ASTER Science Team Meeting Report

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The forty-second Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER) Science Team Meeting took place December 10-13, 2012, at the Sheraton Pasadena Hotel in Pasadena, CA.

Opening Plenary Session

H. Tsu [Japan Space Systems (J-spacesystems)—*Japan ASTER Science Team Lead*] and **M. Abrams** [NASA/Jet Propulsion Laboratory (JPL)—*U.S. ASTER Science Team Lead*] welcomed 61 U.S. and Japanese Science Team members and interested participants to the meeting. The team leaders informed attendees of the renewed Memorandum of Understanding (MOU), agreed upon by the U.S. Department of State and the Japan Ministry of State, which extends the ASTER project for seven more years.

M. Abrams opened with the latest news from NASA headquarters. He introduced **K. Thome** [NASA's Goddard Space Flight Center (GSFC)] as the new Terra Project Scientist [replacing Marc Imhoff (GSFC)] and supplied a timeline for the next Terra Senior Review in 2013. Abrams summarized ASTER science highlights, outreach activities, and recent publications. He concluded with a report on the Terra platform's fuel usage and battery status, confirming nominal spacecraft and instrument operations.

M. Kikuchi [J-spacesystems] reported on ASTER instrument status, addressing lifetime management, radiometric response, and end-of-mission (EOM) planning.

S. Hook [JPL] provided updates on the Hyperspectral Infrared Imager (HyspIRI[1]), Hyperspectral Thermal Emission Spectrometer (HyTES[2]), and Prototype Hyperspectral Thermal Infrared (TIR) Radiometer (PHyTIR[3]) activities. HyspIRI workshops are being held on an annual basis in advance of the post-2020 launch.

B. Eng [JPL] discussed the status of the Landsat Data Continuity Mission (LDCM)—the eighth in the Landsat series—scheduled to launch February 11, 2013[4].

M. Ramsey [University of Pittsburgh] reviewed Mineral and Gas Identifier (MAGI[5]) overflight activities and data analysis. Ramsey also discussed his involvement in outreach activities, including the "PhD in Residence" program funded under his ASTER award.

T. Matsunaga [National Institute for Environmental Studies (NIES)] provided an update on the Hyperspectral Imager Suite (HISUI[6]), a spaceborne instrument with hyperspectral and multispectral imagers. HISUI is the fourth spaceborne optical imager developed by the Japanese Ministry of Economy, Trade, and Industry (METI).

M. Hato [J-spacesystems] reported on ground data system (GDS) status, providing updates on observation scheduling, data processing, and product distribution. He then addressed activities planned for 2013. Level-1A (L1A) software will be updated following the termination of the shortwave infrared (SWIR) data stream, and all GDS Information Management System (IMS) users must reregister following the unification of ASTER and Phased Array type L-band Synthetic Aperture Radar (PALSAR) GDS data distribution systems.

D. Meyer [U.S. Geological Survey Land Processes Distributed Active Archive Center (USGS LP DAAC)] reviewed LP DAAC ASTER activities, including data production, distribution metrics, EOM planning, and the usefulness of application-ready ASTER products such as TerraLook.

M. Fujita [J-spacesystems] presented the Science Scheduling Support Group (SSSG) and Operations and Mission Planning (OMP) report. He reviewed the general status of ASTER scheduling and observation progress for major Science Team Acquisition Requests (STARs).

To close the plenary session, **Y. Yamaguchi** [Nagoya University] proposed two working group (WG) discussion issues: data acquisition monitoring and radiometric calibration coefficient (RCC) updates.

Working Group Sessions

Level-1/Geometric/Digital Elevation Model (DEM)

H. Fujisada [Sensor Information Laboratory Corporation (SILC)] started the session by discussing L1 software updates. Two adjustments are in progress: modifications to the L1 software to account for the suspension of SWIR data, and minor correction for the L1A+ and L1A++ tools. No appreciable problems were reported for ASTER geometric performance, instru-

[1] HyspIRI is a National Research Council (NRC) Decadal Survey *Tier II* mission, containing a visible shortwave-infrared (VSWIR) imaging spectrometer and a multispectral thermal-infrared (TIR) scanner.
[2] HyTES provides science risk reduction for HyspIRI; its first flights on an airborne platform began in July 2012.
[3] PHyTIR supplies engineering risk reduction for HyspIRI; instrument assembly will begin in 2013.
[4] **Update:** LDCM successfully launched on February 11 at 1:02 PM EST from Vandenberg Air Force Base in California.
[5] MAGI, an airborne sensor funded by NASA's Instrument Incubator Program (IIP), has 32 TIR channels.
[6] HISUI will be one of the mission instruments onboard Japan Aerospace Exploration Agency's (JAXA) Advanced Land Observing Satellite-3 (ALOS-3), scheduled for launch no earlier than 2015.

ment inter- and intra-telescope registration, or DEM accuracy. Fujisada then presented plans and improvements for the upcoming ASTER Global DEM Version 3 (GDEM V3).

R. Crippen [JPL] detailed the completion of his merged Shuttle Radar Topography Mission (SRTM)/ASTER GDEM 1-arcsecond DEM. Funded through NASA's Making Earth System Data Records for Use in Research Environments (MEaSUREs) Program, Crippen's hybrid DEM fills voids, removes clouds and glitches, and fixes elevation and shoreline errors. The completed product will be released to the public, free of charge, at three-arcsecond postings in early 2013. He also announced plans to develop a NASA Digital Elevation Model (NASA DEM)—using reprocessed SRTM data—that will be suitable for public release at 1-arcsecond postings.

D. Meyer discussed LP DAAC ASTER data production status and distribution metrics. He also reviewed the U.S. Science Team's recommendation to generate and archive all ASTER L1B and higher-level data products (HLDPs) at EOM. Meyer's talk concluded with discussions on the desirability of a L0 archive, and how to proceed with the NASA/Terra Senior Review's recommendation to include orthorectified HLDPs in the EOM archive.

Temperature-Emissivity Separation (TES)

Y. Yamaguchi presented work on the normalized difference vegetation index (NDVI)-based spatial sharpening of TIR images. Results obtained using the established thermal sharpening method (TsHARP) can be improved when the effect of spatial extent is considered.

H. Tonooka [Ibaraki University (IU)] began his series of presentations by announcing the release Version 1 of the Satellite-based Lake and Reservoir Temperature Database in Japan (SatLARTD-J). This publicly available online database, which uses ASTER TIR data, includes all major lakes and many small water bodies in Japan. Tonooka then proposed the incorporation of a spectral emissivity ratio-based TIR snow/ice index (TSI) to enhance traditional remote sensing techniques for snow and ice. He ended by discussing the National Institute of Advanced Industrial Science and Technology's (AIST) ASTER time-series orthorectified products and IU's role in generating land-surface temperature and emissivity (LST&E) products. Comparison studies to evaluate emissivity maps generated by IU and JPL are underway.

S. Kato [NIES] reported on results derived from a Terra/Moderate Resolution Imaging Spectroradiometer (MODIS) mid-infrared (MIR) and TIR validation experiment. By coordinating a Terra overpass with the intentional burning of a wood building, researchers found that the MODIS MIR bands detected the burning area, but not the TIR bands. Using Moderate Resolution Atmospheric Transmission (MODTRAN) simulations and ASTER TIR comparisons, investigators concluded that *burning events* are detectable by high-resolution sensors at TIR bands and coarser-resolution sensors at MIR bands.

G. Hulley [JPL] detailed methodology to generate a unified high-spectral-resolution (HSR) MODIS/ASTER (MODAST) emissivity database, a NASA MEaSUREs project. Fusing ASTER Global Emissivity Mapping (ASTER-GEM) HSR data with MODIS Baseline-Fit (MODBF) V4.1 data enhances the advantages of the two products while minimizing their individual limitations. Hulley then presented an update on the MODIS-TES (MOD21) LST&E product. Developed at JPL using the ASTER TES algorithm, MOD21 will be released in 2013 with MODIS *Collection 6*.

M. Ramsey summarized the presentation that he and A. Gillespie [University of Washington] gave at the American Geophysical Union (AGU) conference in December 2012 on the variability of emissivity. *Emissivity*, which is typically taken to be constant in remote sensing, is not always immutable. Their presentation detailed two kinds of variable emissivity—*artifactual/apparent* and *natural*—and showed that each can dramatically alter the emissivity spectrum of common minerals.

A. Gillespie provided an update on a study conducted with **E. Abbott** [JPL] aimed at determining if TIR reflectivity of Earth-surface materials is a significant function of *kinetic temperature*. Though samples of field spectra and Nicolet reflectivity spectra initially suggested change, the results were not reproducible in subsequent experiments. They concluded that TIR reflectivity of common Earth-surface materials is constant at ambient temperatures.

M. Ramsey presented mineralogy analysis of the Salton Sea geothermal field using data collected with the MAGI sensor. Comparison work among MAGI data, field data, and Spatially Enhanced Broadband Array Spectrograph System (SEBASS) data is ongoing.

The session ended with two TIR Global Mapping (TGM) presentations. **M. Fujita** reviewed the current status of TGM5; **H. Tonooka** analyzed TGM5 achievements using a MOD35-based cloud assessment, and then initiated a WG discussion on future TGM plans.

Radiometric Calibration/Atmospheric Correction (RC/AC)

B. Eng provided a status update for the U.S. ASTER atmospheric correction (L2) software. Following the verification of bug fixes implemented at the LP DAAC, V3.4 will replace V3.2 as the production version, with completion expected in January 2013. Meanwhile, V3.5 is under development.

F. Sakuma [J-spacesystems] reviewed visible and near-infrared (VNIR), TIR, and SWIR onboard calibration trends; no significant changes were reported. Sakuma also presented TIR outgassing test results.

M. Kikuchi summarized ASTER instrument status. The radiometric response in the VNIR and TIR has been decreasing gradually. To prevent further deviation from the fitting curve, during the first quarter of 2013 RCC parameters for VNIR and TIR will undergo simultaneous revision from V3.12 to V.3.13. Based on the recommendation of the RC/AC WG, the VNIR RCC will remain fixed at a constant value following the RCC version update. Kikuchi also reported fault tree analysis (FTA) results for VNIR and TIR sensitivity degradation, and that inclination adjustment maneuvers (IAM) conducted in 2011 and 2012 had negligible influence on VNIR and TIR sensors. His presentation concluded with an EOM instrument action plan proposal.

A series of discussions describing field campaigns and future plans followed, including presentations by: **H. Yamamoto** and **S. Tsuchida** [Geological Survey of Japan (GSJ)/AIST], **K. Arai** [Saga University]; **H. Tonooka, S. Kato,** and **T. Matsunaga** [NIES], **T. Fukuhara** [Hokkaido University] and **T. Kouyama** [AIST], and **J. Czapla-Myers** and **S. Biggar** [University of Arizona].

Results from cross-calibration studies support the proposal to fix the VNIR RCC at a static value. **K. Arai** conducted a cross-calibration comparison study using ASTER, Enhanced Thematic Mapper Plus (ETM+), MODIS, and Multi-angle Imaging Spectroradiometer (MISR) sensors. His cross- and vicarious-calibration results showed stable gains for all VNIR bands since 1500 days after launch. While these results were in close correspondence, they differed from onboard calibration values. Because this discrepancy is increasing, he emphasized the importance of implementing a fixed RCC value. **H. Yamamoto** and **S. Tsuchida** performed ASTER–MODIS cross-calibration in conjunction with vicarious calibration to help understand the radiometric degradation trend. While cross- and vicarious-calibration results are in agreement, onboard-calibration results deviate. The WG recommends switching to a scaled calibration coefficient (SCC) and discontinuing the use of the onboard calibration degradation curve.

A. Iwasaki [University of Tokyo] discussed his investigation of the relationship between detector and preamp temperature and odd-even stripe noise.

Geology

M. Abrams relayed an ASTER Geoscience Maps of Australia Project report on behalf of **T. Cudahy** [Western Australian Centre of Excellence for 3D Mineral Mapping—*Director*]. A suite of GIS-compatible ASTER-derived mineral map products covering the entire Australian continent was released to the public at the thirty-fourth International Geological Congress (IGC) conference in August 2012. In addition to the maps' targeted use for mineral exploration, these map products can also be used for tracking desertification and assessing climate change impacts. Because mineralogy is a missing component from global resources and environment information system practices, such as the Group on Earth Observations (GEO), the WG encouraged further development of global ASTER geoscience maps.

J. Jay [Cornell University] reviewed ASTER volcano and glacier projects conducted with **M. Pritchard's** [Cornell University] group, and provided an update on the Cornell Andes Project. Thirty-five Andean volcano hotspots have been uncovered from a manual survey that included all ASTER nighttime TIR scenes collected over the region through 2010. (Prior to this study, only eight known hotspots existed in the Andean region). Jay then discussed the Cornell group's analysis of glacier velocities and elevation changes in Patagonian and southeast Alaskan icefields. Results show each icefield is thinning, and that overall mass change rates determined from ASTER DEMs agree with Gravity Recovery and Climate Experiment (GRACE) measurements.

J. Kargel reported on his combined use of ASTER data with field measurements to determine the cause of the May 2012 disaster in Seti River Basin, Nepal. Time-series analysis of data from both these sources showed that a deep-gorge rockfall might have dammed glacier meltwater drainage, creating an impoundment lake. Subsequently, a massive avalanche off Annapurna IV likely triggered the devastating flash flood. Following his fieldwork, Kargel participated in a NASA/U.S. Agency for International Development (USAID) workshop, *From Space to Village*, where he disseminated to the Nepalese public scientific findings related to the Seti River flood disaster.

J. Mars [USGS] discussed a NASA Applications Project that uses ASTER data to map hydrothermal alteration on volcanic summits. Because hydrothermally altered areas are prone to life-threatening debris flows, Mars' first 10 hazard maps will be selected from a pool of 100 mapped volcanoes, based on alteration extent and population distribution. All ASTER-derived map products, including *lahars* hazard maps and GIS shapefiles, will be available for download from the JPL ASTER Volcano Archive (AVA): *ava.jpl.nasa.gov*.

M. Ramsey's first presentation provided an update on the ASTER Urgent Request Protocol (URP) program, a rapid-response volcano-alert system. By highlighting two recent eruptions in the North Pacific—namely, Tolbachik and Chirpoi—Ramsey demonstrated

the effectiveness of the URP system for acquiring, analyzing, and disseminating ASTER volcano data. Ramsey then described work, with graduate student S. Anderson [University of North Colorado], to create TIR and DEM maps of the Kizimen eruption. Ramsey (and Anderson) analyzed time-series ASTER data to document the progression of the lava flow. High-speed TIR video of active pyroclastic flows collected in the field will help validate flow-progression models.

V. Realmuto [JPL] discussed *Plume Tracker*[7] developments. The new V3.0 retrieval algorithms provide high numerical efficiency and high accuracy, ensuring optimal performance for upcoming graphic processing unit (GPU)-enabled radiative transfer (RT) modeling capabilities.

M. Urai [GSJ/AIST] reviewed the use of volcano hotspots to determine nighttime TIR geolocation accuracy. He showed results obtained over Erta Ale, located in northeastern Ethiopia, that indicate accuracy has improved with the implementation of geometric DB V3.02. On the other hand, geolocation errors persist over Erebus, located in Antarctica, indicating a latitude-dependent orthorectification issue.

P. Webley [University of Alaska Fairbanks (UAF)] discussed the importance of monitoring volcanic activity with remote sensing for aviation hazard assessment and risk reduction. He summarized UAF's Alaska Volcano Observatory suite of web tools and real-time thermal detection/alert system: *avo.images.alaska.edu/tools*.

J. Linick [JPL] introduced the newly redesigned AVA (URL listed above)—the online global volcano database of ASTER imagery. The AVA, covering all 1542 volcanoes from the Smithsonian's archive, contains over 134,000 individual granules and almost 3.5 million generated products. The new automatic data validation, ingest, and product generation process allows near-real-time AVA updates, with minimal manual intervention.

D. Pieri [JPL] provided a progress report on *in situ* gas and ash sampling activities at Turrialba Volcano in Costa Rica. Field data are combined with satellite measurements for detailed volcano-emission analysis. To conclude, Pieri presented plans for two upcoming Turrialba airborne deployments to correspond with ASTER overpasses.

Operations and Mission Planning

T. Tachikawa [J-spacesystems] presented a progress report on SWIR-off procedures. To successfully transition to *SWIR-off* mode, it will be necessary to update the following items:

- the *L1A processing algorithm,* to include dummy SWIR data (March 2013);
- the *scheduling parameter*, to reflect the change in data rate for full-mode observations without SWIR data; and
- *activity commands/sequence operations,* by turning off either the SWIR instrument or the SWIR data output to the solid-state recorder (SSR).

The full-mode data rate change may allow a 35% increase in daytime observations. The instrument team recommends turning off the SWIR data output as opposed to turning off the instrument itself.

M. Fujita analyzed ASTER observation resources and provided status updates for various STARs. The Global Mapping 5th Round (GM5) was submitted in February 2012, and will continue to acquire ASTER data globally until April 2017—or until observation rates level off. The achievement rate of nighttime TGM5 continues to be monitored with input from the TES WG. The Underserved Area (UA) STAR 2012 was submitted in June 2012, using the same areas of interest (AOI) as UA STAR 2011. Additional support STARs were submitted for Alaska, to increase collection opportunities in the region. AOIs for the next UA STAR will be generated following the release of GDEM V3. Fujita reviewed observation progress for both the Global Land Ice Measurements from Space (GLIMS) STAR 2012 and the Volcano STAR 2010. He then discussed urgent observation and field campaign success rates. To address failures caused by arbitrary shifts in the one-day schedule (ODS) end time, the ASTER Operation Segment (AOS) system was upgraded to allow operators to manually set the ODS end time. Fujita's presentation concluded with a summary of pointing-cycle resource consumption.

L. Maldonado [JPL] summarized Data Acquisition Request (DAR) user registration statistics for the lifetime of the ASTER mission. On average, 250 new DAR proposals are submitted each year.

T. Tachikawa discussed improved scheduling performance following the August 2012 adjustment of the scheduling priority parameter for cloud avoidance. Tachikawa's analysis revealed an increase in cloud-free ASTER scenes, a significant improvement in nighttime cloud avoidance, and less failure of urgent, GC, and local STARs.

K. Duda [LP DAAC] outlined L1 expedited data set (EDS) processing status, distribution metrics, and options for online access. Duda detailed new LP DAAC EDS website functionalities, including an email alert subscription service and map visualization options.

[7] *Plume Tracker* is an interactive toolkit for mapping volcanic plumes with remotely sensed multispectral TIR data.

Ecosystem/Oceanography

K. Iwao [GSJ/AIST] began by offering a summary of ASTER-related ecology research activities in Japan. He then discussed the current status of the ASTER/AIST Global Urban Area Map (AGURAM). Employing an automated method for integrating ASTER images and GIS data, AGURAM covers 3500 cities at 15-m resolution.

J. Kargel introduced a proposal requesting ASTER inputs to contribute to an in-depth biophysical survey of the Upper Seti Basin, Nepal. Year-round ASTER imaging would help improve understanding of the mass movement environment and processes, including snow avalanches, rockfalls, and debris flows.

L. Prashad [Arizona State University (ASU)] discussed ASU's 100 Cities Project and Java Mission-planning and Analysis for Remote Sensing (JMARS) for the Earth [J-Earth] activities. J-Earth updates include code integration with all JMARS products and the incorporation of *OpenStreetMap*[8] data. While the capability for users to directly import ASTER data is still under development, import is possible by processing ASTER data with *daVinci*[9] and using J-Earth as a display tool. The 100 Cities Project increased their global urban imagery holdings by obtaining all ASTER L1B, surface emissivity (AST05), and surface kinetic temperature (AST08) data for cities with populations over 500,000. The project is working with the LP DAAC to distribute these products as "Urban Bundles" with select urban-relevant datasets. Prashad concluded with examples of humanitarian remote sensing applications.

[8] Founded in the U.K. in 2004, *OpenStreetMap* is a GPS-based community project to generate editable global maps.
[9] *daVinci* is an interpreted language with vector-oriented features that works well as an image-processing tool.

G. Geller [JPL] discussed *TerraLook*[10] activities, including plans for an upcoming "TerraLook-inspired" version of Google Earth Engine.

STAR Committee

The committee heard, reviewed, and approved a new STAR proposal to support the HyspIRI preparatory aircraft campaign. Updates to the GLIMS and Volcano STARs will be forthcoming. **R. Crippen** reported that his GDEM/SRTM void-fill STAR proposal would be finalized by the end of January 2013. The STAR Committee will meet with the TES WG to discuss TGM modifications that will be required following the cessation of the SWIR data stream. The session concluded with the introduction of an action item to promote ASTER DAR and STAR capabilities.

Closing Plenary Session

All attendees reconvened to hear summaries from each WG session and to discuss issues proposed at the opening plenary. A short presentation by the instrument calibration team described their recommended actions to address VNIR response degradation, including fixing the RCC at present values so that RCC values do not deviate further from cross- and vicarious-calibration values. Attendees also discussed TGM data acquisition monitoring following SWIR data-off. Resource allocations will likely be rebalanced between day and night collections.

The meeting concluded with an announcement that the forty-third ASTER Science Team Meeting has been scheduled for June 10-12, 2013, in Tokyo, Japan. ■

[10] The *TerraLook* program provides no-cost access to ASTER and historical Landsat georeferenced *jpeg* images, along with a suite of simple visualization and analysis tools.

NASA Ups the TEMPO on Monitoring Air Pollution

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For More Information

On degradation of air quality over the Canadian tar-sand oil excavation fields

- McLinden, C. A., V. Fioletov, K. F. Boersma, N. Krotkov, C. E. Sioris, J. P. Veefkind, and K. Yang, Air quality over the Canadian oil sands: A first assessment using satellite observations, *Geophys. Res. Lett.*, **39**, L04804, doi:10.1029/2011GL050273, 2012.

On the potential of observing air quality from geostationary orbit

- Fishman, J., et al., Remote sensing of tropospheric pollution from space. *Bull. Amer. Meteor. Soc.*, **89**, 805–821, 2008.
- Fishman, J., *et al.*, The United States' Next Generation of Atmospheric Composition and Coastal Ecosystem Measurements: NASA's Geostationary Coastal and Air Pollution Events (GEO-CAPE) Mission, *Bull. Amer. Meteor. Soc.*, **93**, 1547-1566, doi:10.1175/BAMS-D-11-00201.1, 2012. ■