Three Agents of Space Weather

93 Million Miles from Sun to Earth

R-SCALE
Ultra Violet and X-ray Radiation
8 minutes

S-SCALE
Charged Particle Radiations
10-30 minutes

G-SCALE
Magnetized Blobs of Solar Material
18-96 hours

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Two Types of Space Weather Phenomena

“SPACE HURRICANES”
“SOLAR TSUNAMIS”
CORONAL MASS EJECTIONS

“SPACE TORNADOS”
SOLAR FLARES
Space Weather Impacts From Ultra Violet and X-Ray Radiation

- Radio Blackouts
- GPS Errors
- GPS Loss of Lock
- Satellite Drag (Low Earth Orbit)

“SPACE TORNADOS”

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Space Weather Impacts From Charged Particle Radiation

“SPACE TORNADOS”
“SPACE HURRICANES”
“SOLAR TSUNAMIS”

Satellite Damage
Radiation Exposure

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Space Weather Impacts From Magnetized Blobs of Solar Material

- Transformer Damage
- Grid Collapse
- Pipeline Corrosion

"SPACE HURRICANES"
"SOLAR TSUNAMIS"

Safeguarding Our Nation’s Advanced Technologies
Space Weather Prediction Center

**Our Mission:** To provide space weather products and services that meet the evolving needs of the Nation.

**Our Vision:** A Nation prepared to mitigate the effects of space weather through the understanding and use of alerts, forecasts, and data products.

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NOAA Space Weather Scales

Radio Blackouts: R1-R5
Electromagnetic Radiation

http://www.spaceweather.gov

Radiation Storms: S1-S5
High Energy Particles

Magnetized Plasma

Geomagnetic Storms: G1-G5

Category 5 Storms and Blackouts are High Impact/ Low Frequency Events
Space Weather and Emergency Managers

• FEMA Administrator Fugate visits SWPC

• FEMA Region VIII designated as Space Weather Center of Excellence for FEMA

• Workshop on managing space weather disasters in Transatlantic domain with EU/EC and Sweden held in Boulder (Feb 2010)

• SWPC brief FEMA Leadership at FEMA HQ and FEMA Regions

• Space weather warnings now distributed to FEMA National Response Coordination Center NRCC and FEMA Operations Center

Safeguarding Our Nation’s Advanced Technologies
Meeting Our Nation’s Needs

Working with White House, Congress, and government leadership.

Coordinating on ways forward to develop and implement mitigation strategies to safeguard critical infrastructure from the impacts of severe space weather.

• Secure High-voltage Infrastructure for Electricity from Lethal Damage Act (SHIELD Act) (11 Feb, 2011)

• Meeting at White House with National Security Staff and OSTP (18 Feb, 2011)

• Op Ed on space weather by Holdren and Beddington (10 Mar, 2011)

• Electric Infrastructure Security Summit (EISS) in Capitol building (11 Apr, 2011)

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Space Weather Activity Cycle

ISES Solar Cycle Sunspot Number Progression
Observed data through Sep 2011

Four largest Geomagnetic Storms

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Sample Recent Registrants

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<th>FEMA</th>
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<td>Washington St. Dept of Transportation</td>
<td>John Deere &amp; Caterpillar, Inc.</td>
<td>Major Airlines – UAL, AA, CO, Delta</td>
<td>United Launch Alliance</td>
<td>White House Office of Communications</td>
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*Safeguarding Our Nation’s Advanced Technologies*
ACE: Our Planet’s Space Weather
Early Warning System

GOES 12/13/14/15 IN GEOSTATIONARY ORBIT

20 to 50 minutes of lead time

18 to 96 hours to Sun

EARTH

EARTH'S MAGNETOSPHERE

MOON
USGS Ground-Based Magnetometers:
Situational Awareness

Safeguarding Our Nation’s Advanced Technologies
SWPC’s Goal:
Provide the *right* information... in the *right* format...
at the *right* time... to the *right* people...
to make the *right* decisions