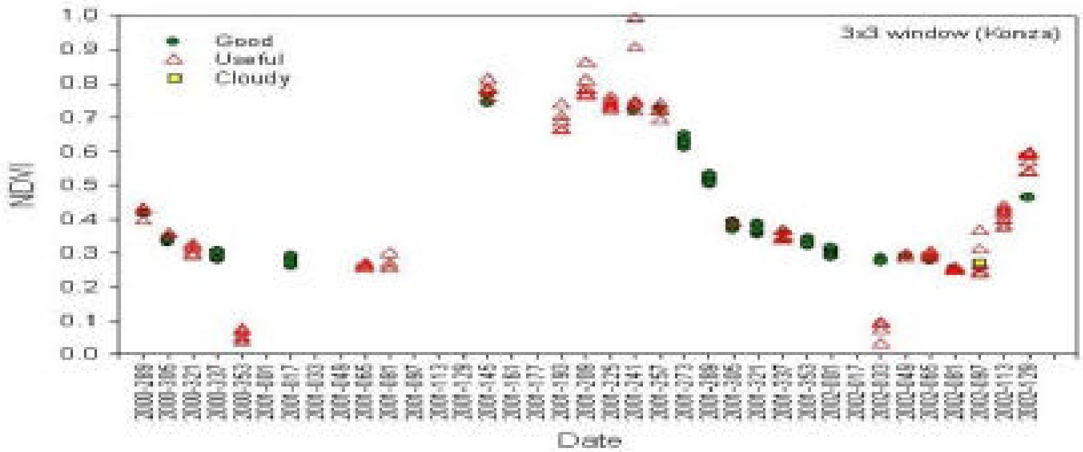



Figure 7: Application of the unique quality measure to a time series. Green symbols represent data with the highest quality; red symbols represent data with acceptable quality. We note the spread of data with red symbols indicating more variability and noise.

Our next goal is to apply this technique to a global long-term data set and assess its usefulness.

## *2.6 Validation Activities*

The MODIS VI product was upgraded to provisionally validated status (Level 1) and was recently upgraded to level 2.

### *2.6.1 LBA Validation (Brazil Science Plan, June - August 2002)*

We conducted an intensive MODIS validation campaign in Brazil along an eco-climatic gradient of vegetation land cover types and land conversions. A full-range spectroradiometer (ASD) was utilized on an ultralight aircraft as well as on the ground. This was accompanied by field biophysical measurements and land cover characterization activities. The various components of this campaign are summarized below:

1. Predictive canopy RT model. We made extensive leaf optical measurements with an integrating sphere (reflectance and transmittance) for the purpose of constructing a radiative transfer model specific to the land cover types of our experiment. This will greatly help with the scaling of limited biophysical measurements to MODIS pixels and in the development of land-cover dependent functional relationships of VI's to biophysical parameters.
2. Land cover characterization/ detection and mapping. Our objective here was to assess MODIS capabilities in resolving several key land cover issues , including:
    a. Assess to what extent we can map the various land cover physiognomies of the cerrado region,
    b. To what extent can we discriminate land converted classes,
    c. To what extent can we detect "hotspots" of change,

3. Seasonal dynamics of cerrado, transition, forest, and converted classes with MODIS. The objective of this component is to determine to what extent MODIS can profile the seasonal dynamics of the various land cover and land conversion activities through our gradient-based study.

The biophysical measurements conducted in the field included:

1. Percent cover components. Categories included, canopy background (soil, rock, litter), green vegetation (grass, herb, shrub, tree), non-photosynthetic active vegetation (wood, dried, litter)

2. Soils. Soil chemical, physical, and optical properties were measured across cerrado to forest gradient transect and across gradient of land use intensities. These included, depth to horizons, carbon, iron, pH, texture, color, bulk density, temperature, moisture, and reflectance.

3. LAI and fAPAR. We used an LAI-2000, a ceptometer, quantum sensors, and a fisheye lense (photos) to conduct measurements of LAI and fAPAR in each of the land cover and land conversion classes.

### *2.6.2 LBA Phase 2 Proposal for MODIS Validation:*

We submitted a low-cost validation proposal in response to NASA NRA-01-OES-06, "Ecological Research in the Large-Scale Biosphere-Atmosphere Experiment in Amazônia (LBA-ECO): Phase II, and Opportunities in Terrestrial Ecology". Our proposal was entitled:

"VALIDATION AND EVALUATION OF TERRA AND AQUA MODIS PRODUCTS IN THE LARGE SCALE BIOSPHERE-ATMOSPHERE EXPERIMENT IN AMAZÔNIA (LBA-ECO)"
Principal Investigator: Alfredo Huete
Co-Investigators: Steve Running, Ranga Myneni, Eric Vermote, Kamel Didan
Brazilian Co-Investigators***:*** Yosio Shimabukuro, Mercedes Bustamante, Jose Epiphanio, Laerte Guimaraes Ferreira, Edson Eijy Sano, Edgardo M. Latrubesse, Bruce Nelson (*collaborator).

*Abstract*

*The Moderate Resolution Imaging Spectroradiometer (MODIS) on board the Earth Observing System - TERRA platform has now been producing a suite of global vegetation data products for nearly two years. These products are provisionally validated and undergoing final post-launch refinements and uncertainty estimates based on near-direct comparisons with correlative measurements and application implementations. In addition, a second MODIS instrument onboard the EOS- AQUA platform will soon be launched and start generating data this summer, 2002. The MODIS Land Science Team (MODLAND) is interested in continuing evaluation and validation activities of MODIS vegetation land products within the Large-Scale Biosphere-Atmosphere Experiment in Amazônia (LBA). The LBA experiment provides an excellent test site for MODLAND to evaluate the quality and performance of our algorithms and products in conjunction with in-situ measures of various ecological parameters. Evaluation and application of MODIS products within LBA is extremely valuable given the existing LBA emphasis on regional, Amazon-wide analysis of land cover and land use changes, and carbon sources and sinks.*

*We propose to evaluate and conduct validation activities related to both MODIS-Terra and MODIS-Aqua instruments and their 'stand-alone' as well as 'combined sensor' terrestrial products, in support of tropical forest*

*conversion studies in the Amazon Basin. The utility of MODIS land products will be assessed over both primary intensive research sites and over regional-based transects that span land use intensity and climatic gradients. We plan to utilize a combination of site-intensive and regionally-extensive approaches to demonstrate the performance and validity of the land products. We also wish to couple and calibrate the CASA model with MODIS data and evaluate region-wide terrestrial NPP of Amazonia. MODIS team members will evaluate the atmospherically-corrected, surface reflectance product; spectral vegetation indices; land cover and land cover change; and a set of vegetation biophysical products, including leaf area index (LAI), fraction of absorbed photosynthetically active radiation (fAPAR), and net primary production (NPP). MODLAND will make available level 2 and level 3 gridded MODIS data products to the LBA-Ecology Science Team so as to maximize data usefulness and evaluation by the broader scientific community.*

*We further propose a MODIS-LBA community outreach training and education program to facilitate usage of MODIS data among LBA investigators and Brazilian Institutions. This would include: (1) training and education on use of MODIS data; (2) assembly and synthesis of regional spatial databases; (3) provide value added MODIS data (reprojected and mosaicked) with quality masks and uncertainty analysis. This is a renewal proposal with a low-cost budget request for Training and Education.*

This proposal was recently "not recommended for LBA phase 2". However, we are still funded to conduct LBA validation activities through our LBA-ECO airborne project involving AVIRIS data for scaling field measurements to MODIS.

### *2.6.3 Colorado River Delta:*

A poster was presented at the Arizona Riparian Council meeting in April 2002, entitled: "Application of MODIS Vegetation Indices to Monitor the Seasonal Responses and Water Use Impacts over the Colorado River Delta Area, NW Mexico", The poster contrasts the use of Landsat and 250m MODIS for studying vegetation dynamics in riparian and wetland areas in the Colorado River Delta.

We requested and designed AVIRIS overflights along the lower Colorado River for MODIS validation research. We flew a reconnaissance mission along the Mexican portion of the Colorado River to coordinate an MQUALS mission to complement AVIRIS. We flew MQUALS over Topock Marsh, Arizona in May, where we collected color infrared images and radiometric data using an Exotech. The flight was coordinated with a ground crew collecting biophysical data (Fig. 8).

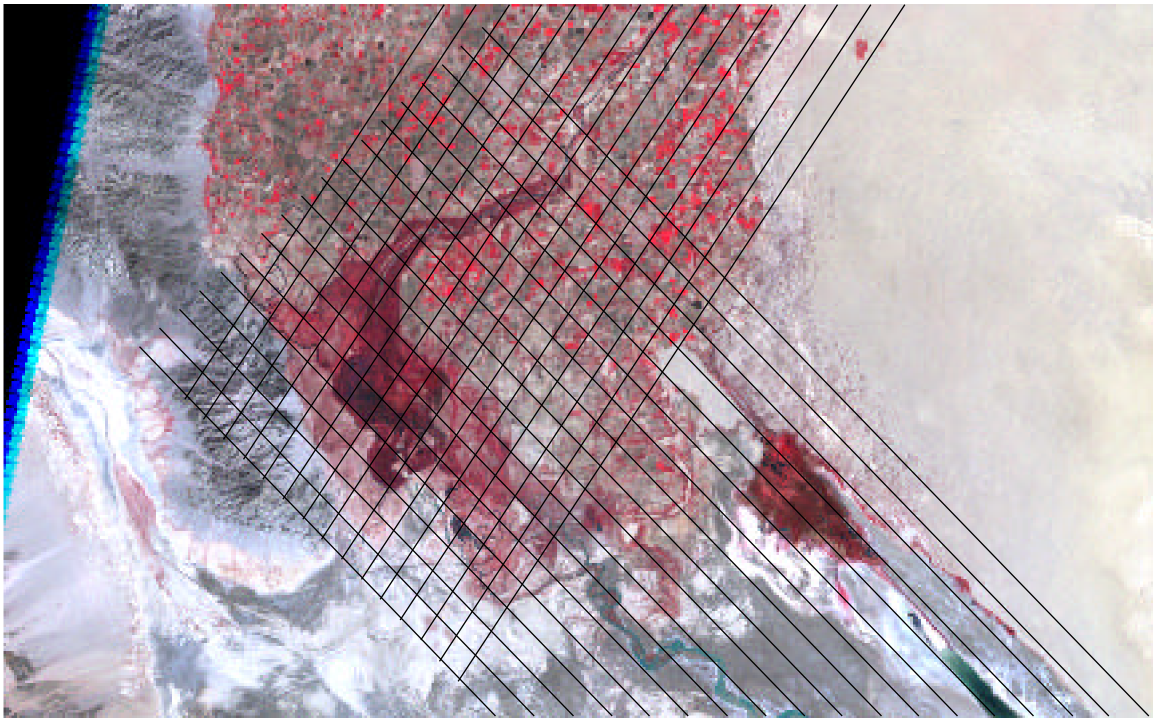


*Figure 8. Planned AVIRIS flightlines for planned MODIS field validation experiment along the lower Colorado River.*

### *2.6.4 Walnut Gulch Experimental Watershed*

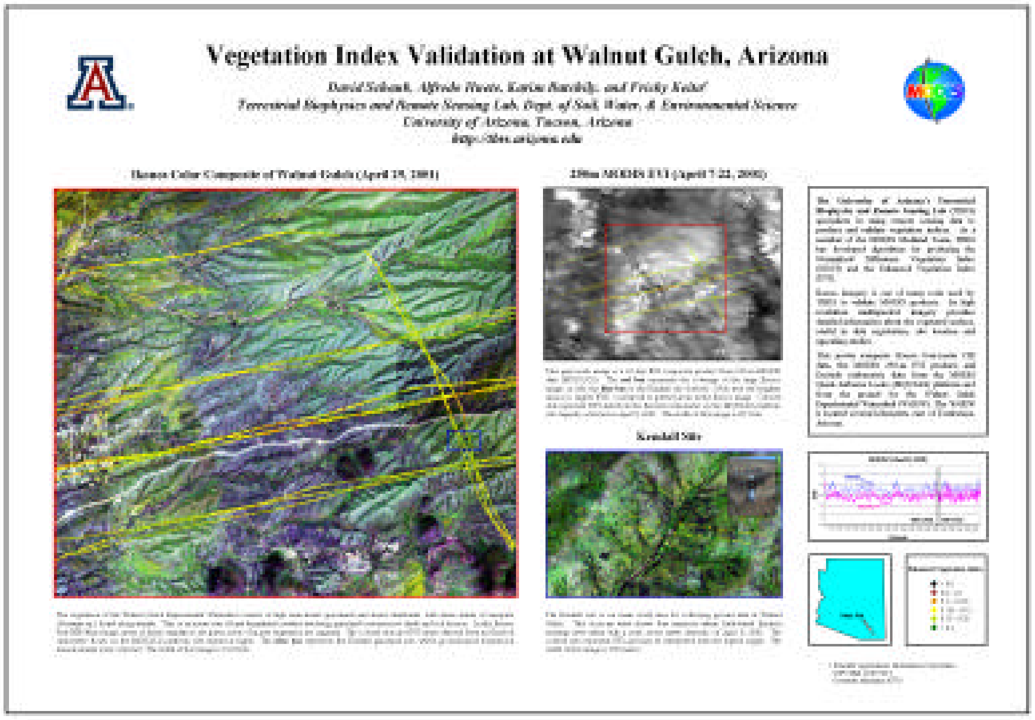



*Figure 9. Poster on "Vegetation Index Validation at Walnut Gulch, Arizona" at the High Resolution Commercial Imagery Workshop, Reston, Virginia in March. The poster illustrated how Ikonos imagery and MQUALS data have been used by the TBRS lab to validate MODIS VI products.*

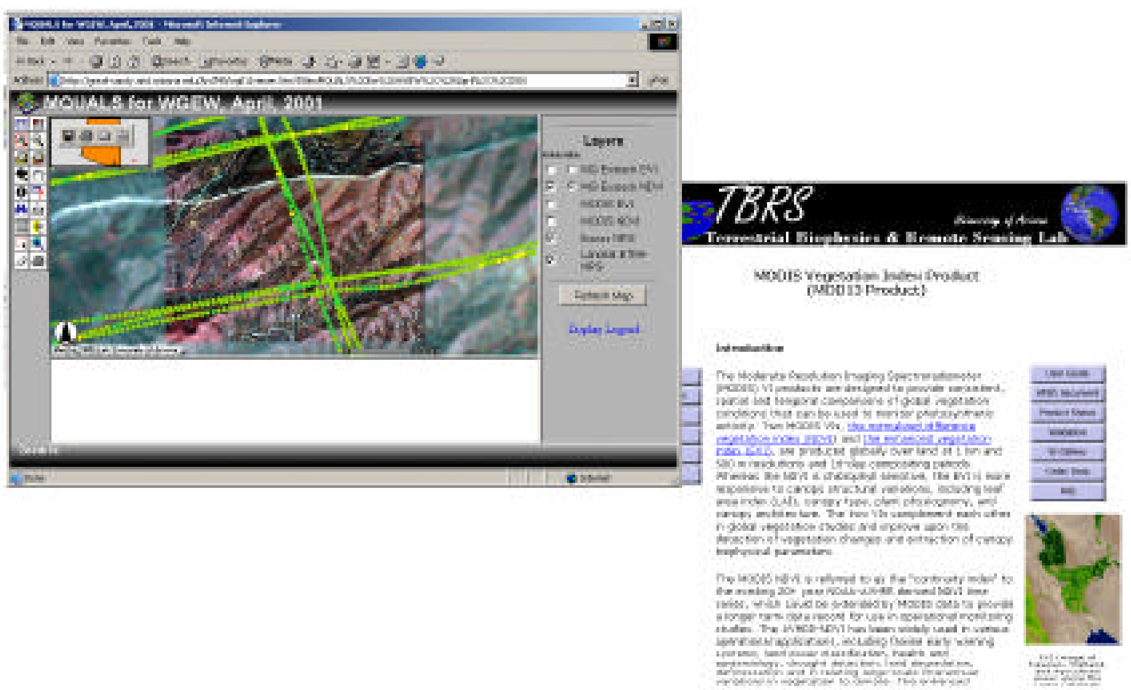


*Figure 10. Creation of three new ArcIMS sites to display 2001 MQUALS validation data: Walnut Gulch, Brasilia National Park, and Araguaia National Park.*

## *2.7 MODIS VI Continuity:*

We're in process of acquiring the AVHRR 20 year NDVI data sets for continuity studies and comparison. We also submitted a proposal for 'continuity studies', but have not heard any outcome yet. The proposal was submitted in response to NASA NRA-01-OES-06 "Ecological Research in the Large-Scale Biosphere-Atmosphere Experiment in Amazônia (LBA-ECO): Phase II, ***and Opportunities in Terrestrial Ecology***". The proposal was entitled: "Multi-sensor Calibration of Vegetation Indices for Continuity and Time Series Studies on Ecosystem Variability and Responses" by:

Dr. Tomoaki Miura (P.I.)
Alfredo Huete as co-investigator along with Dr. Hiroki Yoshioka of Aichi Prefectural University, Aichi 480-1198, Japan, and Dr. Christopher Potter of the Ecosystem Science and Technology Branch, NASA Ames Research Center as collaborator.

### Abstract

*There is significant interest within the terrestrial science community for using satellite data from multiple sensors for vegetation monitoring of the Earth's surface. To accomplish this goal, satellite data product continuity and compatibility need to be investigated. There are 'historical' satellite data continuity applications, e.g., AVHRR and MODIS vegetation index time series data as well as 'synergistic' applications such as MODIS – Landsat ETM+ multi-resolution analyses. In this proposal, we wish to establish and develop a quantitative basis for deriving and optimizing vegetation index inter-relationships (translation equations) across different sensors. Spectral vegetation indices (VIs) are one of the more important products in monitoring seasonal and inter-annual changes related to land cover and various vegetation biophysical properties, including fraction of photosynthetically-active radiation (fAPAR), leaf area index (LAI) and net primary productivity (NPP). VI continuity of AVHRR and MODIS class sensors are of particular importance because of the historical long term observations of AVHRR going back to 1980's and extensions of the observations by the planned NPP and NPOESS missions. We propose to develop and validate translation equations that will couple the NOAA-14 AVHRR NDVI to Terra-/Aqua-MODIS VI products.*

*We will approach this issue in three steps. We will first investigate NDVI/reflectance continuity in terms of change detection by simulations using canopy and atmosphere radiative transfer models and synthesizing spectral bandpasses of various sensors including AVHRR and MODIS from field measured and hyperspectral image data. A quantitative basis and framework which gives a theoretical justification of cross-sensor VI continuity are presented in this proposal. Their continuity accuracy and uncertainty as well as the limitations associated with canopy biophysical/structure (i.e., land cover) dependency, calibration uncertainty, atmospheric contaminations, sun-target-view geometry will also be investigated. The effects of spatial resolutions will be investigated by spatially aggregating hyperspectral images and scaling-up the developed translation equations to various spatial resolutions, simulating the "synergistic" uses of multiple-sensors such as ASTER, MISR, ETM+, AVHRR, and/or MODIS. The developed translation equation will then be "scaled-up" to moderate and coarse spatial resolutions using an atmospherically-corrected, near-nadir view reference data set of the AVHRR and MODIS extracted over the well-characterized, EOS land validation core sites as a calibration data set. The effects of the scaling-up procedures will be investigated and uncertainty values will be estimated. Finally, the translated "MODIS-like" AVHRR NDVI products along with the MODIS VI products will be used as inputs to an ecosystem process model to validate the developed translation algorithm by cross-comparisons of the model outputs. The results of this study will enable the continuous uses of the AVHRR and MODIS products which will greatly aid seasonal and inter-annual carbon balance studies in global ecosystem. The quantitative basis and analysis framework to be developed in this study*

*will establish a means of inter-relating the AVHRR NDVI to MODIS VI products and will be able to be applied to the continuity/compatibility studies for future satellite sensors for global ecosystem studies including the NPP and NPOESS missions as well as other VIs.*

## *2.8 Data Management and Organization Plan*

Due to the huge size of MODIS VI global data, including L2G and L3, it's necessary to devise an effective data management and organization plan. This management plan will make MODIS VI data available for internal research and for possible cooperation with outsiders and as part of our public outreach. This data management plan was implemented and tested for internal use, and is currently being used by our students and researchers. However, it is limited to the TBRS lab internal use for now, and will possibly be made public in the future, for scientific or industrial users.

**Implementation**

1. Design a set of search criteria that are based on current remote sensing data users and MODIS specific information,
2. Database designed according to these criteria (21 at the moment),
3. Web interface for searching, which supplies interacts with users to define and fulfill the search,
4. Results are reported and proper location for data are accessed,
5. All resultsare linked to quick looks for further quality inspection and order finalization.

**Accomplishment**

In the first half of 2002, we accomplished the following:

1. Order, download, process, and backup of MODIS VI data, from 2001 321-336 to 2002 145-160 period, including L2G and L3,
2. Finish all quick looks and global mosaic processing for MOD13A1 and MOD13A2 data,
3. Organized and populated the database for searching and lookup,
4. Maintained the database server and the web server.

## *2.9 Publications And Meetings*

### *2.9.1 Peer-reviewed publications*


Huete, A., Didan, K., Miura, T., and Rodriguez, E., 2002, Overview of the Radiometric and Biophysical Performance of the MODIS Vegetation Indices. *Remote Sens. Environ. (special issue, in press)*.

Morisette, J.T., Nickeson, J., Davis, P., Wang, Y., Tian, Y., Woodcock, C., Shabanov, N., Hansen, M., Schaub, D.L., Huete, A.R., Cohen, W.B., Oetter, D.R., and Kennedy, R.E., 2002, The Use of NASA's Commercial Data Purchase Program in Support of MODIS Land Validation, *Remote Sens. Environ. (special issue, in press)*.

Ferreira, L.G., Yoshioka, H., Huete, A., and Sano, E., 2002, The seasonal response of spectral vegetation indices in the Brazilian Cerrado: an analysis within the large scale biopshere-atmosphere experiment in Amazonia, Remote Sens. Environ. (special issue on LBA, in press).

Gao, X., Huete, A.R., and Didan, K, 2002, Radiometric and biophysical validation of MODIS vegetation indices at La Jornada Experimental Range, Remote Sens. Environ. (in revision).

Miura, T., Huete, A. R., Yoshioka, H., and Holben, B. N., 2002, An error and sensitivity analysis of atmospheric resistant vegetation indices derived from dark target-based atmospheric correction, *Remote Sens. Environ.* 78:284-298.

Ferreira, L.G., Yoshioka, H., Huete, A., and Sano, E., 2002, Optical characterization of the Brazilian savanna physiognomies for improved land cover monitoring of the cerrado biome: Preliminary assessments from an airborne campaign over an LBA core site, *Journal of Arid Environments* (in revision).

### *2.9.2 Symposia, Conferences and Meetings*

Schaub, D., Huete, A., Batchily, K., and Keita, F., 2002, "Vegetation Index Validation at Walnut Gulch, Arizona", presented at the High Resolution Commercial Imagery Workshop, Reston, Virginia in March (Poster).

Rodriguez, E. P., Didan, K., Huete, A. R., and Miura, T., 2002, "Application of MODIS Vegetation Indices to Monitor the Seasonal Responses and Water Use Impacts over the Colorado River Delta Area, NW Mexico", presented at the Arizona Riparian Council meeting in April (Poster).

Huete, A., Gao, X., Miura, T., Ross Bryant, R., Moran, S., and Hollifield, C., 2002, Multiple scale analyses of land degradation at the Nacuñan reserve, Argentina with Hyperspectral EO-1 and MODIS data, *29th International Symposium on Remote Sensing of Environment, Buenos Aires, Argentina, April 8-12*.

Rodriguez, E. P., Didan, K., Huete, A. R., and Miura, T., 2002, Application of MODIS vegetation indices to monitor the seasonal responses and water use impacts over the Colorado Delta Area, NW Mexico, *29th International Symposium on Remote Sensing of Environment, Buenos Aires, Argentina, April 8-12*.

Miura, T., Huete, A. R., Yoshioka, H., and Kim, H.J., 2002, An application of airborne hyperspectral and EO-1 Hyperion data for inter-sensor calibration of vegetation indices for regional-scale monitoring, *IGARSS 2002 – 24th Canadian Symposium on Remote Sensing, Toronto, Canada, June 24-28*.

Yoshioka, H., Miura, T., Yamamoto, H, and Huete, A., 2002, A technique of inter-sensor VI translations using EO-1 Hyperion data to minimize systematic differences in spectral band-pass filters, *IGARSS 2002 – 24th Canadian Symposium on Remote Sensing, Toronto, Canada, June 24-28*.

**(invited)** Huete, A. , Ratana, P., Ferreira, L., Shimabukuro, Y., Didan, K., and Miura, T., 2002, "A Look at Amazon Basin Seasonal Dynamics with the Biophysical Products from the Terra-MODIS Sensor", presented at the Second International LBA Scientific Conference, Manaus, Brazil, July 7-10.

(invited) Ferreira, L., Yoshioka, H., and Huete, A.R., 2002," Monitoring The Spatial And Temporal Dynamics Of The Brazilian Cerrado Physiognomies With Spectral Vegetation Indices: An Assessment Within The Large Scale Biosphere-Atmosphere Experiment In Amazonia (LBA)", presented at the Second International LBA Scientific Conference, Manaus, Brazil, July 7-10.

Ferreira, L., Sano, E.E., and Huete, A.R., 2002, "The Potential of Combined SAR Data and Optical VI´s for Vegetation Mapping in the Brazilian Cerrado", presented at the Second International LBA Scientific Conference, Manaus, Brazil, July 7-10.

Huete, A., Miura, T., Didan, K., Ferreira, L., Sano, E., Shimabokuro, Y., Bustamante, M., and Klink, C., 2002, "Use of Airborne Remote Sensing for Uncertainty Assessments in Regional Extrapolations of Ground LBA Ecology Measurements with MODIS Data", presented at the Airborne Remote Sensing Post-Conference Workshop, Manaus, Brazil, July 11-12.

**MODIS Outreach Workshop on MODIS Vegetation Variables (VI/LAI/FPAR/NPP), July 15-19th 2002, University of Montana, Missoula, MT**

Huete, A., et al., 2002, "MODIS Vegetation Indices (MOD13)", Presented at the MODIS Outreach on MODIS Vegetation Variables (VI/LAI/FPAR/NPP), July 15-18, University of Montana, Missoula, MT.

Didan, K., 2002, "MODIS Vegetation Index Production Algorithms", Presented at the MODIS Outreach on MODIS Vegetation Variables (VI/LAI/FPAR/NPP), July 15-18, University of Montana, Missoula, MT.

Huete, A., 2002, "Global Validation of EOS Vegetation Indices", Presented at the MODIS Outreach on MODIS Vegetation Variables (VI/LAI/FPAR/NPP), July 15-18, University of Montana, Missoula, MT.

Didan K., Huete, A., and Miura, T., 2002, "MODIS Vegetation Index Product series", Presented at the MODIS Outreach on MODIS Vegetation Variables (VI/LAI/FPAR/NPP), July 15-18, University of Montana, Missoula, MT (Poster).

Didan, K., Gao, X., and Huete, A., 2002, "MODIS Vegetation Index Quality Assurance Processing and Application", Presented at the MODIS Outreach on MODIS Vegetation Variables (VI/LAI/FPAR/NPP), July 15-18, University of Montana, Missoula, MT (Poster).

Yin, Y., Didan, K., and Huete, A., 2002, "MODIS VI Data Management in TBRS", Presented at the MODIS Outreach on MODIS Vegetation Variables (VI/LAI/FPAR/NPP), July 15-18, University of Montana, Missoula, MT (Poster).

Gao, X., Huete, A., Schaub, D., Ferreira, L., Miura, T., Didan, K., 2002, "Global Validation of EOS-MODIS Vegetation Indices", Presented at the MODIS Outreach on MODIS Vegetation Variables (VI/LAI/FPAR/NPP), July 15-18, University of Montana, Missoula, MT (Poster).

Rodriguez, E.P., Huete, A.R., Schaub, D., Didan, K., Miura, T., Glenn, E., and Nagler, P., 2002, "Application of MODIS Vegetation Indices to Monitor Seasonal Responses and Water Use Impacts over the Colorado River Delta Area, Mexico", Presented at the MODIS Outreach on MODIS Vegetation Variables (VI/LAI/FPAR/NPP), July 15-18, University of Montana, Missoula, MT (Poster).

Morisette, J., Vernote, E., Huete, A., Privette, J., and Roy, D., 2002, "Validation Analysis, Continuous Land Product Example: NDVI", Presented at the MODIS Outreach on MODIS Vegetation Variables (VI/LAI/FPAR/NPP), July 15-18, University of Montana, Missoula, MT (Poster).

***MODIS Meeting (July 22-24 2002)***

Huete, A., Didan, K., Ratana, P., Ferreira, L., Shimabokuro, Y., Miura, T., and Gao, X., 2002, "Seasonal Variability Studies Across the Amazon Basin with MODIS Vegetation Indices ", presented at the MODIS Science Team Meeting, Greenbelt, Maryland , July 22-24.

## 3. FUTURE ACTIVITIES:

In the next 6 months we will concentrate our efforts on the following activities:

- Collection 4 processing and evaluation,
- MODIS Vegetation Index data sampler CD-ROM, revised version to be put on ftp site,
- MODIS Vegetation Index User manual, in progress, and should be ready in October,
- MODIS Vegetation Index ATBD, in progress, and should be ready later this year,
- Further work on VI snow issues,
- Global Analysis of MODIS VI quality assurance,
- MODIS L3 product projection change,
- MODIS VI Climate Modeling Grid and IDS algorithm,
- Implementation of an automatic global data set generation in house,
- Complete our web site validation summary, status, and update page.

Future papers and meetings:

**(Invited)** Huete, A., Yoshioka, Y., Miura, T., Didan, K., and Rodriguez, E.P., 2002, “Inter-Sensor Calibration of Vegetation Indices for Synergistic Monitoring and Continuity Studies of Ecosystem Variability “, to be presented at the First International Symposium on "RECENT ADVANCES IN QUANTITATIVE REMOTE SENSING", Torrent, Spain, 16-20 September.

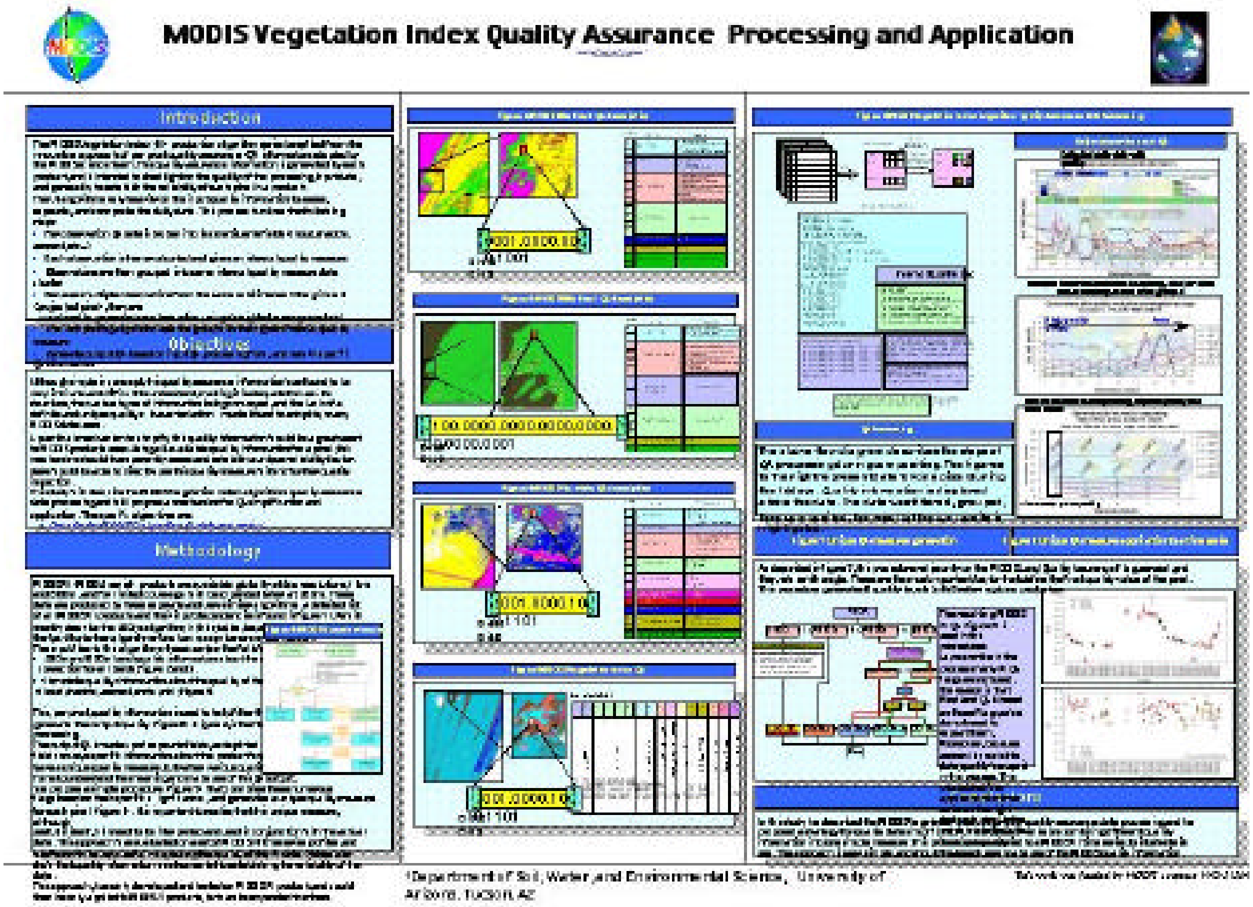
Attend MODIS Workshop on Land Surface Radiation Budget Variables and Snow and Ice products. Boston, MA. October 2002.

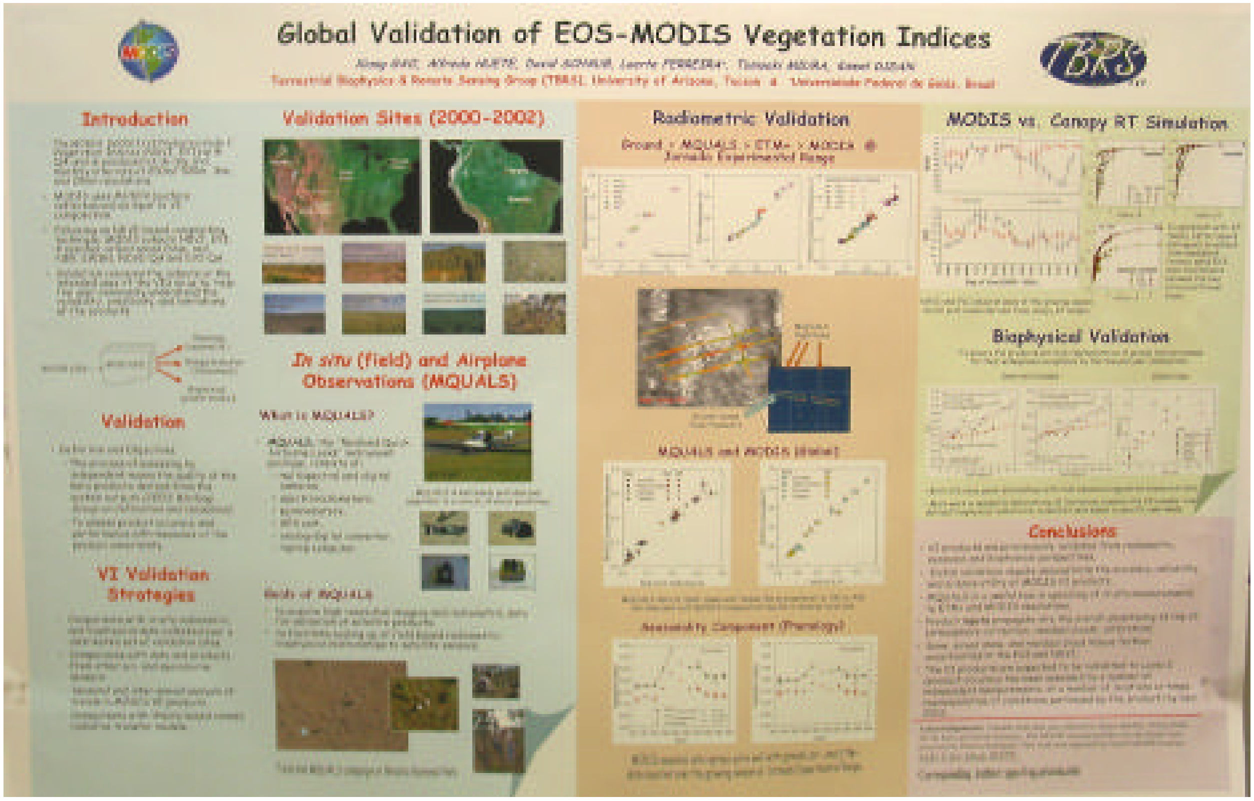
(Invited) “Spectral Remote Sensing of Vegetation” Conference, The United States Environmental Protection Agency (USEPA), Environmental Sciences Division of USEPA, Las Vegas, Nevada, December 3-5, 2002.

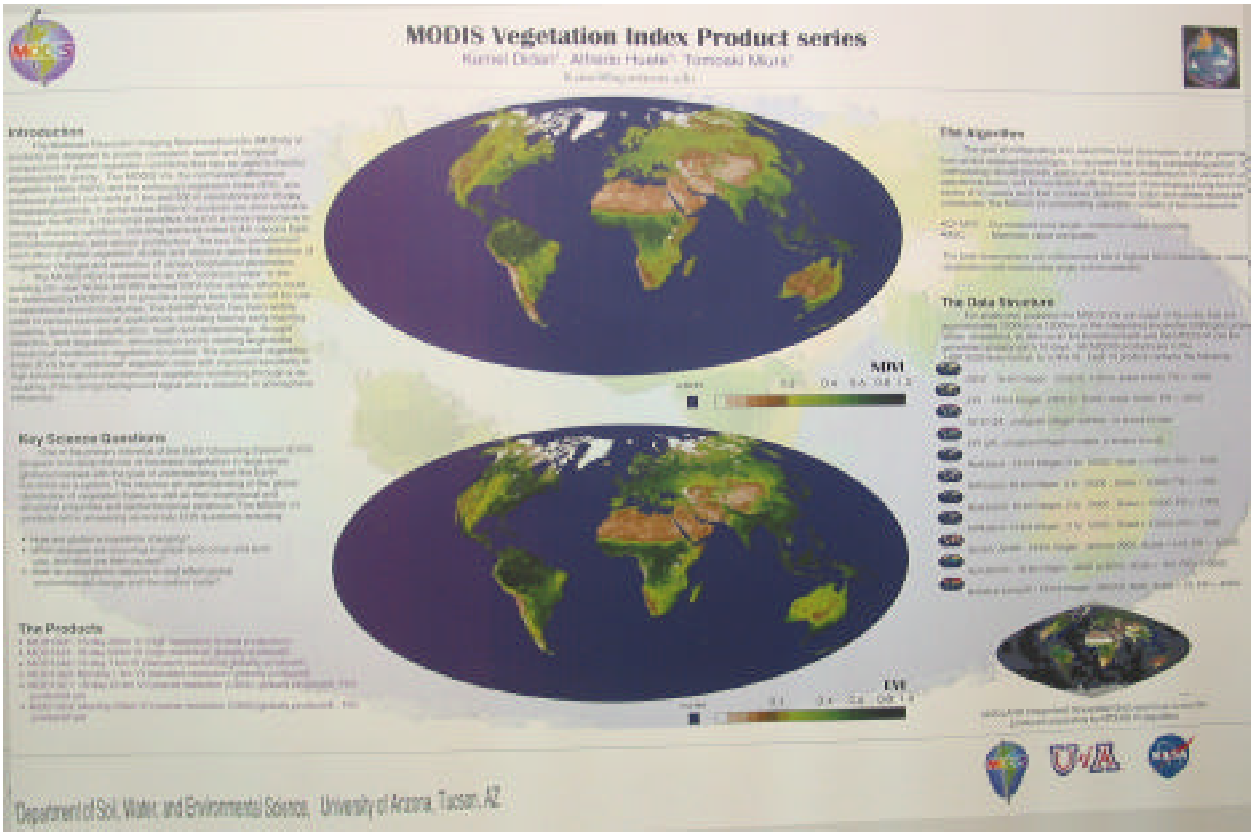
(Invited) Special session for LBA research, Carlos Nobre and Michael Keller will convene a special session for LBA research at the upcoming Fall Meeting of the AGU in San Francisco, December 6-10. 2002. WAGU Fall meeting, San Francisco, December 2002.

APPENDIX:

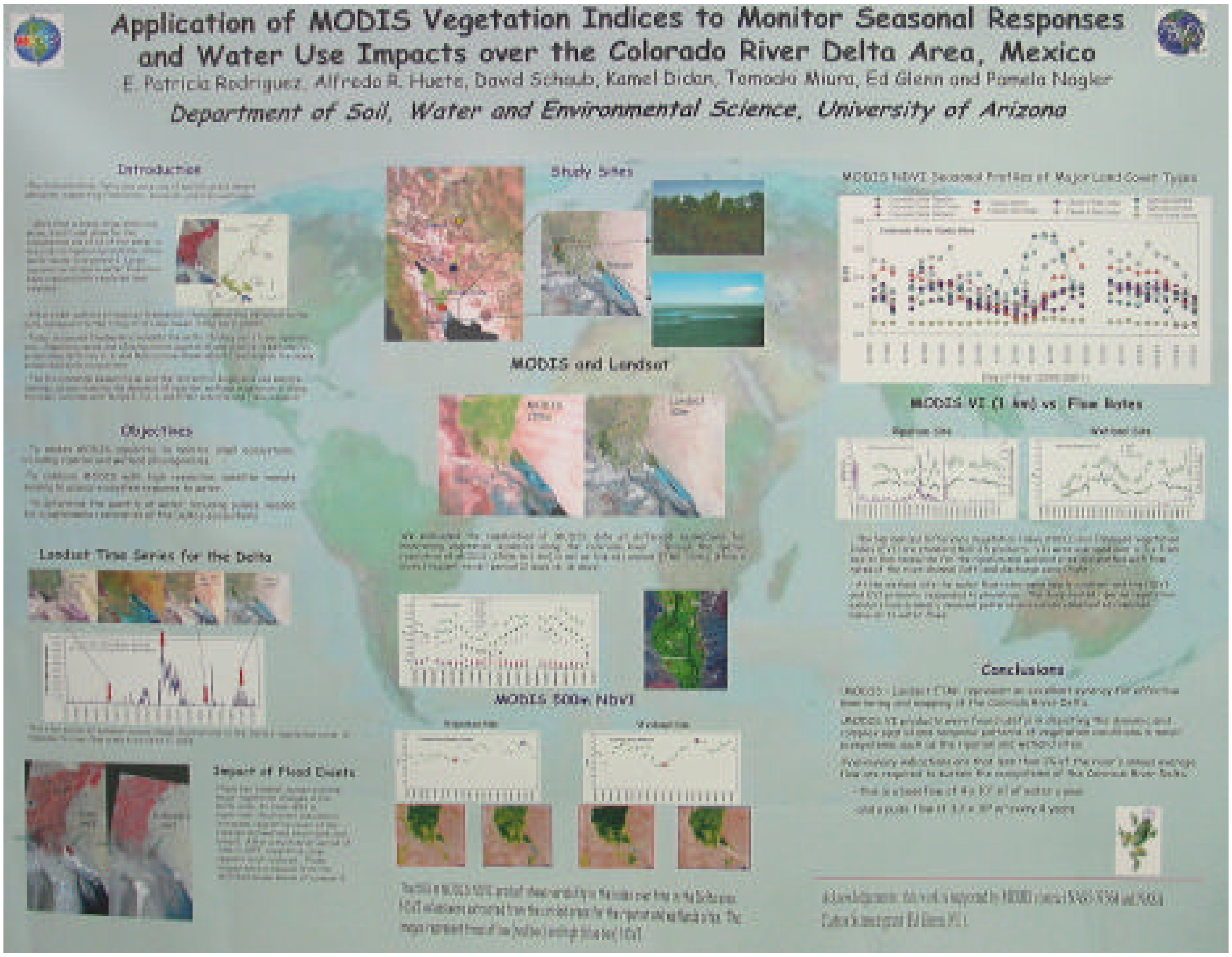
Some Posters from the Vegetation Outreach Worshop




Global Validation of EOS-MODIS Vegetation Indices
Introduction
Validation Sites (2000-2002)
Radiometric Validation
MODIS vs. Canopy RT Simulation
Validation
In situ (field) and Airplane Observations (MQUALS)
What is MQUALS?
VI Validation Strategies
Biophysical Validation
Conclusions



MODIS Vegetation Index Product series
Introduction
Key Science Questions
The Products
NDVI
EVI
The Algorithm
The Data Structure
Department of Soil, Water, and Environmental Science, University of Arizona, Tucson, AZ


Application of MODIS Vegetation Indices to Monitor Seasonal Responses and Water Use Impacts over the Colorado River Delta Area, Mexico
E. Patricia Rodriguez, Alfredo R. Huete, David Schaub, Kamel Didan, Tomoaki Miura, Ed Glenn and Pamela Nagler
Department of Soil, Water and Environmental Science, University of Arizona
Introduction
Study Sites
MODIS NDVI Seasonal Profiles of Major Land Cover Types
MODIS and Landsat
MODIS VI (1 km) vs. Flow Rates
Objectives
Landsat Time Series for the Delta
MODIS 500m NDVI
Conclusions
Impact of Flood Events