WRITTEN TESTIMONY BY
DR. NEIL JACOBS
ASSISTANT SECRETARY OF COMMERCE
FOR ENVIRONMENTAL OBSERVATION AND PREDICTION
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
U.S. DEPARTMENT OF COMMERCE

HEARING ON
UNDERSTANDING THE CHANGING CLIMATE SYSTEM,
AND THE ROLE OF CLIMATE RESEARCH

BEFORE THE
COMMITTEE ON APPROPRIATIONS
SUBCOMMITTEE ON COMMERCE, JUSTICE, SCIENCE,
AND RELATED AGENCIES
UNITED STATES HOUSE OF REPRESENTATIVES

FEBRUARY 26, 2019

Introduction

Good morning Mr. Chairman and Members of the Committee. Thank you for the opportunity to testify at this hearing. I am Neil Jacobs, Assistant Secretary for Environmental Observation and Prediction at the National Oceanic and Atmospheric Administration (NOAA) in the Department of Commerce.

It is widely recognized that understanding weather has an overwhelming impact on not only the protection of lives and property, but also on the U.S. economy. Weather-related impacts to the U.S. economy are estimated to reach hundreds of billions of dollars annually. The recently issued Fourth National Climate Assessment also included estimates of potential economic impacts under future climate scenarios (including out to the year 2100). However, much less attention has been given to the importance of understanding sub-seasonal to seasonal forecasts, where current forecasting skill is low, yet the potential economic benefits of improvements to these forecasts are very high. This opportunity was recognized by Congress with the Weather Research and Forecasting Innovation Act's focus on increased forecasting skill of sub-seasonal to seasonal weather prediction.

In addition, the recent reauthorization of the National Integrated Drought Information Systems Reauthorization Act of 2018 created the Earth Prediction Innovation Center, or EPIC, which will improve the United States weather and climate models through focused attention and investment throughout the entire atmospheric modeling community, including short term weather, sub-seasonal and seasonal oscillations, and long term climate patterns. Implementation of EPIC is among the Department's and NOAA's highest priorities and will directly benefit taxpayers as well as the U.S. climate science enterprise. Improvements in weather and climate models will feed advancements in operational forecast products, impacting many sectors of the United States economy, ranging from agriculture and fisheries management to energy markets and inland water management.

NOAA is a global leader in the full spectrum of scientific understanding of Earth's climate system through sustained observations and monitoring, integrated environmental modeling, historical data management, and interdisciplinary research. Because so many factors influence the Earth’s climate, and these factors can be highly variable, accurate and long-term observations of the current state of the Earth's environmental conditions are critical. NOAA's observing system network extends throughout the global systems. NOAA records information from all of the world’s oceans and major seas, measuring key metrics including temperature, currents, chemistry, and sea level. Terrestrial observations monitor precipitation, soil moisture, land use and vegetation, snow cover, glaciers, Arctic sea ice, as well as many derived values from proxy data.

NOAA samples the physical and chemical properties of the atmosphere through a wide range of systems from *in situ* observations provided by weather balloons, aircraft, and surface instrumentation to remotely sensed satellite and radar data. High-quality, uninterrupted, long-term measurements of greenhouse gases, aerosols, water vapor, ozone, and ozone-depleting gases are essential. Furthermore, quantifying the sources and sinks of each of these climate-forcing agents, and characterizing the roles they play in the climate system, are vital to advancing the state of knowledge in climate science. In addition, through collaboration with our National Aeronautics and Space Administration (NASA) colleagues, NOAA's Space Weather Prediction Center monitors the total wavelength-integrated energy from sunlight, which is referred to as the total solar irradiance. To derive meaningful information on trends and interactions from all of these observations, they must be monitored without interruption for many decades or longer.

NOAA has been operating polar-orbiting satellites that have been providing continuous global observations used in climate science since 1978. Data from these satellites has been invaluable for studying and monitoring phenomenon related to changes in sea surface temperature, changes in the cryosphere, desertification, composition of the atmosphere, cloud climatology, vegetation dynamics, and biomass burning. Some challenges in this activity include periodic reprocessing of the data to maintain consistency over different satellite series, combining NOAA data with data from partner agencies, and blending data from satellites, models, and other observations.

NOAA's predictive capabilities span the medium range and sub-seasonal to seasonal and beyond. NOAA’s suite of prognostic tools can be divided into statistical and dynamical models. Dynamical tools used for the monthly to seasonal forecasts include the Climate Forecast System, or CFS, which is based on a low-resolution version of the Global Forecast System, and the North American Multi-Model Ensemble, which is based on a suite of forecasts from seven different global forecast models. The CFS model projects out nine months, but there is research underway to extend the longer-range predictions to 24 months.

Prediction of climate variations, ranging from El Niño and the Madden-Julian Oscillation to sudden stratospheric warming events altering the polar vortex, provide longer-range probabilistic guidance on when future conditions will be favorable for extreme weather events that impact lives and property, from tornadoes and hurricanes to cold air outbreaks, heat waves, and flooding. The next-generation CFS will be a Finite-Volume Cubed Sphere (FV3)-based atmospheric model that is two-way coupled to an ocean model, which can handle everything from meltwater and thermal expansion, and with increasingly realistic representations of the physical and chemical interactions of the complex climate system. The new FV3-based CFS will be part of NOAA's transition to a unified forecast system (UFS), which spans large time and space scales with a common architecture used by the broader scientific community.

Decadal forecasts, produced by NOAA's Geophysical Fluid Dynamics Laboratory, are used in very long-range projections. The verification of these model simulations is made using historical analyses and reforecasts made over the past several decades, resulting in models that are among the best, if not the best, in the world. In order to extract a meaningful signal at longer time ranges, a large ensemble of models and substantial high-performance computing resources are required.

In addition to the suite of dynamical models, NOAA runs several statistical models. These statistical models include canonical correlation analogs and regressions from post-processed dynamical model output. These are valuable assets not just as predictive tools, but also as a means to refine and improve the dynamical climate models.

In an effort to improve transparency, NOAA makes all of its data, from raw observations to post-processed model output, available to the public via archives preserved at NOAA's National Centers for Environmental Information. In addition to the data, the source code used to process the data is also made available; however, much of this existing code lacks sufficient documentation and technology support for users outside of government systems. This makes experiment replication and software change justification challenging for those outside the federal climate science field. While NOAA’s primary near-term objective will be to develop more accurate and reliable models, I also hope to address the factors limiting transparency in the near future through initiatives such as EPIC, which will enhance community modelling support and give the public more confidence in the code and scientific methods we employ.

Substantial progress has been made over the last several decades in Earth system science observations, modeling, and understanding by NOAA scientists working with experts in other agencies and the private sector. However, the mission remains incomplete and many questions still remain unanswered. Key scientific uncertainties limit scientists' ability to understand and forecast seasonal to decadal changes in the climate system. The factors responsible for climate forcing, and those underlying climate variability, need to be better characterized and quantified to improve the Nation’s ability to predict the future state of the climate system, including the occurrence of extreme events, with more accuracy than today.

Mr. Chairman, Ranking Member Aderholt, and Members of the Subcommittee, thank you again for inviting me to participate today. I would be pleased to answer any questions you may have about NOAA's climate programs.