

**WRITTEN STATEMENT BY
WILLIAM MURTAGH
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
U.S. DEPARTMENT OF COMMERCE**

**ON
SPACE WEATHER: ADVANCING RESEARCH, MONITORING, AND FORECASTING
CAPABILITIES**

**COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY
SUBCOMMITTEE ON ENVIRONMENT
AND
SUBCOMMITTEE ON SPACE AND AERONAUTICS
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Introduction & NOAA's Role

Good morning Chairs Fletcher and Horn, Ranking Members Marshall and Babin, and Members of the Committee. My name is Bill Murtagh and I am the Program Coordinator for the National Oceanic and Atmospheric Administration (NOAA) Space Weather Prediction Center (SWPC) in the Department of Commerce. Thank you for the opportunity to testify at this hearing about space weather. NOAA is the U.S. Government's official source of civilian space weather forecasts, warnings, and alerts to the general public, industry, and government agencies. NOAA works closely with our partners in the U.S. Air Force (USAF) 557th Weather Wing, who are responsible for all Department of Defense (DOD) and related national security needs for space weather information.

Through the SWPC, NOAA's mission is to deliver space weather products and services that protect our society and economy from space weather events that could wreak havoc on our Nation's electrical grid, telecommunications, GPS-dependent technologies, astronauts and space exploration, and aviation.

SWPC operates 24 hours a day providing observations/situational awareness, forecasts, and warnings of space weather storms with advance notice ranging from hours to days. In addition to the DOD, SWPC efforts are closely integrated with other agencies, including the Department of Homeland Security, National Aeronautics and Space Administration (NASA), National Science Foundation (NSF), and the U.S. Geological Survey (USGS), as well as commercial service providers, private industry, and academia. SWPC also works with international partners to ensure access to essential data and analyses that support our mission, and to ensure consistency in forecasts. It is SWPC's goal to produce accurate and timely space weather products and decision-support tools that protect national critical infrastructure.

Observation Platforms

NOAA's space weather products and services start with observations. NOAA uses an array of space- and ground-based observatories that use specialized instruments that support our space weather forecast operations and related research.

NOAA, through its National Environmental Satellite, Data, and Information Service, operates space-based observatories at three viewpoints to meet SWPC's operational requirements: deep space Lagrange point 1 (L1), the point located one million miles above the surface of the Earth for solar wind measurements; in geostationary orbit at 22,240 miles for key observations of solar flares, x-rays, and energetic particle radiation enhancements; and in low Earth orbit polar-orbit at 310 miles for measurements of the ionosphere. NOAA also ingests supplemental information by leveraging additional data from NASA research, and European research and operational satellites. NOAA is currently in the process of developing the Space Weather Follow-On (SWFO) program, which will provide mission continuity and augment capabilities at the L1 point and geostationary orbit.

Ground-based data are also important in SWPC operations. The underpinning data used by NOAA to supply geomagnetic storm warnings and alerts are the ground-based magnetic field observations provided by the USGS Geomagnetism Program. These observations describe the local intensity of the changes in magnetic fields and allow NOAA to characterize the intensity of geomagnetic storms. NOAA also relies on the USAF Solar Electro-Optical Network (SEON) and NSF's Global Oscillations Network Group (GONG). SEON provides continuous solar optical observations and solar radio emissions from ground stations around the world. GONG consists of a network of six stations that provide continuous solar imaging and magnetograms.

Modeling and Product Dissemination

Using these observations, forecasters predict the probability of eruptions on the Sun. When an eruption occurs, forecasters feed the data from the data collection platforms into computer models to determine the likely effects of solar events on Earth. The models help forecasters estimate when the effects will begin, how long they will last, and how severe the event will be. The model output will also provide critical infrastructure owners and operators with key decision points and thresholds for action, enabling more effective mitigation procedures and practices. NOAA is actively working with NASA and NSF to tap into their support of research and space weather modeling developed in the academic community to increase forecast skill.

NOAA is also pursuing a more effective Research-to-Operations-to-Research process through its new program, the Earth Prediction Innovation Center (EPIC). EPIC will utilize partnerships with academia, the private sector, and relevant agencies to validate and test new capabilities (e.g., products, models, observations, applications, and techniques), transition those capabilities from research to operations, and establish a process to evaluate and improve existing operational capabilities. As part of EPIC, space weather prediction models will benefit from the increased focus on enterprise collaboration.

NOAA forecasters communicate current and forecasted space weather conditions using a variety of products. Similar to the categories we use to classify hurricanes, there are also Space Weather Scales for communicating the relative severity of space weather storms. Space weather scales communicate potential impacts such as Radio Blackouts (from solar flares), Solar Radiation Storms (due to solar energetic particles), and Geomagnetic Storms (from coronal mass ejections). The scales list possible impacts for each level and indicate how often such events happen. Watches, warnings, and alerts are issued by email via a product subscription service and by telephone notification to critical customers such as power grid operators, FEMA, and Mission Control at NASA. NOAA's space weather alerts and warnings are essential for enhancing national preparedness for space weather.

In September 2019, NOAA and USGS announced the release of the new Geoelectric Field model. This model indicates the level of space weather impact affecting the U.S. electrical power grid and helps operators mitigate effects on critical infrastructure. The model relies on USGS magnetometers (described above), and work has already begun on improving the product to include Canada and to add a prediction capability that will rely on L1 measurements.

Commercial Sector Engagement

Additionally, NOAA continues to actively engage the commercial sector on opportunities to meet U.S. government requirements for weather and space weather information. NOAA ensures all space weather data, real-time and retrospective, and services are made available to the growing private sector service providers. The NOAA-private sector partnership plays a vital role in meeting the nation's needs for space weather services. NOAA recognizes that a strong public-private partnership is essential to establish the observing networks, conduct research, create forecast models, and supply the services necessary to support national security and economic prosperity. NOAA is committed to working toward the growth of the private sector as the national infrastructure demands more space weather services. These activities are governed by the NOAA Policy on Partnerships in the Provision of Environmental Information, NOAA Commercial Space Policy, and the NESDIS Commercial Space Activities Assessment Process. NOAA will continue to explore partnerships with the commercial sector as it maintains its operational capabilities to provide space weather awareness.

NOAA's Interagency Coordination with SWORM

On March 26, 2019, the National Science and Technology Council released the National Space Weather Strategy and Action Plan. This is an update to the original Strategy and Action Plan published in October 2015. The Strategy and Action Plan unites the U.S. national- and homeland-security enterprise with the science and technology enterprise to formulate a cohesive approach to enhance national preparedness for space weather. Key to the success of this update was input from the public on ways to leverage private capital and expertise on space weather research, observations, forecasts, and mitigation of effects on critical infrastructure. The National Science and Technology Council, Space Weather Operations, Research, and Mitigation

(SWORM) Interagency Working Group, comprised of over 20 Federal Departments and Agencies, is the interagency body that defines, coordinates, and oversees implementation of the objectives in the Strategy and Action Plan. This important update seeks to improve the government's coordination on long-term guidance for Federal programs and activities to enhance national preparedness to space weather events. The new strategy aligns with priorities identified by the Administration in the 2017 National Security Strategy and the Space Policy Directives.

NOAA appreciates the on-going support we have received from Congress for our critically-important space weather program. We will continue to collaborate with other Federal agencies and the private sector to develop and strengthen our activities in space weather research and forecasting. Thank you for the opportunity to testify today. I look forward to answering any questions you may have.