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U.S. Space Weather Enterprise

(Submitted by Terrance Onsager)

Summary and Purpose of Document

The purpose of this document is to summarize the multi-agency effort in the United States that comprises the U.S. space weather enterprise. Space weather activities in the U.S. benefit from broad participation among numerous government agencies and include the involvement of academia and industry. Space weather efforts among U.S. government agencies are organized through the National Space Weather Program (NWSP). The NSWP publishes a Strategic Plan and an Implementation Plan that outline the roles of the various agencies and define goals to be achieved through interagency cooperation.

Upcoming satellite missions include the GOES-R series of the NOAA Geostationary Operational Environmental Satellites, the Deep Space Climate Observatory (DSCOVR) at the L1 Lagrange point in the solar wind, the Sunjammer satellite to test solar sail capabilities in the solar wind, and the follow-on GNSS Radio Occultation mission: Constellation Observing System for Meteorology, Ionosphere, and Climate (COSMIC-2).

ACTION PROPOSED

The Inter-Programme Coordination Team is invited to consider the activities of the U.S. national agencies in space weather as it promotes global space weather cooperation.

REFERENCE: 2010 US National Space Weather Program Strategic Plan.

DISCUSSION

1. INTRODUCTION

The U.S. space weather enterprise is a coordinated, multi-agency effort that covers the full spectrum of activities from basic research to operational services to emergency response. The agency activities are organized through the National Space Weather Program (NSWP), which is an initiative that began in 1994 with the goal of achieving “an active, synergistic, interagency system to provide timely, accurate, and reliable space weather warnings, observations, specifications, and forecasts” (www.nswp.gov). The NSWP acts to enhance resilience to space weather, which has been designated by the U.S. Subcommittee on Disaster Reduction (www.sdr.gov) as one of six Grand Challenges for Disaster Reduction.

The NSWP is comprised of the following U.S. government agencies: Department of Commerce (DOC), Department of Defense (DoD), Department of Energy (DOE), Department of Homeland Security – Federal Emergency Management Agency (DHS-FEMA), Department of the Interior (DOI), Department of State (DOS), Department of Transportation (DOT), National Aeronautics and Space Administration (NASA), and National Science Foundation (NSF). The NSWP promotes partnerships among academia, industry, and government, with involvement from the space weather user community, operational forecasters, emergency managers, researchers, modelers, instrumentation and data providers, and educators.

A primary goal of the NSWP is to improve predictive models of the space environment. Extensive research, modeling, and monitoring efforts have been directed at understanding the space environment and have produced a broad spectrum of data and numerical modeling resources. As progress is made in developing predictive capabilities, the NSWP also strives to transition these resources into operational use. This involves the critical evaluation of new capabilities and the testing and development of new products and services. The testing and transition of civilian data and modeling capabilities is accomplished primarily through the Community Coordinated Modeling Center (CCMC), which is a multi-agency activity hosted at the NASA Goddard Space Flight Center, and through the Space Weather Prediction Testbed (SWPT) within the NOAA Space Weather Prediction Center. The CCMC concept began in 1998 with the goal to enhance space weather research, develop space weather models, and provide a means for more effective transitioning of research models to operations. The SWPT was formed to transfer new research and technology, in many cases after evaluation in the CCMC, into operational space weather products and services.

As part of its space weather enterprise, the U.S. also publishes Space Weather, The International Journal of Research and Applications and holds two annual space weather meetings: Space Weather Workshop and Space Weather Enterprise Forum. Through these activities, a valuable dialogue is maintained between researchers, industry representatives, and service providers.

The vision for future space environment services is to utilize a suite of real-time, data-driven, operational models that provide quantitative predictions of conditions throughout near-Earth space. The regions of interest include the Sun, the solar wind, the terrestrial magnetosphere, the ionosphere, and the upper atmosphere. Future operational models, together with forecasters' expertise, will make possible an accurate and comprehensive set of products to better serve national and international needs. This progress will be achieved through coordinated, interagency cooperation by the NSWP agencies and through the cooperation with international partners.

2. NSWP AGENCY ROLES AND MISSIONS (text reproduced from the NSWP Strategic Plan, June, 2010)

Department of Commerce (DOC). “Within DOC, NOAA has the mission of describing and predicting the space environment. NOAA’s Space Weather Prediction Center (SWPC) has a dedicated operational forecast center that serves as the national and world warning center for disturbances that can affect people and equipment working in the space environment. NOAA maintains unique space weather expertise to assist in the design of new systems and to reduce effects on existing systems. The agency also collects, provides, and archives space environment data from its polar-orbiting and geostationary satellites, from other agencies, and through international data exchange. Research and development is directed toward understanding processes and interactions as energy leaves the Sun, propagates through the interplanetary medium, and arrives at the Earth’s atmosphere.”

Department of Defense (DoD). “The Air Force provides operational space weather support to warfighters, coalition partners, civilian partner agencies, and classified national-level users. This support includes remotely sensed data from ground- and space-based platforms /systems, operational space weather model output, and mission-tailored products. Examples of tailored support includes a variety of alerts and warnings for significant space weather phenomena that will impact DoD operations, the hourly analysis of the Earth’s geomagnetic field, and specification and forecasts of the ionosphere directly supporting high frequency (HF) radio and satellite communications. The Air Force Research Laboratory and the Naval Research Laboratory work with each other, a variety of other governmental agencies, and academia to develop operational space weather models, ground- and space-based sensors, and system impact applications.”

Department of the Interior (DOI). “The Department of the Interior’s U.S. Geological Survey’s Geomagnetism Program provides high-quality, ground-based magnetometer data continuously from 13 observatories distributed across the United States and its territories. The program collects, transports, and can disseminate these data in near real time, and it also has significant data processing and data management capacities. Working through the INTERMAGNET organization, and with other national geomagnetism programs, the USGS Geomagnetism Program assists in the coordinated, global-scale monitoring of the Earth’s magnetic field. The Geomagnetism Program also supports research on magnetic field activity, magnetic storms, and magnetic climatology, and it is currently developing a real-time storm-time disturbance (Dst) service.”

Department of Energy (DOE). “The core space weather program within DOE and its national laboratories supports research, applications, and operations in the satellite-based detection of nuclear explosions. The program develops and supplies the Air Force and other agencies with instruments that are fl own on the Global Positioning System and other geosynchronous platforms to measure local plasma and particle distributions and remote ionospheric electron content, all in near real time. Related efforts also provide the databases, assimilative models, and scientific support to the broader community, including research on possible impacts on electricity delivery and reliability.”

Department of Transportation (DOT). “The Federal Aviation Administration (FAA) has the responsibility to provide the operational requirements for space weather services in support of aviation and for coordination of these requirements with the International Civil Aviation Organization. The increasing number of polar flights by commercial airliners and the emerging commercial space transportation sector have elevated the importance of space weather products and integration of the data into the National Airspace System (NAS). As a result, the FAA is formulating space weather requirements for the NAS by 2013, and plans to integrate space weather data and products into the Next Generation Air Transportation System by 2016.”

Department of State (DOS). “The Office of Space and Advanced Technology (OES/SAT) ensures that U.S. space policies and multilateral science activities support U.S. foreign policy objectives and enhance U.S. space and technological competitiveness. OES/SAT has primary responsibility for U.S. representation to the United Nations (UN) Committee on the Peaceful Uses of Outer Space (UNCOPOUS), where a wide range of space policy issues are discussed. The office also leads interagency coordination on all civil space-related international agreements implementing important NASA, NOAA, and USGS cooperation with other space agency partners, and plays a key role in the implementation of National Space Policy focused on dual-use space applications such as space-based positioning, navigation, and timing, satellite-based remote sensing and Earth observation, and space weather monitoring.”

National Aeronautics and Space Administration (NASA). “The Heliophysics Division of NASA’s Science Mission Directorate is tasked to fulfill the science strategy laid out by the National Research Council’s Decadal Survey. It advances our understanding of events and conditions in space; develops and uses new technologies; develops and maintains data that determine the nature of space weather conditions and provide insight into physical understanding; and generally observes and interprets the variable heliophysics system. The NASA Space Operations Mission Directorate (SOMD) is responsible for all human space operations in Low-Earth Orbit and beyond. SOMD provides the agency with all oversight for safe and effective operation of human exploration, including launch services, space transportation, and space communications in support of both human and robotic exploration. The NASA Office of the Chief Engineer is responsible for developing agency standards for environmental impacts on spacecraft systems and subsystems and addresses space weather issues across NASA.”

National Science Foundation (NSF). “NSF is responsible for maintaining the health of basic research in all areas of the atmospheric sciences. The Foundation supports theoretical, observational, and numerical modeling research with the goals of increasing fundamental understanding of space environment processes and improving space weather predictive capability. Research areas of emphasis are: (1) solar region evolution and eruptive events; (2) interplanetary transport; (3) magnetospheric physics and dynamics; (4) ionospheric physics and dynamics; and (5) upper atmospheric physics and dynamics. Knowledge of the processes that are fundamental to each of these areas is enhanced by a multi-disciplinary approach to investigating the basic mechanisms through which these areas interact.”

3. Future Plans

A number of future missions are planned and numerical model development projects underway that will contribute importantly to space weather service capabilities. Upcoming satellite missions include the GOES-R series of the NOAA Geostationary Operational Environmental Satellites, the Deep Space Climate Observatory (DSCOVR) that will replace the Advance Composition Explorer at the L1 Lagrange point in the solar wind, the Sunjammer satellite to test solar sail capabilities in the solar wind, and the follow-on GNSS Radio Occultation mission: Constellation Observing System for Meteorology, Ionosphere, and Climate (COSMIC-2). Numerical prediction models under development for use in space weather operations include a magnetohydrodynamic model of the magnetosphere-ionosphere system (Geospace) and a data assimilation model of the coupled atmosphere-ionosphere system.

GOES-R:

- Launch planned for 2016
- Instruments include:
  Extreme Ultraviolet and X-ray Irradiance Sensors (EXIS)
  Solar Ultraviolet Imager (SUVI)
  Space Environment In-Situ Suite (SEISS) – Electrons, Protons, Heavy Ions
  Magnetometer

DSCOVR:

- Launch planned for late 2014 - early 2015
- Instruments include:
  Plasma sensor (Faraday cup)
  Magnetometer
  Electron spectrometer

Sunjammer:

- Launch planned for late 2014 - early 2015
- Instruments include:
  Plasma sensor (provided by University College London)
  Magnetometer (provided by Imperial College London)

COSMIC-2:

- Joint Taiwan-U.S. 12-satellite constellation
- First launch (6 low-inclination satellites) planned for 2016
- Instruments include:
  GNSS Radio Occultation Sensor