National Aeronautics
and Space
Administration

2026 NASA Earth Science
Senior Review



NASA SUMMARY REPORT
November 2026

NASA Earth

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2026 NASA Earth Science Senior Review

NASA Summary Report | November 2026

Senior Review Panel

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National Interests Participating Agencies and Organizations: Centers for Disease Control and Prevention (CDC); Environmental Protection Agency (EPA); National Oceanic and Atmospheric Administration (NOAA)/National Weather Service (NWS) and National Ocean Service (NOS); United States Geological Survey (USGS); United States Army Corps of Engineers (USACE); United States Department of Agriculture (USDA); National Geospatial-Intelligence Agency (NGA); and a Private-Sector Representative

Technical and Cost Panelists: Jim Wells, Takenya Roberts, Jason Feldman, and Mike Guan

Table of Contents

1. Introduction 1
2. Review Process 3
3. General Panel Findings 5
    Overview 5
    Panel Findings Summary 5
    2026 Senior Review Panel Feedback 9
4. Mission-Specific Findings Summary 10
    Aqua | Summary Findings 12
    Aura | Summary Findings 15
    ECOSTRESS | Summary Findings 18
    EMIT | Summary Findings 20
    GEDI | Summary Findings 23
    GPM | Summary Findings 26
    GRACE-FO | Summary Findings 29
    ICESat-2 | Summary Findings 32
    OCO-2 | Summary Findings 34
    OCO-3 | Summary Findings 37
    PREFIRE | Summary Findings 39
    SAGE III | Summary Findings 41
    SMAP | Summary Findings 43
    SWOT | Summary Findings 45
    TEMPO | Summary Findings 47
    TSIS-1 | Summary Findings 49
Rating Definitions 52
    Science and Data Quality Rating Definitions 52
    Utility Rating Definitions 53
    Technical Risk Rating Definitions 53
    Cost Risk Rating Definitions 54
Acronyms and Abbreviations 56

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SECTION 1

Introduction



1. Introduction

This National Aeronautics and Space Administration (NASA) summary presents the findings of the 2026 Earth Science Senior Review. The review evaluated 16 NASA Earth Science missions in extended operations: Aqua, Aura, ECOsystem Spaceborne Thermal Radiometer Experiment on Space Station (ECOSTRESS), Earth Surface Mineral Dust Source Investigation (EMIT), Global Ecosystem Dynamics Investigation (GEDI), Global Precipitation Measurement (GPM), Gravity Recovery and Climate Experiment Follow-On (GRACE-FO), Ice, Cloud, and Land Elevation Satellite-2 (ICESat-2), Orbiting Carbon Observatory-2 (OCO-2), Orbiting Carbon Observatory-3 (OCO-3), Polar Radiant Energy in the Far-InfraRed Experiment (PREFIRE), Stratospheric Aerosol and Gas Experiment III (SAGE III), Soil Moisture Active/Passive (SMAP), Surface Water and Ocean Topography (SWOT), Tropospheric Emissions: Monitoring of Pollution (TEMPO), and Total and Spectral Solar Irradiance Sensor-1 (TSIS-1).

The review was based on proposals from each of the mission teams, followed by an in-person session where mission representatives presented the proposal and answered questions from the independent Senior Review panel with membership from the Earth science and applications communities and NASA cost and technical subject matter experts. The following criteria were the basis of review: scientific merit (including uniqueness and new knowledge enabled by extension); relevance to NASA's Earth Science to Action (ES2A) Strategy, Administration priorities, and applications objectives; standard data product quality; utility and impact of the data products for applied and operational uses; technical risk; and cost risk. The missions were reviewed independently from each other. The portfolio of 16 missions for the 2026 Senior Review includes a wide range of mission types: ambitious multi-instrument pioneer missions that have been operating for decades (Aqua, Aura); missions on the International Space Station (ISS) (ECOSTRESS, EMIT, GEDI, OCO-3, SAGE III, TSIS-1); missions focused on specific components of the Earth system (GPM, GRACE-FO, ICESat-2, OCO-2,OCO-3, SMAP); partner missions (Aqua, Aura, GPM, GRACE-FO, SWOT); and Earth Venture Class missions (ECOSTRESS, EMIT, GEDI, PREFIRE, TEMPO). The 2026 Senior Review panel found that all the reviewed NASA Earth Science missions have very high scientific merit, meet the requirements for very high relevance to NASA and applications objectives, are contributing to a broad range of operational applications, and are in good health and ready for extended operations.

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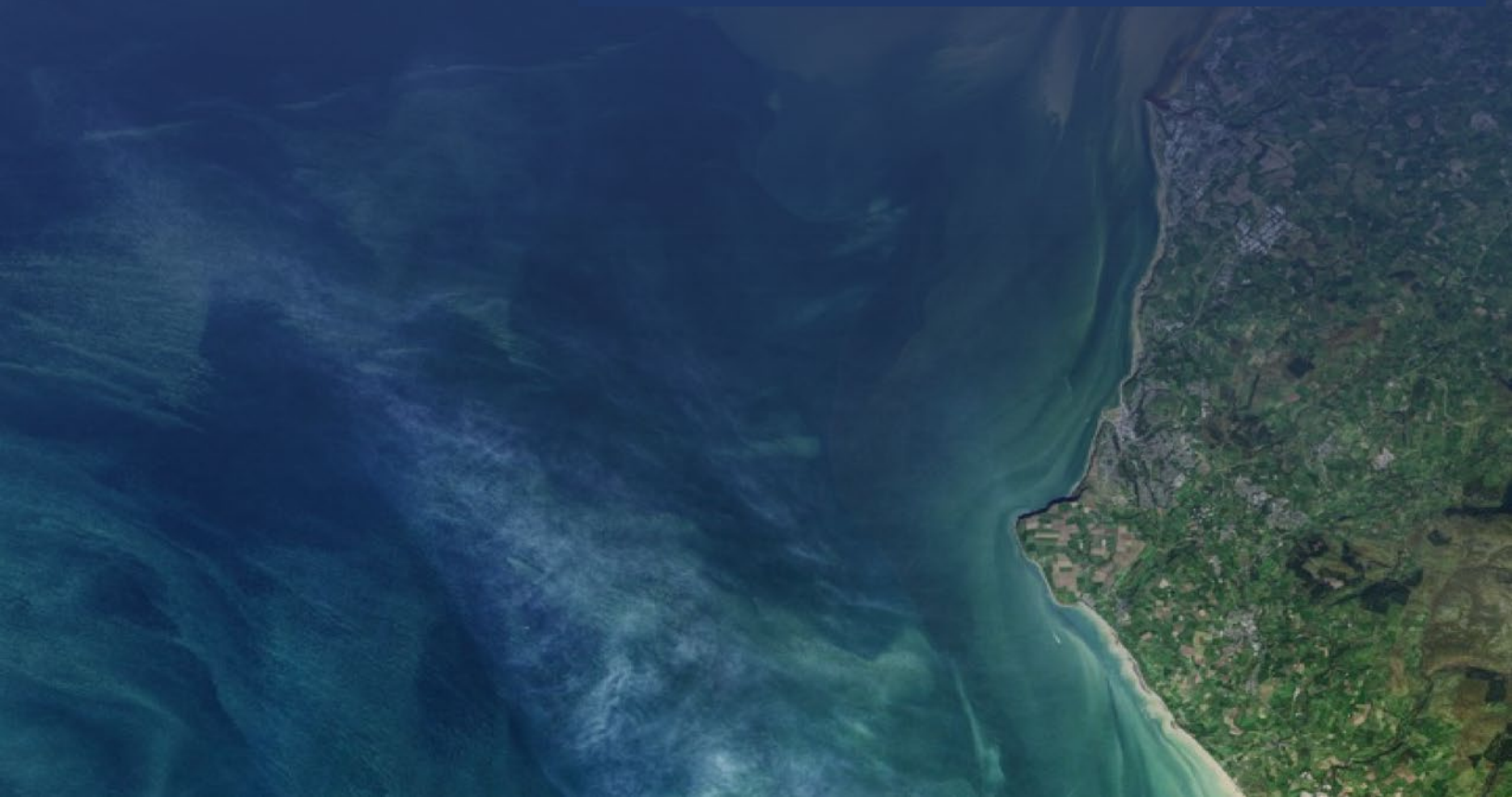
SECTION 2

Review Process



2. Review Process

The streamlined 2026 Senior Review process began on January 16, 2026, when NASA issued the Call for Proposals inviting 16 NASA missions in or near extended operations to submit proposals for continuation, due March 27, 2026. The 2026 process included a major structural change: the former Science, National Interests, Technical, and Cost panels were streamlined into a single combined Senior Review Panel, composed of members from the Earth science research and applications communities and NASA technical and cost subject matter experts (SMEs). Under the revised process, missions submitted a PowerPoint-format proposal along with a new one-page National Interests "fact sheet," which was distributed as part of the National Interests survey to participating agencies and organizations. The resulting feedback was used to inform the panel during the week of the plenary.

The independent panel convened virtually on March 27, 2026 for a Kickoff Meeting to review procedures, confirm reviewer assignments, and initiate evaluation activities. Consistent with the streamlined approach that emphasizes cross-disciplinary integration across science, applications, technical, and cost perspectives, each mission was assigned a Lead Reviewer and at least two Secondary Reviewers from the science and applications members. NASA SMEs reviewed the technical and cost sections of each mission proposal. The panel then met for a single in-person plenary on April 13–17, 2026, at which all missions presented their proposals. Lead and Secondary Reviewers led the Question and Answer (Q&A) portion of each session, which lasted 30 minutes and allowed panelists to probe scientific, applied, technical, and cost considerations. Each Q&A session was immediately followed by a closed-panel discussion, during which reviewers deliberated and synthesized their assessments across all evaluation criteria.

These closed-panel discussions supported the development of the panel's collective evaluation for each mission. Technical and cost subject matter experts provided input throughout the plenary. The Senior Review Chair presented the consolidated results and overall findings to NASA management on June 27, 2026. This NASA summary presents these consolidated results as well as the panel's science, applications, and technical findings together with the National Interests survey results in each mission section.

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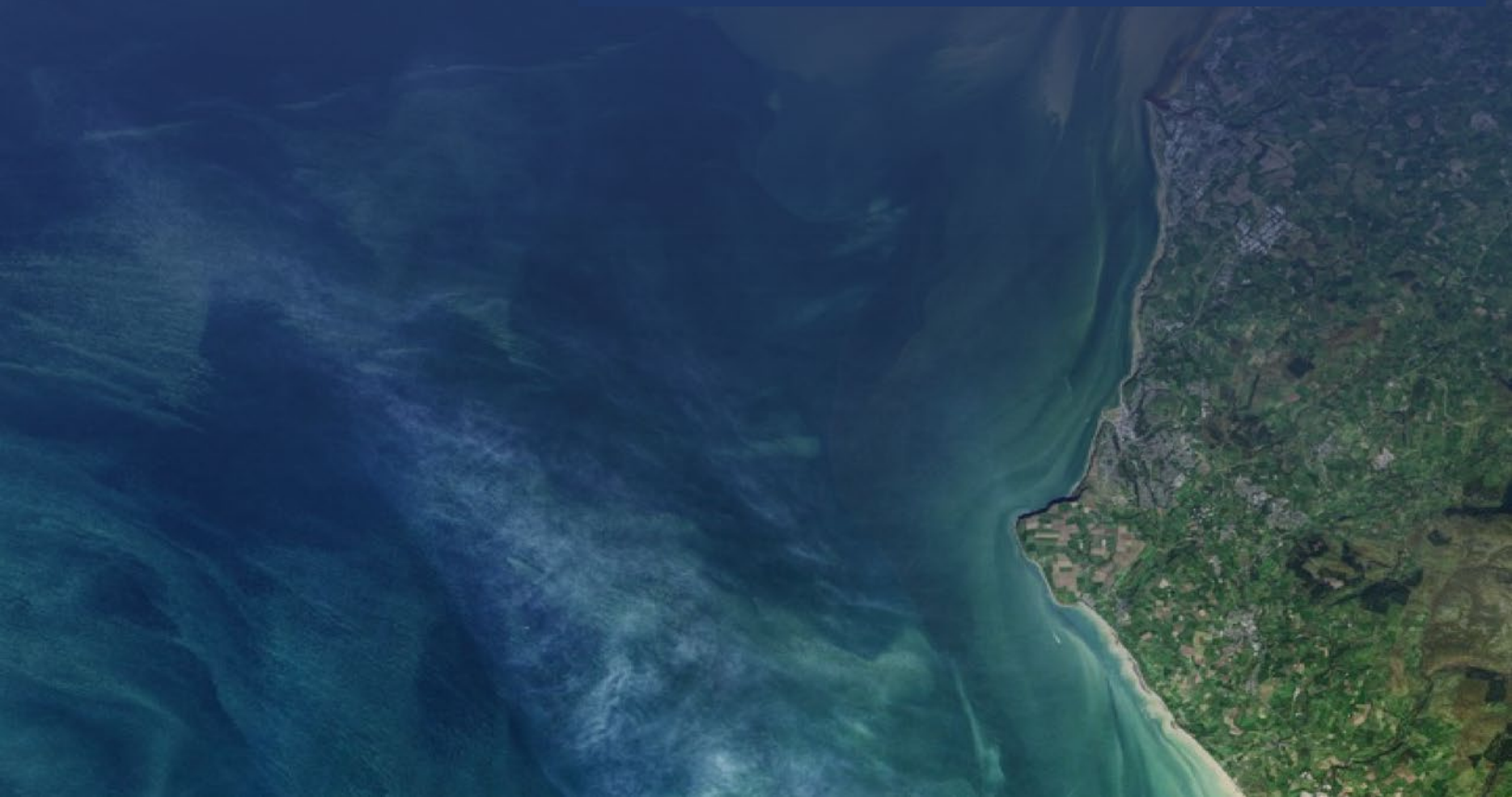
SECTION 3

General Panel Findings



3. General Panel Findings

Overview

Across the 16 NASA Earth science missions reviewed, the panel consistently found that each mission has met or exceeded its prime objectives and continues to play a central role in Earth system science. The missions were widely viewed as highly successful, producing influential datasets that are uniquely valuable or serve as benchmark references for the global research community and many applied and operational users. Scientifically, these missions have greatly advanced understanding of the Earth system, from improving knowledge of water, carbon, and energy cycles, to enabling critical assessment of atmospheric composition, stratospheric and oceanic processes, terrestrial ecosystems, and extreme events such as droughts, wildfires, and floods. The quality and reliability of the missions' data products were consistently commended; the data are widely used, well validated, trusted, and frequently adopted as standards for calibrating other sensors and training Super Intelligence (SI)/Machine Learning (ML) models. The panel emphasized the continued and growing demand for these data streams for disaster preparedness, resource management, risk assessment, and operational decision making, demonstrating broad relevance to NASA and applications objectives, including resilience, economic growth, food and water security, environmental observation, and technology innovation. Most missions were found to be in excellent health, with technical risks deemed low, and had demonstrated adaptability and efficiency in operations. The potential for future contributions is strong: extended datasets are critical for tracking long-term trends, improving predictive models, validating and connecting with upcoming missions, and enabling new applications and scientific discoveries. In summary, the panel supported the extension of all 16 missions, highlighting their important roles in advancing Earth system science and supporting operational and applications communities.

Panel Findings Summary

Table 1 presents the 2026 Earth Science Senior Review panel ratings for each mission, summarizing performance across four evaluation areas. The Science rating reflects the scientific value of extended data collection, including new knowledge enabled by extension, the uniqueness or irreplaceability of the observations, projected long-term data quality and consistency, and relevance to NASA priorities and Administration objectives. The Overall Science rating represents the combined scientific merit, relevance, and standard data-product quality ratings. Table 1 also gives the final panel median scores; the intermediate categories fall between adjacent ratings.

The Applications and National Interests Utility ratings capture the extent to which mission products support operational, applied, economic, and policy needs across federal, regional, and local stakeholders. This includes intrinsic value, frequency of use, latency, private-sector use, and the number of agencies that would face critical impacts if mission data were discontinued ("Critical National Impacts" in Table 1). The Technical Risk rating represents technical risk informed by spacecraft and instrument health, mission operations performance, and planned efficiency improvements during the extension period. The Cost Risk rating reflects cost risk based on historical spending relative to allocated resources. Together, these criteria inform overall mission merit, applications utility, risk posture, and extension findings for Fiscal Year (FY) 2027–2029.

The panel rated four missions Excellent, ten Excellent/Very Good, and two Very Good for science overall. The portfolio includes missions with more than 20 years of operations and missions recently out of their prime phases. The panel noted that these high science scores reflect the continued excellence of NASA Earth Science missions in producing measurements and data products that enable Gold Standard Science.

The data products from these missions have led to new and deeper understanding of the Earth system and lay the foundation for new scientific knowledge enabled by their extension. The use of data from these satellite missions continues to expand for science, applications, and operational communities.

To inform its assessment of mission utility, the panel considered input from participating agencies and organizations regarding their use of NASA Earth science mission data products for applied, operational, and non-research uses. Participating organizations provided mission- and sensor-level inputs describing the value of the data products, frequency of use, latency needs, overall utility, and whether loss of the data products would create critical impacts or otherwise negatively affect their organization's activities. The panel considered these inputs alongside information provided by the project teams.

Organizations that provided National Interests input included NOAA/NWS, NOAA/NOS, USDA, USGS/Department of Interior (DOI), CDC, EPA, USACE, NGA, and an end user private-sector representative.

The panel found that all missions provide at least some applied, operational, or decision-support value. Multiple agencies identified adverse impacts associated with the loss of data from most missions under review, underscoring the importance of these observations to government, industry, and stakeholder communities. The rapid adoption of products from newer missions, together with continued reliance on long-standing

datasets from legacy missions, demonstrates the broad value of NASA Earth science observations across research, operational, commercial, and public-service applications.

The Technical Risk scores ranged from Low to Medium across the missions, with no significant risks identified.

The Cost Risk scores ranged from Low for Aqua, Aura, ECOSTRESS, GEDI, GPM, ICESat-2, OCO-3, PREFIRE, SAGE III, TEMPO, and TSIS-1, Medium/Low for GRACE-FO, OCO-2, and SWOT, Medium for EMIT, to Medium/High for SMAP.

Based on these findings, the panel concluded that, if extended, all reviewed missions would continue to provide important contributions to NASA science objectives and Administration priorities.

Table 1. NASA 2026 Earth Science Senior Review Panel Summary

Mission	Science and Data Ratings					National Interests		Risk		FY2027-FY2029 Finding
	Science Merit	Relevance	Standard Data	Overall Science	Science Rating	NI Utility	Critical National Impacts	Technical Risk	Cost Risk	
Aqua	4.50	4.50	4.75	4.50	Excellent/Very Good	Very High	7	Medium	Low	Continue
Aura	4.50	4.00	4.25	4.25	Very Good	Very High	4	Medium/Low	Low	Continue
ECOSTRESS	4.50	5.00	4.50	4.50	Excellent/Very Good	Very High	3	Low	Low	Continue
EMIT	5.00	5.00	4.75	5.00	Excellent	High	4	Low	Medium	Continue
GEDI	4.50	4.50	4.00	4.50	Excellent/Very Good	High	2	Low	Low	Continue
GPM	4.50	4.75	4.50	4.50	Excellent/Very Good	Very High	4	Low	Low	Continue
GRACE-FO	5.00	4.75	4.50	4.75	Excellent/Very Good	High	3	Low	Medium/Low	Continue
ICESat-2	5.00	4.50	4.50	4.50	Excellent/Very Good	Very High	5	Low	Low	Continue
OCO-2	5.00	4.00	4.50	4.50	Excellent/Very Good	Some	0	Low	Medium/Low	Continue
OCO-3	4.50	4.00	4.50	4.50	Excellent/Very Good	Some	0	Low	Low	Continue
PREFIRE	5.00	4.00	3.00	4.00	Very Good	Some	0	Medium/Low	Low	Continue
SAGE III	4.75	5.00	5.00	5.00	Excellent	Some	1	Low	Low	Continue
SMAP	4.50	4.50	4.50	4.50	Excellent/Very Good	High	3	Medium/Low	Medium/High	Continue
SWOT	5.00	5.00	4.50	5.00	Excellent	Very High	5	Low	Medium/Low	Continue
TEMPO	5.00	5.00	4.25	5.00	Excellent	Very High	3	Low	Low	Continue
TSIS-1	5.00	4.50	4.50	4.50	Excellent/Very Good	High	3	Medium/Low	Low	Continue

Note: Science values are medians from the final panel scores. National Interests utility and critical-impact counts reflect the final mission-level results. Technical and cost entries are risk ratings.

2026 Senior Review Panel Feedback

The combined panel format enabled direct discussion among science reviewers, applied and operational users, and NASA technical and cost subject matter experts. This differs from earlier reviews in which separate subpanels provided summary reports and ratings. This change in process should be noted when comparing results with previous Senior Reviews. Applied and operational users' descriptions of how mission data support preparedness, resource management, and other decisions informed the panel's assessment of relevance.

Finally, the 2026 Senior Review panel echoed two concerns that have been previously raised in past Senior Reviews. First, applied and operational users are still hesitant to transition to new sensors and products for operational applications, with many agencies indicating critical impacts to their operations from legacy missions like Aqua that will soon end operations. The high utility of many NASA missions to applied and operational organizations is a clear indicator of success and the value of these data beyond their fundamental science and applications. However, 2026 Senior Review panelists recommended that the agency continue to prioritize efforts to transition and facilitate adoption of new data products into agency and industry users' data streams. The second concern noted by 2026 Senior Review panelists was the challenge of evaluating relatively young Principal Investigator (PI)-led Earth Venture missions and older flagship missions using the same review criteria. As the fleet of NASA Earth science missions continues to diversify, 2026 Senior Review Panelists recommended that the agency adapt evaluation criteria for future Senior Reviews to better reflect the different classes of missions and the range of mission maturity, particularly with regards to data products and national interests use.

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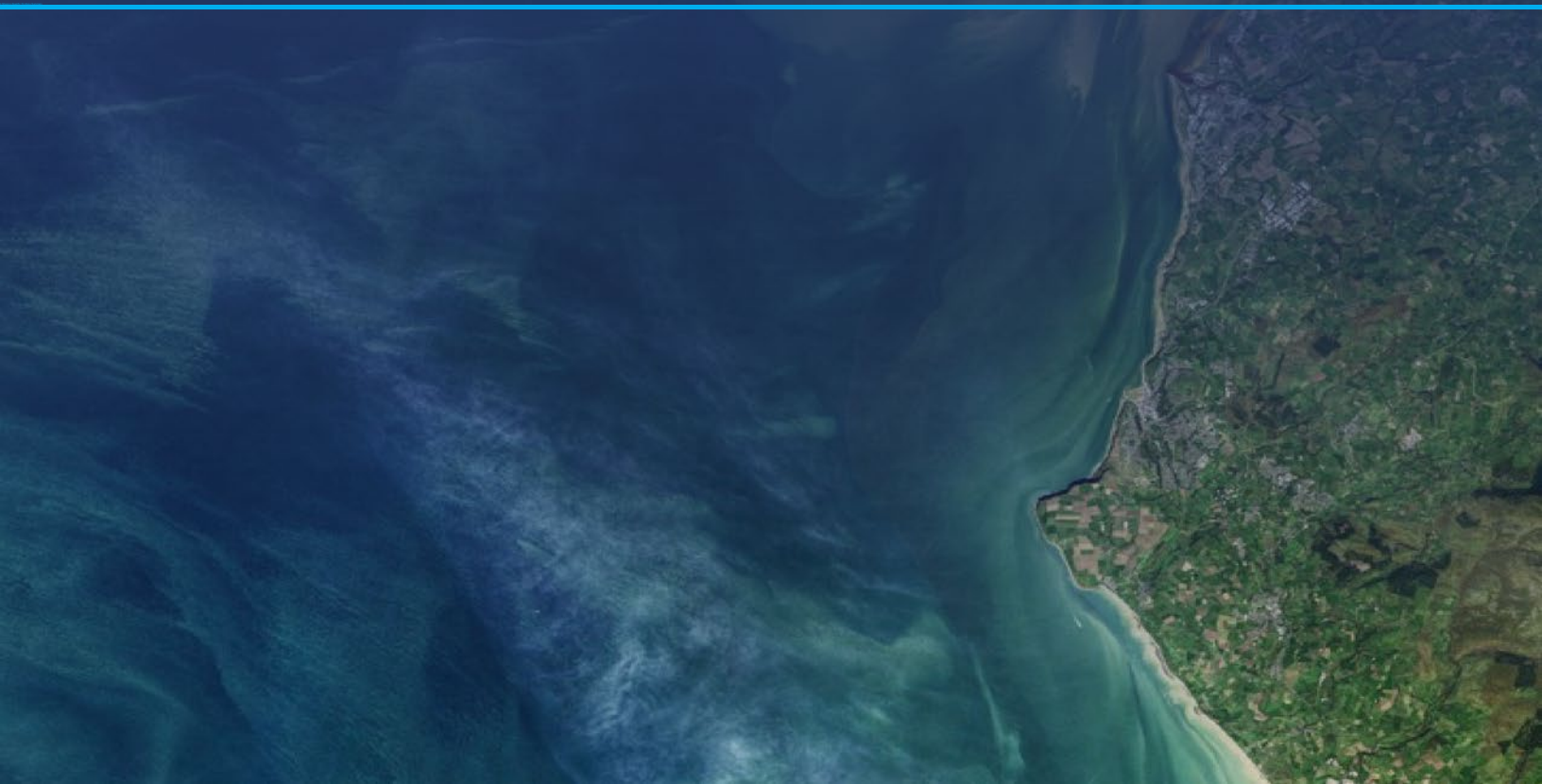
SECTION 4

Mission-Specific Findings Summary



MISSION 01 | FINDINGS SNAPSHOT

AQUA

Atmospheric profiles and trace gases, land and ocean properties, fires, clouds, and Earth's radiation budget

FY2027–FY2029 PANEL FINDING **Continue mission**

OVERALL SCIENCE MEDIAN	SCIENCE RATING	NATIONAL INTERESTS
4.50	**Excellent / Very Good**	**Very High**
CRITICAL NATIONAL IMPACTS	**TECHNICAL RISK**	**COST RISK**
7 agencies	**Medium**	**Low**

AT A GLANCE

01

A 24-year, multi-instrument Earth observation record with exceptionally broad scientific and operational use.

02

Supports wildfire response, weather forecasting, drought assessment, air-quality management, and sea-ice mapping.

03

The panel prioritized final calibration, reprocessing, and preservation of the long-term data record.

PANEL TAKEAWAY

The panel found Aqua remains highly valuable because of its mature, widely used data products and the unique advantages provided by its long-term data record. The extension supports final observations and closeout work, with emphasis on essential reprocessing and a fully archived record rather than all proposed new algorithm development.



Aqua | Summary Findings

The panel found that Aqua continues to provide exceptional scientific and societal value through one of NASA's longest and most influential Earth observation records. The mission has exceeded all prime mission objectives and produced broadly used datasets that support atmospheric, land, ocean, and Earth system science. Aqua observations continue to advance understanding of long-term environmental change while enabling new scientific discoveries across a wide range of disciplines. The panel emphasized the importance of completing final calibrations, next-generation algorithm reprocessing, and development of a fully archived 24-year record that will support future Earth science investigations and emerging super intelligence (SI), including machine learning (ML) applications. Aqua's extended observations have also provided a unique opportunity to examine late-afternoon observations associated with the mission's orbit drift and strengthened long-term data records that will support future missions and Earth system assessments even after the mission has ended.

The panel also highlighted Aqua's extensive contributions to operational applications and national interests. USDA and the National Drought Mitigation Center use Atmospheric Infrared Sounder (AIRS) drought products that contribute to the U.S. Drought Monitor, while EPA uses Moderate Resolution Imaging Spectroradiometer (MODIS) products for air-quality analyses and exposure assessments. USGS, the Department of Homeland Security (DHS), the U.S. Coast Guard, the Federal Aviation Administration (FAA), weather forecasting centers, and defense organizations use Aqua observations to support land-cover mapping, wildfire monitoring, ice navigation, atmospheric hazard assessment, environmental monitoring, and numerical weather prediction. Near-real-time data delivery through the Land, Atmosphere Near real-time Capability for Earth (LANCE) observation system and a global direct-broadcast network enables disaster response, forecasting, and environmental monitoring activities worldwide. Private-sector organizations also use Aqua products for agricultural forecasting, environmental analytics, and insurance risk assessment, while MODIS observations serve as a widely recognized benchmark for commercial Earth observation systems.

The panel concluded that Aqua has made significant contributions to NASA's Earth Science to Action Strategy through applications that support disaster preparedness, resilience, environmental stewardship, agricultural productivity, and economic decision-making. Tools such as the Fire Information for Resource Management System (FIRMS) support wildfire response and situational awareness, while AIRS observations improve weather forecasting and drought assessment capabilities. The panel noted that many operational users continue to rely on Aqua's long, consistent data record and emphasized the importance of preserving that record through high-quality reprocessing and archival activities. The panel suggested that NASA assess the value of eliminating

development of new algorithm versions and the value of focusing on final reprocessing of Level 1b radiances and higher-level products. As the mission approaches the end of its operational life, completion of these activities would preserve the value of nearly twenty-five years of observations and ensure continued access to the Aqua record for future scientific research, operational applications, and long-term environmental monitoring.

MISSION 02 | FINDINGS SNAPSHOT

AURA

Atmospheric chemistry and ozone observations

FY2027–FY2029 PANEL FINDING **Continue mission**

OVERALL SCIENCE MEDIAN	SCIENCE RATING	NATIONAL INTERESTS
4.25	Very Good	Very High
CRITICAL NATIONAL IMPACTS	**TECHNICAL RISK**	**COST RISK**
4 agencies	Medium / Low	Low

AT A GLANCE

01

MLS instrument remains uniquely capable of measuring key stratospheric trace gases and water vapor at broad spatial coverage.

02

OMI and MLS instruments provide benchmark atmospheric-composition measurements used across science and national interests applications.

03

Priorities include irradiance products and transition to future observing systems.

PANEL TAKEAWAY

The panel found Aura continues to provide reliable benchmark measurements after more than two decades. The panel supported continued MLS operations, which are particularly important for stratospheric observations and for overlap with future missions, while there is value in product transition and preservation of the most valuable capabilities.



Aura | Summary Findings

The panel supported continuing Aura, with particular emphasis on sustaining the unique Microwave Limb Sounder (MLS) instrument observation record and enabling continuity with future stratospheric observing systems. Aura has provided reliable and widely used data for more than two decades, and Aura's products support the scientific community as well as applied and operational users. While current satellites provide datasets that can replace the Ozone Monitoring Instrument (OMI) instrument, no other satellite instrument currently measures halogens and trace gases in the stratosphere or stratospheric water vapor with the same spatial coverage as the MLS. Extending the lifetime of Aura would allow MLS to continue monitoring the stratosphere for perturbations such as volcanic eruptions and would provide important overlap with the European Space Agency's (ESA's) Atmospheric Limb Tracker for Investigation of the Upcoming Stratosphere (ALTIUS) mission, planned for launch in 2028. ALTIUS could then bridge the gap to the NASA Stratosphere Troposphere Response using Infrared Vertically-resolved Light Explorer (STRIVE) mission's Advanced Limb Infrared Chemistry Experiment (ALICE) instrument, proposed for launch in 2030, helping maintain continuity in key stratospheric composition measurements.

The panel highlighted the long, stable, and high-quality MLS and OMI records as important benchmark datasets for atmospheric composition observations. These measurements have characterized long-term changes in stratospheric water vapor and temperature, and improved understanding of major atmospheric perturbations, including volcanic eruptions and stratospheric smoke injections from severe wildfires. OMI's extensive record also provides valuable continuity for evaluating and validating newer atmospheric composition missions and products, while MLS continues to provide unique measurements of stratospheric composition that no other satellite system currently offers with comparable spatial coverage. These long-term records further support technological innovation through training and validation of super intelligence (SI) and machine learning (ML) models and atmospheric re-analyses.

Aura observations strengthen resilience and economic growth through applications in air-quality management, atmospheric forecasting, public health, volcanic-hazard monitoring, and their potential to inform environmental policies. EPA uses OMI observations in air-quality modeling and evaluation activities, while CDC uses Aura data to assess population exposure to air pollution and ultraviolet radiation. USGS applies Aura observations to volcanic-hazard monitoring and atmospheric composition applications. NOAA and the NWS use MLS and OMI products to support weather forecasting and aviation-related activities, while the European Centre for Medium-Range Weather Forecasts (ECMWF) and NASA's Global Modeling and Assimilation Office (GMAO) incorporate Aura observations into atmospheric forecasts and re-analyses. The panel noted that Aura's long and consistent record remains particularly valuable for

trend analysis, environmental exposure assessment, validation of newer atmospheric composition measurements, and transition planning to successor observing systems.

Overall, the panel concluded that Aura continues to provide unique stratospheric measurements, broad scientific impact, and substantial operational value. The mission's observations of volcanic emissions, stratospheric composition, tropospheric air pollution, and the ozone support both NASA's Earth Science to Action Strategy and Administration priorities related to public health, environmental stewardship, resilience, and economic growth. The panel also found value in activities that would facilitate the transition to products from future missions and support the creation of seamless long-term data records, including preservation of the OMI record for future scientific and operational use.

MISSION 03 | FINDINGS SNAPSHOT

ECOSTRESS

Thermal infrared ecosystem and water-use observations

FY2027–FY2029 PANEL FINDING **Continue mission**

OVERALL SCIENCE MEDIAN	SCIENCE RATING	NATIONAL INTERESTS
4.50	**Excellent / Very Good**	**Very High**
CRITICAL NATIONAL IMPACTS	**TECHNICAL RISK**	**COST RISK**
3 agencies	**Low**	**Low**

AT A GLANCE

01

Unique field-scale thermal observations combine fine spatial resolution, frequent revisit, and diurnal sampling.

02

Supports agriculture, wildfire, urban heat, public health, water use, infrastructure, and critical-mineral applications.

03

The instrument is healthy; the panel identified value in product improvements and user access.

PANEL TAKEAWAY

The panel found significant benefit in continuing ECOSTRESS because its thermal observations are difficult to replace and serve a wide range of public and private applications. The panel found value in data-record processing, mineral mapping, user access, and commercial integration.



ECOSTRESS | Summary Findings

The panel found compelling justification for continued operation of the ECOSTRESS mission. ECOSTRESS delivers unique multispectral thermal observations that combine fine spatial resolution, frequent revisit capability, and sampling throughout the diurnal cycle, enabling measurements that other freely available observing systems cannot provide. The mission demonstrated strong scientific productivity during the review period and established itself as an important calibration reference for both government and commercial thermal imaging systems. The panel identified the mission's strong public-private partnerships and broad user engagement as notable strengths. The extended dataset would directly support NASA's Earth Science to Action Strategy through applications in agriculture, water resources, critical minerals, wildfire fuels, urban heat, infrastructure awareness, and public health while advancing Administration priorities related to resilience, economic growth, and local decision-making.

The panel also highlighted ECOSTRESS as an important source of actionable information for a variety of operational and applications users. DOI, USGS, and USDA use ECOSTRESS observations to support natural resource management, environmental monitoring, agricultural assessment, and water-use applications. CDC and NIH use the data to better understand heat exposure and related public health impacts. State and local governments apply ECOSTRESS observations to urban heat resilience planning, environmental assessment, and water-resource management, while private-sector organizations use the data for precision agriculture, wildfire risk assessment, geothermal resource identification, and thermal sensor calibration. The panel emphasized that the mission's unique field-scale thermal observations and diurnal sampling capabilities fill an important observational gap and provide significant value to both research and decision-support communities. The panel identified no concerns with instrument health and concluded that ECOSTRESS remains well positioned to continue delivering high-impact scientific and societal benefits during the extension period.

MISSION 04 | FINDINGS SNAPSHOT

EMIT

Mineralogy, dust sources, and surface composition

FY2027–FY2029 PANEL FINDING **Continue mission**

OVERALL SCIENCE MEDIAN	SCIENCE RATING	NATIONAL INTERESTS
5.00	**Excellent**	**High**
CRITICAL NATIONAL IMPACTS	**TECHNICAL RISK**	**COST RISK**
4 agencies	**Low**	**Medium**

AT A GLANCE

01

Achieved its prime objective and established a global benchmark for mineral and surface-composition measurements.

02

Supports critical minerals, agriculture, wildfire, water quality, industrial-event assessment, and defense applications.

03

Priorities are core data analysis, continued product development, and future mission preparation.

PANEL TAKEAWAY

The panel found benefit in continuing EMIT due to its unique imaging spectroscopy measurements, with strong scientific value and broad relevance to Administration priorities and national interests. The panel most valued core analysis and EMIT's role in preparing for the future EAGLE missions.



EMIT | Summary Findings

The panel found multiple compelling benefits in continuing EMIT. The mission achieved its prime objective of halving uncertainty in mineral dust's solar radiative effect, demonstrating the foundational role of EMIT observations in understanding the Earth system. EMIT provides unique imaging spectroscopy measurements, establishes a global benchmark for instrument performance, and serves as a calibration reference for civil and commercial missions. Continued observations would expand the global spectroscopic baseline, support studies of wildfires, water quality, agriculture, the cryosphere, land-surface composition, and atmospheric emissions, and would provide important preparation for the Explorer for Artemis Geology, Lunar, and Earth-Visible to Shortwave Infrared (EAGLE-VSWIR) and EAGLE Thermal Infrared (EAGLE-TIR) missions. The panel highlighted EMIT's role in developing calibration approaches, retrieval methods, and global spectroscopic datasets that will support these future observing capabilities. The panel also highlighted EMIT's contributions to critical mineral mapping, including minerals associated with rare earth elements, and its contribution to Moon and Mars analog studies.

EMIT data support a growing range of government and commercial applications. NGA uses EMIT observations for spectral Geospatial Intelligence (GEOINT), while DOI applies the data to mineral mapping, volcanic activity, agriculture, land-surface characterization, and preparation for next-generation Landsat systems. USDA uses EMIT data for cover-crop mapping. The Federal Aviation Administration (FAA) and the Defense Advanced Research Projects Agency (DARPA) use or have identified applications for EMIT data, and CDC, National Institute of Health (NIH), and USACE have expressed interest in potential public health, environmental exposure, and infrastructure applications. Companies involved in Earth observation, mining, energy, and geospatial analytics use or evaluate EMIT products for mineral exploration, methane and natural-gas leak detection, calibration, land characterization, and commercial decision support.

The mission directly supports NASA's Earth Science to Action Strategy through applications in critical minerals, wildfire fuels and recovery, water quality, precision agriculture, atmospheric emissions, cryosphere studies, and ecosystem analysis. EMIT's incorporation of SI and advanced data-system capabilities also supports Administration priorities related to technology innovation, operational efficiency, economic vitality, domestic resource security, and Moon-to-Mars exploration. The panel identified EMIT's high radiometric fidelity, global spectroscopic capability, public-private partnerships, and efficient Science Data System as major strengths. It also noted that large data volumes and complex processing requirements can limit adoption by users who lack expertise in imaging spectroscopy. Continued development of automated

analysis and on-demand processing would help make the data more accessible to operational organizations and other non-research users.

The panel supported continuing EMIT and found value in activities that sustain data analysis, calibration and validation, atmospheric products, cloud-based on-demand processing, and preparation for EAGLE-VSWIR and EAGLE-TIR. The panel placed particular importance on core data analysis and continuing product development. These activities would preserve the quality of EMIT's standard products, strengthen cross-calibration with future, and expand the mission's scientific and applied value.

MISSION 05 | FINDINGS SNAPSHOT

GEDI

Forest structure and biomass observations

FY2027–FY2029 PANEL FINDING **Continue mission**

OVERALL SCIENCE MEDIAN	SCIENCE RATING	NATIONAL INTERESTS
4.50	Excellent / Very Good	High
CRITICAL NATIONAL IMPACTS	**TECHNICAL RISK**	**COST RISK**
2 agencies	Low	Low

AT A GLANCE

01

Unique waveform-lidar measurements characterize vegetation height, vertical structure, biomass, and terrain.

02

Supports timber, commodities, wildfire preparedness, insurance, ecosystem assessment, and complementary remote sensing.

03

Extension strengthens the benchmark record for EDGE and enables added value with NISAR, BIOMASS, ICESat-2, and TanDEM-X.

PANEL TAKEAWAY

The panel found GEDI provides a distinctive structural view of terrestrial ecosystems that cannot be reproduced by optical or radar observations alone. The panel found value in continued observations, improved waveform and terrain processing, and expanded use with current and future complementary missions.



GEDI | Summary Findings

The panel found substantial benefits in continuing the GEDI mission which provides the only active spaceborne full-waveform lidar measurements of vegetation height, vertical vegetation density, ecosystem structure, and terrain. GEDI's observations support estimates of forest biomass, carbon stocks, timber volume, biodiversity, and fire behavior. The mission has produced the most detailed near-global record of canopy structure to date, and its waveform measurements provide information that optical, infrared, and synthetic aperture radar observations cannot independently reproduce. Continued observations would strengthen the benchmark record for the proposed NASA Earth Dynamics Geodetic Explorer (EDGE) mission and support complementary investigations with the NASA-Indian Space Research Organisation (ISRO) Synthetic Aperture Radar (NISAR) mission, ESA's BIOMASS mission, the NASA Ice, Cloud, and land Elevation Satellite-2 (ICESat-2), and the joint German Aerospace Center (DLR) and Airbus Defence and Space TerraSAR-X Add-on for Digital Elevation Measurement (TanDEM-X) mission.

GEDI data support forestry, land and resource management, wildfire preparedness, ecosystem assessment, carbon monitoring, biodiversity analyses, and geospatial decision support. USDA uses GEDI's vegetation-structure and biomass information in forestry and resource management applications, while USGS applies the data to forest structure, ecosystem assessment, natural-resource observation, and wildfire-related analyses. EPA identified value in GEDI for environmental assessment and ecological applications. Government and non-governmental users also incorporate GEDI data into workflows for carbon-stock estimation, deforestation monitoring, timber assessment, and land management. GEDI's structural measurements provide an important reference and context for optical, infrared, and radar datasets, strengthening combined analyses with the NASA/USGS Landsat missions, ESA's Sentinel-1 mission, NISAR, the ESA BIOMASS mission, and other Earth observations.

Private-sector users apply GEDI data to timber and commodity analysis, insurance modeling, wildfire risk evaluations, forest recovery monitoring and assessment, commercial risk analytics, and geospatial decision support. These applications support Administration priorities related to timber production, wildfire prevention and response, economic growth, and resilience. Unlike weather missions that require very low data latency, GEDI primarily supports longer-term assessments of forest condition, ecosystem structure, biomass, and land-management needs.

The panel supported continuing GEDI and found value in improving waveform processing, error detection, topographic correction, and higher-level products. The panel also highlighted the need for stronger validation of the full waveform and downstream products. These activities would improve the accuracy and usability of GEDI products,

strengthen their value for agency and commercial applications, and support continuity with EDGE.

MISSION 06 | FINDINGS SNAPSHOT

GPM

Global precipitation and storm observations

FY2027–FY2029 PANEL FINDING **Continue mission**

OVERALL SCIENCE MEDIAN	SCIENCE RATING	NATIONAL INTERESTS
4.50	**Excellent / Very Good**	**Very High**
CRITICAL NATIONAL IMPACTS	**TECHNICAL RISK**	**COST RISK**
4 agencies	**Low**	**Low**

AT A GLANCE

01

DPR instrument is the only precipitation radar in space, GMI instrument is a global calibration standard, and IMERG is a leading merged product.

02

Supports forecasting, water resource management, disaster response, agriculture, food security, insurance, and private-sector risk analysis.

03

Extending GPM to overlap with the upcoming PMM mission is important for radar calibration

PANEL TAKEAWAY

The panel strongly supported GPM because of its precipitation products, extensive operational use, and healthy instruments at the time of review. Priorities include algorithms, machine-learning retrievals, retrospective processing, and calibration overlap with PMM, planned for launch in 2030.



GPM | Summary Findings

The panel found compelling scientific and operational justification for continuing GPM. The Dual-frequency Precipitation Radar (DPR) instrument remains the only precipitation radar operating in space, the GPM Microwave Imager (GMI) instrument serves as the global calibration standard for passive microwave rainfall instruments, and Integrated Multi-satellite Retrievals for GPM (IMERG) provides a leading merged precipitation product. GPM's precessing orbit samples the diurnal precipitation cycle across all hours, while its intercalibrated record supports analysis of storms, precipitation processes, hydrologic extremes, and long-term variability. Continued GPM operations would allow for overlap between DPR and the upcoming joint NASA/ JAXA Precipitation Measurement Mission (PMM), planned for launch in 2030. The panel highlighted this overlap as necessary for PMM radar calibration and important to PMM future mission success. GPM would also continue to provide the calibration foundation for the international passive-microwave precipitation constellation and sustain the long-term record used to produce IMERG.

GPM supports an extensive operational community in weather forecasting, tropical-cyclone analysis, flood and landslide monitoring, agriculture, food security, water management, disaster response, and financial risk assessment. The National Hurricane Center (NHC), NWS, United States Air Force (USAF), Naval Research Laboratory (NRL), NOAA's National Environmental Satellite, Data, and Information Service (NESDIS), and international forecasting organizations use GMI imagery and IMERG products for tropical-cyclone and precipitation forecasting. The 557th Weather Wing, AccuWeather, StormGeo, Tomorrow.io, and other forecasting organizations also use GPM products in weather applications. Near-real-time DPR and GMI products and the staged delivery of IMERG products allow users to select data based on their latency and quality needs.

Google Flood Hub, the Landslide Hazard Assessment for Situational Awareness, the Famine Early Warning Systems Network, FloodMapp, Fathom Science, the Pacific Disaster Center, and USACE tools use IMERG data for flood forecasting, landslide assessment, disaster response, and hazard awareness. USDA's Foreign Agricultural Service (FAS), Nutrien Ag, and water-management organizations use GPM data for agricultural monitoring, food-security assessments, and water-resource decisions. Munich Re, Swiss Re, Howden, Raincoat, CyStellar, Floodbase, and other private-sector organizations apply IMERG products to catastrophe modeling, risk pricing, parametric insurance, and resilience planning. These uses demonstrate GPM's contributions to Administration priorities related to disaster preparedness, agricultural productivity, economic growth, operational efficiency, and resilience.

The panel highlighted the value of activities that would deploy Version 08 algorithms, retrospectively reprocess the long-term precipitation record, improve machine-learning

retrievals, and continue development of precipitation and microphysics products. Version 08 development had already demonstrated measurable improvements in retrieval performance, although full processing and validation remained underway at the time of the review. The panel also identified the mission's reliance on future Tracking and Data Relay Satellite capacity as an operational risk because any loss of near-real-time delivery could affect forecasting and hazard-response users. Overall, the panel supported continuing GPM and emphasized the importance of preserving its unique radar measurements, global calibration role, merged precipitation products, and essential overlap with PMM.

MISSION 07 | FINDINGS SNAPSHOT

GRACE-FO

Time-variable gravity and terrestrial water storage

FY2027–FY2029 PANEL FINDING **Continue mission**

OVERALL SCIENCE MEDIAN	SCIENCE RATING	NATIONAL INTERESTS
4.75	**Excellent / Very Good**	**High**
CRITICAL NATIONAL IMPACTS	**TECHNICAL RISK**	**COST RISK**
3 agencies	**Low**	**Medium / Low**

AT A GLANCE

01

Provides the only global observations of time-variable gravity and large-scale mass redistribution.

02

Supports water management, drought assessment, geospatial infrastructure, ice-mass analysis, and risk assessment.

03

Priorities include data analysis, mitigation of flight-system aging, and preparation for GRACE-C.

PANEL TAKEAWAY

The panel found the GRACE-FO record unique and non-substitutable for understanding large-scale water storage, ice mass, and other changes in Earth's mass distribution. The panel supported continued operations and also preserving data quality, expanding higher-level products, and maintaining readiness for the upcoming GRACE-C mission.



GRACE-FO | Summary Findings

The panel found that GRACE-FO provides a unique global record of changes in Earth's gravity field and large-scale mass redistribution. Together, GRACE and GRACE-FO provide a nearly continuous multidecadal record that supports analysis of terrestrial water storage, groundwater depletion, ice-mass change, hydrologic extremes, ocean processes, and solid-Earth dynamics. No other observing system provides equivalent global measurements of mass redistribution, including changes in subsurface water storage. Continued operations would strengthen the long-term record, improve understanding of cumulative human impacts on groundwater resources, and support integrated investigations with NISAR, SWOT, ICESat-2, Sentinel-1, satellite altimetry, and ground-based Global Navigation Satellite System networks.

GRACE-FO supports water security, drought assessment, geospatial infrastructure, water-resource management, ice-mass analysis, and environmental risk assessment. NGA incorporates GRACE-FO gravity fields into gravity-based products, validates internally developed models, and uses the observations in geoid-modeling analyses. NOAA's National Geodetic Survey applies time-variable gravity data to modernization of the National Spatial Reference System and development of the North American-Pacific Geopotential Datum of 2022. USGS uses GRACE-FO as a noninvasive source of information for groundwater and hydrologic assessments, while the U.S. Drought Monitor, the California Department of Water Resources, and Texas water programs apply terrestrial water-storage products to drought and water-resource monitoring.

CDC and NOAA identified value in GRACE-FO data for environmental situational awareness, retrospective public health studies, and vulnerability assessment. Private-sector users apply the observations to coastal risk modeling, infrastructure planning, real estate risk assessment, and analysis of long-term hydrologic stress and ice-mass loss. GRACE-FO findings have also informed groundwater-management discussions in the southwestern United States and India. The panel noted that higher-level products account for most non-research uses, underscoring the importance of products that translate gravity measurements into terrestrial water-storage and mass-change information.

The panel identified the mission's coarse spatial resolution and standard-product latency as limitations for localized groundwater management and time-sensitive applications. GRACE-FO measures total water storage rather than groundwater alone, so users need complementary estimates of soil moisture, snow, and surface water to isolate groundwater change. The panel found value in a Quick-Look Level-3 product that could improve the timeliness of terrestrial water-storage information, while noting that the product remained experimental and required further validation before serving untrained operational users. The panel also identified opportunities to produce more decision-

ready groundwater products and longer-window Level-2 and Level-3 products that emphasize long-term variability at improved spatial resolution.

The panel supported continuing GRACE-FO and highlighted activities focused on accelerated data analysis, the Quick-Look Level-3 product, and mitigation of risks associated with aging flight systems. Continued collaboration with Germany's GFZ Helmholtz Centre for Geosciences remains essential to project management, operations, and data analysis. Continued GRACE-FO operations would also provide overlap with GRACE-C, planned for launch in 2029. The panel emphasized that this overlap would enable direct satellite-to-satellite comparison, provide a Gold Standard validation opportunity, and help preserve continuity across the GRACE, GRACE-FO, and GRACE-C global mass-change records.

MISSION 08 | FINDINGS SNAPSHOT

ICESat-2

Ice-sheet elevation and surface-height measurements

FY2027–FY2029 PANEL FINDING **Continue mission**

OVERALL SCIENCE MEDIAN	SCIENCE RATING	NATIONAL INTERESTS
4.50	**Excellent / Very Good**	**Very High**
CRITICAL NATIONAL IMPACTS	**TECHNICAL RISK**	**COST RISK**
5 agencies	**Low**	**Low**

AT A GLANCE

01

Photon-counting laser altimetry delivers high-accuracy elevation and surface-change products across land, ice, water, and vegetation.

02

More than two trillion laser shots support 26 products, over 1,000 publications, and a broad government and commercial user base.

03

Continuation preserves high-quality observations and supports ice-sheet mass change, snow depth, lake-ice freeboard, and on-demand products.

PANEL TAKEAWAY

The panel found ICESat-2 to be a highly successful, technically healthy mission with exceptional data quality and broad national-interest value. Extending the mission preserves its core observations and enables carefully selected product improvements and simplified on-demand access.



ICESat-2 | Summary Findings

The panel found that ICESat-2 remains a highly successful and technically healthy mission that provides uniquely accurate measurements of Earth's surface height and change. Its photon-counting laser altimeter supports observations of land ice, sea ice, oceans, land, vegetation, the atmosphere, inland water, and shallow coastal bathymetry. ICESat-2 has established a Gold Standard reference for topography and surface change, converted more than two trillion laser shots into 26 data products, and supported more than 1,000 publications. Continued observations would preserve important records of ice-sheet elevation, sea-ice thickness, vegetation structure, and other Earth-system variables while supporting new products for ice-sheet mass change, snow depth, and lake-ice freeboard.

NGA uses ICESat-2 bathymetric returns and photon-level observations to support nautical charting, global elevation products, GEOINT, and independent accuracy assessments. NOAA uses near-shore bathymetry and surface-height products, while USGS, EPA, and USACE apply ICESat-2 observations to environmental assessment, terrain analysis, water-resource applications, infrastructure planning, and elevation-model validation. The U.S. Coast Guard uses sea-ice information to support Arctic and Antarctic operations. Private-sector organizations use ICESat-2 data for navigation, flood-risk analysis, commercial lidar development, and other geospatial applications. The mission's lake-ice products also offer potential value for commercial shipping and cargo operations in the Great Lakes.

The panel identified cloud cover, the 91-day repeat cycle, and product latency as limitations for some time-sensitive applications. It nevertheless highlighted the mission's continued work to improve accessibility through SlideRule, icepyx, Quick-Look products, cloud-enabled processing, and SI-enabled on-demand product generation. The panel also noted that atmospheric products developed after the end of the Cloud Aerosol Lidar Infrared Pathfinder Satellite Observations (CALIPSO) mission help address an observational gap in atmospheric structure.

The panel supported continuing ICESat-2 at its current baseline. Continued observations would limit the potential gap in high-accuracy laser-altimetry measurements before the planned launch of EDGE in 2030 and provide an important basis for connecting the ICESat-2 and EDGE records. The panel highlighted opportunities to combine ICESat-2 data with GEDI and NISAR for vegetation and land applications, and with SWOT for complementary elevation and water observations. It also found value in continued validation, resolution of small inter-product biases, and planning for changes in observing geometry as the mission approaches later stages of operations.

MISSION 09 | FINDINGS SNAPSHOT

OCO-2

Atmospheric carbon dioxide observations

FY2027–FY2029 PANEL FINDING **Continue mission**

OVERALL SCIENCE MEDIAN	SCIENCE RATING	NATIONAL INTERESTS
4.50	**Excellent / Very Good**	**Some**
CRITICAL NATIONAL IMPACTS	**TECHNICAL RISK**	**COST RISK**
0 agencies	**Low**	**Medium / Low**

AT A GLANCE

01

Provides the space-based XCO2 reference used to evaluate and calibrate other observations.

02

Solar-induced fluorescence products support agriculture, drought-stress assessment, ecosystem analysis, and wildfire-risk modeling.

03

The panel encouraged coordinated OCO-2 and OCO-3 activities and higher-level products that expand user uptake.

PANEL TAKEAWAY

The panel found OCO-2 data to be scientifically excellent and increasingly valuable as the record captures a wider range of ecosystem responses and atmospheric conditions. Continuation is supported, with additional value possible through coordinated operations and development of products tailored to application users.



OCO-2 | Summary Findings

The panel found that OCO-2 provides the highest quality space-based column-averaged carbon dioxide (XCO2) record. The instrument's stability, calibration, precision, and extensive validation make OCO-2 an important reference for evaluating and calibrating other carbon-observing missions. The record becomes more valuable as it captures a wider range of droughts, floods, fires, El Niño and La Niña conditions, and ecosystem responses, allowing researchers to improve understanding of atmospheric, terrestrial, and ocean carbon exchange. Continuation of this record is of key significance, as a strong El Niño phase of the El Niño-Southern Oscillation (ENSO) cycle is expected during the mission extension period, typically marked by strong efflux from the Tropics due to drought conditions. OCO-2 also provides solar-induced fluorescence (SIF) measurements that support studies of photosynthesis, drought stress, crop response, ecosystem productivity, and wildfire risk.

The EPA uses OCO-2 observations in studies of atmospheric transport, vegetation health, ozone-deposition processes, and electricity-generating facilities. Private-sector risk modelers use SIF, water-vapor, and surface-pressure products to assess vegetation drying, wildfire risk, streamflow, water resources, and severe-weather risk. The panel noted that OCO-2 data have also stimulated development of field-scale spectrometers for agricultural and environmental applications. Although the mission team has expanded training and outreach to agricultural, urban-management, and related communities, operational adoption remains limited. Sparse sampling, orbit-based product formats, and limited availability of higher-level products make the data difficult for some nonexpert users to apply directly.

OCO-2's long, stable record remains important as related missions begin operations. For example, the panel highlighted OCO-2's role as a transfer standard for JAXA's Greenhouse Gases Observing Satellite Global Observing SATellite for Greenhouse gases and Water cycle (GOSAT-GW), CNES's MicroCarb mission, and ESA's Carbon Dioxide Monitoring Mission (CO2M), noting that new carbon-dioxide missions can require several years to produce fully calibrated and scientifically useful products. OCO-2 also provides a reference for ESA's Tropospheric Monitoring Instrument (TROPOMI) observations and a high-quality record that can help connect current and future space-based carbon dioxide measurements. Its SIF record complements TROPOMI and will provide context for ESA's Fluorescence Explorer (FLEX) mission.

The panel supported continuing OCO-2. It found value in improving SIF validation and developing rasterized, fused, and higher-level products that would make OCO-2 information easier for applications users to incorporate into existing workflows. The panel also highlighted potential efficiencies from combining OCO-2 and OCO-3 Mission Operations and Data Analysis activities and the value of applying efficiencies to products such as land-atmosphere exchange, multi-sensor SIF, and photosynthesis

products. Mission operations and data production for OCO-2 is being transitioned to the California Institute of Technology under a four-year partnership agreement with NASA.

MISSION 10 | FINDINGS SNAPSHOT

OCO-3

Carbon dioxide observations from the ISS

FY2027–FY2029 PANEL FINDING **Continue mission**

OVERALL SCIENCE MEDIAN	SCIENCE RATING	NATIONAL INTERESTS
4.50	**Excellent / Very Good**	**Some**
CRITICAL NATIONAL IMPACTS	**TECHNICAL RISK**	**COST RISK**
0 agencies	**Low**	**Low**

AT A GLANCE

01

Adds unique diurnal sampling and Snapshot Area Maps to the high-quality OCO carbon-dioxide and fluorescence record.

02

Supports urban-observations, agriculture, crop planning, wildfire-risk applications, and local decision support.

03

The panel encouraged coordinated OCO-2/OCO-3 operations and higher-level products to increase application utility.

PANEL TAKEAWAY

The panel found OCO-3 extends the OCO measurement record with sampling capabilities that are especially useful for cities, targeted areas, and diurnal studies. Continuation is supported, along with exploration of shared operations and higher-level product development with OCO-2.



OCO-3 | Summary Findings

The panel found that OCO-3 extends the high-quality OCO carbon dioxide and SIF record with capabilities enabled by its location on the ISS. OCO-3 provides diurnal sampling and Snapshot Area Maps (SAMs), which allow the mission to examine urban gradients, targeted regions, ecosystem processes, and atmospheric carbon exchange at finer spatial scales. OCO-3 and OCO-2 now produce consistent results at collocated observations, and a longer OCO-3 record would help researchers distinguish diurnal land-atmosphere exchange signals from atmospheric transport and variability at other timescales.

SAMs support analysis of urban emissions and allow researchers to estimate mass balance for urban plumes without relying exclusively on large-scale transport models. EPA uses OCO-2 and OCO-3 observations in studies of vegetation health, carbon combustion, urban-scale emissions, atmospheric transport, and electricity-generating facilities. City and state governments use or evaluate SAMs for land-use and urban-planning applications, while C40 Cities has expressed interest in urban emissions information. USFS and logging organizations use or evaluate SIF observations to identify forests at risk from water stress and wildfire. Private-sector risk modelers use SIF data in wildfire applications.

Coincident observations with ECOSTRESS have demonstrated changes in water-use efficiency throughout the day. The panel highlighted opportunities to use SAMs and machine-learning techniques to resolve finer-scale carbon dioxide and SIF patterns. It also noted that the applications remain concentrated in case studies and emerging uses and that SIF requires stronger validation.

The panel supported continuing OCO-3. OCO-3 would continue the OCO record while providing diurnal and mapped observations that OCO-2 cannot acquire. These measurements can inform the use of wide-swath and area-mapping observations from JAXA's GOSAT-GW, CNES's MicroCarb, and the planned ESA CO2M missions. The panel found particular value in increasing SAM observations where operationally feasible, coordinating observations with EMIT and ECOSTRESS, and developing higher-level products that make OCO-3 data more useful to applications communities. Mission operations and data production for OCO-3 is being transitioned to the California Institute of Technology under a four-year partnership agreement with NASA.

MISSION 11 | FINDINGS SNAPSHOT

PREFIRE

Polar far-infrared energy budget observations

FY2027–FY2029 PANEL FINDING **Continue mission**

OVERALL SCIENCE MEDIAN	SCIENCE RATING	NATIONAL INTERESTS
4.00	Very Good	Some
CRITICAL NATIONAL IMPACTS	**TECHNICAL RISK**	**COST RISK**
0 agencies	Medium / Low	Low

AT A GLANCE

01

Fills a major observational gap by measuring far-infrared energy over polar regions with two small satellites.

02

Offers a unique dataset for surface-atmosphere interactions, polar prediction, weather applications, and model evaluation.

03

Extension provides time for full validation, a multiyear global record, user development, and an auxiliary collocation product.

PANEL TAKEAWAY

The panel found a substantial scientific case for continuing PREFIRE. Expanded geographic coverage, full validation, a multiyear far-infrared record, and an auxiliary satellite collocation product would strengthen its scientific and applied value. Operational use remains at an early stage.



PREFIRE | Summary Findings

The panel found meaningful scientific value for extending PREFIRE because the mission fills a major observational gap in Earth's energy budget. Far-infrared wavelengths account for approximately half of Earth's outgoing longwave radiation but have not previously received comprehensive global sampling. PREFIRE's two commercial off-the-shelf CubeSat platforms provide unique spectral measurements over the polar regions. Continued observations could establish a multiyear record and broaden global coverage, improving understanding of polar surface-atmosphere interactions, snow and ice emissivity, cloud processes, upper-atmosphere moisture, and potential compensating biases in Earth system models.

PREFIRE observations could improve seasonal sea-ice and ice-sheet predictions for Arctic military and commercial activities and may eventually support weather forecasting and alpine water-resource analysis. Potential users include organizations involved in Arctic operations and commercial shipping. However, the panel noted that the data had not yet been fully validated and that federal and commercial organizations had not established operational use of PREFIRE products at the time of the review. It also found that operational assimilation by NWS remained unlikely during the review period because the necessary validation and product development were still underway.

PREFIRE provides measurements that complement ESA's Far-infrared Outgoing Radiation Understanding and Monitoring (FORUM) mission and the Canadian Space Agency's planned Thin Ice Clouds and Far InfraRed Emissions (TICFIRE) mission. The panel noted that FORUM will provide different spatial sampling and TICFIRE will provide different spectral sampling, giving PREFIRE a distinctive role in establishing a broader far-infrared record. An auxiliary satellite-collocation product would also improve comparisons between PREFIRE and other Earth-observing missions and strengthen integration across the observing fleet.

The panel supported continuing PREFIRE and highlighted activities that would complete validation, extend the multiyear far-infrared record, broaden coverage beyond the polar regions, build user engagement, and improve integration with the larger NASA Earth-observing fleet. These activities would strengthen PREFIRE's scientific foundation and help translate a new class of measurements into products with greater potential value to forecasting, polar operations, and resource-management communities.

MISSION 12 | FINDINGS SNAPSHOT

SAGE III

Stratospheric aerosols, ozone, and water vapor

FY2027–FY2029 PANEL FINDING **Continue mission**

OVERALL SCIENCE MEDIAN	SCIENCE RATING	NATIONAL INTERESTS
5.00	**Excellent**	**Some**
CRITICAL NATIONAL IMPACTS	**TECHNICAL RISK**	**COST RISK**
1 agency	**Low**	**Low**

AT A GLANCE

01

Provides highly accurate ozone, aerosol, and water-vapor measurements using a self-calibrating solar-occultation technique.

02

Serves as a benchmark for other stratospheric instruments and supports volcanic-aerosol and aviation-related assessments.

03

The instrument is healthy; planned improvements make expedited products more useful by releasing data files rather than images.

PANEL TAKEAWAY

The panel found SAGE III scientifically excellent, technically low risk, and valuable as a reference for stratospheric composition. Continuation preserves accurate observations as Aura approaches the end of its operational life and improves the usefulness of expedited products for volcanic-aerosol and aviation-related observations.



SAGE III | Summary Findings

The panel found that SAGE III provides unique measurements of stratospheric ozone, aerosols, and water vapor. Its self-calibrating solar-occultation technique produces highly accurate observations without relying on assumptions about aerosol particle size, making SAGE III an important benchmark for stratospheric aerosol and atmospheric composition measurements. Continued operations would preserve critical observations needed to monitor the ozone-layer and volcanic and wildfire-related aerosol perturbations, and to continue ozone, aerosol, and stratospheric water-vapor records as Aura approaches the end of its mission.

SAGE III data support ozone monitoring, volcanic-aerosol monitoring, Earth-radiation-budget studies, atmospheric research, and monitoring of stratospheric perturbations that may affect aviation operations. The mission's long-term, highly accurate record serves as an important reference for evaluating atmospheric change, validating other observing systems, and supporting resilience through improved awareness of events that can affect air travel and the atmospheric environment. The panel also highlighted the value of distributing expedited products as data files rather than images to improve accessibility and usability for stakeholders.

The panel noted that SAGE III is expected to serve an increasingly important role in maintaining continuity of stratospheric composition observations and validating future observing systems. Continued observations would provide benchmark measurements for future missions, including ESA’s ALTIUS, planned for launch in 2028, and NASA's ALICE instrument on STRIVE, planned for launch in 2030, while helping sustain long-term atmospheric-composition records through the transition between observing systems.

The panel supported continuing SAGE III. It found value in continued improvement of stratospheric-composition products, validation of future missions, and delivery of more usable expedited products. These activities would preserve SAGE III's role as a benchmark observational record and support continuity in stratospheric observations.

MISSION 13 | FINDINGS SNAPSHOT

SMAP

Soil moisture and freeze/thaw observations

FY2027–FY2029 PANEL FINDING **Continue mission**

OVERALL SCIENCE MEDIAN	SCIENCE RATING	NATIONAL INTERESTS
4.50	**Excellent / Very Good**	**High**
CRITICAL NATIONAL IMPACTS	**TECHNICAL RISK**	**COST RISK**
3 agencies	**Medium / Low**	**Medium / High**

AT A GLANCE

01

Mature, widely adopted products support soil-moisture, drought, water-resource, weather, defense, and ocean-salinity applications.

02

Core products are well validated, and the instrument remains healthy, with improved efficiency and modernized operations.

03

The panel prioritized sustained soil-moisture and freeze-thaw observations and preservation of validated core products.

PANEL TAKEAWAY

The panel supported continuing SMAP, emphasizing sustained observations and validated products for drought assessment, agriculture, and water management. Selected product improvements should preserve the core record.



SMAP | Summary Findings

The panel found that SMAP remains a high-value and widely used mission with strong scientific merit, mature standard products, and broad relevance to operational and applied users. SMAP provides soil-moisture, freeze-thaw, and ocean-salinity information that supports hydrology, weather and land-data assimilation, drought monitoring, agriculture, water management, wildfire analysis, hazard preparedness, and environmental assessment. The long-term record provides particular value for identifying variability, extremes, and changes in land-surface conditions.

NOAA and NWS use SMAP observations in weather, hydrologic, and forecasting activities, while USDA uses soil-moisture products for agricultural monitoring, drought assessment, and crop analysis. USGS and other water-resource organizations apply SMAP data to hydrologic and environmental assessments. NGA uses the information in defense and geospatial applications, including analysis related to terrain and trafficability. SMAP observations also contribute to the U.S. Drought Monitor and NASA's Goddard Earth Observing System (GEOS) assimilation activities.

The panel noted that spatial resolution and product latency limit some operational applications and several higher-level products also depend on external datasets, models, and observations. Combining SMAP with ESA's Soil Moisture and Ocean Salinity (SMOS) mission and ESA's Sentinel-1 mission can improve coverage and resolution, while overlap with NASA's NISAR mission creates opportunities for higher-resolution soil-moisture products. The panel found scientific and applied value in SMAP-NISAR integration but noted questions about global scalability, validation, workforce demands, and highlighted the importance of preserving SMAP's established core data record.

The panel supported continuing SMAP with emphasis on sustained observations and preservation of mature core products. It found value in selected enhancements that improve resolution and expand applications while placing less emphasis on the full scope of the proposed SMAP-NISAR product and some Level-4 developments. Continued SMAP operations would preserve an established soil-moisture and freeze-thaw record, support current forecasting and decision-support systems, and provide complementary observations for NISAR and other land and water missions.

MISSION 14 | FINDINGS SNAPSHOT

SWOT

Surface water and ocean topography

FY2027–FY2029 PANEL FINDING **Continue mission**

OVERALL SCIENCE MEDIAN	SCIENCE RATING	NATIONAL INTERESTS
5.00	**Excellent**	**Very High**
CRITICAL NATIONAL IMPACTS	**TECHNICAL RISK**	**COST RISK**
5 agencies	**Low**	**Medium / Low**

AT A GLANCE

01

Revolutionary KaRIn instrument observations measure surface-water and ocean topography at unprecedented resolution and accuracy.

02

Supports river discharge, water storage, flood risk, coastal processes, ocean currents, waves, bathymetry, and wetland studies.

03

The panel supported product improvements, expanded applications, and novel science.

PANEL TAKEAWAY

The panel found SWOT has exceeded expectations early in its mission, opening opportunities in hydrology and oceanography. Continued observations and product development would support scientific discovery and adoption by users.



SWOT | Summary Findings

The panel found that SWOT has exceeded expectations and opened major new opportunities in hydrology and oceanography. The Ka-band Radar Interferometer (KaRIn) instrument measures surface-water and ocean topography at unprecedented resolution and accuracy, supporting analysis of rivers, lakes, reservoirs, wetlands, coastal areas, ocean currents, tides, waves, and the land-ocean interface. SWOT observations have already improved understanding of water storage and discharge, river-channel characteristics, coastal processes, and small-scale ocean circulation. The panel highlighted the mission's early scientific accomplishments, data quality, and rapid adoption by users.

NOAA and NOS use SWOT information in ocean, coastal, and vertical-datum applications, including work associated with VDatum. USGS applies the observations to surface-water and hydrologic analysis, while NGA uses SWOT data in geodesy, gravity, bathymetry, and other geospatial applications. The EPA and water-resource organizations have identified applications in water quality, wetlands, flood risk, and environmental assessment. Private-sector organizations use or evaluate SWOT products for flood and catastrophe-risk modeling, infrastructure planning, water-resource applications, and coastal analysis.

The panel noted that SWOT's 21-day repeat cycle limits rapid-response use for some transient events and that narrow rivers, coastal areas, and complex terrain continue to present product and validation challenges. It highlighted the importance of improved uncertainty characterization, validation, product maturity, and user guidance. SWOT's observations also complement ICESat-2 elevation measurements, NISAR wetland and land-deformation observations, and Plankton, Aerosol, Cloud, ocean Ecosystem (PACE) measurements of ocean biology and color. Combined analyses can connect surface-water storage and discharge with land change, coastal processes, ocean circulation, and biological productivity.

The panel supported continuing SWOT and found value in activities that improve data products, expand applications and usability, and enable additional science. These activities would help translate SWOT's early measurement success into mature products for water management, flood-risk assessment, coastal planning, geodesy, and ocean applications while strengthening complementary investigations with ICESat-2, NISAR, and PACE.

MISSION 15 | FINDINGS SNAPSHOT

TEMPO

Hourly geostationary air-quality observations

FY2027–FY2029 PANEL FINDING **Continue mission**

OVERALL SCIENCE MEDIAN	SCIENCE RATING	NATIONAL INTERESTS
5.00	**Excellent**	**Very High**
CRITICAL NATIONAL IMPACTS	**TECHNICAL RISK**	**COST RISK**
3 agencies	**Low**	**Low**

AT A GLANCE

01

The first and only sub-hourly, high-resolution air-quality instrument focused on North America.

02

Rapidly adopted by federal, state, and local agencies for air-quality, wildfire, emissions, and surface-level applications.

03

Priorities include standard products and proposed nighttime, surface-NO2, and ocean capabilities.

PANEL TAKEAWAY

The panel found TEMPO unique, productive, and already important to operational air-quality users. Product improvements and proposed new capabilities would broaden scientific and applied use.



TEMPO | Summary Findings

The panel found that TEMPO provides a unique and highly valuable air-quality observing capability. TEMPO is the first and only sub-hourly, high-resolution air-quality instrument focused on North America, filling an important temporal gap by measuring atmospheric composition throughout daylight hours. The mission supports analysis of nitrogen dioxide, ozone, formaldehyde, aerosols, wildfire emissions, industrial activity, and other processes that influence surface air quality. Continued observations would improve emissions constraints, extend the record across a wider range of environmental conditions and extreme events, and strengthen Earth-system and air-quality models.

The EPA, NOAA, CDC, USGS, state agencies, and local air-quality organizations have rapidly adopted TEMPO products for air-quality assessment, forecasting, emissions analysis, wildfire monitoring, and public-health applications. The EPA uses TEMPO information through air-quality modeling and data-distribution systems, while NOAA applies the observations to atmospheric analysis and forecasting. State and local agencies use the mission's hourly measurements to examine pollution episodes, wildfire smoke, changing emissions, and differences in air quality throughout the day. The panel found that TEMPO's temporal resolution provides information that polar-orbiting systems cannot supply over North America.

TEMPO also forms part of an international geostationary atmospheric-composition constellation with South Korea's Geostationary Environment Monitoring Spectrometer (GEMS) and ESA's Sentinel-4. Comparisons with ESA's TROPOMI and observations from Pandora ground-based instruments support calibration and validation and help connect measurements across geostationary and polar-orbiting systems. Continued TEMPO observations would lengthen the record, capture more fires, droughts, floods, emissions changes, and other environmental conditions, and strengthen connections between current air-quality measurements and future geostationary observing systems.

The panel supported continuing TEMPO and found value in standard-product enhancements, computational resources, and new nighttime, surface nitrogen dioxide, and ocean capabilities. It noted that cloud and aerosol retrievals require continued refinement and validation but found that rapid adoption by operational agencies demonstrates strong demand for TEMPO data. These activities would improve established products, broaden scientific and applied use, and strengthen air-quality decision support and forecasting.

MISSION 16 | FINDINGS SNAPSHOT

TSIS-1

Solar irradiance observations

FY2027–FY2029 PANEL FINDING **Continue mission**

OVERALL SCIENCE MEDIAN	SCIENCE RATING	NATIONAL INTERESTS
4.50	**Excellent / Very Good**	**High**
CRITICAL NATIONAL IMPACTS	**TECHNICAL RISK**	**COST RISK**
3 agencies	**Medium / Low**	**Low**

AT A GLANCE

01

Preserves the solar-irradiance reference record needed for Earth-system modeling and continuity with TSIS-2.

02

Provides accurate solar-irradiance measurements for calibration and evaluation of Earth's energy balance.

03

Continuation preserves the multidecadal record and provides overlap with launch and evaluation of TSIS-2.

PANEL TAKEAWAY

The panel found TSIS-1 essential for preserving the solar-irradiance reference record that is the foundation for Earth-system modeling. Overlap with TSIS-2, planned for launch in 2027, would support cross-calibration and continuity across the instrument transition.



TSIS-1 | Summary Findings

The panel found that TSIS-1 continues to deliver stable and highly accurate Total Solar Irradiance (TSI) and Spectral Solar Irradiance (SSI) measurements with traceability to NOAA standards. This traceability links the measurements to an independently maintained reference and provides confidence that changes in the record reflect actual variations in solar output, rather than changes in instrument calibration. It also allows scientists to compare observations from different instruments and missions on a consistent radiometric scale, distinguish real solar variability from measurement offsets, and connect datasets collected over multiple decades. These qualities make TSIS-1 a trusted international reference for solar irradiance measurements and support its use in instrument calibration, data validation, Earth-energy-budget studies, solar-variability modeling, and long-term assessments of the Sun-Earth system.

TSIS-1 provides a common reference for calibration and validation across multiple observing systems. Its data complement measurements from current and future missions, including the Clouds and the Earth's Radiant Energy System (CERES), Calibration Absolute Radiance and Refractivity Observatory (CLARREO) Pathfinder, and Libera in assessments of Earth's energy budget. Comparisons with Aura/OMI and TEMPO help validate atmospheric-composition measurements and build consistent long-term records. TSIS-1 also provides essential calibration for a wide range of current and future missions, including TEMPO, the Aerosol Robotic Network (AERONET), Multi-Angle Imager for Aerosols (MAIA), and NOAA Geostationary Operational Environmental Satellite (GOES) instruments. By providing a common reference scale, TSIS-1 helps researchers determine whether differences among datasets represent actual changes in the Sun-Earth system or differences in instrument calibration and performance.

The mission's observations support the development and validation of solar-irradiance models and NOAA long-term data records. Through the NASA Solar Irradiance Science Team program, TSIS-1 observations support the development of solar-forcing datasets used in Earth system modeling and model intercomparison activities. TSIS-1's near-infrared measurements also support analyses of Earth's energy budget and the radiative effects of solar magnetic features.

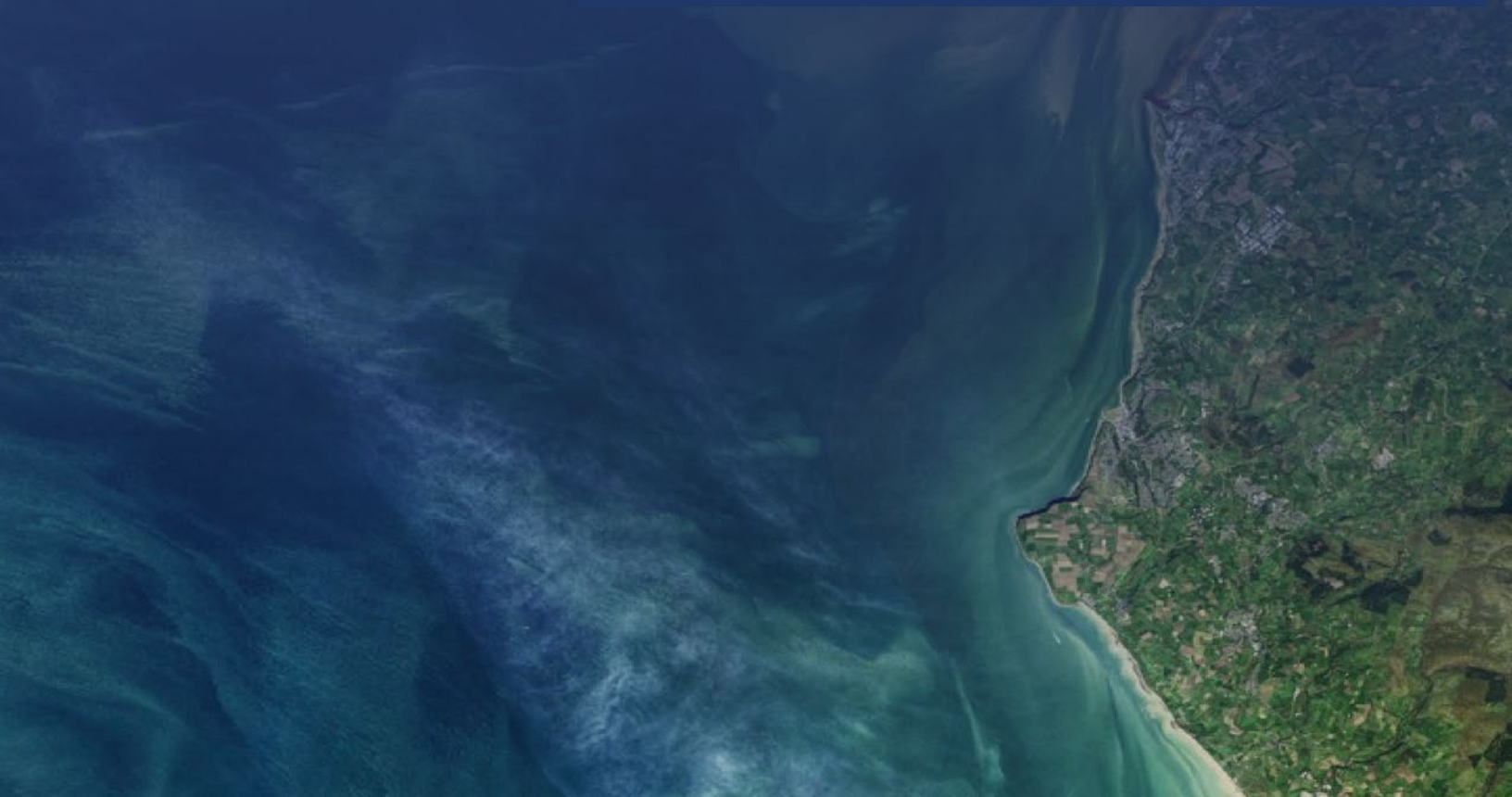
Continued TSIS-1 operations would preserve the multidecadal solar-irradiance record while providing overlap with TSIS-2, planned to launch in 2027. That overlap would enable direct comparison and cross-calibration between the two instruments, connect TSIS-2 measurements to the existing reference scale, and reduce the risk that an apparent change between the missions could result from an instrument offset rather than a real change in solar output. The overlap would also support the commissioning and evaluation of TSIS-2 and maintain continuity in the long-term TSI and SSI records.

The mission extension would also capture additional variability during the declining phase of Solar Cycle 25. Measurements through this phase would extend the record across a substantial portion of the approximately 11-year solar cycle and improve understanding of changes in solar output and their relationship to Earth's energy budget and atmospheric processes. Combined with the overlap with TSIS-2, these observations would strengthen the scientific value and internal consistency of the solar-irradiance record across timescales ranging from individual solar cycles to centennial trends. The panel supported continuing TSIS-1 at its current baseline, preserving its role as an international reference and maintaining the measurement continuity needed by Earth-observing missions, models, and long-term data records.

NASA **Earth**

REFERENCE

Rating Definitions



Rating Definitions

Science and Data Quality Rating Definitions

Science Definitions

The panel used the adjectival scale Excellent, Excellent/Very Good, Very Good, Very Good/Good, Good, Good/Fair, Fair, Fair/Poor, and Poor. The five anchor definitions below are the NASA FAR Supplement adjectival rating definitions; intermediate ratings fall between adjacent categories.

Excellent: A comprehensive and thorough proposal of exceptional merit with one or more significant strengths. No deficiency or significant weakness exists.

Very Good: A proposal having no deficiency which demonstrates overall competence. One or more significant strengths have been found, and strengths outbalance any weaknesses that exist.

Good: A proposal having no deficiency and which shows a reasonably sound response. There may be strengths or weaknesses, or both. As a whole, weaknesses not offset by strengths do not significantly detract from the offeror's response.

Fair: A proposal having no deficiency and which has one or more weaknesses. Weaknesses outbalance any strengths.

Poor: A proposal that has one or more deficiencies or significant weaknesses that demonstrate a lack of overall competence or require a major proposal revision to correct.

Data Quality Definitions

Excellent: Mission data products are mature, stable, well-documented, and extensively validated. Users understand uncertainties, limitations, and calibration characteristics. Data are readily accessible and broadly used by scientific, operational, and applications communities. Independent assessments consistently demonstrate high quality and reliability.

Very Good: Mission data products are mature and reliable, with well-characterized uncertainties and broad user adoption. Most products have undergone extensive validation, although some limitations or areas for improvement may remain. Data quality supports both scientific and applied uses with a high degree of confidence.

Good: Mission data products provide useful and reliable information, but some products may require additional validation, documentation, calibration refinements, or user support. Data are suitable for many scientific and applications purposes but may not yet represent the highest level of maturity.

Fair: Mission data products remain usable but exhibit limitations in maturity, validation, accessibility, consistency, or documentation. Users may need to exercise caution when

applying the data, and significant improvements would be necessary to achieve broader adoption or confidence.

Poor: Mission data products exhibit substantial limitations in quality, validation, documentation, accessibility, or reliability. Users may encounter significant challenges when applying the data, and better information may be available from alternative sources.

Utility Rating Definitions

Very High Utility: These missions have one or more very relevant and highly valued data products which are routinely used by one or more of the participating organizations for important activities. Loss of the data product(s) would have a significant negative impact on national agencies and organizations.

High Utility: These missions have one or more data products which are routinely used by one or more of the participating organizations for their activities. Loss of the data product(s) would have a measurable negative impact on national agencies and organizations.

Some Utility: These missions have one or more data products which are used by one or more of the participating organizations. Loss of the data product(s) would have a small but measurable negative impact on national agencies and organizations.

Not Applicable (Minor/Negligible): These missions had no identified or significant applied or operational utility to the participating organizations. Loss of the data product(s) would have no or negligible negative impact on national agencies and organizations.

Technical Risk Rating Definitions

The panel used Low, Medium/Low, Medium, Medium/High, and High. Its assessment considered spacecraft and instrument health, expected operating life, system performance, and operations and data-collection plans for the extension period.

Low Risk: There are no problems evident in the mission that cannot be normally solved well within the resources available. Problems are not of sufficient magnitude to doubt the proposer's capability to continue the proposed investigation well within the available resources.

Medium/Low: Problems have been identified but are considered well within the proposal team's capabilities to correct within available resources with good management and application of effective engineering resources. Mission design may be complex.

Medium Risk: Problems have been identified but are considered within the proposal team's capabilities to correct within available resources with good management and application of effective engineering resources. Mission design may be complex and resources tight.

Medium/High: One or more problems of sufficient magnitude and complexity have been identified that are unlikely to be solved within the available resources.

High Risk: One or more problems are of sufficient magnitude and complexity deemed to be unsolvable within the available resources.

Cost Risk Rating Definitions

The panel used Low, Medium/Low, Medium, Medium/High, and High. Its assessment considered historical cost performance against allocated resources, proposed costs, staffing and schedule, planned resources, and reliance on in-kind support or shared infrastructure. Extended missions are assessed against available resources rather than project cost reserves. Cost risk ratings are separate from NASA funding decisions.

Low: The mission's cost is adequate, and mission success is expected. Cost estimates, staffing plans, and schedules are realistic and consistent with projected work requirements. Independent analysis verifies the estimates, and the project demonstrates strong resource management.

Medium/Low: The mission's cost is somewhat tight, but the mission should succeed. Independent assessment identifies manageable concerns related to cost estimates, staffing, or resource management. Although risks exist, available resources appear sufficient to address expected challenges.

Medium: The mission's cost is tight, and mission success requires careful management of resources. Independent assessment identifies significant cost, staffing, or resource management concerns. Available resources appear adequate, but unexpected issues could place additional pressure on the budget.

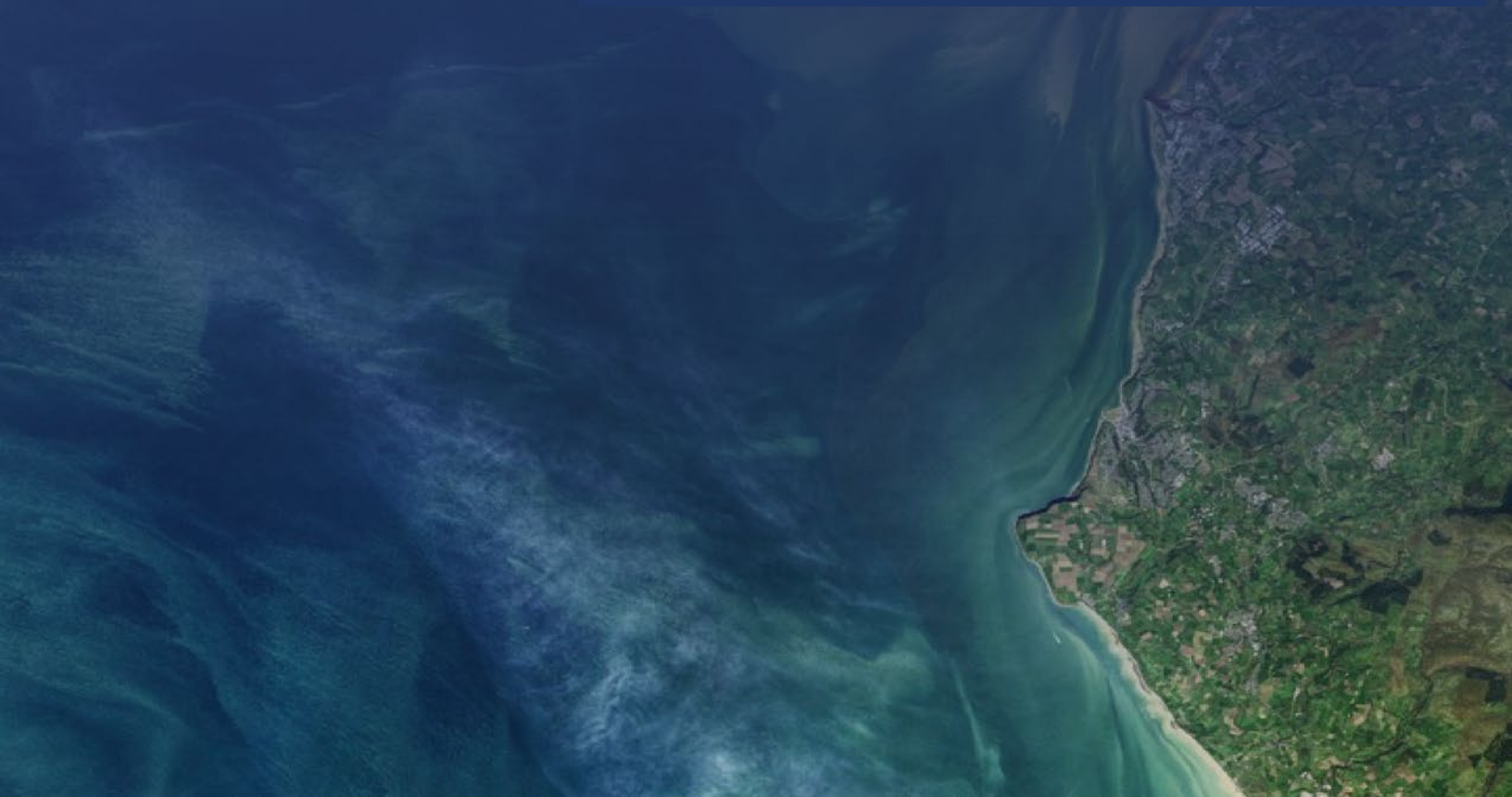
Medium/High: The mission's cost is very tight, and the mission is likely to require additional resources to fully execute planned activities. Independent assessment identifies substantial uncertainty regarding cost estimates, staffing, or resource management. Managing identified threats within existing funding constraints may prove difficult.

High: The mission's cost is inadequate and substantial additional resources would likely be required to complete planned activities successfully. Independent assessment identifies major weaknesses in cost estimates, staffing plans, or resource management. Projected threats exceed available resources or have not been adequately acknowledged or mitigated.

NASA **Earth**

REFERENCE

Acronyms and Abbreviations



Acronyms and Abbreviations

Term	Definition	Term	Definition
AERONET	AErosol RObotic NETwork	**MAIA**	Multi-Angle Imager for Aerosols
AIRS	Atmospheric Infrared Sounder	**ML**	Machine learning
ALICE	Advanced Limb Infrared Chemistry Experiment	**MLS**	Microwave Limb Sounder
ALTIUS	Atmospheric Limb Tracker for Investigation of the Upcoming Stratosphere	**N/A**	Not Applicable
CDC	Centers for Disease Control and Prevention	**NASA**	National Aeronautics and Space Administration
CERES	Clouds and the Earth's Radiant Energy System	**NGA**	National Geospatial-Intelligence Agency
DLR	German Aerospace Center	**NI**	National Interests
DOI	Department of the Interior	**NISAR**	NASA-ISRO Synthetic Aperture Radar
DPR	Dual-frequency Precipitation Radar	**NO2**	Nitrogen Dioxide
EAGLE	Explorer for Artemis Geology, Lunar, and Earth	**NOAA**	National Oceanic and Atmospheric Administration
ECOSTRESS	ECOsystem Spaceborne Thermal Radiometer Experiment on Space Station	**NOS**	National Ocean Service
EDGE	Earth Dynamics Geodetic Explorer	**NWS**	National Weather Service
EMIT	Earth Surface Mineral Dust Source Investigation	**OCO-2**	Orbiting Carbon Observatory-2
EPA	Environmental Protection Agency	**OCO-3**	Orbiting Carbon Observatory-3
ES2A	Earth Science to Action	**OMI**	Ozone Monitoring Instrument
ESA	European Space Agency	**PI**	Principal Investigator
FIRMS	Fire Information for Resource Management System	**PMM**	Precipitation Measurement Mission
FY	Fiscal year	**PREFIRE**	Polar Radiant Energy in the Far-InfraRed Experiment
GEDI	Global Ecosystem Dynamics Investigation	**SAGE III**	Stratospheric Aerosol and Gas Experiment III
GMI	GPM Microwave Imager	**SAM**	Snapshot Area Map
GOES	Geostationary Operational Environmental Satellite	**SIF**	Solar Induced Chlorophyll Fluorescence
GPM	Global Precipitation Measurement	**SMAP**	Soil Moisture Active/Passive
GRACE	Gravity Recovery and Climate Experiment	**STRIVE**	Stratosphere Troposphere Response using Infrared Vertically-resolved Light Explorer
GRACE-C	GRACE-Continuity	**SWOT**	Surface Water Ocean Topography
GRACE-FO	GRACE Follow-On	**TanDEM-X**	TerraSAR-X Add-on for Digital Elevation Measurement
ICESat-2	Ice, Cloud and land Elevation Satellite-2	**TEMPO**	Tropospheric Emissions: Monitoring of Pollution
IMERG	Integrated Multi-satellite Retrievals for GPM	**TSIS**	Total and Spectral Solar Irradiance Sensor
ISRO	Indian Space Research Organisation	**USACE**	United States Army Corps of Engineers
ISS	International Space Station	**USDA**	United States Department of Agriculture
KaRIn	Ka-band Radar Interferometer	**USGS**	United States Geological Survey
lidar	Light Detection and Ranging	**XCO2**	Column-averaged dry-air mole fraction of carbon dioxide