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ON THE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION'S FY 2022 BUDGET REQUEST

BEFORE THE
HOUSE COMMITTEE ON NATURAL RESOURCES, SUBCOMMITTEE ON WATER, OCEANS, AND WILDLIFE

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Chair Huffman, Ranking Member Bentz, and Members of the Committee, thank you for the opportunity to testify today regarding the President's FY 2022 budget request. The Department of Commerce's National Oceanic and Atmospheric Administration (NOAA) appreciates the continued support of Congress, the Administration, and our broad and diverse base of stakeholders.

For FY 2022, NOAA proposes a budget of $6,983,329,000 in discretionary appropriations, an increase of $1,543,531,000 from FY 2021 Enacted. This budget supports NOAA's goal of scaling up efforts to research and mitigate impacts of the climate crisis through investments in NOAA's data, tools, and services including research, observations and forecasting, restoration and resilience, ecologically sound offshore wind development, and equity at NOAA through programs that touch everyday lives. It also includes additional investments in fleet support and satellites to ensure the continuity of vital observations, and space weather observations and prediction services to protect critical infrastructure that provides the backbone of this country's economic vitality and national security.

Climate

The atmosphere, ocean, water, and land ecosystems all show indicators of a warming and changing climate. To persist and thrive in this changing world, the Nation must make well-informed choices and embrace solutions that pave the way for a viable economy and the sustainable infrastructure to support it.

Communities around the country are struggling with the effects of extreme events like hurricanes, floods, droughts, wildfires, heat waves, and fisheries collapse. In 2020, there were 22 weather and climate disaster events in the United States that each had losses exceeding $1 billion.[1] The 2020 wildfires in California - the worst in the state's history - are a paramount example of the environmental and socio-economic devastation that environmental events can wreak on communities, businesses, and the environment. NOAA's FY 2022 budget requests an

[1] NOAA National Centers for Environmental Information, *U.S. 2020 Billion-Dollar Weather and Climate Disasters,* (2020), https://www.ncdc.noaa.gov/billions/

additional $855.1 million over enacted levels to help meet the Administration's climate science goals, including implementation of Executive Order (EO) 14008 on Tackling the Climate Crisis at Home and Abroad, by expanding investments in climate research, supporting regional and local decision making with climate data, tools, and services, and helping the most vulnerable communities improve adaptation, mitigation, and resilience to climate change.

For over 50 years, NOAA has provided science, service and stewardship to the nation. NOAA develops actionable climate science and information needed to help solve the climate crisis. NOAA leverages diverse authorities for climate, weather, fisheries, coasts, and the ocean; huge stores of environmental data and observations; world-renowned expertise; and networks of public, private, and academic partnerships to co-develop and deliver the most up-to-date knowledge and actionable products to meet the needs of decision makers. This information is critical to resilience-building, national security, and economic vitality; the protection of life and property; the sustainable use of our resources; and the preservation and resilience of our natural environment. From sun to sea, NOAA takes a comprehensive earth system approach.

Through the following targeted investments to support an integrated approach to the climate crisis, NOAA will be on track to develop and deliver new and improved climate tools and products that provide useful climate information and services to decision makers, communities, businesses, and the public, including:

Research: NOAA will strengthen core research capabilities Foundational research will improve products and services and will help communities prepare for and adapt to impacts of extreme weather and climate events that have become more frequent and costly in recent decades.

Observations and Forecasting: NOAA will expand its delivery of the best-available climate observations and information (physical, biological, social, economic assessments, predictions and projections) to understand, mitigate, prepare for, and adapt to future conditions, especially in frontline and underserved communities that are disproportionately vulnerable to the impacts of climate change.

Restoration and Resilience: NOAA will invest in ecological restoration and community resilience, and address an increasing demand for NOAA's science and services needed to enhance natural and socioeconomic resilience of our ocean and coasts through our expertise, robust on-the-ground partnerships, and place-based conservation activities. NOAA will support the Administration's goal to conserve at least 30 percent of the Nation's lands and waters by 2030, collaborate with the new Civilian Climate Corps, and coordinate with partners on other related whole-of-government initiatives.

Offshore Wind: NOAA will further the Administration's goal to deploy 30 gigawatts of offshore wind in the U.S. by 2030, while protecting biodiversity and promoting ocean co-use.

Equity: NOAA will enhance its consideration of equity dimensions across the organization, from management, to policies, to service delivery. NOAA will cultivate a more diverse,

climate-ready workforce of the future that builds upon NOAA's long history of investments in graduate and postgraduate training, fellowships, and extension programs.

Collectively, these investments will support our efforts to build resilient communities, economies, businesses, and ecosystems.

Research

NOAA science plays a critical role in informing the Nation and the world about current and projected changes in the climate system. Standing on the firm foundation of world-class earth system and climate science, NOAA provides data, tools, and services that reach every American every day.

To strengthen core research capabilities to respond to increasing demand for the data, tools, and services that this research provides, NOAA is requesting an increase of $149.3 million. We will improve understanding of climate change on time scales from weeks, to decades, to centuries. We will build on this understanding to improve precipitation, fire weather, and sea level rise forecasts, and identify impacts of climate change on fisheries, protected species, and living marine resources to improve management. Of these funds, NOAA will commit $40 million to the Advanced Research Projects Agency for Climate (ARPA-C), harnessing NOAA's restoration and conservation efforts to help sequester carbon while also protecting marine ecosystem diversity.

NOAA will research the ways in which our ocean influences, and is influenced by, climate change. For example, the total amount of excess heat absorbed by the ocean, or how the ocean's role as a sink for anthropogenic carbon will change over time are still not fully quantified. It is imperative that NOAA dedicates research towards understanding and projecting coastal inundation from rising seas, high lake levels, heavier precipitation, shrinking sea ice, and more frequent extreme weather events associated with our warming climate.

NOAA will invest additional resources to improve predictions and projections in a research environment. In particular, NOAA will improve precipitation predictions across weather and climate timescales for transition to operations through the Precipitation Prediction Grand Challenge Initiative. This is a cross-NOAA effort to advance subseasonal-to-seasonal and seasonal-to-decadal forecasts, and will be conducted in collaboration with our academic research partners, and will include more skillful precipitation forecasts using NOAA's Unified Forecast System. In addition, NOAA will develop a global high-resolution model to improve the understanding and prediction of extreme events.

As we increase our understanding of the changing climate in the short and long term, we will simultaneously research and develop new and improved tools for decision makers to address extreme impacts such as sea level rise, fire weather, and impacts on living marine resources. NOAA will enhance our Effects of Sea Level Rise (ESLR) extramural grant program in partnership with the Department of Transportation, to support research that informs adaptation planning and coastal management decisions in response to to sea-level rise, flooding, and inundation threats, including evaluation of nature-based solutions for enhancing the resilience of coastal transportation infrastructure. NOAA also proposes an increase to develop a collaborative

and integrated fire weather research program to enable new research into the coupled modeling for both the short-term fire-atmosphere and sub-seasonal to climate-scale modeling systems.

Our research will address the needs of sustaining a healthy "blue economy," which includes tourism, recreation, commercial fishing, renewable energy, and more. Last year the Bureau of Economic Analysis, in partnership with NOAA, released initial findings showing that the U.S. marine economy contributed about $373 billion to the Nation's gross domestic product in 2018 and grew faster than the nation's economy as a whole.[2] The NOAA Climate and Fisheries Initiative will significantly increase fisheries surveys, sampling, and analysis capabilities to deliver information on the changing distribution and abundance of commercial and recreationally valuable species due to climate change so that decision makers can determine best management strategies. In addition, NOAA will build a national ocean/ecosystem modeling and prediction system spanning U.S. coastal waters, the Arctic, and the Great Lakes, leveraging its global climate modeling system. This research will develop tools for decision makers to prepare for changing conditions in the ocean and Great Lakes, reduce climate impacts, and increase the resilience of all living marine and Great Lakes resources and the communities that depend on them.

Through the ARPA-C initiative, NOAA will pioneer research on blue carbon, carbon stored in ocean and coastal ecosystems, and factors that influence sequestration. This will lead to a better understanding of the effectiveness of certain climate mitigation strategies, such as different renewable energy choices and the role of coastal and ocean ecosystems, including in National Marine Sanctuaries and National Estuarine Research Reserves in carbon sequestration.

NOAA's data are critical for every Federal agency that seeks to better understand the impacts of climate change on their specific mission. To ensure these data are actionable, NOAA convenes and works directly with other Federal agencies to produce climate science and to support the agencies who need to use our science within their missions. One of the primary interagency collaborations is through the U.S. Global Change Research Program (USGCRP), under which NOAA co-leads the quadrennial National Climate Assessment and multiple interagency working groups focused on adaptation and resilience, international collaboration, climate and human health, sustained assessments, and the social sciences of climate and global change.

Observations and Forecasting

Measuring and predicting climate change impacts are core to NOAA's mission. NOAA proposes a $368.2 million budget increase to enhance and improve climate observations and forecasting to assist the Nation to become safer and more resilient under a changing climate.

NOAA provides timely, actionable access to global, national, regional, and local environmental data from satellites, radar, surface systems, atmospheric greenhouse gas sampling stations, ocean buoys, uncrewed systems, aircraft, and ships. In FY 2022, NOAA will continue to invest in these platforms to meet the increasing demand for observations. We will continue tracking marine ecosystem conditions to provide critical information for marine industries like fisheries, shipping, and offshore wind. We will also continue to track

[2] Bureau of Economic Analysis and NOAA, *Ocean Economy*. (2020), https://www.bea.gov/data/special-topics/ocean-economy

local environmental conditions that inform farming, forestry, building and construction, resource planning, disaster preparedness, and more. NOAA's local weather stations, climate monitoring stations, and research facilities across the country will continue to maintain long-standing climate records, such as temperature and rainfall observations, taken by experts and community scientists. These records are made publicly available and used to prepare, plan, and execute critical decisions at the local level. NOAA uses these data to establish a baseline normal state against which to compare new environmental states over time.

NOAA's ocean observing system is the basis for forecasting both natural climate variability, as well as the impacts of long-term climate change on our ocean resources and on ocean patterns that, in turn, drive our weather. The FY 2022 request will allow NOAA to begin addressing gaps that can be filled to improve forecasts. NOAA provides more than 50% of global in-situ ocean observing through our Argo and Tropical Pacific Observing System, to help us monitor the changing ocean environment. Enhancement and reconfiguration of the existing Tropical Atmosphere Ocean (TAO) moored array, implementation of the Tropical Pacific Observing System (TPOS) backbone observations, and calibrations of the radiation sensors across the observing network are essential to improving NOAA's climate forecast capabilities. These observations, supported by uncrewed platforms like ocean gliders, are also essential to describing the present state of the ocean, detecting long-term changes, and providing necessary operational weather, marine, and climate services worldwide.

The FY 2022 request will allow NOAA to support and maintain long-term atmospheric observations, which serve as a baseline and record of trends for the release and sequestration of carbon dioxide, methane, other important greenhouse gases, and other atmospheric aerosols and particles that affect climate, weather, and human health. NOAA will invest in our fleet of aircraft to continue to monitor long-term atmospheric and climate change trends. We will complete the acquisition of the G-550, which improves hurricane forecasting approximately 15-25%. We will also conduct critical maintenance on our two P-3 Hurricane Hunter aircraft, which have unique airborne data collection tools.

One of the greatest forecasting challenges facing NOAA is the need to improve precipitation forecasts across timescales from weather to climate. Related, there is a critical need for improved projections of how the climate will change on more granular, regional scales and over the next several decades. Investments to fully develop a Seasonal Forecast System will improve climate projections on these scales to better inform regional and local adaptation and resiliency planning for infrastructure, natural resource management, food production, finance, national security, and other sectors. Wildfires are influenced by the weather and climate, and the weather and climate are influenced by wildfires. Of particular interest to NOAA in FY 2022 are the opportunities to improve fire weather and smoke management forecasting. NOAA will work to improve short-term forecasts to better predict fire behavior and the longer-term modeling of interactions between climate variability, climate change, and the likelihood of hazardous wildfire conditions. Tools will be developed in concert with the U.S. Forest Service, the Department of the Interior, and relevant Tribal organizations.

Looking beyond the interior to the coast, investments in improved precipitation forecasts, a modernization of water level and land height observations, and a completion of the operational coastal oceanographic modeling system will together provide real-time inundation alerts, high-tide flooding outlooks, and long-term sea level trends. NOAA will convey this information using a Next-Generation Coastal Inundation Dashboard to allow coastal decision makers to evaluate flood risk at a local level and varying timescales.

NOAA's weather and climate predictions and information must be reliably delivered to users to impact decision making. The FY 2022 request includes a critical investment in the NWS Integrated Dissemination Program plan to address reliability and capacity issues necessary to ensure the provision of weather and climate forecasts and warnings to the public, emergency management partners, and the U.S. weather and climate enterprise. NOAA will invest in dissemination of rapidly increasing open data with the establishment of a NOAA Cloud Program to streamline and accelerate the transition of all NOAA mission areas to the cloud. This, in conjunction with the evolution of NOAA's Open Data Dissemination, will provide worldwide cloud access to NOAA climate and earth system dynamics data crucial to improve climate modeling. NOAA will work with data users to ensure they have access to the data necessary to better understand and decrease climate risks. NOAA must also invest in the transition of legacy telecommunications infrastructure to the government-wide Enterprise Infrastructure Solutions contract, which will adopt modern technologies and a service-based approach. This modernization effort will support all of the observing and forecasting efforts described above.

Restoration and Resilience

Forty percent of the U.S. population live and work in coastal counties,[3] making a disproportionate segment of our society and economy at increasing risk from such hazards as hurricanes and coastal inundation. Therefore, NOAA is requesting $259.3 million in FY 2022 for investments in ecological restoration and community resilience that are integral to NOAA's climate strategy. There is an increasing need for NOAA to create and foster natural and economic resilience along our coasts through direct financial support, expertise, robust, on-the-ground partnerships, and place-based conservation activities. These activities would also support the Administration's efforts to conserve at least 30 percent of the Nation's lands and waters by 2030.

Grants in the FY 2022 request will help states, Tribes, and other landowners plan and implement habitat conservation and restoration projects, including for candidate, proposed, and ESA-listed species, increasing habitat acres restored by over 60 percent. Healthy coastal habitats, such as marshes and coral reefs, protect ecosystems, shorelines, and communities from waves, storms, and floods, and help to prevent loss of life, property damage, and erosion. They also are a key source of livelihoods, through tourism and fishing. In addition, restoration activities and the construction of natural infrastructure employs construction workers, engineers, ecologists, project managers, and heavy-equipment operators, and generates a wide array of economic co-benefits. A 2020 reexamination confirmed an initial assessment that a $10 million investment in

[3] NOAA Office of Coastal Management and U.S. Census Bureau, *American Community Survey Five-Year Estimates*. (2017), https://coast.noaa.gov/digitalcoast/data/acs.html

ecological restoration of Michigan's Muskegon Lake in 2011, would power up the local economy by approximately $60 million through increased home prices and recreational visits.[4]

NOAA will work with partners to foster resilience of coastal ecosystems and the communities that depend on them. NOAA requests funds to expand the National Coastal Resilience Fund to help coastal communities and ecosystems prepare for and recover from extreme weather events, climate hazards, and changing ocean conditions. NOAA also will enhance the National Coastal Zone Management Program for coastal states and territories to support community adaptation efforts, including a focus on underserved communities disproportionately vulnerable to hazards. With funding requested in FY 2022, NOAA will remove marine debris, increasing such removal by 60 percent, and foster public awareness of the effects of marine debris. NOAA will continue to partner with the National Fish and Wildlife Foundation through the Fishing for Energy program to provide funding support to commercial fishermen to aid removal, disposal, and prevention of derelict fishing gear and plastic found at sea and aid in economic recovery for this sector.

NOAA will support endangered and threatened marine species through the U.S. Marine Biodiversity Observation Network, to support ecosystem-based management of commercially harvested species through advanced biological observing, modeling, and other innovative tools to inform adaptation strategies. NOAA will combat stony coral tissue loss disease, an especially lethal disease first reported in 2014 that spreads rapidly, causing high coral mortality. NOAA will build capacity for disease detection, prevention, and response efforts, and engage partners, coral reef managers, and regional fisheries managers.

NOAA's active engagement and partnerships with regional users and climate service delivery providers facilitate the uptake and application of NOAA's authoritative information. NOAA's National Sea Grant College Program will increase coastal community understanding of climate risk factors, develop key decision tools, and address critical knowledge gaps for coastal communities. NOAA's Regional Integrated Sciences and Assessments (RISA) program will work with communities to co-produce and operationalize lasting and equitable climate resilience plans in 50 cities around the Nation, prioritizing underserved communities particularly vulnerable to a changing climate. NOAA will improve response readiness in preparation for more emergency events through an investment in our Office of Response and Restoration. This will strengthen the national capacity to respond to emergency events by addressing internal and external preparedness gaps, investing in more efficient response equipment, and initiating a nationwide refresh of the Environmental Sensitivity Index to ensure an accurate understanding of the baseline for timely decisions during a disaster.

NOAA's FY 2022 request supports locally-driven management decisions regarding NOAA trust resources through increased engagement with partners, underrepresented communities, Tribes, and local indigenous groups to strengthen conservation outcomes. For example, in National Marine Sanctuaries, NOAA will double climate vulnerability assessments, promote climate resilience, and enhance work with states and local communities to achieve on-the-ground conservation goals. NOAA will also provide enhanced technical support and increased capacity

[4] Grand Valley State University, *Muskegon Lake Area of Concern Habitat Restoration Project: Socio-Economic Assessment Revisited*, (2020), https://www.glc.org/wp-content/uploads/Habitat-socioeconomic-Study-July-2020.pdf

within the National Estuarine Research Reserve System to further the benefits of blue carbon, to monitor marsh resilience to sea level rise, and to identify conservation corridors and habitat gaps for conservation and restoration planning. NOAA will convene technical experts, decision makers, and stakeholders to ensure that coastal adaptation investments are science-based, community-driven, and offer equitable solutions, making communities and the environment more resilient to climate impacts.

Offshore Wind

Offshore wind development is rapidly expanding in the United States, particularly in the Northeast and Mid-Atlantic, and is being considered along the Gulf and West Coasts as well. This represents a relatively new use of our marine waters and will require scientific and regulatory review to balance energy production with protecting marine resources and fisheries production. NOAA will continue to work closely with the Bureau of Ocean Energy Management (BOEM) to minimize the effects of offshore energy projects on protected resources, fisheries, and important habitats in the region; avoid delays and minimize adverse economic impacts to the fishing industry and related coastal communities; and mitigate impacts to fisheries surveys in the Northeast and Mid-Atlantic. NOAA is requesting a total of $20.4 million in four complementary areas to enhance interagency engagement, siting, and permitting of offshore energy projects to minimize impacts on our trust resources and constituencies: 1) Offshore energy assessment and scientific advice to support the regulatory process; 2) dedicated resources for offshore energy assessment related to protected resources; 3) increased support for environmental assessments and consultations with BOEM; and 4) development of new fisheries survey design and methods to address anticipated changes in habitats around offshore wind developments. Working in partnership with BOEM and other relevant agencies, these funds will support NOAA's role in achieving the Administration's goal to deploy 30 GW of offshore wind in the U.S. by 2030, while protecting biodiversity and promoting ocean co-use.

Equity

The Biden Administration policies, including those described in EO 13985 on Advancing Racial Equity and Support for Underserved Communities Through the Federal Government, make it clear that agencies will integrate equity dimensions into the DNA of their organizations—from management, to policies, to service-delivery. Underserved communities are especially vulnerable to weather, water, and climate events, with large disasters posing public health and safety risks and causing poverty rates to increase.[5] In FY 2022, NOAA requests $57.9 million to develop a framework to lay the foundation for successfully integrating equity considerations throughout the organization. This will position NOAA to help vulnerable communities better prepare for and respond to extreme weather and climate disasters. For example, in many localities whose budgets have already been constrained by the pandemic, major storms cause local revenues to fall by 6% to 7%, with that figure two times greater for municipalities with a significant racial minority population.[6]

[5] Hallegatte, S., Vogt-Schilb, A., Rozenberg, J., Bangalore, M., & Beaudet, C. (2020). From poverty to disaster and back: A review of the literature. Economics of Disasters and Climate Change, 4(1), 223-247.

[6] Rhiannon Jerch & Matthew E. Kahn & Gary C. Lin, *Local Public Finance Dynamics and Hurricane Shocks*, (NBER Working Papers 28050, 2020, National Bureau of Economic Research, Inc. 2020)

This effort includes investing in NOAA's internal capacity to better respond to the needs of vulnerable populations, assessing key services to identify and address barriers to access to all Americans, funding targeted investments in historically underserved communities, and enhancing NOAA's capabilities, such as the Drought Portal and the Sea Level Rise Viewer. NOAA's concrete goals will be responsive to promoting equitable delivery of government benefits and equitable opportunities as outlined in EO 13985and provide an action plan to make service delivery more equitable. This includes delivering Spanish-language translation of weather information from NWS offices and enhancing Tribal consultation on substantive policy matters with at least 30% of federally recognized Tribes in FY 2022. NOAA will also establish a NOAA Climate Cooperative Science Center as part of the José E. Serrano Educational Partnership Program with Minority Serving Institutions (EPP/MSI) to train post-secondary students in climate science. NOAA will modify award-winning Digital Coast tools and products to make them more accessible and conduct more robust engagement with underserved and vulnerable coastal communities. The National Sea Grant College Program will also increase, in FY 2022, the number of Sea Grant tools, products, and information services that are used to advance environmental literacy and workforce development services for underserved communities.

NOAA also seeks to strengthen equity efforts internally to accelerate efforts to attract, retain, and develop talent, including from diverse backgrounds. NOAA will enhance recruitment programs and communication tools to support STEM recruitment efforts from Historically Black Colleges and Universities and other MSIs. NOAA will also leverage these institutions through more tailored recruitment in the NOAA Corps recruitment, and the IT Fellowship Program. NOAA will accelerate implementation of the Diversity and Inclusion Strategic Plan and training and outreach for staff, supervisors, and leaders. These investments in supporting equity in our current and prospective workforce will allow NOAA to leverage diversity to provide better services to all Americans.

Fleet

The FY 2022 request includes significant investments for NOAA's observational infrastructure, such as the NOAA fleet, a key component of the NOAA mission. NOAA drives the Nation's economy, protects and creates better opportunities for the American public, and responds to climate-induced impacts with products and services firmly rooted in data. These data depend on NOAA's fleet of 15 ships. The $5.4 trillion and 31 million jobs that pass through our Nation's ports,[7] the $244.1 billion in sales and 1.74 million jobs connected to the Nation's fisheries,[8] and resiliency and prosperity of coastal communities all use data from NOAA ships. NOAA's detailed recapitalization plan and transformational maintenance strategy is a targeted approach to provide the Nation the most effective at-sea data. NOAA has made significant advancements in reliability and capabilities and, in turn, increased the days at sea available to support national requirements for data collection.

[7] Martin Associates for the American Association of Port Authorities, *2018 National Economic Impact of the U.S. Coastal Port System*, Spring Conference 2019, http://www.aapa-ports.org.

[8] NOAA, *Fisheries Economics of the United States, Economic Impact Trends, 2017*, (2017) https://www.fisheries.noaa.gov/national/sustainable-fisheries/fisheries-economics-united-states

In FY 2022, NOAA requests $101 million to support mid-life maintenance on the NOAA Ship Ronald H. Brown and to construct the Southeast Marine Operations Hub to replace Pier Romeo in Charleston, South Carolina, which is the homeport for the Brown and NOAA Ship Nancy Foster. The Brown, NOAA's largest oceanographic research vessel, collects oceanographic and atmospheric data worldwide in direct support of NOAA's climate missions, including data from buoys that drive accurate weather forecasts and climate models and ocean acidification data that informs global carbon models. Upon completion of maintenance, the Brown's expected life span will increase to provide 15 more years of reliable and highly capable support for at-sea data collection.

Satellites

The FY 2022 request also includes significant investments for NOAA's observational infrastructure, such as NOAA satellites, a key component of the NOAA mission. NOAA is committed to a flat $2.0 billion budget for the National Environmental Satellite, Data, and Information Service (NESDIS) starting in FY 2022 with no outyear increases other than government-wide inflation assumptions. The FY 2022 budget request underscores NOAA's commitment to making crucial, time-sensitive investments to ensure that the Nation's next-generation satellite systems not only improve capabilities, but that they also expand delivery of essential climate, weather, atmospheric, and oceanographic information to meet the needs of the American public. In support of EO 14008, the FY 2022 budget will help NOAA better observe environmental phenomena, including greenhouse gas measurement, connected to climate change-related impacts and patterns, and deliver products, information, and climate services to inform decision makers.

The value of NOAA's data is dependent on users' ability to access and apply it. The FY 2022 budget supports much-needed improvements to NOAA's data infrastructure that will ensure that the data collected are preserved for the future and can be easily accessed in a cloud-based environment. This includes funding to transition NOAA to cloud computing for data ingest, processing, dissemination, and archiving, which will expand the size and diversity of NOAA user communities and data applications.

For decades, the U.S. government was alone in developing Earth observing satellites on behalf of the Nation. Now the government is joined by U.S. companies in the midst of another space race -- a race to deploy constellations of satellites for communications and connectivity. The growth of the U.S. space industry has created new opportunities for Federal agencies like NOAA. Plus, there are more sophisticated commercial technologies and capabilities available than ever before to advance NOAA's national mission. NOAA will initiate development of the next generation of cutting-edge earth observing instruments to continue leading the world in this critical science and technology field, setting the global standards for such observations.

NOAA's current constellation has proven its worth and will continue to do so for close to another decade. While robust, NOAA must invest in the development of the next generation of environmental satellites with the needs of all of our communities in mind. Today's funding for future geostationary, low earth orbit, and space weather observations will ensure critical data continuity from legacy systems, while providing significant improvements in data and products that the U.S. requires to meet complex societal and environmental needs. Our program

investments also allow us to immediately exploit the National Aeronautics and Space Administration (NASA)'s research satellite observations for NOAA requirements and to integrate critical research observations into NOAA's operational mission.

With advances in technology, NOAA can build a more capable and efficient observing system, one that supports our vision to create an integrated, digital understanding of our Earth environment, that can evolve quickly to help our communities adapt and thrive, and maintain a stable and predictable budget path that avoids outyear cost growth which creates risk to both NESDIS as well as other NOAA priorities. This observing system, composed of satellites deployed by NOAA and our partners in Earth observations, including NASA, the Department of Defense (DOD), European Organization for the Exploitation of Meteorological Satellites (EUMETSAT), and others, will provide advanced, real-time data critical to saving lives and protecting property. It will improve Earth and space weather forecasting and expand capabilities for ocean, air quality, and climate observations. It will also enable NOAA to continue long-term monitoring and continuous services with no gaps in coverage of key climate parameters essential to understanding our changing environment.

In the current world of increasing environmental changes and disasters, NOAA must invest in the next generation of satellites, products, and services to meet the demands for more accurate and expanded environmental information and services for the American public. Continuity of NOAA's current satellites and information services, exploitation of partner research observations, and implementation of NOAA's plans for enhanced observing capabilities of future satellites and for fostering vital partnerships, will directly support the entire weather enterprise and EO 14008.

Space Weather

This request also supports additional capacity for the forecasting of space weather events, which can have far-reaching impacts on our Nation's economy, communications, and national security. An extreme space weather event can severely impact an entire hemisphere and the globe. Impacts might include disruptions to satellite communications, impacts to the terrestrial electric grid, and communication outages to cross polar airline flights, yet current observations and prediction services do not meet the needs of agencies and operators of critical infrastructure to mitigate against these events. The Space Weather Operations, Research, and Mitigation (SWORM) Interagency Working Group, which includes 34 Federal departments and agencies, identified research-to-operations and operations-to-research (R2O2R) as a critical gap in our Nation's ability to improve existing space weather forecast and warning services. To close the gap, the Promoting Research and Observations of Space Weather to Improve the Forecasting of Tomorrow Act (PROSWIFT) (Public Law 116-181) authorizes Federal agencies to develop formal mechanisms to transition space weather research models and capabilities to NOAA.

In FY 2022, NOAA requests $5 million to build towards a space weather prediction capability that will ensure national and global communities are ready for and responsive to space-weather events. For NOAA's Space Weather Prediction Center (SWPC) to improve these model forecasts, observations, and related watches and warnings, NOAA has identified four goals: implement a formal inter-agency R2O2R Framework; develop and sustain a Space Weather Prediction Testbed; transition new capabilities onto NOAA's operational national infrastructure;

and establish two PROSWIFT directed community collaboration efforts, the Space Weather Advisory Group and National Academies Roundtable on Space Weather.

To address the R2O2R gap, NOAA will partner with NASA, National Science Foundation (NSF), DOD, Department of Interior (DOI), and other Federal agencies to implement a formal framework to accelerate space weather research, observations, and model advances into NOAA operations. As a vital component of this framework, NOAA will develop and sustain the Space Weather Prediction Testbed (Testbed) that will leverage the expertise of academia, agencies, and commercial enterprise partners by fostering collaboration to validate, demonstrate, and transition emerging science and technologies into operations. In the Testbed, stakeholders participate in collaborative exercises and experiments using new capabilities under quasi-operational conditions. Following successful validation, the Testbed will demonstrate readiness and then enable the implementation of matured capabilities into NOAA operations.
NOAA will also support two community efforts: the National Academies Roundtable and the Space Weather Advisory Group (SWAG). The Roundtable will discuss approaches and constructs on implementing the R2O2R framework and seek to identify ways to integrate relevant research from across the entire U.S. science and technology enterprise. SWAG will advise SWORM on methods to advance the space weather enterprise of the Nation by improving the coordination and facilitation of R2O2R.

Conclusion

NOAA is uniquely positioned to observe and predict the changing climate and communicate the scientific information that underpins necessary actions. NOAA's FY2022 budget request includes significant investment in NOAA's capabilities to develop and deliver climate information and services that enable society to understand, prepare for, and adapt to the changes that we are already seeing and those that are yet to come.