



National Aeronautics and  
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# **Committee on Science, Space, and Technology**

## **U.S. House of Representatives**

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Statement of:  
Dr. Joel R. Carney  
Assistant Administrator  
Office of Strategic Infrastructure

117th Congress

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**Dr. Joel R. Carney**  
**Assistant Administrator**  
**Office of Strategic Infrastructure**  
**National Aeronautics and Space Administration**

**before the**

**Committee on Science, Space, and Technology**  
**U.S. House of Representatives**

Chairwoman Johnson, Ranking Member Lucas, and Members of the Committee, thank you for the opportunity to appear today to discuss NASA's efforts to increase resilience and adapt to the effects of climate change to ensure the Agency's complex, aspirational missions are executed with continued success. Climate variability and climate change present important challenges that must be responsibly and proactively managed to ensure continuity of NASA's mission objectives. NASA's climate adaptation and resiliency planning efforts address not only the Agency's vulnerabilities that present risk to its missions, assets, and operations, but also provide information and tools that will be available to help address similar challenges being faced across the Federal Government.

NASA is one of several Federal agencies that conducts Earth observation, research, and data analysis critical to assessing climate risks and vulnerabilities. From the vantage point of space, as well as using airborne and ground-based platforms, NASA Earth Science measures and provides openly available data and information on Earth's radiation budget, oceanic and atmospheric temperatures, sea level rise, greenhouse gases, air pollutants, precipitation, soil moisture, changes in land cover and land use, distributions of sea and land ice, and biological activity on land and oceans, among many other things. NASA undertakes this work with the full knowledge that key Agency facilities are imminently threatened by the changing climate and we will need to take our own science and data into account in developing Agency policies, strategies, infrastructure master plans, and partner engagements.

**Climate Resilience Challenges to NASA Infrastructure**

Approximately two-thirds of NASA assets, when measured by their replacement value, are located within 16 feet of mean sea level along America's coasts. Sea level rise, extreme weather events, coastal and river flooding, heat waves and other changes have damaged or are projected to damage our Centers in the future. Since 2003, NASA expenditures for recovery, hardening and stabilization against these risks are estimated to have exceeded \$1 billion. For example, NASA has spent over \$200 million over the past 20 years repairing damage at Centers due to flooding alone. Since 2017, it has been necessary to undertake repairs resulting from hurricanes at four NASA installations: Kennedy Space Center (KSC) in Florida, Johnson Space Center (JSC) in Texas, Stennis Space Center (SSC) in Mississippi, and the Michoud Assembly Facility (MAF) in Louisiana.

Since 2012, NASA has spent \$85 million at the Wallops Flight Facility in Virginia and \$39 million at the Kennedy Space Center (KSC) in Florida on shore restoration projects. In 2014, NASA completed construction of a 1.2-mile inland dune, 15 feet in height, and approximately 50 feet wide at the base, at KSC. More than 180,000 grass specimens were planted, by hand, over a period of two months for shoreline stabilization.

While NASA has invested in projects to repair and protect its Centers against climate risks, the Agency has also benefited from proactive climate risk analysis and broader planning efforts. NASA recognized in 2005 that regional climate variability could pose a risk to operations and missions and identified it as a risk within the Agency's management framework. Subsequent initiatives, such as risk assessment workshops held in 2007, confirmed that natural hazards could impact NASA Centers and their ability to execute mission activities. From 2009 to 2012, NASA held workshops at each Center that provided NASA asset stewards and operations managers an opportunity to develop a greater understanding of potential Center-level climate impacts over time.

From 2010 to 2016, NASA sponsored Climate Adaptation Science Investigators, known as CASI, from the Goddard Institute for Space Studies, to work on research projects linked to local climate change issues and challenges. CASI supported multiple government-wide initiatives, including working with our regional partners at the St. Johns River Water Management District and the Indian River Lagoon National Estuaries Program in Florida. Both partnerships are focused on analyzing sea level rise scenarios for KSC and the surrounding Indian River Lagoon estuary. Results suggest that sea level rise on the order of 0.4 m, which NASA scientists project for the contiguous U.S. as soon as mid-century, will inundate approximately 25% of KSC's current land area, converting extensive wetlands into open water.<sup>1</sup> Warming weather and less frequent and intense cold spells may also allow the expansion of mangrove forest into the region, displacing current high marsh habitats that are home to numerous species of special concern.

Knowing that rocket engine testing at SSC depends on surrounding forests to buffer the necessary testing noise and vibration, CASI scientists used a model to assess forest health based on growth and decline observations compared to climate and weather observations and predictive models. This approach, baselined with observed and verified measurements, helped SSC resource managers better understand the buffer zone's resilience to climate change, approximate future climate impacts, plan accordingly, and implement proactive adaptation strategies.

Through the CASI initiative, climate projection data was provided for and subsequently used by all NASA sites in infrastructure master planning and engineering studies, including a 2019 adaptation study at KSC that identified individual facilities and roads and bridges that would be impacted by sea level change. In 2021, NASA initiated a second round of CASI studies to support enhanced climate adaptation strategies throughout the agency.

NASA's Climate Action Plan, released October 7, 2021, responds to President Biden's Executive Order 14008: Tackling the Climate Crises at Home and Abroad. The Plan presents five priority adaptation actions:

- Ensuring Access to Space
- Integrate Climate Adaptation into Agency and Center Master Plans
- Integrate Climate Risks into Risk Analysis and Agency Resilience Planning
- Update Climate Modelling to Better Understand Agency Threats and Vulnerabilities
- Advance Aeronautics Research on Technologies and Processes that Reduce Contributors to Climate Change

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<sup>1</sup> NASA Kennedy Space Center Future Development Concept, 2012-2031.

NASA is working to secure our nation's access to space by ensuring the resiliency of its infrastructure, using lessons learned from past climate-related events that have impacted facilities and operations. Past studies and current initiatives are the basis for a resilience framework that will provide a process for identifying threats, vulnerabilities, and risks that may impact the Agency's mission and operations, including risks associated with climate change. In 2020, NASA engaged the U.S. Department of Energy's (DOE) National Renewable Energy Laboratory to study climate resilience at NASA Centers. NASA plans to complete the initial resiliency studies for all Centers by 2025.

NASA is developing an Agency Master Plan (AMP), which will provide a 20-year vision for physical infrastructure and real property assets, aligned with projected mission requirements. The AMP will provide a roadmap to support advanced facilities planning, including the future development and redevelopment of Agency facilities and land assets and will demonstrate NASA's commitment to integrating climate risk management and resiliency into all Agency management processes and tools. The AMP will be completed in FY 2023 and will provide a single, cohesive mission-driven strategy for infrastructure investment, divestment, and sustainment, while maintaining a long-term risk mitigation strategy. The AMP will promote sustainability actions to provide climate mitigation and adaptation benefits, such as green energy technology, bioretention systems, permeable pavers, and tree box systems that can help manage stormwater runoff.

### **NASA Science and Technology Research Informs Climate Adaptation and Resilience Efforts**

NASA is both a consumer of climate science and a leading source of climate data and information through its provision of the latest climate observations, research, models, and analyses, providing foundational and decisional knowledge in cooperation with many partners. As such, NASA plays an important role in implementing the President's Emergency Plan for Adaptation and Resilience, also known as PREPARE. NASA leads and contributes to the latest climate observations, research, models, and analyses, providing foundational and decisional knowledge in cooperation with many partners. NASA's Science Mission Directorate influences the global climate science community by leading the development and operation of climate observing satellites for the nation and promoting principles of open-source science and data that foster more rapid progress in Earth system science. This not only provides fundamental knowledge about Earth system behavior and evolution, but also informs climate adaptation and mitigation. NASA is one of the few government agencies that generates climate projections at downscaled resolutions that are useful to support regional climate studies and adaptation efforts. NASA will use this climate change knowledge, working in concert with many partners, to assess exposure, identify vulnerabilities, and develop adaptation strategies to address climate risk.

Anticipating and responding to climate change requires an ongoing, iterative cycle of assessment, action, reassessment, learning, and response. Advancements in climate science, modeling, analysis, and data visualization will support more rigorous vulnerability assessments. NASA will continue to improve our capabilities in the modeling of climate change and its associated impacts, refining estimates of climate impacts as models evolve and sharing this data with the scientific community and other government agencies that also model climate change. These refined modeling outcomes can enable better scenario planning and longer-range decision making for managers in a range of U.S. sectors, including insurance, agriculture, water resource management, forest and land management, transportation, and aviation, among others.

NASA coordinates with numerous international, Federal, state, local, tribal, and territorial government partners, as well as non-governmental organizations (NGOs), educational institutions, and U.S. commercial companies, to provide U.S. leadership in developing and carrying out Earth observations and research that informs strategic climate adaptation. NASA participates in and leads international forums

like the Committee on Earth Observation Satellites and sponsors and engages extensively in formal interagency activities organized under the auspices of the National Science and Technology Council, most notably the Subcommittee on Global Change Research, the Subcommittee on Ocean Science and Technology, the U.S. Group on Earth Observations, and the Subcommittee on Resilience Science and Technology. NASA's most active Federal agency partners include the National Oceanic and Atmospheric Administration, U.S. Department of the Interior/U.S. Geological Survey, U.S. Department of Energy, U.S. Department of Agriculture, National Science Foundation, U.S. Environmental Protection Agency, and the U.S. Department of Defense. NASA is a co-founder and an active participant in the Inter-Agency Forum on Climate Risks, Impacts and Adaptation, which supports knowledge sharing across the Federal Government and many other participating organizations.

The innovative global observations that NASA brings to the nation and the world synergistically complement satellite and in-situ surface-based observations that many of NASA's interagency partners produce. NASA's observations can also be used to inform the models and decision support systems used by other agencies. NASA's Applied Sciences Program plays a particularly important role in connecting and applying NASA-developed observations, data, and model products to the products and services provided by other Federal agencies, NGOs, and others in their service to the American public and the world.

NASA's Earth Science research enables improved knowledge of the Earth system, including the natural and human-induced processes that drive it, the processes by which it responds to these drivers, and the responses as a function of time and space. This knowledge can be incorporated into climate projections which can be used for adaptation planning. A specific example is demonstrated by the Gravity Recovery and Climate Experiment (GRACE) and GRACE Follow-on mission data, which show the large-scale movement of surface and groundwater throughout the continental U.S. CASI uses NASA Earth Exchange (NEX) products to provide NASA Centers and their regions with long-term (decadal to century) projections for climate change adaptation planning. These projections are based on downscaled global climate model results for temperature, precipitation, humidity, and radiation under a range of greenhouse gas emission scenarios.

NASA also plays a critical role in developing the technology that will reduce the amount of greenhouse gases emitted during air travel. NASA's Aeronautics Research Mission Directorate (ARMD) explores aviation concepts and technologies, some of which support NASA climate resilience. ARMD's aviation concepts, combined with NASA Earth Science observational data, help the Agency and others to reduce vulnerability to extreme events and long-term climate change. ARMD's research and development of advanced aircraft technology and operations lead to climate change mitigation benefits for the global community, including greenhouse gas emission reductions through electric propulsion and other advanced propulsion systems, as well as advanced composites and vehicle configurations. NASA will collaborate with Federal partners, industry, and other stakeholders to develop and implement aviation solutions that enable climate adaptation, while supporting the aviation community's goal to aggressively reduce carbon dioxide emissions.

NASA's missions support the national aviation community and Federal, state, and local emergency response communities. These efforts will support improved preparation for, response to, and recovery from disasters through collaborative aviation research programs, which can, for example, result in improved control of wildfires and management of cascading impacts. NASA leads cooperative efforts on the Global Fire Emissions Database that allows for near real-time emissions estimates (<https://www.globalfiredata.org>). NASA's "Fire Earth Information System Pilot Project" and Agency projects like "Forecasting of Weather, Fire Behavior, and Smoke Impact for Improved Wildland Fire Decision Making" deliver online information products to users (<https://maps.disasters.nasa.gov>).

## **Conclusion**

To ensure NASA's continued success and capability in driving advances in science, technology, aeronautics, and space exploration, the Agency must responsibly steward its infrastructure to support its current and future mission requirements. NASA is committed to protecting its assets and capabilities from the growing challenges of climate extremes and climate-related changes to our environment. NASA has prioritized investments to address these challenges and to ensure continued U.S. global leadership in Earth Systems Science. When complete, NASA intends to use its Agency Master Plan and Center resiliency studies to better position the Agency to anticipate and project the resources that will be required to ensure sustainable mission success. NASA will continue to apply its science, engineering, and technological expertise to provide data, information and tools that will be of value to its continued mission success, and to other Federal agencies and users across the nation and world as we meet the future together.

In conclusion, I thank the Committee for the opportunity to testify before you today. I would be happy to answer any questions that you may have.