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Statement of
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Chairwomen Horn and Fletcher, Ranking Members Babin and Marshall, and members of the Subcommittees, I am honored to appear before these Subcommittees to discuss NASA's contributions to understanding space weather and its impacts on our society.

Space weather is the result of complex interactions between the Sun, solar wind, Earth's magnetic field, and Earth's atmosphere. Our ability to understand and predict space weather is of growing importance to our nation's economy, national security, and even NASA Astronauts.

Through its Artemis program, NASA is accelerating its exploration plans and working to land the first woman and next man on the surface of the Moon by 2024. To meet these objectives, we continue to accelerate development of the systems required to ensure success. The Artemis missions will send humans beyond the protection of Earth's magnetic field for the first time since Apollo, and expose our astronauts and the systems upon which they will depend to a unique, and potentially hazardous space weather environment. NASA's Heliophysics division is working closely with the Artemis Program to support the human exploration of deep space, and on potential approaches to measure the radiation environment on and around the Moon. These measurements would aid in the prediction and validation of the radiation environment to which our astronauts will be subjected. Looking further in the future to journeys to Mars, NASA astronauts will need the capability to autonomously generate their own space weather data and predictions. To this end, the Heliophysics Division is working with the Space Radiation Analysis Group (SRAG) at the Johnson Space Center on possible experiments in cislunar space to develop the science and technology needed for such predictions.

Artemis holds important potential as a platform for scientific research. There is intense interest in what we can discover at the Moon. The lunar samples returned during the Apollo Program dramatically changed our view of the solar system, and scientists continue to unlock new secrets from the samples. We know the Moon can tell us more about our own planet, and even our Sun. Artemis missions may include installation of space weather instruments on the Moon, and studies of the lunar surface could yield significant insights into the space weather over long time scales. There is so much more to learn – knowledge we can acquire with a sustained human and robotic presence on the Moon. NASA will conduct many more science investigations and technology demonstrations on the Moon ahead of a human return through its Commercial Lunar Payload

Services (CLPS) initiative. Several payloads among those already selected through this program earlier this year will provide data of interest to solar and space physicists, and future payloads could include dedicated space weather instruments. The Artemis Program seeks to establish a sustainable architecture with our commercial and international partners on the Moon by 2028 and this architecture will support a future of scientific research.

NASA already addresses space weather impacts on astronauts and spacecraft while maintaining the International Space Station (ISS) and protecting the astronauts living there. The Community Coordinated Modeling Center (CCMC) team at the Goddard Space Flight Center works with NOAA's Space Weather Prediction Center (SWPC) to provide data and forecasts to the SRAG, who can then assess risks to the ISS. This experience will help NASA as it considers how best to protect Artemis astronauts from space weather impacts.

Space weather events are not only a concern for our astronauts and spacecraft; airline travel, communications and precision navigation and timing systems like the global positioning system (GPS), and the electrical power grid, on which we depend each day, can all be impacted by space weather. The NASA Heliophysics Division continues to study the Sun, how it influences the very nature of space, the atmospheres of planets and in the case of Earth, the technology that exists in low earth orbit and on the surface.

The extensive, dynamic solar atmosphere surrounds the Sun, Earth, and planets and extends far out into the solar system. Mapping out this interconnected system requires a holistic study of the Sun's influence. NASA has a fleet of spacecraft strategically placed throughout our heliosphere -- from Parker Solar Probe nearest the Sun, observing the very start of the solar wind, to satellites around Earth, to the farthest human-made object, Voyager, which is sending back observations on interstellar space. Each mission is positioned at a critical, well-thought out vantage point to observe and understand the flow of energy and particles throughout the solar system.

Several key missions are particularly focused on improving our understanding of space weather. The Parker Solar Probe, a first-of-its-kind mission, will visit the Sun's atmosphere, or corona, and provide information about coronal heating and the source of the solar wind. The Advanced Composition Explorer along with NOAA's Deep Space Climate Observatory observe the solar wind as it travels away from the Sun toward Earth and the other planets. The Solar Dynamics Observatory, the Solar and Terrestrial Relations Observatory, and the joint ESA/NASA Solar and Heliospheric Observatory all observe solar eruptions on the Sun. And finally, the Global-scale Observations of the Limb and Disk (GOLD) mission and the Ionospheric Connection (ICON) mission, launched earlier this month, will improve our understanding of what is happening in the ionosphere. Each of these missions provide a different view of the complex system that leads to the space weather we experience.

NASA Heliophysics works as the research arm of the nation's space weather effort, coordinating with NOAA, the National Science Foundation (NSF) and the U.S. Geological Survey, and Department of Defense (DoD). NASA is also a member of the Space Weather Operations, Research, and Mitigation (SWORM) Interagency Working Group run by the National Science and Technology Council, which coordinates interagency efforts to carry out the actions and meet the objectives identified in the National Space Weather Strategy and Action Plan. In addition to research missions, NASA supports improvements in space weather prediction models, such as those used by NOAA SWPC, the U.S. government's official source for space weather forecasts.

The NASA CCMC plays a key role in supporting our sister agencies by transitioning space research models to space weather operations.

NASA's Space Weather Science and Applications (SWxSA) project works to effectively support the transition of heliophysics science results to applications that enhance the user communities' ability to address impacts caused by the dynamic space environment. This activity supports interagency space weather efforts and is consistent with the recommendations of the 2013 Decadal Survey for Solar and Space Physics. Under SWxSA, NASA plans to competitively fund ideas and products, leverage existing agency capabilities, collaborate with other agencies, and partner with user communities. NASA established SWxSA in collaboration with sister federal agencies, academia and industry. Recent achievements include the award of grants that target research efforts to advance science priorities identified by our operational agency partner, investments in high end computing and the community coordinated modeling center.

Furthermore, in coordination with NOAA, we have initiated a pilot program to expand the interagency capability and improve space weather products and services for Research to Operations and Operations to Research (R2O2R). We are meeting regularly with NOAA to develop a shared framework for research to operations, and once we have established an effective and efficient process, we will further integrate NSF, DoD, academia and private industry into the framework.

NASA appreciates the continued support from these committees, which ensures that the United States maintains a superior position in understanding space weather and is prepared to respond to space weather events. We look forward to continued collaboration with our sister agencies, international partners, academia, and industry.

Thank you for the invitation to be here with you today, and I am happy to answer any questions you may have.