Type of Report: Semi-Annual, January to June, 1996. Alfredo R. Huete, University of Arizona NAS5-31364

TASK OBJECTIVES

Most of this period was focused on the SWAMP land review, preparation of a test site plan, a validation plan, and in revision of the algorithm theoretical basis document, ATBD v.2. Continued research was oriented towards the level 3 vegetation index compositing methodology; the blue-band sharpening for 500 m blue band incorporation into the 250 m vegetation index products; analysis of the NDVI saturation problem and the use of the green channel for high biomass, NDVI sensitivity. The above items needed immediate consideration for effective coding of the level 2 and level 3 vegetation index algorithms. Of most urgency is the incorporation of 1km BRDF data streams into the 250 m vegetation index products, since the atmospherically-corrected MODIS vegetation indices have sharper anisotropic behaviors, a form of noise that must be stabilized for effective change detection with vegetation indices.

Other documents prepared included:

(1) Vegetation and radiometric "measurement packages" for MODLAND validation activities.
(2) A draft Level 1b, MODLAND validation plan for joint MCST- MODLAND field efforts.
(3) An ADEOS-II GLI meeting summary report with joint MODLAND algorithm development and field validation activities.

WORK ACCOMPLISHED

1. ATBD v2 revisions:

Current emphasis is being placed on the v.2 ATBD revisions. The level 3 vegetation index compositing approaches are being incorporated into the ATBD. The vegetation index products will be produced at daily, 8-day , 16-day and monthly temporal resolutions at 250 m spatial resolution. The atmospherically corrected, surface reflectance data and corresponding quality control flags will be used as input (MOD09A). The composited vegetation index will also be produced at a global circulation grid-cell size of 0.25 km, by spatially aggregating the 250 m resolution surface reflectance data.

Cloud effects on the data will be minimized by using the MODIS cloud mask. View angle effects will be minimized by standardizing the measurements to nadir. Since MODIS sampling geometry and cloud cover may limit the BRDF correction due to limited observations of the Earth's surface, an alternative compositing approach is applied (a view angle constrained, maximum NDVI approach, similar to the current AVHRR composite algorithm).

1.1 Current outline of version 1 vegetation index composite:

The compositing criteria for the 8- and 16-day vegetation index composite products at 250 m are:

i. the maximum vegetation index value within a view angle threshold |15degrees| ; if no results, then;
ii. use standardized reflectance factors with the BRDF algorithm; if results are not good, then;
iii. use maximum NDVI at any view angle for the rest of the data points.

For the 8- and 16-day composite vegetation index products at 25 km, the reflectances obtained at 250 m are first aggregated and reflectance value QC flags and cloud cover statistics are used in the averaging computation. Subpixel (25 km) statistics on percent of area vegetated will also be provided. The outputs will be the NDVI and SARVI with QA flags attached. The monthly vegetation index composite products, at 250 m and 25 km, are obtained from the 16-day composites. Since any given month may contain three composite periods, the algorithm is designed to handle zero, 1, 2 or 3 composite periods in case data or files are missing. For all of the vegetation index products, the outputs will be the NDVI and SARVI with QA flags attached.

1.2. Improvements to the vegetation index composite algorithm for v.2 ATBD:

The current compositing criteria has the disadvantage of causing some discontinuities when the view angle threshold is applied, i.e., separate compositing approaches cause spatial discontinuities in the resulting image product. Results from different compositing runs indicated that the view angle threshold was particularly noticeable in the regions of the world with frequent observations and thus minimal cloud cover (arid climates).

Initial tests and results suggest that the BRDF can be applied directly to the data set, including near-nadir acquisitions, thus eliminating the need for a view angle threshold. This is an area in need of further testing over as wide a global range of conditions as possible.

1.3. Blue-band sharpening for the 250 m SARVI products:

The blue band is currently being used in minimizing residual aerosol influences not corrected by the coarser-grid surface reflectance product. Preliminary research has indicated that the use of the blue band can also aid in removal of smoke and light cirrus cloud contamination. However, the blue channel on MODIS will be at 500 m while the red and NIR channels are at 250 m. Since the blue band is mostly used for aerosol resistance, we have experimented in sharpening this band to 250 m in order to preserve the spatial resolution of the SARVI at 250 m. The tests were as follows:

1. Divide a 500 m blue pixel into four, 250 m pixels using equal reflectance values in all four subpixel cells.;
2. Interpolate within the additional subpixel cells using nearest neighbor averaging; and
3. Regress the blue and red bands and use this relationship to partition the values for the four subpixels. Thus the 250 m red band information is used to "sharpen" the blue band.

Preliminary analysis on simulated, observational, and TM data sets, indicates that the blue-red regress technique performs the best. A report on the technique and results will be available for the ATBD v.2 report.

2. Vegetation Index View Graphs for MODLAND products:

We are preparing a series of visual vegetation index product examples with precursor data sets. These view graphs are to be made available for MODLAND presentations and will be posted on the World Wide Web.

i. A pseudo color scheme was designed for vegetation index visualization using intervals of 0.1 vegetation index units. This color schematic design was applied to AVHRR, TM, and AVIRIS data to show samples of MODIS products. Software was written to process the AVIRIS data and convolve the high spectral resolution data to MODIS, MISR, AVHRR, TM, ASTER, GLI, and SPOT bands. The effects of spectral bandwidth and position on the vegetation index were visualized for MODIS and AVHRR bands. The NDVI and SARVI were compared as well.
ii. The MODIS vegetation index composite algorithm was applied to 16-days of global AVHRR data. The MODIS algorithm was compared to maximum NDVI and other compositing methodologies and histogram and data subsetting tools were developed to analyze and compare these compositing methodologies. Another color scheme was designed to specifically visualize the quality control flags related to the MODIS composited vegetation index product.
iii. Landsat TM data for the tropical rain forest (Rondonia) and semi-arid desert (Sahelian region) were also processed to 250 m and 1000 m spatial resolution to show differences in MODIS spatial resolutions, vegetation indices, vegetation index saturation, and vegetation index scaling effects.

3. SCAR-B Update

Kamel Didan a graduate student was hired to process the AVIRIS images obtained last summer during the SCAR-B campaign in Brazil for vegetation index studies. The AVIRIS processing project consisted on five steps:

i. Extraction of raw data from the AVIRIS scenes;
ii. Computation of the apparent reflectances using the exo-atmospheric irradiance from MODTRAN;
iii. The AVIRIS bands are then convolved into MODIS, AVHRR, MISR, LANDSAT TM, and SPOT spectral bands using a weighted integration procedure;
iv. Convolve the atmospherically corrected data (from ATREM) to the same bands above;
v. NDVI and SARVI images were then computed.

The objectives of this experiment include:

i. Vegetation index (VI) algorithm development in high biomass conditions.
ii. Analyses of the red band saturation problem in MODIS by simulating the MODIS red band.
iii. Testing of the atmospheric resistance concept in the SARVI under the conditions of smoke particles, water vapor, trace gases, and clouds from burning activities of theforested and savanna sites.

4. Global TM Data Set

We are continuing with our use TM imagery for level 2 vegetation index validation efforts with more global scenes and with an implementation of a dark object subtraction routine. The applied program "tm2modis" based on Fourier interpolation was modified to increase the computer memory allocation, and to process a full TM image. Now this program processes a whole TM scene arranged in a band sequential database. The implementation of a dark object substraction routine (total atmosphere correction) is being carried out now in the lab with the aim of simulating the MODIS processing chain. Also, the 6S atmospheric radiative transfer program is being used when only a partial, Raleigh molecular correction is needed. The original 30 m nominal spatial resolution images are aggregated to 250, 500, or 1000 m resolutions to simulate the MODIS bands, and to facilitate data storage and reduction of image processing time.

The use of TM imagery for vegetation index validation activities has expanded to include 18 scenes over our Chilean test sites and an additional 17 TM scenes over the Amazon basin and Brazilian cerrado. Additional imagery is being acquired over the dry and humid Pampas of Argentina and the Patagonia region. All of these images are being converted into MODIS simulation, 250 m data.

Along with previously acquired TM imagery over global land cover test sites (GLCTS), we now have 73 Landsat TM scenes.

5. Validation plan

A first draft of the Vegetation Index validation plan was completed and incorporated into the MODLAND validation plan which is available on the World Wide Web.

5.1. Vegetation Measurement Package

A first draft of a MODLAND vegetation measurement package was assembled with the goal of developing a comprehensive set of measures for validation and quality analysis of the MODLAND products. This section was placed in the current MODLAND validation plan and will be revised for a second submission this September.

A. Intensive Validation

In this section we wish to conduct a series of global vegetation measurements in support of MODLAND algorithms. Intensive measurements are limited to approximately six basic land cover types, and over fairly homogeneous (uniform) areas representative of the land cover type. Here we are attempting to determine the performance of MODLAND algorithms over as wide a global range of vegetation conditions as possible, (e.g., desert grassland, savanna, needleleaf and broadleaf forests). This is a basic validation package. More complicated heterogenous and mixed biomes are in the realm of experimental research. If an algorithm performs well over forest and grass, the user would understand that mixed grass-forest areas may behave unlike either component.

1. Choose uniform and representative sites for six basic land covertypes (see Running, land cover type description). Ideally we would have three replicates for each land cover type (e.g., for desert - Gobi, Sahara, and Atacama), and validation conducted during the wet and dry growing seasons.

2. Locate sites with GPS and set up a 2 km x 2 km square grid composedof 16 (250 m) pixels in the center and 16 (500 m) pixels around it.

3. Sampling may now be conducted with linear (1-d) transects or withthe spatial (2-d) grid, depending on the statistical rigor required for that land cover type.

4. Vegetation Characterization

a. Basic Optics

For dominant vegetation species, measure leaf reflectance and transmittance, in situ or send for lab analysis. Similarly, soil, litter, woody material, and other significant non-photosynthetic material would be sent for optical characterization. The purpose of these measures is to confirm aspects of the Myneni canopy model as well as gain insights into the performance of the vegetation index and LAI and fPAR algorithms.

b. Vegetation Biophysical

(1) Percent cover by components (green, senesced, soil, litter, etc.), (2) LAI (green and total), (3) Biomass (in the case of grasslands and herbaceous types), (4) fPAR, and (5) Basic vegetation structure and morphology, on a qualitative or semi-quantitative basis, dependent on Myneni model needs.

It is recognized that not all measures can be conducted in a similar manner over all vegetation types. In some cases, a limited amount of destructive sampling may be performed, while in the majority of cases, allometric techniques may be employed over indirect methods such as ceptometry. The best measure of vegetation characteristics will normally already be provided by the local "expert" or institute with previous experience over specific land cover types. MODLAND cannot reinvent the wheel on this aspect. The specific method employed will have to be well documented and referenced to previous studies in that area. For example, allometric and other indirect methods will have relationships already established and traceable to "destructive sampling" methods. In other words, the indirect method (ceptometry) will have its own validation and calibration history. In most cases, if the canopy morphology and structure changes, then so will the indirect equations and thus the importance of documenting basic structural properties is evident.

c. Meteorological/Environmental

A basic set of climatic and meteorological parameters, including weekly precipitation, air temperature, incoming or net radiation, vapor pressure deficit, and possibly soil moisture deficit.

d. Radiometric

This is included in the radiometric package. Fundamentally, for a uniform intensive validation site, we would like to know or determine canopy reflectance and transmittance, BRDF, understory reflectance and canopy background reflectance.

B. Long-Term Validation Performance (Temporal Sampling)

Here we are interested in less intensive measures and instead wish to obtain simple and precise measure indicative of "change" in the vegetation canopy. Here is where many indirect methods of vegetation sampling, such as ceptometry, will prove useful. In addition, we would like to employ these rapid measures over a larger set of test sites, which no longer are to be uniform. In fact, here we are interested in test sites or transects which are located in "transition areas" (e.g., the hyperarid to arid transition zones or arid - semiarid transition zones). We would like these sites to be situated in areas where we may most likely expect to encounter "long term" changes and we would like to validate that MODLAND algorithms will be able to detect such changes. We will also determine the performance of MODLAND algorithms by verifying its sensitivity to such changes. For example, in a hyperarid - arid - semiarid - subhumid transect, can an algorithm resolve these classes?

Data Information System

Land cover specific guidelines/templates are needed with respect to documentation efforts of measurements and methodologies. Detailed protocols and guidelines will help to make validation measurements as uniform as possible within the constraints of environmental and vegetation specific properties and practical considerations. A data information system will be needed and designed to make effective use of validation data and data documentation.

5.2. DRAFT Validation Plan for Level 1b MODLAND activities:

MODLAND needs both calibrated radiances and geolocation for higher-level product analysis. The precision and uncertainties of MODLAND geophysical products are dependent upon the geometric and radiometric performance of the instrument. MODLAND has developed a draft validation plan which includes a radiometric measurements package. This radiometric package includes the simultaneous (temporal and spatial) characterization of a wide range of terrestrial surface types in order to validate the following MODLAND radiometric products:

a) Directional surface reflectances in the first 7 MODIS bands (atmospherically corrected);
b) The bidirectional reflectance distribution function (BRDF) and integrated spectral albedos within the first 7 bands;
c) Vegetation indices, and;
d) Land surface temperature.

MODLAND surface-based radiometric properties in the visible and thermal are of critical importance to all MODLAND products and need to validated with great precision. As a result we see a portion of our radiometric validation package overlapping with MCST Level1b vicarious calibration activities.

The surface reflectance and BRDF products are closely coupled with Level 1b vicarious calibration activities through the following areas of commonality, and requirements:

a) Accurate characterization of the atmosphere at the time of an overpass;
b) Uniform areas of surface type;
c) The need for both dark and bright surface types (devoid of vegetation)*;
d) Accurate characterization of the BRDF surface properties (second-order atmosphere backscattering);
e) Fairly clean atmospheric conditions*;
f) Close to nadir satellite observations*.

*It is important to note that the requirements for MODLAND product validation are much more extensive than presented above, i.e., MODLAND will further require validation measures undertaken under a variety of atmospheric conditions (turbid, clear, etc.), with a variety of angular observations, and a greater range of surface types which include variations in vegetation biomass and land cover type. As an example, MODLAND requires knowledge of surface reflectance uncertainties under both turbid and clear atmospheric conditions (low and high aerosols, water vapor, etc.).

A&E Validation Activities (first 13 weeks after launch):

1. Instrument calibration sites: MODLAND intends on participating in a vicarious radiometric calibration site; and in a vicarious geometric calibration site immediately after launch to verify on the performance of the instrument and assess initial impacts on the performance of higher level products. The locations of these sites will be in cooperation with MCST test site requirements and will include uniform areas of bare dark and bright surfaces. Geometric site calibration requirements are still TBD. For these sites MODLAND requires calibrated surface-based EOS radiometers (EOS Visible, Shortwave IR, and Thermal Transfer Radiometers; sun photometers, pyranometer, standard reference (Spectralon) plates, a BRDF apparatus, and GPS. Aircraft or helicopter-based radiometers are also required. We are currently working on a field protocol.
2. MODLAND radiometry test sites: MODLAND is also organizing and developing a global set of test sites to monitor radiometric performance of MODLAND radiometric products over the lifetime of the instrument. These sites fall within the realm of the tier 4 "Globally distributed test sites" (see Earth Observer, Vol.8,No. 2, p.33) and will be instrumented with sun photometers for atmospheric characterization. The globally distributed set of test sites will enable us to extract surface reflectances over as wide a range of atmospheric, sun angle, view angle, surface vegetation, soil, snow, and uniformity/heterogeneity conditions to meet validation criteria.

MODLAND is currently finalizing the list of initial test sites for field validation. Over 60 test sites are currently being explored for long term monitoring and quality analysis. Prioritization of these sites and field validation activities and protocols for pre-launch, A&E, and post A&E activities are in preparation. We expect that during the A&E phase, we will concentrate field validation efforts over vegetated sites, including a forested site, a grassland site, and a cropland site. At each site, we will conduct atmospheric, directional reflectance, BRDF/albedo, and surface temperature characterization. The platforms for these observations will include surface-based, towers and aircraft/helicopter. Because many of the radiometric products involve multiple observations (level 3), the length of each validation activity may be extended to a 16-day cycle. The surface radiances measured with EOS calibrated radiometers will be of interest and useful to level1b instrument calibration activities.

6. ADEOS-II GLI Meeting, Hakone, Japan

The Modland proposal to GLI was accepted as were the proposals from the oceans and atmospheres groups of the MODIS science team. MODIS representatives at the meeting were Michael King, Mark Abbot, and Alfredo Huete. The land group submitted a budget, mostly to support a Post-Doc who will coordinate algorithm development, integration, implementation, and validation between the MODIS and GLI land teams. The GLI budget is tight and the 2-year contracts will not be issued until around September, 1996.
As P.I. to the MODLAND group, I participated in the first GLI Science Team Meeting, held in Hakone, Japan, June 26-28, 1996. My presentation was entitled "Investigation of Cooperative GLI - MODIS Activities for Algorithm Development for Enhanced Global Terrestrial Science". An outline of the MODLAND talk is included below. Notes from the GLI Science Team Meeting, including members of the science team and a list of GLI standard products are included in Appendix A. Additional information may be found in the following web addresses:

http://www.eorc.nasda.go.jp.test/GLI/gli.html
http://www.eorc.nasda.go.jp/eorc/

ALFREDO HUETE (P.I.) UNIVERSITY OF ARIZONA, U.S.A

MODLAND

Chris Justice (U. Maryland)
Alfredo Huete (U. Arizona)
Jan-Peter Muller (U. College London)
Ranga Myneni (U. Maryland)
Steve Running (U. Montana)
Vince Salomonson (NASA/GSFC)
Alan Strahler (Boston U.)
John Townshend (U. Maryland)
Eric Vermote (U. Maryland)
Zhengming Wan (U. Cal-Santa Barbara)

ALGORITHM DEVELOPMENT

Conduct cooperative research for algorithm development
Plan and conduct joint validation and calibration exercises over common test sites
Evaluate and compare standard algorithms for the two sensors
Establish translation and extension between the two sensors
Determine and evaluate advanced synergistic GLI - MODIS applications for standard algorithms

OVERALL GOAL

Integrate the two sensors to aid in the creation of comprehensive long-term

(monitoring) data sets.

WORKPLAN

Identify and utilize precursor 'test' data sets for:

Algorithm development and testing (July 96 - Dec. 96)
satellite data sets
field/aircraft data sets
modeled/simulated data sets

Initial Coding and Data Processing (Jan. 97 - July 97)

Test Site Development and joint field campaigns over a range of land cover types (Summers 96 & 97)

Algorithm refinement, coding, and integration (Sept. 97 - May 98)

LAND DATA PRODUCTS

SURFACE SPECTRAL REFLECTANCE (ATMOS. CORRECTED)
SPECTRAL ALBEDO/BRDF
VEGETATION INDICES
LAI AND fPAR
LAND SURFACE TEMPERATURE
LAND COVER AND LAND COVER CHANGE
FIRE
SNOW/ICE
NET PRIMARY PRODUCTION

DESCRIPTION OF MODLAND PRODUCTS

MODLAND VALIDATION OUTLINE

----

7. Chile AVHRR-TM Validation Study

We are currently utilizing four global land cover test sites (GLCTS) in Chile as part of the vegetation index pre-launch validation activities. The sites span steep latitudinal climatic gradients, making them ideal for combined vegetation and climate studies using remote sensing data and bioclimatic models. The sites include hyperarid areas with less than 300 kg/ha above-ground biomass to over biomass levels above 30,000 kg/ha in the more humid zones. Each site is equipped with meteorological stations and long-term data sets of vegetation measurements and meteorological data. This enables comparative studies of vegetation index performance with calibrated, bioclimatic-based estimates of vegetation parameters. The model simulates weekly biomass variations using solar radiation, temperature, precipitation, and soil water balance as inputs. Model outputs were: total biomass production, soil cover, leaf area index, phenological stage of vegetation, and available soil water.

Thus far, we have compiled a set of Landsat Thematic Mapper images for the 1 986 growing season, to cover each of the climatic zones within Chile. Land cover types include: desert, semiarid shrub, subhumid and arid-steppe grasslands, and temperate evergreen and deciduous forests. The TM data have been converted into 250 m resolution imagery to simulate the EOS, Moderate Resolution Imaging Spectroradiometer (MODIS) and ADEOS-II, Global Imaging (GLI) sensors. The images are corrected for atmospheric molecular scattering and aerosols using a dark-object subtraction program and vegetation index imagery were computed from surface reflectance values for the normalized difference vegetation index (NDVI), the soil adjusted vegetation index (SAVI) and soil and atmosphere resistant vegetation index (SARVI). The resulting vegetation image images are being compared with the independent, bioclimatic model-based derivations of vegetation biophysical parameters as to their capability in predicting biophysical variables such as biomass, leaf area index, % green cover, and absorbed photosynthetically active radiation (APAR) over each of the land cover types. Comparisons of the model derived biophysical variables with those from the vegetation index also enables determinations of VI performance over the different land cover types. This is useful in validation and sampling strategies and in delimiting confidence levels to parameter extraction with remotely-sensed vegetation indices.

8. Presentations

Dr. Wim van Leeuwen presented a paper at the IGARSS'96 conference, May 27-31, 1996, entitled "Comparison of Vegetation Index Compositing scenarios:BRDF Versus Maximum VI Approaches" by Leeuwen van W.J.D., A.R.Huete, Shuping Jia, and C.L.Walthal, 1996. Reference: IEEE-IGARSS'96, Lincoln Nebraska, Vol.3:1423-1425. The abstract is included below:

Satellite sensors, such as the AVHRR, SPOT and soon to be launched MODIS, MISR, VEGETATION and GLI acquire bidirectional reflectance data under different solar illumination angles. These systems will capture the strong anisotropic properties that vary with relative amounts and types of vegetation and soil within each pixel. Therefore, some knowledge of the bidirectional reflectance distribution function (BRDF) is a requirement for successful interpretation of directional reflectance data and vegetation indices, and derivation of land-cover-specific biophysical parameters. The objectives of this research were: a) to parameterize empirical and semi-empirical BRDF models for different land cover types and MODIS bands; b)utilize the BRDF models to correct off-nadir measurements to nadir-equivalent values for vegetation index (VI) compositing and biophysical interpretation; and c) compare different vegetation index compositing scenarios.

High spectral (10-12 nm) , and spatial (3 m at nadir), resolution bidirectional reflectance factor (BRF) measurements from the Advanced Solid State Array Spectroradiometer (ASAS) flown on the NASA-C-130B aircraft were used for the analysis. Leaf area index (LAI) measurements were made concurrently at most of the study sites which included deciduous and coniferous forest, grassland and shrub savanna land covers. The normalized difference vegetation index (NDVI) and modified VI (MVI) were selected as classifiers in five different vegetation index composite scenarios:

1) a maximum VI based on apparent reflectance data;
2) a maximum VI based on at -surface reflectance;
3) a BRDF standardized VI, based on at-surface reflectance at nadir view angle (using a representative sun angle);
4) a BRDF normalized VI, based on at-surface reflectance at nadir view and nadir sun angles;
5) a normalized bidirectional VI distribution function (BVIF).

Nadir-equivalent VI accuracy and predictability were evaluated for all compositing scenarios using the measured nadir observations as a reference.

Extrapolation of the BRDF models to nadir sun angles was found to be inaccurate. VI composite scenarios based on the standardization of reflectance to nadir view angles was more accurate than the maximum VI approach. The results of the analysis emphasize the importance of standardiz ing BRF for vegetation index compositing scheme and retrieval of biophysical parameters.

9. ANTICIPATED FUTURE ACTION

9.1 Presentations

Abstracts have been prepared for presentations to be made at the SCAR-B meeting, Natal, Brazil in November. In addition abstracts were submitted for presentation at the next "physical measurements and spectral signatures" symposium in Courchevel, France, April 1997.

9.2 Research Activities

1. Finish the ATBD v.2 and incorporate the comments from the SWAMP land workshop review for August delivery.
2. Further vegetation index composite research, particularly the BRDF incorporation into level 3 algorithm and research on the feasibility of using the MODIS 1 km BRDF product for the finer resolution 250 m vegetation index product. Also the use of view angle thresholds will be further investigated, with respect to accuracy and visual products. We will evaluate AVHRR composite scenarios with 1 year of AVHRR data. Further work is needed on efficient handling of monthly data for the monthly composite products.
3. Improve upon VI software delivery and incorporate Quality Assurance in the v2 software delivery.
4. SCAR-B analysis, work on establishing precursor "translation" among various sensors, and in particular, MODIS-AVHRR. Include issues of bandwidth and spatial scaling functions.
5. Validation field exercise along Chilean climatic gradients, including limited radiometric measurements at different sites.
6. Order more Landsat TM images from the Global Land Cover Test Sites project, and AVIRIS images, and two years of AVHRR data.
7. Hiring a full time System Analyst/Programmer for SCF development and integration with MODLAND and to develop quality control capabilities for post-launch monitoring of our test sites.
8. Hire a new post-doc for vegetation index validation work.

9. Coupling of vegetation indices with biophysical parameters.

10. References

van Leeuwen, W.J.D. and Huete, A.R., 1996, Effects of standing litter on the biophysical interpretation of plant canopies with spectral indices, Remote Sens. Environ. 55:123-138.

Huete, A.R., 1996, Extension of soil spectra to the satellite: atmosphere, geometric, and sensor considerations, Photogrammetria (in press).

Huete, A.R., Liu, H.Q., Batchily, K., and van Leeuwen, W., 1996, A comparison of vegetation indices over a global set of TM images, Remote Sens. Environ. (in press).

Begue, A., Roujean, J.L., Hanan, N.P., Prince, S.D., Thawley, M., Huete, A., and Tanre, D., 1996, Shortwave radiation budget of Sahelian vegetation during HAPEX-Sahel-1. Techniques of measurement and results, Agric. & Forest Meteorol. 79:79-96.

APPENDIX A. Notes from the GLI Science Team Meeting:

The major task of the GLI team is to produce "standard products" in less than two years. Proposed standard products are to be outlined this year with "primitive" versions provided by March, 1997. At this time, a tentative list of algorithm selection will be made and phase 2 algorithm development will commence on April, 1997. By April 1998, algorithms will be frozen. Due to the shortage of time, there is a good possibility that algorithms developed by MODLAND may play an important role in the final GLI products.

The GLI Science team is divided into four disciplinary groups: land, ocean, atmosphere, and cryosphere.

The land group consists of:

NO	Name	
G06	Dr. Fujiwara	Vegetation map and Vegetation change
G07	Dr. Duong	Vegetation map, Land cover map
G12	Dr. Verstraete	Vegetation map, APAR
G13	Dr. Hock	Biomass (carbon), Vegetation change, Biomass burning
G18	Dr. Huete	Vegetation map (lifeforms), green biomass, APAR and so on
G19	Dr. Trotter	BRDF measurement and modeling, topographic correction
G22	Dr. Awaya	Biomass (carbon), NPP
G23	Dr. Kajiwara	BRDF measurement and modeling
G24	Dr. Honda	Vegetation map
G31	Dr. Tateishi	Land cover map
G34	Dr. Yasuoka	Wetland vegetation map

Name & Affiliation

Dr. Fujiwara: Dept. of Information and Computer Sciences, Nara Women's Univ., Japan.

Dr. Duong: Institute for Geography, National Center for Natural Science and Technology, Vietnam.
Dr. Verstraete: Institute for Remote Sensing Applications, EC, Italy.
Dr. Hock: Centre for Remote Sensing Imaging, Sensing and Processing, National Univ. of Singapore.
Dr. Huete: Soil, Water and Environmental Sciences Dept., Univ. of Arizona, USA.
Dr. Trotter: Landcare Research, New Zealand.
Dr. Awaya: Natural Forest Management Lab., Forestry Research Institute, Japan.
Dr. Kajiwara: Center for Environmental Remote Sensing, Chiba Univ.
Dr. Honda: Center for Environmental Remote Sensing, Chiba Univ.
Dr. Tateishi: Center for Environmental Remote Sensing, Chiba Univ.
Dr. Yasuoka: Information Processing and Analysis Section, National Institute for Environmental Sciences, Japan.

The cryosphere group consists of:

Dr. Tomohiko Oishi (Japan)
Dr. Knut Stamnes (USA)
Dr. Zege Petrovna (Belarus)
Dr. Teruo Aoki (Japan)
Dr. Wolfgang Schneider (Germany).

Finally there is a small group working on surface radiation budget:

Dr. Fred Prata (Australia)
Dr. Rachel Pinker (USA)

The land team leader is Dr. Yoshio Awaya.

In addition to the four discipline groups, there are three working groups on: (1) Algorithm development; (2) Data management; and (3) CAL/VAL.

Project Status Report:

Tentative launch dates for the ADEOS-II platform is Feb. or summer of 1999. ADEOS-II is classified as a research satellite. AMSR and POLDER will also be flown on ADEOS-II. The GLI will be at 803 km, is sun synchronous, 10:30 am crossing time, 4-day recurrent period, with a swath width of 1600 km (+/-43 degree). Spatial resolution is 1 km with six (TM-like) 250 m bands. It has tilting capability of 20 degrees. In contrast to the MODIS channels, the 36 GLI channels are concentrated in the VIS/NIR, with 23 channels below 1 micron and only 7 channels above 3 microns. Its pointing and geolocation accuracies are to within one-half pixel.

Standard Products:

The evaluation of land biomass and primary production on a global scale is considered one of the top science objectives of the ADEOS-II mission. The ADEOS-II science mission plan would like to see the following standard products from the GLI team:

1. 250 m mesh data (cloud free, 10-day)
2. 1 km mesh data (cloud-free, 10-day)
3. Vegetation Index map (create VI-seasonal profiles)

4. Land Cover map (using seasonal spectral signatures)
5. Biomass carbon amount (terrestrial biomass carbon amount will be estimated)
6. Vegetation change map (deforestation and desertification will be detected)
7. Biomass burning map (forest fires, grassland fires, and shifting cultivation)
8. APAR map
9. NPP map
10. Precise Biomass map (in detail)

Thus far, the PIs selected have mainly proposed to produce very specific land cover maps, such as a "wetlands map", a grasslands map, a tropical forest of Vietnam map, a Kansai area map, etc. Biomass maps were proposed as were new vegetation indices. Biomass burning, APAR, NPP, and surface reflectance products have not been assigned and it is unclear how or who will produce them.

In addition there are a list of "common" standard algorithms which include:

1. PAR
2. Surface albedo
3. Earth's surface temperature

The following are the cryosphere standard algorithms:

1. Snow cover distribution
2. Sea ice distribution
3. Polar ice sheets
4. Iceberg monitoring
5. Snow ice albedo
6. Snow ice surface temperature

Miscellaneous Notes:

1. Steve Eckerman will provide a land and ocean "cloud mask" product for GLI data.
2. NASDA has developed an airborne multispectral scanner (AMSS) for ADEOS-II/GLI work to: (1) confirm GLI design and specifications; (2) provide early data for algorithm development; and (3) calibration and validation of spaceborne GLI data with underflight experiments.
3. We should be able to use ADEOS-I data for GLI research activities.
4. Ground field program: various field programs are underway over the Eurasian continent related to ADEOS-I, which we (will) have access to.

Test sites currently in development include the Mongolian grassland site and the Mekong delta rice fields. The Mongolia site is instrumented and will be monitored till 2003. In Thailand there are LIDAR and aircraft available.

5. Compact flagging is supported. Only 8-bit flags with 1-bit extension (cloud, shadow, surface, quality).

ACTION ITEMS:

1. The land group needs "atmospheric correction" applied. There is no one committed to this.

2. PAR is needed over land and oceans. It is proposed that a "land" person should do PAR (24 hour) and provide instantaneous PAR for the oceans group. No one is committed to this yet.
3. The atmospheres group needs BRDF?
4. Next meeting for the GLI team will be next year, possibly July 1997 in Caines, Australia.
5. The land group may try to meet in 6 months in Tokyo.