US SSA Activities Related to Space Weather and Potential Opportunities for US/European Collaboration

17 Nov 2008

Mr Kelly Hand
AFSPC/A5C

This briefing is for information only. No U.S. government to sell, loan, lease, co-develop or co-produce defense articles or services is implied or intended

Purpose

- **Communicate the importance of a robust space environmental sensing, data sharing and information processing infrastructure to support US Space Situational Awareness (SSA) needs and reveal areas of potential US/European collaboration.**

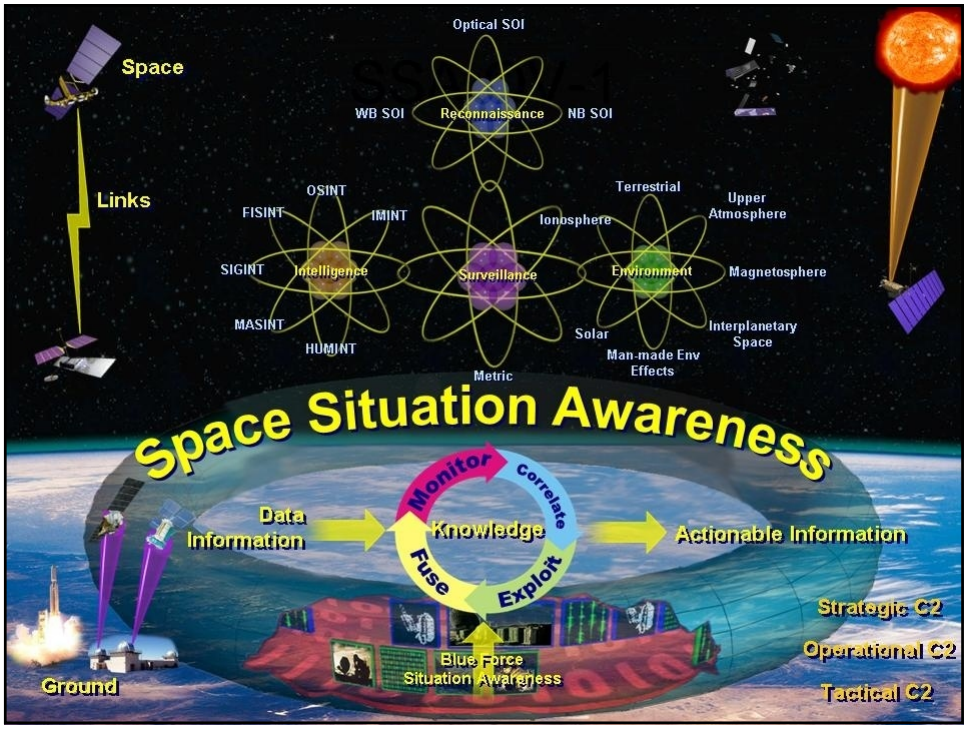
Overview

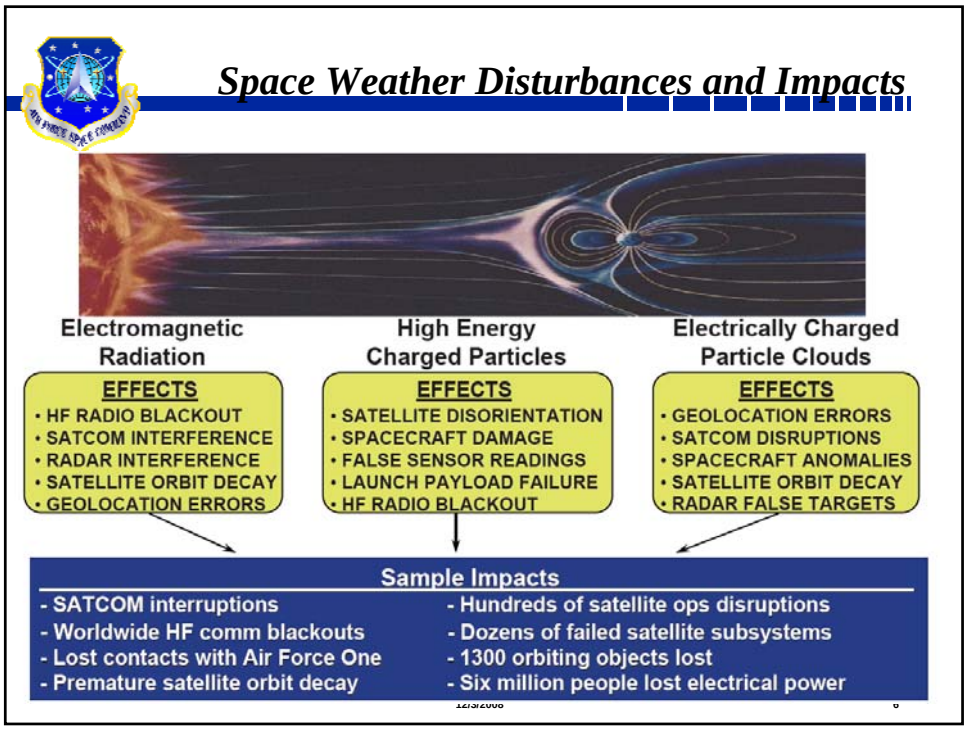
- SSA & the Environment
- Space Weather and Systems/Services Impacts
- Environmental SSA Components
- Need for Partnerships

SSA Definition

"SSA is the result of sufficient knowledge about space-related conditions, constraints, capabilities, and activities—both current and planned—in, from, toward, or through space. Achieving SSA supports all levels of planners, decision makers, and operators across the spectrum of terrestrial and space operations."

Air Force Doctrine Document 2-2.1

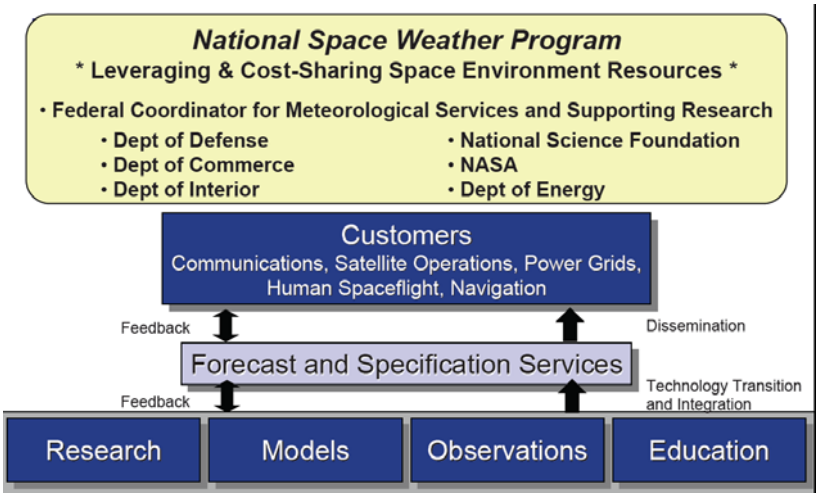

Space
Links
Optical SOI
WB SOI
Reconnaissance
NB SOI
OSINT
FISINT
IMINT
SIGINT
Intelligence
MASINT
HUMINT
Surveillance
Metric
Terrestrial
Upper Atmosphere
Ionosphere
Environment
Magnetosphere
Solar
Interplanetary Space
Man-made Env Effects
Space Situation Awareness
Monitor
Correlate
Fuse
Exploit
Data Information
Knowledge
Actionable Information
Strategic C2
Operational C2
Tactical C2
Blue Force Situation Awareness
Ground


Space Weather Disturbances and Impacts
Electromagnetic Radiation
EFFECTS
• HF RADIO BLACKOUT
• SATCOM INTERFERENCE
• RADAR INTERFERENCE
• SATELLITE ORBIT DECAY
• GEOLOCATION ERRORS
High Energy Charged Particles
EFFECTS
• SATELLITE DISORIENTATION
• SPACECRAFT DAMAGE
• FALSE SENSOR READINGS
• LAUNCH PAYLOAD FAILURE
• HF RADIO BLACKOUT
Electrically Charged Particle Clouds
EFFECTS
• GEOLOCATION ERRORS
• SATCOM DISRUPTIONS
• SPACECRAFT ANOMALIES
• SATELLITE ORBIT DECAY
• RADAR FALSE TARGETS
Sample Impacts
- SATCOM interruptions
- Worldwide HF comm blackouts
- Lost contacts with Air Force One
- Premature satellite orbit decay
- Hundreds of satellite ops disruptions
- Dozens of failed satellite subsystems
- 1300 orbiting objects lost
- Six million people lost electrical power

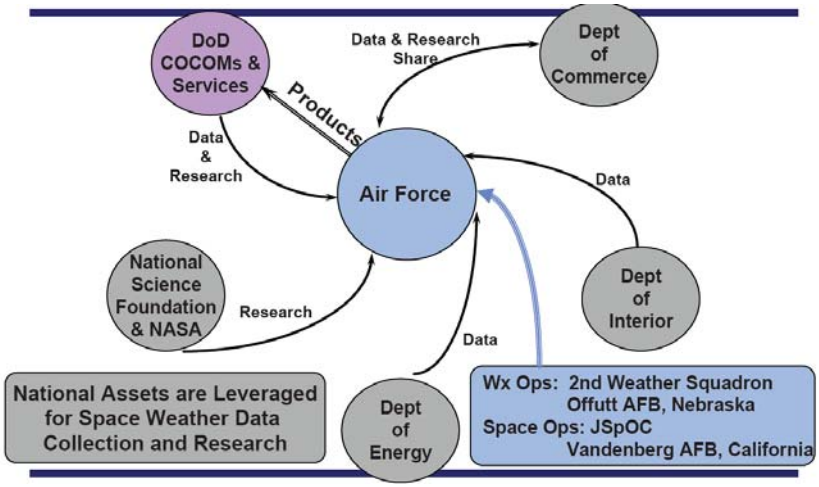
Environmental SSA--Components

- **OBSERVE environmental conditions**
  - **Sensors—Provides eyes on the space environment**
- **PROCESS sensor data**
  - **Environmental Models—Actual & forecast picture of the space relevant environment**
- **DETERMINE EFFECTS**
  - **Data Fusion—Environmental impacts on system/mission operations**
- **INTEGRATE EFFECTS**
  - **Via C2 System**

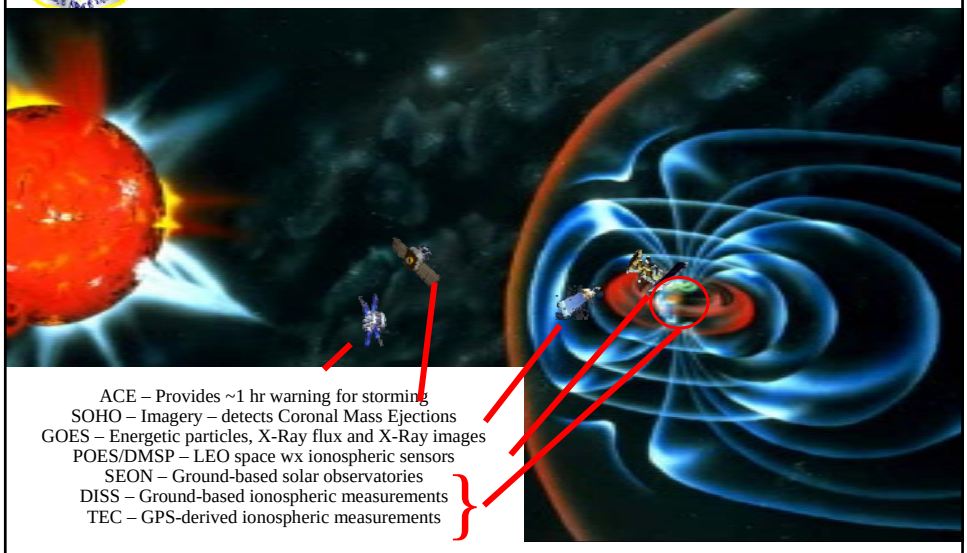
National Cooperative Efforts



DoD Space Operations



Space Weather Sensors



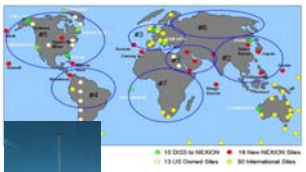
ACE – Provides ~1 hr warning for storming
SOHO – Imagery – detects Coronal Mass Ejections
GOES – Energetic particles, X-Ray flux and X-Ray images
POES/DMSP – LEO space wx ionospheric sensors
SEON – Ground-based solar observatories
DISS – Ground-based ionospheric measurements
TEC – GPS-derived ionospheric measurements

Ground-Based Sensors

AF operates and collects space weather data from DoD ground- and space-based sensors

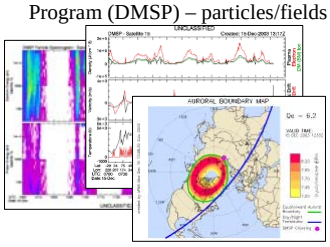
- **The Nation is becoming more dependent on space weather**
- **Data from many government & non-government sources … Data partnerships are crucial**

All Sites

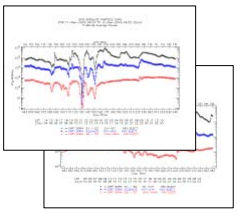


DISS

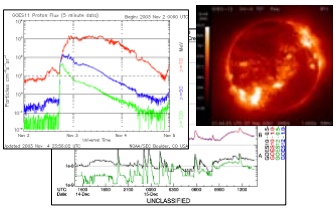
Defense Meteorological Satellite Program (DMSP) – particles/fields



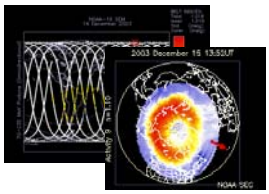
Defense Support Program (DSP) - particles



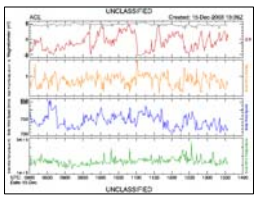
Geostationary Operational Environment Satellite (GOES) – X-ray, particles and fields



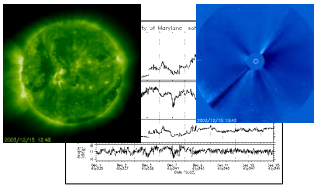
Polar-Orbiting Environmental Satellite (POES) - particles



Advanced Composition Explorer (ACE) – solar wind



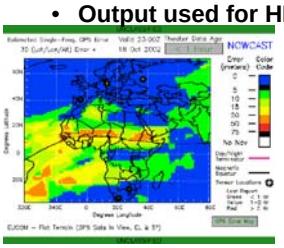
Solar Heliospheric Observatory (SOHO) - solar wind/radiation



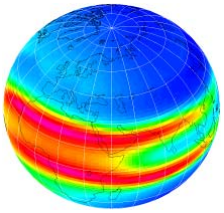
Modeling—Specification and Forecast

AFW provides space environmental data, analyses, forecasts, model output, and critical strategic-level products to DoD users!

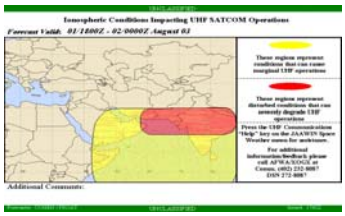
- **Global Assimilation of Ionospheric Measurements (GAIM) Model**
  - **Provides 24 hour forecast of Ionospheric conditions**
  - **Follow-on "full physics" upgrade planned for FY10-12**
  - **Output used for HF communication and refractive correction**



Estimated GPS Error Maps

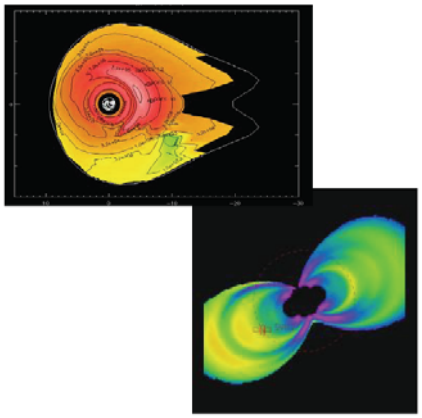


Ionospheric Impacts



SATCOM Outage Maps

Magnetospheric Specification & Forecast Model (MSFM)



- Provides charged particle environment at satellite altitudes
- Can assist in forecasting satellite problems related to spacecraft charging

Summary

- SSA is critical to protecting space systems and providing assured space services—military, civil, and commercial
- Need for robust SSA infrastructure
  - Continue planning and budgeting for space environment capabilities
    - Bigger challenge than any one on us can tackle
- Opportunities: Effective Partnerships—Cross Agency, Academia, and International