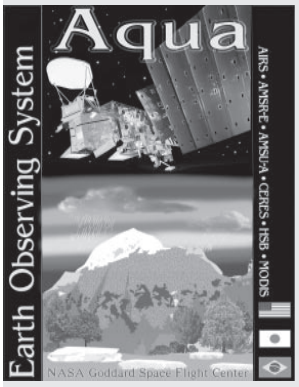


Minutes of the Aqua Science Working Group Meeting

— Steve Graham, (steven.graham@sesda.com), Aqua Outreach Coordinator,
— Claire Parkinson, (claire.parkinson@gsfc.nasa.gov), Aqua Project Scientist

Introduction and Status of Aqua

The Aqua Science Working Group met for a day-long meeting on August 2, 2001 at Goddard Space Flight Center (GSFC). The meeting was chaired by Aqua Project Scientist Claire Parkinson, who opened the proceedings by showing a preliminary animation of the anticipated A-train sequence of afternoon satellites, with Aqua flying over the Americas followed by ESSP 3 (formerly PICASSO-CENA), CloudSat, Parasol, and Aura, all due to be launched within the next several years. The animation was produced by Jesse Allen of Science Systems and Applications Incorporated and will be enhanced over the next several months. Parkinson then showed the newly published AIRS brochure and praised the AIRS Science Team and especially Mike Gunson and AIRS Team Leader Mous Chahine for its quality and successful completion. Copies of the brochure were made available to the meeting participants later in the day. Parkinson also described an Aqua lithograph that is currently in press and went over the status of the negotiations and timing of an anticipated Aqua special issue of the IEEE Transactions on Geoscience and Remote Sensing. It is hoped that the deadline for papers for the Aqua special issue will be in early 2002 and that the issue will be published by the end of 2002.

Parkinson then introduced Phil Sabelhaus, the Aqua Project Manager, to give an update on the current status of Aqua. Sabelhaus began by showing several photographs of the Aqua spacecraft, the Aqua solar array, and the thermal vacuum chamber into which Aqua was carefully being lowered on the day of the Working Group meeting. All photos were taken at TRW in Redondo Beach, California.

Sabelhaus explained that vibration, acoustics, shock, electromagnetic interference, and fault management testing have all been completed, as have 108 hours of ground system interface testing. Earlier problems with transponders, transponder interface electronics, and the solid state recorder in the formatter multiplexer unit have been solved, and each of these units was repaired and reinstalled on the spacecraft prior to the baseline System Comprehensive Performance Test (SCPT), which was successfully completed on July 23. In contrast to the initial SCPT conducted back in February 2001, this SCPT included on the flight hardware. The successful completion of the baseline SCPT now means that the spacecraft is ready for the thermal vacuum test, scheduled to begin on August 18. If the thermal vacuum testing goes well, with no major problems identified, Aqua could be ready for shipment to Vandenberg Air Force Base in early December and possibly ready for launch by late January 2002. The launch manifest for Vandenberg is somewhat crowded over the next 12 months, however, so the actual launch date for Aqua will depend on launch slot availability as well as Aqua readiness. *[Editor's note: as of September 2001, the Aqua launch will be no earlier than March 2002.]*

Sabelhaus saved his most contentious issue for last; he stated that he opposes a deep-space maneuver for Aqua citing the risks involved. The AIRS Science Team is similarly opposed, but many scientists from the CERES, MODIS, and AMSR-E teams support the proposed maneuver for calibration purposes. An agreement has been reached to undertake this maneuver on day 60 of the mission. Sabelhaus recognized this agreement and understands that the spacecraft is designed to handle this deep-space maneuver but is still opposed to the plan because he believes the maneuver is unnecessary. Bruce Wielicki from the CERES Team noted that other missions have done such maneuvers successfully and that the risk involved is small and is far outweighed by the potential science benefits. Wielicki agreed with Sabelhaus that the maneuver should be attempted only if the spacecraft is performing well. Sabelhaus concluded by reiterating that the maneuver is in the official timeline and that we can expect it to occur on day 60 (or thereabouts).

Update from NASA Headquarters

The next speaker was Ramesh Kakar from NASA Headquarters. Kakar explained that there is no closure yet on the issue of recompeting the EOS science teams but that Headquarters soon wants to issue a

Request for Proposals (RFP) for maintenance of the approved algorithms, plus a NASA Research Announcement (NRA) for data analysis that can be done using either the approved algorithms or alternative algorithms. Instrument Principal Investigators and Science Team Leaders should submit proposals in response to the RFP. In these proposals, the budget should show a decrease in algorithm-maintenance money with time, to allow more money for data analysis in later years. If necessary, the Instrument Principal Investigators can propose to change the composition of their teams at this time.

Kakar emphasized the need for the Aqua science teams to integrate into their programs the new validation activities that have recently been funded through last year's Validation NRA. Kakar also warned the group that the Senate Appropriations' Committee recently recommended removing $15 million from the EOS algorithm budget for FY2002, although the House of Representatives has not done so and it is not clear at the present time how this issue will work itself out.

CERES Early Results and TRMM/ Terra Experience

Bruce Wielicki from the CERES Science Team followed Kakar and offered an update on the CERES program. The CERES instrument on Terra is performing well with no major anomalies. The only minor issue is that the solar diffusers have experienced degradation of coatings and are not useable. The team will rely on calibration lamps, inter-instrument calibration, and convective cloud stability checks.

Earth Radiation Budget Experiment (ERBE)-like Top Of the Atmosphere (TOA) flux data products continue to be produced as validated products, and there are now 16 Terra months available.

There was a press release on the first year of Terra CERES data. Wielicki views the release as a huge success and praised the Earth Observatory, Goddard Scientific Visualization Studio, and public affairs teams for their considerable work. The release can be found at: earthobservatory.nasa.gov/Newsroom/NasaNews/2001/200106204895.html.

Next, Wielicki commented on the status of CERES data products from the Tropical Rainfall Measuring Mission (TRMM), noting that the TRMM beta Angular Distribution Models (ADMs) are encouraging and there has been a factor of 4 to 8 improvement in clear ocean fluxes. The remaining ADM challenge is viewing zenith angle dependence of cloud fraction and optical depth.

Regarding Terra data products, the ERBE-like TOA fluxes have been validated and processed to the present. However, the MODIS cloud analysis has been slowed by data calibration/noise delays, MODIS data delivery and delays in getting Atmospheric Radiation Measurement (ARM) data used for validation analyzed for overpasses.

Wielicki noted that comparison testing is underway between the Goddard Earth Observing System (GEOS) 3.3.x and the European Centre for Medium-Range Weather Forecasts (ECMWF). This had been planned for the March/April 2001 timeframe, but there was a schedule slip of a month or two by GEOS, which then caused an overlap with TRMM and complications with conflicting personnel responsibilities. This delayed part of the GEOS/ECMWF comparison until late June. Temperature and water vapor profiles obtained by CERES longwave and window channel tests taken in April/May compare well with data from ECMWF data from the same period. The team hopes to wrap up testing in August 2001, pending the renewal of the ECMWF data contract (which ran out on July 31).

The Chesapeake Lighthouse and Aircraft Measurements for Satellites (CLAMS) Field Experiment was run from July 10 to August 2, 2001 over the Chesapeake Lighthouse, located 25 km off the Virginia Beach coast. The goals of the experiment were to develop a better understanding of how the ocean surface reflects sunlight and to validate and improve satellite-based estimates of atmospheric aerosol properties and surface and atmospheric heat budget estimates.

Next, Wielicki commented on the status of the ARM/ Baseline Surface Radiation Network (BSRN) validation data source. ARM is starting to produce routine daily processing near Terra overpasses, and all but the Tropical Western Pacific sites are processed to within three months of current observations. The BSRN archive has been unavailable for the last year and there is still no official word on when it will become available (it was expected to be available in June). A short-term workaround is to contact individual BSRN sites directly.

The CERES team is still waiting for the Terra deep space calibration maneuver. This maneuver would let overlapping instruments intercalibrate to better than 0.1% (95% confidence) in window and longwave radiance using six weeks of overlapping orbit crossing data. Without the deep space look, each scan position has variations up to 0.5% and the CERES team requires 100 scan positions to be determined instead of 1 gain value. With the maneuver, they could approach solar constant level stability of 0.2 W/m^2 in longwave flux. To avoid this concern, the

CERES team supports conducting the Aqua deep-space maneuver early in the mission.

Recent science results from CERES include evaluation of the Iris hypothesis that thin cirrus clouds in the tropics exert a large negative feedback in the climate system. The evaluation was done using CERES/Visible Infrared Scanner (VIRS) TRMM data and the discovery of dramatic changes in the ratio of shortwave cloud radiative forcing (CRF)/longwave CRF during the 1998 El Niño (confirmed by Stratospheric Aerosol and Gas Experiment II measurements).

Data archive issues now being worked include a NOAA/NASA agreement and the transition of NASA data to NOAA's long-term archive. In addition, CERES and other teams are continuing to evaluate data processing hardware requirements.

Science Requirements Flow Down

Following Wielicki, Chi Wu of the Aqua Project gave an overview of the Aqua top-level science requirements flow down. Wu noted that the flow down needs to be completed by early September and most of the work is already done for the instruments, spacecraft, and ground requirements. However, the project needs the Aqua science community's help regarding the top-level science requirements flow down. The top level science requirements consist of the Aqua minimum success criteria (which can be found at aqua.nasa.gov/science.html) and the instrument science requirements, including data collection and data product requirements. The latter are complicated, involving instruments, algorithms, and calibration. Ken Anderson, the Aqua Instrument Systems Manager, will be contacting team members soon for their help and input.

Parkinson added that recent calculations based on the original Aqua minimum success criteria yielded only a 42% probability of mission success. As a result, the requirements and the various interpretations of them are being reevaluated.

Results from the Terra MODIS and MODIS Team Plans for Aqua

Following Wu, Vince Salomonson, the MODIS Science Team Leader, introduced a series of MODIS presenters, beginning with Michael King, the MODIS Atmosphere Group Leader and EOS Senior Project Scientist, who gave a status update on MODIS atmosphere science.

King noted that MODIS atmosphere products are produced on 5-minute granules covering an area of 2330 km x 2000 km. Level 2 atmosphere products include a cloud mask for distinguishing clear sky from clouds, cloud radiative and microphysical properties, aerosol optical properties, atmospheric moisture and temperature gradients, and columnar water vapor content. Level 3 gridded time-averaged atmosphere products include daily, 8-day, and monthly products on a 1° x 1° equal angle grid, and contain mean, standard deviation, marginal probability density function, and joint probability density functions of most atmosphere Level 2 parameters. The algorithms used for these products are comprehensive and efficient as compared to similar products.

King noted that the cloud mask product uses 17 of the 36 MODIS bands and then presented a cloud mask image of Namibian stratus as an example of the product. Additional examples can be found on the MODIS Atmosphere website at modis-atmos.gsfc.nasa.gov.

King then highlighted the MOD12 land cover type classification scheme, noting that the International Geosphere Biosphere Program classification product is being applied to MODIS data.

Next, King quickly moved through examples of cloud top pressure, cloud top temperature, cloud optical thickness, cloud effective particle radius, atmospheric water vapor, and precipitable water over land and sunglint.

King then highlighted the aerosol products from MODIS, which use 7 MODIS bands to derive aerosol properties over the land and ocean. Examples included a Gobi dust outbreak over China and Korea and global aerosol optical thickness and effective radius images for September 2000.

To finish, King offered the near-term plans for MODIS data processing. The updated algorithms were submitted in May and have been integrated into production. Plans are moving forward to test both forward production and parallel reprocessing to fill in a full year of production and should be completed near the time of the Aqua launch. Thirty-five MODIS products have been released to the public thus far, and all users are encouraged to order data from the Distributed Active Archive Centers (DAACs). The availability of MODIS data is published on the MODIS Atmosphere website at modis-atmos.gsfc.nasa.gov/products_calendar.html and is updated on a daily basis.

Following King, Wayne Esaias, the MODIS Oceans Group Leader, gave an overview of MODIS ocean products, including Terra performance and plans for Aqua. The MODIS ocean product suite includes 47 parameters in 9 product groupings (sea surface temperature, water-leaving radiance/atmospheric correction, chlorophyll case 1 and 2, fluorescence, sediments and optical attenuation, coccoliths and

calcite, phycobilipigments, bio-optical properties, and ocean net primary production).

Esaias presented a series of examples highlighting MODIS capabilities, including MODIS-SeaWiFS chlorophyll comparisons, MODIS-SeaWiFS ocean backscatter coefficient product comparisons, chlorophyll motion, aerosol optical depth, water-leaving radiance, coccolith concentration, instantaneous photosynthetically active radiation, fluorescence and productivity, and thermal sea surface temperature (SST). The provisional products, which are in production now, appear superior in many respects to precursor missions. The chlorophyll fluorescence observations and 4 µm nighttime SST observations are very exciting and offer tremendous research potential, although data system performance is a major concern and limitation.

Esaias next reported on MODIS SST coefficient determination. He noted that the coefficients were determined by the SST group through regression of nighttime MODIS brightness temperatures with Advanced Very High Resolution Radiometer (AVHRR) pathfinder SST to avoid diurnal heating contamination. For a satellite-satellite comparison, MODIS SST retrievals were compared with AVHRR pathfinder data and validated using MODIS side A for April and August 2000, and MODIS side B for December 2000. For a satellite-*in situ* comparison, MODIS SST retrievals were compared with Marine-Atmosphere Emitted Radiance Interferometer measurements over the Mediterranean Sea for April 2000 and over the Pacific Ocean for April 2001. The early results look very promising.

Regarding response versus scan angle (RVS) on SST, the radiative transfer approach for SST correction did not meet expectations, but a regressive approach gives promise of useful performance. It is not clear that better RVS from the deep space maneuver will improve the SST product. Thus the need for the Terra deep space maneuver has decreased, but this still leaves open the reasons why the forward physical approach failed. The SST group has concluded that further evaluation is needed, and the current approach requires a global satellite field to regress against. Esaias stressed that the radiative transfer approach for SST will be a priority for Aqua since it will have better characterization in bands 31 and 32. This reemphasizes the need for an Aqua deep space maneuver, to be done early in the mission.

Lastly, Esaias stressed that the Aqua MODIS is a different instrument than the Terra MODIS. The team expects that the initialization process may be more rapid for Aqua than it was for Terra, assuming that both instruments are stable, but that it will likely take longer than 3 months. The ocean group has already planned for the first release of combined Terra-Aqua products at one year after the initial release of Aqua products, but will initially focus on stable, validated products for Aqua and improvements in daily coverage and diurnal variability in SST, chlorophyll fluorescence efficiency, ocean current effects, and AMSR-E comparisons and synergy.

Following Esaias, Steve Running from the University of Montana described the anticipated MODIS-derived Surface Evaporation Index, a new product for the Aqua mission. This product was proposed in 1988, and since that time the algorithm for it has been developed and is awaiting the Aqua MODIS launch. The index uses a scale from 0 to 1, with values determined from the MODIS satellite data. It is felt that the afternoon data provided by the Aqua MODIS will be much more appropriate for this index than the morning data provided by the Terra mission, and hence there are no plans to implement the algorithm until the Aqua data are available. This index is expected to have immediate applications in drought monitoring for agriculture, water management, and fire danger management. It will also be useful in carbon cycle models and in climate models. Several hundred sites around the world will be used for validation.

Vince Salomonson reiterated the fact that the MODIS land, ocean, and atmosphere products are coming along well, as illustrated by the preceding MODIS speakers. He then proceeded to describe the status of the Terra MODIS instrument. There was an instrument shutdown from June 15 to July 2 that was apparently caused by a high-energy particle hit. The MODIS team is greatly relieved that the anomaly has been worked through and that the instrument is again operating, although using the A side electronics rather than the B side, which had earlier been found to be preferable. The shutdown will require a "noise check" and other performance evaluations associated with the change back to the A side.

Overall, the Terra MODIS is providing generally good spatial, spectral, radiometric, geometric, and quantization performance. Instrument noise and a host of other factors have been identified and reduced, leading to a satisfactory state for scientific use. Also, studies are continuing to optimize Level 1b products

Solomonson next reported that approximately 40 science products are in development and nearly all were released for production in Fall 2000. Many of the products are now considered by the MODIS team to be provisionally useful scientifically, but most will be undergoing

further checking and be even more appropriate for scientific use by Fall 2001. Use of the data is being encouraged, both for its inherent value and to get feedback and hasten validation.

Salomonson then presented selected results of the MODIS user survey conducted at the most recent meeting of the American Geophysical Union. While there are many exciting products for the community to use, those surveyed noted that the user interface is cumbersome. Salomonson mentioned that there are now improved data access capabilities and support initiatives. In addition, many user survey respondents noted that they would find the data more manageable if subsets of selected parameters for specific geographic regions were available. Progress is being made in this area, and there should be geographic, temporal, and parametric subsetting capabilities via the initial Data Pools release and FTP Pull distribution by December 2001. Also, some users expressed concern about the data only being available in Hierarchical Data Format (HDF)-EOS format. The team is studying the ability to convert MODIS HDF-EOS data to geographical information system format, based on the success realized from similar TRMM data conversions and on the ability to convert MODIS data to flat binary file format.

Status of the GES DAAC in handling Terra Data

Following the MODIS presentations, Steve Kempler, the GSFC Earth Sciences (GES) DAAC Manager, gave an update on the status of the GES DAAC and Terra data handling.

Kempler started by noting that there are three DAACs responsible for MODIS data ingest, archive, distribution, management, user support, and Level 1 production. These DAACs are the GES DAAC in Greenbelt, Maryland, the National Snow and Ice Data Center (NSIDC) in Boulder, Colorado, and the Earth Resources Observation System (EROS) Data Center (EDC) in Sioux Falls, South Dakota.

Kempler then commented on the status of GES DAAC MODIS Level 1 processing. Over 240 consecutive full days of Level 1 data have been processed, and during the last 8 months, Level 1 production was upgraded to process at 3x (i.e., at three times the rate of raw data collection), in preparation for the first MODIS reprocessing campaign. The EOSDIS Core System (ECS) has been producing Level 1 data in a timely fashion since September 2000, and has proven its processing capability. New ECS functionality is still being developed and delivered, and major new releases could introduce unexpected data handling risks. In meeting processing requirements, input/output is now the processing bottleneck.

Over the last 3 months, there has been an average of 18.3 terabytes of MODIS data archived at the GES DAAC per month, and 20.6 terabytes of data at all the MODIS DAACs. But average daily distribution has been considerably lower than expected, and the demand has not reached the theoretical capacity of approximately 446 gigabytes per day.

Kempler noted that over the last several months of study, survey, and solicitation, several reasons have been identified for the less-than-expected data distribution totals. These include system availability, data maturity, difficulties in ordering data, a confusing interface, very large data files, and the data only being available in HDF-EOS format. The DAAC understands these issues and is focused on resolving them. For example, data access, subsetting, and format tools are now available and ECS implementation of data pools is due in December 2001, which will allow for more flexible in-process data volume reduction software and a wider distribution. In addition, EOS Data Gateway (EDG) and GES DAAC user interfaces will continue to be supported with additional information and instruction, while a resurfacing of web pages will eventually offer additional information on data options. Finally, ECS implementation of the Product Distribution System will greatly enhance the variety of media in which data can be distributed.

Kempler then addressed the fact that there are many ways to obtain MODIS data, which can be confusing. The DAAC user services group is encouraging people to call on them for assistance.

There have been recent growing pains within the DAACs as well. Higher sustained volume increases due to reprocessing at the DAAC concurrent with data returned from the MODIS Team's processing has impacted data ingest into the system. Consequently, automated ingest throttling is being implemented and debugged. Also, approximately 40% of the MODIS Level 0 files are arriving truncated due to network issues, which are causing significant gaps in the data flow. The primary problem appears to be an EOS Data and Operations System (EDOS) network issue. Data gaps are being filled via tape transfer, which takes significantly longer to stage. *[editor's note: "The ESDIS Project notes that this problem has now been solved and reprocessing and retransmission requests to EDOS are virtually reduced to zero."]*

Kempler feels the DAACs will be ready for the Aqua data by the time of the Aqua launch. They anticipate delivery of additional storage space by September 2001, and spares are already on site. They

anticipate that only commercial-off-the-shelf product upgrades will be needed to maintain system support. Finally, operations agreements and operations documentation should be completed without problems.

Public Affairs Office (PAO) Plans for Aqua

The next speakers were Lynn Chandler of the Goddard Public Affairs Office (PAO). Parkinson congratulated Chandler on her recent appointment as the new head of EOS for the Goddard PAO. This position makes Chandler the key PAO representative for Aqua as well as the other EOS programs at Goddard.

Chandler presented an overview of the PAO outreach efforts for Aqua, the goals of which are to increase public awareness of the Aqua Program and its place in NASA's broader EOS program, and to increase scientific literacy regarding the mission. The tools are television, traditional print media, the World Wide Web, and radio, with television emphasized as the tool producing the largest payoff. Television coverage for Aqua will include pre-launch animations and interviews with scientists, a press conference at NASA Headquarters 14 days prior to launch, a press conference at Vandenberg Air Force Base one day prior to launch, and live launch coverage on NASA TV. Post-launch television coverage will emphasize science results as they are developed, including science visualizations. Chandler emphasized the need for scientists to focus the message they want to convey and to make it understandable to an average 12-year-old. PAO will also assemble a pre-launch press kit consisting of fact sheets, lithographs, and press releases. After launch, PAO will provide Aqua's first images and science results. PAO will additionally arrange for media training for Aqua scientists, and produce an Aqua Science Writers Guide for journalists.

PAO is in charge of registering guests for the launch viewing and coordinating bus service to and from the launch viewing site. Chandler mentioned that in light of the delays in the launch, additions can still be made to the launch-invitation list. Anyone connected with the Aqua mission who would like to be invited to the launch should contact Steve Graham at steven.graham@sesda.com and ask to be added to the list. The invitation allows entrance to Vandenberg Air Force Base on the day of the launch; no travel or other funds are included.

Although Goddard Space Flight Center is the lead NASA center for planning, implementation, and coordination of public affairs activities in support of Aqua, other centers have major related responsibilities as well. Kennedy Space Center is responsible for the PAO launch preparations and coverage, including television coverage from Vandenberg Air Force Base. Vandenberg will provide support to the entire PAO team throughout the launch activities. Langley Research Center is responsible for public affairs related to CERES; the Jet Propulsion Laboratory is responsible for public affairs related to AIRS; NASDA is responsible for public affairs related to AMSR-E; and Brazil is responsible for public affairs related to the Humidity Sounder for Brazil (HSB).

Rob Gutro followed Chandler, and explained the role of the EOS Project Science Office Science News and Information Team. Created in July 1998, the News Team's goal is to help identify and promote newsworthy science results and projects sponsored by NASA's EOS Program. The team, led by Gutro, is centered at Goddard but works with EOS researchers around the world, collaborating with the public information offices at the researchers' home institutions. The team has developed press materials with over 40 universities, research institutions and scientific organizations, resulting in media coverage from major television, radio, on-line, and print media outlets. The team also facilitates press coverage at major Earth science conferences and works with NASA TV to create broadcast quality video and graphics.

Gutro described the Aqua Science Writers' Guide that he will be working on over the next several months with the assistance of Aqua scientists. Gutro showed a preliminary list of topics to be covered in the guide and several of the scientists whom he expects to contact about these topics. Gutro also described some recent successes in getting news of EOS science out to the public through television and print media, including widespread coverage in late May and early June of new results on distributions of carbon monoxide from the Measurements of Pollution in the Troposphere (MOPITT) instrument on Terra.

Interagency Issues and the EOS Budget

Following Chandler and Gutro, Jack Kaye of NASA Headquarters was on hand to answer questions concerning interagency issues and the EOS budget. Kaye noted that the Earth Science Enterprise (ESE) is a major contributor to the United States Global Change Research Program (USGCRP). Progress is being made on a draft of the USGCRP ten-year plan, which contains six science themes: the carbon cycle, water cycle, ecosystem resources, climate, land cover/land use change, and atmospheric composition and aerosols. The ten-year plan also addresses cross-cutting issues such as observations, modeling, regional impacts, human

dimensions, and management. The plan is based on a conceptual framework of "change, vulnerability, and resilience" and, if fully implemented, should provide increased ties between traditional providers of global change information and those who need to make policy and management decisions based in part on environmental information.

President Bush has stated that he would like to increase the nation's investment in climate change research and has designated the Secretary of Commerce to coordinate a five-year plan among the relevant agencies. NASA is vigorously engaged in the interagency process and in defining a potential budget initiative for FY03. This new initiative builds on the carbon cycle initiative that has been under development for some time and includes focused components in the areas of modeling and computing.

The results of the House and Senate budget markups were also discussed, most notably the potential $15M reduction for EOS algorithms included in the Senate appropriations' language. If this provision is included in the final budget, it could have significant impacts on the production of products derived from the EOS data.

AIRS Science Team Update

After a lunch break, George Aumann, the AIRS Project Scientist, gave an AIRS/AMSU/HSB Science Team update. Hardware for AIRS, AMSU and HSB have been subjected to warm system testing without any complications; the System Comprehensive Performance Test (SCPT) has also been completed. The pre-thermal vacuum (TVAC) AIRS scan mirror inspection was completed on February 18, 2001, and cleaning was completed on May 20, 2001.

Concerning software status, Product Generation Software (PGS) version 2.1.5 has been delivered to the GES DAAC, and the final interfaces have been frozen. This is the last pre-launch PGS delivery. The next delivery will be a Level 1b post-launch update at launch +7 months.

Level 1b and Level 2 data processing software development contiues at JPL. Level 1b software has been revised based on Lockheed Martin/TVAC data and has been documented in the Level 1b Algorithm Theoretical Basis Document (ATBD) Rev. 2.2i. Level 2 software is based on simulated data derived from a general circulation model (GCM) and has been documented in the Level 2 ATBD.

Aumann noted that the global simulated data, which have been key for software development, have included realistic instrument noise and spectral characteristics. The global data field was based on a National Centers for Environmental Prediction (NCEP) aviation forecast, including multi-layer clouds, liquid water, surface emissivity and surface temperature, realistic gradients over land from AVHRR Normalized Difference Vegetation Index, and emissivity over the ocean from the Masuda model. For software development, the data are also available without clouds/without noise, and without clouds/with noise.

Aumann then stressed that the "golden day" concept is key to pre-launch software development and initial on-orbit verification. Team exercises using a December 15, 2000 simulation were conducted in January, May, and July 2001. These exercises tested data flow, display, retrieval and analysis software, and identified issues with the simulation and retrieval system. The analysis is continuing.

For AIRS/AMSU/HSB validation, the team is working towards the original schedule of DAAC delivery of validated PGS by launch +12 months. The "golden analysis" has been used to test the validation tools. The selections of the NASA Research Announcement (NRA) for the validation support teams were announced in May 2001 with funding to start October 2001. The AIRS Team is working with Bob Atlas of the GSFC Data Assimilation Office to integrate the newly selected personnel into the validation plan.

Next, Aumann reviewed the AIRS/AMSU/HSB verification and validation phase. Instrument operation will begin at launch +1 month and initial verification will be at launch +2 months. Initial validation using SST, internal update of Level 1b software, and data flow to direct assimilation teams will all be at launch +3 months. At launch +4 months, instrument and Level 1b software is expected to be stable, and the ARM/Cloud and Radiation Testbed validation program using dedicated radiosonde launches coinciding with Aqua overpasses will commence. Also, there will be an update of Level 1b software at the DAAC at launch +7 months, and an update of Level 2 software at the DAAC and routine production and distribution from the DAAC at launch +12 months.

Aumann reiterated the challenge set forth by James Baker of NOAA and Dan Goldin of NASA to demonstrate AIRS data assimilation impact by Launch + 12 months. To that effect, a second data assimilation workshop was held on May 16, 2001 (the first was held on December 6, 2000) and was attended by representatives of NCEP, the ECMWF, the UK Met Office, the Canadian Meteorological Center, and the GSFC Data Assimilation Office. The operational data link via NOAA's National Environmental Satellite Data and Information Service is in place and is currently

producing daily AIRS/AMSU-A/HSB "data" using the NCEP Aviation Forecast Model. The current data assimilation uses only Level 1b, cloud-free data. The AIRS science team will assist with cloud-free identification, cloud-cleared radiance utilization, and the forward and tangent model. The next workshop is scheduled for September 2001.

Lastly, Aumann commented on the pre-launch EOS Aqua IEEE special issue, noting that his team has commitments for 16 AIRS/AMSU/HSB related papers. A complete set of abstracts was received by June 20, 2001.

U.S. AMSR-E Science Team Update

Following Aumann, Roy Spencer, the U.S. AMSR-E Science Team Leader presented a status update on the AMSR-E instrument. On the hardware side, there is an issue with the design of the warm load. Thermal conductivity of the warm load is 0.13 $Wm^{-1}K^{-1}$ (compared with SSM/I's 1.37 $Wm^{-1}K^{-1}$). Temperature gradients exist along pyramids on the black body surface and across the entire load. The Mitsubishi Electric Company (MELCO) has implemented a fix that consists of moving two platinum resistance thermometers from the inside to the outside surface of the pyramids (this will help reduce uncertainty). NASDA/MELCO is performing an analysis to characterize the load and obtain calibration coefficients. Frank Wentz plans to do a post-launch analysis and verify the calibration coefficients.

After Spencer, Elena Lobl discussed the scheduling of AMSR-E validation activities, assuming an early 2002 Aqua launch. The soil moisture experiment (SMEX02) is the first AMSR-E campaign scheduled post-launch and is planned to take place in Oklahoma, Iowa, and Georgia. Shortly after the completion of SMEX02, there is a sea ice validation campaign scheduled in Antarctica with a short flight over Brazil on the return ferry (from Antarctica) for soil moisture validation. In 2003 the plan is to do a precipitation validation campaign in Wakasa Bay in collaboration with NASDA, a sea ice campaign in Alaska, and a snow water equivalent campaign in Colorado.

Other validation activities include monitoring a rainfall validation site (radar and rain gauges) in Eureka, California, and a soil moisture validation site in an area around Alabama A&M University (near Huntsville, AL).

Lastly, Lobl presented a list of new AMSR-E validation investigators, all of whom were selected from the scientists that responded to the Aqua Validation NRA.

Japanese Field Experiments for AMSR/AMSR-E Validations

Complementing the U.S. AMSR-E Science Team update, Keiji Imaoka of the Earth Observation Research Center (EORC) of the National Space Development Agency of Japan (NASDA) presented the Japanese AMSR-E Science Team update, focusing on validation strategy and validation sites. Japanese validation activities will cover jointly the AMSR instrument on ADEOS-II and the AMSR-E instrument on Aqua.

Operational activities are ongoing at NASDA/EORC, an *in situ* archive and match-up data generation are in place and continuing. Upper air sounding, precipitation, snow depth, sea-surface temperature, and wind velocity data are operationally collected and available in near real time. Soil moisture and snow data are also routinely observed, although not available in real time.

There are also experimental activities ongoing. An *in situ* archive and match-up data generation continues, a collaborative effort between the AMSR Principal Investigators, and the Global Energy and Water Cycle Experiment Hydrometeorology Panel. Automatic stations are collecting water vapor, cloud water, cloud height, precipitation, snow and soil moisture.

The following are AMSR validation sites with target parameters in parentheses: the Airborne Microwave Radiometer underflight (brightness temperature; i.e., calibration), Siberia (snow, soil moisture, and precipitation), Tibetan Plateau (snow, soil moisture, and precipitation), Mongolia (soil moisture), Thailand (soil moisture), Wakasa Bay (snowfall), Miyako-Yaeyama (precipitation), Minami-Daito and Hegura-jima (water vapor and cloud liquid water).

Update on the Aqua Mission Timeline

Following a break, Parkinson introduced Carolyn Dent, the Aqua Mission Manager, to give an update on the official Aqua Integrated Mission Timeline (IMT). The IMT document covers Aqua's launch and ascent, beginning at one hour prior to launch, and the spacecraft and instrument activation and checkout activities through the first 120 days after launch. It may take up to 30 days, dependent on launch date, before the spacecraft reaches its final intended orbit, at an altitude of 705 km, and is phased appropriately with respect to the Terra and Landsat spacecrafts.

As explained by Dent, if all goes as scheduled, the solar array will be deployed on day 0 (launch day), as will AMSR-E and the two CERES instruments. The AIRS instrument will be powered up on day 2, CERES on day 3, AMSU on day 8, and HSB on day 9. AMSU and HSB checkout activities will take place on days

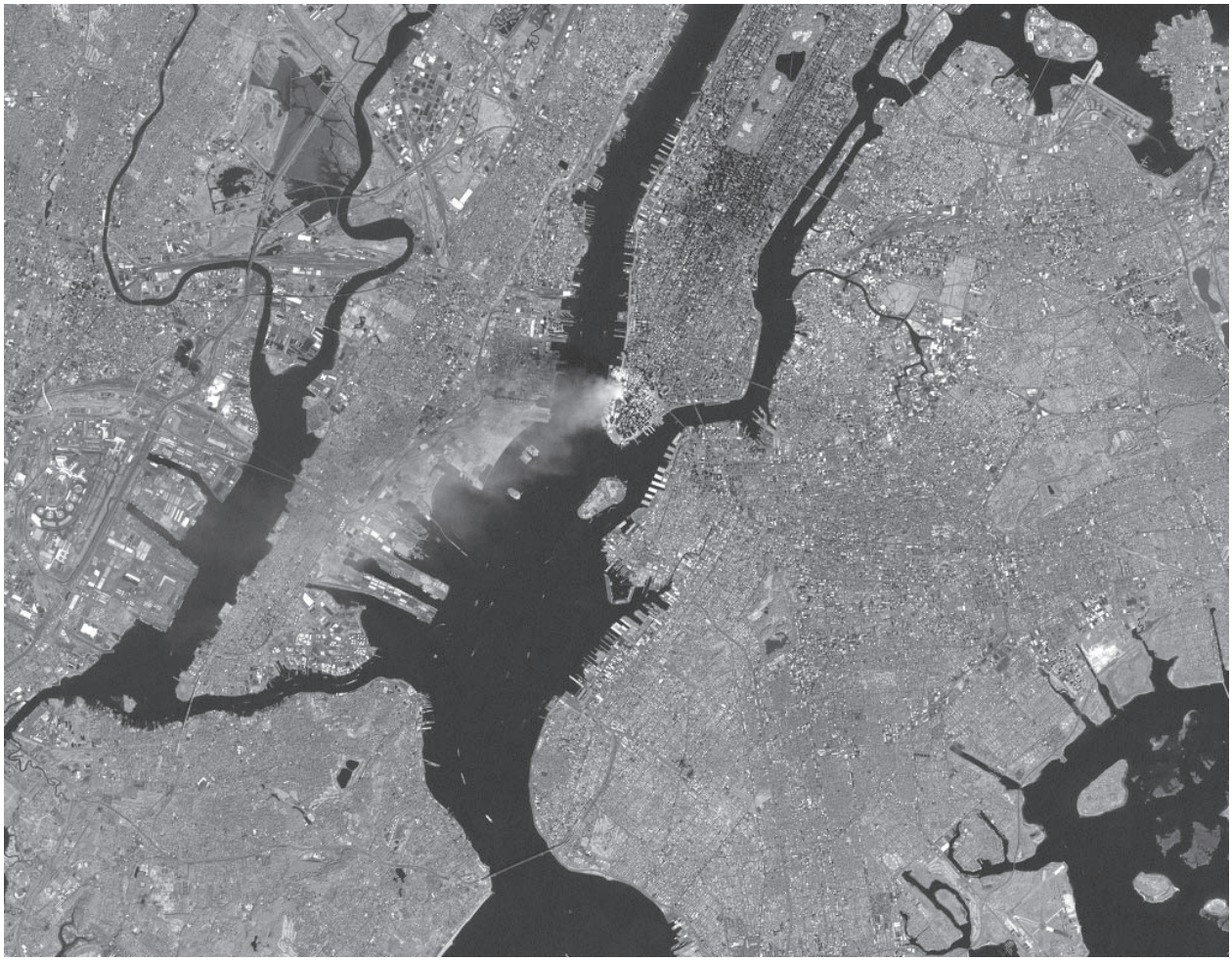
15-21, AIRS checkout activities on days 15-67, and CERES checkout activities on days 18-38. MODIS will be powered up on day 20; the AIRS Earth shield will be deployed on day 29; the AIRS cooler will be turned on 3 days later; and the MODIS space-view door will be opened on day 33. MODIS checkout activities will then take place on days 34-60, with MODIS yaw maneuvers occurring on days 37-38 and 42-43. CERES yaw maneuvers will occur on day 46 and the Aqua deep-space maneuver for CERES, MODIS, and AMSR-E calibrations will occur on day 60 or soon thereafter, depending on the location of the moon. The IMT was baselined on July 18, 2001 and can be found in detail on the Internet at aqua.qssmeds.com/docs.html.

Update on the A-Train (Aqua, ESSP-3, CloudSat, Parasol, and Aura)

The last presentation of the day was on the status of the A-Train and was given by Bruce Wielicki. PICASSO-CENA is now being called Earth System Science Pathfinder 3 (ESSP-3), but will soon be renamed, pending approval from NASA Headquarters. ESSP-3 and CloudSat are back on track for a joint Delta launch in Spring 2004, while Parasol is currently scheduled for a late 2004 launch.

The current formation plan for the A-Train includes CloudSat and ESSP-3 flying near nadir behind Aqua for the first two years. Beginning at the start of the third year, ESSP-3 precesses across the forward-scatter side of the MODIS swath over a one-year time frame, stopping at the edge of the MODIS scan. Parasol stays near nadir but sees a complete angle range.

Parkinson closed the meeting by thanking all the speakers and other participants and explaining that she will hold off on scheduling the next meeting until after Aqua's thermal vacuum testing is completed, at which time we might have a better sense of launch date possibilities.



Aftermath of World Trade Center Attack — This image was taken by the Enhanced Thematic Mapper Plus (ETM+) aboard the Landsat 7 satellite on September 12, 2001, at roughly 11:30 a.m. Eastern Daylight Savings Time. Visit the USGS Landsat 7 Websit for additional Landsat imagery. (Image courtesy USGS Landsat 7 team, at the EROS Data Center.)