MODIS Science Team Meeting
January 4-6, 2006
Radisson Plaza Lord Baltimore, Baltimore, Maryland

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First Plenary Session

Opening remarks

Vincent V. Salomonson, MODIS Science Team Leader

Welcome. I think you will find the meeting substantive and useful. Along with the presentations you will see and hear in plenary session and the discipline sessions, there are over 100 posters to review. The participation of several, key NASA Headquarters program managers is also very much appreciated.

All the instruments are performing nominally. Data processing systems are doing well. The GSFC DAAC is delivering level 1 products consistently and staying very close to real-time. The MODAPS is also doing quite well with forward processing about one day behind real-time. Collection 5 land and atmospheres processing is about to begin (atmospheres) or will begin in the spring (land). The Ocean Color Data Processing System (OCDPS) is doing well in processing and disseminating Aqua oceans products and will eventually assume Terra processing starting with SST and then be followed (tbd) by ocean color products

Terra has been approved by the Headquarters Senior Review panel for an extended mission into 2009. Thanks to Jon Ranson who was serving as the Terra Project Scientist for leading the proposal and presentation effort. Mark L. Imhoff has been appointed recently as the Terra Project Scientist.

It's hard to really convey the success of MODIS, but it is being used very heavily. In the Web of Science, 964 refereed MODIS-related publications to date are listed of which 310 were in 2005 versus 181 in 2004--a rapid growth in the last two years. At least 200 MODIS publications were presented at 2005 Fall AGU. The expectation is that results will continue to grow as the MODIS database that now stands at 6 years of Terra MODIS and 3.5 of Aqua MODIS continues to grow and as products improve though reprocessing, etc.

Opening Remarks

Paula Bontempi, NASA Headquarters MODIS Program Scientist

Dr. Bontempi welcomed everyone and expressed appreciation for their attendance and preparations for the meeting in terms of papers and posters. She reviewed the agenda for the meeting and noted, in particular, that the meeting would begin with the plenary sessions in which representatives from NASA Headquarters will talk about focus areas, key science questions and measurement needs. She expressed appreciation for these program managers taking the time to provide these presentations in that they will give all attendees including the MODIS Science Team insight into the various focus areas and activities into which MODIS science team efforts can now and in the future be expected to make considerable contributions. For example, the EOSDIS Evolution is occurring in support of measurements needs and application sciences national needs. There will be a poster session and the afternoon session will discuss MODIS science and application highlights. Day two will be the group discipline sessions, and day three will be a wrap-up plenary session.

The following presentations were made by NASA Headquarters Program Managers.

Climate Variability and Change, Modeling, Analysis, and Prediction

Don Anderson, Focus Area Lead, Climate Variability and Change

Please visit the MODIS Web site at
http://modis.gsfc.nasa.gov/sci_team/meetings/200601/plenary.php to view this presentation.

Carbon Cycle and Ecosystems

Diane Wickland, Focus Area Lead, Carbon Cycle and Ecosystems

Please visit the MODIS Web site at
http://modis.gsfc.nasa.gov/sci_team/meetings/200601/plenary.php to view this presentation.

Water and Energy Cycle

Jared Entin, Focus Area Lead, Water and Energy Cycle

Please visit the MODIS Web site at
http://modis.gsfc.nasa.gov/sci_team/meetings/200601/plenary.php to view this presentation.

Atmospheric Composition

Phil DeCola, Focus Area Lead, Atmospheric Composition

Please visit the MODIS Web site at
http://modis.gsfc.nasa.gov/sci_team/meetings/200601/plenary.php to view this presentation.

Weather

Jeff Halverson for Ramesh Kaka, Focus Area Lead, Weather

Please visit the MODIS Web site at
http://modis.gsfc.nasa.gov/sci_team/meetings/200601/plenary.php to view this presentation.

EOSDIS Evolution in support of Measurement Needs/Science

Martha Maiden, Program Executive for Data Systems, EOSDIS Evolution in Support of Measurement Needs/Science

Please visit the MODIS Web site at
http://modis.gsfc.nasa.gov/sci_team/meetings/200601/plenary.php to view this presentation.

Applied Sciences

Ron Birk, Program Director, NASA Applied Sciences Program, Decision Support through Earth Science Research Results

Please visit the MODIS Web site at
http://modis.gsfc.nasa.gov/sci_team/meetings/200601/plenary.php to view this presentation.

MODIS Land Sciences Review

Steve Running, University of Montana

The volume and array of MODIS science coming out is impressive. In the mid-1980s, when we first started planning MODIS, I remember thinking the day would come when we would see an array of MODIS science. The day is here, and the science users are not confined to the MODIS Science Team. We have reached "cruising speed."

Professor Running provided a summary of an array of science topics. Chris Justice will follow with land applications.

MODIS BRDF/Albedo products are being produced in an array of different resolutions. The CMG products can be used in global, continental and local scales. We have 5-6 years of time series.

Snow albedo is being used for data sets that use the NCEP model for weather forecasting. We can improve forecasts by improving albedo.

MODIS data were used to look at the fire-induced albedo change and its radiative forcing at the surface in northern Australia. Plotting burn scars shows that in Australia, fires change the surface albedo month by month. What does that mean for instanteous radiative forcing?

MODIS burn scar data are also used in wildfire disturbance analyses for burned area recovery. The forest service has a hard time defining the burned area for recovery management. MODIS burned area gives a measure of the intensity of the burn, not just the area burned. This is especially helpful when large areas are burned or lots of fires occur.

The ratio of LST to EVI as an annual composite gives you an LST dimension to change detection. If you map a biome type to temperature in west, the relationship is linear. LST can help map disturbances in vegetation.

MODIS 250 meter data were used to map persistent flooding and the extent of flooding after Hurricane Katrina.

MODIS EVI is being used to track the seasonality of vegetation and evaluate the growing season of the Amazon. The change in EVI quantifies seasonality between the wet season and the dry season in the Amazon. The EVI stays high through the dry season in the forest, which means you can infer root physiology from a satellite. Another piece of work shows seasonality in MODIS LAI in the Amazon. The seasonality is greater than what we expected from the rain forest. We're starting to follow seasonality of tropical rainforest in a way we never could before. The daily repeat time is crucial in monitoring seasonality.

The first global products for vegetation phenology for 2001-2004 were released this year. The products identify key dates in the growing season. Mark Friedl used the product to look at urban landscapes to see how cities impact phenology. He also quantified the temperature phenology. In Africa, phenology is driven by precipitation. In the high latitudes, phenology is driven by day length and temperature.

Kamel Didan and Alfredo Huete used a cumulative VI anomaly of the entire US to monitor drought in the Southwest. Vegetation dynamics changed in response to a global-warming-like temperature increase induced by a severe drought. The VI anomaly quantifies mountain vegetation versus valley vegetation.

MODIS did an excellent job quantifying the European heatwave of the summer of 2003. The anomaly in fPAR shows the heatwave very well.

Recent tests show that there is progress on the MOD16 evapotranspiration product.

We are developing an integrated MODIS-SeaWinds phenology measure and adding a passive microwave component to help us with the cloud problem. We are building in sensor synergism.

To do a terrestrial carbon monitor, I would want to get an annual measure of land cover change. I would want to understand the phenology of the growing session, and primary production. How do we start stitching these products together? We could do this now.

The NPP anomaly tells us how vegetation is doing. We can combine NPP maps with population maps to look at human vulnerability. NPP has decreased in over 80 percent of populated land areas.

What we have moved into next is forecasting. The Terrestrial Observation and Prediction System uses input from weather networks, satellite data, ancillary data, and climate and weather forecasts to provide daily gross primary production monitoring.

MODIS Land Applications Review

Chris Justice, University of Maryland

This presentation highlighted the uptake of MODIS data for applications of societal benefit and made some suggestions as to how the current NASA applications program can contribute to the emerging GEOSS initiative. It's important to recognize that most land applications require the use of data from more than one sensor and that the combination of MODIS and Landsat data provides a strong basis for land applications. For example, for land cover and land use studies, moderate-resolution (MODIS) daily data are used for change detection, while seasonal cloud-free high resolution (Landsat) data are used to measure the extent of the change.

The NASA Applications Program is focusing on the use of satellite data to enhance decision-making processes in partnership with operational agencies. To be effective in applying remotely sensed data, we need to understand the decision-making process in some detail, recognizing that the NASA data or model output, often provide just one input to the decision process. It is also important that the data products are validated and that the quality of the data is monitored. We also need a commitment to the decision support system in terms of the continuity of data products. If operational agencies are going to invest in using satellite data, then they will expect the data to continue to flow. Data continuity is a problem for research satellites, hence the need to identify the pathway to an operational data supply from the outset. The pathway to transition from research to operation is something that needs attention from the outset.

The NASA cooperation with the USDA Foreign Agricultural Service (FAS) on Global Agricultural Monitoring (GLAM) is providing an opportunity to test the 'transition to operations'. The FAS have a long history of using remote sensing, dating back to the NASA/USDA Agristars Program, which provided much of the foundation for agricultural monitoring. They use a number of time-sensitive inputs including remote sensing, in situ data and country level reporting to generate regular crop production reports. In partnership with NASA, the FAS is in the process of updating from AVHRR to MODIS, incorporating daily MODIS Rapid Response 250 meter data and have added Jason 1 and Topex/Poseidon radar altimeter data to monitor water levels of reservoirs and inland lakes. The MODIS data are being provided via an interface that allows analysts to investigate the multiyear time-series data record. The MODIS Rapid Response system also provides imagery for special events such as floods and droughts. In addition, new approaches are being explored for crop type mapping and monitoring using MODIS.

Another applications example was presented concerning near real-time MODIS fire monitoring in Africa. For this project, a collaboration has been developed between the University of Maryland, the CSIR Satellite Applications Center in South Africa and ESKOM, the South African utility company. ESKOM was interested in monitoring savanna fires which disrupt their electricity transmission lines. An Advanced Fire Information System (AFIS) was developed and tested using the South African MODIS receiving station, a web-based fire mapper, providing an email alert and SMS text messaging of fire locations. Results from the 2004 season showed a 30% drop in the line faults since the introduction of the system. MODIS SMS text messaging capability is being further developed through the newly funded, NASA Fire Information for Resource Management Systems (FIRMS) program with an emphasis on protected areas, in partnership with UNFAO and UNEP. Emphasis will be given to making data easily accessible in ways that users can view the data. An example was shown using Google Earth to display MODIS fire and terrain data for the Virungas National Park in Central Africa.

MODIS data are being used by a number of forest services both for monitoring both fires and forest change. Fire monitoring systems initially established in collaboration with the USFS Remote Sensing Applications Center (RSAC) have now been adopted by MODIS ground stations in a number of countries including Brazil, Russia, Mexico and Australia. In Australia, Sentinel, a MODIS web fire mapping system developed over the last three years in collaboration with the

CSIRO is now being transitioned to an operational organization, Geoscience Australia. In several countries, fire data are being combined from multiple satellite systems, including GOES, Meteosat, AVHRR and MODIS. At NASA GSFC, Sensorweb technologies are being explored using daily moderate resolution (MODIS) fire observations to target high resolution EO1 image acquisition. The MODIS burned area product will be available in collection 5 and it is anticipated that this will be used broadly by both the applications and science communities. When the product is released, it will be a Stage 1 validated product. There is also a direct broadcast version of the code under development. Through the international GOFC/GOLD program we are working with different groups around the world to validate the MODIS burned area product.

An example application the INPE DETER project was presented for forest change monitoring in the legal Amazon of Brazil. A system has been developed for the operational use of MODIS 250m change products for monitoring deforestation. The MODIS derived products are being used to supplement Landsat deforestation mapping efforts. A similar project was shown from the Central Africa Regional Project for the Environment (CARPE) program, where MODIS data are being used in conjunction with multidate, orthorectified Landsat data to show forest changes between 1990 and 2000.

Most land applications have been developed using Landsat data. The 1990 and 2000 global orthorectified Landsat data were major contribution to the science and applications community alike. NASA and USGS are currently developing a similar initiative for 2005. The challenge is to fill the expanding data gap resulting from the failure of the Landsat scanline coorector in 2003. In this mid-decadal global land survey, high resolution data from Landsat 5, ASTER, EO1 and composited Landsat 7 data will be used to provide global cloud free coverage. Landsat 5 data will need to be provided by the international ground station community. The international community continues to be a strong user and supporter of Landsat data. The emerging Global Earth Observing System of Systems (GEOSS) provides an opportunity for strengthening international collaboration and coordination. International issues are of increasing national importance. Opening up the global Landsat archive to free download for historical data would greatly facilitate regional land cover change studies and would be an excellent contribution from the USGS in the spirit of the GEOSS.

In summary there are a number of successful applications, nationally and internationally and NASA continues to make a significant contribution. MODIS is increasingly being used for land applications. Replacing the malfunctioning Landsat 7 needs to be given a high priority for the NASA land science and applications management. Until we have a land satellite mission agency, NASA will need to continue to develop strong partnerships with operational agencies at home and abroad. There are a number of applications which NASA is prototyping some of which are described above, which could provide some of the building blocks for the GEOSS.

Coastal Ocean Processes

Robert Arnone, Naval Research Laboratory

MODIS ocean products are being used to understand coastal ocean processes. These include:
1) Advanced ocean color bio-optical properties besides chlorophyll (CDOM, Detritus, particle scattering, phytoplankton)
2) Linking physical circulation models with MODIS bio-optical and SST properties in the Gulf of Mexico.
3) Linking the biological models with MODIS bio-optical properties in the West Coast.
4) Using MODIS ocean data for particle tracking of ocean features to predict and forecast ocean processes.

Because of recent advances in remote sensing, we can determine different components of water composition besides chlorophyll along the coast. We are developing algorithms to detect different optical components of surface waters using ocean color signatures. Coastal waters have very different components than ocean waters where chlorophyll is dominant. Optical signatures are able

to track coastal water masses using a RGB image of three of these components (i.e. CDOM, Detritus and phytoplankton absorption.)

Our research is extending into real-time applications. The tides, winds, and river discharge rapidly change the optical signatures in the coastal zone. Real-time applications require and we require some idea of conditions today. We take 3 sources of data into a weekly latest pixel composite. Black areas show where we have no data for the past week.
We are using near surface observations from MODIS combined with ocean circulation models from Navy Coastal Ocean Model. These models provide circulation, salinity, and temperature model for forecasting. The navy model used AVHRR for SST, but MODIS Aqua SST data improves the model resolution. This improved data set provides better resolution and improved accuracy in coastal regimes. We are now incorporating sea surface height data, salinity, current, and chlorophyll data to develop a "real time room" at the Naval Research Laboratory.

MODIS Band one at 250-meter resolution is being used with the PC tides model to provide a new capability for monitoring coastal processes in estuaries and rivers. We have developed algorithms to quantify the 250 m products to track turbidity changes on daily and seasonal scales. This new capability provides methods to follow the dispersion of river plumes. The 250-meter product shows a significant amount of detail on plume dispersion.

Besides physical circulation models, biological models are used with ocean color imagery for understanding ecosystems along our coastal zone. Our plans include using MODIS products of inherent optical properties of the surface waters to be used to constrain bio-optical models. We have demonstrated that MODIS chlorophyll products and the biological model chlorophyll output show similar patterns along the West Coastal US. We are looking at differences in magnitude that require constraining using the MODIS fields.

The satellite only sees the near surface. What happens below that? The biological model can derive the subsurface distribution based on MODIS surface observations. The results indicate that significant processes occur below the view of the satellite especially in coastal filaments along the west coast. Coupling the satellite with the models provided new methods to determine the processes influencing coastal fluxes.

We are forecasting ocean properties using MODIS products. A MODIS product of backscattering coefficient distribution was used to determine the density of particles. A forecast circulation model was seeded with the MODIS particle density to determine the image forecast of the backscattering image at 24 and 48 hours. This capability can be used for determine where Algal blooms are moving.

In summary, we have been looking at advanced color products, satellite products linked with models, high resolution MODIS products, coupling ocean color with biological models, and forecasting the ocean processes.

Ocean Carbonate Dynamics: finding a cure for POC envy

William "Barney" Balch, Bigelow Laboratory for Ocean Sciences

When people talk about carbon cycle science, they talk about POC, not carbonates, even though particulate inorganic carbon is one of the major particulate carbon pools.

Calcium carbonate is one of the major carbon pools on Earth. Particulate inorganic carbon (PIC) can be found in several forms, and makes the biological pump run faster due to its ballasting effect on sinking debris. At increasing depth in the sea, there is increasing fraction of the carbon as PIC (as opposed to particulate organic carbon, POC). For example, at 1 kilometer depth in the ocean, about half of the sinking particulate carbon is as PIC. PIC also absorbs dissolved organic matter and carries it to the sea floor in particulate form.

The biomineralization process in the ocean begins with dissolved bicarbonate and produces CO2 and calcium carbonate. The CO2 can go into the atmosphere or be fixed by photosynthesis. Global ocean acidification has been discussed because increasing CO2 is lowering the pH of the surface ocean. Carbon dioxide and seawater produces carbonic acid which dissolves calcium carbonate. This will happen first at the poles.

One of the most important biocalcifiers in the ocean are coccolithophores. There are many species with different optical properties. They enter into the marine food web. Zooplankton consume them. They produce massive ocean blooms. In the mid-1980s we started to look at blooms using satellite remote sensing. One south of Iceland covered nearly all of the North Atlantic. As far as carbonate and ballasting of organic matter, in the blooms you have the fuel for major movement of carbon into the ocean interior. The optical properties of PIC (high refractive index) mean that it is highly scattering. Coccoliths can be a first-order determinate of normalized water-leaving radiance (nLw), which is detected by MODIS. We are used to thinking about ocean radiance measurements from space being primarily driven by chlorophyll but this clearly is not the case. Calcite alone can account for 40-50% of the variance in nLw.

Two PIC algorithms exist: a two band and three band version. The two-band PIC algorithm partitions the variability between PIC and POC. The two-band algorithm is essentially a lookup table based on nLw at 440 and 550nm as input, and, based on the optical properties of chlorophyll-containing and calcite-containing phytoplankton, estimates the chlorophyll and PIC concentrations. The radiometric error of MODIS is 5%. The predicted error of the algorithm is larger because of variability in morphology in particles. The 3-band algorithm, based on wavelengths in the red and infra-red, works best in turbid water. It is least affected by high concentrations of chlorophyll and dissolved organic matter. A merged algorithm is being explored that switches from the two-band algorithm at low PIC concentrations to the three-band algorithm in highly turbid coccolithophore blooms and is showing great promise.

It is important to note that the he algorithms can be fooled by other scattering materials in the surface ocean waters, such as turbid riverine-impacted waters. The primary thrust of our MODIS work is to partition the difference between PIC, POC, and other types of scattering.

We are using a database of ship measurements. With chlorophyll research, measurements have been made since the 1960s. Few people have measured PIC, however. We have had to spend time at sea to build up the data base. We are comparing the algorithms to ships measurements show how binning at 36 kilometers makes a difference in the PIC estimates.

Higher PIC concentration measurements are still needed. Blooms are relatively rare, so why not create a "do it yourself" bloom. Chalk concentration is highly correlated to its backscattering. The average size of ground chalk from the White Cliffs of Dover (U.K) is about the same as coccoliths (indeed, it was originally produced from coccoliths!). We spread chalk over the ocean, and then used balloons to see a mid-scale view of chalk. Radiometers on the ship make the same measurements as

the satellite. Small patches have been created and captured using both MODIS' 1 kilometer ocean bands as well as the 500m and 250m land bands. Estimates of PIC from MODIS match well with the estimates from ship. From these results, we have been able to define the accuracy of the algorithms. The chalk dispersed in thin layers in these patches (but this is another story!).

We have been involved with the UK Atlantic Meridional Transect Cruises (UK to South Africa) to get data from the central Atlantic. We are still working through the data. In the ratio between chlorophyll and PIC, we saw peaks in north and south Atlantic gyres and at the poles with low values at the equator. Microscope counts verified that there were few detected coccolyths or plated cells at the equator, but higher concentrations at the gyres.

In the MODIS data, the pattern from July to September shows high values in the North Atlantic and the Pacific. We saw high values in the Southern Hemisphere from January to March.

We have been able to do a quantitative summary of global PIC for the first time. The Westerlies and the trades have the highest amounts, almost 70 percent of the PICs on Earth. Lower areas are in coastal and polar zones, but this is where we see all of the blooms.

Our paper was published in Journal of Geophysical Research, vol 110 (late 2005).

In summary, ocean calcite is an important part of the global carbon cycle. It is an important source of light scattering, can be quantified from space, and is becoming a major environmental issue as the oceans are being acidified with anthropogenic CO2. MODIS measurements will be instrumental for constructing global ocean carbon budgets.

Synergy of MODIS Deep Blue and Operational Aerosol Products with MISR and SeaWiFS

Christina Hsu, NASA/Goddard

Humanity has a long history of interfering with the environment. One of NASA's goals is to come up with an array of sensors to look at temperature, precipitation, irradiance, ozone and clouds. We need to understand if aerosols counteract greenhouse gas warming or make it worse. We need a product to reduce the uncertainty of aerosol forcing in the next IPCC report. Aerosols are complex and not easy to understand. They are highly variable spectrally, spatially, angularly, and temporally. We can't resolve for each type of aerosol, but we can look at the major types of aerosols.

Historically, people have been using AVHRR to get aerosol optical depths over the ocean. MODIS gives optical depth over land as well. It is a large improvement, but there are still gaps over bright surfaces. We have come up with a new algorithm called Deep Blue to fill in the gaps. We superimposed the channels that we used for MODIS with the GOME spectral reflectance over the Sahara as collected on a clear day to demonstrate the advantage of using the blue wavelengths to do aerosol retrieval. We have integrated this Deep Blue algorithm into the Aqua and Terra data set. The viewing geometry is different for Aqua and Terra than for SeaWiFS. We looked at seasonal differences in SeaWiFS and Aqua data to develop a surface reflectance data base. We ran the radiances through a cloud screening. If there are no clouds, we look at the reflectance for that location. We then compare reflectance to a library of aerosol types and match to either the aerosol type or mixed aerosols.

We calculated the mixing ratio between smoke and dust models to determine which best fits satellite radiance measurements.

Deep Blue works well. We can identify dust sources as well as infer spectral absorption of dust aerosols in bright regions such as the Sahara. This could be an interesting product for the ocean community as well because you can trace dust fertilization to a land source.

Validation over AERONET sites over North Africa as well as in the Persian Gulf show a good match. The region in the Persian Gulf is in particular complex with both dust and aerosols from an oil refinery and thus a good agreement between the Deep Blue and AERONET aerosol optical thickness over this region indicates that the Deep Blue algorithm is able to distinguish dust from anthropogenic fine mode aerosols.

The aerosol observation strategy is to perform the synergy through aerosol product intercomparisons and improvements of the retrieval products derived from various satellite sensors. Using this strategy we could reach a consensus of satellite aerosol climatology and thus reduce the uncertainty of climate forcing due to tropospheric aerosols.
With Deep Blue, the MODIS aerosol product tracks dust plumes over source regions much better than before. Deep Blue can also be used with SeaWiFS. We want to combine Deep Blue with MISR as well. MISR has a narrow swath, so it misses much of the dust event. Holes in the MODIS data in one case were caused when thick dust was screened out as cloud.

If you combine MODIS and SeaWiFS, you can track dust plumes throughout the day, three times a day. SeaWiFS goes to 1997, so we can generate a time series. VIIRS has the same channel needed for Deep Blue, so the time series can extend into the future.

Comparing MODIS and MISR monthly means show differences because MISR misses events (narrow swath) and because MODIS falsely attributes snow cover or clouds as aerosols. With Deep Blue, MODIS matches MISR composites more closely. The differences are all caused by large daily variability in AOT.

In summary, we spent more time with MODIS because MODIS is more complicated in terms of calibration issues. But after extensive testing, we can now provide good quality data of aerosol optical thickness over both land and water from MODIS.

Comparison of MODIS Radiances and Atmosphere Products with AIRS, MISR and Ground-based Measurements

Steve Ackerman, University of Wisconsin

Why combine observations? We can do radiance comparisons and product comparisons for validation. We can co-locate two data sets in time and space to come up with new retrievals. Combining observations can also offer new science insights.

Radiance comparisons of Aqua MODIS and AIRS can be used for climate. When you compare granules, there is a bias, but the discrepancies are fairly consistent. Bias appears to be dependent on temperature. How does that impact CO2 slicing? This will be discussed in detail in the atmosphere breakout.

In product comparisons we have compared cloud detection, cloud top pressure, water vapor and volcanic ash cloud. What is the detectable limit of MODIS and clouds? A combination of cloud physics lidar and MAS scenes suggests that the cloud limit is approximately an optical depth greater than 0.3. AIRS clear flag compared to MODIS cloud mask showed that 84 percent of the time, when AIRS thought the pixel was clear, 90- 100 percent of MODIS pixels were clear. In a cloud height comparison of MODIS versus AIRS over the poles, where cloud height is hard to measure with IR alone, MODIS sees clouds lower than AIRS. If we combine scenes we can try to get a high spectral resolution and high spatial resolution product.

Aqua AIRS and MODIS total precipitable water comparison matches fairly well.

With the ash cloud product, we need to estimate height of ash clouds for the FAA. MODIS CO2 slicing puts the plume lower than MISR, but the variability is similar. With emissivity correction applied, MODIS height goes up and matches MISR better.

We can combine retrievals such as the AIRS cloud detection and the MODIS 1 km cloud mask. If you co-locate a MODIS scene with an AIRS contaminated scene, you get a clear-sky scene. This gets you better temperature and moisture retrievals. It also helps improve radiances. If you assimilate only clear sky radiances, you don't get very many scenes to assimilate into models. Using MODIS gives you more scenes.

Combined observations can yield science insights. In a student project, they collocated smoke from a tire fire in MODIS data with AIRS data to see what is going on chemically in some of the fire smoke plumes.

At 6.7 microns, MODIS can detect mountain wave turbulence over Rocky Mountains where lee waves are present. Waves are frequently observed, but not all are turbulent. A specific pattern indicates turbulence, which aircraft should be avoided. Waves can also be seen in MODIS CO2 channels. What is causing this pattern? AIRS can see farther up, and AIRS has a larger footprint at 6.7 microns. The mountain waves are still visible, but not as well-defined. At 14.2 micron, the waves are still visible. The turbulent waves are vertically propagating. We are using the observations to work with model developers to help validate their simulations.

In summary, combining observations improves confidence in radiance, provides insight to physical processes, and helps mitigate weaknesses of a particular instrument.

Atmosphere Breakout Session (Day Two)

What is a Cloud According to MODIS

Steve Ackerman, CIMSS, University of Wisconsin

Steve Ackerman discussed the ability of MODIS to detect cloud coverage. Currently there is a difference of approximately 10% between satellite derived cloud amount and GCM global climatology. The detection of clouds is application dependent and is a function of the instrument capability and algorithm design. The cloud detection optical depth threshold limit is approximately 0.3. A comparison of MODIS & GLI vs HSRL cloud amounts is generally consistent, with total cloud fraction a function of the cloud optical depth. Cloud detection thresholds vary as a function of viewing geometry, scene illumination and thermal structure. Due to the dependence on these parameters and the use of different satellite instruments, it will be difficult to compare cloud amount products using different approaches and achieve the 1% accuracy needed for long-term monitoring.

Aerosol Radiative Forcing from Combined MODIS and CERES Measurements

Sundar A. Christopher and Jianglong Zhang, University of Alabama
Yoram Kaufman and Lorraine Remer, Goddard Space Flight Center

Sundar Christopher's talk examined the use of merged MODIS and CERES data to determine TOA aerosol radiative forcing. A method was developed to combine the use of satellite aerosol observations to derive aerosol forcing estimates over oceans, accounting for sample bias due to footprint size differences and inclusion of an aerosol angular model (a function of AOT, wind speed and fine mode fraction that facilitated study of anthropogenic aerosol forcing). Results are consistent with those determined using different methods - Global TOA aerosol radiative forcing of -5.3 +/- 1.7 Wm^{-2} and anthropogenic (fine mode) shortwave aerosol forcing of -1.4 +/- 0.8 Wm^{-2}. Future improvements will focus on all sky conditions, multi-year estimates, retrievals over land, MODIS/MISR/CERES fusion, and MODIS/CTM fusion.

Influence of Trans-Pacific Pollution on Cloud Microphysical Properties

Harshvardhan and Robert Green, Purdue University, and
Mian Chin, Goddard Space Flight Center

Harshvardhan discussed a work in progress investigating aerosol-cloud interactions for a cloud layer contaminated by pollution. Limitations within the cloud property retrieval algorithm can result in errors for cases where a layer of pollution overlays a cloud. The effect of these errors is an underestimation of the cloud optical depth and overestimation of the effective radius. Several cases studies of trans-pacific pollution episodes were presented, utilizing the multi-layer cloud flag in MODIS Collection 5 data in combination with GOCART model analysis. The results demonstrated that MODIS on Aqua and Terra, in conjunction with modeling efforts and field campaigns can play an indispensable role in narrowing the range of uncertainty in the indirect radiative forcing of aerosol.

Properties of Tropical Ice Clouds: Analyses Based on Terra/Aqua Measurements

Ping Yang, Gang Hong, Kerry Meyer, Gerald North, Andrew Dessler, Texas A&M University

Bo-Cai Gao, Naval Research Laboratory, and
Bryan Baum, NASA Langley Research Center & CIMSS

Ping Yang presented results on an effort to put satellite derived regional and global cloud properties in terms that the numerical modeling community would find useful. Using the ISCCP classification system for ice clouds, the particular focus of the study is the geographical distributions and seasonal variations of ice clouds, the relationship between cirrus clouds and deep convection and to provide PDFs and CDFs of cloud properties. A preliminary comparison of derived ice cloud properties from MODIS Level 3 1°x 1° daily products and ECMWF for ice cloud fraction, optical depth, effective emissivity, and cloud top temperature showed promise but further work is ongoing which should improve the comparison.

MODIS Observed Land Impacts on Clouds, Water Vapor, and Rainfall at Continental Scales

Menglin Jin, University of Maryland-College Park, and
Michael King, Goddard Space Flight Center

Menglin Jin discussed the impact of continental scale land features on the large-scale hydrologic cycle (clouds, rainfall, water vapor) using MODIS Terra/Aqua, TRMM, GPCP, and NCEP reanalysis data. Looking at continental scale features is important, as it is an index of the land impact on climate, which is critical for the testing of GCMs. The impacts on a continental versus hemispheric scale and land versus ocean were compared. Results of the analysis showed land mass enhances the seasonality of clouds, water vapor and rainfall but decreases the liquid cloud effective radius and cloud fraction.

3D Cloud Structure and Retrievals of Droplet Sizes

Alexander Marshak, Steven Platnick, Robert Cahalan, GSFC, and
Tamas Várnai and Guoyong Wen, UMBC, GSFC

Alexander Marshak presented results from a study of the effect of 3D cloud structure on the MODIS cloud droplet effective radius product. Ignoring sub-pixel (unresolved) variability produces a negative bias in retrieved effective radius and conversely, ignoring cloud inhomogeneity at scales larger than pixel scale (resolved variability)) leads on average to an overestimation of retrieved effective radius. A case study of a cloud scene over Brazil was analyzed and the 3D effects are shown to bias the retrieved cloud droplet effective radius product, however not all large effective radii are the result of a 3D cloud bias and may be real.

Dilemmas in Comparing Observations and Calculations

Richard Frey, CIMSS, University of Wisconsin

Richard Frey's talk examined difficulties in comparing observations and calculations of satellite radiances in the MODIS CO_2-slicing algorithm. For MODIS collection 4 data, MODIS found 5-10% less high, thin clouds than HIRS at mid-latitudes and Level 2 data showed that thinner cirrus was often retrieved as middle or low cloud. Using MODIS collection 5, a calculated clear-sky radiance

bias correction (function of geographic region and band) was applied and contrary to expectations, yielded non-physical results. This indicates the clear-sky radiances are too warm, which is consistent with MODIS LWIR observations being warmer than AIRS. A solution is to apply an "instrument" bias correction for each band which greatly improves the results. Currently this method only relevant to Aqua as there is no easy way to compare global radiance observations with another LWIR instrument (no AIRS on the Terra platform).

MERIS Surface Albedos from Data Fusion with MODIS BRDFs and Data Dissemination using DDS and OGC

Jan-Peter Muller, University College London,
Carsten Brockmann, Marco Zühlke, Norman Fomferra, Brockmann Consult, GKSS, Hamburg,
Jürgen Fischer, Réné Preusker, Thomas Schröder, Freie Universität Berlin,
and Peter Regner, ESRIN, Frascati, Italy

Jan-Peter Muller discussed the development of MERIS spectral and broadband land albedo as an example of fusion at the processing/algorithm level between products from different space agencies. An important product for GCMs, the land albedo as retrieved from MERIS using the MODIS BRDF product as in input was described. An inter-comparison of MERIS, MODIS, POLDER2 and MISR albedo products displayed, in general, good agreement. MISR was consistently higher than MERIS and MODIS, but MODIS and MERIS had good agreement for common spectral bands. Several issues with POLDER2 georeferencing need to be addressed before a proper inter-comparison can be conducted.

Ground-based Measurements of Surface Reflectivity and Emissivity over Desert Regions

Si-Chee Tsay and N. Christina Hsu, Goddard Space Flight Center,
Q. Jack Ji, Richard Hansell, and Myeong-Jay Jeong, UMCP, GSFC

Si-Chee Tsay presented results from several ground-based instruments designed to measure the surface reflectivity, skin temperature and emissivity over desert regions in order to provide quantification of accurate boundary conditions for numerical models and remote sensing retrievals. Measurements of bi-directional reflectance from the UAE desert collected with an ASD radiometer compared well with collocated satellite measurements (MODIS - Terra & Aqua, Deep-Blue data base). The surface skin-temperature as measured by a thermistor device attached to the Scanning Microwave Radiometer (SMiR) agreed within +/- 5K with MODIS - Terra & Aqua daytime retrievals. Better agreement can be achieved with nighttime retrievals. These lead to the inferred microwave emissivity of +/-4% uncertainty, which is not of sufficient accuracy for retrieving atmospheric temperature and humidity profiles.

Towards a Global Aerosol Climatology using MODIS Observations

Lorraine Remer, Yoram Kaufman, Rich Kleidman, Rob Levy,
Shana Mattoo, Charles Ichoku, Vanderlei Martins, and Allen Chu, GSFC
Didier Tanré, Université des Sciences et Technologies de Lille
Rong-Rong Li, Naval Research Laboratory, and
Ilan Koren, Weizmann Institute of Science

Lorraine Remer provided an update on the status of the MODIS aerosol algorithms and development of a global aerosol climatology. Validation using AERONET has produced excellent results, although several issues remain for MODIS retrievals over land. Over ocean, MODIS derived AOT and fine mode fraction are well-correlated with AERONET. A similar good agreement is seen versus POLDER aerosol products. Terra and Aqua estimates of global AOT agree to better than 1%. MODIS aerosol products are of sufficient quality that numerous recent publications have used the data for radiative/climate forcing estimates. A new algorithm for retrievals over land, including a new inversion scheme for better fine mode weighting, new aerosol models and distributions and new land surface parameterizations is nearing completion and ready for implementation.

The Effect of Smoke, Dust, and Pollution Aerosol on Cloud Cover and Height Derived from MODIS

Yoram Kaufman and Lorraine Remer, Goddard Space Flight Center
Ilan Koren and Yinon Rudich, Weizmann Institute of Science
Daniel Rosenfeld, Hebrew University of Jerusalem

Yoram Kaufman discussed the impact of smoke and aerosols on MODIS cloud products, focusing on 1) Smoke inhibition of cloud formation over the Amazon, 2) aerosol effects on shallow clouds over the Atlantic Ocean and 3) aerosol effects on convective clouds over the Atlantic Ocean. MODIS is in a unique position to measure the correlation of aerosol AOT and properties to cloud cover and height. Aerosol was found to increase cloud coverage by 0.05, which corresponds to an aerosol forcing of 6 Wm^{-2} in the June-August time period over the Atlantic. An average increase in cloud height of 400m was also found. Model calculations show that the long-term aerosol cooling over the ocean may compensate for the aerosol effect on cloud cover through aerosol-cloud interactions.

Characterization of Aerosols using Airborne Lidar and MODIS

Richard Ferrare, Edward Browell, Syed Ismail, Gao Chen, NASA Langley Research Center
Yoram Kaufman, Mian Chin, NASA Goddard Space Flight Center
Vince Brackett, Carolyn Butler, Marion Clayton, Susan Kooi, Marta Fenn and Anthony Notari, Science Applications International Corp. (SAIC), LaRC,
Phil Russell, NASA Ames Research Center
Jens Redemann, Beat Schmid, Bay Area Environmental Research Institute,
John Livingston, SRI International,
Antony Clarke, University of Hawaii,
Jean-François Léon, Laboratoire d'Optique Atmosphérique, CNRS

Richard Ferrare's talk centered on the retrieval of aerosol extinction and optical thickness profiles from lidar data for use in combination with MODIS data to: obtain information regarding the vertical distribution of aerosol properties, such as size and fine mode fraction, identify aerosol types vs. altitude, and evaluate the ability of the GOCART model to simulate aerosol extinction profiles and aerosol type. Aerosol optical thicknesses derived from MODIS data were used to help constrain the airborne lidar retrievals for data acquired during the TRACE-P (2001) and INTEX-NA (2004) field campaigns. Initial comparisons from INTEX-A showed good agreement between the lidar retrievals of aerosol extinction profiles and corresponding profiles derived from airborne Sun photometer and in situ data. GOCART simulations of aerosol extinction profiles from several days during TRACE-P were evaluated and showed good agreement with lidar retrievals. An example of how the lidar

extinction and backscatter color ratio and depolarization measurements can be used to infer aerosol type and evaluate the GOCART simulations of aerosol composition was also presented.

Impact of 3D Clouds on Aerosol Retrievals

Guoyong Wen, University of Maryland-Baltimore County, and
Alexander Marshak and Robert Cahalan, Goddard Space Flight Center

Guoyong Wen presented results of a study of the impacts of enhanced diffuse radiation from 3D clouds on the MODIS aerosol retrievals. Using MODIS cloud product and the brightness temperature to construct the realistic cloud optical properties in a cumulus field in Brazil, he computed the radiation field using a 3D radiation model. He found clouds strongly enhance clear sky reflectance nearby compared with that from a 1D operational model. This shadowing and diffuse enhancement influences reflectance such that the reflectance of any given clear pixel depends on the distance from nearest cloud and the optical depth of the cloud. The diffuse enhancement due to clouds makes the clear region nearby appear brighter, and introduces errors in 1D aerosol retrievals. Further analysis is performed to an ASTER image to resolve the MODIS unresolved scales. Estimated errors in 1D AOT are large. Analysis shows that aerosol optical thickness is about 0.11 and 0.27 at 0.67μm and 0.47μm, respectively, rather than 0.2 and 0.4 from MODIS retrievals in an open area of Cumulus.

Simultaneous Retrieval of Aerosols and Marine Parameters in Coastal Waters using Classical Inverse Methods

Knut Stamnes, Wei Li, Kexin Zhang, Hans Eide. Matteo Ottaviani, Stevens Institute of Technology,
Robert Spurr, RT Solutions Inc.,
Wenying Su, Langley Research Center, Warren Wiscombe, GSFC, and
Jacob Stamnes, University of Bergen

Knut Stamnes discussed an inverse modeling approach using a coupled atmosphere-ocean radiative transfer model (CAO-LDISORT) to retrieve ocean color and aerosol parameters. The technique utilizes a direct comparison of measured satellite data with simulated values using chi-square minimization in an iterative inversion scheme allowing simultaneous retrieval of atmospheric and marine parameters combined in one state vector. A comparison of SeaWiFS retrievals using the "old" Look-up Table method and the newer Optimal Estimation method displayed improved residuals for the new method. A further advantage of the new method is the facility for extensive error budget studies.

Simultaneous Retrieval of Aerosol and Surface Properties from a Combination of AERONET and Satellite Data (MODIS/MISR/POLDER)

Oleg Dubovik, Alexander Sinyuk, Brent Holben, Tom Eck, GSFC
François-Marie Bréon, LSCE/CEA, France
John Martonchik, Jet Propulsion Laboratory
Eric Vermote and Jean-Claude Roger, University of Maryland-College Park
Ilya Slutsker, Science Systems and Applications (SSAI)

Oleg Dubovik presented recent improvements in the retrievals of aerosols and surface properties using combined AERONET and satellite data, as fewer assumptions are required for simultaneous

retrievals by combining up and down looking observations. Retrieved properties include aerosol size distribution, complex refractive index, surface BRDF and albedo. The algorithm produced good agreement for surface parameters as derived from AERONET combined with MODIS, MISR and POLDER, and improvements in aerosol retrievals. This approach proved particularly useful over sites with complex surface structure.

Principal Component Analysis of the Evolution of the Saharan Air Layer and the Transport of Dust: Comparisons between MODIS Retrievals and a CARMA Simulation

Sun Wong and Andrew Dessler, Texas A&M University
Peter Colarco, Goddard Space Flight Center

Sun Wong discussed a comparison between MODIS retrievals and CARMA simulations of Saharan dust transport over the Atlantic. Two transport pathways were investigated, west into the mid-latitude Atlantic, and northwest into the north Atlantic. The onset and the direction of Saharan dust transport can be diagnosed by two indices obtained from EOF on the NCEP 850 hPa T field. Transport of Saharan dust simulated by CARMA and retrieved by MODIS show general consistency. EOF-2 (the transport direction) is significantly correlated (–0.5) with the daily west African monsoon index. AIRS T data permits following the warm anomaly and agrees well with NCEP data.

Polar Winds from Satellite Imagers and Sounders

Jeff Key, NOAA/NESDIS, University of Wisconsin, and
David Santek, and Chris Velden, CIMSS, University of Wisconsin

Jeff Key updated progress on recent refinements in the MODIS winds retrieval method. A parallax correction is being tested, and Terra and Aqua MODIS data streams will be combined. The MODIS winds are used operationally by seven NWP centers in four countries. MODIS winds are also calculated at the McMurdo, Antarctica DB site, with more sites to come. Methods to calculate thermal winds from sounders are being refined. Case studies have been performed with AMSU. TOVS winds have been calculated for a 20+ year period. MODIS winds will be used as a boundary condition in the AIRS thermal wind approach. Historical AVHRR winds are being merged with TOVS winds.

Using MODIS and AIRS for Cloud Property Characterization

Jun Li, CIMSS, University of Wisconsin

Jun Li presented new products derived from combining AIRS and MODIS products, taking advantage of the spatial resolution cloud masking from MODIS and the high spectral resolution infrared sounding capability of AIRS. The high spatial resolution cloud mask products of MODIS were used for AIRS sub-pixel cloud characterization, while the MODIS clear radiances within AIRS partial cloudy footprint were used for AIRS cloud-clearing. The combined MODIS and AIRS data demonstrated the ability to provide good cloud properties (cloud-top pressure, optical thickness, particle radius) for nighttime measurements, and quality AIRS cloud-cleared radiance spectra for sounding retrieval under cloudy skies.

Using the MODIS Fire Count Data as an Interim Solution for Estimating Biomass Burning Emissions of Aerosols and Trace Gases in the GOCART Model

Mian Chin, Goddard Space Flight Center

Tom Kucsera, Louis Giglio, Science Systems & Applications (SSAI), and
Thomas Diehl, University of Maryland-Baltimore County

Mian Chin discussed the using the MODIS fire count product to estimate emission. The quality of GCM simulations critically depends on the accuracy of aerosol and trace gas emissions. Biomass burning emission estimates are highly variable in time and space, thus hindering compilation of a climatology for use in a GCM. The use of MODIS fire count data as a near real-time estimate of global biomass burning emission is explored. Initial results of GOCART total aerosol optical thickness simulations look promising and comparisons with MODIS and AERONET are in progress.

Level-3 Gridded Atmosphere Products: Updates for Collection 5 and MODIS Atmosphere Web Site: Overview, New Features, & Metrics

Paul Hubanks, Science, Systems and Applications, Inc.

Paul Hubanks summarized updates to the L3 Scientific Data Sets for Collection 5, including improvements in the L2 algorithm for reduced snow contamination in over-land aerosol retrievals at snow/ice edge, deletion of flux products, addition of cloud fraction derived from aerosol cloud mask, and renaming of cloud products. No know bugs have been detected in L3 software. A software patch to correct the sub-sampling/dead detector issue has been applied.
Recent changes to the MODIS-Atmosphere web site include the posting of detailed collection 5 change summary documents and a greatly enhanced QA Plan document for Collection 5.

Land Breakout Session (Day Two)

Vegetation and ecosystems products

Steve Running, University of Montana

- Systematic products: add soil moisture to current products. Although it is not a MODIS product it is necessary
- Exploratory products that are valuable, but are not ready for delivery as standard MODIS products for global implementation:
    - Vegetation structure
    - Aerodynamic roughness
    - Water content
    - Canopy biogeochemistry
    - Carbon: daily NPP and annual NPP are merely the first step. Biomass is also necessary. Must separate photosynthetic from non-photosynthetic and live from dead
- The status of Vegetation Indices was discussed within the group
- LAI improvements: additional detail from MISR was suggested as a potential benefit but must be weighed with the cost of increased uncertainties
- The group felt that they spent a great deal of time discussing if exploratory variables could become systematic and how this could be accomplished

Surface radiation balance products

Simon Hook, Jet Propulsion Laboratory

- Additions and clarifications (to existing product list)
    - Need detailed description of products, including references
    - Need consistency checks including physical, temporal and spatial dimensions
    - Requirements must be spelled out in detail. There was some discussion about the proper way to do this: objective vs. threshold
    - Archiving requirements including validation data must be worked out
    - Products need to be global (long-term) as well as regional (short-term)
- Writing assignments: Products were assigned to team leaders for fleshing out. These include LST, LSE, BRDF/albedo, PAR/solar radition, snow, soil moisture, sea ice extent, freeze/thaw extent, and fluxes

Land cover products

Jeff Masek, Goddard Space Flight Center

- Focused on science data objectives
- Integration of data sources
- Continuity
- Land cover product issues
    - Land cover continuity- need compatibility with VIIRS
    - Standard classification needed. Classifications should be hierarchical and able to be cross-walked with other systems
    - Continuity of training data. Algorithms must be robust enough to accommodate new training
    - Both 500 m and 1 km resolution products needed by users

    - Need additional classifications: C3/C4, crops, improved forest classifications, wetlands
- Continuous fields issues (similar issues as land cover)
    - Capacity to produce custom products is needed, such as wetlands, inundated forests
    - Need for 30 m global land cover but at coarse temporal resolution (5-10 years)
- Land cover change issues
    - Less 'mature' than the other products
    - Need 30 – 50 m resolution with 1 year revisit times
    - Use VCC/VCF to flag changing areas to reduce the number of high resolution scenes required
    - Need to be consistent with fire products
    - Must enforce uniform approaches across regional efforts
    - Must differentiate between disturbance (natural and sometimes ephemeral) from conversion (anthropogenic and sometimes permanent)
    - Requires a continuity products
- Other issues
    - Phenology needed but is immature
    - Structure – needs a new satellite. Cannot be addressed systematically with current suite of sensors.
    - Land use is needed but difficult to define and produce
- Future needs
    - Accuracy assessments
    - User community needs assessment
    - Ad-hoc products that match roadmap objectives

Fire products

David Roy, University of Maryland

- Systematic products
    - Active fire product – 1 km global, 24 summary with overpass time and instantaneous radiative power
    - Fire affect area product: 500 m globally, monthly, 30 m regionally, periodically
    - Need fusion between the two products
- Retrospective data sets
    - AVHRR 1 km active fire GAC and LAC
    - GAC & LAC
    - All are patchy and perhaps not useful
- Accuracy of fire products
    - Active fire product accuracy is a function of subpixel fraction burning and fire temperature
    - Fire affected area product area is a function of fraction burned and combustion completeness
- Associated data: validation
    - Active fire detection needs higher spatial resolution
    - Fire affected area needs higher spatial resolution
- Associated data: exploratory
    - Fuel load and type
    - Moisture
- Systematic fire product applications
- Product prerequisites
    - Active fire needs: Mid-IR, better geolocation, thin cloud mask
    - Fire affected areas: needs better geolocation, thick cloud mask

Ocean Breakout Session (Day Two)

Headquarters Overview

Paula Bontempi, NASA Headquarters MODIS Program Scientist

Thanks for coming. I tried to go over the notes from the last meeting and summarize the actions that came out of that meeting. Today is a discussion session, not a formal session. The algorithm status reports will be this afternoon. Tomorrow we will come up with a list of recommendations for the plenary session.

Yesterday morning's session provided some information about what you might expect to see in the EOS recompete. It shouldn't be a surprise that we need to focus on the integration of observations. There should have been some insight into the synthesis of observations between sensors. Copies of everything will be available.

In March of last year, I gave an overview of the fiscal 05 budget. There were large cuts. What happened was that the MODIS team lead was cut 3%, algorithm refinement and science data analysis were not cut. If you are missing funds from your 05 increments, let me know. FY06 not clear, but I don't think there will be any cuts.

MOBY is scheduled to end in March 2007. Present funding will keep things going until March 2007. How do we want our deep water site to change? We also need a plan for coastal calibration. What happens to MODIS and SeaWiFS ocean color calibration if MOBY goes away? We need to plan for next generation of calibration.

Efforts are underway to fund a field campaign for an optical closure experiment.

We need a comprehensive plan for calibration integrated with the programmatic advanced plan.

Discussion:
MOBY is an essential part in coastal calibration as well. I haven't seen a case for why MOBY doesn't work in coastal waters. We need MOBY to calibrate the sensor and a coastal instrument to calibrate the atmosphere. NOAA is pushing forward the plans for the GOES R coastal water imager. They are planning 3 campaigns in advance of the launch of GOES-R. The experiments are development, proof of concept and risk management for GOES-R. It is organized through Oregon State and Curt Davis.

Paula Bontempi:
Giulietta will talk more about the web site that lists cruise opportunities.

This is one thing we should think about for ROSES 2006. We will still hold workshops as needed, but there should be more science team review meetings. We may want to set up a monthly telecom. We need to come up with a method for ATBD reviews, and we need to think about integrated efforts.

You heard from Don Anderson about modeling. Some efforts are underway under the MAP NRA. Look at interdisciplinary funding.

Outreach is not doing well. I need copies of publications that may be newsworthy. It's important to get our message out. There are funds to do more than a press release, but we need early notification.

We should discuss the actions taken at previous meetings, MQABI will be addressed later. Has the out-of-band response issue been resolved? The productivity algorithm should also be discussed.

As for advanced planning, the science questions for the OBB program advanced plan are about ecosystems, carbon, habitats, and hazards. We are developing talking points. We are working with the technology group to define what we need in terms of sensors to address the science questions. The draft plan will be available in late March or early April. It still needs calibration ideas.

Notes/Action Items from last meeting and OBPG update

Charles McClain, NASA Goddard Space Flight Center and Oceans Group Leader

The processing group has been very busy. A number of action items came out of the algorithms workshop which we have been working on. Since the meeting we reprocessed Aqua and SeaWiFS. We promised the community that we would leave our hands off the algorithms for a year or so. The queue of improvements is still developing. In collaboration with Bob and Peter, we have recommended a strategy for phasing SST processing from MODAPS to the Ocean Biology Processing Group (OBPG). The transition is moving well. We have implemented a couple of the evaluation products, including the FLH and calcite products. We have a year's worth of each available for comment. Some of the people working in estuarine systems want to be able to use high resolution bands on MODIS. We will be incorporateing these into SeaDAS by this summer. On the polarization working group, Ken has a poster on the results of that work. In the queue for our test processing is using the polarization tables that came out of this process to see what they do to the products.

Algorithm evaluations are underway. The chlorophyll-a workshop will be discussed later. Various improvements to absorbing aerosol detection, the coccolithophore flag, atmospheric corrections over turbid water and cloud mask algorithms have been pursued since the last MODIS team meeting and the spectral optimization scheme was implemented in MSL12 in collaboration with University of Miami team members. The Lee spectral KD and quasi-analytical algorithms are in SeaDAS.

CZCS reanalysis activities are moving forward.

NPP VIIRS testing is moving forward. On the data system and algorithm evaluation side, we are collecting as much pre-launch information as possible.

In terms of data quality, we need to be aware of errors because they affect products.

One of the MODIS-SeaWiFS processing topics is the differences between MODIS 548 nm and SeaWiFS 555 nm bands. The other issues are the 510-555 band ratio in the SeaWiFS chlorophyll algorithm that isn't available for MODIS. To test the MODIS polarization uncertainty, evaluations using modeled polarization sensitivity tables are underway.

Data quality improvements will be incremental.

Data processing and distribution

Gene Feldman, NASA Goddard Space Flight Center

Several months ago I notified the community that SST processing was moving from Goddard DAAC to us. We established a process for forward-stream processing. There are two problems for SST, MODIS SST and the new GHRSST product. The binning methodology has been resolved. Once we verified that Level 2 was consistent, we began reprocessing. By the end of the month, the complete Aqua data set will be available on the ocean color web. At this point, MODAPS will cease production of SST consistent with the plan previously established. Once that is done, we will start Terra SST. We have to pull the entire Terra archive. Then we'll go through the same process as Aqua.

Currently, the calcite and FLH products are being produced and can be made available to the community. There is a Level 3 browser that will let you access them as images of HDF files. As evaluation products become ready in general, they will be added to this site. There used to be a lot of products, but we took a step back to get the radiance right. Now the radiance is right, the products are being added again.

There is not a lot of feedback coming from community for the MACABY equivalent. Everything you need to know about what we are doing is on the ocean color pages. There is a questions forum for you

SeaDAS has been enhanced to support the direct broadcast community with extensive user support. There is a SeaDAS-lite version for image downloads (not data). In the users' forum, questions are answered within a day.

The MACABY equivalent allows you to view data by sensor, product, binning periods, region, date, and number of periods. An extensive help section is available.

The Level -1 and Level-2 browser now supports all of the sensors on the multi-mission browse site. There is a 10-day rolling archive for all near real time data. People are getting data. We broke 5 million downloads. Aqua data are the most popular.

We have been able to keep up technologically with our increased activity. All data are online with a rapid turnaround.

MODIS High Resolution Processing

Bryan Franz, NASA Goddard Space Flight Center

The goal of this is to investigate the use of the 500 and 250 meter land bands for oceans. We are trying to package that work and get it into SeaDAS. We are looking at using the SWIR bands for atmospheric correction. There is a suite of bands that the instrument appears to have in our processing system. To date, we've put this into MSL 12. We completed the initial vicarious calibration to MOBY. An OC2 regression was developed. In the tests now, we are fixing the aerosol model to minimize noise. You do see striping in 250-meter images, which we have not resolved.

We use the 1-kilometer data for atmospheric aerosol calibration.

In the future, we want to look at better ways of interpolating lower resolution bands. We can include other bands. We are investigating using SWIR bands for atmospheric correction.

The products are in SeaDAS, but they are not supported yet.

Discussion/Questions:
It would be more useful to generate 1 kilometer products from 250 meter products than the other way around, particularly in coastal regions.

SeaBASS update

Jeremy Werdell, Science Systems and Applications, Inc
Giulietta Fargion, San Diego State University

It's been a busy year. Our algorithm development activities and the NOMAD data set have dominated our time.

SeaBASS remains the official repository for all of our in situ bio-optical data.

NOMAD is a higher order data product. The data are publicly available online. Data preparation is documented online. Unlike SeaBASS, where new data are immediately available to the community, NOMAD has official releases, and they are not frequent.

We are in a depression as to the amount of data coming into the system. The resulting problemis the lack of geographic and temporal variability in the data set. As a result, there are few data points for validation of our satellite data products. We'd also like additional data to facilitate our algorithm development activities.

McClain: Our push is to get more IOP data than just AOPs as we have in the past.

Fargion: There are 46 PIs collecting in situ data with NASA funding. In the coastal US, there are areas where we do not have a data set. We have a lot of people collecting coastal data globally and a lot of southern ocean activity. Ultimately, there are a lot of data out there. The roadmap for the next generation will require new products. We need to discuss a few things with the community. What are the required data sets that we need to have the community collecting? I would like to see AOPs, IOPs, HPLC, etc. immediately. Future parameters could be carbon data set measurements, primary production, sst, others. We may want to agree with the community how we collect the new data sets.

Please submit your data as fast as you can. Jeremy can help you submit data. There are also online documents to help you. If you are concerned that people are using your data, there are data use conditions in place to protect contributor publication rights. To start, we're primarily interested in acquiring NASA funded data that has yet to be submitted to SeaBASS. . We can get other data if they are offered. Data are screened for quality. We know that there are parameters we want in the future, but we haven't identified all of them at the moment.

Who can retrieve data? People funded under a NASA NRA have unlimited access to the data. Otherwise, the data become publicly available on the 3rd anniversary of collection or sooner if permission is given.

Pigment Processing Status

Chuck Trees, San Diego State University

We were funded under MODIS to do pigments. We proposed to do 3,000 samples per year. We are now obligated to collect 4,800 per year. If I do pigments for someone, they have signed off to make their data available. Our protocol is that we like to see 25 mm glass fiber protocols. I can measure most of the pigment compounds that are there. We follow HPLC protocol for sample handling, storage, and shipping. We don't send pigment data out unless we have data about where and when the sample was collected. We send a template with all of the information needed with the data.

We are going to do 4-5 calibrations per year. From November to September, we did extensive calibrations.

We also measure fluorometric calibrations. We accept all samples. Last year we did 5,390. Bontempi asked, do we want to continue to accept data from non-NASA projects if it costs us to process the samples?

Currently, 670 samples are pending with a contracted 3 month lag time. Bontempi said, if you are behind, you might consider adding a person in the next proposal.

We used Vitamin E as an internal standard, but ran into problems. We switched to . We had other problems with mixing the sample and problems with halogen lamp.

We are involved in SeaHARRE-3 analysis in which we get blank and standard samples for blind standard comparisons. Previously we were in the top three for uncertainty. The new method has a slightly higher uncertainty.

The system seems to be doing well. We may want to revisit who is doing what samples.

MOBY Status Report and Future Plans

Dennis Clark and Carol Johnson

The present system has been deployed for nine years and has produced an 8.5 year continuous record. The Terra and Aqua time series are processed on a near-real time basis and the SeaWiFS acquisitions are processed after the MOBY deployment cycle During this year we have completed the reprocessing of the complete data base including the OCTS data set. We have identified several areas where the measurement quality can be improved (gonio corrections to the Es measurements, using the actual ozone and pressure data in the Lwn calculations) Once we have a working shadowing correction model for MOBY we would recommend reprocessing the data set. The improvements would be small for the short wavelength region with the major changes occurring in the red and NIR. Presently, the pre/post cal evaluations from MOBY 229 to present are being completed

In the future, we have enough spare parts to keep MOBY going for another 3-4 years. The biggest risk is if we lose the dichrotic mirrors which then require NIST to do a complete straylight characterization.We received start up money from NOAA , associated with the transition from research to operations program, to evaluate design issues related to a 2nd generation MOBY. Two main issues impacting a new conceptual design were selected for evaluation: one is to relocate the power generation to the mooring buoy, and two was to redesign the present optical system. A breadbroad optical system was constructed and tested. The breadboard system was integrated with a small buoy and deployed off Oahu in August 2005. The breadboard system test results are excellent. Optically, the system has better straylight correction than the existing system with MOBY. Additionally, the new multiple fiber input system reduces the acquisition time by a factor of 60 which will significantly reduce environmental noise during an observational period.

VIIRS Update

Wayne Esaias, NASA Goddard Space Flight Center

Things are changing very quickly. NPP is a joint mission prior to NPOES. VIIRS is provided by IPO, so they own the specifications. The VIIRS ocean color products that drive the specs are heritage products. The algorithms they have chosen for atmospheric correction are heritage algorithms. The bands for ocean color are comparable in width to SeaWiFS. They aggregate detectors on board. Three detectors are aggregated at nadir. The sample distance and signal to noise will change across the swath. Good signal to noise is predicted. The current launch is April 2009, but that will probably slip. Replanning is underway. EDU testing is underway. Ambient test results are under analysis. Prethermal/vacuum tests begin this week. T/V tests are scheduled for late March or April. They are finalizing the test plan for flight units. The flight unit build and test plan for flight units follow the EDU. Phasing is of some concern because we need more time to evaluate EDU tests.

We are worried about how well we can understand the instrument based on pre-launch tests. Earthshine was a major concern as an impediment to SD calibration. A 100% fix is underway in the form of a new design. There were some manufacturing issues. They may need a vibration waver.

For polarization, the specs on VIIRS are better than MODIS. Progress is being made in understanding test results with the polarization group and ray trace modeling.

In terms of the response versus the scan angle, we are concerned with VIIRS' ability to characterize using SIS to the precision desired for oceans. The stability spec is 0.3%, which is high for ocean color and low for engineers. This spec drove the Earthshine problems. We are recommending that there be system level radiometric calibration. LWIR band registration issues remain. Data handling issues are still a concern.

Additional time will be useful to assure that we get the good solar diffuser screen and a number of these issues are being addressed.

Discussion about the VIIRS SST requirements is ongoing in order to meet specs for skin and bulk. The basic issue on the science side is, compared to AVHRR and MODIS, the algorithm is more complex.

Will NPP provide heritage quality sensor data for ocean color? It is technically challenging, but I see nothing to prevent this from happening. We're going to have to monitor this as the program progresses.

What are the plans for cal/val? The plans are not finalized. NGST and IPO are counting heavily on other government agency participation. The three agencies that have a big interest in cal/val need to get together to form a national plan.

We as a group should start talking about what should happen to the data stream in terms of climate research.

Algorithm Status Reports:

SST

Bob Evans or Peter Minnett, University of Miami

We represent a large group. SST is an important variable that we can measure accurately from space. It has a wide user community, one of which is GHRSST. We want to ensure that MODIS SST is accurate enough to contribute to climate data. The rest of the talk will be about the current status of MODIS SST.

GHRSST stands for GODAE High Resolution Sea Surface Temperature. MODIS is one of several sources that contribute to GHRSST. GODAE is an international effort. Goddard and JPL are part of a consortium that is working to get MODIS SSTs into GHRSST. GHRSST will accept sea surface fields with a latency up to 6 hours. There is a big effort in the real time delivery of the data. Miami does algorithm development and base coding. Goddard integrates the code into the processing DAAC and transfers the files to JPL. JPL converts the files and sends them to Monterey and NODC.

How do we determine accuracy? The measurements in space have to be accurate. We have to have a good algorithm to correct for clear sky atmospheric effects. We need to have a set of instruments that are more accurate than the space craft sensor. For that we have developed the Marine atmosphere emitted radiance interferometer. It is accurate to within a tenth of a degree. Validation data sets are collected by research ship cruises funded by various agencies. We are trying to sample the world's oceans and atmospheres for all climate conditions. At the end of 2005, we had a large data set of over 3,000 days. We also have constant data from M-AERI in the Caribbean. More research cruises have been set up for 2006. An improved scanning autonomous radiometer was developed to be placed on volunteer commercial ships.

In terms of numbers, buoy measurements are far greater than cruise data. We are trying to match cruise, MODIS, and buoy data. Buoy data are collected where ships do not go.

We wanted to modernize the algorithm in MODIS Collection 5. Over the last year, the MCST has improved calibrations. In the initial 3 years of the mission, the two mirror sides did not track each other. That was corrected. We tried to make the algorithm more robust in terms of clouds and aerosols. Two additional bands are now being used to calculate night SST, SST4. The bands are more immune to the presence of aerosols than the traditional 11 and 12 um bands, which allows us to pick up the presence of aerosols at night. We changed the definition of the Level 3 maps to make them more compliant with being able to use locating ocean fronts and calculating SST gradients.

The Aqua collection showed a pronounced seasonal variation. With Collection 5 at nighttime, variation is better. Daytime variation is due to diurnal warming. Mirror side variations have been smoothed out in Collection 5. In the aggregate retrieval statistics between day and night, a comparison with MAERI shows a good match. MODIS SST is accurate and has wide daily coverage.

With this data, we can compute SST. All previous products have a tendency to become cold near a cloud boundary. With this data set, it's rare to see that cold problem. We have added uncertainty fields for SST bias and standard deviation to the GHRSST version of the MODIS SST product. This uncertainty 'hypercube' quantifies the uncertainty as a function of variables such as season, latitude, temperature, water vapor and observation geometry. As you go to higher scan angles or a change in latitude, then if the conditions that are seen by the satellite are reflected by the statistical distribution in the hypercube database, we can figure out how to weight the MODIS SST retrievals in applications such as data assimilation. In addition we can reference the MODIS SST with an analysis field, such as Reynolds OI SST to compute an estimate of bias. There are four quality levels contained within the SST products that allow use in a variety of applications ranging from frontal location to climate.

Going into the aerosols, the temperature difference between Aqua MODIS and AMSRE SST over dust shows the presence of dust. This analysis is used to confirm the presence of dust. The next thing we wanted to do is look at the relationship between Aqua and Terra day and night. You would expect little difference between the two satellites at night. In the day, particularly in the afternoon, the difference is greater due to diurnal warming. When looking at chlorophyll and SST comparisons, be careful with afternoon SST values.

New monthly coefficients removed season bias trends and Terra mirror side trends. The coefficients have been delivered for Aqua and Terra.

Chlorophyll

Janet Campbell, University of New Hampshire

MODIS Chlorophyll a product: The chlorophyll algorithm was started by looking at recommendations. First, the algorithm should provide continuity with SeaWiFS. We should use in situ data sets to test the algorithm, and aim to develop an algorithm that can solve for CDM and chlorophyll a simultaneously.

At the OCBAM workshop in September 2005, we wanted to evaluate ocean color algorithms that produce chlorophyll to determine how new algorithms performed in relation to operational algorithms. A new data set, NOMAD, was available. MODIS and SeaWiFS were intended to be mutually consistent, and they are as much as possible, but there are systematic differences. MODIS chlorophylls are slightly less over most of the oceans. The operational algorithms used between these two sensors are not mutually consistent. A recent paper in GRL computed chlorophyll using the OC4 and GSM algorithms and found differences. Seadom (?) accounts for the differences. OC4 has an inherent correction.

The ground rules are that any algorithm approach can be considered. We are looking for algorithms that compare to OC3 and 4 as replacements. Algorithms will be evaluated with a common data set. Don't run someone else's algorithm. We should regard OC4 and OC3M as the algorithms to beat, not non-operational algorithms. We are only doing chlorophyll. We want to eliminate systematic differences between SeaWiFS and MODIS. The challenge is to reduce errors.

The salient conclusion is that little improvement can be achieved without accounting for the effects of other optically active constituents. The algorithm must be model-based. We want to arrive at a consensus algorithm. Relevant documents are available on the ocean color web site.

Anyone can participate. We ask you to use a subset of the NOMAD data posted on the OCBAM website and submit retrievals to OCBAM at Goddard on an ftp site.

We quantified the uncertainty in the chlorophyll algorithm in a recent paper. A characterization of chlorophyll error allows you to map error. The map reflects uncertainty in a single retrieval. The log error is the basic measure of performance. The operational chlorophyll algorithms are not accurate to within 35%. Globally the uncertainty is on the order of 50%. Uncertainty in OC4 and OC3M were quantified in log bins, which allows for a map.

Where do we go? We need to start creating uncertainty maps for climate data record generation. Anyone is welcome to participate in developing the algorithm.

Calcite

William "Barney" Balch, Bigelow Laboratory for Ocean Sciences

We finished all of our required AMT cruises for our MODIS work. AMT sample processing needs to be done. I am interested in the scattering contribution from calcite, POC, and opal. Data processing is underway. Matchups will be done after processing. High concentrations of calcium carbonate have been found in the southern oceans. In terms of two- versus three-band algorithms, the three band algorithm is best in the high latitudes, but two band most often implemented.

The challenges are in resolving processing differences between Goddard and Miami algorithms.

Using binning improves PIC estimates, with the ocean validation data falling between the values observed for pure chalk and pure coccolith suspensions (created by using a flow cytometer). Aqua PIC vs. SeaWiFS PIC show a positive bias of the Aqua measurements at the lowest concentrations. Otherwise, the comparison is quite good.

POC

Dennis Clark, NOAA (retired)

We presently involved in Q/A tasks which have involved the reprocessing of the optical data. We are about 70% complete with the process. A draft report detailing the protocols we have used for POC, and TSM measurements has been completed. There have been problems reconciling the differences between the CZCS period POC measurements and our present data due to techniques. How representative our geographically limited data set is another major concern. We have obtained the HOTS, BATS and Balch POC data bases and are comparing these data to our measurements. A preliminary comparison seems to indicate that our measurement may be in the middle of the distribution. We should have a reasonably complete evaluation in a couple of months.

PP

Robert O'Malley (Mike Behrenfeld's representative), Oregon State University
Global NPP calculations for ocean productivity are readily available fro the past eight years. We received a high volume of data requests for NPP model results. Researchers are applying NPP model results to a wide range of questions. We are faced with a vast array of possible models. How do you decide which model to use and which to exclude? You would hope documentation would be clear, but often it is not. Everyone needs easy access to the models, documentation, and data. A new Ocean Productivity web site is being brought online. It will be linked from the ocean color web site. Researchers from other fields aim for the standard products page. When this was presented last spring, 3 standard products were expected. Since then, it has been decided to narrow the standard to one. A hybrid was considered, but put in custom products. VGPM data are supplied as the default. Input is MODIS CHL and MODIS SST. This is what you give to the person as a starting point.

The online data are available. If a user needs something that is not offered online, you fill in the data request form. Expert users can go directly to custom products. Thumbnails show differences between the models by year or season for every year. The seasonal comparison page also explains differences between the models. As more models become available, they will be added.

The model code and a full description are given. Will this lead to a more informed decision in which models to use? The purpose of the site is to inform the users and then let them choose. We want to make it easy to access data. This year, the aim is to have as many custom products as possible. I will be contacting modelers for code.

http://science.oregonstate.edu/ocean.productivity

One suggestion for the education section is to have an interactive section that will let them see how tweaking one parameter affects another.

PAR

Watson Gregg, NASA Goddard Space Flight Center

Last time we met, we had no SeaWiFS data, so we had no way of calculating PAR. Now we have data. SeaWiFS PAR applied to MODIS and the Ocean-Atmosphere Spectral Irradiance Model are also used.

Terra MODIS photosynthetically available radiation is now available. We are looking at in situ surface irradiance data sets to see how we are doing. We compared them to OASIM. Bias is eliminated if equatorial data are rejected. Non-equatorial data are scarce.

Over the MODIS record, MODIS and SeaWiFS PAR show little differences, and those at the equator.

Atmospheric Correction using the MODIS SWIR Bands

Menghua Wang, NOAA

A paper was published in GRL 32 outlining the status of the algorithm modifications. Modifications were implemented into MODIS/SeaWiFS data processing. We are still working on implementing the cloud masking and schemes to identify cases with absorbing aerosols and turbid waters.

Using the MODIS SWIR bands, atmospheric correction in coastal region for turbid waters does not require ocean bio-optical model. The MODIS SWIR cloud mask is used in near-shore data processing. Work is still in progress, but initial results show very promising for the method to deal with turbid waters in the coastal regions.

Simultaneous Retrieval of Aerosols and Ocean Color

Knut Stamnes, Stevens Institute of Technology

We are motivated by the problems in the existing methods. The ocean is not black in the near infrared and the ocean is not decoupled from the atmosphere.

The Seabass data base is being used for verification of the CAO-LDISORT model. For sunglint corrections, can we get a better sunglint mask? What is the correct sunglint BRDF of a real ocean surface?

Final Plenary Session (Day Three)

Overview of the Progress on NPP/NPOESS VIIRS

Robert E. Murphy, Senior Staff Scientist/Integrated Program Office (IPO)/George Mason University

The NPOESS program has experienced delays and cost overruns, primarily due to problems with the VIIRS sensor. This has triggered extensive internal and external reviews including an Independent Program Assessment (IPA) led by Brig. Gen. Jack Wormington. The review committee included the former MODIS instrument manager and a MODIS PI. The committee identified a number of technical and programmatic issues, and strongly endorsed a path forward that assures that the technical integrity of the program is maintained. Although VIIRS testing is already comparable to MODIS testing, they recommended increased testing and more time between the EDU and FU testing. Following the independent review, the IPO and NASA organized a classic "red team" which further amplified the issues and recommendations of the IPA.

The IPO has been reorganized and new leadership installed. The head of the program, Brig Gen (S) Sue Mashiko, will report directly to the Administrators of NASA and NOAA and the Undersecretary of the Air Force. This is essentially a new position, as the previous head reported to the Associate Administrator of NOAA. Col Dan Stockton is the new System Program Director. Internally, the role of science at the IPO has been considerably strengthened with the formation of the Algorithm Division, which has responsibility for sensor science, algorithms and validation.

The NPP mission has been moved to an afternoon orbit (1:30 PM descending node), which more closely resembles the Aqua and Aura orbits. The launch date will slip into 2008 or later.

Atmosphere Discipline Group Report/Summary

Michael King, NASA Goddard Space Flight Center and MODIS Atmospheres Discipline Group Leader

The atmosphere group started out as 4 team members, now it's the largest section of MODIS Science Team (34 team members). The status of Collection 5 production was discussed, and the rest of the session focused on science results. Now all Level 2 software have been delivered for Collection 5. The summary of modifications and enhancements in Collection 5 were presented in posters. There have been enhancements in cloud mask, cloud product, aerosol product and water vapor. All Level 2 products are in reprocessing from the beginning of Terra. The Level 3 software is being refined and should be in production in late January 2006. Collection 5 will be available through the Goddard DAAC and AADS. Aqua reprocessing will start around March 1. Atmosphere collection 5 should be completed by August 31.

The Deep blue algorithm retrieves aerosol over bright surfaces. The capability uses the blue wavelength. It is serendipitous because it uses one band (412 nm) that was designed for ocean color purposes. Deep Blue was prototyped and published with SeaWiFS data, and is now being tested with MODIS data over the Middle East, Africa, and Asia.

Spatially complete Spectral Albedo Maps were created in partnership between the atmosphere and land teams. They are now being used by different modeling groups, including the Bureau of Meteorology GCM in Australia, and for remote sensing of aerosols from the ground-based AERONET network. They are also being used in the MODIS cloud product in collection 5.

Work is going forward in comparing MERIS and MODIS surface albedo data for common bands. There are similar efforts underway to compare MISR, MODIS, and MERIS as an outcome of interdisciplinary work.

MODIS polar winds is another serendipitous use of MODIS data. Polar wind measurements are having a large impact on medium range weather forecasting. NCEP has started to use MODIS polar winds operationally, in addition to the European Centre for Medium-Range Weather Forecasts (ECMWF), GMAO, Japan Meteorological Agency, Canadian Meteorological Center, Fleet Numerical Meteorology and Oceanography Center, and the UK Met Office.

Today is Ghassem Asrar's last day at NASA. He is moving to the US Department of Agriculture's Agricultural Research Service as Deputy Administrator.

Land Discipline Group Report/Summary

Chris Justice, University of Maryland and MODIS Land Group Leader

MODIS is providing moderate resolution data of unprecedented quality for land science and applications. Examples of new MODIS science results were presented by Hansen, Huete and Myneni in the Land Discipline session and interesting findings are emerging concerning the phenology of tropical rain forest.

Code testing is underway for Collection 5 and production will start around the end of March. The science team is putting considerable effort into testing the revised code. The DAAC product review of the snow and ice products at NSIDC will begin on January 14. The associated panel report will be available for comment by the community. The EOS DIS Evolution is moving in a good direction and the science team welcomes the expanded role of MODAPS in MODIS data production and distribution.

The USGS is determining the requirements for the long-term archive (LTA) for MODIS and will be developing a user model for the archive, to help identify the products to be archived and plan the functionality of the system.

We are continuing science outreach with MODIS and there will be an international workshop in August in Montana hosted by Steve Running, focusing on long-term global monitoring of vegetation variables using moderate resolution satellites. The meeting will include discussion of product validation and international cooperation in the framework of the GEOSS. Land validation issues will also be discussed at the workshop. Global products can benefit from a coordinated international program of validation with agreed upon standards and protocols. In this regard, the MODIS land team is actively participating in GOFC/GOLD and the CEOS Land Product Validation Working Group.

The Land Discipline group discussed the systematic products to be included by the emerging Biogeochemistry Focus Area land measurement team, in the general context of the move in NASA earth science from 'missions to measurements'. Measurement teams will be addressing the potential synergy between different instruments and current gaps in the land observations. As a result of the breakout session, the land group will initiate white papers on NASA land science data needs. Land measurements are spread across several science focus areas, and cross-focus area measurements will need to be considered. This is a process which will require broad community participation. The white papers will be developed by the end of March and will be posted on the web for initial community comment.

The VIIRS instrument faces some challenges, but the land team is confident that the instrument will be extremely useful for land science. The VIIRS land processing system (PEATE) is under development, building on the success of MODAPS and early versions of the science code for the EDRs are currently being installed. It is clear to the science team that the Land PEATE will need to

generate additional products from the VIIRS instrument to meet NASA land science needs. Given the importance of the instrument for land science and the complexity of the VIIRS program, greater communication is needed between NASA management and the science community about VIIRS.

The land community needs global high resolution data for science and applications. The Landsat 7 scan line corrector failure has resulted in a serious data gap, and as a result, NASA and the USGS are developing a multi-source data set to extend the Geocover product for the period 2004-2006. This data set will be compiled from Landsat 5, ASTER and EO1 data, and Landsat 7 composites. The Mid-decadal Global Land Survey team is also investigating international participation in this initiative with the foreign ground stations and with foreign satellite data providers. The utility of composited Landsat 7 products as part of this data set is being evaluated. The first phase of this project is focused on data acquisition. The second phase which will involve data processing requires NASA budgeting for FY06/07. One approach will be to exercise a distributed community capacity for generating Landsat-class Level 3 data sets. In this context, guidelines and protocols for data set production will need to be generated. A more formal science community oversight would be beneficial for this program.

With the failure of the Landsat 7 SLC and recent problems with Landsat 5, NASA needs to move quickly to launch the LDCM, as the launch date will determine the length of the Landsat data gap. In the interim, data from other satellites such as ASTER can be utilized but the acquisition strategy will need to be modified to provide global coverage. Ideally the opportunity of GEOSS would be used to provide international coordination of the international high resolution assets.

Salomonson: I'm excited about the number and quality of science results that have been displayed during this meeting. As a particular example I am impressed with the tropical phenology effort coming out of the MODIS land efforts, . The variability of LAI going up during the dry season and down during the wet season is somewhat counterintuitive but there are explanations. The results may be even seen as controversial, but it is good to have work that raises such questions. Similarly results of refereed science quality are increasing in atmospheres and ocean efforts.

There has been good progress from the early days of MODIS including the fact that the data distribution system has improved dramatically. The number of direct readout stations is increasing is now near or over 100 worldwide

Oceans Discipline Group Report/Summary

Charles McClain, NASA Goddard Space Flight Center and MODIS Oceans Group Leader

Our session was very productive. We're making a lot of progress in a number of fronts. Two science presentations on day one highlighted the breadth of science that is being done. Our meetings tend to be more technical since science work appears in our spring meeting.

MODIS/Aqua and SeaWiFS reprocessing has been done to make the two more consistent. The products are very close, so data merging can proceed. We need products of similar quality for data merging.

Last summer the University of Miami, the OBPG, and JPL proposed to HQ to migrate SST data processing to the OBPG. The move was driven by GHRSST, so that MODIS SST could be used in support international efforts on GHRSST.

Another team emphasis has focused on coastal data processing at high resolution, which can't be done with SeaWiFS. We started to put together a package that uses the high-resolution MODIS bands. We have done a lot of work using SWIR bands for atmospheric correction and cloud masking schemes. An improved coupled ocean-atmosphere RT model is in development. We are using fluorescence line height to detect chlorophyll-a. Absorbing aerosols remain largest source of error.

The SeaBASS archive for data sets continues to develop. Giulietta Fargion was brought on board to coordinate data collection from scientists. The NOMAD algorithm development data set is now available. HPLC pigment processing has been centralized at San Diego State.

Evaluation products for fluorescence line height and calcite are available from the ocean color group. The MODIS PAR product is ready for implementation and a long-term plan is in development.

One of our methods of migrating products into routine processing is to put them through intense evaluation. We use the algorithm to produce a limited data set for community evaluation. Fluorescence and calcite algorithms have been evaluated. The PAR algorithm will be the next algorithm to be evaluated.

The primary production website (Mike Behrenfeld, Oregon State U.) contains primary production products and educational material and could be used as an interface with the terrestrial primary production community to look at global production.

Algorithms are mature or nearly so. People are starting to think about an ATBD review later this year prior to the recompetition.

The marine optical buoy, MOBY, primary calibration site has provided a constant data set. The team is looking at what a redesign would look like. The current system will be pulled in March 2007.

The SeaDAS software that is provided to the community has been enhanced to include full support for MODIS Direct Broadcast. Data processing and distribution continue to improve with increasing throughput. The Ocean Color Forum increases community communication.

The consistency between SeaWiFS and MODIS is improving. Sea surface temperature product production is transitioning from MODAPS to the OBPG. We should be ready to stand MODAPS down from Aqua reprocessing within a month from now. Terra will take longer. We will revisit the ocean color processing for Terra. The validation of SST shows that in situ SST measurements and MODIS SST show close agreement.

Evaluation products, calcite and FLH, are looking robust. PAR product for MODIS is ready.

We need more IOP data. Future algorithms depend on having more in situ IOP data and improved measurement protocols and instrumentation.

The ocean color web page contains all information about products, data access, and so forth with good documentation. SeaDAS (data analysis system) is the ocean color community's standard data processing tool. Over five million files have been distributed, and Aqua is outstripping SeaWiFS. A lot of work is being done in the Southern Ocean.

As VIIRS develops, the oceans group has been very active because VIIRS is the next sensor for oceans, and the ocean group is very sensitive to sensor problems and accurate prelaunch characterization. System level testing is critical. There has been good progress on the resolution of the Earthshine problem on the solar diffuser. Currently, there is no post-launch calibration and validation strategy sufficiently defined and funded. What is the strategy for data processing and archive?

NASA Earth Science Overview and Comments

Jack Kaye, Director of the Research Division of the Office of Earth Science, NASA Headquarters

For the people writing the original proposals for EOS, the contents of this meeting indicate that this is where we/the Program wanted to be. If you look at the platforms that are flying and the science

that is being done, this is where we wanted to be; i.e., substantial science and applications are resulting from the analyses of data. We have concerns for the future because we wanted to continue to build the system into the future and not have a temporary observing system.

Organizationally, the agency transformed itself in 2004 because there were too many organizations within the agency. A single science mission directorate formed of both Earth and Space science. It is working reasonably well. There has been a change of leadership at NASA with Administrator Michael Griffin coming in, which triggered a number of personnel changes. Dr. Mary Cleave is now the head of the science mission directorate. The Earth and Sun divisions will soon be split because the communities are largely different. There will be four divisions in the Science directorate: Earth, Sun, Space, and Solar System. The budget and management divisions are merging. There is an opportunity for new leadership in the Earth division.

The budget will not be defined for 2006 until we know what is going on in Fiscal Year 07. The Fiscal Year 06 budget wasn't bad since Earth science got hit hard in the 05 budget. The agency and science budget is due to grow because of Mars exploration.

In terms of the external political situation, when the Administration talks about NASA, it is talking about exploration, the shuttle, and the space station. Congress has taken a broader view. Congress wants to see a balance at NASA. I don't know how that balance will shake out.

We are involved in a number of interagency activities such as the climate initiative and the oceans initiative. The NASA/NOAA transition issues revolve around the question: if you start things how do you make sure they are done permanently? We staked the future in NPOESS providing data continuity. We are now talking about moving NPOESS to an afternoon orbit. NPP has moved to an afternoon orbit. We need advanced technology in the morning orbit.

The decadal survey is underway. The decadal survey is supposed to look ahead. An interim report was completed last year, and the final report is to come out next fall.

At NASA, a couple of missions have been confirmed. Hydros is not going to move ahead. It is difficult to make mission termination decisions. We have shut down UARS. Topex/Poseidon is being decommissioned for technical reasons. ROSES 05 was for FY06 funding, Roses 06 is for FY07 funding. We have seen modeling and assimilation progress with the Columbia program fast supercomputing program. The fast calculations needed for data assimilations require us to be at the forefront of supercomputing.

How quickly can we get the issue of Landsat continuity resolved? Political progress is being made, but from an engineering point of view, I don't know. Chris Justice says the data gap could be long. Dr. Kaye responded that the gap is recognized, but we have to use the current structure to get a multi-decadal data set. It is high priority issue. We're trying to get international people to share data.

What is the direction as we go from mission to measurements? We would like to reconfigure as we go from missions to measurement. We want to have teams like a single precipitation team that is not necessarily sensor-based. Somebody still has to pay attention to individual sensors, so we can't go too far in that direction. Validation is still an issue.

Comments and Directions for the Future for the MODIS Science Team

Paula Bontempi, NASA Headquarters MODIS Program Scientist

Everybody is aware that it is not an easy time for science in terms of funding. Our budget is still good. We have seen remarkable progress in all three discipline areas and in NCST. I am appreciative of all of the work people have put in over the past few years. Please send us copies of publications. Those findings are critical to interagency and White House work. It's useful to show that we are making significant progress.

For FY05, we thought we would have to make significant cuts, but I heard about cuts. The grants person said that procurement is holding some of the funds. Salomonson and Bontempi are going to work on resolving the issue. Please turn in renewals as early as possible. Turn in renewals for grants and contracts 90 days ahead of annual end date to allow time for processing. Find out the status of your contracts at your institution. The woman in charge of contracts is Theresa Mautino.

Terra received very high marks and was renewed during the senior review process. Senior reviews go on every two years.

One of challenges of the team was to reap full benefits of MODIS and EOS. How are we doing? The NASA mission is in part to understand and protect our home planet. NASA is in advanced planning. We hope the focus area planning feeds into earth science. Earth science is changing from mission science teams to measurement science teams. The Oceans Team is up and running, the Land Team in development, and the Atmosphere Team is moving forward. GOESS will look at how we feed into decision making. The NRC decadal survey is expected to drive the future of NASA Earth Science. Get familiar with that. Merged products (NPP) and new products are exciting.

We need more interdisciplinary algorithm development approaches. We need to address deficiencies in key data products. Algorithm developers need to represent broader community needs. Algorithm refinement needs to justify use.

We need to plan for ATBD reviews. The goal is to assess the quality of data product suites. We should prioritize EOS data products relative to the community and the needs they serve.

Measurement teams will continue to evolve. Do we want a Terra/Aqua science team meeting?

At our last meeting, we were concerned about seeing progress from the new team PIs. This meeting shows that progress has been good.

The discipline leads can get together after the meeting to discuss the issues we previously encountered. We are now seeing evidence that data are being widely used with fewer issues and concerns to discuss than previously.

Comment/question: A platform approach might be counterproductive, but a large-scale discipline team might be better. It might promote inter-sensor work more.
In Terra senior review, HQ wanted to see more inter-sensor work (MODIS/MISR, for example).

Posters and presentations will be available online. Peer reviewed publications are useful to NASA HQ.

How will measurement teams work? Salomonson responds, I don't know. There will need to be a team leader to come on board to organize the meetings such as this one. It's most important that we have data available to the community. We'll have to figure out the balance between core team and sections that are competed out.

Wrap-up Comments and Plans for the Next Meeting

Vincent V. Salomonson, MODIS Science Team Leader

A potential future issue may arise with the potential loss of MODIS data due to loss of supersets in the solid state recorder. If we lose more, we will start to lose data randomly. We can solve the problem by doing recycling, but approval for this action has to come from Headquarters. The alternative to recycling of the SSR supersets is to change the acquisition of data from 50/50 day/night to 60/40 night/day. This would seem to negatively affect products obtained over the polar regions. I want to accumulate rationale for recycling, so that we possibly can get approval before the

problem occurs. Please send Salomonson any data or comments regarding any impact you may see regarding going to 60/40 verus 50/50 as outlined above.

Consideration is going to be given to having the next meeting may sometime between June and October outside of the Washington/Baltimore area. We will be looking for ideas, guidance, etc., to see what kind of meeting would be best.

Thanks to everyone for their participation and the efforts put forth in preparation of presentations and posters. As noted previously I am very positively impressed with the progress being made in the use of MODIS for science and applications and also when fused with other sensors. It all bodes well for the future. Thank you for coming.