# 2017 ASTER Science Team Meeting Summary

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## Introduction

The forty-eighth joint U.S.-Japan meeting of the Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER) Science Team was held at the Japan Space System's offices in Tokyo, Japan, June 5-7, 2017. The meeting attracted over 40 participants and offered 5 working-group sessions. From the U.S., participants were from NASA's Goddard Space Flight Center (GSFC), NASA/Jet Propulsion Laboratory (JPL), University of Pittsburgh (UP), University of Arizona (UA), University of Washington (UW), and U.S. Geological Survey (USGS). From Japan, participants were from the Japan Space Systems (JSS), Ibaraki University (IU), Nagoya University (NU), University of Tokyo (UT), National Institute of Advanced Industrial Science and Technology (AIST), Sensor Information Laboratory Corp (SILC), National Institute for Environmental Studies (NIES), and Japan Aerospace Exploration Agency (JAXA).The main goals of the meeting were to discuss the:

- status of the ASTER instrument and Terra spacecraft;
- upcoming August 5, 2017, Lunar Deep Space calibration maneuver with the Terra spacecraft;
- release of the Global Digital Elevation Model (GDEM) Version 3; and
- updates on image acquisition scheduling for the following year.

## Session Highlights

### *Opening Plenary Session*

Japan and U.S. Science Team leaders **Y. Yamaguchi** [NU] and **M. Abrams** [JPL] opened the meeting and greeted the participants.

**J. Hendrickson** [GSFC] reviewed the status of the Terra spacecraft, reporting that all systems are operating nominally, with no unusual events since the last team meeting a year ago. He added that fuel consumption is within projected values, and debris avoidance maneuvers have been fewer than last year's.

**M. Kikuchi** [JSS] reported that the ASTER instrument was operating nominally. He stated that the number of off-nadir pointing maneuvers is within operational limits. He also reported that the visible-near-infrared (VNIR) and thermal infrared (TIR) instruments were operating normally.[1]

**T. Maiersperger** [USGS] summarized ASTER-related activities at the Land Processes Distributed Active Archive Center (LPDAAC) over the previous 12 months. He reported that the distribution of ASTER data products has increased by 6-to-10 times since the elimination of charges for ASTER data, starting in April 2016. Maiersperger also introduced the Earthdata interface that will replace Reverb[2] as one of the tools to order ASTER data.

### *Applications Working Group Discussions*

The Applications Working Group provides a platform for team members to present and discuss their science research activities using ASTER data. The majority of work being done is in the disciplines of geology, oceanography, and ecology.

**S. Nakamura** [JSS] provided an overview of JSS's Space Business Court, both a virtual and brick-and-mortar place where entrepreneurs, researchers, and

[1] The ASTER Short Wave Infrared (SWIR) instrument has not been functional since 2009.
[2] Reverb was an Earth science data processing tool developed by Earth Science Data and Information Systems (ESDIS).

Attendees at the 2017 ASTER Science Team Meeting held in Tokyo, Japan. **Photo credit:** T. Tachikawa manufacturers can learn about space-based data, how to add value to remote sensing data, match start-ups with venture capitalists, and provide contacts with engineering companies. The goal is to help the commercial sector use government-sponsored remote sensing data archives and experience. Nakamura also introduced *Fieldnaut*, an Android mobile phone app that combines satellite images, global position system (GPS) technology, photos, and notes to improve the efficiency of field surveys. Finally he presented five international projects sponsored by JSS. Topics included illegal deforestation in Peru, carbon dioxide ($CO_2$) emissions in Indonesia, mineral recycling in Serbia, lead contamination in Zambia, and wetland management in Uganda.

**K. Kurata** [NU] presented her research results on combining multiple lithologic indices by using the hue, saturation, and value (HSV) color model—a common cylindrical representation of points that better represents how people relate to color than the common red-green-blue (RGB) model. This novel method of extracting and displaying mineralogical information from ASTER data by transforming mineral indices into HSV color space provides a simple and effective way to display a large amount of information in one interpretable presentation. Kurata showed an example that displayed clay mineral species as hue, clay mineral amount as saturation, additional information on quartz and carbonates as hue, and topography as value—see **Figure**.

**D. Pieri** [JPL] provided a summary of his work in Hawaii as part of the Hyperspectral Infrared Imager (HyspIRI)[3] preparatory campaign, held over the Island of Hawaii in January and February 2017. He explained that the unmanned aerial vehicle (UAV) flights over Kilauea volcano were coordinated with overpasses of the Moderate Resolution Imaging Spectroradiometer/ASTER Airborne Simulator (MASTER) and Airborne Visible/Infrared Imaging Spectrometer (AVIRIS) scanners onboard NASA's ER-2 aircraft, as well as ASTER satellite overpasses. Near-field sulfur dioxide ($SO_2$) levels of up to 250 parts per million by volume (ppmv) were found, while $CO_2$ levels ranged up to 500 ppmv. The three-dimensional distributions derived from the UAV data will be compared with spatial gas column abundance from the airborne and spaceborne sensors to improve models of volcanic fog or *vog* that causes pollution as far away as Oahu.

*Radiometric Calibration Working Group Discussions*

The Radiometric Calibration Working Group is responsible for monitoring the ASTER instruments to

[3] More information on HyspIRI can be found at *https://hyspiri.jpl.nasa.gov*. A report on the most recent HyspIRI Symposium appears in the May–June 2017 issue of *The Earth Observer* [**Volume 29**, **Issue 3**, pp. 26-30—*https://eospso.gsfc.nasa.gov/sites/default/files/eo_pdfs/May%20June%202017%20color%20508.pdf*].

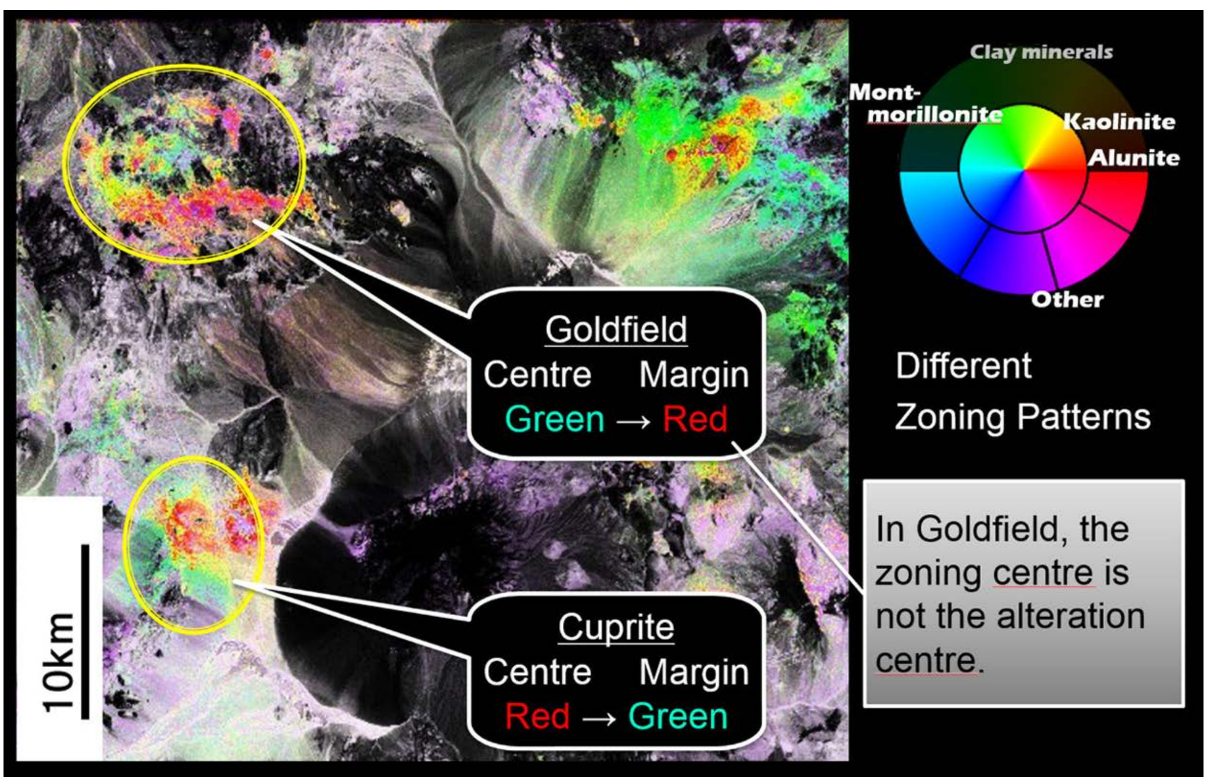


**Figure**. Example of hue, saturation, and value (HSV) processing of ASTER data to highlight mineral composition as hues, mineral amount as saturation, and topography as brightness. The area is in western Nevada over the Goldfield and Cuprite mining centers; clay and mineral composition (montmorillonite, kaolinite, and alunite) are displayed as different hues. **Image credit:** K. Kurata understand and characterize their responses to scenes being observed. The group noted that the instrument response is changing smoothly with time. The group also determined updated calibration coefficients to maintain calibration of the data. To monitor the instruments' performance, the team uses data from the onboard calibration lamps for the VNIR channels and onboard blackbody for the TIR, combined with *in situ* field validation campaigns.

**F. Sakuma** [JSS] reported on the onboard calibration data using two standard lamps. These lamps were calibrated against NIST standards before launch. Their behavior since launch has been monitored with thermistors with well-defined characteristics. As a result, the data are within 1% of the radiometric calibration curves that are used to calibrate the VNIR data. Long-term calibration of the TIR bands, using the onboard blackbody and *in situ* field validation results, continues to be within the threshold of the radiometric calibration curves. In February 2017 the Radiometric Calibration Coefficients (RCC) were updated to reflect small changes in detector responses.

**J. Czapla-Myers** [UA], **H. Yamamoto** [AIST], **H. Tanooka** [IU], **S. Kato** [AIST], and **M. Abrams** [JPL] presented field campaign results. *In situ* validation experiments are used in conjunction with the onboard calibration lamps and blackbody to assess the instrument performance and to update the calibration coefficients. Field campaigns were conducted in the western U.S. at large playas (the Railroad Valley, Alkali Lake, and Ivanpah playa, all in Nevada) and on Kasumigaura Lake in Japan. In the U.S., data from instrumented, autoreporting validation sites (Lake Tahoe and Salton Sea) supplemented the field campaign results. Despite the fact that the previous nine months had been cloudier than average, sufficient data were acquired to confirm that the instrument VNIR and TIR responses were well understood and characterized.

This session also included an in-depth discussion of the upcoming Lunar Deep Space Calibration maneuver for Terra, which is currently scheduled for August 5, 2017. The Flight Operations Team plans to have Terra perform a 360° pitch maneuver to look at deep space and the moon—repeating an experiment conducted in 2003—to obtain accurate performance and response characteristics for the ASTER detectors. In addition, MODIS and the Multi-angle Imaging Spectroradiometer (MISR) will obtain similar calibration data. The Flight Operations Team, working with each instrument team, has spent the last 12 months scripting and practicing the maneuver.

**T. Kouyama** [AIST], **S. Kato** [AIST] and **F. Sakuma** [JSS] described several aspects of the experiment, providing a recap of the 2003 maneuver and the results obtained. They explained that the lunar data obtained in 2003 were used to help calibrate ASTER data and to reveal minor artifacts in the imaging systems. They explained that the 2017 date selected for the maneuver is the best match for the phase angle of the moon relative to Terra such as occurred in 2003. A contingency date in November 2017 has been selected in case the maneuver is waved off (e.g., in the event a debris avoidance maneuver is required).

*Level 1-DEM Working Group Discussions*

The DEM Working Group evaluated improvements to Global Digital Elevation Model, Version 3, (GDEM3), planned for release in July-August 2017 as an ASTER standard product, replacing the current Version 2.

**H. Fujisada** [SILC] and **R. Crippen** [JPL] presented similar methods to address the remaining artifacts in GDEM3. They agreed to work together to produce a combined, cleaned-up GDEM3 for release later this summer. This release will have the minimum number of artifacts of any GDEM version, as each successive version is improved from the previous version. GDEM3 will be the final GDEM produced and released by the ASTER project.

**H. Fujisada** [SILC] discussed corrections and improvements he had made to GDEM3, in version 3.1. Describing his four-step process, he stated that the first step was to replace bad GDEM values with those obtained from Shuttle Radar Topography Mission (SRTM) V3, Alaska DEM, and Canadian Digital Elevation Data (CDED). Fujisada explained that in cases where none of the data sources identified in step one were available, he used GMTED2010 7.5 arc-second data.[4] Further, he explained that where none of the datasets were available, he used interpolation. Step four was to correct a few errors of land adjacent to shoreline, with SRTM V3 data. Volcanic basalt was incorrectly identified as ocean on Norfolk Island, for example. Fujisada then showed examples where these errors were fixed using this four-step process.

**R. Crippen** [JPL] presented his work to remove artifacts in GDEM3, mainly the result of cloud edges that were not removed in the compilation procedure. His method was to: mask the errors in GDEM3; mask errors in GDEM2; fill GDEM3 voids with either GDEM2 or SRTM data; and then fill any remaining voids by interpolation. Additionally, Crippen planned to fix tile edge mismatches (unknown source of error), fix errors of places with negative elevations, replace bad Canadian DEM values, fix coastal issues, and increase SRTM fill resolution using newly-reprocessed SRTM

[4] The 2010 Global Multi-resolution Terrain Elevation Data (GMTED2010) is an elevation dataset from the U.S. Geological Survey and National Geospatial-Intelligence Agency. The data are provided at 30-, 15-, and 7.5-arc-second spatial resolutions.

data. He showed examples to illustrate the effectiveness of his methods.

*Temperature-Emissivity Separation Working Group Discussions*

The Temperature-Emissivity Separation Working Group is responsible for monitoring and maintaining the algorithms to produce the calibrated temperature and emissivity ASTER products from the Level 1 TIR data. The group monitors the acquisition program that obtains global coverage of Earth's entire land surface. A time-series is obtained by repeating the acquisition scheduling on a regular—i.e., several-year—basis. Repeat coverage allows monitoring of changes to the land surface from natural or anthropogenic causes, such as desertification.

**Y. Takahashi's** work on estimating oil thickness over water using ASTER thermal data was presented by co-author **H. Tonooka** [IU]. They analyzed data from the Gulf of Mexico's New Horizon spill in 2010 and the Bunga Kelana 3 spill off Singapore in 2010. Their technique is based on an oil-film radiation model described by Matsui *et al.* in 1974 that related the TIR values in different wavelengths, to the thickness of an oil film.[5] For the New Horizon spill, results from ASTER and MODIS gave consistent and similar results; however, oil thickness near the leak point was smaller than its surroundings because the model was developed for oil films, not for thick oil layers. The second case they analyzed, the Bunga Kelana spill, produced results that were consistent with reported amounts derived from in-water measurements.

**H. Tonooka** [IU] summarized the progress of the nighttime TIR data acquisition program, the goal for which is to obtain global nighttime TIR coverage on a recurring basis, which would be similar to the coverage for the daytime global mapping activity. The present acquisition program has been operating for the past 23 months. During the near-two-year acquisition of data, about 80% of the targeted areas had been observed at least once under clear sky conditions. Because there are few areas that had not been imaged, the group recommended restarting the nighttime global mapping this month (as if no data had yet been acquired).

*Operations and Mission Planning Working Group Discussions*

The Operations and Mission Planning Working Group oversees all scheduling of ASTER instruments. Because ASTER acquires data only on demand, a complex scheduling algorithm has been developed to assemble daily schedules for which scenes will be acquired. Various mapping programs take place simultaneously, such as the global mapping program that operates in the background when no higher-priority acquisitions are scheduled.

**M. Fujita** [JSS] presented summaries and status updates on all of the ongoing acquisition programs. The Global Mapping-7 program has successfully acquired about 44% of the programmed scenes with 20% or less cloud cover; the group recommended continuing it for at least one more year. The currently running Nighttime TIR Global Mapping was to be suspended, and the next mapping program was to begin, based on recommendations from the Temperature-Emissivity Separation Working Group. The Underserved Area program (an effort to acquire images over persistently cloudy areas) will be continued for at least one more year. The Glacier Monitoring Program will be restarted in the next few months based on recommendation from the Global Land Ice Measurements from Space (GLIMS) project. The Volcano Monitoring Program (which provides frequent day and night coverage of 1500 active volcanoes) will continue for the next few years. The Remote Island Program (which obtains single scenes over isolated mid-ocean targets) will continue. Urgent observations (e.g., field campaigns, volcano monitoring, and natural hazards) were summarized, and the reasons for the 2% failures of the urgent and field campaign requests (3 of 143) were examined individually. The failures occurred because of requests received after the allowed scheduling window had closed.

**T. Tachikawa** [JSS] presented a summary of the cloud avoidance algorithm performance. By using cloud predictions, data acquisition efficiency increased about 10%.

## Closing Plenary Session

The chairpersons of each of the working groups presented summaries of discussions and presentations for each of their sessions. Further discussion of the information presented during the sessions by the entire team was encouraged. The Terra platform and the ASTER instrument are performing normally, with no change since the preceding 2016 team meeting. Continuing discussions about the August 2017 Lunar and Deep Space Calibration maneuver verified that plans were acceptable and the maneuver would be carried out as scheduled. The GDEM Version 3 will be released in summer 2017, pending final correction of the few remaining artifacts. The next meeting will be held June 4-6, 2018, at the same venue in Tokyo. ■

[5] M. Matsui, Watanabe, K., Yoshida, K., *et al.,* 1974, Hydrocarbon Components of Floating Oil Pollutants of Seawater, *Bull. Japanese Soc. Of Scientific Fisheries*, 40, 111-116.