The U.S. National Space Weather Strategy and Action Plan


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Societal and economic impacts
Societal and economic impacts – Nov 2015

“Flights disappeared from radar screens in Swedish air traffic control towers during the blackout, which lasted about an hour”
Transformer damage

Failures of GPS based positioning

Numerous Polar flights rerouted

NOTAM
Flight route restrictions due to geomagnetic storm impact on communications

Numerous anomalies on FedSat and other Australian satellites

Solar cell damage on ESA’s Smart-1 satellite

SatComm and HF outages

Nuclear power plants reduced power due to geomagnetic storm

Widespread HF outage over African continent

Oilfield services company reported several cases of survey instrument interference around world

C.R. Luigs drill ship, loses GPS, resorts to backup systems

Transformer damage

SatComm and HF outages

Over 130 hours of HF communication blackout in Antarctic
Extreme Space Weather
Carrington Event – Sep 1-2, 1859

“estimate that there is a 10% chance of a Carrington-level event over the next decade”

Researchers fine-tune estimates of a strong punch that could put out our lights

Visible Aurora, 2 Sep 1859
Science challenges

Forecasting Sunspot emergence and evolution

Solar radiation storms (energetic particles)
- Onset
- Duration
- Peak flux
- Energy spectrum

Geomagnetic storm forecasting
- Predicting Interplanetary Magnetic Field Bz
- Regional predictions of ionospheric and geomagnetic disturbances
National Space Weather Strategy

Tasked by the President to coordinate the implementation of a comprehensive national strategy on space weather

Nov 2014 – Space Weather Operations, Research, and Mitigation (SWORM) Task Force is established

Co-Chaired by White House Office of Science and Technology Policy, National Weather Service, and Dept. of Homeland Security

- Over 20 agencies
- Private sector input
29 October 2015 – Release of the National Space Weather Strategy and Action Plan
National Space Weather Strategy – Structure
Strategy articulates six high-level goals

1. Establish Benchmarks for Space-Weather Events
2. Enhance Response and Recovery Capabilities
3. Improve Protection and Mitigation Efforts
4. Improve Assessment, Modeling, and Prediction of Impacts on Critical Infrastructure
5. Improve Space-Weather Services through Advancing Understanding and Forecasting
6. Increase International Cooperation
Executive Order 13744: Coordinating Efforts to Prepare the Nation for Space Weather Events

“To ensure accountability for and coordination of research, development, and implementation of activities identified in this order and in the Action Plan, the National Science and Technology Council shall establish a Space Weather Operations, Research, and Mitigation Subcommittee [SWORM]”

New space weather appointee at the White House Office of Science and Technology Policy (OSTP) – Steve Clark of NASA
Action 4.1 Assess the Vulnerability of Critical Infrastructure Systems to Space Weather

- Department of Homeland Security will assess the vulnerability of critical infrastructure to space-weather events (as described in the Goal 1 benchmarks).

- The assessment will include interdependencies and failure modes among sectors that can lead to cascading failures and will identify gaps where scientific or engineering research is required to understand or mitigate risks to critical infrastructure.
Action 5.3 Establish and Sustain a Baseline Observational Capability for Space-Weather Operations

- DSCOVR – operational July 2016
- GOES-16 – launched Nov 2016
- GONG network – sustaining ground-based solar imaging (including solar magnetic field) for operational forecasting
- Future L1: planned for 2022 and 2027
- COSMIC-2: planned 2018
Research-to-operations – Executive Order 13744 and Action Plan

“Federal and non-Federal partners must ensure that research is effectively transitioned to operational forecasting centers”
Goal 6. Increase International Cooperation
Countries must work together to foster global collaboration, to improve predictions and preparedness for space weather.

Key objectives of Goal 6:

• Build international support and policies for acknowledging space weather as a global challenge
• Increase engagement with the international community on observation infrastructure, data sharing, numerical modeling, and scientific research
• Strengthen international coordination and cooperation on space-weather products and services
• Promote a collaborative international approach to preparedness for extreme space-weather events
UNISPACE+50
20 to 21 June 2018

Seven Thematic Priorities

1. Global partnership in space exploration and innovation
2. Legal regime of outer space and global space governance: current and future perspectives
3. Enhanced information exchange on space objects and events
4. International framework for space weather services
5. Strengthened space cooperation for global health
6. International cooperation towards low-emission and resilient societies
7. Capacity-building for the twenty-first century
UNISPACE+50 thematic priority: International Framework for Space Weather Services

The objectives of the U.S. Strategy are consistent with this priority:

1. **Strengthen the reliability of space systems** and their ability to respond to the impact of adverse space weather; [6.4.4]

2. Develop a **space weather road map for international coordination** and information exchange on space weather events and their mitigation, through risk analysis and assessment of user needs; [6.2.2; 6.3.1]

3. **Recognize space weather as a global challenge** and the need to address the vulnerability of society as a whole; [6.1.1; 6.4.1; 6.4.7] and

4. Increase awareness through developed **communication, capacity-building and outreach.** [6.4.1]
New Legislation in Congress

S.141 - Space Weather Research and Forecasting Act
2 May 2017 – Passed in Senate unanimously
27 June 2017 – Introduced in House of Representatives

Press Releases
May 02, 2017

Senate Unanimously Approves Bill to Improve Space Weather Prediction
Peters-Gardner-Booker-Wicker-Klobuchar Bill Helps Address Economic Impact of Solar Flares on Technology
“In a world increasingly dependent on interconnected and interdependent infrastructure, any disruption to these critical technologies could have international consequences. Therefore, space weather should be regarded as a global challenge requiring a coordinated global response.”

Additional Slides
## SWPC Operational Model Suite

**Tracking solar storms from “Sun to Mud”**

### GMU/AFRL WSA/Enlil

**Inputs:**
1. GONG solar magnetic field data
2. SOHO/LASCO coronagraph CME images from L1

**Validation:**
1. DSCOVR solar wind character at L1
2. GOES magnetometer shock arrival

Operational since 2011

### U. Michigan Geospace

**Inputs:**
1. DSCOVR solar wind density, temp, speed, mag field at L1
2. Solar F10.7 radio flux measurements

**Validation:**
1. GOES vector magnetic field
2. USGS magnetometer network

Operational Sept 2016

### NOAA/CIRES WAM-IPE

**Inputs:**
1. GFS Tropospheric weather model inputs
2. GOES Solar Extreme Ultraviolet flux
3. COSMIC-2 RO electron density
4. Geomagnetic storm data from Geospace Model

**Validation:**
1. GPS receiver network TEC measurements

Operational FY17-19

### NOAA/USGS E-field

**Inputs:**
1. 1D earth conductivity model (3D coming soon)
2. USGS magnetometer network

**Validation:**
1. Geoelectric field measurements.

Operational FY18

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Note: all models developed with NASA and/or NSF funding at some level.
Societal and economic impacts - March 2012

Solar Flares Knock Out LightSquared Satellite
As Run of Bad Fortune Continues
by Karl Bode  Friday 16-Mar-2012 tags: satellite · business · wireless · alternatives · bandwidth · trouble · wireless
Tipped by viperadamr
Earlier this week we noted that recent solar flares managed to knock HughesNet’s Spaceway 3 satellite offline for a significant part of Tuesday. User viperadamr writes in to note that the flares also took out

Raging Solar Storm 'Blinds' Venus Spacecraft
by Nicole Chip 03/08/2012 Staff Writer
Date: 08 March 2012 Time: 12:01 PM ET

Strong radiation from one of the most intense solar storms in the last five years has temporarily "blinded" a European spacecraft in orbit around Venus, and mission controllers are now racing to fix the problem.

7 March 2012: INCERFA was issued for Air Canada 003 (Vancouver to Tokyo) until communications were established with the flight.

General: Recent solar storm interfered with Air Force satellite
By CHRIS CARROLL
Stars and Stripes
Published March 22, 2012

WASHINGTON — A major solar storm early this month appears to have caused one or more momentary satellite computer failures, but the Air Force's top space official said Thursday the Pentagon's fleet of orbiters is tough enough to withstand an increasingly energetic sun.