Report on U.S./Japan ASTER Science Team Meeting

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The 26th Joint Japan/U.S. Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER) Science Team Meeting was held at Caesar's Palace, Las Vegas, Nevada from December 6 to December 10, 2004. The meeting was attended by about 60 people, including science team members from Japan and the U.S. and NASA Headquarters, as well as participants from other affiliated organizations.

At the opening plenary session, **M. Abrams** (Jet Propulsion Laboratory, JPL) and **H. Tsu** (Earth Remote Sensing Data Analysis Center, ERSDAC), the U.S. and Japan ASTER Science Team Leaders, opened the meeting with greetings on behalf of the U.S. and Japan. **E. Abbott** (JPL) described the schedule of the ASTER Science Team Meeting and other meeting logistics.

W. Turner (NASA Headquarters) talked about the EOS project status. He said rumors indicated the possibility of a 10-20% budget cut for Fiscal Year 2005 after the Office of Management and Budget (OMB) passback in the next few weeks.

F. Sakuma (National Institute of Advanced Industrial Science and Technology, NMIJ/AIST) reported on the instrument status. ASTER is operating normally. Shortwave infraded (SWIR) temperatures increased 1K this summer and then became stabilized. Flight Operations Team (FOT) and Japan Resouces Observation Sytem (JAROS) studied the problem, and concluded normal operations would continue. A new offset in data values is seen and compensated in the processing. Radiometric calibration coefficients for the visible and nead infrared (VNIR) and thermal infrared (TIR) will be modeled using an exponential function.

B. Bailey (U.S. Geological Survey Land Processes Distributed Active Archive Center [USGS LPDAAC]) described the ASTER emergency scheduling interface and control system for use by several preapproved users. He reported on theTerra ASTER metadata inventory web site, available in January, where the Level-1 metadata would be ftp-pulled by authorized users. LPDAAC and Ground Data System (GDS) are completing preparations for use of the Asia-Pacific Advanced Network (APAN) network to replace airplane shipping of data to and from Japan and the U.S. Both sides are changing over to a Linux processing environment by June 2005. Granule-distribution statistics indicate that foreign and educational users make up 60%, followed by commercial users at 20%. The LPDAAC has produced over 5400 digital elevation models (DEMs) so far, but the backlog of orders is 2600 scenes (some large individual orders).

Y. Kannari (Earth Remote Sensing Data Analysis Center, ERSDAC) talked about the status of GDS in Japan. The extension of the NASA/Japan Ministry of Economy, Trade and Industry (METI) Memorandum of Understanding (MOU) was signed on October 22, 2004 through an Exchange of Notes; it extended the MOU until 2012. He described the General Programming Request progress, and noted that the system would be operational last month. APAN and Linux conversions were discussed again from the Japan perspective.

B. Eng (JPL) described the status of the Level 2 software. The next version is being tested at the LPDAAC, and includes TIR recalibration option; SWIR crosstalk correction option; support for optional input hierarchy; and bug fixes.

K. Okada (Earth Remote Sensing Data Analysis Center, ERSDAC) gave the Science Scheduling group report. Over 880,000 ASTER scenes have been observed. He described the Operations and Mission Planning Working Group *ad hoc* meeting in September (details are found in the working group report). The Science Team Aquisition Request (STAR) review is almost completed, and necessary edits are being made to remove requests no longer active nor needed. VNIR pointing issues will be discussed in the OPM working group.

Y. Yamaguchi (Nagoya University) described a committee of Japanese aerospace companies formed to discuss post-ASTER projects. A final report is due in early 2005. The Japan Aerospace Exploration Agency (JAXA) also has a similar committee, with a final report due in spring 2005.

A. Gillespie (U. Washington) and M. Abrams presented the status of the *Remote Sensing of Environment* special issue, and articles submitted to *Transactions on Geoscience and Remote Sensing* (TGARS). In both cases, articles are in review, and publication is anticipated in 6-12 months.

V. Realmuto (JPL) presented an overview of ASTER and MODIS/ASTER (MASTER) airborne simulator work on Mount St. Helens (MSH) by many ASTER team members. ASTER obtained several useful overpasses, despite clouds. The MASTER instrument coincidentally was stationed in Oregon, and was tasked to stay in the area for 3 weeks to overfly the mountain as the volcanic crisis intensified. Several spectacular data sets were obtained, in conjunction with 1-m lidar data for elevation models (EMs).

K. Thome (U. Arizona) laid out the logistics for Wednesday's field trip to Ivanpah Playa, coinciding with an AS-

TER overpass and calibration/validation experiment.

M. Abrams and **Y. Yamaguchi** charged the group with issues to be discussed during the working group meetings, and reported at the closing plenary.

Working Group Reports

Radiometric Calibration Working Group

The radiometric calibration working group and ASTER Calibration Team meeting was held on Tuesday, December 7, 2004. The meeting was co-chaired by **S. Biggar** (University of Arizona) and **K. Arai** (Saga University).

F. Sakuma discussed Radiometric Calibration Coefficient (RCC) determination for ASTER, including the use of fitting to allow for smooth variation of the coefficients with possible extrapolation in the VNIR. Historically, step changes were made in the RCC when the calibration had changed by more than the uncertainty in the absolute calibration. Sufficient data have been acquired to show that the change in the VNIR subsystem according to On-Board Calibration (OBC) data follows an exponential function after a bit less than 2 years in orbit. SWIR is basically stable. The prediction of the TIR RCC was also discussed.

H. Tonooka (Ibaraki University) presented the RCC for the TIR subsystem. The TIR system changes are reflected in the RCC and are updated frequently. Further refinements can be made by accessing the recalibration web site.

The next series of talks focused on results of recent vicarious calibrations.

K. Arai presented vicarious data showing that ASTER is following the trends found earlier. **Tsuchida-san** (AIST) also presented work on the VNIR and SWIR.

Q. Sanford (University of Arizona) presented new work using a cross-calibration with the Moderate-Resolution Imaging Spectroradiometer (MODIS) over Railroad Valley (RRV) and African desert areas. This work indicates that an exponential function predicts the performance of the VNIR subsystem of ASTER when compared to MODIS.

K. Thome presented vicarious results for the VNIR collected since the last calibration meeting. There is an unexplained upward trend in some recent data that will be studied.

H. Tonooka presented recent TIR vicarious results.

R. Alley (JPL) showed additional TIR vicarious results. The vicarious results fit with the trend in TIR response.

S. Hook (JPL) presented recent TIR results from Lake Tahoe and some information about updates to the JPL thermal radiometers used for vicarious calibration. The ASTER TIR subsystem compares well with MODIS over Lake Tahoe, especially when the ASTER data are recalibrated.

B. Eng (JPL) reported the U.S. side is testing production software to make a correction for SWIR crosstalk in bands 5 and 9. This product corrects Level 1A data before it is used in the production of Level 2 and higher products. The crosstalk correction will be an optional step in processing. **A. Iwasaki** (AIST) presented a newly developed correction for the SWIR filter and also for some stray light effects other than crosstalk. This software may be made available at a later date after further testing. **T. Tachikawa** (ERSDAC) gave a short presentation about changes to the science web site. Of note are the links to the recalibration data.

Atmospheric Correction Working Group

The Atmospheric Correction Working Group met Wednesday afternoon co-chaired by **S. Tsuchida** and **K. Thome**. The meeting began with a discussion of past action items during which Thome showed that the look-up table resolution is not the cause of artifacts seen in the Band 2 surface reflectance product.

B. Eng (JPL) gave an update of the current status of the processing software and a description of planned improvements for including MODIS-based aerosols and water vapor, a SWIR crosstalk correction, and the improved water vapor scaling method for the TIR correction.

K. Thome described work to develop a new VNIR/SWIR correction look-up table based on MODIS-derived aerosols as well as comparisons of the AST-07 surface reflectance product to ground-based measurements of surface reflectance. The results of this work show that the Band 1 calibration may be an issue as well as Band 9 crosstalk or water vapor.

H. Tonooka (Ibaraki University) then gave two talks related to the atmospheric correction of the TIR. Comparisons of retrieved emissivities from the atmospheric correction from known surface types to laboratory spectra showed similar results for inputs from both MODIS-based results and from National Centers for Environmental Prediction (NCEP) analysis. Errors in the correction also show larger errors at larger water vapor amounts. The error, as shown by Tonooka in the next talk, decreases dramatically when the water-vapor scaling approach is used.

L. Mars (USGS) gave the final talk for this working group, and showed the results of comparisons of ground spectra to atmospherically-corrected ASTER and Airborne Visible/Infrared Imaging Sectroradiometer (AVIRIS) data. Mars used AST-07 surface reflectance products for the comparison as well as results with and without crosstalk correction and those including column water vapor from MODIS-based retrievals. The overall conclusion was that there is a possible Band 5 calibration issue and that water vapor effects appear to dominate the crosstalk effects in Band 9. In addition, Mars found that the NCEP water vapor

product produced results that were not as good as the MODIS products.

Geology Working Group

D. Pieri (JPL) reviewed the action items from the June team meeting. **M. Bishop** (Indiana University) has been investigating regional mass balance for Himalaya glaciers. He found a negative mass balance, and a warming trend expressed in the geomorphology.

Jeff Kargel (USGS) showed examples from Peru where ASTER data were effective in mapping features of environmental and natural hazards.

A. Gillespie described investigations of geomorphology in Mongolia that demonstrated that ASTER can provide key clues to the understanding of the impact of paleo-climate events on Asia as compared to the impact on North America and Europe.

D. Pieri showed how ASTER data are documenting degradation of permafrost along the Alaskan coast. There is a combination of diminished sea ice and permafrost melting spelling catastrophe for native subsistence villages. Pieri gave two talks on using ASTER for planetary analogs for Mars, and using TIR data to determine spectral signatures applied to spectroscopy of Earth-like extra-solar planets.

L. Trunk (University Washington) is investigating the thermo/spectral signatures of volcanic lakes to develop basic research and hazards methodologies. **R. Dominquez** (NASA Ames Research Center, ARC) introduced a new function that attaches location and elevation to each MASTER pixel. **G. Vaughan** (JPL), **M. Ramsey** (University Pittsburgh) and **S. Hook** (JPL) showed how MASTER data well-documented the evolution of the latest volcanic crisis at MSH, including thermal characteristics and composition. Lessons learned from MSH point to the need for advanced planning for the next eruption in the U.S.

S. Hook presented problems anticipated when we release the ASTER/MASTER data to the public. **M. Ramsey** presented ASTER/Forward-Looking Infrared (FLIR) observation results at MSH and Bezymianny Volcano. **M. Urai** (NMIT/AIST) presented observations at Satsuma-Iwojima demonstrating the ability to monitor and detect high-temperature fumarolic emissions. **D. Pieri** described the Volcano Data System that will permit rapid web access to ASTER volcano data observation histories.

F. Kruse (HGI Imaging) showed comparisons of Hyperion data and ASTER for geologic mapping of hydrothermally altered rocks. ASTER data can be used to separate out many of the important mineral classes, but does not work as well as the hyperspectral data. **D. Sabol** (University Washington) used ASTER data to calculate/discriminate playa thermal inertias, and related that to soil moisture content.

Ecosystems/Oceans Working Group

The Working Group was co-chaired by **A. French** (U.S. Department of Agriculture, USDA), and **Y. Yamaguchi** (Nagoya University).

M. Ramsey (U. Pittsburgh) discussed the current and future mapping and analysis of desert aeolian deposits in the Kelso Dunes, Gran Desierto east of the mouth of the Colorado River in Mexico and desert dunes by Lake Chad. These studies utilize ASTER multispectral, thermal, and high resolution aspects to better understand the relationships between sediment source regions and the dunes.

M. Abrams discussed work he has been doing with Gary Geller on development of the Protected Area Archive Tool, an easy-to-use software tool incorporating a GIS interface to allow conservation resource managers to view ASTER and Landsat data over their lands of interest. The tool was presented at the World Conservation Congress Meeting in Bangkok in November where it attracted very high interest.

W. Stefanov (NASA Johnson Space Center, JSC) presented urban heat island analysis studies over two large and rapidly growing cities: Houston and Phoenix. ASTER, MASTER and Thematic Mapper (TM) observations reveal relationships between social income and environment. Future work will focus on incorporation of the MM5 model (MM5 is a mesoscale model developed jointly by Pennsylvania State University and the National Center for Atmospheric Research) with ASTER observations and astronaut photography.

A. French presented results from surface-energy-flux model intercomparisons over an Iowa site and showed the importance of ASTER thermal bands and their higher spatial resolutions.

H. Tonooka presented again his surface emissivity ratio approach for snow/ice monitoring a second time (to allow those not present earlier in the week to learn of his work).

T. Tachikawa gave an overview of ERSDAC Ecosystem research projects on Ecosystem for 2003, which encompasses seven diverse subject areas including coastal zone monitoring, carbon storage in woodlands and urban heat island analysis. Work for 2004 is similarly diverse and will be presented in full at the next ASTER Science Team meeting.

STAR Committee Working Group

K. Okada discussed the problems with the Science Team Aquisition Request (STAR) tool network at GDS. He offered to change the IP address outside GDS to get it working again. **L. Maldonado** (JPL) committed to send current STARS to reviewers by email until the web tool problem is resolved. **K. Duda** (LPDAAC) described the Emergency scheduler web tool. It will be used by several pre-approved users. Japan GDS was interested in the tool, and Duda

will investigate sharing the software with GDS.

Level 1/DEM/Geometric Working Group

M. Abrams reviewed the action items from the previous meeting, and declared them closed. **H. Fujisada** (Sensor Information Laboratory Corp.) reported that there were no changes to the Level 1 processing software. Level 1 geometric performance for inter-telescope and intra-telescope registrations continues to be well within specifications. A longitude error in the geolocation accuracy was discovered recently. It first appeared in July 2003, and has increased to about 180 m. Fujisada tracked it down to uncompensated terms in the nutation of the Earth's rotation. Numerical modeling almost perfectly models the error. A fix will be made in the next Level 1 software delivery, and the correction will be included in the JPL web site lat/long correction program.

B. Bailey reported that errors were increasing in both the relative and absolute DEMs produced at the LPDAAC. Tests have ruled out operator error. It was decided that 2 commercial off-the-shelf (COTS) packages would be evaluated as possible replacements for the current DEM software.

M. Abrams described a project that produced superresolution DEMs by averaging 4-5 ASTER DEMs, and combining them with Shuttle Radar Topography Mission (SRTM) DEMs. The final product was created as a 10 m DEM, and mostly meets the specification for the Level 3 DTED.

Science Scheduling Support Group/ Operations and Mission Planning Working Group

L. Maldonado reviewed the action items coming from the September *ad hoc* meeting in Tokyo. Twelve items were closed, three were continued. **K. Okada** reported on the instrument support terminal. The hardware has been successfully upgraded and the network established. Work is continuing on the final software installation.

N. Cole (JPL) reported on the Mission Analysis Tool for generating metrics and analysis for mission acquisitions. It is almost operational, and is undergoing final testing. **L. Maldonado** talked about the ASTER Mission Simulator rebuild at JPL. The tool will help future acquisition planning for ASTER. It is almost operational and will be available in a few weeks.

K. Okada led the discussion on the status of the STAR acquisition request reviews. Only two STARs were still out for review. Okada next presented several reports on behalf of speakers who could not be present. He gave a report on behalf of **H. Muraoka** (Geotechnos Co. Ltd.) on the Global Mapping 2nd round. It started August 2003, and 18,000 scenes have been collected with <20% cloud cover. Australia acquisitions have been very successful. Additional STARs will be submitted to fill 162 gaps in Global Map 1. By next team meeting we must have a plan for 2006-08 acquisitions. He also presented a report on behalf of **H. Sekine** (Mitsubishi Research Institute, Inc.) on the status of the Nighttime TIR acquisition project. Areas of interest (AOIs) were finalized, and the requests submitted. The STAR will run for one year, then be re-evaluated. Okada next presented a report on behalf of **A. Miura** (ERSDAC) on the General Programming Request project. The system became operational in November. Finally, Okada presented a report on behalf of **S. Huzikawa** (Geotechnos Co. Ltd.) concerning VNIR pointing. A study revealed the problem with the scheduler during the Spring 2004 test to limit pointings. Future recommendations are to disallow arbitrary pointings and maintain the seven fixed pointings; minimize wide-angle VNIR pointings; and make sure it works properly for the remaining observations.

Temperature/Emissivity Separation (TES) Working Group

A. Gillespie reviewed the action items coming from the Joint Science Team Meeting in June 2004 in Tokyo. No items were closed, three were continued.

H. Tonooka reported on the status of TIR nighttime global mapping. The nighttime STAR is having a big impact but over a limited area. STAR parameter files of all of the AOI are ready now—observations will start soon. After first-year results are evaluated, maybe second and third years will be acquired as indicated.

W. Gustafson (U. of Washington) reported on the status of the atmospheric correction study that has been on-going at U.W. At the June 2004 meeting a problem with the lookup table (LUT) index in atmosphere correction code was suspected. Now it has been proven and B. Eng has fixed it. Maximum radiance error is typically 1-10%, mean is 0.5-4.0%. This includes Tonooka's recalibration. There will continue to be problems under rapidly changing atmospheric conditions. With the correction of this problem, the Temperature and Emissivity Separation (TES) parameters can be restored to their planned values (as opposed to the "detuned" values required by the sub-par performance of the ASTER data and correction algorithms, now corrected).

H. Tonooka talked about snow/ice monitoring using surface emissivity ratios. The emissivity changes with conditions in a well-known way, and ASTER Band 14 is the most sensitive channel. This has been tested with the CIMEL sun photometer. Tonooka proposes a Surface Emissivity Ratio (SER) for 10.4/12 μm: at 10.4 μm, all snow/ice has the same emissivity. The SER increases from frost to ice, but the change is small. However, the Surface Radiance Ratio (SRR) is a function of tem-

perature, unlike SER. Use of SRR may require a new, tuned regression based on predicting minimum emissivity from spectral contrast. ASTER 13/14 is noisy. MODIS may give better results, but the resolution is much worse.

D. Sabol (U. of Washington) gave an update on the continuing TES validation program at the existing sites: Hawaii (28 scenes), Railroad Valley (60 scenes), Salton Sea, and Lake Tahoe. Day/night image results will be compared at playas in the Mojave Desert. Collaboration at the Barrax (Spain) test site was undertaken in June 2004.

H. Tonooka discussed resolution enhancement of shortwave infrared (SWIR) and TIR images (lossless sharpening). Higher resolution SWIR data were used to predict TIR values, controlled by the lower-resolution TIR as possible.

A. Gillespie made further comments on the validation program, which will be expanded by collaboration with Jose Sobrino to include classification with ASTER VNIR data to improve temperature recovery for spectrally flat surfaces, and an adaptation of in-scene relative atmospheric corrections such as In-scene Atmospheric Correction (ISAC) for ASTER. MODIS atmospheric profiles will be used and compared to NCEP data, and an effort will be made to use Multiangle Imaging Spectroradiometer (MISR) and other aerosol products to improve atmospheric correction. ASTER and Multispectral Thermal Imager (MTI) results will be compared in collaboration with Lee Balick at Los Alamos National Laboratory (LANL). Remaining concerns include cirrus.

A. French reported on ASTER TES used for mapping surface temperatures by Frederick Jacob in Toulouse, with test sites there and in Avignon.

A. Gillespie led discussion and assignment of new action items. A new action item was assigned to the nighttime Working Group, to specify new targets for acquisition, to be reported at the Tokyo meeting in June 2005. The atmospheric correction code fix should be documented and team members notified. The TES parameter adjustment may not have been implemented similarly in all versions of the code, and this must be verified.

Field Trip to Ivanpah Playa

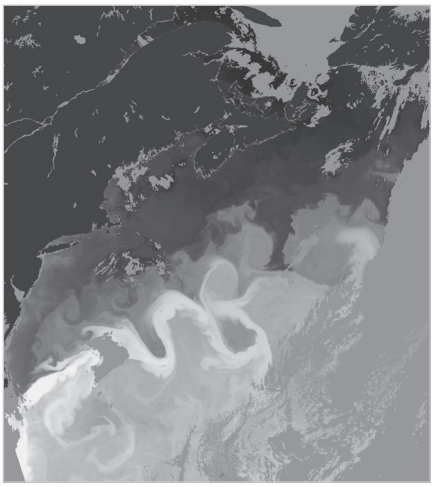
An ASTER acquisition was scheduled for Ivanpah Playa near the California/Nevada border on Wednesday, December 8, 2004. A number of groups doing vicarious calibration took equipment to Ivanpah. Another group of ASTER Science Team members traveled from the Las Vegas meeting location to the playa to observe a vicarious calibration experiment. The observer group left the hotel at about 8 A.M. meeting at the Las Vegas Fashion Mall in Primm.

Groups of investigators from both the Japanese and U.S. ASTER Science Teams set up equipment on the playa during the morning before the scheduled ASTER acquisition (18:32 GMT). Solar radiometers were deployed as were radiometers to measure the spectral reflectance of the playa surface. Thermal radiometers were also set up to measure surface temperature and a radiosonde was launched to measure atmospheric temperature and water vapor profiles. However, there were clouds at various levels during the ASTER overpass so the data collected will be of marginal value for vicarious calibration.

Visiting ASTER Team Members were able to view the equipment and watch the various data collection procedures. Simon Hook tried carrying an ASD radiometer used to measure the reflectance in the VNIR and SWIR wavelength region after watching the University of Arizona group make a collection. In total, about 40 people were involved in the field trip.

Closing Plenary Session

The closing plenary session featured short summations by each of the Working Group chairs, reviewing discussions, presentations and action items. **Jon Ranson** (NASA Goddard) the Terra Project Scientist, described science highlights of the Terra mission, discussed the status of the Terra mission, and presented information on the upcoming NASA Headquarters Senior Review for Terra. **M. Abrams** and **H. Tsu** closed the meeting with a promise to meet again in May or June, 2005 in Japan.



The Gulf Stream Current is one of the strongest ocean currents on Earth. This river of water that ferries heat from the tropics far into the North Atlantic pulls away from the coast of the U.S. Southeast around Cape Hatteras, North Carolina. There the current widens and heads northeastward. In this region, the current begins to meander more, forming curves and loops with swirling eddies on both the colder, northwestern side of the stream and the warmer, southeastern side.

This image shows the sea surface temperature of the Gulf Stream on April 18, 2005. The warm waters (light shades) of the Gulf Stream snake from bottom left to top right, showing several deep bends in the path. In fact, the northernmost of the two deep bends actually loops back on itself, creating a closed-off eddy. On the northern side of the current, cold waters (dark shades) dip southward into the Gulf Stream's warmth.

NASA image courtesy Norman Kuring, MODIS Ocean Team