PROSWIFT Bill and the 2020 Space Weather Operations and Research Infrastructure Workshop from The National Academies of Sciences, Engineering, and Medicine

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The Space Weather Research and Forecasting Act ("Promoting Research and Observations of Space Weather to Improve the Forecasting of Tomorrow Act" PROSWIFT) passed the United States Senate by unanimous consent in July 2020 and passed the House of Representative on September 16. The results of various efforts in the Senate and House since 2016, the bill, among other provisions, directs NOAA to capture remote images of coronal mass ejections (CMEs) which is what the Space Weather Follow-On at L1 (SWFO-L1) will do. This NOAA spacecraft, to be launched as a rideshare on 2024 with IMAP to the Lagrangian L1 point, will carry the Naval Research Laboratory's compact coronagraph (CCOR) as well as a three-instrument in-situ suite built by the Southwest Research Laboratory and the University of California-Berkeley. Ball Aerospace won the contract to build and integrate. CCOR is also planned to be launched in 2023 on GOES-U to geostationary orbit providing a redundant white-light coronagraphic monitoring of CMEs. SWFO-L1 will replace DSCOVR as in-situ monitor of incoming solar wind. Other aspects of the PROSWIFT bill codify into law the roles of the various US agencies and departments which are involved in space weather under the coordination of the Office of Science and Technology Policy (OSTP). The bill also creates an interagency and an outside advisory groups for space weather in the United States.

While the landscape of space weather instrumentation is getting set for the first half of the current decade, there has also been ongoing discussion about what additional infrastructure is required in the medium term. This was the focus of the recently completed space weather operations and research infrastructure workshop organized in two parts by an ad-hoc committee of the National Academies of Sciences, Engineering, and Medicine on 2020 June 16-17 and September 9-11 and co-chaired by Drs. Mary Hudson and Janet Luhmann. The goal of the virtual workshop was to identify options to extend the baseline space weather monitoring beyond SWFO-L1 and to consider options for observations from the ground, in low-earth and geostationary orbits (LEO and GEO), from L1 and L4/L5. The workshop included agency presentations from NOAA, NASA, NSF, the Air Force, the Office of Space and Advanced Technology, and the National Weather Service. There were numerous discussions about various aspects of the needed space weather infrastructure. Future interplanetary measurements will be made from the Lunar Gateway with the Heliophysics Environmental and Radiation Measurement Experiment Suite (HERMES), from the Lagrange L5 mission, currently being developed by the European Space Agency, or through various other instrument and mission concepts as presented during posters. The push to return to the Moon and to have human exploration of Mars will necessary drive an expansion of space weather research and monitoring to the Moon and Mars systems. On another topic, the recently deployed, extremely large commercial LEO constellations come with numerous opportunities as well as concerns, including risks associated with collision, uncontrolled reentry, and space traffic management in general, but they could also be associated with new knowledge of the thermosphere and ionosphere through collaborative commercial+research ventures. Few research or real-time upper atmospheric models are currently tailored to the orbital prediction challenges faced by LEO satellites, and the sizes of

new LEO constellations being deployed are orders of magnitude larger than in a few years ago, exacerbating these challenges. This is especially true as solar cycle 25 ramps up. Many of these constellation satellites have not experienced conditions associated with significant flare or SEP events due to the relatively deep solar minimum in the past years (the last large SEP event and X-class flare to date occurred 3 years ago in September 2017). Radiation environment enhancements associated with solar activity have only recently been probed to an extent that illustrates their complexity. On Earth, geomagnetically induced currents (GICs) have been recognized as a potential catastrophic natural hazard, and various efforts to mitigate but also to measure more precisely ground currents and magnetic fields were discussed. Our still growing reliance on navigation networks and the issues they face when variable ionospheric conditions interfere with their accuracy was another subject where the value of the ability to forecast disturbances came up. On the whole, the combinations of user needs, National policies, mission architectures and science research that were featured in this workshop illustrated the increasingly active agency and community efforts to jointly propel improved space weather knowledge and its applications in the next decade.