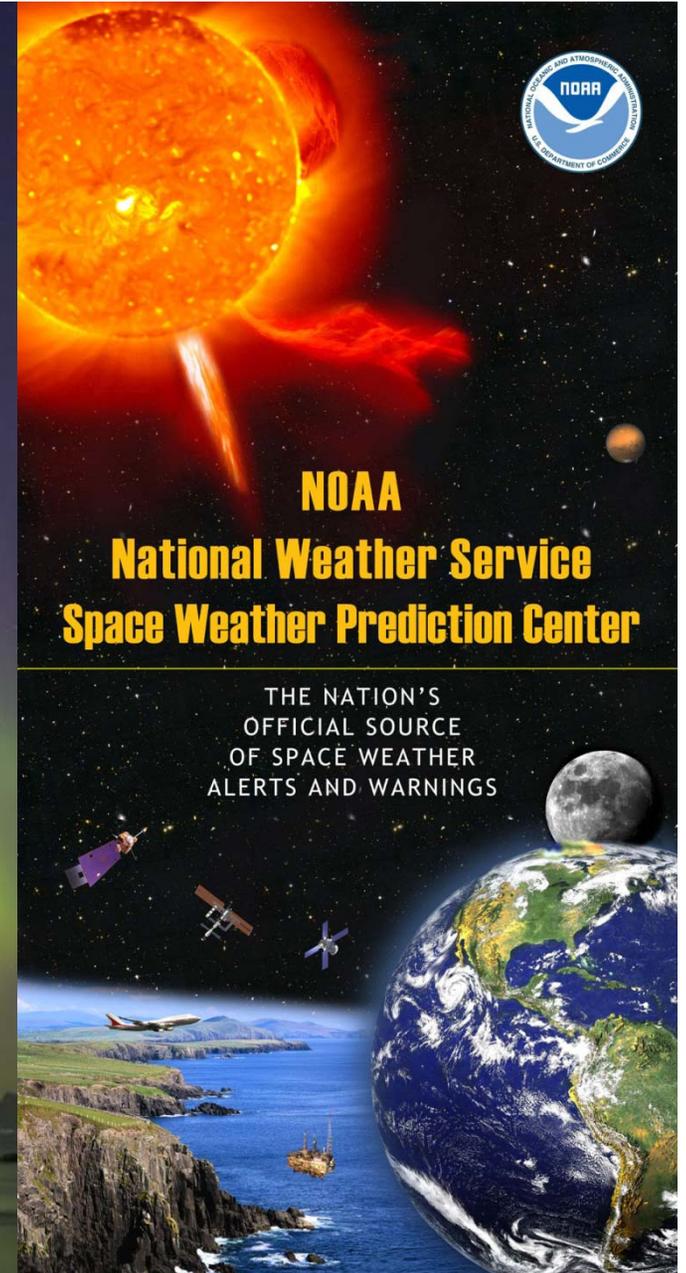


Space Weather

Dr Thomas J Bogdan

*Director, Space Weather Prediction Center
Boulder, CO*



Briefing to NSTC Subcommittee on Disaster Reduction

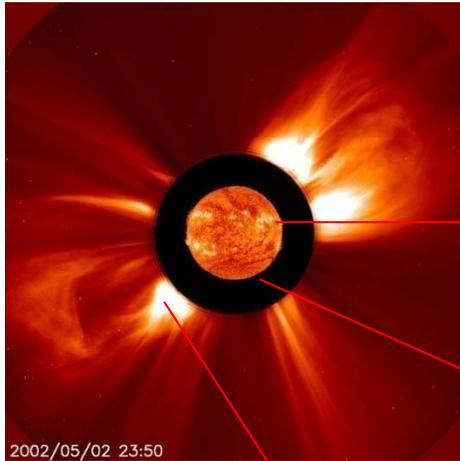
03 November 2011



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

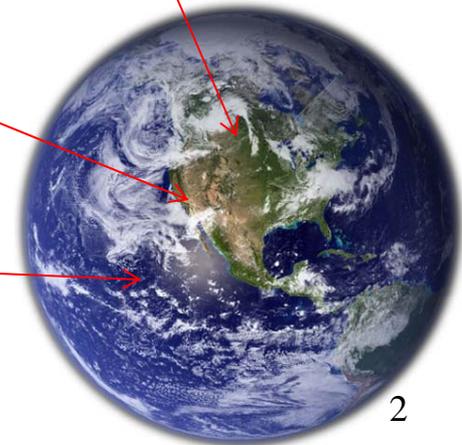
10-30 minutes

**NOAA
Space
Weather
Scales**

Magnetized Blobs of Solar Material

G-Scale

18-96 hours



Safeguarding Our Nation's Advanced Technologies



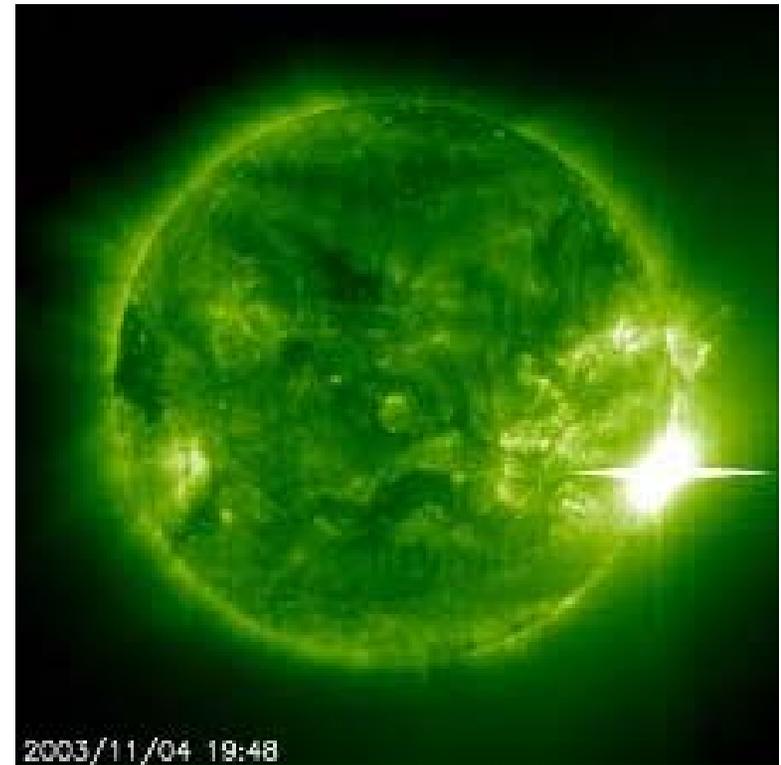
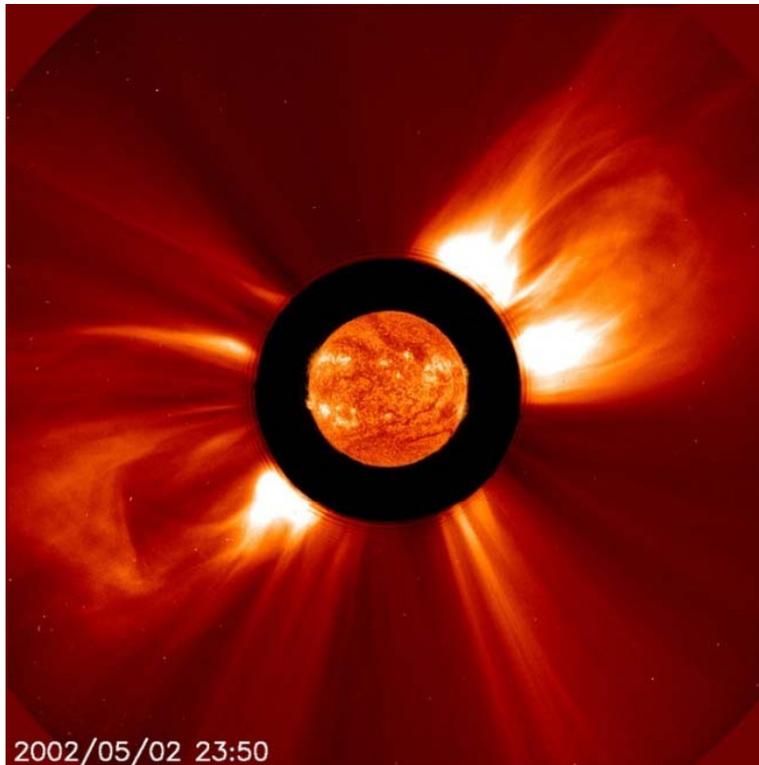
Two Types of Space Weather Phenomena



“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”

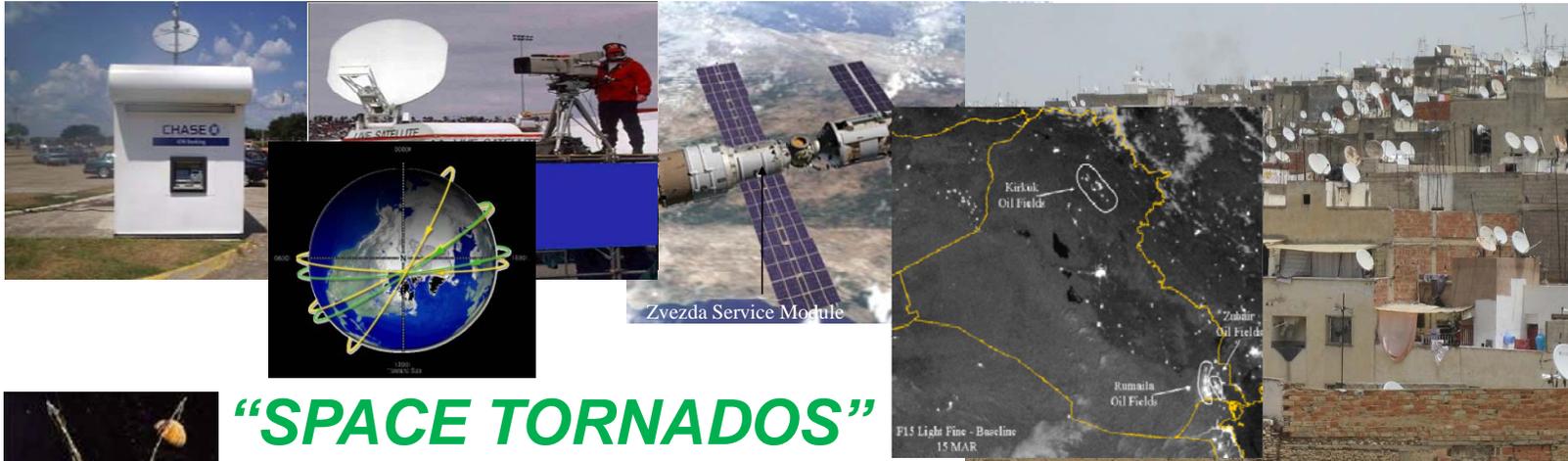
R-Scale



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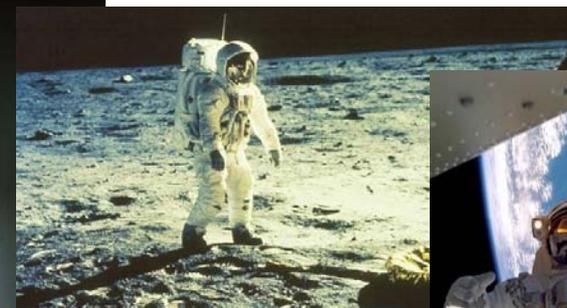
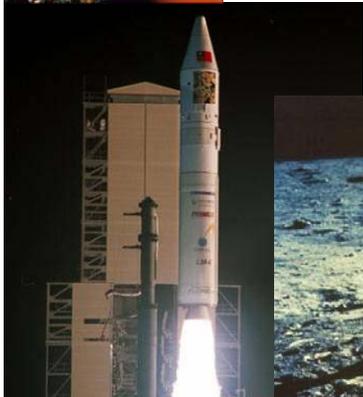
Space Weather Impacts From Charged Particle Radiation



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

Satellite Damage
Radiation Exposure

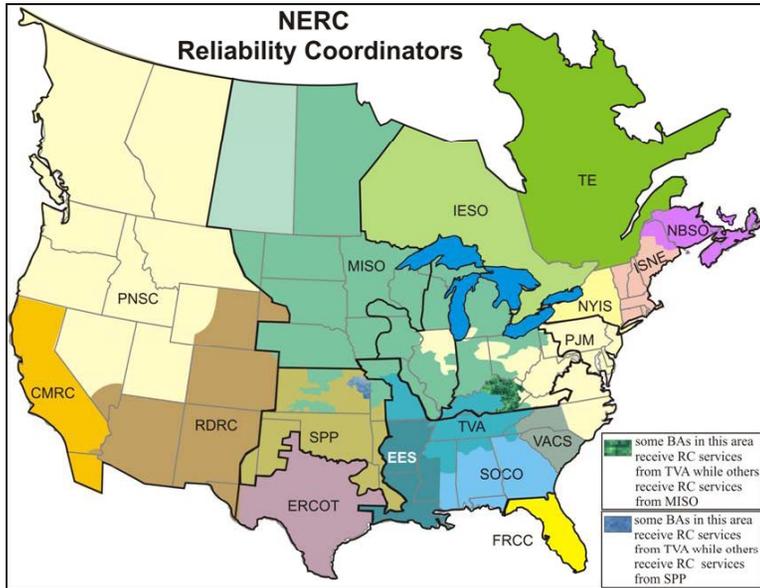
S-Scale



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Space Weather Impacts From Magnetized Blobs of Solar Material



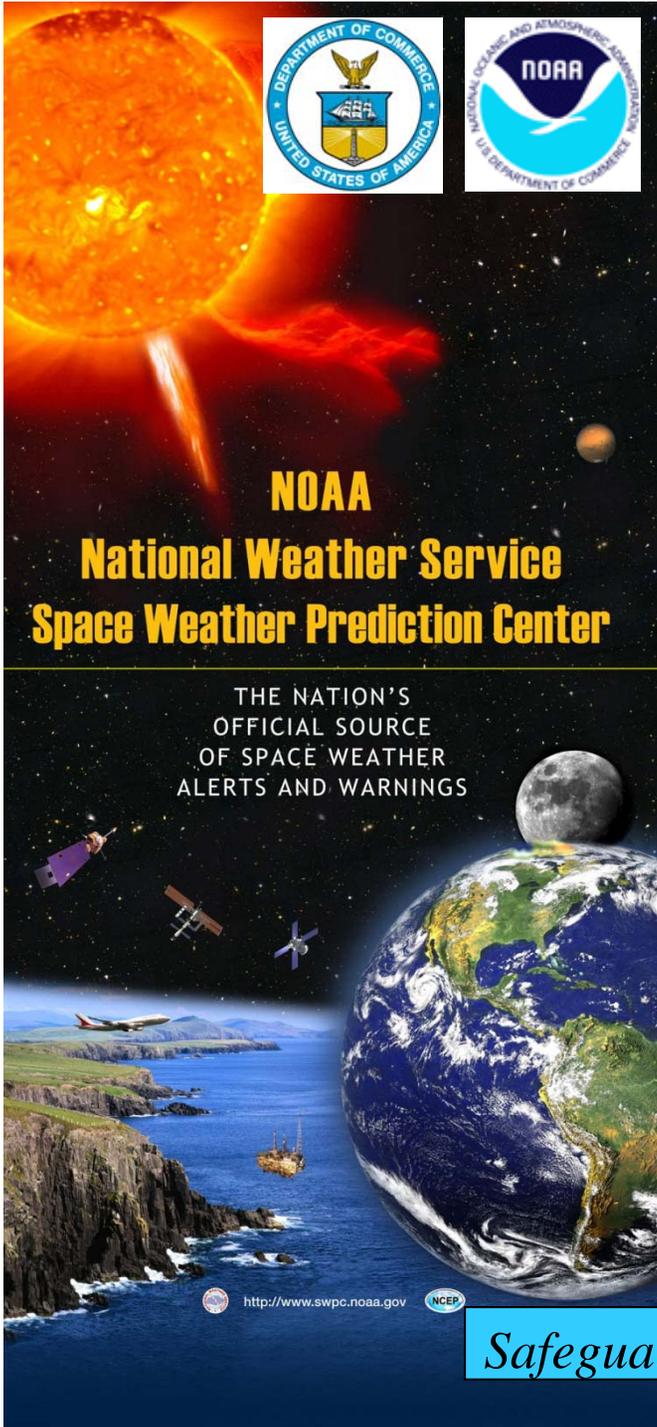
Transformer Damage
Grid Collapse
Pipeline Corrosion

G-Scale

“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



National Weather Service
Space Weather Prediction Center

Site Map News

Top News of the Day: On 01 June 2010 Thule Neutron Monitor Data was discontinued in Space Weather Prediction Center products.

Current Space Weather Conditions

Satellite Displays Popular Pages

<http://www.spaceweather.gov>

Radio Blackouts: none none

Satellite Environment Plot GOES Solar X-ray Flux

Support Services: About Us, Staff, Email Products, Space Wx Workshop, Education/Outreach, Customer Services, News & Media Info.

Contact Us: Contact Us, Webmaster

Radio Blackouts: R1-R5

Electromagnetic Radiation

<http://www.spaceweather.gov>

Radiation Storms: S1-S5

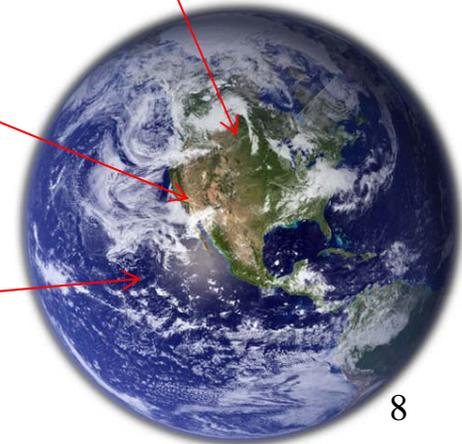
High Energy Particles

Category 5 Storms and Blackouts are High Impact/ Low Frequency Events



Magnetized Plasma

Geomagnetic Storms: G1-G5

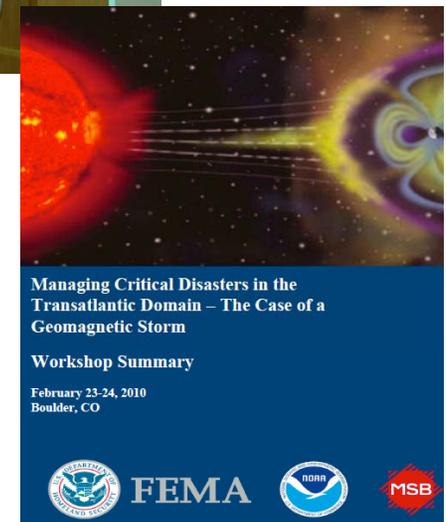




Space Weather and Emergency Managers



- 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)

The New York Times
The Opinion Pages

WORLD U.S. N.Y./REGION BUSINESS TECHNOLOGY SCIENCE HEALTH

I.H.T. OP-ED CONTRIBUTOR
Celestial Storm Warnings
By JOHN P. HOLDREN and JOHN BEDDINGTON
Published: March 10, 2011

Weather is often in the headlines. But largely unnoticed last month was the weather that forced airlines flying the polar route between the United States and Asia to detour south over Alaska. This unusual routing was a response to a "space weather" event — an enormous ejection of charged gas from the Sun capable of scrambling terrestrial electronic instruments.

John P. Holdren is the science and technology adviser to President Barack Obama. John Beddington is the chief scientific adviser to Prime Minister David Cameron.

The New York Times
Opinion

WORLD U.S. N.Y./REGION BUSINESS TECHNOLOGY SCIENCE HEALTH

EDITORIALS COLUMNISTS CONTRIBUTORS LE

OP-ED CONTRIBUTOR
The Sun Also Surprises
By LAWRENCE E. JOSEPH
Published: August 15, 2010

Los Angeles



DESPITE warnings that New Orleans was unprepared for a severe hit by a hurricane, America was blindsided by Hurricane Katrina, a once-in-a-lifetime storm that mad years ago this month. We similarly unready for an potential natural disaster storms, bursts of gas on surface that release tremendous energy pulses.



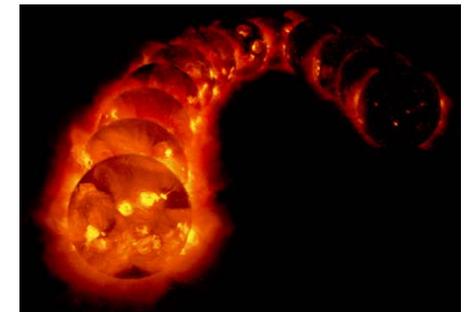
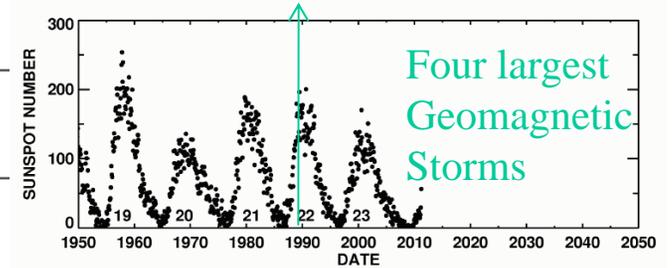
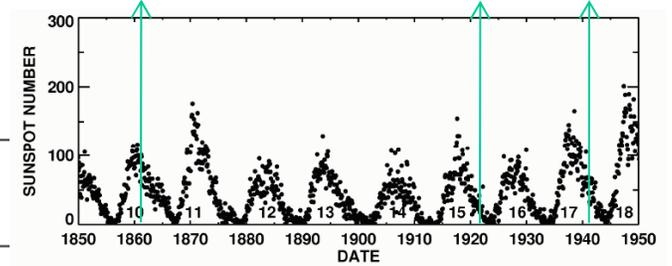
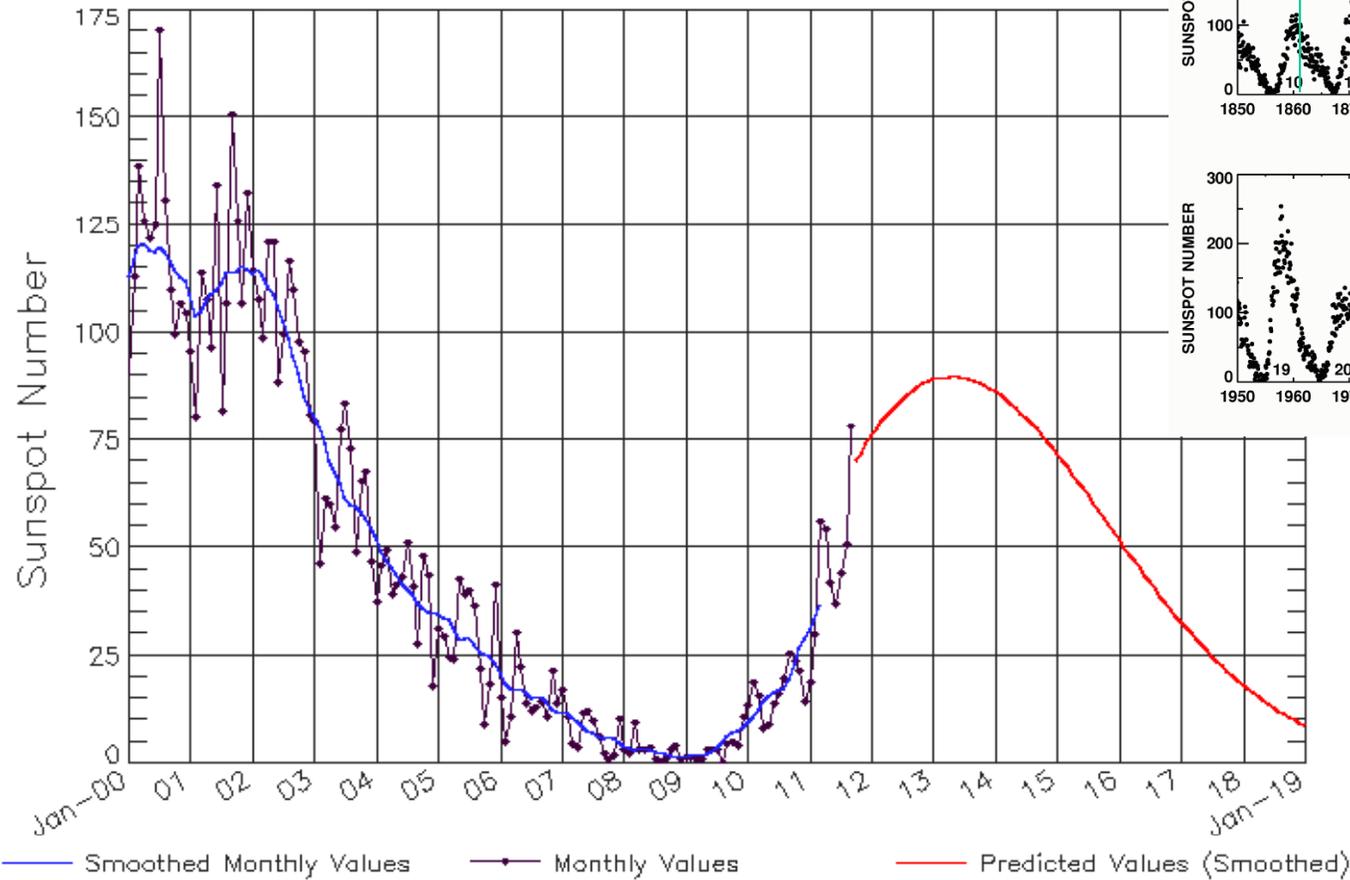
Safeguarding Our Nation's Advanced Technologies

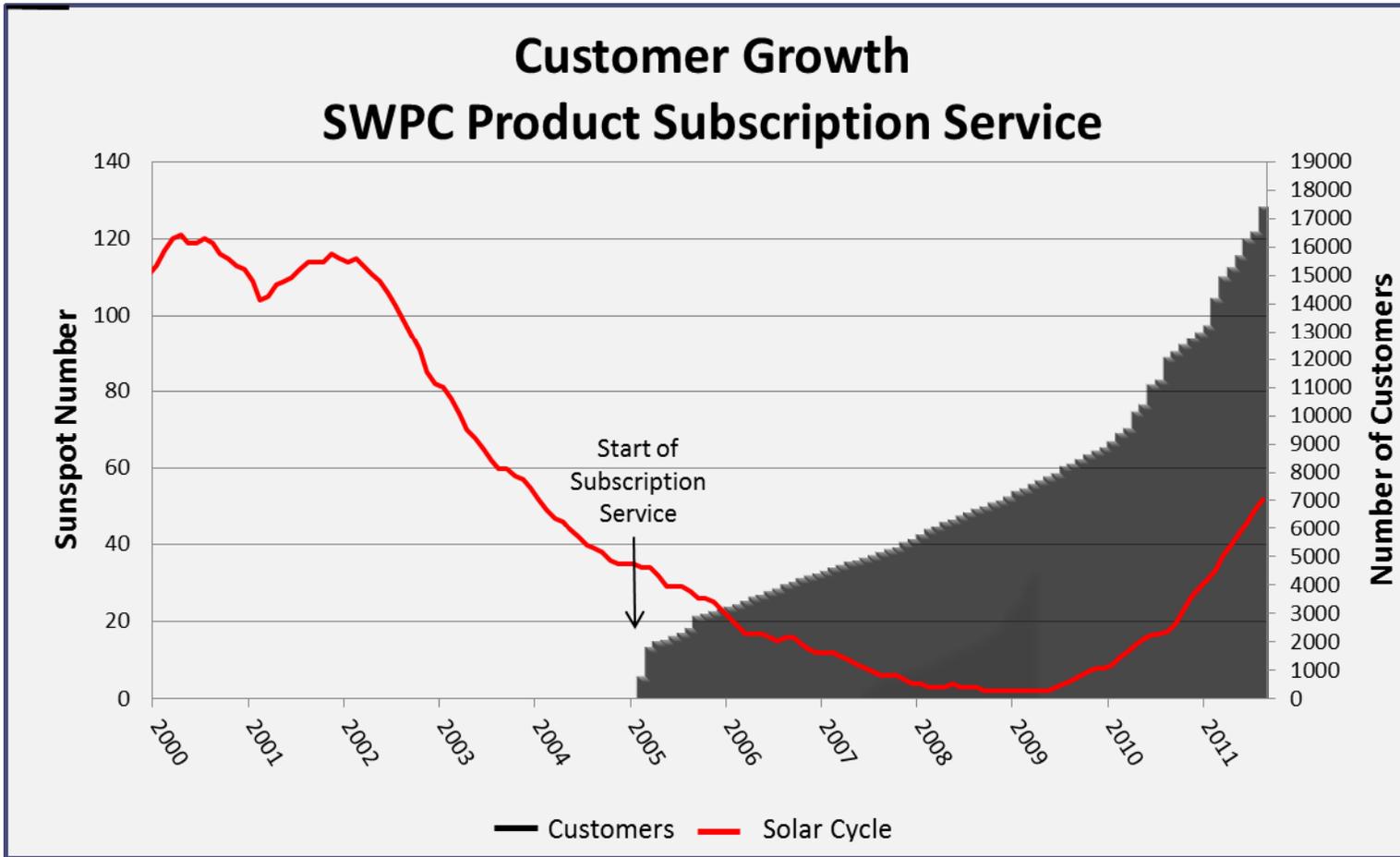


Space Weather Activity Cycle



ISES Solar Cycle Sunspot Number Progression
Observed data through Sep 2011





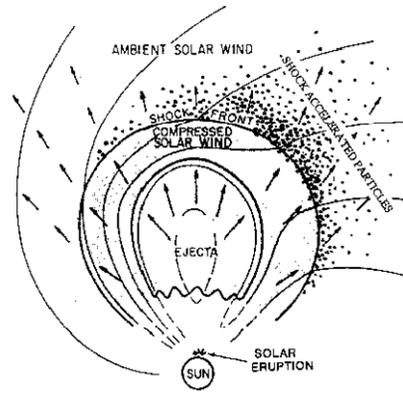
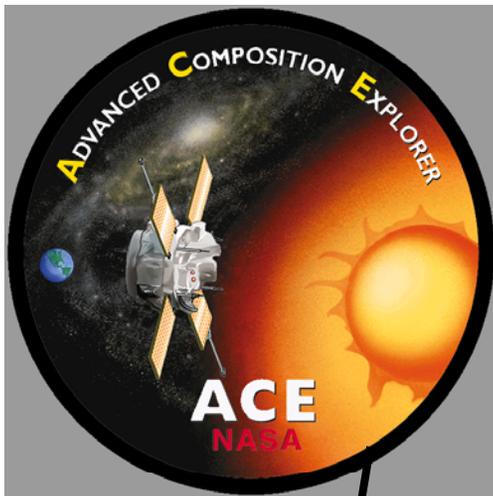
SES Satellite	Inmarsat	FEMA	Boeing	FAA
Alaska DOT	Chrysler	Motorola	British Petroleum America	Multiple Electric Utility Companies
Washington St. Dept of Transportation	John Deere & Caterpillar, Inc.	Major Airlines – UAL, AA, CO, Delta	United Launch Alliance	White House Office of Communications

Sample Recent Registrants

Safeguarding Our Nation's Advanced Technologies



ACE: Our Planet's Space Weather Early Warning System



GOES 12/13/14/15 IN GEOSTATIONARY ORBIT



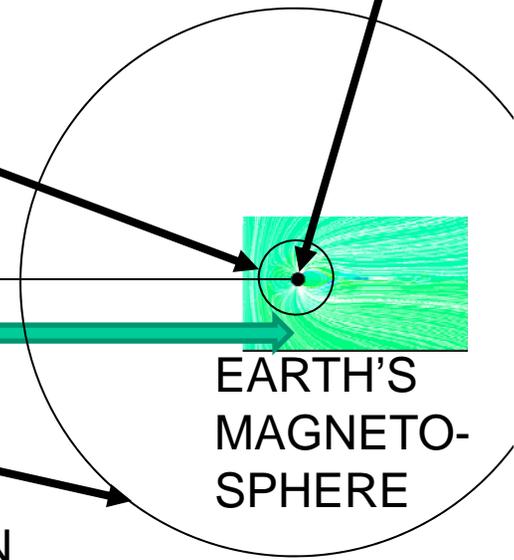
EARTH

← 20 to 50 minutes of lead time →

18 to 96 hours to Sun



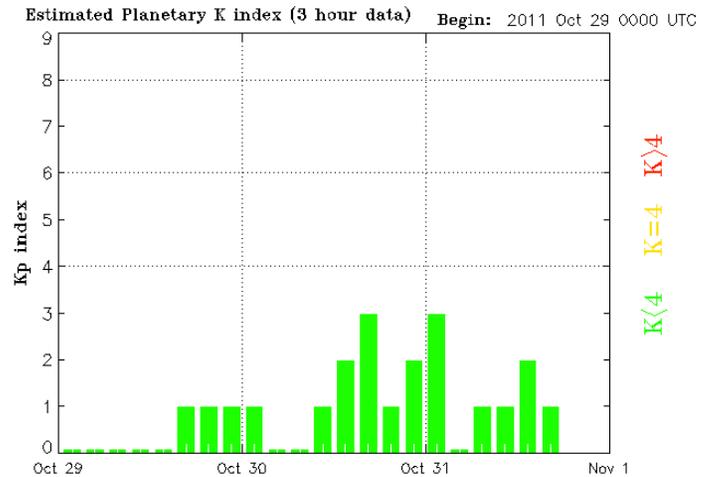
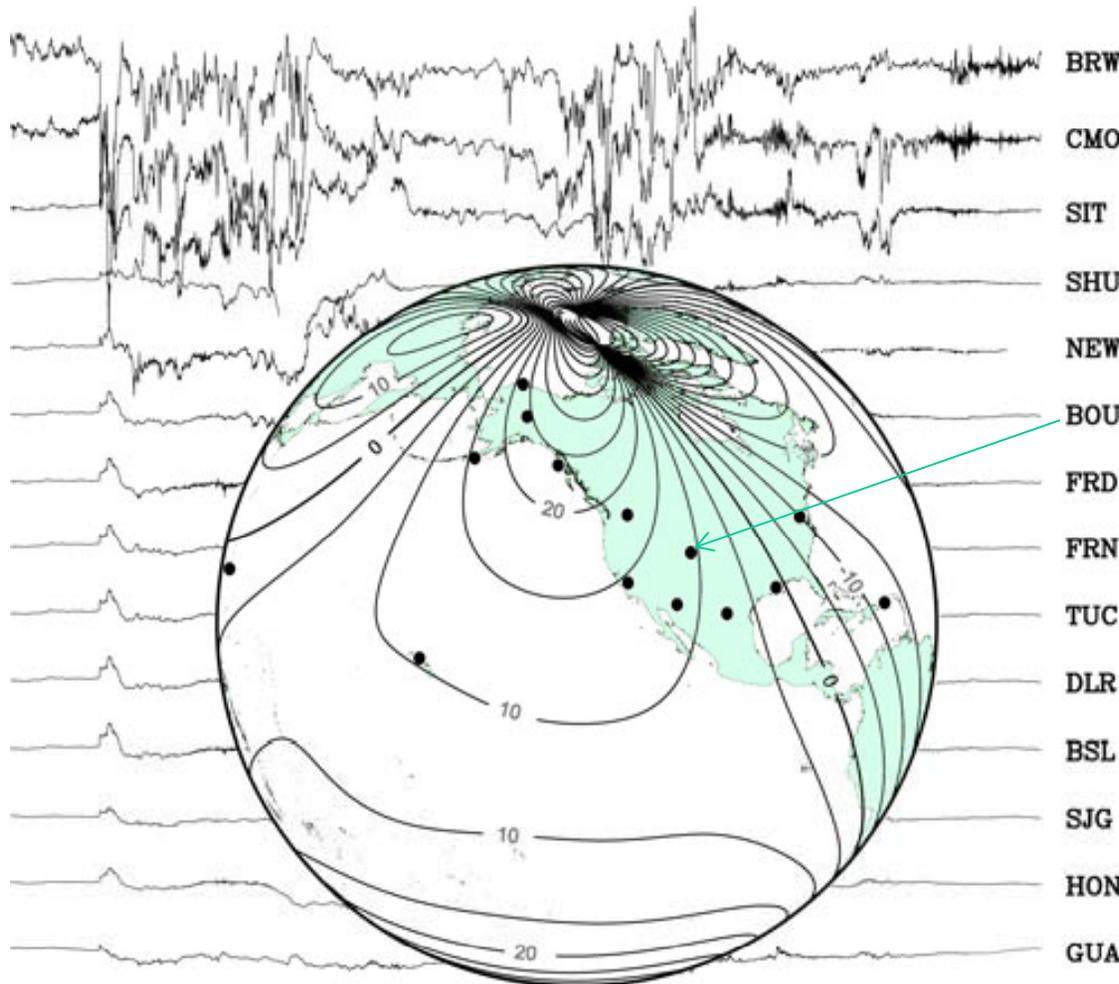
MOON



EARTH'S MAGNETOSPHERE



USGS Ground-Based Magnetometers: Situational Awareness

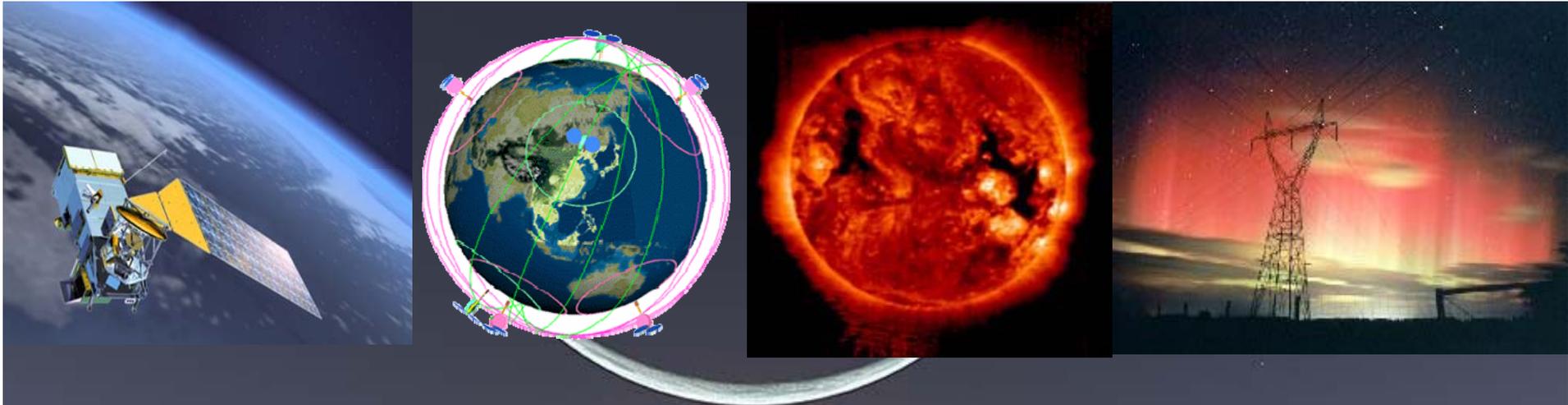


Updated 2011 Oct 31 19:10:02 UTC

NOAA/SWPC Boulder, CO USA



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

