Growing the Space Weather Enterprise

Global Opportunities

Roundtable Session

Space Weather National Workshop
Boulder, CO
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Agenda

• “Celestial Storm Warnings”
  – High Level Support Increasing
• Implications for the Future
• Global Collaboration
• Societal Impacts and Solutions
“Celestial Storm Warnings”

By JOHN P. HOLDREN and JOHN BEDDINGTON
International Herald Tribune; New York Times Web Site: March 10, 2011

• Emphasis on Effects versus Science
• US and UK data sharing and cooperation agreement
  – Wide ranging cooperation
  – Data sharing
• AAAS Meeting
  – Scientists, planners, and emergency managers
  – Risks to international human and economic well being
• Vulnerability and Risks
• Societal Solutions
  – Back up systems (e.g. GPS)
  – Satellite Shielding
  – Hardening Power Grids
  – Replace Aging Satellite Observation/warning systems

Blueprint for the future?
Implications for the Future

What should be on our agenda?

• Global Cooperation and Organization
• Government and Private Sector Collaboration
• Space Weather Science connected to Solution Providers
• Risk Management and Societal Solutions
• Government Emergency Management Connection
• Private Sector Industry Developed Equipment and Services

Some are here now and more will be possible in the future!
Global Collaboration


- 18 of 34 NASA Earth and Space Science Missions impacted
- Flare damages Mars Odyssey probe
- Powerdown of Canadian robotic arm on ISS
- Solar cell damage on ESA’s Smart-1 satellite
- Numerous anomalies on FedSat and other Australian satellites
- Loss of Japan’s ADEOS II satellite

- NOTAM
  Route restrictions due to geomagnetic storm impact on communications
- Nuclear power plants reduced power due to geomagnetic storm
- Widespread HF outage over African continent
- SatComm and HF outages

- 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

Over 130 hours of HF communication blackout in Antarctic

Courtesy of W. Murtagh
Global Collaboration

Group on Earth Observations (GEO)

• Background
  – Multidisciplinary, comprehensive, integrated, coverage, availability of information

• Current
  – Global Earth Observation System of Systems (GEOSS)
  – Nine Benefit Areas (Disasters, Climate, Weather, Energy, Agriculture, Biodiversity, Health, Water, and Ecosystems)
  – USGEO – U.S. Interagency effort led by White House
  – U.S. hosted 2009 GEO plenary, China hosted 2010 Ministerial

• Successes
  – GEO NETCAST
  – Tsunami Warning System
  – Increased global cooperation
Global Collaboration

Group on Earth Observations (GEO)

• Organization (non-UN)
  – 86 Nations and 61 international(UN)/intergovernmental organizations
  – Ministerial level – Earth Observing Summits every 3 or 4 years
  – Headquartered in Geneva
  – Membership open to all countries

• Purpose
  – Achieve comprehensive, coordinated, and sustained Earth observations
  – Capacity building for developing countries
  – Full and open exchange of information

• Support -- voluntary contributions (developed nations)

• Ten Year Plan -- GEOSS
  – Systems and projects (ex. Global Climate Observing System GCOS, Carbon monitoring of forests)
  – Supports Nine Benefit Areas (Disasters, Climate, Weather, Energy, Agriculture, Biodiversity, Health, Water, and Ecosystems)
Global Collaboration

Group on Earth Observations (GEO)

Observing Systems

Global Earth Observation System of Systems

INTEGRATED

Space-based System
Air-based System
Cryosphere-based System
Land-based System
Ocean-based System

Data Management System

Health
Disasters
Forecasts
Energy
Water
Climate
Agriculture
Ecology
Oceans
Global Collaboration

Surface Observations

Global Observing System Components

Space Observations

Marine Observations

Courtesy of Murtagh and Onsager
Global Collaboration

Space Environment Data Network Expansion

International Space Weather Initiative

International GNSS Service

Ultra-Large Terrestrial International Magnetometer Array

N. Jakowski, German Aerospace Center

Circum-Polar Riometer Network

Yumoto et al.

D. Boteler

Courtesy of Murtagh and Onsager
Global Collaboration

Real-Time Specification of Geomagnetic Activity

Near-term NOAA plans:
- Regional K index and/or dB/dt at North America sites
- dB/dt versus K climatology
- Real-time Planetary Kp
- 25 April Users Meeting to explore product needs

Long-term goals:
- Global GIC product suite
- Assimilate global data in prediction models

International Real-Time Magnetic Observatory Network (INTERMAGNET)

Courtesy of Murtagh and Onsager
Global Collaboration

The Recent Chain of Progress!

- Space Weather Brief to White House
- Op-Ed by Holdren and Beddington
- Electric Infrastructure Security Summit (EISS) at Westminster
  - Severe solar flares will cause long term infrastructure failure
  - US and UK data sharing and cooperation agreement
  - Next EISS Summit at Capitol Building in D.C. (Apr 2011)

- Space Weather in the UN
  - World Meteorological Organization (WMO)
  - International Civil Aviation Organization (ICAO)
  - Committee on the Peaceful Uses of Outer Space (COPUOS)

- Next: active GEO participation
  - Disasters
  - Energy
Societal Impacts and Solutions

What people really care about!

- Long Term Infrastructure Failure
  - Blocking devices to harden grids
  - Replacement hardware at the ready
  - Reduced electrical loads during emergencies

- Loss of Critical Communications
  - Increase shielding for satellites and terminals
  - Back up systems - redundancy
  - Advanced Warning

- GPS Black Outs
  - Back-up systems

- Personal Exposure to Harmful Radiation
  - Airline route deviations
  - Increased shielding

The best road to increased support!
Summary

Building the bigger tent takes all parts working together

A Systems Engineering Approach
Summary

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Building the bigger tent takes all parts working together!

A Systems Engineering Approach

Space Weather Research

Inputs
- $ (Funding)
- People
- Facilities
- Education

Outputs
- Understanding Models

Space Weather Operations

Inputs
- 24 x 7 ops
- Operational models
- Warning parameters

Outputs
- Warning Times
- Warning Thresholds

Emergency Management

Inputs
- Appropriate Response

Outputs
- Protection

Solution Providers

Outputs
- Recognition
- Favorable Business Climate

Satisfied Educated Public

Government Policy & Funding

Outputs
- Appropriate Response

A Systems Engineering Approach
Growing the Space Weather Enterprise

BACKUP
The Solar Cycle

In 2010 the F10.7 cm flux is significantly increasing!
The Solar Cycle

In 2010 the number of Sunspots are finally increasing!
Growing international interests in space weather:

- United Nations
  - World Meteorological Organization
  - International Civil Aviation Organization
- Cross Polar Working Group
- International Space Environment Service
- Space Situational Awareness in the EU
- International Space Weather Initiative
Space Weather in the United Nations

World Meteorological Organization (WMO)

• Several WMO Members including Australia, China, the Russian Federation and the United States have placed Space Weather under the responsibility of their National Meteorology Services

• Members lobbied WMO to engage space weather

• WMO – “UN system's authoritative voice on the state and behavior of the Earth's atmosphere”… *extends now to the space environment*

• Executive Council fully endorsed the principle of WMO activities in support of international coordination in Space Weather.”
Space Weather in Emergency Management

Emergency responders becoming increasingly aware of potential impacts of space weather on electric power grid, and on systems critical in emergency response (communications, GPS).

**Prepare** – SWPC staff providing education and training at FEMA Regional Interagency Steering Committees, DHS conferences & more. Emergency preparedness exercises – regional and even international

**Protect** – DHS, DOE and others looking at ways to protect power grid from impacts of geomagnetic storms

**Respond and Recover** – Emergency responders receive space weather products for key situational awareness and for decision making on use of communications systems.

FEMA Region VIII designated as FEMA’s “Center of space weather excellence”
How Do We Grow?

• Community Size
  – Partnerships
  – Industry Associations (AWCIA vs. Separate)
    • Common Policies and Goals
  – Career Life Cycle (education to occupation)

• Public Education/Visibility
  – Community Coherence (work together!)
  – Public Exposure
    • Press and Speaking Events
    • Community Involvement

• Revenue
  – Business Processes for growth
    • Products
    • Customers
The Future

The Ideal Public/Private Partnership

• Common Goals
  – Defined Roles

• Defined Products and Services
  – Public
  – Private

• Mutual Support
  – Commercial associations that advocate Budget Growth
    • PACs, Public Education
  – Government programs that incorporate private contributions
    • Judicious Use of FACA’s, Advisory Committees

• Inclusion of R & D and Operations

• Variety of Partnerships Mechanisms
  – Public/Private

• Collaborative Policy Development Mechanisms

• Frequent Communication
  – Planning to execution

• Mutual Trust