MODIS SCIENCE TEAM MEETING

FEBRUARY 20-22, 1991

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LISTS OF ATTACHMENTS

In the following listings of attachments, material distributed as documents is flagged D and material seen as viewgraphs is flagged V. Some documents which were distributed at the meeting are *not* attached to these Minutes, and are noted by a ' # ' mark following that entry. They are available from archive by contacting:

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ATTACHMENTS 1 : OPENING SESSION

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OPENING PLENARY SESSION

Meeting participants were supplied with an information packet upon arrival. A copy of the meeting agenda, *Attachment A*, was provided as part of that packet.

1. WELCOME AND MODIS STATUS OVERVIEW

The welcome and MODIS overview were given by Dr. Salomonson at the opening plenary session. He commented that MODIS-N/T were confirmed for the EOS-A payload. MODIS-N is in a blackout because the C/D proposals are currently being evaluated. An April 1991 announcement of contract award is expected. The MODIS-N IR calibration is an important issue and there will be a 3 month study after contract award. He indicated that a calibration accuracy comparable to ATSR for the sea surface temperature bands is desirable. This issue will be addressed in the report from the calibration panel. The Ocean Color Data Set (OCDS) proposals are currently being reviewed and the results of the evaluation are expected sometime in March. EOSDIS is now in a brown-out phase and the SEB, headed by Dr. Robert Price, is preparing the RFP for release.

2. HEADQUARTERS PERSPECTIVE

The NASA headquarters perspective was given by Dr. Greg Mitchell, a marine ecologist and MODIS-T Program Scientist. Dr. Mitchell's viewgraphs are provided as *Attachment B*.

On 18 January 1991 10 instruments were selected for the EOS-A platform including MODIS-N and MODIS-T. The selected instruments are detailed in the January 1991 issue of "The Earth Observer" newsletter. The selection of the instruments was "conservative" and based on payload synergism. The decision on additional instruments is funding constrained. The science funding level for FY91 and FY92 is approximately 25% of that requested. The current projected EOS funding levels are: FY91 - $44 M and FY92 $180 M, with some of these funds going to "Earth Probes." The impact of these reductions will be: a) data products will have to be prioritized, b) logistical support including the use of aircraft and ships will be constrained, and c) parallel development of algorithms for the Ocean Color Data Set and MODIS may be required. If the program is to be a success with the current budget constraints, interagency cooperation will be required. He also commented that there are no plans at the present time to fund a "full-up" MODIS simulator. (This was later clarified in view of the development of the MODIS Airborne Simulator).

Dr. Mitchell commented on the action items from the September meeting: discussions are being held with NSF to fund JGOFS and WOCE; NASA will provide some funds to NSF to support optics development; there is no resolution yet on ship time; there is an optical calibration workshop scheduled for September 1991. Dr. Slater wanted to know if in-situ calibration issues would be discussed at that meeting. Dr. Mitchell replied

that they would and that the OCDS people (Bob Kirk and Chuck McClain) would be setting up the meeting. Yoram Kaufman asked about the MODIS Airborne Simulator development and Dr. Mitchell indicated that the science team would be funding most of it; he mentioned Mike King as a contact.

3. PROJECT SCIENCE OFFICE REPORT

Dr. Dozier presented the Project Science Office report. He addressed general issues associated with EOSDIS, MODIS, and specific issues associated with the MODIS budget.

Dr. Dozier stated that there was a delay in the release of the EOSDIS Phase C/D RFP and that the new release date was 1 July 1991. The main reason for the delay was that Hughes was pusuing the purchase of STX, who was aiding in the preparation of the EOSDIS RFP. In order to prevent any conflict of interest a decision was made at GSFC that contractors would not be involved in any further RFP development. He remarked that the 17 December draft of the SOW would be released soon and that NASA has been moving slowly in this area. The 6 month slip in the release of the RFP will also slip the Version 0 award. He also stated that there was going to be a Version 0 workshop at the Greenbelt Marriott on 26 - 28 February.

Dr. Dozier discussed issues associated with cataloging the MODIS data sets. Pathfinder data sets will be accessed under Version 0. AVHRR and TOMS data are part of Version 0 and inclusion of GOES data is possible (at least 100 terabytes of data are available). The inclusion of Thematic Mapper data is dependent on the findings of the Committee on Earth Sciences, which is investigating the continued commercialization of the TM data. Based on current plans a usable system to access data through the DAACs will be available in 1994. Gene Feldman is responsible for assigning beta sites (sites that help with validation of the system) which will be provided access to some of the data held at the GSFC DAAC. Each DAAC will form a local science panel to work with. Members should contact Dr. Feldman to indicate their interest in the science advisory panel for GSFC Version 0 DAAC. A question was asked on how the DAACs will coordinate. Dr. Dozier responded that the Version 0 workshop will address this issue. He added that to date communications have been from the project office to each DAAC but he believes it also needs to be established between the individual DAACs.

Dr. Dozier began the MODIS budget discussions by displaying charts *(Attachment C)* which showed the proposed and projected MODIS science budget. He indicated that the original proposals were based on a 1996 launch and that the new numbers reflect a December 1998 launch date. A question was asked on how the launch slip would effect the OCDS funding. Dr. Dozier responded that the OCDS budget, while "aware" of EOS perturbations, was a separate funding issue based on OCDS requirements.

Dr. Dozier discussed members' contract development schedule next. The schedule *(Attachment D)* consists of the following: a) the Project will meet with the Team Leader and discuss the cost issues and guidelines (due 1 April 1991); b) the Team Leader will meet with Team Members and develop

budget summaries and science and data products to be delivered (due 1 May, 1991); c) the Project will issue the Statement of Work (due 15 May 1991); d) the Team Leader and Team Members will submit their final proposals (due 1 July 1991); and the Project will award the contract (15 December 1991). Dr. Salomonson commented that the data products need to be prioritized to address a variable funding scenario.

Dr. Dozier stated that the end of millennia costs for EOS would reach approximately 15 billion. The instrument and platform budgets for FY91 and FY92 have eroded more than the science and EOSDIS budgets.

The EOSDIS SEB is reviewing the specification and clearing up inconsistencies which should lead to a clearer specification. EOSDIS has to receive code, not just equations. EOSDIS will provide the tools and help to optimize the code. A question was asked as to how the scientists can develop their algorithms and code if EOSDIS is not defined yet. Dr. Dozier responded that the objectives will constantly be reprioritized based on the respective funding levels. The interface between the scientist's code and EOSDIS code will be developed through interaction with the scientist. In Version 0 a decision was made to put a higher priority on access to existing data sets than on product generation implementation because of the budget constraints. Version 0 is meant to bring NASA up to speed in computational capabilities.

The question was asked, "If you don't know what you are going to have to do, how do you write a 10 year contract?" Dr. Otis Brown answered that the scientific research program should be designed with minimum expectations because of the uncertainties in the funding. Dr. Dozier added that there needs to be a sense of prioritization in the contract. The EOSDIS requirements and deliverables are not as rigid as building an instrument. The algorithms for Level 1 data have a higher priority than the geophysical products. There is a need to understand the priority of the science products. The teams need to define these priorities. Dr. Dozier indicated that decisions on setting priorities need

to be made by the Science Teams. Dr. Salomonson added that the contracts should reflect the priorities.

Dr. Alan Strahler presented questions *(Attachment E)* from the Land Group. These included questions on the Pathfinder data sets, algorithm and data transfer, global DTM. A comment was made on the possible use of DMA topographic data. Dr. Dozier commented that Bruce Laxer indicated to him that the DMA data set was not very useful for EOS purposes, and there were security problems associated with presenting DMA data. A question was raised on backup plans for MODIS N/T. Dr. Dozier indicated that MODIS-N/T are very solid on EOS-A1. If the budget really gets "hit" then MODIS-T may be in danger. The current contingency plans do not anticipate all possible disasters. It may be necessary to de-scope the payload in order not to slip the schedule.

Dr. Dozier commented that a December 1997 launch date for the MERIS instrument has been announced by the Europeans.

A comment was made that universities have a problem with 10 year budgets and the small incremental amount of funds which actually come in (compared to the total budget requests.) University facilities and research capabilities are competed for by many groups and those with the better defined funding are likely to get higher priority. Dr. Dozier indicated that it is necessary for NASA to come up with "realistic" cost profiles.

Tom Mace of the EPA commented that some difficulties may be eliminated by making the proposals highly modular.

4. SURFACE TRUTH GUIDELINES

Dr. James Huning, acting manager of the Research Facilities Program, presented an overview of the Ames aircraft program. Dr. Huning's set of viewgraphs are duplicated in *Attachment F*. Dr. Huning indicated that there is a great demand by Code SE to utilize the different aircraft.

The aircraft at ARC include: 3 ER-2s, a Learjet-24, a C141A (supports astrophysics), a DC8 and a C130. The DC8 has just finished a major inspection (D-inspection), the first one in 16 years. The DC8 is for long range, heavy payloads. NASA owns 2 ER-2s, the third is on loan from the Air Force. One ER-2 is used for Ozone measurements for up to 6 months out of the year. Another primary instrument used on the other ER-2s is AVIRIS. The C130 has just completed corrosion repairs ($700K) and was out of service for approximately 3 months. ASAS is the primary GSFC instrument used on the C130. The P3 at Wallops is being upgraded with avionics and flight controls.

Dr. Huning explained that the program is managed by Code SE and is block funded and highly subsidized. The users do not pay for operational costs but are required to pay a "user" fee. These "user" fees help to increase the funded flight hours. The sensor operations are paid for by the discipline managers. User fees help to minimize the data processing costs. Dr. Huning indicated that the airborne geoscience operations are costly. The ER-2 operates on a base of approximately $8.87M which allows 238 flight hours. This is augmented by the "user" (approx. $900K) fees which allows up to a 600 hour season. This total is well under the approximately 1200 hours which can be flown per season. The baseline funding just keeps the aircraft flying. The C130 operates on a base of $3.85 M which also allows for 238 flight hours. The "user" fee (approx. $159 K) increases this to 300 hours per season. The C130 can fly up to a maximum of 550 hours per season. In both cases the fees are paid for by the NASA/HQ discipline manager or the EOS project office. A question was asked as to whether flights could be combined to have more than one PI to share the costs. Dr. Huning indicated that would depend on common usage of test sites.

Dr. Huning presented the user fees for aircraft: DC-8, $2,500/flight hour; ER-2, $1,500/flight hour; and the C-130, $1,500/flight hour. The "user" fees for sensor operations and data production are: AIRSAR, $10,000/scene (3 frequencies, 4 polarizations, 10 km x 7 km); AVIRIS, $4,000/scene (11 km x 11 km in all 224 spectral channels); ASAS, $4,000/flight line (7 viewing angles); TIMS, $1,500/flight line (if JPL has to correct data). Dr. Huning indicated that the fuel costs are dependent on world oil prices and are approximately $1.00/gal at this time. He also pointed out that the ER-2 requires 3 pilots for every deployment. The program costs and availability are affected by contract overruns, DoD cutbacks and by maintenance due to corrosion and FAA mandated upgrades (e.g., GPS upgrade). There are also mission peculiar costs (MPCs) associated with each deployment, e.g., crossing Air Route Traffic Control Centers (ARTCCs). Dr. Huning commented that in order to avoid any "surprises" in the future it will be necessary to find a balance by keeping the yearly flight hours (costs) in line with the EOS development funding.

Dr. Huning presented some suggestions to help minimize flight costs and operational problems. These included: using common data sets and test sites; minimizing temporal requirements; developing conservative data requirements; submitting flight requests (FRs) by due date (late FRs will not be considered); checking test sites for "restricted" air space.

A question was asked on the use of non-NASA aircraft. Dr. Huning

indicated that aircraft from other organizations were available and that NASA aircraft requirements for the next 5 years should be given to Locke Stuart. A question was asked on who pays for ferry flight costs. Dr. Huning commented that on a deployment (non-local), ferry flight time is accounted for separately (block funded) and does not impact the investigators. For AIRSAR and local flights the investigators pay all of the flight costs (if there is more than one investigator, the costs are pro-rated.) A question was asked on the procedures for providing GPS information. Dr. Huning remarked that providing GPS and INS was under evaluation. A question was asked on coordination of flights. It was recommended they speak to Locke Stuart. A comment was made that the Project Science Office is funding the "user" fees only in FY '91; sensor and data production costs must come out of team member funds. A comment was made that "up-front" funding arrangements for payment of fees need to be set

up so that Team Members do not have to pay overhead costs.

5. GEOPHYSICAL VALIDATION OVERVIEW

Dr. Salomonson presented an overview of the MODIS geophysical parameters algorithm development and validation plans and of the MODIS-N and MODIS-T standard product processing scenario for land, oceans, and atmospheres *(Attachment G; Note: The attached charts are updated versions of those presented at the ST meeting)*. He indicated that it was important to determine the level of effort required to develop and validate the algorithms and deliver the products.

Dr. Salomonson discussed the acquisition of land and atmosphere data from spacecraft, aircraft/sensors, surface instrumentation, and field experiments. For oceans, data from satellite, aircraft, ships, surface instrumentation, and field campaigns were discussed.

Dr. Salomonson indicated the need to prioritize the data products that will be delivered. He discussed the MODIS-N and MODIS-T standard product processing system *(Attachment H)* and indicated that in his view the Level 1 algorithms have the highest priority. He then discussed the algorithms associated with land, atmospheres and oceans. For land he suggested that snow cover, land surface temperature, and NDVI might have the highest priority. For the atmospheres, total cloud fraction, cloud top temperature, and optical depth had the highest priority. And for oceans the highest priorities were water leaving radiances, chlorophyll, and sea surface temperature. These "strawman" priorities should be reviewed by the Land, Ocean, and Atmosphere Groups.

There was a discussion on the types and number of data products given on the spreadsheets which were handed out and a comment was made that any duplication of data products should be removed. Dr. Salomonson indicated that the number of products will probably be reduced by funding constraints. A question was asked on how Dr. Salomonson wanted feedback on the data products. He replied that the spreadsheets should be marked up and returned to Locke Stuart.

6. CALIBRATION REPORT

Dr. Slater opened this session and presented a tentative schedule for the calibration group's meeting *(Attachment J)*. He discussed the proposed role of the peer review group for MODIS-N and MODIS-T calibration. He also discussed action items from the last MST meeting. These items included concerns regarding output level of the MODIS-T two-sphere calibrator, the choice of diffuser material and monitor diodes, the choice of a barrel roll or paddle wheel scan mechanism, precision of bandpass position for water vapor filters, MODIS-N between-band registration, use of a math model for relative BRDF, and the polarization effect on spatial and spectral responses in the lab. Dr. Slater indicated that there was a need for calibration and cross-calibration of all of the EOS instruments and that the facilities which will be available for calibration should be determined.

Dr. John Barker presented information on the status of the MODIS calibration plan with emphasis on science and engineering related calibration topics *(Attachment M)*. A detailed discussion of MCST/MODIS calibration topics was covered including: an overview of the MCST with its objectives and approach (*Attachment L);* a calibration plan outline and implementation plan *(Attachment K);* the primary and secondary responsibilities of MCST; product sensitivity to calibration for atmosphere, ocean, and land; at-launch and post-launch MCST/MODIS utility products; and challenges and concerns about communications, instruments, calibration, and data processing. Dr. Salomonson commented that the plan reflected an optimum design and was subject to change in the variable funding environment. He also stated that the main focus of MCST would be on instrument-related characterization and calibration.

7. IR CALIBRATION REPORT

Dr. Bill Barnes presented the preliminary results of a study on the MODIS-N infrared calibration *(Attachment I)*. The purpose of the study was to determine if and by what amount the MODIS-N absolute infrared calibration requirement of 1% could be reduced. An existing MODIS-N error model was used to perform the analysis. This model includes error sources due to background spurious sources, blackbody emissivity, blackbody temperature, wavelength, detector noise, and out-of-band radiance. The results of the analysis showed the following: the out-of-band rejection is the dominant error; blackbody averaging is important; and a 0.3% absolute accuracy may be possible for some channels. Future work included examination of the two blackbody case and the preparation of a NASA/GSFC technical report. Dr. Barnes commented that the background sources are not a problem if the blackbody is at the same temperature. He also mentioned that the original out-of-band specification of 5% was too high and that vendors indicated they could supply 0.01%.

A question was asked as to what happens when there are 5 to 10 degrees K differences between the blackbody and the instrument. Dr. Barnes indicated that he believed these would not have a significant effect. Another question asked if the non-linearity in the detectors was a problem. Dr. Barnes was not sure. A comment was made that truncation error should be examined. Differences between 10 and 12 bits can be large. Another comment was that the band pass error was a function of temperature and this error should be investigated. A comment was made that based on the results of this study, the Level 1 requirement for a sea surface temperature error of 0.2 degrees may be too tight. Dr. Slater wanted to know if the ATSR accuracy could be verified. Dr. Barnes indicated that the only accuracy information available was on the ATSR blackbodies, not the on the instrument.

MINUTES OF THE MEETING
OF THE

ATMOSPHERE

DISCIPLINE GROUP

AT THE

MODIS SCIENCE TEAM MEETING

February 20-22, 1991

Wednesday, February 20, 1991

Meeting Attendees:

Michael King	(team leader)	MK
Yoram Kaufman		YK
Paul Menzel	PM	
Didier Tanre	DT	
Phil Ardanuy		PA
Eric Vermote		EV
Steve McLaughlin	(executive secretary)	SM
Nancy Roman	(stayed only briefly)	NR

Summary in Brief:

This day's session was devoted to a review of existing aircraft flights and to discussion of prospective future flights. As related issues, the status of the MAS and modifications to WILDFIRE were discussed.

Detailed Summary:

AIRCRAFT USE REQUIREMENTS

MK reviewed the existing requested aircraft flights, which have been previously documented. These include:

- **FIRE/CIRRUS flight for PM and MK over Coffeeville, KS using the ER-2, between 11/13/91 and 12/07/91. 60 hours (including transit time) are involved.**
- **Azores flights, funded under the FIRE project, 100 hours (transit time included) are involved.**
- **Separate line item flights using the University of Washington's C-131 airplane.**

NEW possibilities for aircraft flights were suggested and discussed. They included:

- **Use of the UW C-131 and the ER-2 to conduct a biomass burning experiment over Brazil during September 1992. No formal name has been assigned to the project as yet.**
- **Flight using TOGA-COARE on the ER-2 near Kwajalein or Guam in the western Pacific Ocean around December 1992. This flight would stress cirrus cloud components.**
- **Arctic Stratus observations near Barrow was suggested by MK for April 1992. PM likes this possibility because of the many inversions.**

YK noted in subsequent discussion that he had recently met with NASA Headquarters, and that the ER-2 would probably be available for the Brazil flight and that Brazil would probably participate in the experiment. MK noted that the MODIS-N airborne simulator (MAS) may not be complete in time for the FIRE Cirrus campaign; however, it should be sufficiently complete to be brought along on the ASTEX and Brazil flights. The FIRE Science Team prefers that the visible port be completed first, and the thermal port second. Some flight time is desirable to check imagery of the instrument. Some data acquisition could be done during ferrying, but no truth data exist for comparison.

PM raised the issue that he needs some observations in FY 1992 to continue his analysis. The observations should

focus on cirrus and specialized cloud formations. He estimates about 20 hours of mission flight time is required. The largest area of uncertainty is data processing fees. It was jointly decided that 30 hours of engineering test flights in FY 1992 over cirrus clouds with HIS on board would satisfy requirements. This probably can be done without paying for it from MODIS funds.

MAS STATUS

A discussion was held of possible changes to data channels to be used for the MAS. A table from Fred Osterwisch of Daedalus Enterprises (attached) was distributed which showed the suggested bands and spectrometer ports for MAS, with the channels marked " * " coinciding with MODIS observation bands. The following changes were advocated:

- **Changing channel 43 to a 9.73 micron channel for ozone.**
- **Port 1 will be changed from an indium-gallium arsenide detector to a silicon detector in order to add channels in the visible wavelength region.**
- **Channel 11 in port 2 should be altered to mimic MODIS channel 6.**
- **The 4 micron CO_2 bands will be considered for part 3.**

These changes imply future instrument modifications, with a change in ports to individual channels.

As an additional potential modification to the MAS, PM raised the possibility of temporarily deleting a visible channel to get 10 bit depth on 4 infrared (IR) channels, similar to what is now done on MAMS. It could be accomplished by implementing a switch to decide 8 bit vs 10 bit data collection. It can be done by a circuit board placed into the bit bucket--an arrangement requiring decisions before a given flight. Laboratory calibration would be required. In response to questions concerning the complexity of the pilot's role, PM emphasized that pilots can only make simple switch changes.

WILDFIRE DISCUSSIONS

Funding and use of the WILDFIRE instrument was discussed. The possibility of converting the status to that

of a facility instrument for costing purposes was discussed. The funding could come from the atmosphere group members. MK raised the issue and the uncertainty of how the new money system will work in this application. Jim Brass of NASA Ames owns the instrument, and is willing to work with the MODIS Science Team to replace the data system and make modifications. John Arvesen (ER-2 Branch Head at Ames) knows of other changes, mostly in electronics, that need to be done to fix up the instrument. MK will meet with Arvesen and Brass next week. MK and PM will go to Daedelus Enterprises (Ann Arbor, Michigan) for a day in early April to see Osterwisch. Brass, Arvesen, Ken Brown (MAS Instrument Manager), and Peter Abel will also go.

WILDFIRE data processing was discussed. PM noted that a ground based instrument is very useful for verification. Ed Westwater suggests his ARM program is very useful to fly over for truth data. PM has software for quick look and preliminary analysis. It is currently known only as the "MAMS Code", and is specific to the instrument. There are no known user fees for the instrument. Ames does data pre-processing, and supplies uncalibrated data without navigational corrections. Delivery consists of an INS navigation tape and the instrument raw data tape, plus blackbody calibration. The Atmospheres Discipline Group would like Daesoo Han to do the data processing using the MAMS code to produce a level 1B output product consisting of navigated active scan and calibration data for the MAS. They hope to convince him that it might be a prototype for a MODIS level 1B processor.

Thursday, February 20, 1991

Meeting Attendees:

Michael King	**(team leader)**	**MK**
Yoram Kaufman		**YK**
Paul Menzel	**PM**	
Didier Tanre	**DT**	
Phil Ardanuy	**(frequent absences)**	**PA**
Eric Vermote		**EV**
Steve McLaughlin	**(executive secretary)**	**SM**

Summary in Brief:

This session included a discussion of the MODIS Data Product Lists (DPL), the Geophysical Parameter Validation Plan, Program Level technical requirements, direct broadcast channels, future problems and issues, and action items. PM also provided a demonstration of MAMS resolution.

Detailed Summary:

DATA PRODUCT LIST DISCUSSIONS

Group members conducted a discussion of data products contained in the listing "MODIS Data Products Required by EOS Investigators" for which members of the Atmospheres Discipline Group have primary responsibility. They decided upon a prioritization scheme suggested by YK, following in the path set by Vince Salomonson, whereby:

A = High Priority
B = Moderate Priority
C = Lowest Priority

During the discussions, a number of general points were noted. Some of these issues are almost as important as the changes to the DPLs themselves. The following general points were made:

- **There are so many derivative Data Product Lists and of such complexity that they are confusing even to the Science Team investigators.**
- **YK suggests that investigators would prefer if some mechanism could be found to consolidate the variety of lists into a single data base. The group concurred.**
- **Data name changes are very confusing. They cause delay in interpretation, reduction in clarity, and sometimes completely alter the intended meaning of the product. PM observes that there have been ambiguities, redundancies, and errors introduced into the DPLs through the name changes. It is noted that someone has inferred data product matches based solely on names, without really understanding the parameters.**
- **There is frustration that IDS investigators do not appear to truly understand the products they're requesting. Often there is a high demand for products which are viewed by the atmospheres group to be low in applied value. Correspondingly, high value data is frequently ignored. A good example is N_e, the effective emissivity of clouds. This theme of a "cross-over problem" seems to have some general application in all discipline groups. The suggestion was made that a paragraph which describes each data product or provides an appropriate descriptive reference should be included as part of the data base or as an addendum to the data base.**
- **The "Data Products Not Required" is a dangerous list. There is a strong tendency to discount these products, and they may be the first to go if the budget axe falls. Some of these products are viewed as having very high priority for a particular discipline, even though their interdisciplinary usefulness is limited.**
- **There is an exasperation that investigators may see the same DPLs brought up for discussion at the next Science Team meeting.**
- **Investigators view a priority C product as bearing a potential "kiss of death". Consequently, the adopted approach is to priority protect products required by the atmosphere group. Products needed from atmospheres get lowest priority.**

- **YK would like to see larger print sizes in the products lists.**

The following DPL priorities were decided upon:

A = 2429, 2430, 2431, 2663, 2664, 2664, 1017, 2293, 2294, 3321, 1764, 2311, 2312, 1780, 1781, 1528, 1875, 2126, 1023

B = 2471, 2665, 2666, 1874, 1765, 2081, 2082, 2466, 2467, 1022

C = 2380, 2381, 3322, 1333, 1334, 2268

Discrepancies were noted for the following DPL elements:

2429	**856 m --> 1 km**
2430	**428 m --> 500 m**
2431	**214 m --> 250 m**
2294	**TM --> Tanre,Kaufman**
1764	**TM --> King,Menzel**
1765	**TM --> King,Menzel**
2126	**Parameter --> Emissivity::Cloud effective**

The DPL "MODIS Data Products Not Required by EOS Investigators" also was examined to prioritize the products for which atmospheres discipline group members are responsible:

A = 2711, 2094, 1529, 1559, 2116, 2127

B = 2068, 2092, 1560, 2003

C = 2379

Discrepancies were noted for the following DPL elements:

2068	**1/mo --> 1/day**
2092	**1/mo --> 1/day**
1560	**0.5 dg --> 1 dg**
2116	**accuracy --> 0.10::0.05; temporal --> 2/day; horizontal --> 5 km :: G**
2127	**Parameter --> Emissivity :: Cloud effective**
2003	**Parameter --> Single Scattering Albedo :: Aerosol**

Product 2711 for classification of fires has a temperature versus size problem. Some type of new classification scheme may be required.

An attempt was made to prioritize the "MODIS Input Data Requirements" list; however, this activity was abandoned as too complicated.

MAMS RESOLUTION DEMONSTRATION

PM provided 11.1 micron images of the area near the Mississippi River basin delta. These demonstrated the previously discussed bit bucket technique for improving resolution by using 10 bits rather than 8 bits. More gradients were readily apparent in the data. MAMS provides a practical example of what can be expected from MAS for the scene noise to be expected from a narrow spectral channel. For a 225 K target viewed with the 12.5 micron channel, the digitization calculated using a Planck function is 1.5 counts/K for 8 bit digitization and 6 counts/K for 10 bit digitization. This technique will not work for visible channels, but is especially useful for thermal infrared channels and for cold scenes.

DIRECT BROADCASTS

Group members discussed what data would be desirable from MODIS-N if the spacecraft were directly overhead, and direct broadcasts of telemetry were available to support field operations. The following wish list of MODIS channels was decided upon:

Priority 1		Priority 2	
Channel 1	0.66 mm†	Channel 32	12.02 mm
Channel 2	0.87 mm	Channel 29	8.55 mm
Channel 7	2.13 mm		
Channel 31	11.03 mm	**Priority 3**	
Channel 20	3.75 mm	Channel 26	4.57 mm
Channel 33	13.34 mm	Channel 27	6.72 mm

† Channel 4 at 0.56 mm is an alternate

Priority 3 channels are compatible with Meteosat. AVHRR data is free, and used by much of the world for a vegetation index and for sea surface temperatures.

PROGRAM LEVEL TECHNICAL REQUIREMENTS

The group discussed the information presented on the first page of the handout by Greg Mitchell (from NASA HQ) regarding Program Level technical requirements. There was a general feeling that the atmospheres discipline group had not been consulted for inputs to the list, and that the overall resulting list was poorly presented and unfocused in intent and purpose. As applies particularly to atmospheres, there was no mention of water vapor and atmospheric stability. MODIS-T was viewed as being of minimal concern.

GEOPHYSICAL PARAMETER VALIDATION PLAN

Group discussions of the algorithm development and validation plans provided the following updates to the Salomonson handout on validation mechanisms for MODIS data for the atmospheres group:

SPACECRAFT

- **Meteosat**
- **GOES-VAS**
- **LANDSAT-5 thematic mapper (TM); YK wants MODIS to buy some TM images of clouds and put them in the Browse facility (a mechanism used by FIRE)**

AIRCRAFT (discussed in 1/25/91 memo to Stuart)

- **MODIS-N Airborne simulator (MAS)**
- **High Resolution Interferometer Sounder (HIS) on ER-2, San Antonio at end of October or early November**
- **Cloud Absorption Radiometer (CAR) on University of Washington C131-A**
- **POLDER available on French Fokker and MARS on UK C-130 aircraft during ASTEX**
- **delete list item for cloud particle size**

SURFACE

- **PM adds ground based HIS data (Revercomb) under Colorado cirrus clouds**
- **Note that almucantar = azimuth plane through sun**
- **Biomass Burning in Brazil - August 1992**

- **TOGA-COARE - December 1992**

FIELD CAMPAIGNS

- **Math/Engineering/Science Opportunities done during 20 hours/year, an item discussed at length previously**
- **delete reference to ARM work**

FUTURE ATMOSPHERE DISCIPLINE GROUP ACTIVITIES

Limited discussion was conducted about the possibility of extending the atmospheres group to include more members. There is not currently enough money to staff up; however, PM noted that Wiley and Ackerman are adjunct members of his investigations. Rossow was also suggested, but not deemed advantageous. It was noted that Wilicki and Coakley are already members of CERES and close collaborators with MK.

Global ground based validation is a future issue which will address who is really going to adjust the algorithms. The group will be looking for international contacts and centers to do analysis. Some linkages do already exist. As examples PM knows Merv Lynch in Australia, YK knows people in Israel and Europe, and MK knows people in Japan. Atmospheres should consider if they should set an example for the rest of the MODIS team.

There is a concern that resources are not currently available to do post-launch global validation. Should a MODIS validation group be established? PM volunteered that he has a meeting soon in La Jolla to discuss experiences with calibration validation.

Very little is known about the MODIS instrument. Group members are anxious to see it.

ACTION ITEMS

1. MK -- Return DPLs, Broadcast list, and Mitchell's page 1 to Vince Salomonson.

2. PM and MK -- meet with Fred Osterwisch.

3. Get Daesoo Han to coordinate getting the data processed.

MINUTES OF THE MEETING
OF THE

MODIS CALIBRATION WORKING GROUP

AT THE

MODIS SCIENCE TEAM MEETING

February 19-22, 1991

February 19 - Preliminary Session

The meeting started at 8:30 A.M Tuesday, February 19. The names of attendees are given in *Attachment AA*.

ROLE OF THE MODIS CALIBRATION PANEL

P. Slater opened the meeting, and talked briefly on the following topics to be discussed during the meeting:

1. **Review of plans and progress of MODIS Characterization Support Team (MCST)**
2. **Proposed role of Peer Review Group for MODIS-N/T calibration**
3. **Review of instrument vendor plans and progress for MODIS-N calibration**
4. **Review of GSFC plans and progress for MODIS calibration**

***Attachment BB* is a copy of the proposed schedule of the topics to be presented by participants.**

STATUS OF THE MODIS CALIBRATION PLAN / ROLE OF MCST

J. Barker made a presentation on the Status of the MODIS Calibration Plan, and the role of MCST. His presentation was covered by *Attachments CC* and *FF*. These documents are extremely detailed, and require only minimal review in the minutes of the meeting. Six major topics are included:

1. **MCST overview**
2. **Characterization/calibration**
3. **MCST responsibilities**
4. **Product sensitivity to calibration**
5. **MCST/MODIS utility products**
6. **Challenges and concerns**

MCST Goals presented by Barker are to:

1. Identify calibration issues
2. Review outline of calibration plan
3. Define what is needed to prepare input for calibration plan
4. Draft MCST calibration
5. Prepare inputs for first draft by May 24, 1991

Barker's wrap-up at the conclusion of the session covered:
1. Summation of action items for MCST and individuals
2. What to present to MST
3. What to discuss at Calibration Working Group meeting
4. Input to EOS calibration meeting April 22-23

An MCST overview is presented in *Attachment CC*, page 5 Objectives of MCST are:
Support MODIS -- Team Leader, Team Members, and EOS Instrument Managers
For Instrument -- Characterization/Calibration, Parametric Sensitivity, Utility Products
During all phases -- Definition, Pre-launch Fabrication and Integration, On-orbit operational, and End-of-Life

Approach/priority
Primary: Instrument related system characterization and calibration
Secondary: TM-MCST Discipline-Related Product Sensitivity to calibration
Tertiary: Utility Products

Types of Data Products:

Level 1-product for calibration and characterization
Level-2 for validation

CALIBRATION IMPLEMENTATION PLAN: *Attachment CC*, page 6

Objective:

Develop and maintain "Official " Level-1A to 1B algorithms, both for MODIS-N and MODIS-T instruments, for radiometric, geometric and spectral characteristic models

PROJECT PLAN: *Attachment CC*, page 8

PRIMARY MCST RESPONSIBILITIES: *Attachment CC*, page 10

MODIS CALIBRATION CHALLENGES AND CONCERNS: *Attachment CC*, page 16

Review of Cross Calibration Activity:

- **What activity to take place at vendors**
- **Peer review, immediately after engineering review.**
- **Peer review in the form of workshops**

STATUS OF THE EOS CALIBRATION/VALIDATION PANEL

B. Guenther briefly discussed the Status of the EOS CAL/VAL Panel. His major points of discussion were:

- **Separate funding from NASA/HQ for calibration workshops**
- **thermal channels-meeting to be held along with Oceans meeting at New Orleans, January '92**
- **VIS-NIR meeting, -time TBD**
- **PEER CALIBRATION WORKSHOP- La Jolla, California, April 22-24; input is needed form the MODIS group**
- **Scientists should be involved in PEER REVIEWS at PDR and CDR.**

LAND GROUP CALIBRATION

A.R. Huete of the University of Arizona provided a brief presentation *(Attachment P)* of a study he conducted for the Land Group calibration. He carried out preliminary sensitivity analyses. Various scenarios treated included:

- **desertification**
- **grass to woodland conversion**
- **deforestation**
- **mixed systems**

MODIS sensor challenges are spatial, spectral, and radiometric.

ATMOSPHERIC GROUP CALIBRATION

The Atmospheric Group calibration issues were treated briefly by Y. Kaufmann. He discussed the problem of non-linear gain when going from short wavelengths to infrared wavelengths.

OCEAN GROUP CALIBRATION

R. Evans presented issues relevant to the Ocean Group calibration work. SEAWIFS data is available in the visible, and it is possible to build a match-up data base using that data.

SESSION INTERMEDIATE SUMMARY

According to P.Slater, the following issues need to be revisited at the next MST meeting:

1. **Status of the EOS Cal/VAL Panel (B.Guenther)**
2. **Atmosphere Group calibration scenario, requirements, and expectations (Kaufman & King)**

3. Land Group calibration scenario, requirements, and expectations (A.R.Huete, V.C. Vanderbilt)
4. Oceanography Group calibration scenario, requirements, and expectations (R.Evans)

PLANS FOR LUNAR CALIBRATION

H. Keiffer discussed plans for calibration activities using the moon. His presentation is summarized in *Attachment Q*. Lunar calibration is primarily an engineering exercise.

Lunar calibration is to be done once a month, at full moon, over the north pole. It provides an in-flight calibration capability with the assets:

- **gain stability > 1%**
- **absolute calibration of about 1%**
- **polarization is very small**
- **calibration can be radiance or reflectance based**
- **cross calibration can be done with other instruments for verification**

A problem in Lunar Calibration is that the geometry is complicated. A study must be done of the phases of the moon and the topography. Libration and phase of the moon are important, and atmospheric correction is substantial and dependent on wavelength.

MODELLING OF SENSORS

J.P. Muller talked about geometry, orientation, and modelling of sensors. Further information is included in *Attachment O*.

Interior orientation: optical systems, mechanical systems
Exterior orientation: platform pointing, jitter, instrument pointing
simulation studies: using input from ASAS, MEOSS, SPOT, ASTER camera models

Math model is an end-to-end wavefront model, using ray tracing through the sensor and detector. Spectral, spatial, optics, and transmission are factored in, as is a topographic correction. He has done these procedures on LANDSAT TM and SPOT; and is willing to be involved in MODIS.

AIRCRAFT FLIGHT REQUIREMENTS FOR CALIBRATION PURPOSES

Aircraft flight requirements for Slater, Abel, and Markham were discussed. The end product of these discussions is provided in *Attachment X*.

February 20 - Continuing Session

MODIS THERMAL CHANNEL CALIBRATION PLANS

W. Barnes talked about plans for MODIS thermal channels calibration. The problem definition is: "can MODIS-N absolute infrared calibration requirements of 1% be reduced? If so, by how much?"

The major error sources in the infrared are:

- **background spurious sources,**
- **blackbody emissivity**
- **blackbody temperature and wavelength**
- **detector noise**
- **out-of-band radiance**

Conclusion: 0.3% absolute calibration appears possible for some channels.

PLANS FOR PRE- AND POST-LAUNCH CROSS CALIBRATION

P. Slater and S. Biggar talked about their plans for pre- and post-launch cross calibration. The plans include:

1. **Inflight calibration using ground reference sites**
2. **Inflight calibration using solar diffuser and ratioing radiometers**
3. **Preflight calibration at EOS calibration facilities using ultrastable, portable radiometers.**

The plan also includes ground and atmospheric measurements and reference to another calibrated satellite sensor.

MODIS AIRBORNE SIMULATOR

M. King briefly talked about the aircraft program. He discussed the development of the MODIS Airborne Simulator as an Ames instrument, and the possibilities for flying the instrument.

RADIOMETRIC RECTIFICATION

F. Hall talked about Radiometric Rectification. This process uses sequences of images, finds radiometric control sets (such as reflectance-stable landscape elements, both bright and dark), then uses means of the radiometric control sets to make estimates. As an example, he showed radiometrically rectified a 1989 LANDSAT TM image vs. a 1989 atmospherically corrected TM image. The agreement was quite good.

MODIS-T CALIBRATION PLANS

W. Eichhorn and S. Hetherington discussed MODIS-T calibration plans. For solar calibration *(Attachment R)*, a known solar constant is assumed.

Solar calibration is done only within +/- 20 degrees of the equator. They discussed stability, contamination of the solar diffuser plate, the degradation of the Halon coating in the integrating sphere, as well as the use of a double vs. single integrating sphere. A 1% reflection change of the integrating sphere will result in a 5% loss of flux. Degradation effects need to be checked out. Photodiode degradation was discussed and J. Barker stated that LANDSAT TM monitored the output with lamp.

SUMMARY

The group discussed MODIS calibration challenges and concerns, paying special attention to the calibration-related issues like plans for vendor testing (see *Appendix GG*).

MINUTES OF THE MEETING
OF THE

LAND

DISCIPLINE GROUP

AT THE

MODIS SCIENCE TEAM MEETING

February 20-22, 1991

Meeting Attendees:

A. Strahler (Acting Chairman), C. Justice, P. Muller, J. Townshend, A. Huete, S. Running, D. Hall, Z. Wan, V. Vanderbilt, Y. Kerr, P. Teillet, D. Carneggie, C. Woodcock, T. Goff, D. Toll, N. Laporte, and T. Mace (EPA)

Wednesday, February 20, 1991

Ten Year Contract Proposal: Tom Hamilton from GSFC procurement indicated the Facility Instrument 10-year contract is designed to act like a grant. V. Salomonson indicated he will work out the details of the contract individually with the investigator. He also indicated another trip by the investigator to work out the details is not necessary. The agreement may be worked out through phone calls, FAX and GSFC Mail.

MODIS Products: A. Strahler said the land team should work as a team in the development and evaluation of MODIS at-launch products. He indicated there could be a core set of at-launch products. D. Carneggie indicated the MODIS products should be created in an innovative procedure. A. Huete emphasized the need for atmospherically corrected land leaving radiance. D. Toll recommended adding a land leaving radiance to the land MODIS products. He also indicated the atmospheric group may find it easier to produce a surface reflectance in place of a surface radiance. S. Running stressed the importance of terrestrial net primary productivity as a MODIS product.

Topography Requirements: A. Strahler reported a sensitivity study of topographic related requirements is needed, such as a 1 km DEM data set related to different MODIS data output products.

Test Sites: **A. Strahler recommended there will be baseline sites (LTER, Nat'l Park Serv., and IGBP) and innovative sites (BOREAS, HAPEX Niger, and MAC's). The baseline sites would be in cooperation with ongoing studies where the MODIS land team contribution would come from primarily a remote sensing perspective. The innovative sites would directly involve the MODIS science team in many phases of the experiment. P. Muller said a data management system such as the FIFE Information System (FIS) may be needed for the MODIS related baseline sites. S. Running indicated LTER data are currently archived and available through networking. A. Strahler reported we may provide specification to LTER personnel for collecting data conducive to MODIS evaluations. He also indicated the possibility to reciprocate through providing remote sensing data of the LTER. A. Strahler reported a need to request the groups responsible for the baseline sites to measure data specified by the land team. These data may include land cover related ground truth, snow depth and extent, land surface temperature, surface emissivity by land cover, LAI, and percent cover.**

Thursday, February 21, 1991

MODIS Products: **C. Justice stated the strong need for MODIS to provide atmospherically corrected radiance as an integral part of the MODIS land products. In addition, he indicated the "Thermal Anomaly" product is recommended as a basic product. He and other team members indicated the existing land products are viewed as a minimum data set.**

Land Discipline Group Journal Paper: **S. Running volunteered to coordinate a MODIS land science paper. He thought linking the paper to terrestrial net primary productivity will provide a central theme since the approach to estimate NPP requires input of all four of the MODIS products indicated by A. Strahler.**

Contract Proposal: **V. Salomonson reported the software Version 1 schedule has slipped back two years to 1996. Hence, the facility investigators can move back the delivery date in their proposal two years and then correlate with the funding profile.**

P. Muller indicated he is currently estimating the total number of computer lines for the generation of his MODIS products as needed by EOSDIS.

NASA HQ MODIS SCIENCE SUMMARY VISUAL:
V. Salomonson stated that the 8 bullet Program Level Technical Requirement reported by G. Mitchell is a public relations effort. He indicated that on a scale of 1 to 10, the effort by the land team to review the summary should be 6.

NASA HQ: **G. Mitchell indicated his relationship with the land group would be general and that for specific interactions with HQ the land science team should work with the appropriate managers such as Dianne Wickland and Bob Murphy. He indicated he is not directly involved with any of the**

financial related matters and his strength is not in land science. He did indicate he will soon read the land team related proposals and will attempt to represent the land science team at HQ. C. Justice indicated it would be helpful to the land group if a specific need such as the requirement for a global 1-km DTM to be generated would be supported and advocated by someone such as Greg at HQ. Chris indicated an emphasis should also be placed on land science related contributions as well as on data products. Last Chris reported HQ should provide the coordination for IDS Science and Facility Instrument Science. G. Mitchell indicated topical science reviews may be implemented with links provided by Stan Wilson. V. Salomonson indicated the Conceptual Science Review may provide a mechanism for collaboration between groups.

LAND MODIS PRODUCT REPORTS

LAND COVER (A. Strahler)

A. Strahler indicated a literature survey, including 60 reprints, with an emphasis on AVHRR data is currently under evaluation. He reported C. Griner is attempting to obtain a copy of the IDS executive phase proposals. Test site possibilities are currently under evaluation. Algorithm development is pursued towards multiple bands and features, time trajectory analysis, pre-launch evaluation using AVHRR and MSIM, post-launch evaluation using perhaps 24 months of data, and characterization of units. Under current evaluation is the validation planning. Issues to be studied include land cover change, post-launch related processing, and a land cover team meeting at EDC in April.

P. Muller indicated the climate community has a need to have a system for the land cover to be based on a land-climate system. T. Mace indicated USGS is developing a new (2nd ed.) land cover/remote sensing classification scheme.

A. Strahler indicated validation planning will be somewhat opportunistic based on collaboration with ongoing field studies. C. Justice indicated sample sites will be needed for the range of global conditions for which the products will be generated. S. Running stated we could provide remote sensing data and collaborative field investigators could assist with ground data collection.

A. Strahler indicated developing algorithms for land cover change products derived using MODIS time trajectory data should be a post-launch activity.

J. Townshend said that global land cover related issues will be addressed later this year by the IGBP.

Satellite Data Acquisitions: D. Hall said the federally owned Landsat data may be an economical and practical data set for use by the Land Team. D. Carneggie emphasized the need to plan a budget for LTER Landsat TM acquisitions. C. Justice indicated a need of an EOS blanket agreement on EOSAT purchased data. D. Carneggie said our group is a collective group under a federal contract and should be able to share EOSAT purchased data. However, this agreement should include IDS and other instrument groups.

SNOW COVER (D. Hall)

D. Hall indicated they will develop a global algorithm to delineate snow cover at a 1 to 10 km resolution. In addition, large basins will be mapped with finer resolution 250m and 500m MODIS data. The mapping of snow reflectance is a secondary objective. D. Hall is studying snow versus clouds/fog discrimination when confounded by heavy forests.

- Study sites include Howland, ME (Feb. & Mar. 1990); Malaspine, Glacier, Alaska; Glacier National Park, and Yellowknife, NWT.

- V. Vanderbilt indicated the Spectron Engineering spectrometer may need a temperature correction.

- D. Hall is collaborating with NOAA/NESDIS on snow vs cloud discrimination and snow mapping. An additional problem is from snow mapping associated during fogs and high cirrus. D. Hall is also studying the unique capabilities provided by MODIS data to map snow cover relative to using AVHRR data.

Glacier Nat'l Park Study Site: The Glacier Nat'l Park study planned for this Mar. 1991 will include C-130 with ASAS and TM simulator and DC-8 with C and L band SAR. Site measurements will include snow depth, free water content, snow density, and crystal size measurements. C. Justice indicated the possible evaluation of snow/forest BRDF measurements may be useful for the team. P. Muller indicated stereo photos should be obtained concurrently. A. Huete raised the question of atmospheric related corrections of aircraft data and the concurrent measurement of atmospheric data associated with the airborne overpass.

SURFACE TEMPERATURE (Z. Wan)

Z. Wan is currently evaluating LOWTRAN-7 and MODTRAN with comparisons of the molecular absorption coefficients at a 5 cm^{-1} spectral resolution. He will evaluate at a higher spectral resolution the CO_2 absorption spectra. Results will be evaluated systematically under cirrus, aerosol and fog conditions. In addition, he is modeling effects from the following:

- **surface emissivity spectral characteristics;**
- **heterogeneity effects within a pixel;**
- **scattering effects by atmosphere and land surface;**
- **solar radiation reflectance (land and atmosphere) (3-5 microns).**

Z. Wan indicated a need to have spectral emissivity estimates by land cover.

Z. Wan indicated validation planning will include data from FIFE (AVHRR, TIMS and field), AVHRR (1km), AMRIR (500m), ERS-1, and ATSR.

IGBP surface temperature data also will be used. He would like to conduct further work when available with MODIS-N aircraft simulator data.

Z. Wan reported field campaigns will include surface temperature and emissivity measurements using a spectroradiometer. In a response to a question from C. Justice, the purchase of a spectroradiometer is approximately $55k. C. Justice indicated the spectroradiometer acquisition should be clearly labelled in the budget. He also recommended coordination between Wan and Tanre/Kaufman on thermal related atmospheric corrections.

VEGETATION INDEX (A. Huete)

A. Huete indicated the validation of a spectral vegetative index may be defined to rigorously include a calibration of vegetation characteristics (such as relating vegetation density and primary productivity related directly to scaled MODIS data). On the other side, the index may be validated relative to radiometric calibration, spectral calibration, atmospheric correction, and BRDF correction, thereby reducing the level of validation planning.

- A. Huete is currently conducting research relative to spectral shifts, atmospheric correction, Sun zenith angle, and BRDF effects. His work to date has removed soil effects successfully. He indicates a 20% error from Sun and view angle effects may be reduced to 5% by using a cosine correction.

- C. Justice reiterated the importance of an atmospheric correction.

ATMOSPHERIC EFFECTS (D. Tanre and Y. Kaufman)

D. Tanre gave a presentation to the land group on atmospheric related effects. He reported on the effects of ozone absorption, aerosol scattering, and Rayleigh scattering on NDVI estimates. He needs BRDF of land features for further evaluations.

Y. Kaufman indicated that for NDVI corrections in an iterative procedure a combination of many data sets will be likely.

Y. Kaufman reported on his progress of using dark vegetation to provide an estimate of aerosol optical depth and a surface reflectance estimate. He indicated in a second atmospheric correction procedure by Tanre called, "Contrast Reduction", the adjustment is determined by locating pixels between dates with a constant target reflectance.

C. Justice indicated the need to obtain both aerosol optical depth and atmospheric radiance measurements from ground stations. These measurements should be associated with each related MODIS land aircraft program.

Y. Kaufman and D. Tanre have modified a transmissometer to obtain an atmosphere path radiance in addition to an aerosol optical depth. The total cost of each unit is approximately 8k.

Y. Kaufman summarized their related needs.
- Aerosol optical depth by climatic region.
- Network of aerosol optical depth and atmosphere radiance data.
- Concurrent atmosphere measurements with ASAS, AVIRIS, TM, and AVHRR sensors.
- Compare experiments, study effects of aerosols and clouds, and study NDVI related effects.
- Need one person for coordinating atmospheric measurements and calibration of sensors.

Y. Kaufman plans on using the MODIS simulator, having the same spectral channels as MODIS-N.

THERMAL ANOMALIES (C. Justice)

C. Justice gave a brief presentation on Thermal Anomalies. The work is in conjunction with Y. Kaufman. Work in FY91 is low but will be picked up in FY92. The science objectives include determining global emissions from fires. In addition, fire classifications will be identified by smoke type, size of fire, and temperature. Cooperation is underway between NASA/USFS and INPE and IBAMA related to fire emission detection activities. Activities are also proposed in conjunction with the Trace-A experiment in Africa and Brazil.

BRDF, ALBEDO AND SURFACE ROUGHNESS - P. Muller

BRDF: BRDF work to date by P. Muller includes field spectrometer measurements of corn as a function of growth. Physiological effects of vegetation stress are also studied. Simulation work is towards BRDF at airborne level and at ground level using ray tracing models. He described other work including automatic tie point generation from air photos.

Albedo: Albedo related work includes using a single off-nadir view angle to estimate a hemispheric reflectance. Hemispheric reflectance estimation from a combination or a string of directional reflectance data is continuing using interpolation schemes (Kriging) and spherical harmonics.

Surface Roughness: Surface roughness work is also underway. He is pursuing several different methods including fractal variogram analysis.

M. Barnsley Related Work: Reported by P. Muller. The work included analyzing BRDF scenarios with MODIS-T, MISR and POLDER. Barnsley's group is also working with sensor analysis techniques using sparse sets of angular data. He is also conducting work related to the Hapke vegetative canopy radiative transfer model.

Next Year's Work: Work through next year by P. Muller includes mathematical modeling; simulated AVHRR and ATSR scenes; acquisition of a $40k high spectral resolution spectrometer; atmospheric correction at large Sun zenith angles and scan angles over the FIFE site; Hapke based vegetative canopy models; terrain and atmospheric aerosol correction; and BRDF from AVHRR.

Planned Albedo Work: Compare ray tracing and radiosity vegetative canopy models; examine sensitivity of surface absorption of solar radiation to climate models; and compare AVHRR with ERBE measurements for broad band conversions.

Planned Surface Roughness Work: Work includes working with J. Shuttleworth's Hydra instrument to measure z_0 in forests and to study BRDF inversion techniques for estimating z_0.

Summer 1991 Activities: Summer 1991 activities by P. Muller include analysis of vegetation canopies from close range stereo photogrammetry; develop motorized BRDF collection of the land surface; conduct field work at the Wytham, U.K., the Maricopa, AZ, and the pre-Boreas Howland, ME sites.

BRDF (A. Strahler)

BRDF: A. Strahler summarized his work related to BRDF. He is extending his geometric optics vegetative canopy model. He is working with canopy model inversion techniques, atmosphere-vegetative canopy radiative transfer coupling, and evaluating satellite collected "string"

radiance data related to BRDF estimation. He is also evaluating new expanded processors for improving computing efficiency. He is collaborating with Muller and Barnsley and a Chinese NSF associate. He is evaluating tilt scenarios with the Science Data Support Team. He has several "special needs" for work with the MODIS land team's activity at the Innovative Sites. Last he raised the question if a surface structure product may be produced instead of a BRDF product?

TERRESTRIAL PRIMARY PRODUCTIVITY (S. Running)

S. Running indicated the need to use the four baseline products outlined by A. Strahler to estimate an annual net primary productivity. He would like to see the productivity product be a baseline product. Output of evapotranspiration may be produced as an extension to the model. His recommendation at this point is to produce evapotranspiration as a post-launch product. Work now is emphasizing primary productivity work over 4 biomes: conifer; grass; shrub; and broadleaf.

General Comments: C. Woodcock recommended the MODIS products described should be considered as an integrated group of products and that all of them should be kept as high priority.

Science Data Support Team: P. Ardanuy from the Science Data Support Team is looking for feedback from the land group. Possible assistance was recommended by the land group on registration accuracy and geometric related effects (C. Justice), BRDF and MODIS-T related studies (A. Strahler), and support for a ray tracing mathematical model related to MODIS-N AND -T (P. Muller).

EOS Bulletin Board and Remailer Status: A. Fleig gave a handout and summary on EOS Bulletin Board & Remailer Status.

Friday, February 22, 1991

NASA HQ Summary Visual: A. Strahler gave a vu-graph overview of his modification to the Program Level Technical Requirements, Level 4 for G. Mitchell.

Land Cover Meeting Update: The land cover meeting was decided to be held at EDC on April 8 thru April 10 at 2:00. Approximately one-half of a day will be devoted towards information relative to EDC.

VEGETATIVE INDEX AND POLARIZATION (V. Vanderbilt)

Polarization Modified Vegetative Index: V. Vanderbilt gave a presentation related to studying the removal of the vegetative specular reflection component, leaving only the internal leaf reflected radiation. This removal of the specular reflectance is hypothesized to improve the accuracy of the MODIS vegetative index. He indicated the specular

reflection effect is more pronounced when the sensor is oriented towards the Sun. In the summer of 1991 he will conduct field measurements as a function of Sun position over several different vegetation canopies. V. Vanderbilt indicated POLDER data are needed for the land MODIS science team.

Polarization Related Collaboration: C. Justice emphasized the need to collaborate with EOSP investigators. V. Vanderbilt stated he is collaborating with POLDER related science activities.

IDS and MODIS Land Team Links: C. Justice developed a list between the IDS proposals and the responsible MODIS investigator *(Attachment Y-1)*. The designated MODIS team member will be responsible for informing the IDS group of MODIS activities and for obtaining information from the IDS group concerning test sites and IDS data products. Attendance by the indicated investigator at the IDS meetings is encouraged.

EOS-A Sensor Status and MODIS Land Team Links: *Attachment Y-2* summarizes a link between the MODIS team investigator and the EOS-A sensor status. The indicated MODIS team investigator is responsible for staying current on the latest sensor related developments and relevant scientific objectives and products relevant to MODIS synergism.

EDC AND EOSDIS MANDATE (D. Carneggie, *Attachment N*)

D. Carneggie said NASA and USGS guidelines were established for the EROS Data Center (EDC) to serve as a land processing DAAC for all Level 3 and higher data with a shared responsibility with Goddard on Level 2 data. Activities will include processing such as resampling, averaging, compositing, NDVI derivation, and land cover generation.

EDC is currently planning on the development of a MODIS precursor for activities through 1994. The work would be related to archiving, processing, and distribution. One plan is to develop and implement a strategy for using a 1 km AVHRR global data set. They need to work out with the land team specific requirements related to: when needed; temporal data collection requirements; cloud screening; spectral band requirements; etc. Also requirements for directories, catalogs, inventory, query and browse are needed.

Ancillary Data: EDC has a question of Landsat TM and MSS data requirements by the land team. D. Carneggie noted the Landsat MSS historic data over two years old are available at a much reduced price. Also any preprocessing requirements such as an atmospheric correction or sensor correction should be specified.

FY92 Activity: EDC proposes for a Version 0 FY 92 activity to acquire, archive, preprocess continuous daily afternoon 1 km AVHRR data over North and South America for one year. Other activities will include HRPT station site locations, acquire and archive additional LAC data, and provide NDVI products for the U.S. at bi-weekly, monthly and TBD intervals.

EDC and MODIS Related Issues: **D. Carneggie raised the question of how the land team will interact with EDC Version 0. Further, team requirements need to be resolved for a high speed browse and query with data transmission rates to and from EDC. In addition, the land team should consider the relation of an EOS 1km and 4km AVHRR data set in comparison to the NASA/NOAA Pathfinder/AVHRR (characteristics to be determined) and NOAA AVHRR GVI (16 km) data sets. Another question to be resolved is who actually pays for Landsat data.**

Rationale for April 1991 Meeting at EDC: **D. Carneggie indicated a meeting at EDC will help define 1992 EDC activities and data set requirements. In addition, the land team will become more familiar with EDC/EOSDIS. They can also meet with scientists conducting work on global change, evapotranspiration, net primary productivity, land cover, albedo, and soils.**

J. Townshend indicated a justification for a 1km AVHRR data set is being given through the IGBP.

R. Murphy indicated there is a possibility bulk Landsat TM data sets may be procured from EOSAT at a group discount.

A. Strahler said EDC may help out with Landsat TM and NOAA AVHRR acquisitions. In addition, EDC may also play a role in historic satellite data acquisitions.

EMAP (T. Mace)

Environmental Monitoring and Assessment Program: **T. Mace reported the EMAP includes an ecological risk assessment in addition to a health assessment. The program will determine sample site locations using a systematic sample to determine site locations. The sites will have a 5 to 10 year repeat cycle. Ecosystem sites will include arid, coastal, wetland, etc. Ecosystem indicators of ecological health will be collected in cooperation with other federal agencies such as the Fish and Wildlife Service and the U.S. Department of Agriculture.**

T. Mace indicated the landscape characterization activity will include analyzing AVHRR scenes to select Landsat scenes for more detailed analysis. Currently, there is a contiguous mapping operation undergoing of the Chesapeake Bay area. Last, color IR photography is being collected of wetlands and land use.

HAPEX-II Sahel Overview: **Y. Kerr of LERTS gave a detailed overview to the land group of the HAPEX-II Niger experiment plan along with a hand-out.**

R. Murphy added he is funding a C-130 aircraft with ASAS and perhaps TIMS. Based on FIFE related experiences associated with lack of data use and preprocessing problems, NS001 TM simulator data is not planned at this time. R. Murphy said there is planned work related to passive

microwave and soil moisture measurements by B. Choudhury; plant productivity by S. Prince; spatial variability studies by J. Franklin; canopy chemistry by D. Schimel; and energy balance/satellite analyses by E. Smith and S. Nicholson. A. Huete and A. Strahler are invited but should use their MODIS funds.

HAPEX-2 Extended: C. Justice indicated he is interested in extending the HAPEX-II site for the MODIS study to include a wide range of vegetation types. He recommends to fly a transect over selected sites extending south to the Atlantic Ocean using ASAS, POLDER, and MSIM sensors. He indicated a $500k cost requirement, including $200-300k for aircraft data. He indicated the sites to be covered are ongoing research sites by French IGBP-SALT investigators.

R. Murphy would like to see MODIS assist with paying the 60 hours of ferry time by the C-130. C. Justice assumed these costs were being covered by the Niger Experiment.

Y. Kaufman indicated at a minimum transmissometers should be used. A. Strahler indicated land cover as a function of spatial scale may be also evaluated. In addition, BRDF measurements may by made over the extended HAPEX-II sites if possible.

MODIS SIMULATOR (M. KING)

M. King gave a summary of the aircraft MODIS simulator. He indicated HQ will pay an additional amount to cover the expenses for sensor development. The sensor will have 50 channels. The 470 nm band requested by D. Tanre may not be available. Issues King briefly summarized include: Daedalus should be under contract by March 1991; sensor should be completed by Nov. 1991; radiometric calibration related concerns; Level 1b type processing is same as MAMS (U. Wisc. software); combined roll, pitch, yaw data with active scan data; EOSDIS related processing; the sensor should fit on the C-130 and the ER-2 but not the DC-8.

BOREAS UPDATE (S. Running)

S. Running indicated there is an open meeting planned for May 13-17 in Saskatoon near Prince Albert Park. He indicated there are two possible sites with one to the north in Manitoba and the other to the south near Saskatoon. Although travel must be at own expense, interested investigators are encouraged to attend. A NASA RFP is expected this fall 1991. F. Hall and P. Sellers at GSFC are involved in the planning and could be contacted directly for additional information. Running also indicated the AGU/EOS recently published an article on BOREAS.

GLOBAL TOPOGRAPHY (P. Muller)

P. Muller gave a presentation on Global Topography. He reported there is a NASA/ASI Global Topography Working Group Meeting scheduled for April 10-12, 1991 in Washington, D.C. He is investigating the use of MISR data to provide a DEM. He indicated he will provide a DEM to EOS

investigators if they provide SPOT stereo optical coverage (i.e., two Spot AVHRR digital and stereo scenes).

A. Strahler said we need to have a demonstration package to indicate the necessity of the land group to use a DEM in a topographic correction procedure to produce accurate MODIS products.

Validation Requirements: A. Strahler summarized the test site and sensor needs. He indicated the deployment may be approximately 1/3 domestic and 2/3 foreign. Further details are provided in the land plenary summary during the afternoon of Feb. 22.

MODIS Products: A. Strahler indicated the MODIS products should be considered as an integrally related. *Attachment Y-3* summarizes the linkages between products.

LAND GROUP ACTION ITEMS

- S. Running indicated a need for each Land Team member to receive a copy of the land execution stage proposals. In addition, a copy of the IDS execution stage proposal is wanted for each land science team member.

- To have B. Conboy add Greg Mitchell to the MODLAND group.

- S. Running indicated he will provide information on the LTER network and NPS study site activities.

- In response to a question by C. Justice, D. Carneggie will determine if TM data can be purchased by EDC for the land group as part of the EDC support activity.

- A. Huete indicated he will be responsible for coordinating MODIS Land Team Landsat TM and MSS related requirements within the next few weeks for FY91.

- D. Carneggie and P. Teillet will develop a demonstration satellite radiance/topography data set to indicate the importance of topography on the accuracy of MODIS related products. They will also help define with J. Townshend and P. Muller land related topographic requirements.

- A. Fleig indicated the land group should by the end of March, E-mail comments to Ramapriyan related to MODIS anticipated data amounts and data transmission rates. The information will be used in a RFP related to EOSDIS.

- The team members indicated in *Attachment Y-1* on "IDS-Links" should contact the designated IDS projects. Similarly, those team members responsible for providing an EOS-A link, as indicated in *Attachment Y-2* should contact the designated EOS-A facility instrument project.

- S. Running should draft an outline of the planned group paper for each member.

- C. Justice should draft a letter for EDC related to the land groups specifications for the global 1k AVHRR data set.

- A. Strahler should organize the agenda for the land cover meeting.

- The MODIS Administrative Support Team should provide each land team member a copy of the land Execution Stage Proposals.

MINUTES OF THE MEETING
OF THE

OCEANS

DISCIPLINE GROUP

AT THE

MODIS SCIENCE TEAM MEETING

February 20-22, 1991

The Oceans Discipline Group meeting was chaired by Wayne Esaias, and attended by Mark Abbott, Otis Brown, Ken Carder, Dennis Clark, Robert Evans, Howard Gordon, and Frank Hoge (team members), Greg Mitchell (NASA HQ), Vince Salomonson (occasional) and Locke Stuart. Presentations to the group were made by Brad Poston, Daesoo Han and Al Fleig.

Geophysical Parameter Validation Plan

Geophysical Parameter Validation Plan outline *(Attachment S)* was presented by Wayne Esaias. The outline addressed the Ocean Color Data Set (OCDS) Calibration/Validation schedule, the recommended MODIS Oceans *in situ* observations and activities, and possible MODIS/OCDS interactions.

Contracts

Contracts were discussed with the group by Brad Poston, Procurement manager for the MODIS contracts. The next contract will cover 10 years (as opposed to the current yearly contracts). The Execution Phase proposals already submitted by the team members were scoped for ten years, but need to be reviewed and modified in light of the likely funding profile over at least the next few years. While the budget cannot be "finalized" for the 10 year period (or even solidified at present for the next year), Goddard Procurement hopes to reduce paperwork by simply giving the team member an appropriate share of the available funding, and require no further proposal modifications or submissions. However, if funding is below the level proposed, it may be necessary for the team member to inform the contracts technical officer of the anticipated slip in the schedule for deliverables. Greg Mitchell volunteered that he felt that a knowledge of funding levels for 2 years is a minimum in working up plans for deliverables. Vince Salomonson averred that "real numbers" for FY'92, and a more realistic picture of future years,should be available in April.

Team members from the University of Miami stressed the need for flexibility in moving money from one category to another; currently their financial managers require NASA intervention in a lengthy procedure to meet approval requirements. The "Federal Demonstration Project" was cited as an example of a streamlined

method for expediting the utilization of federal funding. In light of severely reduced budgets and questionable schedules for approval, there is also a need for the university to carry funding from one fiscal year into the next. Locke Stuart and Tom Hamilton will investigate.

Funding Levels and New Proposals

Funding Levels and New Proposals were discussed as a logical follow-on to contract discussions. It was generally felt (by NASA management and team members alike) that funding, at least for the first 2 or 3 years, would likely be below the currently proposed level -- even at about the 25% level for FY'91 and '92. At these levels, a number of significant questions were posed about what should be paid for out of team member funding.

In response to a question about costs of MODIS data, Dr. Salomonson responded that Project would bear those costs and provide data, but may have to control the amount of data going to an individual team member.

Questions arose about proposing cost estimates for ship time; both Drs. Salomonson and Mitchell agreed that providing ship time (both for MODIS and the OCDS) was a NASA Headquarters problem, and that EOS Project should submit an overguide request for ship time in FY'92 and '93. However it appears that the *amount* of required ship time should be addressed in the modified proposals. *From FY'94 on, costs for ship and aircraft time are currently designated to be the responsibility of the team member, and must be addressed in the proposal.*

Dr. Mitchell did question the need for new in-situ data sets as opposed to using existing data sets. The group stressed the inadequacy of existing optical data with respect to the spectral advances of MODIS, and the need for precision improvements in data sets, specifically addressing the unique qualities of MODIS. Currently available data sets, which are planned to be collated, would be satisfactory for nothing more than a modestly improved Coastal Zone Color Scanner (CZCS) algorithm. It is essential that an adequate data base of in-situ near-IR measurements, taken in concert with the visible and biological parameters, be obtained as soon as possible. Such data, required for both MODIS and OCDS, does not presently exist.

Schedule slippages were also of concern. Initially, a milestone chart was submitted which showed no slippage in the EOSDIS ('94) requirement for preliminary algorithms. A more recent schedule presented to the group by Dr. Salomonson showed a significant slip, so that the group generally agreed that EOS had slipped nearly 2 years, and that it might be possible to realign the previously proposed requirements by slipping the proposed budget -- and consequently the deliverables -- by 2 years (Locke Stuart was requested to send an Excel-formatted disk of their previously proposed budget to each Ocean Team member.). Dr. Salomonson stressed the likelihood of further budget reductions, and the consequent need to prioritize algorithms and development/calibration/validation efforts in preparation for such an eventuality. Dr. Brown directed his remarks toward the extreme condition of continued funding only at the 25% level, in which event only CZCS and AVHRR algorithms would be available by launch -- an unsatisfactory arrangement insofar as the Oceans community is concerned. In an evening session, Ken Carder reported that

Stan Wilson (NASA Headquarters) urged the Oceans Group to pull together as a team and present a strong case for increased funding to NASA Headquarters. Wayne Esaias felt that, considering the absence of HIRIS from Platform-A, some IDS investigators might be willing to assist in the lobbying effort.

Concern was also expressed to Dr. Wilson about the large financial requirements of EOSDIS. According to Ken Carder, Wilson felt the funding was justified, but agreed that *funding reductions should equally affect EOSDIS and the science teams*.

Dr. Evans stressed that certain Ocean Team members have a greater need for higher funding levels in the early years; of particular note is Howard Gordon, whose early modelling and algorithm development work is an underpinning to the work of other team members. Evans also wondered about the funding "emphasis": since the budget is separated into science, algorithm development, and computer costs, guidance needs to be given on how the reduced funding should be apportioned. (Later, Tom Hamilton noted that the apportionment was very flexible.) In a similar discussion, Dennis Clark asked if portions of his funding could be used for ship time, at his discretion. Stuart replied that, assuming such a requirement is part of Clark's proposal, NASA has no problem.

Skepticism was expressed by some of the group regarding NASA's decision to continue fully funding teams which were not selected to fly on Platform-A. Some felt that NASA's money would be better spent by proportionately increasing the Platform-A team funding above the 25% level; others argued that the instruments designated for later platforms need continued funding in order to "mature" into viable instruments, and that the funding was a negotiated consolation for non-selection.

Ocean Color

Ocean Color support was carefully questioned by the team members, who see the efficiency of synergism between OCDS and MODIS. Concern was expressed about the absence of immediate funding for OCDS development, and what the approach should be toward MODIS Ocean Color products (In light of budgetary constraints, perhaps they should be initially developed under OCDS, or not at all). It was noted that thermal infrared algorithms are completely uncoupled from OCDS activities, and will receive their only funding through MODIS.

It was generally conceded that planning for the 2 efforts is inseparable, that their budgets should be worked in parallel, and that NASA Headquarters needs to make every effort to crystallize the OCDS budget so that MODIS planning on ocean color work may proceed. Greg Mitchell stressed that, while the MODIS Oceans Group must address MODIS requirements only, it should do so in a way to maximize the returns for OCDS. An evident undercurrent of fear was that MODIS support would be expected to pay the OCDS bill, which is totally unrealistic in light of the severely curtailed initial MODIS budgets.

OCDS also intensifies the MODIS ocean color algorithm development effort, in that OCDS algorithms are required 2 years sooner than MODIS, thereby requiring a "hump" in MODIS/OCDS funding in order to produce the algorithms in time for the OCDS launch. It was generally felt that such extensive funding would not be

immediately available. In the absence of significant funding, OCDS might have to rely on modestly improved CZCS algorithms.

Data Product Prioritization

Data Product Prioritization discussions initially sought agreement that *no* products would be deleted; only delayed from at-launch to post launch. Those products considered important early on, but for which funding for rigorous documentation might be lacking, would be considered non-standard research products, and still be scientifically useful at launch. Exacerbating the documentation problem is the lack of information on coding standards required by EOSDIS; without knowledge of these standards it is difficult to plan costs. Current generalized requirements for browse, metadata, and documentation are very expensive.

In general, it was felt that the current budget posture has introduced a 2-year slip into the algorithm development plans; this is in concert with the launch slip, and probably with the latest EOSDIS data development requirements.

Interdisciplinary Science (IDS) requirements did not play a major role in the prioritization. Ken Carder reported that Stan Wilson felt that many IDS investigators did not understand well the instruments' data production capabilities, and should not be factored into the prioritization process. Dennis Clark suggested that a representative from each oceans IDS investigation be invited to the next MODIS Ocean Group meeting, in order to understand their requirement more adequately, and to improve their understanding of MODIS capabilities.

***Attachment T* is an updated list of "prioritized" MODIS ocean data products, categorized into:**

1. **Fully documented at-launch "standard" products**
2. **At-launch "research" products, requiring no *immediate* archival and minimum Science Data Support Team (SDST) support, and designated to become post-launch standard products**
3. **Post launch research products, requiring no archival support.**

Many of the category 3 products are intermediate to the standard products, and will have to be examined by group members during validation of the standard products. However, following this they need not be archived. Twenty-seven (27) standard products fully supported at-launch (two-thirds of those previously listed), 10 at-launch research products, and 34 post-launch research products, a total of 71, are currently planned under a reduced funding scenario. The 71 products include several different time/space averaging period of 34 different bio-geo-physical parameters (13 standard, 5 at-launch research, 19 post-launch research). This prioritization is based on reduced funding, and is not recommended as an "optimum" selection if the originally proposed level of funding were available. Ultimately it is hoped that even the 3's could be converted to 1's. *An important implication to the reduction in fully-supported at-launch data products is the savings effected on EOSDIS and the SDST; Ocean Group members strongly urged that a portion of these savings be passed on to increase the Team members' budgets!*

MODIS-T Tilt

The Land Discipline Group (Strahler) has presented a proposal for sharing MODIS-T time with Oceans. In order to understand fully what land areas will be available for land bidirectional reflectance distribution function (BRDF) studies, it is important for the Land Group to know the maximum planned tilt angle for Oceans coverage. Howard Gordon felt that this angle is directly related to the maximum glint extent and should be the angle below which noise due to glint exceeds 1 digital count. Additionally, Otis Brown felt that the tilt angle should be selected to minimize ocean data loss, without regard to sun glint. Ken Carder stressed the need for significant amounts of data on slopes and shelves, because of their higher productivity and their role in serving as a conduit for dissolved organic carbon to the deep ocean; time cannot be yielded to Land BRDF studies at the expense of studies of these areas. Howard Gordon felt that a study would be necessary before the scenarios for changing tilt angle could be specified, and that study would require significant funding. It was generally conceded that 50° tilt is probably unusable; 30° tilt probably useful. Additionally, verification and probable fine tuning of the optimal tilt strategy will be required post-launch. The group felt that selection of BRDF intensive study sites based on pre-launch studies, unless very conservative guidelines are used, could lead to severe conflicts. ***Howard Gordon was requested to write up the tilt concerns of the Oceans Group, particularly how a decision at this time and under the current level of knowledge would be unwise.***

In an evening session, Ken Carder reported that Stan Wilson suggested that MISR might answer the Land BRDF requirements, if MISR could be redesigned to tilt sideways, in addition to fore and aft. Mounting MISR with a small fixed tilt to the right might also prove beneficial.

Surface and Aircraft Data

Surface and Aircraft Data emphasized the need for near-term cruises -- some of them dedicated -- in order to begin algorithm development. Existing data can be helpful, but the "uniqueness" of MODIS drives the requirement for different bands and higher accuracies. IDS investigators may also assist in emphasizing the need for ship data in support of EOS and MODIS.

Most of the aircraft requirement is tied up in the work being done by Frank Hoge, who is primarily interested in non-scanning instruments (radiometers). Hoge also advertised the Wallops aircraft capabilities, with (in addition to the well-known P-3A) a Skyvan ($1100/hr), helicopters with winches (water samples - <$1K/hr), and a T-39 at 40,000 ft with a range of 1500 miles. It was stressed that NASA Headquarters funding for aircraft and ship work in FY'92 and '93 is heavily encumbered by existing fixed aircraft costs, thereby relatively diminishing the amount available for cruises. Additional aircraft use by Gordon is required to develop white-cap corrections to the water-leaving radiance algorithms, using the Xybion sensor. This non-NASA aircraft will be scheduled independent of the NASA aircraft requirement by Gordon.

Criteria and locations for cruises in support of MODIS (and OCDS) were discussed:

- **East Coast -- Sargasso Sea, Eastern Boundary Current;**
- **West Coast -- diatoms, upwelling;**
- **High dust area -- Atlantic off the Sahara in February/March;**
- **Large River outlets -- Orinoco, Amazon;**

- **High latitude oceans;**
- **Plankton blooms;**
- **Costa Rica dome, gulf of Tehuantepec (upwellings);**
- **Required OCDS cruises in the summer '92 and fall '93 (post launch);**
- **Chesapeake Bay (near-IR turbidity -- Naval Academy)**
- ***Surface upwelling and downwelling radiance at 1, 4. and 10 meters must be accurate, and are the basis for the Level-2 measurements.***

Howard Gordon, Ken Carder, and Wayne Esaias felt that measurements in Case II waters would be of lower priority, except for *gelbstoff*. It was concluded that work with Case II waters was necessarily regional, with one Case II region not necessarily being representative of another (i.e., Mississippi Delta versus North Sea). On the other hand, Case I waters can be treated globally, atmospheric correction problems are reduced, and satellite calibration can be more accurately effected over these areas. Global chlorophyll requires both Case I and Case II inputs. It may be necessary to suffer large error bars on Case II accuracies.

Numerous previously planned cruises were mentioned:

- **JGOFS in the mid-Pacific in 1992 -- a possible opportunity for fluorescence studies.**
- **JGOFS in 1994, wherein John Parslow hopes to carry optical experiments into the Southern Oceans;**
- **WHOI to Iceland this summer (Ken Carder -- near IR possibilities)**
- **NOAA cruises to the equatorial Atlantic (Orinoco and Amazon - Carder);**
- **German cruise off the Canaries, possibly equipped with a current meter;**
- **moored buoys in Monterey Bay (ONR cruises also) and Hawaii; and**
- **Soviet Antarctic expeditions ($200/person/day) starting this fall.**

Dennis Clark has promised to approach the NOAA Ship Council regarding the possibilities of joining planned NOAA cruises, and support for dedicated MODIS/OCDS cruises starting within the next year or two. Ken Carder likewise intends to seek out ships of opportunity for near-IR measurements in Case II waters.

Greg Mitchell agreed to pursue the following actions:

- **Prepare budget for OCDS for FY'91 and "92 (NASA Headquarters);**
- **Seek approval for dedicated ship time;**
- **Look for targets of opportunity on existing cruises;**
- **Verify the plans for ship support starting in FY'94. *The Oceans Group urges Headquarters to submit the FY'94 ship requirements as an overguide to the MODIS/EOS budget, rather than taking the funding out of the team members' budgets.***

Additionally, Wayne Esaias felt that the constitution and convention of the OCDS Pre-launch Science Working Group should be pursued by Mitchell (with Shelby Tilford). Greg Mitchell promised to emphasize to Tilford that MODIS funding is totally insufficient to support OCDS science development.

Ancillary Data

As algorithm validation sources, AVHRR/ATSR and OCDS data will be highly useful in MODIS data product development. But again it is to be stressed that MODIS funding is insufficient to handle OCDS algorithm development, at the

schedule required for OCDS. OCDS data are expected to be available in September/October 1993.

Howard Gordon mentioned the need for a list of measurements that the optical oceanographers will need. Since few existing cruises focus on optical oceanography, such a list will help serve

as justification for dedicated cruises. Ken Carder went further to suggest that the list of required measurements for each output product be updated.

Measurement Protocols

Measurement Protocols should follow the JGOFS biochemical protocols, in order to assure calibration transferability, according to Wayne Esaias. Also cited by Howard Gordon was the NASA/ONR/NSF Optical Protocol Workshop. Emphasizing Ken Carder's previous suggestion, Esaias believes that measurements required for each output ocean product must be determined, and the protocol for the measurement assessed and established. He hopes that the OCDS Working Group will discuss strawman protocols at their April meeting. Dennis Clark emphasized the need for strict calibration/characterization protocols.

Calibration/Characterization

Calibration/Characterization plans and requirements were discussed in some detail. Vince Salomonson reported that Phil Slater intends to purchase portable radiometers, which may be useful in the calibration of other surface truth instruments. Ken Carder stressed the need for a standard receiver for looking at the sun. Atmospheric correction accuracies were addressed; it was mentioned by Howard Gordon that 2% absolute was not good enough (e. g., it would mask ozone). The need for Oceans calibration facilities for cross-calibration of in-situ instruments was addressed by Howard Gordon. Two facilities, operated by Ocean Group members, will be used to are assure group intercalibration. Intercalibration with the greater ocean community is also required to make use of serendipitous data collection. Discussions on meeting this need, involving ONR, NASA HQ, GSFC Calibration Office, the OCDS project as well as the MODIS Ocean Team, are ongoing.

EOS Bulletin Board

EOS Bulletin Board was presented by Al Fleig. *Attachment U* provides details of the service.

Science Data Support Team

Science Data Support Team responsibilities and questions were presented by Daesoo Han to the Oceans Group *(Attachment V)*. Of particular significance were Han's comments regarding the EOSDIS schedule. Due to Source Evaluation Board (SEB) activities, information on the texture and schedule of EOSDIS will not be available until after July, 1992. In this vein, it is not clear how the software development responsibilities will be divided between EOSDIS and the science teams. Currently we are required to deliver a full-up MODIS Data Processing System to EOSDIS -- in their specified format. It is apparent that EOSDIS will also be involved with Earthprobe data, probably at least the archive and distribution functions. EOSDIS roles in Earthprobe data processing are not well defined. Han foresees the need for Version 1 algorithms about 3 months prior to the June 1996 Version 1 System Release.

Bob Evans takes comfort in the fact that Pathfinder data sets will establish the the methodologies and mechanisms for handling large data sets in EOSDIS *prior* to the handling of MODIS data. Responsibilities should have been clarified, standards established.

Cloud Cover Masks

Cloud Cover Masks have proliferated from the simplistic requirement of one mask to serve all products, to the possibility of a "tailored" mask for each product. Vince Salomonson led a discussion on the special requirements of various MODIS data products; stressed the need to develop cloud identification algorithms early, because of their requirement in Level 1 processing; and posed the question of how many different algorithms would be needed to satisfy adequately the requirements of the many different MODIS output products. Each team member is tasked with developing cloud identification requirements to suit his products; the Science Data Support Team will seek ways to combine the "masks" into the most efficient identification procedure.

Technique Library

A "Technique" Library was suggested by Bob Evans. He foresees a common need of the many different teams and investigations to employee certain "utility" algorithms (such as extracting areas, doing correlations). A Library of these utility algorithms should be maintained by EOSDIS. Evans stressed the *immediate* need to establish a mechanism for sharing, since these subroutines would represent some of the earliest developments. Dr. Salomonson agreed to the need, said that mechanisms exist wherein MODIS would handle the sharing of within-team developments; and the EOS Project Scientist (Jeff Dozier) would coordinate the between-team sharing. Evans will pursue the Technique Library concept in the Data Information System Committee meetings.

SUMMARY SESSION

1. GROUP DISCUSSIONS

The group discussions were opened by Dr. Salomonson. Mr. Tom Hamilton was introduced to answer questions on funding issues. Dr. Salomonson indicated that Dr. Dozier would provide him with budget estimates by April 1. He would then meet with Locke Stuart and Harold Oseroff to produce a 10 year funding profile. This profile must be reflected in the investigator's cost profile. A comment was made that the investigators were being asked to write unrealistic technical proposals since the funding would not cover all of the work to be performed. Dr. Salomonson indicated that it is necessary to prioritize, and to rewrite the proposal and budget to fit the funds which are available. Another comment suggested that a realistic proposal should be submitted and the work to be done should be negotiated year-to-year. Dr. Salomonson indicated that the investigator's tasks have to match the yearly budget. A comment was made that mid-course corrections will have to be made. It was indicated by Dr. Salomonson that this was indeed the case and the current costs are best guesses and will probably have to be revised over time.

A comment was made that the first 2 years' money for science/algorithm development and computer facilities had different sources. With 22% available for both, should the funds be distributed evenly? Mr. Hamilton indicated that the science, algorithm, and computer budgets together will cover the 22%. The money will be given from different "buckets", but the investigators may budget as they see fit. Another question was asked on who will keep track of funding removed from contracts for NASA aircraft operations (to reduce the overhead and university fees.) Mr. Hamilton indicated that bookkeeping will be set up to handle the accounting. A comment was made that incremental funding needs to be explained to university accounting to indicate that funding is budgeted from year-to-year even though the funds come in smaller increments. A written explanation needs to be sent to the universities. Mr. Hamilton indicated they would look into it and notify the universities. It was commented that the universities are audited differently than NASA. All funding issues and directions regarding expenditures of funds should be explicitly stated in the contract. Another comment was made that the contract should explicitly state that NASA will allow carryover funds to be expended by the investigator and not go to the university if not spent.

2. GLOBAL CHANGE VIDEO

Dr. J-P. Muller presented a video on global change. This video provides a visualization of global data sets. It will be use to promote interest in how to save the planet. The video was developed on Sun workstations and uses terrain elevation with AVHRR GAC data. Dr. Muller requested assistance from anyone that might have additional data sets.

3. DISCIPLINE LEADER REPORTS

3.1 ATMOSPHERES

The Atmospheres Group summary report *(Attachment W)* was presented by Dr. Michael King. Dr. King discussed the MODIS-N Airborne Simulator (MAS), airborne field campaigns for FY92-FY96, prioritized atmosphere data products, geophysical parameter validation plans, direct broadcast of selected MODIS-N channels, and general issues and concerns. The Atmospheres Group believes the MAS to be a better means of developing retrieval algorithms than theoretical simulations. Ten members of the MST and NASA Headquarters will be contributing $180K to modify the Wildfire spectrometer. A contract for the modifications is expected to be awarded to Daedalus Enterprises by early April 1991 and the MAS is expected to be available by November 1991.

Dr. King discussed the prioritized (primary, secondary, and tertiary) atmosphere data products. A comment was made that the Oceans Group was very interested in the total ozone product. Dr. King also discussed the primary, secondary, and tertiary direct broadcast channels. In closing Dr. King indicated that the atmospheric requirements are largely ignored, NASA Headquarters should know about the plans for the MAS, and that the ratio of planning exercises to money received is disproportionately large.

3.2 OCEANS

Dr. Wayne Esaias presented the Oceans Group summary report *(Attachment Z)*. Dr. Esaias opened with a discussion of funding issues. He commented that the current funding constraints would result in a schedule slip of 2 years and that a continued 25% funding level was unacceptable to satisfy any serious ocean requirements. Dr. Esaias indicated, in response to the BRDF requirement, that the optimal tilt scenario requires modelling studies and post-launch verification. He said it would be difficult to commit to a particular tilt scenario without further study. He strongly urged that MISR be used for BRDF studies. Dr. Esaias indicated he was pleased with the FY94 line item request for ship time and would actively support it; however, he felt that a cruise effort was needed for FY92 and especially for FY93. He mentioned that the OCDS is extremely important to EOS and will directly benefit some MODIS data products and data calibration/validation efforts. Dr. Esaias commented that the MODIS-N thermal SNR study performed by Dr. Barnes was an excellent beginning and he was looking forward to the final report.

3.3 LAND

The Land Group summary report *(Attachment Y)* was presented by Dr. Alan Strahler. Dr. Strahler indicated the need for a tight, interlocking set of products with shared responsibility among the investigators. He discussed the surface truth requirements including baseline test sites and campaigns. He displayed a chart which showed the land product relationships and provided tables showing EOS-IDS liaisons for land products and MODIS Land Group points of contact. Dr. Strahler discussed the baseline test site

needs including; land cover maps, snow cover maps, land surface temperature, NDVI, atmospheric measurements, DTM, areal net primary productivity, and daily meteorological data. He commented on the campaign data and instrument requirements and the aircraft requirements for FY91-FY96.

3.4 CALIBRATION

The Calibration Panel summary report *(Attachment X)* was given by Dr. Slater. He discussed the prioritized MCST activities for developing, analyzing, and maintaining the MODIS characterization data base. He presented a review of the MODIS-T on board calibration and indicated a number of concerns associated with the calibration that he believed should be treated as action items to be addressed before the next MST meeting. The priorities of the University of Arizona were addressed, the highest being the design, construction, and use of a stable, portable radiometer. He indicated that the calibration panel wanted to review the on-board calibration conceptual plans including the number of black bodies, stability, spectral response, etc. He recommended a study of the methods to monitor contamination of the paddle-wheel scanner. Dr. Slater suggested as an action item that MCST perform a first cut selection of the uniform "super" test sites on the North American continent using available AVHRR data sets. He also indicated as an action item that MCST look at MODIS snow and cloud masks and that the incorporation of higher level data products in the calibration algorithms be discussed at greater length at the next MST meeting. In closing he presented a list of aircraft requirements for FY92 - FY94.

4. ISSUES/ACTIONS/PLANS SUMMARY AND CLOSING REMARKS

Dr. Salomonson stated that he understands the frustrations associated with the planning and budgeting that the Team Members are experiencing. He indicated that the next MST meeting is scheduled for the Fall of 1991 and that in the interim all interested parties should keep in touch by telemail, etc.

ACTION ITEMS

PERSONAL ACTION ITEMS

KEN CARDER

1. **Seek out ships of opportunity for near-IR measurements in Case II waters.**

DAVID CARNEGGIE

1. **Determine if TM data can be purchased by EDC for the land group as part of the EDC support activity.**
2. **Together with P. Teillet, develop a demonstration satellite radiance topography data set to indicate the importance of topography on the accuracy of MODIS related products.**
3. **Help J. Townshend and P. Muller define land related topographic requirements.**

DENNIS CLARK

1. **Approach the NOAA Ship Council regarding the possibilities of joining planned NOAA cruises and support for dedicated MODIS/OCDS cruises starting within the next year or two.**

BARBARA CONBOY

1. **Add Greg Mitchell to the MODLAND group.**

JEFF DOZIER

1. **Coordinate between-team sharing of algorithms for a Technique Library.**
2. **Provide V. Salomonson with budget estimates by April 1.**

ROBERT EVANS

1. **Pursue the Technique Library concept in the Data Information System Committee meetings.**

HOWARD GORDON

1. **Write up the tilt concerns of the Oceans Group, particularly how a decision at this time and under the current level of knowledge would be unwise.**

TOM HAMILTON

1. **Establish bookkeeping procedures to keep track of funding removed from contracts for NASA aircraft operations.**
2. **Provide written explanations to universities regarding the year-to-year nature of NASA's incremental funding policies.**
3. **In cooperation with L. Stuart, investigate streamlined methods for expediting the utilization of federal funding in order to improve flexibility in moving money from one category to another. The "Federal Demonstration Project" is one such example.**

DAESOO HAN

1. **The Atmospheres group has requested that Han coordinate the processing of the MAS data using the MAMS code to produce a level 1B output product.**

ALFREDO HUETE

1. **Assume responsibility for coordinating MODIS Land Team Landsat TM and MSS related requirements within the next few weeks for FY91.**

CHRIS JUSTICE

1. **Draft a letter for EDC related to the Land Group's specifications for the global 1k AVHRR data set.**

MIKE KING

1. **Meet with Arveson and Brass next week to discuss WILDFIRE issues.**
2. **Go to Daedalus Enterprises in early April to see Osterwisch. Will be accompanied by Menzel, Brass, Arvesen, K. Brown, and Abel.**
3. **Return marked-up Data Product Lists, direct broadcast list, and marked-up copy of Greg Mitchell's handout page 1 to Vince Salomonson.**

PAUL MENZEL

1. **Go to Daedalus Enterprises in early April to see Osterwisch. Will be accompanied by King, Brass, Arvesen, K. Brown, and Abel.**

2. **Pursue further the issue of whether a 10-bit rather than 8-bit implementation of the MAS is possible.**
3. **In cooperation with MCST, verify methodology used by MODIS Science Data Support Team.**

GREG MITCHELL

1. **Crystallize the OCDS budget so that MODIS planning on ocean color work may proceed.**
2. **Seek approval for dedicated ship time.**
3. **Look for targets of opportunity on existing cruises.**
4. **Verify the plans for ship support starting in FY '94.**
5. **Emphasize to S. Tilford that MODIS funding is totally insufficient to support OCDS science development.**
6. **Working with S. Tilford, pursue the the constitution and convention of the OCDS Pre-launch Science Working Group.**

JAN-PETER MULLER

1. **Help J. Townshend define land related topographic requirements.**

STEVE RUNNING

1. **Draft an outline of the planned group paper for each member.**
2. **Provide information on the LTER network and NPS study site activities.**

VINCE SALOMONSON

1. **Produce a 10 year funding profile in cooperation with L. Stuart and H. Oseroff.**

ALAN STRAHLER

1. **Organize the agenda for the land cover meeting.**

LOCKE STUART

1. **Send an Excell-formatted disk of their previously proposd budget to each Ocean team member.**
2. **In cooperation with T. Hamilton, investigate streamlined methods for expediting the utilization of federal funding in order to improve flexibility in moving money from one category to another. The "Federal Demonstration Project" is one such example.**
3. **Supply the April "Surface Truth Workshop" proceedings to the MST.**

PHILLIP TEILLET

1. **Together with D. Carneggie, develop a demonstration satellite radiance topography data set to indicate the importance of topography on the accuracy of MODIS related products.**
2. **Help J. Townshend and P. Muller define land related topographic requirements.**

JOHN TOWNSHEND

1. **Help P. Muller define land related topographic requirements.**

GROUP ACTION ITEMS

ATMOSPHERES DISCIPLINE GROUP

1. **Consider the issue of whether a MODIS validation group should be established to do post-launch global validation. Establish international contacts to promote this goal.**
2. **Complete modifications to the MAS observation bands.**

CALIBRATION DISCIPLINE GROUP

1. **Determine facilities needed for calibration.**
2. **Consider a study of the methods to monitor contamination of the paddle-wheel scanner.**
3. **Refine calculations for the two-sphere calibrator.**
4. **Consider alternate selections for diffuser material and monitor diodes.**
5. **Consider problem of contamination of output of spheres and recommend methods to monitor contamination.**
6. **Consider a ratioing radiometer approach.**
7. **Consider the use of internal sources for pre-flight and in-flight calibration.**

CALIBRATION PANEL

1. **Review on-board calibration conceptual plans, and stability and knowledge of system spectral responses.**

EOSDIS

1. **Establish a "Technique" Library to satisfy the common need of the many different teams and investigations to employee certain "utility" algorithms. This mechanism for sharing techniques should be given immediate priority.**

EOS PROJECT

1. **Submit an overguide request for ship time in FY'92 and '93.**

LAND DISCIPLINE GROUP

1. **By the end of March, The land group should E-mail comments to Ramapriyan related to MODIS anticipated data amounts and data transmission rates.**
2. **The team members indicated in Attachment Y under "IDS-Links" should contact the designated IDS projects. Similarly, those team members responsible for providing an EOS-A link, as indicated in Attachment L-2 should contact the designated EOS-A facility instrument project.**

MODIS CHARACTERIZATION SUPPORT TEAM

1. **Perform a first cut selection of the uniform "super" test sites on the North American continent using available AVHRR data sets.**
2. **Look at MODIS snow and cloud masks.**
3. **Discuss incorporation of higher level data products in the calibration algorithms at greater length at the next Science Team meeting.**
4. **Require adequate time in the vendor and G.E.-integration for cross-calibration testing.**
5. **In cooperation with P. Menzel, verify methodology used by MODIS Science Data Support Team.**

MODIS ADMINISTRATIVE SUPPORT TEAM

1. **Check if it is possible for non-government Science Team members to receive reduced rate government fares.**
   This issue was quickly resolved. It is not legally possible.
2. **Consider whether the variety of data product lists presented to the investigators at the meeting can be consolidated into a single list.**
3. **Consider inserting a paragraph into the data base which describes each data product or provides a reference.**
4. **Consider whether larger print size can be used in the data product lists.**
5. **Provide each Land team member with a copy of the Land Execution Stage proposals.**
6. **Provide each Land team member with a copy of the IDS Execution Stage proposal.**

OCEAN COLOR DATA SET WORKING GROUP

1. **Discuss strawman protocols at the OCDS April meeting.**

OCEANS DISCIPLINE GROUP

1. **Acting as a coordinated group, present a strong case to NASA Headquarters for increased funding. Solicit assistance from IDS investigators based on the absence of HIRIS from Platform-A.**
2. **Promote precision improvements in existing optical data sets in order to better address the unique qualities of MODIS. The goal is to obtain as soon as possible in-situ near-IR measurements, taken in concert with visible and biological parameters.**
3. **Review execution phase proposals to check for modifications in light of the likely funding profile for the next few years.**

SCIENCE DATA SUPPORT TEAM

1. **Seek ways to combine Science Team member cloud cover masks into the most efficient cloud identification procedure.**

SCIENCE TEAM ACTION ITEMS

1. **Consider if LANDSAT-5 thematic mapper (TM) images of clouds can be purchased and put into the Browse facility.**
2. **Each team member is tasked with developing cloud identification requirements (i.e. cloud cover masks) to suit his products.**
3. **If interested in the science advisory panel for GSFC Version 0 DAAC, contact G. Feldman.**
4. **Supply NASA aircraft requirements for the next 5 years to L. Stuart. Additionally, all questions regarding coordination of flights should also be forwarded to Stuart.**
5. **Invite IDS representatives to future MODIS ST meetings, in order to help promote understanding of IDS requirements.**
6. **Address costs and amount of ship and aircraft time in modified proposals for time periods from FY '94 on.**