Input into NOAA's Space Weather Observations Program: the IMF Bz Issue

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The NOAA Space Weather Next (SW Next) program advances NOAA's goal to reduce the impact of severe space weather events, as directed by the 2020 Promoting Research and Observations of Space Weather to Improve the Forecasting of Tomorrow (PROSWIFT) Act. The SW Next program will ensure that observations support the forecasting of space weather events, such as geomagnetic storms, ionospheric disturbances, solar wind, solar flares and coronal mass ejections (CMEs), as well as provide backbone measurements necessary for research. The Space Weather Observations Programs Division, a new joint NOAA-NASA office, will manage both the new SW Next program and existing Space Weather Follow-On (SWFO) program. NOAA co-sponsored the NASEM Space Weather Operations and Research Infrastructure Workshops, Phase 1 and 2. NOAA is co-sponsoring the next Decadal Survey for Solar and Space Physics and is looking forward to recommendations that will improve the SW Next program and follow-ons.

I. NASEM Phase I and II Workshops

Proceedings, reports on NASEM website

- The workshop goals were to review options for observational continuity and for enhancements of the existing operational and research infrastructure.
- The workshop presentations focused on programmatic, research and technological options for advancing space weather capability
- They also review instrument and other technologies, and mission support for in situ and remote sensing observations from ground or space vantage points
- https://tinyurl.com/2jvvvdpw

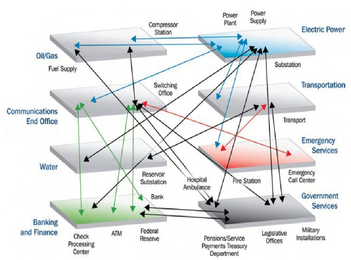
Data Continuity: Many of the present systems are long past life expectancy without replacements (End of life: 2025 time frame). For critical data continuity, NOAA initiated the Space Weather Follow-on Program.

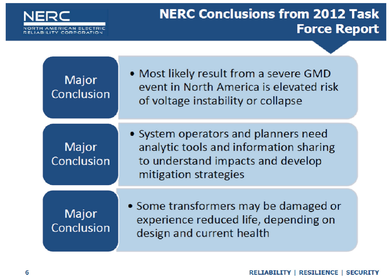
II. NOAA Space Weather Charter

- **Building capacity to advance space weather policy**
  - Inception and implementation of National Space Weather Strategy and Action Plan
  - Implementation of the 2020 Promoting Research and Observations of Space Weather to Improve the Forecasting of Tomorrow (PROSWIFT) Act
- **Accelerating growth in NOAA and its space weather services**
  - Identify and sustain fundamental observations to support operations
  - Provide timely, accurate, and relevant models and forecast products
  - Transition scientific and technological advances into operations (R2O2R)
  - Support growing private sector activities to fill data and technology gaps and provide value-added services and products
- **Integrating approach and collaboration between research and operations**

III. User Needs

- User needs were presented in more detail. Example: Updates from the NERC 2012 Task Report.





IV. Table 2-1 from NASEM Infrastructure Report

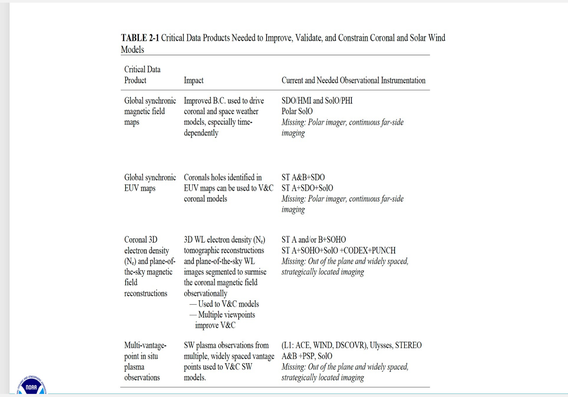


TABLE 2-1 Critical Data Products Needed to Improve, Validate, and Constrain Coronal and Solar Wind Models

Critical Data Product	Impact	Current and Needed Observational Instrumentation
Global synchronic magnetic field maps	Improved B.C. used to drive coronal and space weather models, especially time-dependently	SDO/HMI and SolO/PHI Polar SolO *Missing: Polar imager, continuous far-side imaging*
Global synchronic EUV maps	Coronals holes identified in EUV maps can be used to V&C coronal models	ST A&B+SDO ST A+SDO+SolO *Missing: Polar imager, continuous far-side imaging*
Coronal 3D electron density (N_e) and plane-of-the-sky magnetic field reconstructions	3D WL electron density (N_e) tomographic reconstructions and plane-of-the-sky WL images segmented to surmise the coronal magnetic field observationally — Used to V&C models — Multiple viewpoints improve V&C	ST A and/or B+SOHO ST A+SOHO+SolO +CODEX+PUNCH *Missing: Out of the plane and widely spaced, strategically located imaging*
Multi-vantage-point in situ plasma observations	SW plasma observations from multiple, widely spaced vantage points used to V&C SW models.	(L1: ACE, WIND, DSCOVR), Ulysses, STEREO A&B +PSP, SolO *Missing: Out of the plane and widely spaced, strategically located imaging*

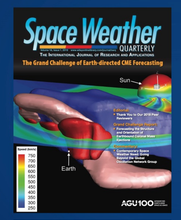
Improvement of Space Weather observations quoted from the proceedings of the NASEM Workshop on Planning the Future Space Weather Operations and Research Infrastructure conducted in 2020 and 2021

V. PROSWIFT, SWORM

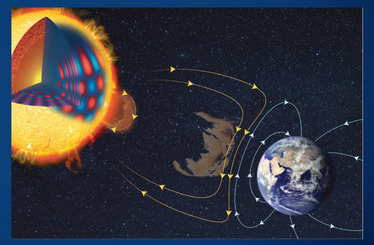
The 2020 Promoting Research and Observations of Space Weather to Improve the Forecasting of Tomorrow (PROSWIFT) Act legalizes the OSTP Subcommittee for Space Weather Operations Research and Mitigation (SWORM) goals and tasks, in particular Goal 2.2 Preservation of Critical Observations including the preservation of CME images, L1 imaging and in-situ data, solar and radio ground based observation networks, geomagnetic surface measurements, radio occultation, neutron monitoring and international coordination.

VI. IMF Bz Problem

ngGONG : A ground-based solar synoptic network that includes Space Weather needs from its inception



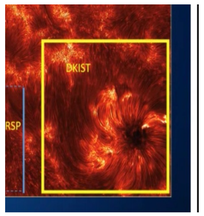
Kilupa et al., 2019



The B_z problem: Despite all this monitoring and modeling, we currently cannot predict the orientation of the magnetic field of the coronal mass ejections (CMEs) when they arrive Earth: the Bz problem

VII. IMF Prediction from DKIST: Holy Grail?

Drastic progress could be achieved in the prediction of the IMF arriving at Earth's magnetosphere with advanced CME transport models using better initial conditions including solar surface magnetic field evolution



VIII. Summary

- The Phase II Workshop on Space Weather Operations and research infrastructure (April 11-14, 2022) was funded by NOAA, NASA, and NSF and organized by the NASEM as a follow-up to the Phase I workshops in 2020.
- It focused on research more than on operations, and generated discussions on how to move forward in developing space instrumentation, ground systems, and models/data processing software.
- It identified initiatives by government, academia, and commercial vendors and emphasized the framework of the PROSWIFT Act. It highlighted the activities of agencies (NOAA, NASA, DOD, NSF, USGS, etc.), academia, and industry, and the activities of interagency and broader-scope groups.
- The workshops provided timely and useful context for the development of the SW Next Program. We can use their materials for general awareness of the space weather community and in the planning and preparation of the Program reviews.