

Request for Information for NASA's Terra, Aqua, and Aura Data Continuity Workshop

NNH23ZDA010L

Release Date: March 1, 2023

Response Date: April 4, 2023

This Science Mission Directorate (SMD) Request for Information (RFI) does not constitute a commitment, implied or otherwise, that the National Aeronautics and Space Administration (NASA) will take action in this matter.

1. Summary

The NASA Earth Observing System (EOS) was conceived in the 1980s, built in the 1990s, and launched late in 1999 and in the early 2000s. EOS is comprised of the coordinated, polar-orbiting [Terra](#), [Aqua](#), and [Aura](#) (T/A/A) satellites, designed to monitor and understand key components of the climate system and their interactions through long-term global observations. Over the past two decades the T/A/A missions have provided invaluable observations of radiation, clouds, water vapor, and precipitation; the oceans; greenhouse gases; land-surface hydrology and ecosystem processes; glaciers, sea ice, and ice sheets; ozone and stratospheric chemistry; and natural and anthropogenic aerosols. As the time series of measurements from these platforms have become longer, they have become useful not only for studies of Earth system processes and applications for societal benefits, but also for detecting climate trends through the construction of climate data records (CDRs). The satellites have provided tremendous benefits to the Earth science community, have substantially outlived their design lifetimes, and constitute the backbone of NASA Earth Science Division's current observing system.

These aging spacecraft are nearing their end of life. The inevitable end of the missions creates a challenge for the NASA research and applications communities that have relied on the continuous availability of the multitude of T/A/A measurements, for process studies, use in applications, and for the detection of long-term trends. The current Senior Review of the missions, as required by statute as well as the federal budget process, will determine the final date when each mission will end its operations. (Available at: <https://science.nasa.gov/earth-science/missions/operating>)

Regardless of the eventual end date for each mission, it is critical to plan for and minimize impacts for NASA stakeholders from the end of these missions. It is important to evaluate the preparations that have been made over the past several years and the existing alternatives, and to determine possible further actions to facilitate transition to alternate data sources during this final phase of operations. NASA requests input from the science community addressing these questions. Input from the science community (comprising both research and applications) will be considered in the development and implementation of a Terra/Aqua/Aura Data Continuity Workshop in the spring of 2023.

The workshop will be aimed at identifying (i) possible alternatives to the Terra/Aqua/Aura data products for process studies and applications, (ii) mechanisms for continuing T/A/A CDRs, and (iii) critical gaps.

A response to this RFI does not guarantee a commitment that NASA will include submitted content in the workshop agenda or invite the respondent(s) to attend.

This RFI seeks responses broadly from U.S. industry, universities, non-profit organizations, individuals, NASA centers, Federal Funded Research and Development Centers (FFRDCs) such as the Jet Propulsion Laboratory, and other U.S. federal, state, local, tribal government agencies as well as the international science community. NASA will use responses to further inform planning and implementation of the Terra/Aqua/Aura Data Continuity Workshop. Responses are subject to the restrictions placed on NASA by SEC. 526 of the “Consolidated Appropriations Act, 2022” that prohibit bilateral relationships with China. For full details of the NASA restriction at: <https://www.congress.gov/117/plaws/publ103/PLAW-117publ103.pdf>.

A complementary RFI was released in September 2022 to obtain information in preparation for a Workshop focused on “Drifting Orbits”. That RFI (NNH22ZDA018L) closed for responses on October 11, 2022 and that workshop was held November 1-2, 2022. This RFI has a very different focus on data product continuity. NNH22ZDA018L respondents must create a totally new response and not resubmit their prior responses to this RFI.

2. Terra/Aqua/Aura Background and Status

Terra

Terra initiated the EOS (Earth Observing System) era with its launch on December 18, 1999. Terra's name denotes the emphasis that its five instruments – [ASTER](#), [CERES](#), [MISR](#), [MODIS](#), and [MOPITT](#) - place on studies of the Earth system providing data products on the state of the atmosphere, land, and oceans, as well as their interactions with solar radiation and with one another. The length and accuracy of Terra's data record allow characterization of inter-annual variability, observation of decadal-scale trends, and determination of climate statistics not imagined when Terra was launched. Multiple federal agencies use Terra's land and atmosphere products for volcanic ash monitoring, weather forecasting, forest fire monitoring, carbon management, and global crop assessment. Data from the Terra mission have led to >20,000 peer-reviewed publications. More information can be found at: <https://terra.nasa.gov>.

Terra was launched into the Earth Sciences Constellation 16-day repeating orbit at an altitude of 705 km. Terra's orbit was maintained to control its descending equatorial crossing to between 10:29 and 10:31 am mean local time (MLT) from 2002 until 2021 when fuel limitations ended this tight control. Current projections are that the MLT will reach 9:00 am at an altitude of 689 km in February 2026, and that Terra will be unable to operate past mid-2026.

Aqua

Aqua is the second flagship mission of the EOS program. Launched on May 4, 2002, Aqua has six Earth-observing instruments on board – [AIRS](#), [AMSU-A](#), [HSB](#), [AMSR-E](#), [MODIS](#), and [CERES](#) - and is named for the large amount of information it collects about water in the Earth system, including almost all elements of the water cycle and water in its liquid, solid, and vapor forms. Additional variables being measured by the Aqua instruments include radiative energy fluxes, aerosols, vegetation cover on land, phytoplankton and dissolved organic matter in the oceans, and air, land, and water temperatures. The Aqua data have been used in well over 15,000 scientific publications and in practical applications ranging from weather forecasting to monitoring forest fires, oil spills, algae blooms, and sea ice coverage. More information can be found at: <https://aqua.nasa.gov>.

Until January 2022, Aqua was in what is commonly referred to as the A-Train or Afternoon Constellation. It was orbiting at an altitude of 705 km, with ascending equatorial crossings at approximately 1:35 p.m. Due to fuel limitations, the tight control over the orbit was ended, with resulting orbital drift. Should the mission continue to operate, current projections are that in August 2026 the mission would likely be close to its end-of-life due to insufficient power generation.

Aura

Launched on July 15, 2004, Aura is the third flagship mission of the EOS program and is so named for the large amount of information it collects about Earth's atmosphere. The suite of Aura measurements from its two currently operating instruments – [MLS](#) and [OMI](#) – continues to provide information on how Earth's ozone layer and air quality respond to changes in atmospheric composition caused by both human activities and natural phenomena. In addition, Aura makes contributions to climate science through its measurements of geophysical variables, such as stratospheric water vapor, ozone, solar irradiance, and absorbing aerosols. The Aura Microwave Limb Sounder (MLS) provides a suite of daily near-global vertically resolved atmospheric composition observations used for monitoring the stability of the ozone layer, as well as the role of the middle atmosphere in climate and air quality. More information can be found at <https://aura.gsfc.nasa.gov>.

Aura orbits with ascending equatorial crossings at approximately 1:45 p.m. and is projected to keep this orbit into early 2023. Fuel limitations may result in termination of continuing inclination adjustment maneuvers, which would result in a drift toward later MLTs. Should the mission continue to operate, it will orbit at approximately 705 km through late summer/early fall 2025. Aura is projected to reach end-of-life in late summer/early fall 2025 due to insufficient power generation.

3. Current Preparations for Terra/Aqua/Aura Continuity

The [Suomi National Polar-orbiting Partnership](#) (S-NPP) spacecraft was launched on October 28, 2011. It resulted from a NASA/NOAA partnership to build and fly a series of polar-orbiting satellites with afternoon equator-crossing times to provide global

environmental data. A primary objective with Suomi-NPP was to provide the capability to continue many of the observations initiated by the T/A/A missions, and to act as a precursor to the NASA/NOAA Joint Polar Satellite System (JPSS). It currently is in a sun-synchronous, 824 km orbit with an ascending, 1:30 PM equator crossing time. Instruments carried by S-NPP include the Visible Infrared Imaging Radiometer Suite ([VIIRS](#)), which is very similar to the MODIS instruments on Terra and Aqua, the Cross-track Infrared Sounder ([CrIS](#)), similar to Aqua AIRS, the Advanced Technology Microwave Sounder (ATMS), similar to Aqua AMSU, the [CERES Flight Model 5](#) instrument which followed Flight Models 1 – 4 on Terra and Aqua, and the Ozone Mapping and Profiler Suite ([OMPS](#)). OMPS consists of three instruments - a mapping spectrometer, and nadir and limb profilers. OMPS provides expanded ozone measurement capabilities compared to OMI.

JPSS continued with the launch of NOAA-20 - designated JPSS-1 prior to launch - on November 18, 2017 into the same orbit as Suomi-NPP and carrying essentially the same instrument complement (although its OMPS does not include the OMPS limb-profiling instrument), and NOAA-21 (named JPSS-2 prior to launch) launched November 10, 2022. JPSS is planning the launch of JPSS-3 at the end of 2027 and JPSS-4 at the end of 2032. These satellites enable a significant level of continuity with T/A/A.

NASA has supported the use of measurements from these NOAA-operated satellites to create EOS continuity data products which span the T/A/A, S-NPP and JPSS (NOAA-20, NOAA-21) platforms (<https://www.earthdata.nasa.gov/eosdis/science-system-description/eosdis-standard-products>). Many of these qualify as climate data records that minimize platform-related discontinuities, enabling scientific studies and applications by providing consistent multi-satellite data products. The measurements from NOAA-operated satellites constitute a substantial resource for the T/A/A community in need of EOS-continuity data products following the loss of T/A/A spacecraft. One of the goals of this RFI/workshop is to identify gaps between NASA's current utilization of S-NPP and JPSS data and NASA stakeholder needs.

4. Other Possible Sources of T/A/A Continuity

Other currently operating spacecraft may provide additional sources of continuity with T/A/A measurements or provide measurements that might be satisfactory alternatives for those data users currently relying on T/A/A measurements, depending on the type of continuity required. Data from the satellites in the European Copernicus and Sentinel Programs, e.g., the ESA Tropospheric Monitoring Instrument (TROPOMI) on the Sentinel-5 Precursor satellite, may provide continuity with several T/A/A measurements.

NOAA also produces CDRs ([see https://www.ncei.noaa.gov/products/climate-data-records](https://www.ncei.noaa.gov/products/climate-data-records)), which may be suitable for some purposes. Workshop goals include consideration of the utility of such alternative measurements for NASA T/A/A data users.

5. Requested Response Topics

NASA seeks information relevant to planning for the inevitable end of the Terra/Aqua/Aura missions. In particular, NASA seeks information on the use of alternative data, gaps in suitability of alternative data products, and barriers to transition that could potentially be overcome.

Regarding alternatives to the Terra/Aqua/Aura data products and critical gaps, the following categories are possible:

1. An alternative data product is available for a scientific or applied purpose and is an adequate replacement for a T/A/A data product.
2. An alternative data product exists and is an adequate replacement for a T/A/A data product but is unavailable to the NASA user community for some potentially solvable reason(s).
3. An alternative data product is available but the data product is inadequate. The inadequacy could be for several reasons, including instrument limitations, insufficient geographic or temporal sampling, or inadequate retrievals.
4. An alternative data product could possibly be produced from alternative observations but such a data product is not currently being produced.
5. An alternative data product does not exist without new suborbital or orbital measurements.

NASA is interested in identifying the above situations for Terra/Aqua/Aura data products with this RFI and the workshop that will follow, and critically, possible solutions that could be implemented to reduce the impact of the end of the missions. NASA is therefore requesting responses to this RFI that answer all of the following questions:

1. Who are you representing with your response – yourself, a specific organization, or a specific community?
2. What is the Terra/Aqua/Aura data product that is the subject of your RFI response?
3. Which category above best describes the situation for the data product? (Please provide a detailed explanation, particularly for categories 2 – 4. If none of the categories above seem to apply, please describe your situation of interest clearly.)
4. How is the data product utilized for your research or applications needs, your organization's research or applications needs, or your community's research or applications needs?
5. What is the importance of the data product for your research or applications needs, your organization's research or applications needs, or your community's research or applications needs?
6. What is a possible solution that NASA could consider that may minimize the impact of the loss of the Terra/Aqua/Aura data product?

In your answers to the questions above, please provide sufficient detail to support your

responses, within the length constraints of responses to this RFI described below. It would be most helpful to copy and paste the questions into your response so the answers to each question can be easily identified. Referring to the categories listed above, Category 1 responses will help determine the current suite of acceptable and available alternative data products. Category 2 – 4 responses will provide NASA ESD with guidance concerning possible near-term actions enabling adaptation to the loss of T/A/A. Category 5 responses will help with longer-term planning. The answer to Question 5 will help with prioritization and is particularly important. Please note that a request to fly the T/A/A spacecraft until the last possible moment is not a useful answer to Question 6, as the goal of the workshop is to consider specifically the inevitable post T/A/A landscape.

Any public discussion by NASA of the results of this RFI will not disclose the identities of the respondents.

It is emphasized that this RFI is NOT a Request for Proposal, nor is it an Invitation for Bid. This RFI is being used to obtain information for planning purposes only, and the Government does not intend to award a contract at this time. As stipulated in FAR 15.201(e), responses to this notice are not considered offers and cannot be accepted by the Government to form a binding contract. Pursuant to FAR 52.215-3, entitled Request for Information or Solicitation for Planning Purposes, this information is being made available for market research, information, and planning purposes and to allow the broader community the opportunity to verify reasonableness and feasibility of the requirement, as well as promote competition. This RFI is subject to review or cancellation at any time and is not to be construed as a commitment by the Government to enter into a contract. The Government will not pay for the information submitted in response to this request.

Please do not request a copy of the solicitation, as no solicitation currently exists. If a firm requirement is developed and a solicitation is issued, the solicitation will be made available through the NASA Solicitation and Proposal Integrated Review and Evaluation System ([NSPIRES](#)). It is the responsibility of Offerors and interested parties to monitor the internet sites for the release of the solicitation and amendments, if any, and they will be responsible for downloading their own copy of the documents. NASA Clause 1852.215-84, Ombudsman, is applicable. The Center Ombudsman points of contact for potential acquisitions can be found at: <https://www.hq.nasa.gov/office/procurement/regs/Procurement-Ombuds-Comp-Advocate-Listing.pdf>.

6. Requested Information

Respondents may not submit confidential information, controlled unclassified information (CUI), proprietary information, or export-controlled information, including International Traffic in Arms Regulations (ITAR) and the Export Administration Regulations (EAR) restricted information, in response to this RFI.

The response should contain input addressing the questions listed in Section 5. Multiple submissions by an individual are allowed for different data products. There is no limit on the number of responses from an individual, an institution, or its organizational units.

7. Response Instructions

All responses must be received by 11:59 p.m. Eastern time on April 4, 2023.

All responses to this RFI must be submitted in an electronic format via [NSPIRES](#).

For this RFI, a response submission will take the form of a Notice of Intent (NOI) within the NSPIRES online announcement data management system. The RFI response itself will be a PDF-formatted document that is attached (uploaded) to the NSPIRES system.

All responses must adhere to the following formatting requirements:

Length:	3 pages maximum
Page size:	8.5" x 11.0" paper size
Paragraph:	Single-spaced, single-column text with no more than 5.5 lines per vertical inch of text
Margins:	One-inch margins on all four sides with no content in the margins
Font:	Font size 12, not to exceed 15 characters per horizontal inch, including spaces, sans serif font recommended.
Inserts:	Figures, tables, and other inserts are permitted

You must be registered with NSPIRES to submit a RFI response. See registration instructions at <http://nspires.nasaprs.com/> (select "Create an account"). Neither institution registration nor an institution affiliation is required to respond to this RFI.

When you have an NSPIRES account, go to the NSPIRES page for "[Request for Information for NASA's Terra, Aqua, and Aura Data Continuity Workshop](#)".

1. Click "Create"
2. Log in when requested
3. Enter the Request for Information: Response title. NOTE: NSPIRES will show this as "NOI title"
4. Select "do not link at this time" for submitting organization page.
5. Click "Save" on next page.
6. It is not necessary to complete any of the "NOI Details"; all requested information should be included in the attached PDF document. Information that is entered into "NOI Details" but not included in the attached PDF document will not be considered
7. Prepare your RFI response offline and save as a PDF document (NSPIRES instructions on PDF formats are described in the NSPIRES PDF Guidelines available at http://nspires.nasaprs.com/tutorials/PDF_Guidelines.pdf). The

response document must include the respondent's Name, institution, and e-mail address so the file is self-contained. File names format should be "PI Last Name - First Name – Number - RFI". "Number" will be used to distinguish multiple responses from the same PI. The response should not exceed 3 pages in length excluding references.

8. To attach (upload) your PDF document:
 - a.) Click "add" under NOI attachments section;
 - b.) Select "Proposal Document" from the drop-down list;
 - c.) Browse to attach your PDF file;
 - d.) Select "Upload";
 - e.) Click "OK";
 - f.) Your RFI document has been uploaded to NSPIRES.
9. Click Submit NOI button. NOTE: Clicking "Submit NOI" does not complete the submission process.
10. Ignore any warnings about incomplete NOI elements.
11. Click "Submit". This will take you to the NOI submission confirmation page, which provides you with the NOI/RFI number for your records.

Please note: You may delete and replace the uploaded document any time before the submission deadline; however, once your RFI is submitted, it cannot be deleted.

8. Point of Contact

Please email questions and comments concerning this RFI to an email address below, no later than Wednesday, March 29, 2023 at 11:59 p.m. Eastern, with the subject line: NASA's Terra, Aqua, and Aura Data Continuity Workshop RFI Question/Clarification. Depending on the nature of received questions, NASA may respond on an individual basis by email or may post responses to inquiries in a "Questions and Answers" document available on the RFI's landing page on NSPIRES at <https://go.nasa.gov/TAARFI4VCW>. Any posted Q&As will be edited to preserve the anonymity of persons and institutions who submit questions and are intended to address inquiries of broader interest and general clarification.

The below email is not to be used for RFI response submissions; any submissions made via this email address will not be considered.

David Considine
Earth Science Division
Science Mission Directorate
National Aeronautics and Space Administration
Washington, DC 20546
david.b.considine@nasa.gov