Summary of the Fifty-First U.S.–Japan ASTER Science Team Meeting

Michael Abrams, NASA/Jet Propulsion Laboratory/California Institute of Technology, mjabrams@jpl.nasa.gov
Yasushi Yamaguchi, Nagoya University/Japan Science and Technology Agency, yasushi@nagoya-u.jp

Introduction

The Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER) Science Team (ST) organized a three-day workshop that took place November 7–9, 2022 at Japan Space System's (JSS) offices in Tokyo, Japan. Over 40 people from Japan and the U.S. participated in the in-person meeting—some of whom are shown in **Photo 1** below. This was the first ST meeting—and the first ASTER-related in-person meeting—since prior to the pandemic in 2019.[1] U.S. participation included representatives from NASA/Jet Propulsion Laboratory (JPL), NASA's Goddard Space Flight Center (GSFC), NASA's Land Processes Distributed Active Archive Center (LPDAAC), University of Arizona (UA), University of Pittsburgh (Pitt), and University of Washington (UW). Japanese participation included representatives from JSS, Ibaraki University (IU), Nagoya University (NU), University of Tokyo (UT), Tohoku University (TU), National Institute of Advanced Industrial Science and Technology (AIST), and University of Tsukuba (UTs).

The main objectives of this meeting were to discuss mission status; data products; science team projects; data calibration, validation, distribution, and applications; as well as end-of-mission plans.

Another topic of immediate concern was NASA Headquarters' (HQ) recent Request For Information (RFI) for new science that could be conducted as the orbits of Terra, Aqua, and Aura drift; and the associated Aqua, Aura, and Terra Drifting Orbits Workshop (held online November 1–2, 2022), where each instrument team discussed the appropriate submissions with their constituency, and sought additional ideas for new science. With the 2023 Senior Review coming up in the spring of 2023. NASA HQ has some important decisions to make regarding future funding for Terra, Aqua, and Aura. The information collected during the Drifting Orbits workshop is expected to help inform the decision making.[2]

Opening Plenary Session

The opening plenary session took place on the afternoon of the first day of the ASTER workshop and was devoted to general topics about mission operations, instrument status, and data distribution. **Yasushi Yamaguchi** [NU] and **Michael Abrams** [JPL]—the ASTER Science Team Leaders from Japan and the U.S., respectively—opened the meeting and welcomed participants.

The next three presenters gave updates on the status of the Terra spacecraft, the Terra Ground Data System, and the ASTER instrument, respectively.

Jason Hendrickson [GSFC—*Terra Flight Systems Manager*] reviewed the status of the Terra platform. He reported that all systems are functioning nominally. In September, ASTER agreed to completely turn off the short-wave infrared (SWIR) instrument, saving over

[1] To read a summary of the most recent meeting, see "Summary of the Fiftieth ASTER Science Team Meeting" in the September–October 2019 issue of *The Earth Observer* [**Volume 32**, **Issue 5**, pp. 21–25—*go.nasa.gov/3XwB0Bp*].

[2] To learn more about the topics discussed in this paragraph, see page 2 of "The Editor's Corner" in this issue.

Photo 1. Some of the attendees at the Fifty-First ASTER Science Team workshop. **Photo credit:** Akiko Arima/JSS

meeting summaries

200 watts of power for the platform. In October, Terra executed two Morning Constellation-exit maneuvers,[3] lowering the orbit by 5.5 km (~3.4 mi). Since its final inclination maneuver in February 2020, Terra has been drifting; the orbit reached 10:15 AM Equator crossing time (from 10:30 AM) in October, and will continue to drift earlier, reaching 9:00 AM in late 2026. Data capture—for all five instruments—continues at ~100%.

Akira Miura [JSS—*Deputy Director*] described the status of the Terra Ground Data System. After the October Morning Constellation-exit maneuver, the Level-1A (L1A) ASTER processing failed. JSS is investigating the cause of this failure. All acquired data are meanwhile being archived for later processing.

Hitomi Inada [JSS—*ASTER instrument Manager*] summarized the status of the ASTER instruments. All systems are performing nominally—with the SWIR instrument having been turned off in October. Telemetry of monitoring systems on ASTER report that systems are currently stable.

The next three presenters focused on issues related to ASTER data acquisition, storage, and distribution in the U.S. and Japan.

Frank Lindsay [GSFC] discussed the Earth Science Data and Information System (ESDIS), which manages NASA's DAACs and provides guidance for post-mission ASTER archive activities. He showed several documents during his presentation that describe the required standards for information archiving. These documents can be viewed at *go.nasa.gov/3lFn7mQ*.

Chris Torbert [LPDAAC] presented the status of ASTER data processing at the LPDAAC. In Fiscal Year 2022, LPDAAC distributed eight million files of Global Digital Elevation Model (GDEM) data, and six million files of ASTER L1 data.

Koki Iwao [AIST] summarized ASTER data processing at AIST. He reported that the number of scenes had reached four million this year. AIST continues to distribute ASTER DEMs and pseudo-true-color composites. The LPDAAC, along with other NASA organizations, is moving data sets to the Earthdata Cloud, for processing and distribution.

The plenary session ended with a series of presentations where the speakers highlighted other missions of interest to the ASTER ST. **Osamu Kashimura** [JSS] reported that data from the Japanese Ministry of Economy, Trade, and Industry's (METI) Hyperspectral Imager Suite (HISUI) on the International Space Station (ISS), would be released to the public in 2023. **Michael Abrams** presented an update on the joint NASA–U.S. Geological Survey (USGS) Landsat program, and on NASA's Earth Surface Mineral Dust Source Investigation (EMIT) hyperspectral instrument, also on ISS. **Simon Hook** [JPL] described the status of the multispectral thermal infrared (TIR) on the ECOsystem Spaceborne Thermal Radiometer Experiment on Space Station (ECOSTRESS), and also spoke about NASA's future Surface Biology and Geology (SBG) mission—which is part of the planned Earth System Observatory.

[3] Terra was part of the Morning Constellation, a formation of satellites that had Equator crossings in the late morning around 10:30 AM (and late evening, at about 10:30 PM) Landsat-8 and -9 are still in the Morning Constellation.

Applications Working Group

The applications session provided a sampling of the wide variety of applications that make use of data from ASTER, as summarized below.

ASTER has proven to be a workhorse when it comes to applications, which, over the last two decades, have run the gamut from social phenomena, e.g., monitoring urban sprawl and slum growth, to geochemical and geophysical phenomena, e.g., deriving thermal inertia for geologic mapping, volcanism, and its consequences—including near-real-time (NRT) monitoring of ash- and sulfur dioxide (SO_2)-rich volcanic plumes—see **Figure 1** below—and seismic events. The presentations in this session highlighted a host of other applications as well, clearly demonstrating the wide and deep utility of ASTER applications.

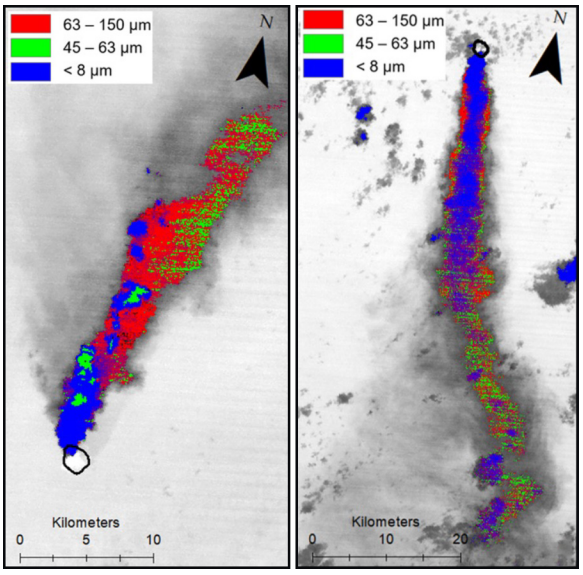

Figure 1. Particle size distribution of Nishinoshima eruption ash plume based on ASTER daytime thermal data acquired July 24, 2020 [*left*]; and on ASTER nighttime thermal data acquired July 31, 2020 [*right*]. The island is at the bottom of image on the left and the top of the image on the right. **Figure credit:** Daniel Williams/Pitt

Calibration/Validation Working Group

This working group is responsible for monitoring the radiometric performance of ASTER's visible-near-infrared (VNIR) and TIR instruments. For the VNIR, calibration and validation are performed by analysis of onboard calibration lamps and measurements of pseudo-invariant ground targets during field campaigns.

Reports on ASTER calibration and validation activities covered a wide range of activities. There were reports that Level-1 (L1) data processing is progressing, that L2 production is up to date, that calibration lamp trends are largely consistent, that the blackbody source onboard Terra is stable, and on aspects of lunar calibration. There were also presentations about the eight successful TIR field campaigns that have occurred since the last meeting in June 2019, and how onboard calibration is keeping the designed accuracy to less than 1 K—see **Figure 2** below. Of note is that, to date, over 100 million GDEM files have been ordered—clear testimony to the utility of ASTER's calibrated and validated data.

Temperature-Emissivity Working Group

This group is concerned with ASTER's kinetic temperature and emissivity (T-E) products. They also discuss applications of these products and review the status of the nighttime TIR global map program. Activities in this area include developing microbolometer TIR cameras—now with one for high temperatures, and one for lower. Comparing spaceborne temperature versus *in situ* measurements using LandBrowser (a new tool to search, browse, and download satellite data that can be accessed at *gsrt.digiarc.aist.go.jp*) revealed systematic differences between the two sources—see **Figure 3** on page 24. Researchers noted that there have been problems with emissivity retrievals in volcanic plumes, and, as a consequence, the T-E Separation algorithm sometimes gives anomalous results in ash-rich clouds. Data processing and algorithm development continue, including developing a VIIRS[4]–ASTER 375-m near-real-time land-surface temperature algorithm using ASTER emissivity for corrections. The precision of nighttime ASTER emissivity images, which involved a comparison ASTER emissivity using NCAR–NCEP and MOD07 water profiles,[5] showed increased errors with increased water vapor. In a new approach, research is underway to evaluate the performance of generative adversarial network (GAN) for pseudovisible color transformation of TIR images.

[4] VIIRS stands for Visible Infrared Imaging Radiometer Suite, which flies on the Suomi National Polar-orbiting Partnership (Suomi NPP), as well as on NOAA-20 and NOAA-21.
[5] NCAR–NCEP stands for National Center for Atmospheric Research (NCAR)–National Centers for Environmental Prediction (NCEP). They provide a joint globally-gridded water profile that is continually updated. MOD07 is a water profile product using data from the Moderate Resolution Imaging Spectroradiometer (MODIS).

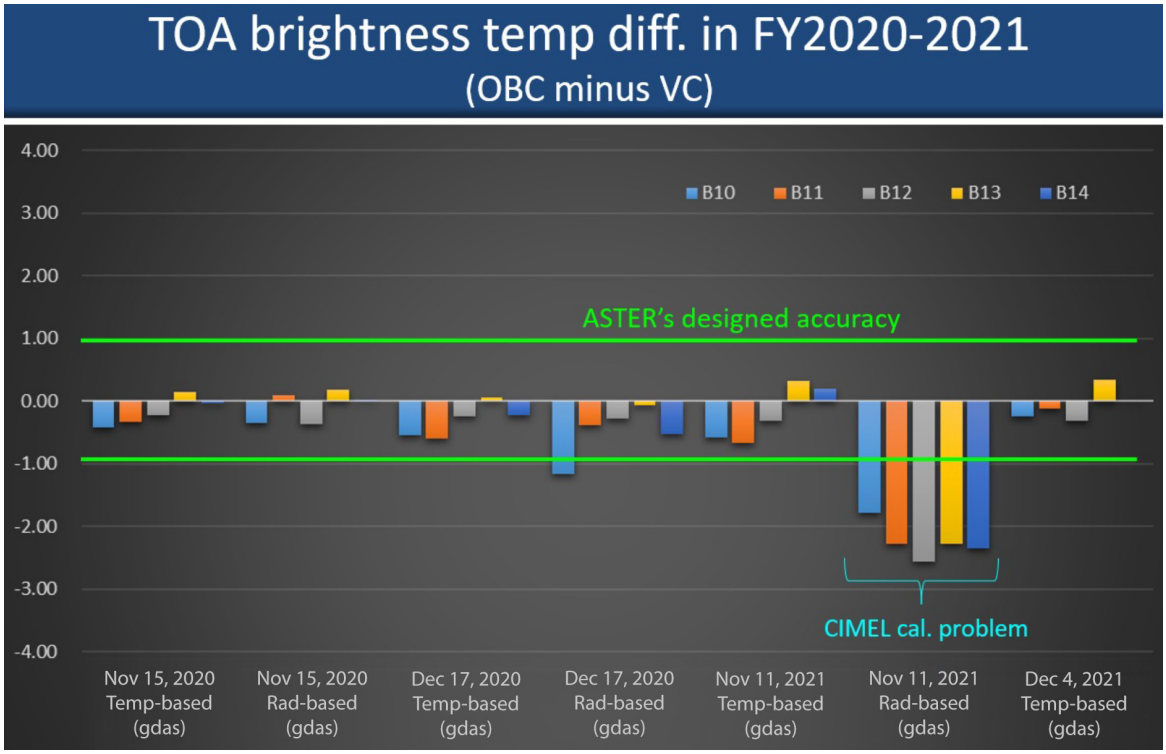

Figure 2. Validation of ASTER TIR bands at Lake Kasumigaura, Japan. Comparison of *onboard* calibration (OBC) minus *vicarious* calibration (VC) via *in situ* measurements obtained by a CIMEL Electronique (CIMEL) radiometer observing the lake surface. With the exception of November 11, 2021—when the CIMEL malfunctioned—the matchup is well within ASTER's performance specifications. **Figure credit:** Hidoyuki Tonooka/IU

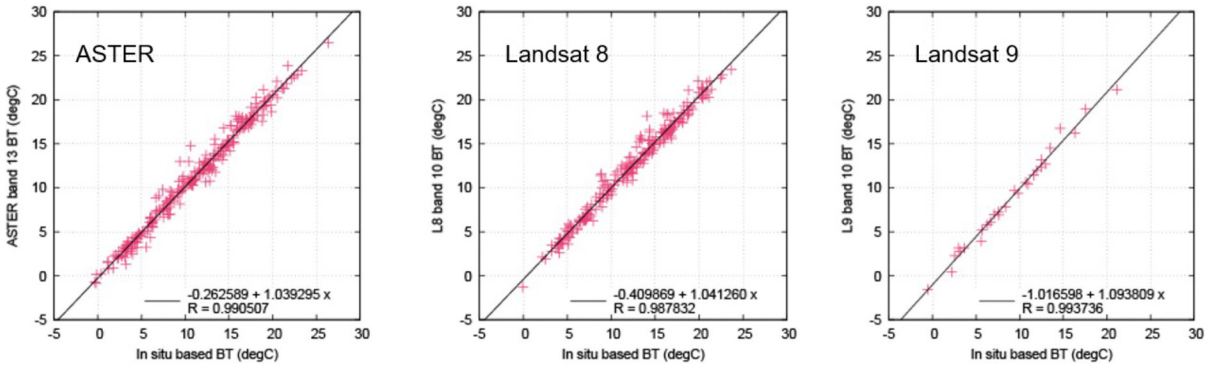

Figure 3. Top of atmosphere brightness temperature (BT) versus 10 µm bands for ASTER [*left*], Landsat 8/Thermal Infrared Sensor (TIRS) [*center*] and Landsat 9/TIRS-2 [*right*]. Negative offset and slope less than 1 imply that *in situ* BT is overestimated at lower temperatures and underestimated at higher temperatures. **Figure credit:** Shunyu Suzuki/IU

Operations and Mission Planning Working Group

This working group oversees and reviews the acquisition programs executed by the ASTER scheduler. Because ASTER data acquisitions have to be scheduled every day (due to ASTER's average 8% duty cycle), an automatic program was developed to select ~600 daily scenes from the possible 3000+ in the request archive. **Tetsushi Tachikawa** [JSS] reviewed the status of acquisition scheduling. Urgent observations receive the highest priority and can be scheduled close to acquisition time. Approximately 70 scenes are programmed per month, with over 95% acquisition success.

By contrast, global mapping data acquisitions receive the lowest priority and are used to fill in the scenes for the daily quota. ASTER's goal is to acquire at least one cloud-free image each season for every place on Earth. Due to persistent cloud cover, success is typically ~85% after several years, at which time the program is restarted. For example, on October 1, 2022, having achieved 83% success with acquisitions, ASTER was restarted. (The last such restart was exactly two years earlier on October 1, 2020.)

The thermal group submits areal requirements to acquire global nighttime coverage with the thermal bands. After the restart in October, the thermal group was asked to prepare new areas-of-interest acquisitions covering areas that were not imaged previously, either because of persistent clouds, or because their priorities were too low. Several other acquisition programs focus on islands, volcanoes, glaciers, and cloudy areas. The global volcano image acquisition program will continue with no change to the observation parameters. Acquisition of images of islands and over cloudy areas will also continue in current form. The global glacier acquisition program was modified to increase the imaging time window for some regions.

Closing Plenary Session

The chairpersons of each of the WGs presented summaries of presentations and discussions of their sessions. The overall consensus of participants was that ASTER continues to perform nominally, with no change since the 2019 meeting. Updates of the calibration coefficients took place in 2020, incorporating results from onboard calibration sources, the 2017 Deep Space Lunar Calibration Maneuver, and field-based validation measurements. The GDEM Version 3 and the new ASTER Water Body Dataset were released in July 2019. NASA and METI signed a Diplomatic Note, extending joint operation of the ASTER project for an additional seven years, until October 2026. The Science Team forwarded recommendations to the LPDAAC concerning which ASTER products to archive at the end of the Terra mission.

Conclusion

The fifty-first ASTER Science Team Meeting was a success, after an absence of face-to-face meetings for over three years. Attendance by almost the entire joint science team resulted in presentations of new ASTER science results, lively discussions, and resolution of future archiving issues. Plans were made for the fifty-second meeting in mid-to-late 2023, at the same Tokyo venue. ■

Acknowledgments

Work by the lead author of this article was carried out at the Jet Propulsion Laboratory, California Institute of Technology, under a contract with NASA.