Summary of the 53rd U.S.–Japan ASTER Science Team Meeting

Meeting Summary The Earth Observer

Introduction

The Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER) Science Team (ST) organized a three-day workshop that took place September 9–11, 2024, at the Japan Space System's (JSS) offices in Tokyo, Japan. About 30 people from Japan and the U.S. participated in the in-person meeting – see **Photo 1**.

U.S. participants included representatives of two NASA centers, Goddard Space Flight Center (GSFC) and Jet Propulsion Laboratory (JPL); from the NASA Land Processes Distributed Active Archive Center (LPDAAC); from two universities, University of Arizona (UA) and University of Pittsburgh (UPitt); and from two private companies, Grace Consulting (GC) and Science Systems and Applications, Inc. (SSAI). Japanese participants included representatives from Japanese government agencies, including JSS, Geologic Survey of Japan (GSJ), Ministry of Economy, Trade and Industry (METI), National Institute for Environmental Studies (NIES), National Institute of Advanced Industrial Science and Technology (AIST), and Remote Sensing Technology Center of Japan (RESTEC); as well as from several universities, including Ibaraki University (IU), Nagoya University (NU), University of Tokyo (UT), and University of Tsukuba (UTs).

Photo 1. Several attendees at the 53rd ASTER Science Team workshop pose for a photo taken at Japan Space System's (JSS) offices in Tokyo, Japan – where the meeting took place.

Photo credit: Yasushi Yamaguchi (Nagoya University)

The main objectives of the 53rd ASTER STM were to:

- discuss impacts of the NASA-decreed 50% reduction to the Terra mission's budget for Fiscal Years 2024–2026 on ASTER (one of 5 instruments flying on the Terra platform);
- respond to current and plan for future impacts on ASTER from the ongoing efforts to conserve power (reduce load) on the Terra platform;
- review revised Terra spacecraft management protocols from the Flight Operations Team;
- receive updates on data acquisition status, data calibration and validation activities, and data distribution plans and applications using ASTER observations; and
- discuss Terra and ASTER end-of-mission plans.

The remainder of this article will summarize the highlights from the meeting. The report begins with a brief review of the opening plenary session. The bulk of the content is dedicated to summaries of the four working group sessions. As the name implies, this is where the bulk of the work done during a typical ASTER STM is accomplished. A brief review of the closing plenary, which included summary reports from the chairpersons of all the working groups, rounds out the summary, followed by some overall concluding thoughts – including plans for the next meeting. Access to full presentation reports is password protected; those interested in gaining access to more information should contact the author directly.

Opening Plenary Session

Yasushi Yamaguchi [NU—*Japan ASTER Science Team Leader*] and **Michael Abrams** [JPL— *U.S. ASTER Science Team Leader*] welcomed participants and reviewed the agenda for the opening plenary and the schedule for the rest of the week's working groups. **Shinsuke Nakao** [Geologic Survey of Japan—*Director General*] presented a special welcome and spoke of ASTER's continuing value for geologic applications.

Abrams presented highlights of science results based on ASTER data, reviewed the status of the 2023 Senior Review, and discussed the 50% reduction of the Terra project (and JPL ASTER project) three-year budget. He reported that Terra passivation is scheduled for March 2027 and briefly described Terra's power status.

Kurt Thome [GSFC—*Terra Project Scientist*] presented on the status of the Terra spacecraft – including more on its power management situation in light of this year's solar shunt array failures. The power issues notwithstanding, Terra remains mostly healthy after 24 plus years of operation.

Hitomi Inada [JSS] provided a status report on the ASTER instrument. Inada explained that while many of the monitored components (i.e., visible-near-infrared (VNIR) pointing motor) are beyond their original useful life in orbit, the aging hardware shows no signs of wearing out or decreasing in performance. She showed that the temperature and current telemetry trends remain straight lines.

Cole Krehbiel [LPDAAC] presented ASTER product distribution statistics. The ASTER Digital Elevation Model continues to be the most ordered product. As defined by the ST at the last meeting, most ASTER data products will be created as physical, archived files before the end of the mission and placed in a searchable/orderable archive that can be accessed through NASA's Earthdata tool.

The ST reviewed the list of products and formally accepted it. Krehbiel said that LPDAAC will start producing these files in January 2025.

Koki Iwao [AIST] presented product distribution statistics for his organization. The largest number of users of products from Japan were from the U.S. He said that the most requested product was the pseudo-neutral color rendition.

Tetsushi Tachikawa [JSS] reviewed the status of ASTER observation programs since the beginning of the mission. He reported that all of the global observation programs are functioning normally, acquiring data as planned. Updates to the observation programs will be considered by future working groups. Tachikawa also added that the change of the orbit repeat – after Terra's October 2022 exit from the Morning Constellation – has been accommodated in the ASTER scheduler.

Mike Abrams then presented a report from **Simon Hook** [JPL], who was unable to attend the meeting, on the status of the multispectral thermal infrared (TIR) bands on NASA's ECOsystem Spaceborne Thermal Radiometer Experiment on Space Station (ECOSTRESS) mission. The TIR bands on ECOSTRESS are similar to those on ASTER – but ECOSTRESS has different observation repeat cycles due to being located on the International Space Station [Altitude: 408 km (254 mi); Inclination: 51.6°; Period: 90 min] as opposed to being located on a polar-orbiting platform, such as Terra/ASTER [Altitude: 705 km, (438 mi); Inclination: 98.5°; Period: 99 min, 16-day ground track]. Abrams also spoke about NASA's future Surface Biology and Geology (SBG) study, which is being conducted to come up with concepts and ultimately narrow down and select the design for the SBG mission that will be part of the planned Earth System Observatory. SBG would be the next U.S. mission (after Terra/ASTER and Landsat) to make TIR observations.

Tsuneo Matsunaga [NIES] presented the status of Japan's Greenhouse Gases Observing Satellite (GOSAT) program. First made operational in 2009, GOSAT measures the concentration of carbon dioxide (CO_2) globally. The third satellite in the series, GOSAT-GW will be launched in 2025. It has both a wide swath mode [90–911 km (~145–1465 mi)] and a narrow swath mode [3–10 km (~5–16 mi)]. Matsunaga explained that the wide swath allows for global, repeating coverage while the narrow swath enables higher spatial resolution observation, useful for observing point sources of greenhouse gases. He then reviewed the status of the Hyperspectral Imager Suite (HISUI) hyperspectral scanner on the International Space Station. He showed examples where HISUI data are used to detect CO_2 emissions from power plants.

Applications Working Group

The applications session provided a sampling of the wide variety of applications that make use of data from ASTER. A few examples are highlighted below.

Michael Ramsey [UPitt] reported the current progress of the Urgent Request Protocol (URP). He explained that the protocol triggers ASTER expedited acquisitions using thermal triggers from higher temporal sensors, such as the Moderate Resolution Imaging Spectroradiometer (MODIS). Each month, between 40–50 scenes are triggered via URP. Ramsey said that these acquisitions provide high temporal and spatial resolution observations of active (erupting) volcanoes – see **Figure 1**. Email notifications are automatically forwarded to more than 40 observatories working at each of the volcanoes.

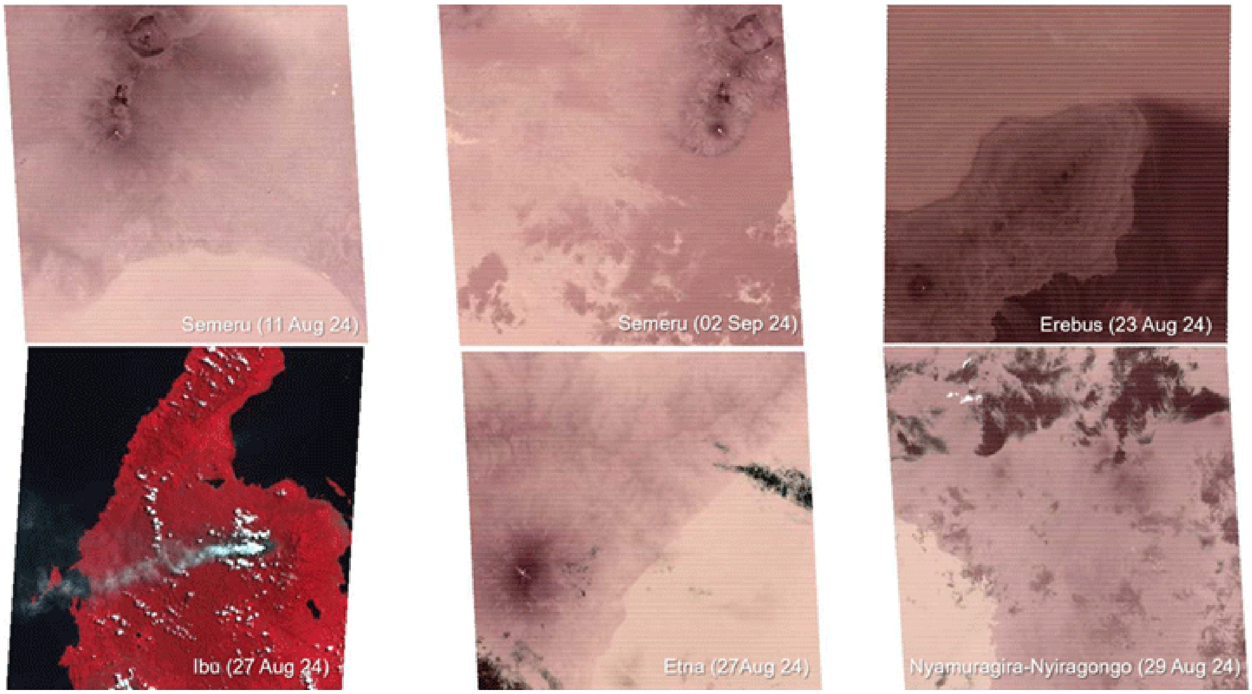

Figure 1. Nighttime thermal and daytime visible acquisitions of five different erupting volcanoes, captured in August and September 2024, triggered by the Urgent Request Protocol program. The volcanoes include Semeru in East Java, Indonesia, August 11, 2024 [*top left*]*;* Semeru, September 2, 2024 [*top center*]; Erebus in the Ross Dependency, Antarctica, August 23, 2024 [*top right*]; Ibu on Helmehera Island, Indonesia, August 27, 2024 [*bottom left*]; Etna, in Sicily, Italy, August 27, 2024 [bottom center]; and Nyamuragira/Nyamulagir in the Virunga Moutains of the Democratic Republic of the Congo, August 29, 2024 [*bottom right*]. Thermal hot spots in night images are white. The eruption plume from Ibu volcano day image is white, with vegetation depicted in red.

Figure credit: Michael Ramsey (University of Pittsburgh)

Mike Abrams presented the use of ASTER's 25-year history for geologic mapping and mineral exploration applications. He explained how the first published papers appeared a few years after launch and validated the unique mineralogical information contained in the ASTER data. Over the following 20 years, several reports from mineral exploration companies announced the discovery of gold, chromite, and lithium deposits – which were found largely based on analysis of ASTER data.

Ashley Davies [JPL] presented an update on the status of the ASTER Volcano Archive (AVA), operated by JPL. He showed examples from the archive, which has over 1.4 million ASTER scenes from over 1542 active volcanoes that have been acquired since the beginning of the mission in 2000. Davies also demonstrated how users can search the archive by volcano name and download various ASTER products, useful for volcano monitoring. He indicated that future products envisioned for AVA include sulfur dioxide (SO_2) concentration maps and quantitative thermal detection and data analysis.

Calibration/Validation Working Group

This working group is responsible for monitoring the radiometric and geometric performance of ASTER's VNIR and TIR instruments. Three deferent calibration and validation techniques are used including: analysis of onboard calibration lamps, comparison with blackbodies, and measurements of pseudo-invariant ground targets during field campaigns. The Level-2 (L2) software algorithms are being updated for the final, archival processing.

Bjorn Eng [JPL] reported that the newest version of the L2 algorithm for calibration and validation of ASTER VNIR and TIR data has been delivered to the LPDAAC for ingest and testing. He explained that the new version of the software includes the capability to use Modern-Era Retrospective Analysis for Research and Applications, Version 2 (MERRA-2) data, which allows users to create atmospheric profiles for temperature, pressure, water vapor, and ozone. MERRA-2 is an improvement – both spatially and temporally – over the National Centers for Environmental Prediction's (NCEP**)** Global Data Assimilation System (GDAS) that is used in the original MERRA. Eng asked for volunteers who would be willing to compare L2 products created with the new version of the software to those created using the old version, to verify the accuracy of the new software before it is used for the archival processing.

Cole Krehbiel reported on the assessment of geometric performance of the L1 processing software, which was updated to the new Landsat ground control point library and an improved global digital elevation model. He showed that the new products show minor improvement over the old. Krehbiel explained that the revised software will be used for the archival processing.

Satoshi Tsuchida [GSJ] presented the results from calibration field campaigns conducted at Railroad Valley, NV in August 2023 and 2024. They show that ASTER VNIR Bands 1, 2, 3N, and 3B have not deviated from the current calibration curves. Each of the bands continues to show no degradation in performance, indicating that the current radiometric calibration table does not need updating.

Satoru Yamamoto [GSJ] presented updates to the calibration trends of the onboard VNIR lamps. Several analyses of the calibration lamps showed no significant change in all the data trends. The signal-to-noise ratios are still greater than the requirement of 140, which indicates that retrieval of surface reflectance to less than 1% accuracy is possible.

Hideyuki Tonooka [IU] presented the results of five recent TIR field calibration campaigns: two in Japan and three in the U.S. He showed some preliminary results from two campaigns conducted at Lake Kasumigaura, Japan. The data indicate that the difference between lake temperatures measured by ASTER and those measured *in situ* were less than 0.8 K – which is within the required specifications. Tonooka also reported that the three September 2024 field campaigns in Nevada and Utah went well. However, these three events were held just a week prior to the ASTER STM, so results are not yet available. .

Mike Abrams presented a report on behalf of **Simon Hook**, on TIR validation using automated sites at Lake Tahoe, NV, and Salton Sea, CA. These two sites have been used since 2000 to monitor ASTER's TIR performance. Measurements from several automated buoys are recorded and telemetered every few seconds and compared to each of ASTER's five TIR bands. After atmospheric corrections and adjustments for ASTER's TIR detector responses are applied, the calculated radiance values from ASTER were compared to the *in situ* observations. Abrams noted that – as has been the case in previous years – all the 2024 measurements show excellent agreement – see **Figure 2**.

Mehran Yarahmadi [SSAI] results (published in a 2024 paper in *Remote Sensing* on which Yarahmadi was lead author) from an intercomparison of ASTER's VNIR bands versus similar data from the Operational Land Imager (OLI) on Landsat-8 and OLI-2 on Landsat–9 using the Radiometric Calibration Network (RadCalNet) data from Railroad Valley, NV. Researchers found 100 matchups between the two instruments that occurred between 2013 and 2023. The RadCalNet provided accurate *in situ* measurements of surface reflectance. The team compared Landsat and ASTER surface radiation measurements using radiative transfer software and measured atmospheric conditions. In addition, they compared the ratios for both OLI and ASTER with *in situ* values, which provided quantitative evaluation of the radiometric performance of both instruments – see **Figure 3**.

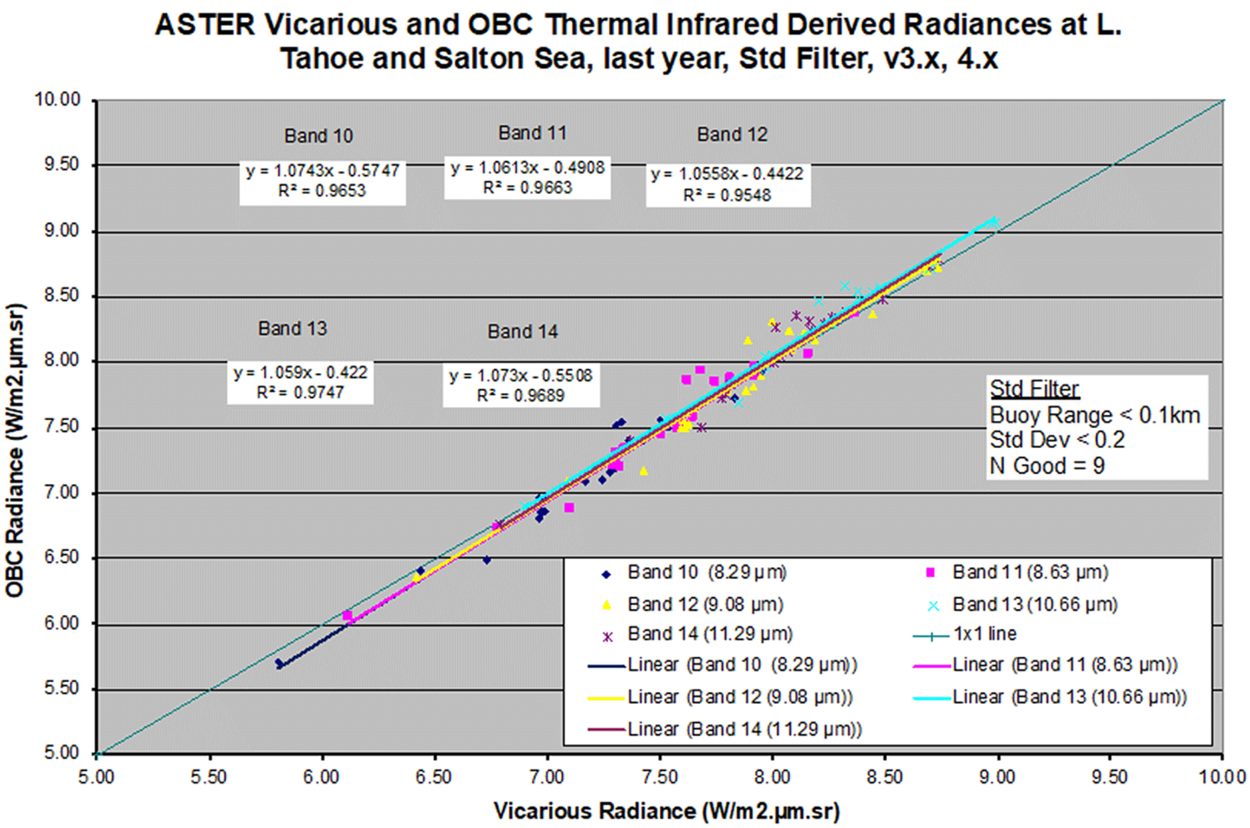

Figure 2. Comparison of *in situ* derived radiances versus ASTER on-board radiances for 2024, determined at Lake Tahoe, NV and Salton Sea, CA sites. The plot shows all five ASTER TIR bands. As indicated by the R2 values, the agreement is excellent, similar to all prior years.

Figure credit: Simon Hook (NASA/Jet Propulsion Laboratory)

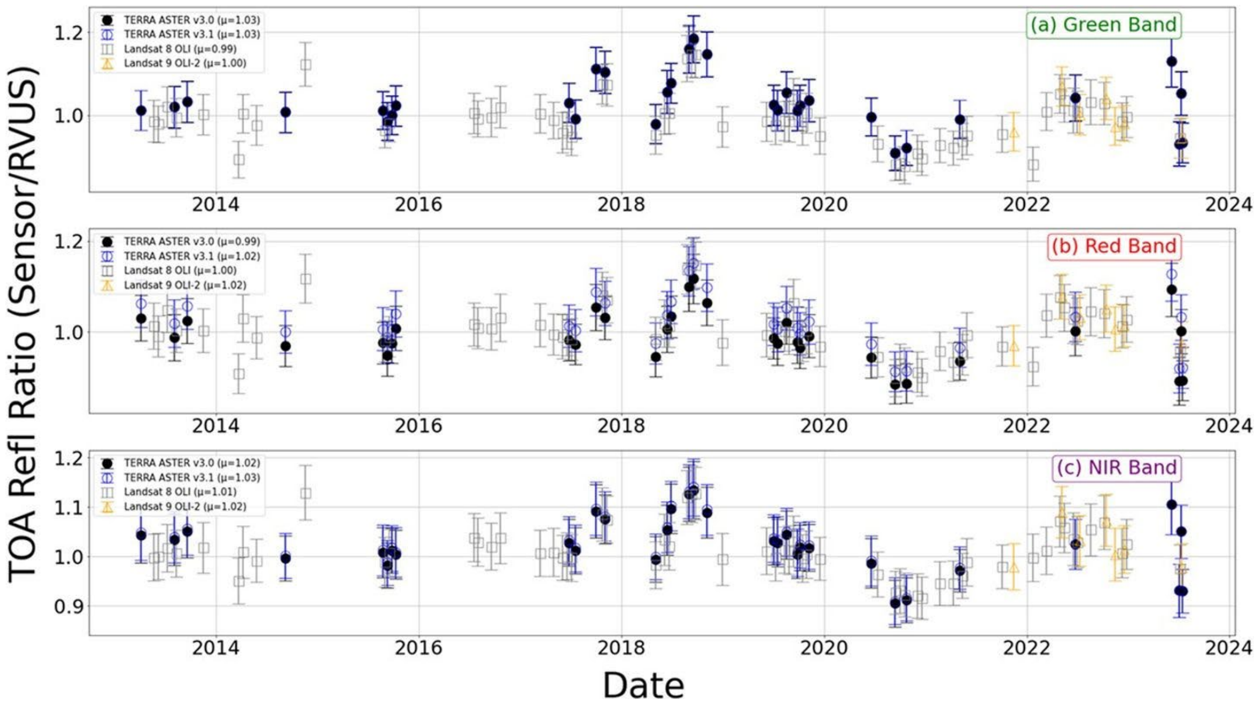

Figure 3. Reflectance ratio of Landsat versus *in situ*, and ASTER versus *in situ* values.

Figure credit: Mehran Yarahmadi (Science Systems and Applications, Inc.)

Temperature-Emissivity Working Group

This group focuses on ASTER's kinetic temperature and emissivity (T–E) products, as well as application of these products and review of the nighttime TIR global mapping program status.

Mike Ramsey presented TIR spectral retrievals of volcanic emissions from the new 12-channel Miniature Multispectral Thermal Camera (MMT-gasCAM) instrument, with comparisons to ASTER TIR. He explained that the project pairs a commercial TIR microbolometer camera with a custom filter wheel assembly. Ramsey said that the new instrument improves on the six-channel instrument, previously operated in the field both on the ground and from a helicopter. The first tests were conducted in Italy in June 2024 – see **Photo 2**.

Photo 2. Deployment of University of Pittsburgh's new 12-channel TIR camera [*far right*] at Vulcano, Italy in June 2024 with Italian collaborators and their instruments.

Figure credit: Michael Ramsey

Hideyuki Tonooka discussed the worldwide distribution of radiometer stations that JPL operates to calibrate and validate several spaceborne TIR scanners, including ASTER. In the U.S., stations are located on Lake Tahoe, which straddles the border of Nevada and Utah, and at Salton Sea, CA and Russell Ranch, CA. Internationally, there are stations at LeCrau Nature Preserve, France and Venice, Italy. He also discussed plans to install JPL's automatic radiometer at Lake Kasumigaura, Japan no earlier than April 2025.

Tonooka also reviewed the status of the current Thermal Global Mapping acquisition program to acquire cloud-free TIR nighttime images over most of the Earth's land surface. He explained that the program is refreshed every year, as the acquisition success starts to exhibit diminishing returns due to remnant cloudy areas. The latest program started in May 2024. Tonooka then reported on analysis of the TIR acquisitions based on cloud cover. As of September 2024, 92% of the required global areas had been observed at least once under clear sky.

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 to accommodate ASTER's average 8% duty cycle, ST members developed an automatic program to select 600–700 daily scenes from the more than 3000 possibilities in the request archive.

Tetsushi Tachikawa reviewed the status of acquisition scheduling. Urgent observations receive the highest priority (via the URP discussed in Michael Ramsey's presentation) 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. Tachikawa explained that the ASTER team's goal is to have the instrument acquire at least one cloud-free image for every place on Earth. Due to persistent cloud cover, success is typically ~85% after several years, at which time the program is restarted. He reported that the next restart is planned for October 2024. He explained that the thermal group submits areal requirements to acquire global nighttime coverage with the thermal bands. The working group's recommendation was to continue the scheduling as planned. Tachikawa next gave short updates on three other acquisition programs that focus on islands, volcanoes, glaciers, and cloudy areas respectively. 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 will be modified to change the VNIR gain settings to optimize images over snow and ice.

Tachikawa also discussed ASTER instrument operations in response to the Terra Load Shedding Plan. The working group agreed on the following order of preference: no change to the current operation; putting the VNIR instrument into safe mode and operating only the TIR instrument, putting ASTER into safe mode, and putting ASTER into survival mode.

Closing Plenary Session

Each chairperson summarized the presentations, discussions, and recommendations that occurred during the working group session they chaired. The overall consensus arising from these discussions was that the ASTER instrument is operating normally – with no indications of any component failures. The ST is preparing to absorb the impact of the 50% budget reduction on the Flight Operation Team at GSFC as well as they can. The main impact, so far, has been a small increase in lost data (1–2%) – because of the absence of operators to attempt immediate recovery. The ST also approved plans for ASTER's contribution to the Terra power mitigation plan and the recommendation has been forwarded to the Terra Project Scientist and the Flight Operations Team.

Conclusion

The 53rd ASTER STM successfully covered all of the critical issues introduced during the Opening Plenary Session. The ST worked on formulating priorities for reduction of ASTER instrument operations in response to Terra power reductions. During working group sessions participants received updates on a variety of topics: e.g., instrument scheduling, instrument performance, archiving plans, and new applications.

The organizers announced that the 54th ASTER STM will be held in Spring 2025 at the same venue in Tokyo. Watch the ASTER website for details on specific dates.

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