NASA Climate Action Plan Progress Report

Climate Adaptation Plan

2022 Progress Report

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Agency Climate Adaptation Webpage	https://www.nasa.gov/emd/sustainability

SECTION 1: UPDATES ON PRIORITY ACTIONS

1. Priority action progress summary

Priority Action Progress			
Action	**Current Status**	**Estimated date of completion**	**Brief Description of Progress**
[Priority Action #1] Ensure Access to Space	In progress	Ongoing	NASA pursued two primary initiatives in Fiscal Year (FY) 2022: (1) work to improve and strengthen the supply chain and (2) continue resiliency assessments of our facilities and working to integrate that as well as a new effort to assess climate projections into Agency Master Planning (AMP) initiatives; accordingly, NASA is analyzing Federal contracts data, including through interface with the Federal Procurement Data System, and engaging in cooperative efforts with the General Services Agency and Department of Defense (DoD) to import multi-tier supplier information into a cyber-secure aggregated database that performs financial, environmental, and other supply chain risk assessments. NASA is developing a prioritized list of assets for hardening, relocation, or identified needed redundancy for inclusion in the Agency Resilience Framework (ARF); see Priority Action 3) report, which will be integrated in findings and recommendations for the AMP; (see Priority Action 2).

[Priority Action #2] Integrate Climate Adaptation into Agency and Center Master Plans	In progress	5/2023	The AMP Team is aligning with ARF efforts to ensure adaptation and resilience strategies are integrated in the Agency's long-term AMP strategy and collaborating with the Agency Climate Scientists included in the process (NASA's Climate Adaptation Investigators 2 [CASI2]). A checklist being developed by the AMP Team and in collaboration with key master planning stakeholders across the Agency to include climate change adaptation strategies will be presented to the Mission Support Council for approval in fall/winter of 2022.
[Priority Action #3] Integrate Climate Risks into Risk Analysis and Agency Resilience Planning	In progress	9/2027	In FY 2022 NASA is continuing to develop its ARF; NASA partnered with the Department of Energy (DOE) National Renewable Energy Laboratory (NREL) to collect information to develop NASA's ARF for completion in FY 2023. In FY 2022, NASA performed a Center Resilience Assessment (CRA) and developed a Center Resilience Plan (CRP) at Kennedy Space Center and began this process at Goddard Space Flight Center as part of an effort to complete two Centers per year through FY 2026 in coordination with NASA's CASI2 team (NASA conducted its first CRA and developed its first CRP for Johnson Space Center in FY 2021).
[Priority Action #4] Update Climate Modeling to Enable Better Understanding of Agency Threats and Vulnerabilities	In progress	Ongoing	NASA is developing tools and techniques to use the latest climate projections for extreme weather, sea level rise, coastal and riverine flooding, fires, air quality, energy, and water budgets to aid resiliency and investment planning at its Centers. The Agency recognizes a need for guidance, data, and tools that support risk-informed decision making, and NASA's ongoing efforts include (1) a Climate Strategy Working Group (CSWG), led by Chief Scientist and Senior Climate Advisor, Dr. Katherine Calvin, and (2) CASI2, which is continuing the analysis of future climate conditions and is working with NASA Office of Strategic Infrastructure's stakeholders

			on tools that effectively inform future investment decisions of the risks from climate change.
[Priority Action #5] Advance Aeronautics Research on Technologies and Processes that Reduce Contributors to Climate Change	In progress	9/2024	NASA Aeronautics Research Mission Directorate (ARMD), under the Scalable Traffic Management for Emergency Response Operations (STEReO) activity, continues its engagement with wildfire management experts to further refine aeronautics-related concepts of operation, integration with workflows and maturation of reliable technologies to improve effectiveness of aerial support during active wildfires, which is especially important as climate change may lead to more frequent and dynamic fire regimes; anticipating this need, NASA has developed and demonstrated capabilities to improve situational awareness for Unmanned Aerial Systems pilots, as well as a mobile display for shared awareness of aerial and ground assets to facilitate communication and decision making across multi-organizational wildfire response teams. NASA's ARMD's Sustainable Flight National Partnership demonstrates the agency's commitment to contributing viable solutions to the nation's goal of net-zero greenhouse gas emissions by FY 2050, and NASA's all electric experimental aircraft, the X-57 "Maxwell," is one of the Agency's first aircraft demonstrating greener flight technology; set to take flight later this year, the X-57 is intended to have zero in-flight emissions.

2. Priority Action Progress Examples

NASA, in collaboration with several DoD organizations, is implementing a next generation hybrid supply chain software for logistics, engineering, sustainment, and contracting personnel to complement other supply chain risk management capabilities. The software uses real-time environmental data, as well as program and industry financial benchmark data, to effectively model and simulate climate change impacts on both the product and supplier economic viability throughout a product life cycle. Recent activities include updating the graphical user interface to include geographic supplier visualization of floods, storm and drought projections, wildfires, hurricanes, and other extreme weather events. This capability provides critical support of NASA's access to space and other mission requirements, accounting not only for specific supplier locations but also supply routes, as well as reporting optimized risk management options.

NASA is developing an AMP. The AMP Team is leading workshops at all ten NASA Centers to identify opportunities to reduce capability redundancy, improve resiliency, and optimize infrastructure configuration and mix for mission support. This process includes development of recommended resilience and climate adaptation metrics to include in the Master Planning Checklist that will serve as a guiding document for AMPs. Managing climate risk and implementing sustainability best practices are now included as goals within the AMP objectives and associated project development process.

In partnership with DOE NREL, NASA is leveraging internal climate science expertise and knowledge to identify climate risks in support of ongoing Center Resilience Assessments. This effort demonstrates strong coordination and collaboration internally within NASA and externally with NREL. The interagency team gathers stakeholder input from questionnaires, surveys, and other data gathering tools to ensure a final product that supports coordinated, holistic Agency climate adaptation efforts.

The CASI2 team is working to enhance capabilities for vulnerability assessments that leverage internal climate science and the ability to overlay asset locations with climate data and projections to assess exposure to relevant direct physical risks (e.g., hurricanes, wildfires, or inland flooding) in the present and future. These teams and other stakeholders are investigating methods for further integration of data analytics and geospatial capabilities with climate risk analysis activities. Completion of latest generation CASI2 toolsets is expected in the winter of 2022.

The ARMD successfully demonstrated a prototype ad hoc communications network intended for remote environments to assist with wildfire response and management. Formal planning is underway for a follow-on initiative, Advanced Capabilities for Emergency Response Operations (ACERO), to occur in FY 2023 through FY 2028. The purpose of ACERO is to develop an interagency unified concept of operations to ensure consistency of operational priorities, technology adoption, and programmatic alignment for national needs and to extend and promote infusion of airspace operations technologies, safety methods, communications, and aircraft capabilities to coordinate aerial support with key stakeholders and partners active in wildfire management.

SECTION 2: UPDATES ON OTHER INITIAL PLAN TOPICS

1. Climate-Risk Reduction

NASA strategically manages various risks to its mission, assets, operations, and financial position by connecting component elements of risk management, climate science, vulnerability assessments, and financial accounting. To assess fiscal exposure from physical risks, NASA understands the need to connect updated climate science data and vulnerability assessments with asset management databases. The Climate Action Plan (CAP) supports an Agency-wide effort to further incorporate climate considerations within enterprise risk management (ERM) processes. NASA has identified climate change impacts as a key infrastructure risk through its structured ERM process. The need to maintain and replace aging critical infrastructure exacerbates this issue. These efforts will support assessment of the Agency's financial capacity to adapt or otherwise protect against losses from low probability, high-consequence events, and aligning short-term expenditures and long-term investment plans. Through identification of threats and vulnerabilities, the NASA portfolio will be evaluated for Agency fiscal risk exposure due to climate change.

The Agency is further incorporating these risks in decision making to make climate change adaptation a routine part of program planning, execution, and evaluation. For example, the Agency considers climate risk in infrastructure project development through the Construction of Facilities Program. The Agency further recognizes that managing climate risk supports its mission, and efforts to reduce these risks must consider impacts to workforce, operations, and supply chain. The Agency also considers climate impacts on external systems like utility infrastructure, which can impact NASA activities such as launches. Therefore, regional collaboration and coordination with local and state officials is also critical for overcoming barriers to addressing climate risks, and NASA continues to partner with other entities (Government or non-Government) to find common solutions. NASA continues working toward the removal of barriers to climate risk reduction and has recognized a need to incorporate climate change expertise within integrated project teams and Agency review boards.

2. Climate Vulnerability Assessments

Climate change and extreme weather events impact NASA's structures, managed lands, utility systems, roadways, and operations. NASA assesses its climate-related risks through a combination of qualitative and quantitative processes, conducting resilience assessments to evaluate operating risks to climate-related hazards. Inputs include current vulnerability assessments, projected climatic changes, frequency and severity of events, and recovery time and cost. The objective of these resilience assessments is to examine the various vulnerabilities and threats that could interrupt operations, damage property, threaten personnel, and could prevent the Agency from carrying out missions. Analyzing how vulnerabilities can result in interruptions to power, water, transportation, communications, and other assets or resources for NASA sites supports planning to invest in resilience.

Twenty percent of the NASA portfolio has been analyzed through the resilience assessment process complimented by the Master Planning Asset Inventory Assessment. This combination of information allows the start of the short-term and long-term analysis of investments needed. Of its ten Centers, the Agency has completed Center region assessments at Johnson Space Center and Kennedy Space Center and has begun its assessment at Goddard Space Flight Center, in addition to formalizing the overarching agency Resilience Strategy Framework. Knowledge gained from the resiliency assessments is incorporated into the Agency Master Planning process as a focus to provide the best oversight of Agency and Center responsibilities and operations. NASA's structured approach to managing climate risk involves supporting decisions that reduce

hazard exposure and sensitivity, while increasing adaptive capacity. The Agency, through coordination between internal climate scientists and institutional managers, is developing tools to help identify vulnerabilities and evaluate trade-offs among adaptive pathways. NASA also promotes climate event recovery as an opportunity to improve, rebuild, replace, or retrofit infrastructure systems in a manner that accounts for a changing climate and improves resilience. The Agency works to enable opportunities such as efficient investment in sustainable development and collaboration with partner organizations to avoid maladaptive recovery.

3. Climate Literacy

The NASA Chief Scientist and Senior Climate Advisor leads climate literacy initiatives for the Agency, which has included Agency-wide coordination through the CSWG. NASA has also continued internal climate education and training by focusing on existing communities of practice. This allows the Agency to address critical climate literacy requirements specific to employee's day-to-day responsibilities and operational and mission support duties. The topic of climate risk is also captured in Master Planning activities as well as Sustainability Program information sharing, such as through a climate risk SharePoint that the Agency is actively developing to support employee outreach.

NASA is interested in coordinating basic climate training modules with other Federal agencies and has monitored associated efforts through the Federal CAP community network, which continues to develop a centralized hub for climate information exchange for the Federal workforce. NASA also provides training on its Earth-observation information through the Applied Remote Sensing Training (ARSET) program. ARSET offers online and in-person trainings for beginners and advanced practitioners on a range of datasets, web portals, and analysis tools covering topics such as air quality, agriculture, disaster, land, and water resources management. NASA trained over 4,000 Federal Government participants through ARSET in 2021 alone.

4. Tribal Engagement

NASA has a focused effort in cultural resource management, which is included in climate-related planning and decision-making activities, when warranted. The Agency's Cultural Resource Officers will involve tribal governments early in the planning process for proposed actions that may have the potential to affect protected tribal rights, land, or resources and endeavor to complete consultation prior to project implementation. Assessments to identify projects are still underway at Centers where the Cultural Resource Officers will serve as the lead contact for needed cultural activities. NASA complies with the National Environmental Policy Act and the National Historic Preservation Act for all its Federal actions and undertakings and engages tribes, as appropriate, in the discussion of possible impacts to the human environment and culturally significant properties. NASA is also developing an Agency-wide Tribal Consultation Plan to further coordinate Agency efforts and improve engagement.

The Agency is both aware of how Earth observations can benefit indigenous communities and that insights from these communities may help make NASA data more useful to its user communities. NASA's Earth Science family continues to share with communities in need. A great example is how NASA responded to census data, identifying a lack of potable water in the homes of at least 70,000 Navajo Nation residents, to create a Drought Severity Assessment Tool. This tool helps to monitor conditions and support resource allocation.

5. Environmental Justice

NASA CAP implementation continues to follow the Agency's Equity Action Plan foundational focus areas. The NASA Earth Science Division (ESD) has further committed to an internal strategy with their extended equity and environmental justice commitment to expand engagement with communities, nongovernmental organizations, philanthropies, academia, industry, and Federal partners. For example, through open-source science initiatives, NASA's Earth Science Data Systems Program is making NASA Earth science data more interoperable, transparent, usable, and open. Furthermore, NASA Earth Science Division and its Socioeconomic Data and Applications Center (SEDAC) conducted their first Equity and Environmental Justice Virtual Workshop to facilitate increased communication between NASA and environmental justice communities; and NASA's Research Opportunities in Space and Earth Science (ROSES)-2022, *A.28 Interdisciplinary Research in Earth Science, Subelement 4: Environmental and Climate Justice using Earth Observations*, includes opportunity to address questions at the intersection of Earth observations and environmental/climate justice.

6. Partnerships

NASA continues to expand existing partnerships and establish new interagency and external climate adaptation partnerships. In October of 2021, NASA and the Federal Emergency Management Agency (FEMA) expanded the Resilient Nation Partnership Network with a series of virtual forums, encompassing 31 organizations to explore diverse approaches to building Alliances for Climate Action. NASA continued its collaboration with FEMA and published an action guide, called "Building Alliances for Climate Action," to help make informed decisions on how to manage the risks of climate change. ARMD completed planning for a series of demonstrations of sustainable aviation operations with the Federal Aviation Administration and airline partners. In FY 2022, data collection has begun with American Airlines, Southwest Airlines, and Envoy Air at Dallas Fort Worth International Airport and Dallas Love Field on the reduction of fuel consumption, noise, and emissions through efficient surface scheduling and departure rerouting. Testing will continue in FY 2023, targeting validation of the system in more complex airspace in FY 2024. NASA also contributes to the National Climate Task Force established by President Biden, which encourages a Government-wide approach to address climate change. With more than two dozen satellites and instruments observing key climate indicators, NASA brings its observations and understanding of changes to Earth to help advance shared climate initiatives.

NASA has also partnered with European Space Agency (ESA) and Japan Aerospace Exploration Agency (JAXA) to create an open-source platform to showcase worldwide changes observed during COVID-19. New global environmental changes have been added to the dashboard since October 2021 on six new themes: atmosphere, oceans, biomass, cryosphere, agriculture, and the economy. NASA also works with Environmental Systems Research Institute (Esri) to share NASA data such as a landslide prediction tool in DisasterAWARE, as well as a NASA-developed global flood model to be added in 2022. NASA also renewed its memorandum of understanding (MOU) with the Comisión Nacional De Actividades Espaciales (CONAE) of the Argentine Republic for cooperation in space geodetic research for an additional ten years and the MOU with German Research Centre for Geosciences (GFZ) for cooperation on the Gravity Recovery and Climate Experiment Follow-on (GRACE-FO) mission.

SECTION 3: NEW TOPICS FROM E.O. 14057

1. Policy Review

NASA has a long history of incorporating climate and resilience considerations into Agency risk management and investments and into Center-level processes. Ongoing efforts include continual Agency policy and process reviews at regular intervals, as well as addressing new Federal policy requirements. NASA uses climate projections to manage risk and inform short- and long-term investment decisions through various workflows. In the Master Planning community, for example, climate data are used to strengthen the risk-based analytic framework to ensure decisions are consistent with the Agency goals/AMP. Procedure and guideline reviews will continue to include the addition of needed climate-related details and clarifications, as well as the modification of policies and directives that require more thorough incorporation of climate adaptation efforts. Sustainability efforts and focused climate risk analysis will continue to be a part of current and future processes, and NASA will continue to make updates, as needed, based on internal needs and Federal or other regulatory mandates.

2. Climate Scenario Analysis

NASA understands the importance of scenario analysis for informing decision makers with a range of scientifically plausible future climate conditions. Risk management strategies that accommodate potential future conditions include taking adaptation actions that perform well across multiple scenarios and objective measures of well-being. To support this endeavor, NASA climate scientists employ cogeneration (or coproduction)—a form of knowledge production based on the dynamic interaction between scientists and stakeholders to develop useful, usable, and used information products—in product development. Assessing how products can be made more useful and usable, and inquiring how the user community would like to seethe data presented, results in product capabilities directly linked to the decisions they will support.

The aforementioned process allows for a portfolio of key current and future climate risk information for Center managers and their regions. The CASI2 team is working to provide climate projection information for the 2020s through 2100, such as for temperature and precipitation. These projections include multiple scenarios (based on the scenarios assessed by the Intergovernmental Panel on Climate Change Sixth Assessment Report). The spatial scale of an approximately 27-kilometer (km) grid supports Center-level assessments, and the team will work toward higher resolution (an approximately 5 to 6-km grid) in later iterations. Tools include maps, tables, and associated data tailored for NASA Centers resilience decisions.