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Long-Term Support Is Needed for Crucial Ground-Based Sensor Networks

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Abstract Recently, many in the space weather community have taken up the cause to advocate for an orphan among our own. It's an important fight—for ground-based sensor networks. Although ground-based sensors are used across all disciplines of space weather, in terms of long-term support, they have no single clear home in any United States agency or department. This has resulted in an ongoing struggle throughout the community to maintain important space weather sensors and networks.

The Promoting Research and Observations of Space Weather to Improve the Forecasting of Tomorrow (PROSWIFT) Act of 2020 (S.881—116th Congress, 2019) attempts to clarify Federal roles and responsibilities, stating that "… ground-based observations provide crucial data necessary to understand, forecast, and prepare for space weather phenomena," which it defines as "radars, lidars, magnetometers, neutron monitors, radio receivers, aurora and airglow imagers, spectrometers, interferometers, and solar observatories."

The data from this list of sensors and arrays support research across the space weather domains, including magnetospheric, ionospheric, and atmospheric science. Networks are run by governmental, academic, and commercial providers, and are used to support a range of end-users, from aviation to the power sector. Given the wide range of applications, it's not surprising that no single entity has primary custody.

In separate sections of PROSWIFT, sustainment of these instruments is assigned to "The Director of the National Science Foundation, the Director of the United States Geological Survey, the Secretary of the Air Force, and, as practicable in support of the Air Force, the Secretary of the Navy" who are directed to "maintain and improve ground-based observations of the Sun, as necessary and advisable," and also to the National Oceanic and Atmospheric Administration, as the civil operational space weather agency that is responsible for maintaining "ground-based… assets to provide observations needed for space weather forecasting, prediction, and warnings."

While PROSWIFT's clarification of federal responsibilities is welcome, what is highlighted is a problem of the "ownership" of the issue of long-term sustainability of such varied instruments.

We can start to unravel the ownership problem by understanding its history. One complication to an easy definition is that ground-based sensor networks support both space weather science and operations. The NSF has a long history of supporting novel instrument development, small arrays of sensors placed for scientific research (fundamental research is the foundation of NSF's mandate), and mid- and larger-scale facilities. But the needs of science do not necessarily intersect the needs of operations, and neither do their requirements in terms of engineering and support. Operational sensors, in many cases, are entirely different than scientific sensors.

Like scientific arrays, operational sensors must provide the "right" data—accurate and relevant—but the delivery of those data must also be timely, consistent, and reliable. In other words, the data must be useable for space weather predictions, forecasts, and alerts. The USGS is one example of a federal provider of operational ground-based data. The commercial sector, by mandate of PROSWIFT, is another.

Whether scientific or operational, ground-based networks need to be supported and maintained long-term to fulfill their missions. It is more expensive to shut down and rebuild an array than to keep it operating, and strategic planning is required to prioritize and balance needs across the space weather enterprise.

Those taking up the initiative to support ground-based sensors span the space weather enterprise, reflecting the interdisciplinary and cross-sector need for these data. In addition to a myriad of white papers submitted to the Heliophysics Decadal Survey (e.g., Bhatt et al., 2022; Hartinger et al., 2022) and publications (see Bain et al., 2023; Engebretson & Zesta, 2017), advisory groups such as the Space Weather Advisory Group (SWAG) and the National Academies Space Weather Roundtable, both put into place by the PROSWIFT Act itself, have taken up the cause. The SWAG, in a public meeting on 20 March 2023 (https://www.weather.gov/swag), called for a "paradigm shift," agreeing upon a recommendation that there is a need "Provide long-term support for operational ground-based and airborne sensors and networks."

It's clear that these data are crucial for space weather—both space weather research and operations. With the approach of solar maximum, and the associated rise in space weather hazard, what's less clear is whether this problem will be solved in time. The community efforts have been effective in raising awareness about the dire situation facing many ground-based sensor networks. What is needed now is a mechanism to maintain these networks long-term, and advocacy for new Federal appropriations to support the organizations that take on the responsibility.

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