WRITTEN STATEMENT OF

DR. STEPHEN VOLZ
ASSISTANT SECRETARY OF COMMERCE
FOR ENVIRONMENTAL OBSERVATION AND PREDICTION (ACTING),

AND

MS. NICOLE R. LEBOEUF
ASSISTANT ADMINISTRATOR FOR OCEAN SERVICES
AND COASTAL ZONE MANAGEMENT (ACTING)

HEARING ON NOAA CLIMATE SERVICES

BEFORE THE HOUSE COMMITTEE ON APPROPRIATIONS
SUBCOMMITTEE ON COMMERCE, JUSTICE, SCIENCE,
AND RELATED AGENCIES

APRIL 15, 2021

Chairman Cartwright, Ranking Member Aderholt, and Members of the subcommittee, thank you for the opportunity to testify today regarding climate data, tools, and services provided by the Department of Commerce's National Oceanic and Atmospheric Administration (NOAA).

NOAA's mission is science, service, and stewardship. Our reach goes from the surface of the sun to the depths of the ocean floor as we work to keep the public informed of the changing environment around them. We know that major elements of our Earth's life support system are changing in ways never before observed in recorded history. Foundational environmental parameters – atmospheric composition, surface temperature, ocean chemical balance, global sea levels, polar sea-ice cover, global land use distribution – are all changing at unprecedented rates.

Extreme weather events, exacerbated by climate change, are projected to continue worsening in intensity, duration, and frequency over the coming decades in the United States and around the world, and chronic conditions, like sea level rise and heat waves, threaten both our natural environments and built infrastructure. These changing conditions significantly threaten lives and livelihoods. They put our government institutions and economy at risk, from U.S. military readiness to the insurance industry, from real estate to public health. Unless substantial large-scale action is taken to plan for and address these and other climate-related risks at the local community level, the impacts on human and natural systems are likely to worsen this century. We know that addressing climate change is crucial for our environment, our people, and our

economy – as well as for job creation. Many climate change impacts are already being felt across our Nation, making climate-resilient adaptation of paramount importance. We must take bold and effective steps to safeguard our society in both the near and long term. NOAA knows climate, and we know how to inform and help prepare our nation and our communities for these challenges.

To thrive in this changing world, we need to understand the changes taking place, and we need to convey that understanding to decision makers, businesses, and everyday people – on every coast and in the heartlands. We provide data in charts and scientific publications and build sustained interactions with communities and partners to ensure this information is used effectively to benefit the American people. We observe and understand the entire Earth system – the ocean, the land, the atmosphere, the polar regions, the sun, as well as humans – and model the complex interactions among them all. NOAA provides daily weather forecasts and severe storm warnings, science-supported fisheries management, coastal and ocean protection and restoration, and data to enhance marine commerce. NOAA is the lead administrative agency for the congressionally mandated National Climate Assessment under the U.S. Global Change Research Program. The National Climate Assessment provides a climate service to the Nation by providing an accessible summary of the state of climate science, updated observations and trends for different regions of the country, future projections for key climate parameters, and a characterization of sector- and region-specific risks and impacts under a changing climate. NOAA works with partners in all areas, from observations to end-service delivery. NOAA's products and services promote economic vitality, affecting more than one-third of America's gross domestic product. NOAA saves lives, protects property, and increases community resilience through timely delivery of trusted information.

Measuring, short-term prediction, and longer-term projection of climate change and its impacts have been at the core of NOAA's work since our inception. Our observational records, going back centuries in some cases, helped support our Nation's growth and prosperity. NOAA's data and information support a worldwide weather and climate enterprise that has grown into a $7 billion dollar industry.[1] NOAA personnel are world leaders in generating and delivering climate impact information and prediction, using state-of-the-art Earth system and climate modeling and coastal, marine, terrestrial, aerial, and space-based observing platforms in service of the American people. Other federal agencies, states and local governments, communities, U.S. industry, and international partners depend on measurements we collect through our Global Greenhouse Gas Reference Network. NOAA has the ability to turn our suite of data into reliable, actionable information, including for vital industries like shipping, fishing, agriculture, construction, finance, and water resources, and to deliver that information with our boots on the ground in every state and territory in the United States.

[1] https://www.weather.gov/media/about/Final_NWS%20Enterprise%20Analysis%20Report_June%202017.pdf

Preparing for, mitigating, and adapting to the impacts of climate change is daunting; however, NOAA is ready to scale up our efforts, rooted in our mission.

Data and Information: Core Observations, Prediction, and Research

NOAA gathers global environmental observations from satellites, radar, atmospheric greenhouse gas sampling stations, ocean buoys, uncrewed systems, aircraft, and ships. We track marine ecosystem conditions, conduct fisheries stock assessments and map seafloor characteristics, discovering new species of life and providing critical information for marine industries like fisheries, shipping, and wind farms. We track 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 maintain long-standing climate records, such as temperature and rainfall observations, taken by experts and citizen scientists, that 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.[2] By continuously tracking new data over time, we are seeing that the baseline is changing in clear and dramatic ways in nearly every aspect of the planet's environment.

NOAA satellites from the late 1970's to our current generation provide a long-term record for monitoring essential key climate parameters, including temperature, water vapor, clouds, Earth radiation, atmospheric wind, precipitation, sea ice, snow cover, ozone, land and ocean surface observations. These observations are turned into useful information for various stakeholders. For example, vegetation health derived from NOAA satellite land products are used by many people and agencies, such as USDA, for monitoring agriculture productivity. Our sea surface temperature and ocean color products are used to monitor the health of coral reefs and marine populations and as inputs for NOAA weather forecasts and climate projections across timescales. Trends in polar sea ice[3] are used for decisions related to Arctic navigation and for local communities in Alaska to make decisions on fishing and hunting, and they also inform the weather events that disrupt historic expectations, such as the recent freeze in the lower Midwest of the United States. Each new generation of NOAA's satellites enhances the capabilities of the earlier generation because of the continued demand for more accurate information.

Our current generation of NOAA satellites contribute significantly to monitoring these and other events. As we replace our satellite fleet with the next generation, we expect to continue to improve our observing capabilities and continually make our climate data record more robust. For the future, we anticipate enhanced satellite capabilities to detect fires faster, more precisely monitor changes of coastal ecosystems, and provide more detailed air quality observations that, when combined with ground-based observations, will enable NOAA and our partners to make

[2] https://www.climate.gov/news-features/videos/tell-me-why-we-need-normals
[3] https://arctic.noaa.gov/Report-Card

more accurate warnings and forecasts. For hurricane forecasts, we will be able to provide higher spatial, temporal and vertical resolution from next generation imagers and sounders on satellites to be able to significantly improve intensity forecasts.

NOAA science plays a critical role in informing the Nation and world about changes in the climate system. Ongoing research and investment is advancing sub-seasonal and seasonal forecasts, including more skilled precipitation projections. NOAA's long-term atmospheric observations serve as a baseline and record, which can be used to monitor the effectiveness of efforts to reduce climate change through greenhouse gas mitigation or other means. In 1958, Scripps Institution of Oceanography's Charles Keeling began collecting the world's longest record of carbon dioxide levels, and in 1970, NOAA joined and expanded the effort at Mauna Loa into a global network of atmospheric monitoring. NOAA continues to serve as the global leader, monitoring long-term atmospheric trends in CO_2, methane and other potent greenhouse gases as important drivers of the changes. In 2018, observations and analyses from NOAA's Earth System Research Laboratories provided evidence of violations of the world's ozone-depleting gas reduction protocol, leading to international pressure and eventually renewed enforcement and inspection measures. NOAA is also conducting research to inform the effectiveness of certain mitigation strategies, including the weather and climate science regarding renewable energy choices, marine cloud brightening, carbon sequestration in coastal ecosystems, and the critical role of the ocean in removing CO_2.

Covering about 70% of the planet's surface, the global ocean has absorbed over 90% of human-caused heating and roughly 30% of human CO_2 emissions to date.[4] Additionally, the ocean is a major driver of regional climate variability, influencing the frequency and severity of extreme events such as droughts, floods, and hurricanes. Human activities are impacting the ocean environment, resulting in ocean warming, rising sea levels, and ocean acidification, and disrupting marine ecosystems. Understanding how the ocean influences, and is influenced by, climate is one of NOAA's highest research priorities. NOAA provides more than 50% of global in-situ ocean observing, for example, through our Argo and Tropical Pacific Observing System, producing the observational data system to help us monitor the changing ocean environment. These observations are essential to describing the present state of the ocean, detecting long-term changes, and providing necessary operational weather, marine, and climate services worldwide. NOAA's ocean observing system is the basis for forecasting 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. NOAA is also using uncrewed platforms, like ocean gliders, to improve our understanding of changing conditions, ranging from how ocean warming affects hurricane intensity to how the Antarctic is experiencing climate change. This work requires NOAA to collaborate with industry and academia. For example, NOAA has partnered with the University of Southern Mississippi with a new facility under construction in Gulfport, Mississippi that will

[4] https://www.ipcc.ch/srocc/

improve how uncrewed systems are used to collect important ocean observation data and augment NOAA's operational capabilities.

Moreover, monitoring ongoing changes in the ocean is an essential input into NOAA's world-class Earth system models that characterize our changing climate, with predictive capabilities on seasonal, annual, decadal, and centennial time scales. NOAA collaborates across agencies and with academia and the private sector to improve models that assess intersecting human, ecosystem, and environmental factors as an integrated Earth system. Even higher resolution models, enabled by advanced high performance computing, could deliver improvements to forecast local weather and climate events, continuing to bolster American leadership. At home and abroad, NOAA's collaborative modeling efforts help communities prepare for, mitigate, adapt to and become more resilient in the face of climate change. For example, NOAA's participation in the UN Decade of Ocean Science for Sustainable Development (2021-2030) promotes cooperative research and data sharing to improve the global understanding of the ocean and its effects on our climate and on the global community.

NOAA's long-standing observational infrastructure, such as the National Spatial Reference System, is essential to monitoring, predicting, and warning communities about the impacts of climate change, such as increased flooding. It provides an accurate understanding of changes in land elevation, which tells us "where the water will go" and helps us to assess inland, riverine, and coastal flooding risk. This system also provides the foundation for all geospatial datasets that support surveying, mapping, and charting, all part of major industries such as construction, transportation, and agriculture. NOAA's National Water Center in Tuscaloosa, AL is essential to the development of the National Water Model (NWM), a state-of-the-art modeling framework that simulates streamflow over the entire continental United States out to 30-days. The NWM also provides the basis for flood inundation mapping, which has been demonstrated for inland rivers and streams, and is being expanded to coastal areas.

In addition to providing the framework for land-based positioning, NOAA operates and maintains the National Water Level Observation Network (NWLON). This network of more than 200 long-term, continuously operating gauges is essential for understanding change over time, including sea level rise. This information is already enabling city and community planners to revise building codes and land use plans on decadal and longer timescales. With more flooding expected in the future, NOAA's foundational and climate data have the potential to play an increasing role in helping our Nation decide how and where to build.

Informing a wide range of coastal management applications, such as flood modeling, habitat characterization, and storm damage assessment, NOAA's Coastal Mapping Program defines the Nation's 95,000-mile shoreline. As a leader in seafloor mapping and surveys, NOAA's ship fleet collects hydrographic data used to produce and maintain the Nation's nautical charts for safe marine navigation. We use these data in our predictions of storm surge and inundation,

particularly where the seafloor is expected to have changed as a result of a major coastal storm. NOAA's exploration and characterization activities complement seafloor mapping in offshore environments, providing bathymetry, critical oceanographic measurements, and biological data in some of the most remote habitats within U.S. waters. These measurements inform our understanding of heat and carbon sinks in the ocean and provide baseline biodiversity information to monitor climate impacts in particularly vulnerable remote habitats like canyons and seamounts off the US east coast and hydrothermal vent systems in the Pacific. These and other uses of NOAA's mapping, exploration, and characterization data directly benefit the American people.

NOAA's Climate Data, Tools, and Services

Standing on the firm foundation of its world-class Earth System and climate science, NOAA provides data, tools, and services that reach every American every day. From farms to fisheries to the floor of the Chicago Mercantile Exchange and other markets, American commerce depends on a continuous stream of goods and services supported by NOAA's observations and forecasts. Our satellite observations that measure vegetation health and precipitation help farmers and ranchers, and our leadership of the interagency National Integrated Drought Information System provides data on current drought conditions at a county by county level that is critical for water resource managers. NOAA's geostationary satellites provide real-time alerts of fires across North America that, when combined with our higher resolution polar satellites, provide critical information that help detect, monitor, and characterize wildfires and air quality in support of local emergency response services. Our aircraft, outfitted with the most advanced research equipment such as Tail Doppler Radar, fly into hurricanes to collect data that improves hurricane forecasts by 20%. Improved El Niño forecasts can boost agriculture production by an estimated $300 million annually.[5]

Along our coasts, NOAA's Integrated Ocean Observing System Program measures ocean winds, currents, and wave height for navigation assistance and marine warnings in support of America's commercial and recreational fishing fleets – an industry that annually contributes an estimated $244 billion in economic activity and 1.7 million jobs. America's seaports depend on NOAA's coastal charting and real-time observations to support safe and efficient marine navigation for an industry that contributes nearly $4.6 trillion to the economy.[6] Every day, Americans use products and services that either come from or through our Nation's coasts or ocean, and NOAA programs such as PORTS® (Physical Oceanographic Real-Time System) and Precision Navigation facilitate this commerce. Systems like NOAA's PORTS® and Precision Navigation efforts also enable mariners to safely use every inch of available channel depth, thereby increasing the amount of cargo moved per transit. One additional inch of vessel draft can account for several

[5] https://cpo.noaa.gov/Our-Work/Success-Stories

[6] https://www.performance.noaa.gov/wp-content/uploads/NOAA-Contribution-to-the-Economy-Draft-24-4oct2018.pdf

millions of dollars in cargo value per transit. For example, in the Port of Los Angeles/Long Beach, improvements in NOAA services allowed port authorities to increase the draft for incoming ships from 65 feet to 69 feet and provided savings estimated at $10 million per year by reducing the number of transits required.[7] Delivering these key NOAA observations and services to ports and the fishing industry as our ocean and coastal environment changes, is vital to our prosperity and the delivery of goods and services across our Nation.

NOAA's science and services can inform infrastructure decisions and benefit natural ecosystems that protect lives, property and our economy against the impacts of climate change. NOAA works directly with states and local communities through its Coastal Zone Management Program, NOAA Sea Grant, Community-based Habitat Restoration Program, and National Coastal Resilience Fund, among others, to restore coastal habitats such as marshes, mangroves, and coral reefs. These habitats are the lifeblood of their surrounding ecosystems, benefiting natural and human communities through protections from storms or through fishing and tourism. Restoration of these habitats creates an average of 15 jobs per $1 million invested[8] and require a diverse set of skills that directly and indirectly employ a wide variety of people, including construction workers, engineers, fishermen, ecologists, project managers, and heavy equipment operators. These habitats also bolster tourism, such as in Florida where the total tourism value of Florida's coral reefs is estimated at $1.1 billion annually, supporting 71,000 jobs in south Florida alone.[9]

NOAA also has a critical role in supporting agency mandates for sustainable management of the Nation's valuable fisheries and protected resources – which, in turn, support the many diverse people, businesses, and communities that depend on them. For example, NOAA research improves understanding of how ocean changes are influencing the distribution, productivity, and abundance of marine and coastal habitats, fish stocks, marine mammals, and sea turtles. Understanding these changes is essential to sustaining commercial and recreational fishing industries.

These and other vital sectors of our economy are increasingly threatened by the impacts of climate change, including extreme weather events. Since 1980, the United States has sustained more than 285 weather disasters at a total cost of nearly $2 trillion.[10] Particularly noteworthy is the rate of change over the last 40 years during which the average annual number of billion-dollar disasters has quadrupled. During just this past Atlantic hurricane season, there were a record 30 named tropical storms – more than double the average season. Twelve of these storms made landfall and seven of them each produced at least $1 billion in damage. [11]

---

[7] https://oceanservice.noaa.gov/economy/inch-water/
[8] https://repository.library.noaa.gov/view/noaa/15030
[9] https://floridadep.gov/rcp/coral
[10] https://www.ncdc.noaa.gov/billions/
[11] https://www.ncei.noaa.gov/news/calculating-cost-weather-and-climate-disasters

NOAA knows that supporting a climate-ready Nation is about more than just collecting data. It is about turning such information into insights that help people make informed decisions. We produce trusted, usable climate information that evolves based on stakeholder needs, helping the public, and other decision makers understand how the Earth's climate is changing, how that change is affecting their lives, and what they can do to protect human lives, property, and natural systems. NOAA leads the annual *State of the Climate* report in the Bulletin of the American Meteorological Society, a definitive report on the changes in the climate system over the previous year. This report distills and contextualizes the immense amount of data collected by NOAA and other global entities into an accessible form for decision makers, the scientific community, and the general public.

NOAA is also the steward and archivist of environmental data for the Nation at the National Centers for Environmental Information (NCEI) producing meaningful information products, from straightforward indices like drought indicators or global temperature, to summary reports that put today's conditions across the earth system into historical perspective. In addition, NOAA's Climate.gov website provides continuously updated U.S. Government-wide climate science and information, such as the Global Climate Dashboard. This online resource raises climate and environmental literacy for educators and the public at large, empowering them to consider how our changing planet impacts our daily lives. For more specialized users, NOAA's extensive suite of online tailorable products and services, such as the Digital Coast, the Coastal Inundation Dashboard, and the National Integrated Drought and Information System, help decision makers reduce risk to life and property now and into the future.

We make available stakeholder-driven research and offer extensive education, outreach, and technical assistance to a broad suite of local, state, and regional partners that specialize in community-based engagement. Through our Regional Climate Services, Sea Grant Program, Regional Integrated Sciences and Assessments (RISAs) program, IOOS Regional Associations, Fisheries Science Centers, National Coastal Zone Management Program, among others, NOAA builds and leverages trusted relationships to identify what users need.

In addition to community-driven service delivery, NOAA has unique statutory missions and programs that provide "boots on the ground." Our 122 Weather Forecast Offices, thirteen River Forecast Centers, and ten National Centers, including the Climate Prediction Center, provide operational forecasts for every U.S. county and territory. By living and working locally, NOAA employees are able to more efficiently and effectively deliver our products and services. From state climatologists to geodetic survey specialists, NOAA works with local experts to build and refine our national products to meet the specific needs at state and local scales. For example, scientists at the NOAA Beaufort Laboratory partnered with the Department of Defense to determine if salt marshes at Marine Corps Base Camp Lejeune can protect the shoreline in the

face of sea level rise. As a result of NOAA expertise and research, Camp Lejeune is now implementing ecosystem-based management to reduce coastal erosion, and lessons learned can inform decisions at other coastal military installations and improve military readiness.

NOAA knows that each sector of society – urban and rural, coastal and inland – must be engaged in collaborative planning, adaptation, and resilience. NOAA practices a continuous engagement model with multiple sectors, and through our regional and local service programs, and develops products and services needed by communities and commercial sectors. NOAA builds relationships and collaborates with other federal agencies to enable sector-specific resiliency efforts through tailored climate observations and decision support. The demand for NOAA to function as a collaborative partner, source of authoritative science, and climate service provider is even greater for those in underserved communities.

Across the Nation, NOAA serves vulnerable communities, which are often disproportionately impacted by climate change and less resilient to severe weather and climate impacts, in a number of ways. For example, NOAA measures local urban heat islands (highly developed urban areas that experience mid-afternoon temperatures 15°F to 20°F warmer than surrounding vegetated areas on the hottest days of summer) through our National Integrated Heat Health Information System. NOAA has mapped street-level summer temperatures in 25 U.S. cities, including Detroit, Honolulu, and Baltimore, and found that urban heat islands are frequently associated with communities of color, exacerbating climate impacts for already underserved populations. These tools and services put extreme weather in a local, community-focused context – information that is critical for those populations who may be more at risk from climate impacts. NOAA's tailored information services can be extended to more cities and towns across the Nation to help them scale up and accelerate the pace of climate resilience-building.

NOAA actively engages a diverse suite of partners and stakeholders to assess and address their climate-related challenges. For example, in Hawaii and the U.S. Pacific Remote Island Areas, NOAA collaborates with the Pacific Risk Management 'Ohana (PRiMO) to engage with communities, agencies, and experts across the region. PRiMO includes more than 100 participants, including emergency response organizations, other federal agencies, nonprofits, universities, local planning groups and the medical and private sectors. These programs facilitate partnerships that incorporate indigenous knowledge on the environment and provide education, training, outreach and extension services to rural, remote, and underserved communities, often more vulnerable to climate change risks. These partnerships help ensure a more equitable distribution of NOAA services.

NOAA routinely coordinates efforts with and provides climate-related data, tools, and services to regional, state, territorial, local and tribal authorities, governments, universities, organizations and associations. For example, NOAA regularly connects with Tribal leaders in the Missouri River Basin, and with the 10 federally recognized Tribes in the East to build awareness of our

climate information and services. We regularly engage with states as they build their Hazard Mitigation Plans and factor in changing climate information. NOAA also works with and supports associations such as the Association of State Floodplain Management, the American Planning Association, the American Association of State Climatologists, and the National Association of Counties and others.

Increasing Demand for NOAA's Climate Data, Tools, and Services

NOAA's integrated approach to understanding Earth's systems is essential to providing the climate data, tools, and services needed today and into the future. To meet growing demand for accessible and accurate climate data, tools, and services that help protect the American public, our economy, and our natural ecosystems in the face of changing conditions, NOAA continues to work to strengthen our core observation, prediction, and research capabilities. This work includes replacing our aging ships, planes, radars, and water level and ocean observing systems; investing in our current and next generation satellites; maximizing our high-performance computing capabilities; and bringing our tools to communities to help them make better decisions and build greater resilience to climate threats. We must also meet this research challenge by recruiting the best and increasingly diverse modelers, oceanographers, and biologists to NOAA, as well as community liaisons. NOAA will also aim its operational research ambition to achieve immediate improvements to predict and forecast fire weather, precipitation, and coastal inundation events to allow communities to improve their resilience to growing threats. Creating actionable products and services will help all Americans, especially rural and underserved communities, adapt to reduce the risk of harm. Our coastal and ocean management and conservation programs will help support coastal communities and the resources on which they depend.

NOAA is a leader in global and regional observations, science, and prediction, and delivers trusted climate information, forecasts, and services to our Nation's decision makers at all levels of government, in all U.S. regions, across geographic scales from national to local, and in all economic sectors. With our expertise and unique capabilities, NOAA can help our Nation better understand our changing planet and make better decisions to prepare for, adapt to, and tackle the climate crisis. Together, we can meet the moment.