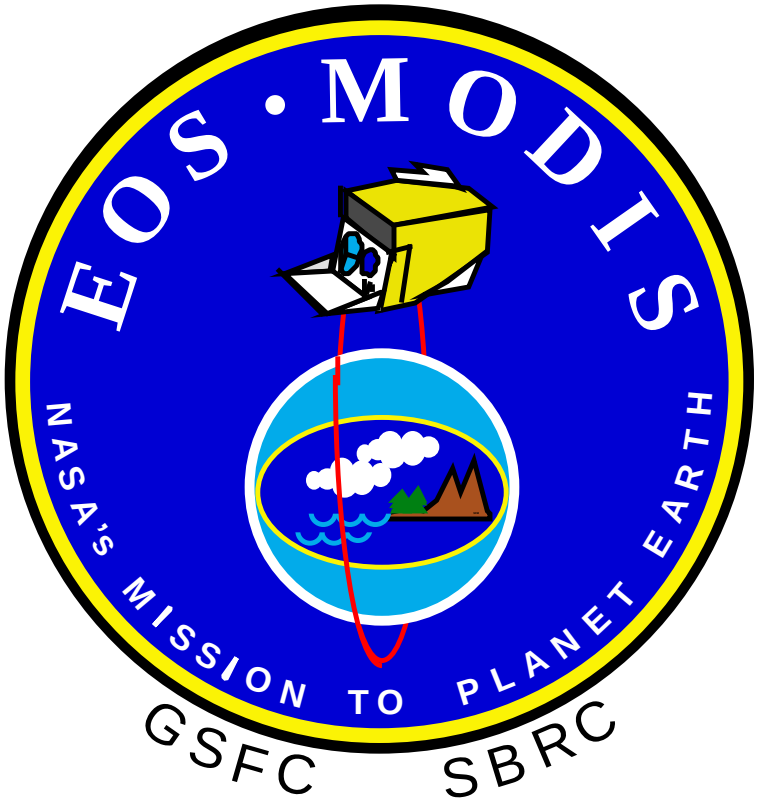
MODIS SCIENCE TEAM

MEETING MINUTES



March 24 - 26, 1993
NASA / Goddard Space Flight Center
Greenbelt, Maryland 20771

Prepared by: Science Systems and Applications, Inc.

MODIS SCIENCE TEAM MEETING MINUTES
March 24 - 26, 1993

TABLE OF CONTENTS

MODIS SCIENCE TEAM MEETING MINUTES

March 24 - 26, 1993

LIST OF ATTACHMENTS

(Note: Some Documents are referenced in multiple locations within the minutes. Documents are grouped according to the first place that they are referenced within the text of the minutes. In the following list of attachments, material distributed as documents is flagged "D" and material seen only as viewgraphs is flagged "V". Copies of the Minutes or Attachments are available in the MODIS Documents Archive and can be obtained by contacting: David Herring; Code 920; NASA/GSFC; Greenbelt, MD 2077; or calling (301) 286-9515.)

ATTACHMENTS: PLENARY SESSIONS

1. EOS Project Science Viewgraphs	V	Michael King
2 MODIS Status	D	Richard Weber
3 SDST Topics	V	Al Fleig
4 EOS Project Presentation	V	Chris Scolese
5 MPE Organization Chart	V	V. Salomonson
6 ESDIS Project Status	V	H.K. Ramapriyan
7 Topics From the MODIS Calibration Working Group	D	Phil Slater
8 Atmospheric Discipline Discussion	V	Michael King
9 MOCEAN Agenda	V	Wayne Esaias
10 Algorithm Theoretical Basis Document Outline	D	V. Salomonson
11 Simplified Land Data Products Interrelations	V	Chris Justice
12 MODIS Calibration Working Group Action Items	V	John Barker
13 EOS-AM Spacecraft Pointing—MODIS Pointing	D	General Electric
14 Pointing & Registration Have High Visibility at SBRC on MODIS	D	SBRC

MODIS SCIENCE TEAM MEETING MINUTES

March 24 - 26, 1993

LIST OF ATTENDEES

The following persons registered at and attended the MODIS Science Team Meeting. Those flagged with "**" are secretarial staff and support personnel. Telephone numbers were obtained from previous Science Team Meeting Minutes and could now be outdated.

	NAME	AFFILIATION	PHONE NUMBER
1.	Bruce Albrecht		
2.	Ken Anderson	NASA GSFC	301-286-6845
3.	Paul Anuta	RDC	301-286-9412
4.	Philip Ardanuy	RDC	
5.	Charles Bachmann		
6.	Bill Bandeen		
7.	John Barker	NASA GSFC	301-286-9498
8.	Bill Barnes	NASA GSFC	310-286-8670
9.	Ian Barton	CSIRO Australia	61-3-5867666
10.	Thomas Bascom		
11.	John Bauernschub	NASA GSFC	301-286-6395
12.	Stuart Biggar	Optical Sciences Ctr.	602-621-8168
13.	Joe Bolek		
14.	Francesco Bordi		
15.	Graham Bothwell	JPL	818-354-6057
16.	James Brass		
17.	Otis Brown	University of Miami	305-361-4018
18.	Ken Brown	NASA GSFC	301-286-3296
19.	Tom Bryant		
20.	Dixon Butler	NASA HQ	202-358-0256
21.	Jim Butler**	NASA GSFC	301-286-4606
22.	Kendall Carder	University of South Florida	813-893-9148
23.	David Carneggie	Department of the Interior	605-594-6059
24.	Lloyd Carpenter	RDC	301-286-9412
25.	Dave Case		
26.	Edward Chang	NASA GSFC	301-286-6964
27.	Jy-Tai Chang		
28.	Ruming Chen		
29.	Nicholas Clapp		

30.	Eugene Clothiaux		
31.	Barbara Conboy**	NASA GSFC	301-286-5411
32.	Gerard Dedieu		
33.	Dave Diner	JPL	818-354-6319
34.	Frank Eden		
35.	Wayne Esaias	NASA GSFC	301-286-5465
36.	Robert Evans	University of Miami	305-361-4799
37.	Al Fleig	University of Maryland	301-286-7747
38.	Kate Forrest	NASA Wallops	7-1245
39.	Stan Freden		
40.	Aman Gambhir**	GSFC	
41.	Brij Gambhir	SSAI	301-731-9300
42.	Bo-Cai Gao	USRA	301-286-5818
43.	Howard Gordon	University of Miami	305-284-2323
44.	Bruce Guenther	NASA GSFC	301-286-5205
45.	Liam Gumley	RDC	301-982-3748
46.	Dorothy Hall	NASA GSFC	301-286-6892
47.	Joann Harnden	NASA GSFC	301-286-4133
48.	Janine Harrison**	NASA GSFC	301-286-5324
49.	Patricia Henderson**		
50.	David Herring**	SSAI	301-286-9515
51.	Frank Hoge	Wallops	804-824-1567
52.	Simon Hook	JLP	818-354-0974
53.	Soug Hoyt		
54.	Paul Hubanks		
55.	Tony Janetos	NASA HQ	202-358-0274
56.	Chris Justice	NASA GSFC	301-286-7372
57.	Yoram Kaufman	NASA GSFC	301-286-4866
58.	Linda Kempster		
59.	Mark Kempster		
60.	Yann Kerr	EROS Data Center	33-61-274472
61.	Jeffrey Key		
62.	Michael King	NASA GSFC	301-286-8228
63.	John Kogut		
64.	Brian Krupp		
65.	Ed Knight		
66.	Yun-Chi Lu	NASA GSFC	301-286-4093
67.	Ed Masuoka	NASA GSFC	301-286-7608
68.	David McDougal		
69.	Paul Menzel	NOAA / NESDIS	608-264-5352
70.	Aaron Moody		
71.	John Moses		
72.	Jan-Peter Muller	San Diego State University	
73.	Steve Neeck		
74.	Barbara Nolan		

75.	Harold Oseroff**	UMD	301-286-9538
76.	Tom Pagano	SBRC	805-562-7343
77.	J.J. Pan		
78.	Bernard Pinty		
79.	H. Ramapriyan	NASA GSFC	301-286-9496
80.	Lorraine Remer	SSAI	301-286-8235
81.	Lisa Rexrode	NASA GSFC	301-286-6614
82.	George Riggs		
83.	Mike Roberto	NASA GSFC	301-286-4004
84.	Steve Running	Univesity of Montana	406-243-6311
85.	Shahin Samadi	NASA GSFC	301-286-8510
86.	Vince Salomonson	NASA GSFC	301-286-8601
87.	Greg Schmidt		
88.	Chris Scolese	NASA GSFC	301-286-9694
89.	Piers Sellers	NASA GSFC	301-286-4173
90.	A. K. Sharma		
91.	Bo Silva		
92.	Howard Silverman	General Electric	613-952-2737
93.	Rejean Simard	Canada Ctr. for Remote Sensing	
94.	Jeff Simmonds		
95.	Yosio Shimabukuro		
96.	Philip Slater	University of Arizona	602-621-4242
97.	Carl Solomon		
98.	Alan Strahler	Boston Univrsity	617-353-5984
99.	Jim Storey		
100.	Locke Stuart**	GSFC	301-286-5441
101.	Anand Swaroop		
	Tsutomu Takashima		
103.	Philippe Teillet	Canada Center for Remote Sensing	613-952-2756
104.	Dave Toll**	NASA GSFC	301-286-9256
105.	John Townshend	University of Maryland	301-405-4050
106.	Si-Chee Tsay	USRA	301-286-9710
107.	Steve Ungar	NASA GSFC	301-286-4007
108.	John Vandercastle		
109.	Vern Vanderbilt	NASA Ames	415-604-4254
110.	Eric Vermote	University of Maryland	301-286-7282
111.	Michel Verstraete	CEC Joint Research Ctr.	39-332-785507
112.	Zhengming Wan	University of California	805-893-4541
113.	Lalit Wanchoo		
114.	Richard Weber	NASA GSFC	301-286-5992
115.	Linda Weir		
116.	Daniel Wenrert		
117.	Carol Wesman		
118.	Diane Wickland	NASA HQ	202-358-0274

119.	Bruce Wielicki	Langley Research Ctr.	804-864-5683
120.	Claire Wilda		
121.	Jim Young	SBRC	805-562-7180
122	Dot Zukor	GSFC	301-286-8551

AGENDA

MODIS Science Team Meeting

March 24-26, 1993; Lanham, MD

Wednesday, March 24:

0800: Registration
0830: Welcome & MODIS Overview----------V. Salomonson
0850: Headquarters' Perspective----------G. Asrar, A. Janetos
0930: EOS & MODIS Budget Perspectives ----------M. King
1000: BREAK
1015: Project Status----------D. Weber
1045: PDR Review---------- B. Barnes, D. Weber
1115: Calibration Test Sites ----------B. Guenther, J. Barker
1145: LUNCH
1230: SBRC Status Report----------SBRC
1500: BREAK
1515: Data Products & Peer Review----------V. Salomonson
1615: Validation Plans ----------A. Fleig, B. Guenther
1645: SCAR Experiment----------Y. Kaufman

Thursday, March 25:

0800: MAST Report----------L. Stuart
0815: Project Status---------- C. Scolese
0830: EOS Instruments, IDS Reports----------D. Diner, B. Wielicki, Y. Kerr
0900: MCST Report---------- J. Barker
1000: BREAK
1015: SDST Report----------E. Masuoka, A. Fleig
1115: EOSDIS Status Report ----------H. K. Ramapriyan, et al.
1200: LUNCH
1300 - 1730: Discipline Group Meetings ---------- All Afternoon Groups meet in assigned conference areas. Discussions should address actions & objectives.
1800: SOCIAL - Catered
1930 - 2200: Discipline Group Meetings (optional)

Friday, March 26:

0800 - 1200: Discipline Group Meetings (continued) ----------All Morning Groups meet in assigned conference areas. Discussions should address actions & objectives
1200: LUNCH
1300: Data Products---------- G. Asrar
1330-1500: Final Plenary Discussions---------- Group Leaders, V. Salomonson
1500: ADJOURN SCIENCE TEAM MEETING

23 Mar. '93

MEETING OBJECTIVES

- Confirm output data products and accuracies
- Discuss data quantities and storage requirements
- Tie data products to instrument specifications
- Discuss development of masking and utility algorithms
- Develop philosophy and implement plan for data simulation
- Review the Calibration/Validation plans
- Review concept for "generic" test sites and their utility to MODIS
- Confirm process and schedule for peer review
- Review geometric registration requirements

MODIS SCIENCE TEAM MEETING MINUTES

March 24 - 26, 1993

GLOSSARY OF ACRONYMS

ADEOS	Advanced Earth Observing Satellite
AGU	American Geophysical Union
AIRS	Atmospheric Infrared Sounder
APAR	Absorbed Photosynthetic Active Radiation
ARVI	Atmospherically Resistant Vegetation Index
ASAS	Advanced Solid State Array Spectrometer
ASTER	Advanced Spaceborne Thermal Emission and Reflection Radiometer
ATMOS	Atmospheric Trace Molecule Spectrometer
ATSR	Along Track Scanning Radiometer
AVHRR	Advanced Very High Resolution Radiometer
AVIRIS	Advanced Visible and Infrared Imaging Spectrometer
BAT	Bench Acceptance Test
BOREAS	Boreal Ecosystem Atmospheric Study
BRDF	Bidirectional Reflection Distribution Function
CAR	Cloud Absorption Radiometer
CCB	Configuration Control Board
CCRS	Canadian Center for Remote Sensing
CDR	Critical Design Review
CEES	Committee on Earth and Environmental Sciences
CEOS	Committee on Earth Observation Satellites
CNES	Centre National d'Etudes Spatiales (French Space Agency)
CZCS	Coastal Zone Color Scanner
DAAC	Distributed Active Archive Center
DADS	Data Access and Distribution System
DEM	Digital Elevation Model
DIS	Data Information System or Display and Information System
DoD	Department of Defense
DOE	Department of Energy
DPWG	Data Processing Working Group
ΔPDR	Delta Preliminary Design Review
ECS	EOS Core System (part of EOSDIS)
EDC	EROS Data Center
EOS	Earth Observing System
EOSDIS	EOS Data and Information System
EPA	Environmental Protection Agency
ER-2	Earth Resources-2 (Aircraft)
ERS-2	ESA Remote Sensing Satellite
ESA	European Space Agency
ESTAR	Electronically Steered Thinned Array Radiometer
FIFE	First ISLSCP Field Experiment
FOV	Field of View
FTP	File Transfer Protocol
GE	General Electric
GIFOV	ground instantaneous field-of-view

GLAS	Goddard Laser Altimeter System
GLI	Global Imager
GLRS	Goddard Laser Ranging System (now GLAS)
GOES	Geostationary Operational Environmental Satellite
GSFC	Goddard Space Flight Center
GSOP	Ground System Operations
HAPEX	Hydrological-Atmospheric Pilot Experiment
HIRS	High Resolution Infrared Radiation Sounder
HRPT	High Resolution Picture Transmission
HRV	High Resolution. Visible
I & T	Integration and Test
IDS	Interdisciplinary Science
IFOV	Instantaneous field-of-view
IGBP	International Geosphere-Biosphere Program
IPAR	Incident Photosynthetic Active Radiation
ISLSCP	International Satellite Land Surface Climatology Experiment
IWG	Instrument Working Group
JERS	Japanese Earth Resources Satellite
JPL	Jet Propulsion Laboratory
JRC	Joint Research Center
LAI	Leaf Area Index
LARS	Laboratory for Applications of Remote Sensing
LTER	Long Term Ecological Research
MAB	Man and Biosphere
MAS	MODIS Airborne Simulator
MCST	MODIS Calibration Support Team
MISR	Multiangle Imaging Spectro-Radiometer
MODIS	Moderate-Resolution Imaging Spectroradiometer
MODIS-N	MODIS-Nadir
MODIS-T	MODIS-Tilt (this instrument has been cancelled)
MODLAND	MODIS Land Discipline Group
MOU	Memorandum of Understanding
MPCA	MODIS Polarization Compensation Assembly
MSS	Multispectral Scanner (LANDSAT)
MST	MODIS Science Team
MTF	Modulation Transfer Function
NASA	National Aeronautics and Space Administration
NASIC	NASA Aircraft Satellite Instrument Calibration
NDVI	Normalized Difference Vegetative Index
NEΔL	Net Effective Radiance Difference
NESDIS	National Environmental Satellite Data Information System
NIR	near-infrared
NIST	National Institute of Standards and Technology
NOAA	National Oceanic and Atmospheric Administration
NPP	Net Primary Productivity
NPS	National Park Service
NSF	National Science Foundation
OCTS	Ocean Color and Temperature Scanner
OSC	Orbital Sciences Corporation
OSTP	Office of Science and Technology Planning
PDR	Preliminary Design Review
PGS	Product Generation System
QCAL	calibrated and quantized scaled radiance
RAI	Ressler Associates, Inc.

RDC	Research and Data Systems Corporation
RSS	Root Sum Square
SAR	Synthetic Aperture Radar
SBRC	Santa Barbara Research Center
SCAR	Smoke, Cloud, and Radiation Experiment
SCF	Scientific Computing Facility
SDSM	Solar Diffuser Stability Monitor
SDST	Science Data Support Team
SeaWiFS	Sea-viewing Wide Field of View Sensor
SNR	Signal-to-Noise Ratio
SPDB	Science Processing Database
SPSO	Science Processing Support Office
SRC	Systems and Research Center
SRCA	Spectroradiometric Calibration Assembly
SSAI	Science Systems and Applications Inc.
STIKSCAT	Stick Scatterometer
SWIR	shortwave-infrared
TBD	to be determined
TDI	time delay and integration
TDRSS	Tracking and Data Relay Satellite System
TIMS	Thermal Imaging Spectrometer
TIR	thermal-infrared
TLCF	Team Leader Computing Facility
TM	Thematic Mapper (LANDSAT)
TOMS	Total Ozone Mapping Spectrometer
TRMM	Tropical Rainfall Measuring Mission
UARS	Upper Atmosphere Research Satellite
VIRSR	Visible / Infrared Scanning Radiometer
VIS	visible

MODIS Science Team Meeting
March 24 - 26, 1993

SUMMARIES OF THE MINUTES

1.0 PLENARY SESSIONS

Before the meeting began, Locke Stuart announced that the proceedings were being video taped to assist in the taking of minutes. Copies of the tapes are available to Science Team members, and may be obtained from the MODIS Document Archive by contacting Harold Oseroff at (301) 286-9538.

Stuart also announced that for the first time the MODIS Banquet will feature a guest speaker—Nicholas Clapp, who is credited with the discovery of the lost city of Ubar.

The Plenary Session of the MODIS Science Team meeting was chaired by Vince Salomonson.

1.1 Welcome and MODIS Overview

Salomonson began with a brief discussion of the Agenda and tasked the group to work together to accomplish the meeting objectives (see pages ix and x).

He reported that several issues currently on his mind are MODIS Data Products and their accuracies, the EOSDIS Core System which was unveiled this week, and the calibration and validation of MODIS and its data products.

1.2 Headquarters Perspective

Tony Janetos reported that he doesn't yet know the status of funding for MODIS for FY94. He said that President Clinton's Administration has not yet determined NASA's funding allocation.

Janetos emphasized the importance of listing the accuracies of data products. He stated that it is also important for the Science Team to have a plan for the selection and utilization of test sites.

1.3 EOS Platform Status

Salomonson introduced Michael King, the EOS Project Scientist, to report on the EOS Platform Status. King said that no decision has been reached on Level 1 requirements; any proposed changes must go through the Configuration Control Board.

1.3.1 Announcements

King announced that he appointed Piers Sellers as EOS AM Platform Project Scientist and Chuck McClain as Project Scientist for EOS COLOR.

The latest issues of *The Earth Observer* and the *EOS Reference Handbook* were recently published.

1.3.2 EOS and MODIS Budgets

King reported that the total EOS budget is $8 billion, 10 percent of which has already been appropriated through FY93. To date, MODIS has received $15.5 million; 59 percent of MODIS' FY93 funding has already been disbursed (See Attachment 1). He noted that starting in FY92, funding was split into two different UPN's—SCI and SCF. Although there is currently no official definition of SCI and SCF funds, these categories determine on what the funding may be spent. King added that all of MODIS' FY93 SCF funding has already been distributed.

Alan Strahler asked if there will be an attempt to renegotiate the contracts due to the differentiation of funds into SCI and SCF. Stuart interjected that it is up to Dick Weber and John Bauernschub to define SCI and SCF. Meanwhile, he said he would notify any team members who were attempting to spend from the wrong category. Stuart was given an action item to communicate with Carol Arkwright and Project on this problem.

1.3 MODIS Project Reports

Weber reported that most of the descopes requested at the last Science Team meeting were implemented; there are no further descopes planned as of this meeting (See Attachment 2). Weber recalled that ground and onboard calibrators were a major topic of interest at the last meeting. He said that the ground calibrators have been simplified and some improvements in testing have been made at SBRC.

1.3.1 MODIS Development Overview

Weber reported that the MODIS detectors are looking much better and yields are improved. The instrument's beryllium structure is out for bids, which are due later in March. Also, there will be two ΔPDR's next week.

Weber reported that the Review Team was pleased with Bruce Guenther's presentation on the rationale behind and design of the MODIS SRCA (Spectroradiometric Calibration Assembly). They are now convinced of the necessity of having onboard calibrators.

Weber stated that the Review Team is also happy with the electronics of the instrument. Several lenses within the aft optics assembly have been redesigned. There are problems with the throughput, and two of the bands—29 and 36—don't currently meet specs.

1.3.2 MODIS Management

Weber reported that cost caps are being met as stated in the instrument development contract. SBRC is about one month behind schedule, but they are catching up. There are currently about 160 people at SBRC working on the MODIS instrument, with zero slack on their work schedules.

1.3.3 MODIS Science Data Products Processing Load

Weber said there is currently a mismatch between SDST's estimates and EOSDIS' allocation of processing capacity for MODIS products. He said that whereas EOSDIS has allocated 70 Mflops, SDST has estimated that MODIS will require more than 1000 Mflops without the Level 1b Processing for which an estimate will be provided by MCST at a later date.

Salomonson interjected that 70 Mflops is dead wrong; 1100 Mflops is a better estimate. He said the original estimate only took Level 3 products into account. Yun-Chi Lu interjected that the original number was provided by the MODIS Team 2 years ago.

1.3.4 Announcements

Weber announced that radiation tests of the MODIS filters will be conducted in April and May of '93. Also in May, the final filter deliveries will be made to SBRC and the scan motor/encoder subcontract will be established. The MODIS CDR (Critical Design Review) will be held in October or November of this year, and sometime between November '93 and April '94, the MODIS structural model will be assembled.

Salomonson said that he supported "one-stop shopping" for MODIS hardware and data products, and they are both now Weber's responsibility.

1.3.5 MODIS PDR

Barnes reported that there were 130 action items assigned at the MODIS PDR, most of which have already been completed.

1.4 EOS Calibration Test Sites

Guenther reported on the EOS Calibration Panel's activities. He said the Panel is looking forward to supporting the instrument teams in data product validation. According to Guenther, the Calibration Panel won't be able to provide all the support they would like to, so they must use their resources efficiently. Therefore, he said, we must first get a good knowledge of who is already out there doing the measurements we're interested in. The Panel is planning to include outside researchers.

There was some discussion of test sites at the February 1 Calibration Meeting in San Diego, for which people were asked to bring information on previously established test sites. Guenther said that ASTER and MISR has test site lists and MODIS does not; although, he said, MODIS will want to use LTER test sites. He said that the Panel is considering making test site data available on the Global Flinn Network, which is a solid Earth network. Other networks being considered are SLR (Satellite Laser Ranging) and VLBI (Very Long Baseline Interferometry).

Guenther said that the advantage to using one of these networks is that they consist of test site locations where measurements are currently being made, and we know which agencies are making those measurements and at what accuracies. Another advantage is that an infrastructure already exists in these networks. Guenther proposed producing a database for investigators illustrating where test site operations are and what

measurements are being made. Ultimately, he said he plans to add LTER sites to whichever network is chosen.

Salomonson questioned the relevance of solid Earth and the Flinn Network. He suggested that FIRE may provide a network infrastructure.

Frank Hoge interjected that he has a test site at Wallops Island from which he takes data on a region blanketing much of the east coast, from Cape Hatteras to New York and outward to the Sargasso Sea. He said his project uses research vessels and a P-3 plane to gather take measurements.

Salomonson observed that MODIS has the responsibility to state what kinds of calibration and validation activities the Team will conduct. He tasked Guenther to compile a list of already ongoing test site efforts and report to the Team on what georeferenced databases are available.

1.5 SBRC Reports

Tom Pagano, SBRC, showed a series of transparencies tracing the latest engineering developments and current design issues facing MODIS. He told the Team that if they need copies of any of his viewgraphs or charts, they should simply record the specific log number and then send him a request.

Pagano reported that SBRC has almost finished building SeaWiFS, which is very similar in design and calibration methodology to MODIS. The SeaWiFS instrument is approximately 1 m in width and height, and 1.6 m long.

1.5.1 Instrument Introduction and Overview

Pagano gave an overview of the technical capabilities of MODIS. He said SBRC chose a modular design for the instrument so there could be a separate team of engineers to report on and manage each module. He reported that the mainframe drawings are complete; as is the design for the scan mirror assembly and the optical bench. There are twenty optical surfaces between the Earth scene and the thermal IR (infrared) detectors.

SBRC has finalized the detector mask configuration. Contrary to what was decided at the last MODIS Science Team Meeting, they opted not to use subpixels in the detector masks. Full pixel masks can be produced to specification. Pagano reported that SBRC also accommodated the requested changes in bands 21 and 26. The engineering model of the FPA (focal plane assembly) will be completed by August '93.

King asked if the 1.38-µm channel can be used in the day mode. Pagano responded that it can be used in both the day and night modes.

1.5.2 Onboard Calibration Modules

Pagano reported that the scan mirror allows views of multiple calibration sources: the SRCA, SDSM, solar diffuser, the Sun, the Earth, deep space, and the blackbody (which

is full aperture with v-grooves). Based on thermal analysis results, SBRC can detect a temperature gradient of the blackbody to within 0.1°K.

SBRC changed the diffusion of the transmission screen in the solar diffuser to 8.5 percent, resulting in about 54 percent albedo. Pagano said that the SDSM aperture rotates to view the sun, then looks at the black surrounding for reference. He also noted that the SDSM views the diffuser at equal but opposite angles to the scan mirror's view of the diffuser.

Pagano reported that the spectral range of the SRCA is planned to extend from 0.41 µm to 2.13 µm; however, an engineering model is not yet completed.

1.5.3 MODIS Performance Requirements

Pagano reported that SBRC is meeting specs on instrument size and mass, as well as data and power rates. He stated that Band 5 does not have two-point calibration, but ultimately SBRC will meet the specifications for it, as well as Band 26. The saturation levels have been reduced on Band 21.

Pagano reported that they have met the goal of 36 percent signal-to-noise (SNR) margin in all but four bands. On bands 29 and 36 there is a problem with the dichroics—transmission is down from 85 to 75 percent due to coatings. They are addressing this problem. Regarding noise versus radiance, SBRC is achieving very high SNRs (above 1,000).

Pagano said meeting the 2 percent reflectance accuracy requirements in the reflectance bands will be a challenge. However, they are meeting the goals in the IR bands. Carder asked why Band 9 shows increased radiometric error. Pagano responded that this is the radiometric error from looking at the solar diffuser, not at an actual Earth scene.

SBRC is meeting their requirements on MTF, misregistration, and pointing knowledge. However, they are having problems with the long wave edge slope on Bands 27-31 and are not currently meeting specs on Bands 27 and 29. Pagano said that SBRC is trying to get better dichroics to address the problem. He solicited constructive input from the Science Team. Joann Harnden stated that MCST has a mechanism in place to assess the problem, it they can get the data in numerical form.

Pagano reported that specs are being met on Band 36, but the band shape looks a little asymmetrical.

1.5.4 SBRC Reports on MODIS Calibration

Jim Young, SBRC, began his presentation with a review of the guidelines the Science Team gave SBRC at the last Science Team Meeting. He reported that the descope options taken since the last meeting helped reduce cost. In-flight calibration capability was changed, which also resulted in cost savings. SBRC conducted an extensive review of their philosophy and have accepted some additional risk.

He noted the following descope options were NOT followed:
•Using the SRCA to replace the ground-based calibrator;
•Enhancing the redundancy of the SRCA (Young noted that there is a fair amount of redundancy already);
•Measuring MTF in vacuum; and
•Monitoring SRCA radiometric mode output with Silicon Photodiodes.

Young stated that although the SRCA has limited capabilities, it remains a good device for detecting in-orbit performance changes. The SRCA consists of three modules: 1) source module, 2) monochromator, and 3) collimator. He said it is not easy to get this configuration to operate at ambient temperature and in a vacuum, but tests show that it is possible. The SRCA can measure registration while in flight to determine any launch-induced errors, and can measure 1/40 FOV in the scan direction.

To help reduce risk, SBRC will maintain a dedicated MODIS calibration test facility with a 12' by 9' chamber. Young said that they have not yet addressed the issue of calibration testing over hot targets; they will report on this issue at the next Science Team Meeting.

1.6 Peer Review and Data Products
Salomonson briefly discussed Skip Reber's (Upper Atmosphere Research Satellite [UARS] Project Scientist) presentation on peer review and algorithm development at the last MODIS Technical Team Meeting (for more information on Reber's presentation, refer to the MODIS Technical Team Minutes from the March 11, 1993 meeting). Salomonson said additional thought must be given to the peer review process.

Salomonson went on to briefly discuss his upcoming presentation of MODIS Data Products to the IWG and solicited input on how he could best represent the Team at that meeting. He recounted some of the characteristics of MODIS, pointing out that it is an evolutionary step above its heritage instruments—AVHRR, SeaWiFS, HIRS, and TM. He reminded the Team of the addition of the 1.38-µm band (which replaced the 4.56-µm band) for the detection of stratospheric aerosols.

Salomonson showed rough drafts of the MODIS Data Products flow diagrams for each discipline group; the Science Team offered constructive criticisms. David Herring was tasked to revise the diagrams. (Subsequent to the meeting, the flow diagrams were revised—see Attachment 3.)

Salomonson tasked each discipline group to produce a MODIS At-Launch Data Products List that details each product name, investigator, and accuracy.

1.6.1 Tying Data Products to Instrument Specifications
According to Salomonson, Headquarters has mandated that each instrument team must tie its data products to instrument specifications. He stated that the MODIS Science Team needs to show progress in this area; it would perhaps help to understand what efforts UARS, ASTER, and MISR have made.

1.6.2 Algorithm Theoretical Basis Documents (ATBDs)

Salomonson tasked each Science Team member with generating an ATBD to describe the physics, mathematics, and computer program considerations behind the algorithms for which he is responsible. Team members may incorporate all of their algorithms into one document. ATBDs are due July 30, 1993.

1.7 MCST Reports

John Barker distributed copies of his MCST Report, which contains information on the MODIS Calibration Methodology & Level-1 Algorithm, MODIS System Performance Simulation, and MODIS Level 2-A Cloud / Utility Masks. He presented organization charts of the MODIS Support and Review Teams and briefly reviewed the milestone schedule for MCST tasks and algorithm development.

1.7.1 Calibration Methodology

Barker announced that MCST intends to explore and maintain different calibration methodologies. He said they will also provide as robust and unique algorithms as possible. MCST will characterize calibration precision between two and six months after launch; they will characterize accuracy on a time scale of years after launch; and will validate the math model over the 10- to 15-year lifetime of the EOS mission. Barker asked for inputs from the Science Team on their calibration requirements.

Salomonson asked if MCST will derive greater accuracy than MODIS' current general specs. Barker responded that specs don't change, so the instrument has to meet specs. As a goal, however, Barker hopes to attain a greater accuracy than is currently required in the specs.

MCST's intent is to build redundancy into the MODIS calibration system to lower risk—they intend to normalize data in cross-calibration, perform ground instrument characterizations, end-to-end performance models, and spacecraft-based geometric characterizations. MCST's intent with the calibration algorithm is to provide some degree of coefficient derivation. The methodology will be organized so that any changes in calibration can be analyzed onboard and in flight. The way the calibration system is operated will depend on what MCST finds when the instrument is in orbit. Barker reported that MCST will release a document describing the calibration methodology in greater detail for peer review by August, 1993.

Wayne Esaias asked if the SRCA will provide information on possible spectral shifts, that would therefore allow correction. Barker responded that MCST will provide an algorithm to correct spectral shifts. He said that calibration coefficients will be changed every half-orbit, with Kalman filtering for normalization.

Esaias asked if MCST will track the calibration history of the instrument. Barker responded affirmatively. MCST will provide the best coefficients at any time to apply to any previous data. Team members may decide on the significance of the coefficients, or they may defer to MCST's provided recommendations as to which set of coefficients

are most applicable to any given data set. In short, MCST will provide automatic updates on all data every six months based on the best current information. These coefficients will be contained in the Level 1-B algorithms, but there will be pointers to them in the 1-A algorithms.

1.7.2 MODIS System Performance Simulation

Regarding MODIS system performance simulation, Barker stated that MCST's objective is to provide spectral, spatial, and temporal simulation of MODIS imaging end-to-end performance for developing and testing the Level-1 calibration / masking algorithm and performing product-to-instrument calibration sensitivity studies. The approach will be to obtain and maintain SBRC's MODIS radiometric math model, provide for the simulation of MODIS imagery from TM imagery, and to use PRA's (Photon Research Associates) GCI (Global Change Initiative) Toolkit as a user-friendly software shell to allow the insertion of user-developed models of the atmosphere, target and instrument characteristics, and synthetic scenes.

Barker briefly discussed MODIS band change tolerances and the resulting shifts in spectral reflectance. He displayed a chart plotting the band changes by comparing SNR and spectral shift error.

Barker reported that MCST is simulating MODIS scenes to help develop the masking algorithm. He showed scenes of Chugach, Alaska in which snow, clouds, and vegetation were all differentiated.

1.7.3 SBRC Documentation Tracking

Barker reported that MCST is tracking all SBRC documentation. Currently they are using Microsoft Excel to index the documents, but they will soon convert to Oracle. MCST will "hand off" their document index to MAST later this year, who will eventually hand off to EOSDIS in the 1995-96 time frame.

1.7.4 MODIS Level 2-A Cloud / Utility Masks

Barker briefly discussed the MODIS Level 2-A Cloud / Utility Masks and showed flowcharts illustrating the algorithm flow of the mask procedure. He stated that he will simulate MODIS imagery using Landsat Thematic Mapper Bands 4 and 6. After launch, these masks will use—in the day mode—combinations of Bands 1, 2, 5, 6, 23, 24, and 30. The Cloud / Utility masks will be produced as part of the Level 1 calibration process, and will be available for use in the production of any Level 2 or higher data products. These masks will be available in three 32-bit Level-2A images, one for each of the different 250-, 500-, and 1000-m MODIS spatial resolutions.

Chris Justice reminded Barker of the request that masking activities be tied closely to discipline activities. Barker said he would like each group to identify someone with whom MCST can work in order to relate the instrument to group products.

King stated that he is not comfortable with certain channels MCST is using for cloud screening. He said there is a need to increase cloud dialogue to include the latest science from the general cloud (remote sensing) community.

1.8 SDST Reports

Ed Masuoka and Al Fleig reported on SDST activities (see Attachment 3). Fleig began with a discussion of the Calibration / Validation meeting in San Diego on Feb. 1. He asked the Science Team members to let SDST know whom they plan to have validate their output products. SDST will provide input data to whomever is going to maintain the database. SDST will also assemble all validation plans into a single document.

1.8.1 MODIS Data Processing and Storage Requirements

Fleig reported that SDST is in the process of updating their estimates of MODIS' processing and storage requirements. He asked Science Team members to report what they really plan to put out for a product. And what do they mean when they say "product"? In short, do the Science Team members have anything SDST can use to scale their processing requirements? .

Fleig distributed a draft of SDST's *Level 1A System Requirements Document* and asked the Science Team to review it and forward comments and input back to him.

Eventually, Fleig said, SDST will inquire as to the quality assurance of each product. He would like to know what sort of simulated data the Science Team wants; and when they want it.

Fleig announced that SDST plans to assist each member in the development of their software. Who should SDST contact with questions / concerns regarding Team members' software development? He said that if the Team is interested, SDST will put together a seminar to assist Team members in software development.

Fleig also offered SDST's help in producing ATBDs. He reminded the Team that they are scheduled to deliver their code by Jan. 1, 1994.

1.8.2 Toolkit Environment

Masuoka discussed briefly SDST's plans for the MODIS Science Computing Facility environment—they plan to use the Product Generating System (PGS) Toolkit, POSIX compliant UNIX, ANSI C and ANSI FORTRAN, and a Hierarchical Data Format. However, they will probably not use C++. The hosting hardware to the Toolkit will consist of Sun, DEC, Silicon Graphics, Hewlett-Packard, and IBM computers. SDST will use QA / FORTRAN and QA / C as their quality checking tools.

1.8.3 Science Computing Facility (SCF) Plan

Masuoka said that SDST will issue an SCF Plan describing software and data management, software development, and configuration management, by the end of June, 1993.

1.8.4 MODIS Prototyping Effort

Masuoka stated that the MODIS Airborne Simulator (MAS) is good for prototyping and that SDST plans to use MCST's simulated MODIS data. Paul Menzel recommended that SDST review HIRS prototyping efforts.

1.9 Smoke, Cloud, and Radiation (SCAR) Experiment

Yoram Kaufman reported on his plans to conduct SCAR experiments in 1993 and 1994, leading to the collection of data pertaining to deforestation and biomass burning in Brazil. Kaufman would like to conduct a pre-SCAR experiment in the Eastern United States in July, 1993. He invited anyone interested to participate. SCAR will provide atmospheric data (physical, chemical, and radiative effects of biomass burning on the atmosphere); as well as remote sensing of vegetation, fires, smoke, water vapor, and clouds. The approach will be to conduct remote sensing from aircraft—MAS (MODIS Airborne Simulator, CAR (Cloud Absorption Radiometer), and AVIRIS (Advanced Visible and Infrared Imaging Spectrometer)—in the 0.4- to 14-µm bands; make in situ measurements of physical, chemical, and optical properties of trace gases, water vapor, smoke particles, and cloud drops; take ground-based measurements of vegetation, fires, and smoke aerosols; and to also use satellite observations from AVHRR, GOES, and Landsat's Thematic Mapper.

Howard Gordon suggested that SeaWiFS might also prove helpful to the SCAR experiments.

This concludes the minutes from the Day 1 Plenary Session.

1.10 MAST Reports

Locke Stuart began the Day 2 Plenary Session by announcing that Landsat TM data is available to the MODIS Science Team at a reduced price. Chris Justice is gathering information on Landsat scenes for the Land Group. Anyone interested in obtaining specific data should contact Stuart. Given the specific day and time for a scene, and latitude and longitude, Stuart offered to convert the path row for MODIS Team users of the data.

1.10.1 Leasing Equipment

Stuart asked Team Members to inform him if they have leased or plan to lease any equipment in the $50K range. If Team Members do plan to lease equipment in this price range, they should notify Harold Oseroff of their requirements as soon as possible. Stuart noted that in some instances the Team Member may have to justify leasing rather than purchase equipment as it is sometimes cheaper to buy.

1.10.2 SCI versus SCF Funds

Stuart reported sending out an e-mail memo that was "nebulous" regarding SCI versus SCF funds. He plans to meet with John Bauernschub, Michael King, and Bernie Cullinan to clearly define the two funding categories. For FY93, Stuart said, Science Team members should have received all of their SCF funds and most of their SCI.

Justice asked when the FY94 Budget figures will be released. Stuart responded that he has prepared an FY94 strawman budget and will soon present it to the Team Leader. Justice asked if the total funding will be more or less than originally planned. Stuart replied less, but not much less.

1.10.3 New MAST Team Leader

Stuart introduced Janine Harrison and announced that she will become the new MAST Team Leader early this fall, before the next Science Team Meeting.

1.11 EOS Project Status

Chris Scolese announced that Piers Sellers is the new EOS AM Project Scientist.

He reported that cooperation between EOS instrument teams has been good—MODIS is regarded as having one of the most favorable working relationships with other teams.

Scolese summarized EOS accomplishments over the previous six months—MODIS and CERES PDRs were completed, spacecraft and subsystem PDRs were completed, and the ASTER subsystem PDR was completed (for more details, see Attachment 4). He reported that the EOSDIS Project Toolkit will be out in August.

Scolese stated that EOS AM Project has streamlined its interface with each instrument's Science Teams. An instrument manager has been appointed to each team to make sure that funding goes through, milestones are reached, and "all of the pieces come together". Scolese announced that Dick Weber is the Instrument Manager for MODIS, and Ed Chang is the Operations Manager.

Scolese discussed the policy he reported on at the last MODIS Science Team Meeting: projects that exceed their budgets by 15 percent or more will be reviewed by HQ; and projects that exceed their budgets by 25 percent or more will be eliminated. This is a concern given that contractor rates are going up because U.S. Department of Defense budgets are going down.

1.11.1 Reorganization

Scolese reported that Daniel Goldin reorganized NASA's Office of Space Science and Applications (OSSA) into three divisions: Astrophysics, Mission to Planet Earth (MPE), and Life Sciences. Shelby Tilford is the acting Associate Administrator for MPE and plans to reorganize the division into three subdivisions: Flight Division (which includes all flights, such as EOS, TRMM, GOES, TOMS), to be headed by Mike Luther; Operations and Data Systems, to be headed by Dixon Butler; and the Science Division, to be headed by Bob Watson (See Attachment 5).

1.11.2 Pointing Knowledge

Alan Strahler said he is concerned about pointing knowledge. He asked Scolese if we will do geometric registration across the different EOS platforms. Scolese said that this is a concern, but that registration across platforms hasn't been decided yet. He noted

that ASTER is driving the specs. There will be a Project meeting in April to discuss pointing knowledge requirements.

Esaias asked if the EOS-AM Platform will be able to pitch to view the moon. Scolese said he is about 85 percent sure that it will be able to either pitch or roll to view the moon.

1.12 MISR Reports

Dave Diner, MISR Team Leader, reported on his instrument's status. There have been small changes in its spectral bands.

Diner said geolocation is a concern to MISR—the EOS Platform is required to provide position accuracies, however Project has made no official requirement on this issue. He said that although GE agrees to provide pointing knowledge of ± 90 arc-seconds, MISR would like breakdowns into static and dynamic uncertainties. He feels that MODIS has similar requirements and invited the MODIS Team to work with MISR to obtain Project's commitment to make this a contractual requirement for GE.

1.13 EOSDIS Report

H. K. Ramapriyan (Rama), EOSDIS Deputy Project Manager, gave an overview of EOSDIS (EOS Data and Information System). (See Attachment 5.) The EOSDIS core system (ECS) negotiations have been completed. Version 0 of ECS has been active for 2.5 years and is demonstrably interoperable with DAAC (Distributed Active Archive Center).

Rama reported that EOSDIS has already held two Focus Team meetings. He explained that there are four teams whose role is to serve the science community and gather input from that community. The four teams are Data Processing (managed by Ted Myer and Stan Scott), Data Organization and Access, Science Data and Planning Operations (managed by Ed Chang and Paul Wong), and Flight and Mission Operations.

Chris Justice interjected that having Project personnel serve as chair and co-chairs of these teams will make it harder to get major criticisms through if the systems needs to be changed. Gail McConaughy assured the Team that EOSDIS is responsive to complaints and has built-in mechanisms to receive feedback.

1.13.1 Data Products

Rama stated that Ghassem Asrar, EOS Program Scientist, has produced a reduced list of data products for each instrument, which is the list EOSDIS is using. They hope to receive an updated list in August, at which time they will re-size the ECS and determine whether or not they can support the entire list of products.

Rama explained that ECS was designed to grow by 20 percent per year to allow for growth in the number and/or sizes of data products.

1.13.2 Science Software Development

Rama reported that the science software and data management requirements were defined and refined through meeting with the science software developers and the Data Processing Focus Team.

Rama stated that the ECS contractor is responsible for developing and integrating the Product Generating System (PGS) Toolkit. The software developer and the DAAC will support the integration process. The system will then be independently verified and validated.

1.13.3 ECS Contract Scope

Rama stated that design, procurement, development, fabrication, test, delivery, installation, verification, product assurance, and documentation of hardware and software are all within the scope of the ECS contract. Development of prototypes and conducting ongoing analysis of EOS/ECS requirements are also within scope. Ultimately, the ECS contractor will be responsible for the maintenance and operation of the ECS, which includes ingesting, archiving, and distributing data products from NASA's Earth Probe missions and other sources.

Barnes asked if Landsat is included in the scope of the ECS contract. Rama responded that EOSDIS is responsible for archiving and distributing data from Landsat 7.

Esaias commented that he would be more comfortable if there were a milestone chart illustrating the transition from Version 0 to Version 1 software support of the DAAC. He asked if Rama has a schedule for that transition. Rama responded that there are currently 572 data sets which must be prioritized, and cost is the driver on that. He said he will determine the schedule based on the costs. However, he said, EOSDIS plans to support the DAAC with Version 0 at least until 1997.

1.13.4 ECS Actions

Rama announced the upcoming "early phase" ECS Actions, as outlined at the last Project Management Review. Over the next 12 months, EOSDIS has set the following goals:

- Hughes (ECS contractor) will become familiar with Version 0 DAAC software and the DAAC organization;
- Hughes will establish a development and prototyping facility and demonstrate initial prototypes;
- begin developing an algorithm interface toolkit;
- establish a liaison with the DAAC;
- begin analysis of new requirements;
- begin development of selected test criteria;
- conduct reviews of project management, system requirements, system design, and prototype results; and
- establish a hardware management team to procure the system.

Justice asked what action will be taken to solicit feedback from the instrument teams. Rama responded that the Focus Teams are the mechanism for soliciting feedback. He added that the reviews are all open meetings.

Justice said that as it stands now, the only interface between the instrument teams and EOSDIS seems to be through the DAAC. He feels that relationship is too "sketchy". McConaughy interjected that EOSDIS will have two mechanisms for receiving feedback—1) the ECS contractors will develop a Science Office with scientists to go out and visit principal investigators (PIs) in their environments; and 2) "in-house" people will talk directly to the instrument teams. McConaughy stated that each instrument team needs to make sure that it has representation among the Focus Groups.

Masuoka said he has been selected to represent the MODIS Science Team, but he will need plenty of lead time on actions items and activities, so that he may get viable input from team members.

Bob Evans emphasized that there has to be effective, two-way communication between the instrument teams and EOSDIS, which has been missing up to now. He said there have been two meetings to discuss science scenarios and none of the MODIS Science Team members were asked what they have in mind, what algorithms they require, or what they will need to assist them. In short, he said, the instrument teams have had no input. Evans feels it would be useful to establish an electronic bulletin board to keep the PI community informed on important deliberations. He is specifically interested in such topics as error handling, portability, error coding, and the PGS Toolkit and its execution environment.

Evans voiced a number of other concerns; such as, What does the PGS Toolkit support? Is it possible for the Science Teams' algorithms to exist within the PGS environment? Will the PGS Toolkit support a database from which algorithms can select parameters? Evans concluded that the PIs need to make their needs known or EOSDIS could evolve to the point where it is not responsive.

Rama responded that EOSDIS has an electronic bulletin board on which they post weekly reports. Michael King added that important information regarding EOSDIS is also included in *The Earth Observer*, the EOS newsletter.

1.14 CERES Reports

Bruce Wielicki, CERES Team Leader, gave an overview of the CERES instrument. He stated that CERES moves in azimuth as well as elevation to scan the Earth at all angles. CERES plans to develop angular models over the first year of its mission. CERES will also enable modeling studies and will observe cloud properties.

Wielicki showed a flow diagram of the CERES data products. He discussed interactions with other instruments and some of the technical aspects of CERES' products. CERES' Level 1 products will be based on the Earth Radiation Budget Experiment (ERBE) products. They will consist of instantaneous cloud-radiation products**,** and averaged

cloud-radiation products. Wielicki commented that CERES cannot identify clouds on a single pixel level, nor will it be able to unscramble in single pixels in multiple layers of clouds. CERES can flow the layering information horizontally to unscramble.

Wielicki said CERES needs to develop algorithms in concert with MODIS' algorithm development. CERES would also like to obtain MODIS' Level 1B radiances. He offered to make CERES cloud algorithms available for MODIS—CERES has a number of people who specialize in cloud remote sensing.

1.15 IDS Concerns

Yann Kerr, IDS principal investigator, briefly discussed IDS concerns. He said there needs to be more IDS involvement and interaction with the different instrument teams. Kerr feels that the proliferation of acronyms presents a communication problem.

Kerr suggested that the instrument teams produce some very basic products; i.e., radiance for users who know how to use the products. The instrument teams should also produce "specialized" products for less knowledgeable users. Kerr is also concerned about delivery time of products.

In summary, Kerr listed the following as products / processes he is interested in: surface reflectance / radiances, cloud identification, geometric processing, atmospheric corrections, accurate calibration, vegetation types and classification, and surface temperature. He also listed the following concerns:

- Are the algorithms proposed by people who are used to dealing with large data sets?
- Pixel registration;
- Who will provide a digital elevation model (DEM), and of what quality?
- Scan angle, because most of the data will not be at nadir;
- Links with other sensors;
- Validity of simulations;
- The need for other data products from other instruments;
- Preliminary data products;
- Participation in large field experiments should be a higher priority;
- Data availability (e.g., access, cost, delays, and reprocessing)

1.16 FINAL PLENARY

On Friday, March 26, the group reconvened for the Final Plenary Session. Salomonson began the meeting with a review of the new organization charts of NASA's Mission to Planet Earth.

1.16.1 Calibration Group Reports

Phil Slater announced that there will be a workshop on Atmospheric Correction of Landsat imagery on July 22.

Regarding image-based calibration of MODIS, Slater said there are still come points of concern, but much has been clarified between the Calibration Discipline Group and

MCST. The Calibration Working Group issued the following action items (see Attachment 7 for more details):
•Review the preflight solar-based calibration of SeaWiFS and the implications for MODIS;
•Review MCST's plans for MODIS calibration;
•Offer some preliminary suggestions for combining multiple data sets; and
•Analyze the stability of the SRCA for a duty cycle of greater than 20 percent to ensure that it is operationally capable.

Slater said he is concerned that too great an emphasis is being placed on image-based analyses. On the other hand, insufficient emphasis is being placed on the development of sensor models. He said we need a greater understanding through modeling of sensor instabilities. We also need to provide smooth transition, not step functions, in calibration coefficients as a consequence of sensor models. Additionally, Slater stated MCST needs to provide comprehensive error budgets.

Slater suggested using an integrated approach to calibration. He recommended implementing peer review of Level 1 MODIS calibration algorithms.

1.16.2 Atmosphere Discipline Group Reports

Michael King began his report with a discussion of the three MODIS channels currently not meeting specs (see Attachment 8). The Group feels that it is OK to relax the specs on Bands 27 and 29; however, Band 36 is more sensitive to SNR and he wants to make sure that there is no "roll off" on the dichroic beamsplitters.

King said the Atmosphere Group members will complete their ATBDs by the end of July (as a goal). He reported that no further funding is available from HQ to support Kaufman's proposed SCAR and Pre-SCAR experiments. Moreover, HQ wants Kaufman to secure all of the necessary funding before beginning the paperwork plans. King announced that there will be a planning workshop on April 27-28 for the SCAR and Pre-SCAR experiments.

Regarding the masking utility algorithm, King stated that MODIS will need greater use of the 1.38-µm and thermal IR channels in cloud screening. He said the Atmosphere Group will work closely with CERES to develop effective cloud masking procedures.

King said that it is necessary to generate a global MODIS simulation data set in close consultation with the entire team.

Bob Evans asked what impact the FY'94 25 percent budget reduction will have on MODIS. King responded that although the budget will be 25 percent less than requested, it will still increase by 36 percent next year.

1.16.3 Oceans Discipline Group Reports

Wayne Esaias announced that the launch of SeaWiFS will probably be moved back from Oct. 15 of this year to sometime in March or April of next year. Esaias showed the latest

flow diagram of MODIS Oceans data products and the latest accuracy tables (with caveats). Esaias asked if interim products would be archived. Salomonson responded affirmatively. (See Attachment 9 for more details.)

Esaias raised the possibility of merging EOS COLOR and MODIS Ocean products. He stated that Oceans Group needs access to OCTS (Japan's Ocean Color Temperature Scanner) Level 2 and 3 chlorophyll (and other) products (OCTS is a sensor on the ADEOS satellite). Salomonson asked what sort of grid sizes should be used. He tasked the Oceans Group to explore this topic further.

Esaias stated that the FY94 budget is a concern—if the Oceans budget is reduced to 75 percent of expected funding levels, it will impact SeaWiFS' obligations in support of MODIS' long-term science development. He said the MODIS Science Team members should define the impacts to MODIS as soon as possible. Of particular concern to Esaias are validation and delivery of algorithms and products for MODIS.

Ian Barton stated that there is a problem with Bands 31 and 32 going linearly up to 400°K because that would severely reduce the sensitivity of the SST measurements. He said we must either go back to a bilinear gain or shift one of the other channels to increase saturation temperature. Esaias added that stray light and bright target response could be a problem.

Esaias stated that Science Team members are highly significant users of the EOSDIS DAAC and should have more participation in the Focus Groups other than just adjusting data products. Al Fleig voiced his concurrence.

Esaias said that it is a good idea to have test sites at the EOS level. He feels optical test sites in the southern oceans are needed. He noted that the assimilation of all test and validation data are limited by budget constraints.

1.16.4 Algorithm Theoretical Basis Documents (ATBDs)

Salomonson instructed the Team members to tie their data products to instrument characteristics. In their ATBDs, Team members are to state how their products relate to MODIS' bands, specs, etc., and should also include error analyses. ATBDs are due by the end of July. (For more details, see Attachment 10).

1.16.5 Land Discipline Group Reports

Chris Justice began his report with a discussion of the MODLAND data products flow diagram (see Attachment 11). He said MODLAND plans to produce a "metadesign document" within 6 to 12 months that will explain the relationships between the products. Justice also discussed a chart listing the accuracies of the Land products.

Justice reported that the Land Group had a productive discussion with GE on pointing knowledge and is satisfied that it is recognized as a critical issue. He feels that GE will do better than spec. He suggested establishing a platform-level focus group—put

together by Michael King and Piers Sellers—to improve communication between GE and the Science Team.

Justice said he is concerned about continuous access to TDRSS (Tracking & Data Relay Satellite System). This is an EOS issue, not just MODIS. He also feels there is a need to discuss the specs for the EOS-PM platform. Alan Strahler said that there's an incorrect perception that there's no need to worry about pointing accuracy if ASTER does not fly on that platform. On the contrary, MODIS and MISR also have stringent pointing accuracy requirements.

Justice said that the saturation levels of Bands 31 and 32 need to be better than AVHRR. Weber interjected that a bilinear gain on MODIS is highly unlikely to be implemented now; it was never a requirement and to make it so now would be prohibitively expensive. Pagano added that dual gain was difficult to implement. Justice responded that this is a critical issue.

Barnes observed that we will get the 0.05 NEΔT that is required. Quantization noise is part of that spec—noise and quantizers are the same width. Now the Team wants to go below that. He feels that the Team is trying to get something out of the instrument they never asked for. Barnes felt that the Configuration Control Board (CCB) will not approve such a change at this point.

Regarding ancillary data requirements, Justice stated that more communication is needed between MODIS and the other instruments, as well as IDS. He noted that pre-launch global 1-km AVHRR data are currently being collected by EDC (EROS Data Center) as part of the DAAC activity. However, it is not clear how the data will be accessible to the Team.

This concludes the minutes of the Plenary Sessions. Following are highlights of the discipline group deliberations, when they met in session the second and (morning of the) third days.

2.0 ATMOSPHERE DISCIPLINE GROUP

Michael King began the Atmosphere Discipline Group meeting with a discussion of the MODIS data products flow diagram for the Atmosphere Discipline. David Herring was tasked to make several changes in the diagram.

The group also discussed accuracies of MODIS Atmosphere at-launch data products. Attachment 3 lists those products, their accuracies, and any important caveats associated with them.

2.1 MODIS Bands 27 and 29

Paul Menzel recalled that at the Plenary Session Tom Pagano, SBRC, asked for relief on Bands 27 and 29 because meeting specs on those bands will be difficult and could be costly. Menzel suggested that it is more important to accurately characterize spectral

channels than to keep them within spec. He feels it is okay to relax the spec for those bands. The Atmosphere Group concurred.

Regarding the Band 36 central wavelength shift problem, Menzel said that he is not concerned about the shift—he is concerned about lower than required transmission and its implication on reducing the signal-to-noise ratio. He feels it is too early to back off of specs for Band 36, but he recognizes that we may have to eventually.

2.2 Menzel's Reports

Menzel reported that seventeen ER-2 flights were conducted during the recently completed TOGA-COARE deployment. He obtained many cirrus data, as well as data on deep convection, radiation, and ozone. Menzel plans to summarize his work in a NASA technical memo, which will make the data more useful to other investigators.

As a result of his investigations of the 1.38-µm band, Menzel concluded that it is not possible to simulate that band using MAS. He did, however, test the 0.66- and 1.83-µm bands. He said 0.66 µm is "ambiguous"; it is not good for sensing high, cold clouds. The 1.83-µm senses high, cold clouds and filters out low- and mid-level clouds. He showed some image data to illustrate his findings.

Menzel said he compared different IFOVs of MAS cloud image data in order to determine the effects on cloud cover as a function of FOV. He compared 50 m, 250 m, 1 km, and 4 km, and concluded that good data can only be obtained using resolutions of 1 km or less.

There was a general discussion of possible channel configurations for using MAS to conduct the SCAR experiments. Kaufman and Menzel agreed to discuss this topic further and report to Ken Brown, of MCST.

2.3 STS Experimental Data

Bill Barnes announced that a 7-day IR experiment is scheduled for the Space Shuttle in 1994. The experiment will utilize a six-channel radiometer (in the IR) to gather very high resolution imagery data. He asked if the group is interested in obtaining any of the data, or in using the radiometer's spare channel. There was no interest.

2.4 Kaufman's Reports

Kaufman discussed his work in remote sensing of aerosols over land using dark targets. His objective is to locate dark targets using Mid-IR channels to which most aerosols are transparent. Kaufman and Lorraine Remer, of SSAI, wrote a paper on the relation of surface reflectance from 0.63 µm to 3.75 µm. He plans to use MODIS Mid-IR channels to identify pixels for the remote sensing of aerosols. He stressed the need for a global data set on aerosols, and surface properties.

Kaufman reported that he is also conducting remote sensing of aerosols over the ocean. His purpose is to retrieve the optical thickness as well as the size of the aerosol particles. He is also analyzing the relation of path radiance of aerosol properties at a scattering

angle of 120° and scattering phase function. His data should be operational this summer.

Kaufman is analyzing AVHRR data taken over Brazil to try to gain insights into smoke-aerosol interactions and aerosol-cloud interactions. Specifically, he is trying to determine how thinner clouds are affected by aerosols. Presumably, the higher the cloud top temperature, the thinner the cloud—assuming the cloud top temperature is not affected by the smoke-cloud interaction.

Kaufman announced that Bo-Cai Gao's paper on the 1.38-µm channel is forthcoming. This channel will be used for remote sensing of stratospheric aerosol.

He feels that EOS Project needs to develop a global data set to test the end-to-end operation of algorithms. He stated that the Team needs a realistic time frame for developing the algorithms.

Kaufman strongly recommends conducting MODIS simulations, and suggested the following procedure:

- Generate a global MODIS simulation;
- Conduct sensitivity studies to include all types of noise and distortion envisioned for MODIS;
- Develop the simulations in close consultation with the Science Team; and
- Perform an example simulation to include the following:
  - global AVHRR land local area coverage (LAC) data for January, April, July, and October;
  - oceans data using GAC (global area coverage);
  - artificial targets for performance simulations
  - MAS, AVIRIS, CZCS, and HIRS data; and
  - increased spatial resolution using local statistics.

2.5 ATBDs

King does not feel the ATBDs can be completed by July, 1993, but the group adopted that date as a goal.

2.6 Data Quantities and Storage Requirements

Menzel is the only member of the Atmosphere Discipline Group that has determined the storage requirements for his products.

2.7 Masking Utility Algorithms

King stated that he notified John Barker of Atmosphere's intent to expand the cloud mask utility algorithms beyond the VIS into the IR channels.

3.0 CALIBRATION DISCIPLINE GROUP

The MODIS Calibration Working Group Meeting convened at 8:25 am on March 23 at NASA / GSFC Building 22, Room 365. The chairman of the meeting was Phil Slater and the session recorder was Jim Butler.

3.1 MODIS Instrument Calibration

Jim Young, of SBRC, presented detailed information on the current status of MODIS calibration. Young emphasized that the one significant change to the MODIS calibration requirements is that the geometric characterization has been changed to 0.2 IFOV with a goal of 0.1 IFOV. Young also pointed out that the radiometic performance requirements for the MWIR and LWIR are more stringent than those for the visible reflectance bands. Young stressed that MODIS calibration will be based on a comprehensive set of characterizations that will be tied to NIST (National Institute of Standards & Technology) in as many ways as possible. The preflight, on-board, and vicarious calibration techniques will all be used in the calibration of MODIS. The calibration of the VIS and IR preflight calibration sources will be performed by NIST, the University of Arizona, NASA, and SBRC.

Regarding the on-board calibrators, Young stated that the Spectroradiometric Calibration Assembly (SRCA) will be used as the primary link between preflight and inflight calibration. The Solar Diffuser Stability Monitor (SDSM) may be used as a secondary tie between preflight and inflight calibration. The calibration of the SRCA will be transferred to the SDSM after launch and the SDSM will then assume the role of primary inflight calibrator.

With respect to the SDSM, Young expressed increased confidence in its ability to perform preflight calibration of the solar diffuser BRDF (bidirectional reflectance distribution function). With respect to BRDF, the assumption is being made that any degradation of the diffuser will be symmetric in nature. Therefore, the azimuthal angle at which the SDSM views the diffuser does not have to be exactly the same as the azimuthal angle at which MODIS views the diffuser. Young stated that because of its nice optical properties, the diffuser material will be Spectralon. Young also indicated that, per the request of the Science Team, the cooled SWIR detectors in the SDSM have officially been eliminated.

With respect to the SRCA, the issue of redundancy in the design was addressed. Young stated that redundancy is found in the number of lamps, the motor windings, and the radiant feedback / constant current monitoring system for the lamps. Young also pointed out that the SRCA is of limited value if it is used to calibrate MODIS in a preflight sense. That is, the SRCA cannot be used to measure spectral band registration in the along track direction.

Regarding the preflight thermal / vacuum testing of MODIS, the decision to make all thermal / vacuum measurements at one angle permits SBRC to build a dedicated MODIS T / V facility at SBRC. This will save the program money and time.

A detailed discussion was held on the possibility of ambient-to-vacuum shifts in the MODIS filters. Young presented some ETM (Enhanced Thematic Mapper) data on filters which were uncorrected and corrected for air-to-vacuum shifts. The residual error in the corrected data is being examined by SBRC for lamp temperature difference effects. Young also reported that the filters used in SeaWiFS employed ion bombardment manufacturing techniques and that these filters exhibited no shift from ambient to vacuum.

The issues of being able to operate the SRCA and/or SDSM extensively following launch were discussed. With respect to the SRCA, SBRC is currently assuming a 20 percent duty cycle. SBRC would need direction from NASA to examine the thermal effects of operation in excess of 20 percent. The SDSM could be operated extensively at the possible expense of exceeding the rated lifetimes of the doors which need to be opened and closed, and at the possible expense of more rapid diffuser degradation.

Young examined the preflight radiometric and reflectance accuracy budgets. SBRC believes that there is sufficient margin in the preflight radiometric accuracy, but the preflight reflectance accuracy may be difficult to meet. Young added, however, that the SBRC models predict that all budgets can be met.

The approach of using the SRCA to perform wavelength calibration was examined. Young stated that SBRC will make measurements over the whole band and will use a centroid analysis to find the center. Young also presented information on the SBRC design for the integrating sphere source in the SRCA. The approach of using phase delayed reticles in the SRCA to perform inflight registration checks was also examined.

With respect to the on-board blackbody, Young stated that the temperature uniformities of the blackbody operated at 13° K and at ambient are 0.2° and 0.03° K, respectively. The issues of Earth scene radiant temperature and alternative blackbody geometries were raised during this session.

The proposed SBRC design for the ground support equipment (GSE) was examined. SBRC proposes to place the collimator inside the vacuum chamber and the sources outside the chamber. Young produced designs of a new, tapered blackbody calibration source employing a low reflectance, specular anodized aluminum surface.

3.2 Atmospheres Group Calibration Perspective

Paul Menzel of NOAA/NESDIS presented the calibration perspective of the Atmosphere Discipline Group. Menzel stated that the Atmosphere Group would like to have any non-uniformities in the infrared background radiation and any nonlinearities in the detectors well calibrated and characterized before launch. The group would also like to know if there is a thermal characteristic to the spectral response function and if there is a functional dependence of the background radiation with scan angle.

3.3 MODIS Calibration Methodology and Level 1 Algorithm

John Barker spoke on the MODIS calibration methodology and the Level 1 algorithm. Barker stated that there will be one official calibration for MODIS. With respect to the MODIS scientific calibration requirement, Barker requested feedback from each group on the irradiance and radiance requirements for each product. Barker particularly requested the group examine the at-satellite radiance requirements of their products. He reviewed how MCST proposes to integrate information from various sources to provide an instrumental calibration for MODIS. He also produced a hypothetical prediction of the anticipated accuracies of MODIS based on radiometric characterization methods for the reflective bands as a function of time.

3.4 Required MODIS Calibration Documents and Meetings

Bruce Guenther requested that MCST provide information on the following three items to the designated groups: (1) the calibration methodology and finalized Level 1 algorithm to SDST by the next Science Team Meeting; (2) the calibration plan to the Science Team by September 1993; and (3) plans for the calibration peer review process to Guenther and the Science Team.

3.5 Methods for Combining Multiple Calibration Sets

Slater addressed a list of topics concerning MCST (see Attachment 7), including possible solutions to the questions of how to combine preflight, onboard, and vicarious calibration data, and how to assign relative weightings to these data. Slater presented a historical perspective on this problem. He stated that we must combine the precision of the frequently obtained onboard results with the absolute uncertainty of the less frequently obtained vicarious results. Slater also warned that this could be difficult to do given the numerous onboard MODIS methods which may provide the same level of uncertainty as the vicarious methods.

Slater briefly raised the question of overflight sites. With respect to the use of multiple calibration data sets, he identified three possible mathematical approaches. One is the linear least squares fit of relative calibration data in order to produce an offset. The second is a change in the position and slope of the curve to fit absolute calibration data. The third is a combination of the above two approaches. Slater recommended that (1) a review of the error budget for each procedure should be conducted, (2) auxiliary data—such as focal plane and calibration results—should be examined, (3) repeatability and trends should be considered, and (4) the number of days in orbit should be considered. He recommended a continuous analysis and reweighing of the data as it is obtained.

3.7 MODIS Cross Calibration Plans

Stuart Biggar addressed developments on the cross calibration radiometers and the projected role of the University of Arizona radiometers in these cross calibration plans. He reported that the radiometers will be used directly in the round-robin calibration of EOS instruments and in the calibration of those instruments which will be used to provide vicarious calibration, validation, and algorithm development to EOS instruments. Biggar stated that the University of Arizona proposes to build four radiometers spanning the 0.4- to 14.5-micron wavelength region.

3.8 MCST Action Items

John Barker reviewed outstanding action items, which were designated as closed, open, or as waiting on a response from the Project (Attachment 12).

3.9 Ocean Group Perspective on Calibration

Bob Evans presented the perspective of the Ocean Group on calibration. Evans stated that the SeaWiFS instrument will be an important prototype for MODIS. Evans also stated that participation in the SeaWiFS calibration round-robins has been very important. SeaWiFS will provide a set of working tools for MODIS and will provide important experience in the use of the sun and moon as calibration sources. The Ocean Group calibration requirements include spatial and spectral calibration, relative calibration between detectors, and absolute calibration.

3.10 Land Group Perspective on Calibration

Alfredo Huete presented the perspective of the Land Group on calibration. Huete designated pixel geolocation accuracy as the biggest calibration issue for Land. The Land Group has asked MCST to look at the problem of misregistration and to provide guidance in instrumental cross-calibration activities at Land sites used for product validation and quality control.

4.0 LAND DISCIPLINE GROUP

The MODLAND (MODIS Land) Group met during the afternoon of Thursday, March 24 and the morning of Friday, March 25. The primary issues discussed were data products, data accuracy and algorithm design, joint research with the atmosphere group, MODIS geometry issues, test sites, and data plans.

4.1 Data Products

On the Land Data Products Flow Diagram, Alan Strahler recommended the land leaving radiance at-launch product be retitled to “surface reflectance”. Surface reflectance is considered an improvement over surface radiance for calculation of surface properties. Strahler and Muller recommended that surface spectral albedo be derived for all MODIS bands at the same temporal frequency using the BRDF (bi-directional reflectance distribution function) derived from MISR.

MODLAND recommends holding an albedo product meeting with other instrument scientists (e.g., CIRES and MISR). Dave Diner wants MODLAND backing on the development of a 1.1-km MISR BRDF product in place of a 2.5-km product. MODLAND indicated a strong support for the MISR 1.1-km spatial resolution cell. A second draft of the MODLAND land cover product paper was given out by Strahler. Wan provided comments and suggestions for the MODIS emissive bands.

4.2 Data Accuracy & Algorithm Design Document

MODLAND developed an intermediate data product accuracy specification for the land products. The MODLAND group will develop an Algorithm Theoretical Basis Document (ATBD) this summer which will help further improve the accuracy

estimates. Piers Sellers said MODLAND should clearly flag potential problems with the data products. Justice said MODLAND should initially emphasize interactions between products. Important problems include clouds, atmospheric correction, digital elevation data, and geometric accuracy.

4.3 SCAR Workshop

Mike King, Yoram Kaufman, and David McDougal summarized plans for the Smoke, Cloud, and Radiation (SCAR) experiment for the eastern United States in 1993, and for Brazil in 1994 or 1995. The overall objective of the experiment is to study the radiative and physical effects of biomass burning on the atmosphere, and to prepare a comprehensive data set for the evaluation of remote sensing procedures from aircraft and satellites. The eastern U.S. plans include use of the MODIS Airborne Simulator (MAS) and Airborne Visible-Infrared Imaging Spectrometer (AVIRIS). There is a possibility that a MISR simulator may be placed in the nose of the plane. Chris Justice wants to obtain flight plans for the eastern United States in 1993 for possible modification to cover MODLAND or LTER sites. MODLAND has particular interest with the Harvard Forest and Virginia LTER. Additionally, further coordination for 1993 is needed with the Sun photometer network managed by Brent Holben. The Brazilian SCAR experiment is planned for 1994 or 1995. Additional work has to be conducted to secure funds and international arrangements with the Brazilian scientists. Kaufman will keep MODLAND informed.

4.4 MCST and SDST

MODLAND reviewed MCST data products. MODLAND wants MCST to focus on an accurate cloud mask. They are not generally supportive of MCST producing additional land cover type masks. Dorothy Hall wants to interact closely with MCST for snow cover derivations. MCST wants MODLAND to assist with MODIS sensitivity studies related to changes in sensor radiometry. Strahler said one approach for MCST is to use the MODLAND products at-satellite radiance, surface reflectance, normalized difference vegetation index (NDVI), and leaf area index (LAI) in a sequential mode to study the effect of increasing complexity for changes to the radiometry. MODLAND also would like MCST to address geometry-related issues. Townshend recommended a complete end-to-end system analysis to maximize efficiency of expenditures improving geometric and calibration accuracy.

Ed Masuoka and AL Fleig discussed SDST issues related to MODLAND. SDST wants general estimates from MODLAND on SCI versus SCF funding. They would like inputs soon for the software and data management plan previously given to science team members. MODLAND wants SDST to support MODLAND with the global 1-km AVHRR data set from EDC, serving as a prototype MODIS data set.

4.5 Test Sites and Data Plans

David Carneggie, from EROS Data Center (EDC), reported they are making significant progress on development of a global 1-km AVHRR data set over an 18-month period. The composite is to be completed this spring and will be available for the cost of reproduction. MODLAND needs raw data (300-400 passes) besides the composite.

EDC is also providing MODLAND with selected Landsat MSS and TM scenes. EDC needs a signed trade secret agreement for dissemination of Landsat TM data.

Forest Hall gave an update of BOREAS. MODLAND will use BOREAS to develop and validate algorithms. MODLAND wants to ensure BOREAS will include the MAS. Wan will give thermal inputs to BOREAS. Hall will address snow issues. Strahler is assisting with the biometry measurements. Steve Running should send a representative to the next BOREAS meeting.

Justice reported briefly on links to Long Term Ecological Research (LTER) sites and NASA plans. Sellers said the focus for MODLAND should be to emphasize only a few sites where comprehensive measurements may be derived. A major concern expressed by MODLAND is the need for development of a global DEM data set.

4.6 Geometry

John Townshend chaired a session with GE and SBRC on geometric-related issues affecting MODLAND. Terry Ford from GE summarized spacecraft geometric requirements and plans (See Attachments 13 & 14). MODLAND asked for clarification as to whether GE is under contract to provide NASA with detailed geometric models. MODLAND recommended reporting specifications at a 2-sigma level versus a 3-sigma level. Barnes reported that EOS-AM geometry is driven by MISR and ASTER. He said since MISR and ASTER will not be on subsequent platforms with MODIS, that MODLAND should soon provide specifications for EOS-PM.

Tom Pagano elaborated further on the overview presentation from Wednesday, discussing MODIS geometric issues. Pagano said the band-to-band registration requirement for the 250-m versus 500-m bands is at a 250-m specification. The goal is a 50-m accuracy for a 500-m cell (error is worse in the scan direction). MODLAND wants detailed information on static, systematic, and random geometric errors.

Fleig reported on the types of misregistration that can be modeled and the types that cannot. Diner said that real time specification of a 150-m accuracy in all axes is not formally in the system. Diner also reported that the TDRSS Onboard Navigation System (TONS) navigation is not guaranteed. Additionally, navigation-related complications may arise from TDRSS. Fleig said the final MODIS product geometric error is based on the success of modeling after launch. Justice stressed the need for SDST to continue to assess the use of image registration processing as part of the MODIS processing chain.

4.7 Future MODLAND Meetings

- BOREAS meeting in April. Running to see if Ray Hunt or substitute can attend.
- MODIS aerosol and atmospheric correction meeting in May in Greenbelt.
- BRDF meeting scheduled for June in London.
- September MODLAND meeting in Estes Park, CO, for LTER and land cover.
- Surface Temperature and ASTER meeting in November in Japan.

5.0 OCEANS DISCIPLINE GROUP

At the first meeting of the Ocean Discipline Group, the session chairman was Dr. Wayne Esaias and the session recorder was Dr. Jim Butler, both of NASA/GSFC. Esaias began the meeting by asking the group for suggestions and additions to a strawman agenda for the Ocean Group meetings.

5.1 SeaWiFS Update

Esaias briefly updated the group on the status of SeaWiFS. He presented the first SeaWiFS image taken at SBRC on March 8, 1993. It was reported that the first SeaWiFS files have been supplied to the DAAC and are available from Jean Feldman. Work is currently being done to provide the first image to the DAAC. The first image is ± 58° of scan with 400 lines. Interesting dark/bright features are seen in the image. Esaias stated that not only the first image but also information on SeaWiFS global coverage will be available through the DAAC. Esaias also stated that he has received some preliminary SeaWiFS spectral response analysis files. Esaias is waiting on the out-of-band response information from SBRC.

5.2 Ocean Data Products and Accuracies

Following a previous request from Salomonson, Esaias requested that the group review and revise as necessary the viewgraph on Simplified Ocean Data Product Interrelations. The group made several changes to the chart, including a designation of those products which have historical ties to CZCS and SeaWiFS. At-launch data products were clearly indicated. David Herring was tasked to revise the chart.

5.3 MODIS Oceans Level 2 Products

Esaias gave a brief evolutionary history of the list of Level 2 products. At SBRC, the products were identified as either at- or post-launch products. Then, the Technical Team asked the discipline groups to prioritize their products on a scale of 1, 2, or 3, with 1 being the highest priority.

5.4 MODIS At Launch Data Products

Esaias requested that the group list the Ocean Group's at-launch data products and place accuracies and caveats on these products. Headquarters would like to tie down the accuracies on these products and use them as Level 1 requirements as soon as possible. SBRC requested feedback on product accuracies and their implications at the instrument level. Tom Pagano, of SBRC, stated that he will be available for individual discussions on this. Both Kendall Carder and Howard Gordon expressed a need for instrument stability and careful calibration on an orbit-to-orbit basis. Gordon also expressed a concern with the optical ringing effect seen in SeaWiFS being a potential problem in MODIS. Pagano reported that MODIS will be extremely stable in single orbits and that all systematic error will be removed from the instrument. Pagano did express some concern with spatial effects, such as seeing 10 to 20 percent errors in high entropy scenes.

5.5 SCI/SCF Budgets

With respect to SCI/SCF budgets, it was reported that the budget will be higher than this year next year, but will be 25 percent less than expected. Locke Stuart will get budget feedback information to the discipline groups as soon as possible.

5.6 Algorithm Theoretical Basis Document

Esaias reported that Salomonson is hoping that the Ocean Group's document will provide a template or standard from which the other discipline groups can mold their documents. Esaias expressed the hope for generating a complete, coherent document from the Oceans Group.

5.7 Calibration Approach

Esaias expressed the need for the Oceans Group to meet with John Barker and his Calibration Working Group. The Group feels that the best way to calibrate MODIS well is to do a good job calibrating SeaWiFS.

5.8 Test Sites

Esaias stated that several good bio-optical sites already exist in the northern hemisphere and that the Oceans Group needs to make recommendations to the Project on additional sites that should be adopted. It was agreed by the group that two southern hemisphere sites that could be viewed in the same orbit would be very valuable.

5.9 Ocean Data Product Flowchart

The Ocean Discipline Group reconvened on Friday, March 26, 1993 at 8:30 am. Esaias began the meeting by presenting the revised Oceans Data Product chart as discussed the previous day; he asked the group for final changes. Primary productivity, IPAR, and clear water epsilon entries were polished and the chart was again returned to Herring for revision.

5.10 MODIS Instrument Concerns

The Ocean Group identified the major instrument concerns: saturation in Bands 31 and 32, MODIS bright target recovery, solar calibration for MODIS (similar to that done on SeaWiFS), and out-of-band problems surrounding the dichroics in MODIS.

5.11 Interim Data Products

Significant discussion was held on the storage of interim data products. The group wanted to know which products will be stored; how they will be stored; and for how long they will be stored. Bob Evans stated that the cost of the storage medium will essentially be the storage cost. Hughes is trying to set things up so that retrieval will be rapid.

5.12 1994 Budgets

Frank Muller-Karger requested input from the group to carry to the IWG on what the impacts the anticipated 1994 funding profile will have on ocean science. The group requested more information on the funding profile for 1994 before furnishing a final answer to the request.

Several areas were identified in which a 75 percent level of funding will potentially have an impact. These include the following areas which are related to data product validation and algorithm delivery: the primary productivity product, the dissolved organic carbon product, the interim products, and southern ocean validation activities.

5.13 Impact of SeaWiFS Delays on MODIS

The Ocean Group examined the potential effect of delays in the SeaWiFS launch on MODIS activities. Esaias stated that a 1-year delay in the SeaWiFS launch should have little impact on MODIS.

5.14 Algorithm Theoretical Basis Document (ATBD)

Esaias stated that he sees the document as being several smaller documents making up a larger document. The group listed 10 documents which will make up the ATBD document. Authors were assigned to each document.

5.15 Calibration

The group heartily endorsed having a meeting with John Barker, Phil Slater, and the Calibration Working Group to discuss instrument calibration and capabilities. Barker firmly stated that changes to the instrument calibration will be made only with a good scientific understanding of the instrument change. Changes will be made using redundant methodologies and all changes will be completely understood. The Science Team will be extensively briefed on the nature of the instrument change before implementation of the calibration change. The Ocean Group expressed a need to access the original instrument data along with the calibration data. Several members of the group stated that they will make a model of the instrument which they will change. The week of May 17 was earmarked as a good week for holding the meeting between the Ocean Group and the Calibration Group.

6.0 ACTION ITEMS

1. *Stuart*: Obtain a clear definition of SCI versus SCF funds from Carol Arkwright and EOS Project and forward to the MODIS Team as soon as possible. [Status: ??]
2. *Guenther*: Compile a list of already ongoing test site efforts and report to the Team {when?} on what georeferenced databases are available. [Status: ??]
3. *SBRC*: Report on calibration testing over hot targets at the next MODIS Science Team Meeting. [Status: ??]
4. *Herring*: Revise the MODIS Data Products flow diagrams for each discipline group and forward them to Salomonson prior to the IWG. [Status: Done]
5. *MODIS Discipline Group Leaders*: Produce a MODIS At-Launch Data Products List that details each product name, investigator, and accuracy prior to the IWG. [Status: Done]
6. *MODIS Science Team Members*: Tie your data products to instrument specifications {due date?}. [Status: Open]
7. *MODIS Science Team Members*: Generate an ATBD that describes the physics, mathematics, and computer program considerations behind your algorithms by July 30, 1993. [Status: Open]

8. *MODIS Science Team Members*: Forward your calibration requirements to MCST {due date?}. [Status: Open]
9. *MODIS Discipline Group Leaders*: Identify someone as soon as possible with whom MCST can work in order to relate the instrument to group products. [Status: Open]
10. *MODIS Science Team Members*: Let SDST know as soon as possible whom you plan to have validate your output products. [Status: Open]
11. *MODIS Science Team Members*: Report on the following to SDST as soon as possible:
•What do you really plan to put out for a product (Do you have anything SDST can use to scale its processing requirements estimate?);
•Review SDST's *Level 1A System Requirements Document* and forward comments/input back to SDST;
•Indicate what sort of simulated data you want and when you want it;
•Indicate who SDST should contact with questions/concerns regarding Team members' software development? (Also, indicate whether you want SDST to conduct a seminar to assist you in software development.) [Status: Open]
12. *MODIS Science Team Members*: Deliver your code to SDST by Jan. 1, 1994. [Status: Open]
13. *Herring*: Obtain information on how to access the EOSDIS electronic bulletin board and forward to the Science Team as soon as possible. [Status: Open]
14. *Calibration Discipline Group*: Review the preflight solar-based calibration of SeaWiFS and the implications for MODIS; [Status: Open]
15. *Calibration Discipline Group*: Review MCST's plans for MODIS calibration; [Status: Open]
16. *Calibration Discipline Group*: Offer some preliminary suggestions for combining multiple data sets; [Status: Open] and
17. *Calibration Discipline Group*: Analyze the stability of the SRCA for a duty cycle of greater than 20 percent to ensure that it is operationally capable. [Status: Open]
18. *Kaufman and Menzel*: Discuss possible channel configurations for using MAS to conduct the SCAR experiments and report any decisions to Ken Brown. [Status: Done]
19. *MCST*: Carry forward to the Project the recommendation that SBRC perform thermal analysis of the operation of the SRCA for duty cycles greater than 20 percent. It is desired by MCST that an extensive checkout of the SRCA be performed following launch to ensure its operability and stability. [Status: Open]
20. *MCST*: Carry forward to the Project the recommendation that SBRC examine the possibility of using the solar diffuser on every orbit. Use of the solar diffuser every orbit for a period of time following launch will ensure a rapid and complete transfer of the calibration of the SRCA to the solar diffuser and will minimize the chances of component failure affecting the calibration transfer. [Status: Open]
21. *MCST*: Carry forward to the Project the request that a contamination monitor be flown. Information from the contamination monitor will be extremely valuable in determining the operating times at which contamination will be minimized. [Status: Open]
22. *MODIS Discipline Groups*: Provide to MCST the specific radiometric, spectral, and geometric requirements placed on MODIS performance by your data products.

23. *Barker & Slater*: provide Guenther information on (1) how the calibration methodology will be used in generating the MODIS Level 1 algorithm, (2) the MODIS Calibration Plan, and (3) the MODIS peer calibration review process. [Status: Open]
24. *MODLAND*: Coordinate through the AM Platform Scientist to hold an albedo product meeting with other instrument scientists (e.g., CERES and MISR). [Status: Open]
25. *MCST*: Townsend recommended giving a complete end-to-end system analysis to maximize the efficiency of expenditures improving geometric and calibration accuracy. [Status: Open]
26. *Running*: Send a representative to the BOREAS meeting. [Status: Open]