Climate Change Research

Lead: Science Mission Directorate

Goal Leader:

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Earth Science Division Director
Goal Overview

Goal statement
Use the global vantage point of space to advance our understanding of the Earth system, its processes, and changing climate. By September 30, 2023, NASA will advance climate change research by delivering two new observing systems and an upgrade to NASA’s primary global Earth systems model.

Problem to Be Solved
  o To establish and maintain a robust cadence of missions, including new observing systems, to enable new and updated models, observations, research, and applications.

What Success Looks Like
  o After completing on-orbit checkout, commence Landsat 9 operations and release first light images, delivering the first new observing system
  o Competitively select Earth Venture Mission (EVM)-3 science investigations to address important science questions and produce data of societal relevance within the Earth science field
  o Develop and release Version 4 of the NASA GISS Model E, NASA’s model used most extensively in assessments of climate change
  o Launch the Surface Water Ocean Topography (SWOT) mission, delivering the second new observing system
  o Complete related activities (e.g., mission-development milestones, solicitations to advance equity and environmental justice in NASA Earth science research and applications) that also will enable NASA to use the global vantage point of space to advance our understanding of the Earth system
### Tracking the goal

#### Goal target(s)

In the table below, please repeat the key metrics included in the goal statement (previous slide) that will be used to track progress.

*Please update this column each quarter.*

<table>
<thead>
<tr>
<th>By...</th>
<th>We will...</th>
<th>Name of indicator</th>
<th>Target value</th>
<th>Starting value**</th>
<th>Current value</th>
<th>Frequency</th>
</tr>
</thead>
</table>
| 12/31/2021 | Launch Landsat 9  
• Launch Landsat 9  
• Complete on-orbit checkout  
• Release first light images | Landsat 9 Launch | 100% | 0% | 100% | quarterly |
| 12/31/2021 | Competitively select Earth Venture Mission (EVM)-3 science investigations  
• Issue Announcement of Opportunity  
• Select EVM-3 investigations | EVM-3 Selection | 100% | 0% | 100% | quarterly |
| 03/31/2022 | Release Equity and Environmental Justice (EEJ) solicitations  
• Release Earth Science Applications: Equity and Environmental Justice  
• Release Environmental and Climate Justice using Earth Observations | EEJ solicitation | 100% | 0% | 100% | Quarterly |
| 12/31/2022 | Release NASA GISS Model E  
• Develop model  
• Test model  
• Release model | GISS Model E Release | 100% | 0% | 0% | quarterly |
| 06/30/2023 | Launch SWOT  
• Complete Operational Readiness Review  
• Deliver SWOT to launch site  
• Complete integration with launch vehicle  
• Launch SWOT | Launch SWOT | 100% | 0% | 0% | quarterly |
| 09/30/2023 | Complete mission development milestones  
• Deliver EMIT for launch  
• Complete Libera Critical Design Review  
• Deliver PREFIRE cubesats | Mission milestones | 100% | 0% | 33% | quarterly |
Goal Strategies

In May 2021, NASA announced the implementation of the Earth System Observatory (ESO) in response to the 2017-2027 Decadal Survey, consisting of a new set of Earth-focused missions to provide key information to understand the Earth’s systems and processes, as well as interactions between the processes on the land, ocean, and in the atmosphere. We use our understanding of natural processes and their interactions to provide objective information on changes happening now, as well as estimates of how our environment might evolve in the future.

By September 30, 2023, NASA will further advance climate change research and the recommendations of the Decadal Survey by delivering two new observing systems, Landsat 9 and SWOT, and an upgrade to GISS Model E, NASA’s model used most extensively in assessments of climate change. NASA also will complete several activities that will enable us to conduct ESO research in a way that better addresses diverse community needs and will expand our ability to use the global vantage point of space to advance our understanding of the Earth system. NASA will:

• Competitively select a low-cost, innovative Earth system mission (EVM-3)
• Deliver an investigation for the ISS that will study the role of dust in climate change and Earth science
• Deliver a set of cubesats that will study Arctic warming, sea ice loss, and ice-sheet melting
• Complete a major review in the development of the Libera instrument (planned to fly on NOAA’s Joint Polar Satellite System-3), which will measure solar radiation reflected by Earth’s surface and atmosphere and terrestrial radiation emitted by Earth and vented to space
• Release equity and environmental justice research opportunity solicitations to expand their role in NASA’s research program
### Key Milestones

<table>
<thead>
<tr>
<th>Key Milestone</th>
<th>Milestone Due Date</th>
<th>Milestone Status</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Release Landsat 9 first light images to continue the program’s critical role in monitoring, understanding and managing the land resources needed to sustain human life</td>
<td>FY 2022 Q1</td>
<td>Completed</td>
<td>First images were obtained on 10/31/2021</td>
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<tr>
<td>Competitively select Earth Venture Mission (EVM)-3 to enable low-cost, innovative capability to better understand the Earth system</td>
<td>FY 2022 Q1</td>
<td>Completed</td>
<td>Selections announced on 11/5/2021</td>
</tr>
<tr>
<td>Release Equity and Environmental Justice research opportunity solicitations to expand the role of EJ and Equity in NASA’s research program</td>
<td>FY 2022 Q2</td>
<td>Completed</td>
<td>Selections expected for Applications solicitation in 2022, R&amp;A in 2023.</td>
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<td>Deliver Earth Surface Mineral Dust Source Investigation (EMIT) for launch on ISS to explore the role of dust in climate change and Earth science</td>
<td>FY 2022 Q3</td>
<td>Completed</td>
<td>Delivered 5/3/22 in preparation for launch.</td>
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<tr>
<td>Initiate Phase A for at least two of Earth System Observatory missions addressing four designated observables from the 2017 Decadal (Atmosphere; Clouds, Convection, and Precipitation; Surface Biology and Geology; and Mass Change) to create a 3D, holistic view of Earth, from bedrock to atmosphere</td>
<td>FY 2022 Q4</td>
<td></td>
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<tr>
<td>Develop and release Version 4 of the NASA GISS Model E Earth system model to improve assessments of climate change</td>
<td>FY 2023 Q1</td>
<td></td>
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<td>Complete Libera Critical Design Review (CDR) to enable continuity in the vitally important Earth radiation budget climate data record</td>
<td>FY2023 Q2</td>
<td></td>
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<td>Launch the Surface Water Ocean Topography (SWOT) mission to make the first global survey of Earth’s surface water and measure how water bodies change over time</td>
<td>FY 2023 Q3</td>
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<td>Deliver Polar Radiant Energy in the Far InfraRed Experiment (PREFIRE) CubeSats to understand Arctic warming, sea ice loss, and ice-sheet melting</td>
<td>FY2023 Q4</td>
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During Q3, progress on Version 4 of the GISS Earth System Model continued in many directions. As NASA moves to higher model resolution, testing of new higher resolution ocean modules at 25 and 12 kilometer began. We have made progress on evaluation of the dynamic land ice component that was implemented in the model in order to allow for changing glacier and ice sheet morphology due to melting. In the development of the atmosphere in Version 4, we are evaluating and testing the coupling of the new stratiform cloud microphysics scheme to the aerosol microphysics, which is critical for proper representation of the indirect effect of aerosols. We also made improvements in the model stratospheric chemistry scheme, associated with ozone depletion and impacts of volcanic eruptions. Finally, testing of the automated machine learning for overall model tuning continued. Many model parameter values are required in an Earth system model, and the machine learning approach allows for the discovery of an optimal set.
During Q2, NASA continued to make progress on various aspects of Version 4 (v4) of the GISS Earth System Model (ESM). To support improvements in model resolution in v4, we reconfigured the ocean-atmosphere coupling to allow for more consistent representation of surface fluxes when the ocean resolution reaches 25 or 12 kilometer. In order to improve the radiative components of the ESM, we upgraded the surface reflectivity calculations for sea ice, land ice, and vegetation. We also improved model representation of soils, lakes and river flow, which improves model representation of moist processes. To improve atmospheric processes, we fully completed a new cloud microphysics scheme, as well as expanding the model capability to couple fire processes into climate and adding chemical process representation into fire plumes.

NASA advanced two research opportunity solicitations designed to expand the role of Equity and Environmental Justice (EEJ) in its research program.

- NASA released the first solicitation, to advance progress on EEJ domestically through the application of Earth science, geospatial, and socioeconomic information, on December 8, 2021. With this program element, NASA expressed specific interest in proposals from or partnered with non-Federal domestic organizations, community-based non-profit institutions, tribal governments, local governments, and academic institutions active in addressing EEJ issues that would benefit from the insights offered by NASA Earth science information. Proposals addressing the three elements, landscape analyses, community-based feasibility projects, and data integration projects that combine Earth science information and socioeconomic datasets, were due March 18, after NASA had held two pre-proposal informational teleconferences. Selections are anticipated in 2022.

- NASA’s release of the second solicitation, Interdisciplinary Research in Earth Science, on February 14, 2022, included a specific theme addressing Environmental and Climate Justice Using Earth Observations, in recognition that the world’s poorest and marginalized communities are disproportionately influenced by environmental exposures and vulnerabilities. This is also notably the case for impacts related to climate change, referred to as Climate Justice. The solicitation encourages proposals that address high priority Environmental Justice and Climate Justice needs, such as air pollution impacts on human health; urbanization impacts on heat islands effects and/or changes in precipitation; land cover/use change impacts on food, energy, and/or water; impacts of upstream activities on coastal communities; and exposure and vulnerability to geohazards. Proposals are due in November, with selections anticipated in 2023.

Also in Q2, NASA delivered the Earth Surface Mineral Dust Source Investigation (EMIT) on May 3 in preparation for launch on the International Space Station (ISS) to explore the role of dust in climate change and Earth science.
Data Accuracy & Reliability

Verification and Validation:
- NASA monitors and tracks its progress towards this goal using various Agency documents and reports, including Directorate Program Management Council (DPMC) materials, monthly reports from projects and partners, and other program-internal documents.

Data Source(s):
- Emails and program-internal documents indicating progress toward advancing our understanding of the Earth system, its processes, and changing climate.

Level of Accuracy Required for Intended Use:
- Using the documents and reports referenced above, the Agency is able to accurately report at the end of each quarter on whether or not it has met its planned milestones.

Data Limitations:
- Materials may include export-controlled technical information or industrial partner proprietary information, which could not be released publicly.

How the Agency Compensates for Data Limitations:
- NASA has not identified any data limitations that would preclude it from reporting accurate, reliable, and timely performance information.
Organizations

International Partners
- SWOT: Centre National de Etudes Spatiales (CNES), Canadian Space Agency (CSA), United Kingdom Space Agency

Interagency Partners
- Landsat 9: U.S. Geological Survey (USGS)

Contributing Programs

Program Activities:
- Applied Sciences; Earth Science Data Systems; Earth Science Research; Earth Science Technology; Earth System Explorers; Earth System Science Pathfinder; Earth Systematic Missions; Suborbital programs

Stakeholder / Congressional Consultations

NASA provides periodic updates on progress to the Office of Management and Budget and Office of Science and Technology Policy. NASA also consults regularly with the science community and experts from industry and academia, such as the Earth Science Advisory Committee (ESAC) and the Committee on Earth Science and Applications from Space (CESAS) of the National Academies.