MODIS Atmosphere Discipline Group Meeting
Tuesday, January 23, 2001
GSFC Building 33, Room H114

I. Welcome and Summary of Expected Outcomes

Michael King welcomed the group and summarized the focus of the meeting, indicating that the main goal was to bring together code developers and validation scientists to initiate dialogue that would be useful to both. The meeting would also cover processing status, and an introduction to data tools that those in his group have been developing to visualize and subset data. These meeting notes have been organized around the agenda (Attachment 1).

II. Data Processing and Post-Launch Evaluation

A. PGE Update and Processing Status
Rich Hucek provided a product generation executive (PGE) update schedule, and also discussed code and ancillary data changes, as well as data processing system performance issues (Attachment 2).

Atmosphere products began to be released in September, starting with the cloud mask and finishing with the Level 3 monthly atmosphere composite, released on January 22. Among the PGE code changes still needed are updates to PGEs 03, 04, and 56 to accommodate new ECS-determined metadata standards, and changes to the Level 1B reader that will permit identification of interpolated pixels. In addition, common Level 3 code will be moved to a shared code library.

They have been producing a daily Level 3 QA product at 1- and 0.1-degree resolution. Due to processing and memory constraints the .1° (10 km) product does not include all parameters. What kind of long-term storage is planned for these products is undecided. Hucek indicated that currently they are not propagating the lower level flags into this QA product, but they will look into the possibility.

MODAPS is preparing for a transition to Version 2 software, which should have a better file I/0. PGEs must be updated to run in V2 MODAPS, and to be able to distinguish between Terra and Aqua data. This new system could be baselined (used for product testing) in the first week of February 2001. MOSS tests are scheduled for February 20-23; V2 is scheduled to be installed March 15.

Finally, Hucek discussed the sometimes-problematic introduction of changes to ESDTs. The EOS Data Gateway (EDG) ordering interface for MODIS data requires 2 weeks to insert new ESDTs. If you miss the first cycle, you have to wait for the next one, which means that the product may be invisible in the EDG for up to a month. However, if you have a subscription, the data continue to arrive normally. In addition, the GES DAAC provides its own interface for ordering data, and it is unaffected by the ESDT change cycle of the EDG.

A. Windhoek Processing Facility

Bill Ridgway gave a presentation (Attachment 3) on the Windhoek facility**,** which is an adjunct machine next to MODAPS from which files can be moved via subscriptions or simple pull. Windhoek provides short-term archival (they have about 1.3 TB capacity), production of global and granule browse, and support of field campaigns. In particular, they are storing one “Golden Day”, April 19, from which they have all granules. This day is used for PGE testing and development.

Over the past six months Windhoek archived data for several field campaigns, including all granules from SAFARI 2000. It also provided both Level 1B and Level 3 images for the Atmosphere web site, and it provided PGE development for the Golden Month/Consistent Month.

Unfortunately, Windhoek was down for almost six weeks due to a security breach that affected both it and the Atmosphere web site, and they lost files. They are expecting some hardware upgrades in February that will bring the system up to 3.5 TB on line, as well as some additional offline storage that will allow them to do some permanent archival. In the next six months, they plan to develop the capability to run all products from Level 0 to Level 3.

Finally, Ridgway summarized MODAPS processing status and discussed the implications for future reprocessing. Currently MODAPS is almost 8 weeks behind real time (6 weeks behind the GES DAAC, which is about two weeks behind real time). Kaufman wondered whether there were any plans to speed MODAPS up. Ridgway said that V2 MODPAS was expected to speed things up some, but they don’t know how much. Being behind enough to have to pull data from the tape library slows things down even more. Ridgway reminded the group that MODAPS’s strong point was not speed, but flexibility to change and test code and processes. That kind of flexibility is expensive to duplicate.

Finally, Ridgway suggested that the Atmosphere group needs to make some decisions about how to use Windhoek should any kind of reprocessing be undertaken.

II. Visualization and Data Analysis Tools

Eric Moody gave a presentation (Attachment 4) on the development of data manipulation tools by Code 913 in response to a need to be able to easily find data so that they could test code changes, do quality assurance, and make sure inputs were correct for products. They have developed tools that will generate an automatic search for a specified latitude/longitude when your data subscription comes to your local disk. They also have an IDL-based, point-and-click global map. There are also granule locator tools within the EDG ordering guide.

Another tool allows users to subset data either spatially, or by parameter, which minimizes file sizes and can speed downloads. The tools have the capacity to subset all atmosphere and Level 1B products, and they are written so that they can be modified to handle other HDF data sets.

They have some outstanding visualization/analysis tools that can be used for 1 and 0.1 degree L3 products, as well as global and granule Level 1B, Level 2 ancillary input, output, and QA and byte flags. Some of these tools are available on the Atmosphere web site (http://modis-atmos.gsfc.nasa.gov), with full documentation, and others can be obtained from Moody or Mark Gray directly. The system requirements for the tools are IDL and PERL for the visualization, and FORTRAN 90 and PERL for the subsetting tools. Some tools require EOSDIS toolkits while others do not.

Finally, the group took a tour of the E-Theater, where Mike Manyin demonstrated a visualization tool called an interactive image spreadsheet, which works much like a regular spreadsheet, allowing you to display different data in different cells and then combine them using equations. Manyin and Fritz Hasler are interested in collaborating with scientists to continue the development of their tool for other platforms (currently runs on SGIs.)

III. Correlative Measurements of Use in Data Validation

A. Cloud Property Validation

Gerald (Jay) Mace from the University of Utah presented work on using surface data collected by both passive and active sensors to validate cloud microphysical property retrievals. They are running a project called the Facility for Active Remote Sensing (FARS), which has lidars, a cloud radar, and passive sensors, and these are supplemented with photography. The site supports 6 to 12 Terra overpasses each month.

They are using operational data streams and reducing them into an atmospheric column over the Atmospheric Radiation Measurement (ARM) site in Oklahoma as well. They will generate products that compile a set of cloud microphysical properties into a net cdf file, which will be graphed and placed on the web for browsing. They are developing their algorithms using mutli-parameter and single-parameter regression, and climatological models to assign microphysical descriptions to all hydrometeors. The effective radii used in the algorithms come from comparisons with a validated algorithm.

Their EOS validation website, http://www.met.utah.edu/mace/homepages/research/eos.html, allows users to search hundreds of potential case studies using drop down menus and interactive calendars. Users can view lidar and in situ data; however microphysical data aren't yet available. The microphysical products are being evaluated in house at this time, but Mace indicated that they could be made available to the Terra team. They have recently acquired MODIS data, and are beginning to work with it.

B. Cloud Validation Sets in the Arctic

Taneil Uttal from the NOAA Environmental Technology Laboratory summarized ongoing work to produce cloud validation sets for the arctic (Attachment 5). Data sets such as these for the arctic are especially important since climate models show large disagreements in polar regions. Arctic clouds figure prominently into the radiation balance of that region, in which cloud-radiation feedbacks are linked to snow/ice-albedo feedbacks.

They have been involved in field campaigns using several instruments including cloud radar, dual polarization lidar, radiometers, and microwave radiometers. They are also using a variety of inputs and retrieval techniques. They have been developing an IDL-based GUI, which is available on their web site, that allows users to first visualize data from the ARM site on the North Slope of Alaska, and then allows them to select a cloud microphysical retrieval method that is optimal for the conditions. Their goal is to come up with a retrieval method that will return microphysical properties for every cloud type.

They have a great data set for validation from aircraft data over the SHEBA location from which they are calculating broad based statistics such as range, median, and mean for various parameters—effective radius, liquid water content, mean diameter (ice), and ice water content. In addition they are doing month-to-month comparisons of fractional cloud cover. One challenge is that even in winter there are large numbers of liquid water clouds, which frequently attenuate the lidar. They are currently recalculating liquid water paths for the entire North Slope of Alaska data set because they discovered that the absorption coefficient for the liquid water measurements taken with the radiometer was not suited to the Arctic.

Uttal concluded by saying that they are in a place to do comparisons, and would like to collaborate with scientists who have data to compare.

C. Evaluation of Aerosol and Water Vapor Measurements

Rich Ferrare of the NASA Langley Research Center presented work underway to evaluate Terra MODIS aerosol and water vapor measurements using ARM Southern Great Plains data (Attachment 6).

They analyzed data from March until the third week of November using the Raman lidar and a sun photometer. (They have to extrapolate to MODIS wavelengths, since the lidar is a 355 nm.) Their results indicate fairly good agreement between MODIS aerosol optical thickness measurements and the Cimel/Raman lidar aerosol optical thickness SGP data; however, there appears to be a systematic bias in the MODIS near-IR water vapor measurements, which are 30-40 percent higher than the SGP data. Bo-Cai Gao indicated that unpublished papers suggest that the 0.94 μm water vapor band line intensity should be increased as much as 21.3 %. However, a simple scaling may not be the best approach. Other suggestions were that changes in the L1 B calibration tables mean that perhaps they aren't using optimal look up tables.

Finally, Ferrare discussed results of their analysis of the vertical variability in backscatter of aerosols. Comparisons between Raman lidar and IAP data show large vertical variability—15-25%. While the differences may be small over the long term, on any given day, there may be a large variation of aerosol properties with altitude. Beginning in March 2000, they instituted a program of routine aircraft flights to measure aerosol scattering and absorption, plus chemical composition.

D. Cloud Microphysics
Andy Heymsfield gave a talk on his group's work to provide high-quality data sets of microphysical properties in order to improve retrieval algorithms.They have found that.treating ice cloud microphysical properties as uniform isn't appropriate, especially for effective radii.

To improve the algorithms, they are developing models of masses and fall velocities that are based on the ratio of density to cross-sectional area. Using Cloud Particle Imager data they have developed a new set of mass relationships, which they have applied to 4 or 5 cases. The algorithms seem to work pretty well, and can identify particle mass as a function of height.

IV. Field Experiments and Validation

A. PRIDE
Lorraine Remer gave a joint presentation with Si-Chee Tsay and Jack Ji on the Puerto Rico Dust Experiment (PRIDE) (Attachment 7). She explained that dust is difficult to model because, unlike smoke, sulfates and maritime aerosols, dust in non spherical. There is disagreement as to the effect of using a spherical model on non-spherical particles, but their tentative solution was to use spherical models and make adjustments later, using Mie theory. Knowing that they were using an approximation likely to produce errors, they were not expecting to do well on the aerosol dust retrievals for PRIDE.

Instead, they found excellent agreement between MODIS and AERONET optical thickness and effective radius retrievals at 0.66 μm. At other wavelengths, the agreement wasn't as good, especially for effective radius. MODIS seems to be underestimating the size of particles by inflating the number of small particles, i.e., inflating the fine mode, and missing larger particles. MODIS will enable us to measure the nonspherical phase function of the dust aerosol, and adjust the retrieval algorithm accordingly.

Tsay gave an overview of the PRIDE (Attachment 8), showing the site and the instruments, including the new 14-channel sun photometer. They saw 6 dust events in 4 weeks. He explained that afternoon convection interferes with aerosol measurements. Using all the data they had, they sorted out aerosol optical depth and then plotted it against air masses in order to study energetics on the surface. He calculated an aerosol radiative forcing equal to about 95 W/m^2. The data from which he drew his calculations are available at http://particle.gsfc.nasa.gov/smart.

B. SAFARI

Steve Platnick gave a summary of the Southern Africa Regional Science Initiative (SAFARI 2000) (Attachment 9). The experiment followed a dry/wet/dry-season cycle. They got in 19 ER-2 flights, for a total of 117 hours. The group encountered a lot of weather problems, and had difficulty getting cloudy days, but they had better luck with aerosol measurements.

Data is just beginning to be analyzed, and Platnick hopes that Remer and Kaufman will be interested in it. Preliminary data analysis of cloud-top pressures and temperatures, aerosol retrievals, and cloud phase estimates has been conducted. They did see some ice phase clouds, not just liquid water. The optical thicknesses were around 10 or less, but some were as high as 15. Effective radius retrievals for liquid water clouds were reasonable—in the 10 µm range.

C. GLI

Terry Nakajima described the use of MODIS data in the Global Imager (GLI) project (Attachment 10). He indicated that numerous validation sites are present throughout China, Okinawa, and Japan, and that these sites could ultimately be useful for MODIS validation as well.

Nakajima presented results from work submitted to the Journal of Climate on the direct effect of anthropogenic aerosols on radiative forcing. Their work using the CCSR/NEIS Aerosol Climate Model shows that the direct effects are very small and negative (-0.2 W/m^2). However, they are also considering the indirect effects of aerosols, such as their potential to interact with low clouds. These effects are greater, an estimated -0.79 W/m^2, with anthropogenic sources constituting about 15% of that number.

They are also studying particle microphysical properties and their distribution patterns across Asia. Their results over the oceans show a predominance of small aerosol particles near the land, which can be an indication of anthropogenic aerosols. Over land, low clouds also show a lot of small particles.

D. APEX

Takashi Nakajima spoke about the use of MODIS data in the Asian Atmospheric Particulate Environment Change Study (APEX) (Attachment 11). APEX used MODIS data collected in conjunction with ground-based measurements taken on Amami—Oshima, which is south of Japan. They developed algorithms that convert MODIS Level 1B data into GLI data format, so that Level 2 products can be created on their system. While the two data formats both have 16- bit structure, the GLI format has overlapping scan lines, which MODIS does not, and the DN-radiance conversion tables are more complex than MODIS.

The converted data were successfully used during APEX, and normally L2 was uploaded onto the web site within 18 hours from the time of observation. The data were used to derive a number of parameters including cloud optical thickness, effective radius, and cloud top temperature. Comparisons between their products, aircraft, and MODIS L2 products will be made in the near future.

V. Future Field Experiments for Validation of MODIS Data

A. CLAMS

Vanderlei Martins spoke about an upcoming project called Chesapeake Lighthouse and Aircraft Measurements for Satellites (CLAMS) (Attachment 12). The project will run this summer from July 10 through August 2, and the objective is to provide validation of EOS data products, mostly for CERES, but also for MODIS and MISR. Another similar mission is being considered for Aqua.

The focus of the mission is to collect data for validating satellite aerosol retrievals. This means they have to try to find cloud-free environments in a region that is cloud-covered 50-60% of the time. AERONET indicates peak aerosol in the region around July; however, the area is more likely to be cloud-free in fall. Since the difference in cloud cover between summer and fall is not large, and since summer is a minimum time for contrails, they selected summer. The mission will include several aircraft platforms and sensors, including water-based instrumentation and ground-based instrumentation.

They have about 32 hours of ER-2 flying time to split between MODIS and MISR objectives. They are planning validation of aerosol retrievals in cloud and cloud-free areas and will be looking at correlation between lidar measurements and MODIS measurements.

Aside from validation, additional objectives include development of new optical thickness measurements over glint and characterization of urban aerosols. They still lack an aerosol transport modeling component/forecasting component to the mission. There will be a CLAMS planning workshop on February 21-22, 2001, at NASA Langley Research Center starting at 8 am.

B. ACE-Asia

Si-Chee Tsay talked about a field experiment planned for this year called ACE-Asia and Terra: A 2001 Field Campaign on Asian Dust and Pollution Aerosol (Attachment 13). In Asia, land is becoming desertified at a rate of 2460 km^2/year, which is almost 27% of the land having been desertified since man began settling Asia. One consequence of this desertification is devastating dust storms, which can propagate to the US and Canada. While destructive on the one hand, dust transport also provides essential iron nutrients to the oceans.

TOMS data looking at spatial and temporal trends over the last four years show that the dust storms are intensifying and are increasing in frequency. Furthermore, it shows that Asia is the only continent where sulfur emissions are still increasing.

The dust storms and pollution raise numerous societal concerns: might rainfall be so affected by aerosol that agriculture is harmed? will fisheries be contaminated by trace metals from acidified dust? will aerosol particles pose health hazards? The ACE-Asia experiment will investigate the type, distribution and health effects of aerosols. Surface measurements will be taken using chemistry, lidar and sun photometers.

VI. Future Plans

A. MODIS Airborne Simulator

Jeff Myers summarized the status of the MODIS Airborne Simulator (MAS) (Attachment 14). In FY 2000, MAS did 70 missions (four major deployments), for a total of 304 flight hours. The simulator experienced some problems during the SAFARI 2000 campaign, mostly related to failures of climatic control that caused extreme thermal stress. Essentially, the instrument cold-soaked at very low temperatures for 7 or 8 hours. The instrument did survive, but some parts were damaged.

The 3-5 μm channels ruptured a gasket, and the dewar is not salvageable; however, the detectors are OK. They will have to replace or recoat the second dichroic, the scan mirror, and the first diffraction grating to port 1. Also, the telescope glass needs refurbishing. The most affected bands are the visible and short wave IR.

MAS collected a lot of ground data during SAFARI 2000, including data from Etosha Pan, and the calibration seems OK. The final calibration may include degradation derived from color-corrected hemisphere data and ASD data in Pietersburg as well as additional field campaigns.

For the deployment scheduled for March in Texas, they will take the telescope and scan mirror from the MASTER instrument, as well as the port 3 dewar. Port 4 is being inspected. Noise calculation with the MASTER port 3 installed on MAS shows good results. Not as good as MAS has ever been, but still usable. If the new optics are installed by CLAMS, they may have to be artificially aged.

B. Group Discussion

1. Product quality levels

The first point King raised for discussion was the terminology associated with data product quality levels. The use of these categories, such as beta and provisional, leads the Project to ask what is the schedule for releasing science-credible products. King thought that by sometime this spring the group should be able to designate all its products into a new category, having addressed issues such as calibration, day/night transitions, and ecosystem variations. Kaufman felt that that timeline was reasonable for aerosol products. Liam Gumley indicated that for MOD07, they need to get the entire Golden Month back at Wisconsin to come up with their second round of improvements.

When data get to the point where the group considers them able to be used for publications, then they must be retained in the archive; however, the DAACs can’t keep all MODIS products. The plan is to rewrite beta products with provisional products after reprocessing. As the group continues to refine its products, DAACs will only save the software that produced the old version, but not the data themselves.

2. Another issue King raised was that the atmosphere team currently has no plan for combining Terra/Aqua data. This is something that they will have to discuss in the future.

3. The third issue the group discussed was the large lag behind real time processing and possible solutions. King indicated that one not-very-popular strategy is to process only 50% of products in year 1, 75% in year two, and then keep stepping up. Kaufman asked about pressures from outside the team to increase processing efficiency. King confirmed that Ghassem Asrar has indicated that all avenues for achieving system efficiency must be exhausted, including hardware, software, and algorithms, before additional money would become available for system improvements. King commented that atmosphere's use of the total resources was small, and is quite close to the original estimate they provided. He doubted whether the savings they could achieve in their algorithm efficiencies would have a significant impact on the system as a whole.

Kaufman said he would be agreeable to skipping days or selecting one eight-day period in a month, or some other temporal subsetting in order to get MODAPS caught up.

Finally, King commented that while the EDC DAAC is filling a lot of requests for MODIS Land data, the GES DAAC is not getting a lot of requests for Atmosphere data. He reminded the group that when they themselves process data for users and push it out, it looks like the data aren't being used by the community. It's important to make it clear that there is interest in the group's products.