Air Force Space Weather Way Ahead

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Air Force Space Weather Overview

- Mission
- Capabilities
- Forecasting Future
- Interagency Coordination
- Challenges and Opportunities
“Weather operations provides accurate, timely, relevant, and consistent air and space environmental information to AF and specified Army units, including their respective Reserve Components, and as directed, joint forces, coalition forces, and other agencies, such as those combat support agencies under the purview of the Under Secretary of Defense for Intelligence” – Weather Operations Mission, AF Policy Document 15-1, Nov ‘15
AF Mandate for DoD Space Weather Ops

“CSAF is responsible for space weather operations and capabilities in support of all elements of the DOD”
– CJCSI 3810.01E (May 2016)

“AFWA [557 WW] is the POC for all DOD and IC space weather information”
– JP 3-14 (May 2013)

“It is the sense of Congress that the SecDef should ensure the timely provision of operational space weather observations, analyses, forecasts, and other products to support the mission of the DOD including the provision of alerts and warnings for space weather phenomena that may affect weapons systems, military operations, or the defense of the United States.”
– NDAA FY18

Integrity - Service - Excellence
## Warfighter Impacts

**Tailors Space Weather Information** -- satisfying Warfighter Mission Requirements and Delivers Support to appropriate Classification Level

### X-Rays, EUV, Radio Bursts

- SATCOM Interference
- Radar Interference
- HF Radio Blackout
- Geolocation Errors
- Satellite Orbit Decay

*Arrival: 8 min / Duration: 1-2 hours*

### Energetic Particle Events

- High Altitude Radiation Hazards
- Spacecraft Damage
- Satellite Disorientation
- Launch Payload Failure
- False Sensor Readings
- Degrade HF Comm (high latitudes)

*Arrival: 15 min to hours / Duration: days*

### Scintillation

- Degraded SATCOM
- GPS Error
  - Positioning
  - Navigation
  - Timing

*Daily / Ionospheric Disturbance*

### Geomagnetic Storms

- Spacecraft Charging and Drag
- Geolocation Errors
- Space Track Errors
- Launch Trajectory Errors
- Radar Interference
- Radio Propagation Anomalies
- Power Grid Failures

*Arrival: 1-3 days / Duration: days*
Interagency coordination drive by Executive Order (13744)
Coordinating Efforts to Prepare the Nation for Space Wx Events

- Overarching National Space Wx strategy
- OSTP led SWORM efforts implement National Space Wx strategy
- Partnering with federal agencies and academic community to develop models, observing systems, & technologies to enhance national preparedness
  - AFRL, NRL, JHU/APL, modeling, sensors & data
Threats in the future operating environment include:

- Potential for engagement with near-peer adversaries
- Space domain will become increasingly contested and congested
- Counter-space technologies and operations
  - Space weather data has to expand to provide environment information to feed rapid anomaly attribution
Discussion: VHF radio communication are predicted to be extremely unfavorable, mostly at high latitudes, due to warning-level geomagnetic storms. A geomagnetic storm is caused by an increase in charged particles emitted from the sun, which temporarily disturb the magnetic field around the Earth. These storms will modify the ionosphere and interfere will VHF signal propagation. Satellite communications in this region will also be degraded or completely unavailable, which includes the ability to track LEO satellites. Please visit www.spaceweather.af.mil/VHF for additional details.
Assessment of Space Weather Environment in support of Spacecraft Anomaly Resolution - Quick-look minutes; Detailed Study follows days/weeks later

![Electron Fluence at GEO](image)

CRESS Electron and Aurora Models show that F-15 was outside auroral oval and outside horns

![Global Radiation Belt Model](image)

Assessments Completed by 2 WS

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Workforce Development & Training
- Force of highly educated military and civilian operators
- Trained to support national security, warfighter needs; understand and communicate global space environment impacts

Next Generation Technology & Responsive RDT&E
- All AF space-based sensors to have ECP sensors onboard
- Whole-atmosphere/coupled modeling & impact assessment tools
- Develop next generation ground/space-based sensing technologies
- Energize RDT&E relationship with labs, academia, industry; emphasize open architectures, Gov’t data rights, rapid development/adoption

Warfighter Engagement & Civil Collaboration
- Integration into planning/employment systems
  - Multiple security enclaves
- Complementary support to federal partners for national security issues
AF Space Wx Forecasting Future, Modeling & Research Priorities

- Ionosphere
  - Scintillation
  - Total electron content (TEC)
  - Electron density profile (EDP)

- Magnetosphere
  - LEO energetic particle characterization
  - Spacecraft charging in all orbits

- Solar event forecasting
  - X-ray flares
  - Radio bursts
  - CMEs

- Space wx impact tool / anomaly assessments
- GPS Block III coming online: transmits over several frequencies
  - More accurate estimates of TEC
  - More accurate scintillation S4 index spectra
- GPS Block III will transmit at higher power levels
  - More disperse ground location of TEC columns
  - More disperse ground location S4 measurements
AF Space Wx Forecasting
Future, the Magnetosphere

Utilize data from DMSP and GEOS with new understanding of Magnetospheric processes from Van Allen Probes

Future real-time access to ECP data from GPS and other Assets
AF Space Wx Forecasting
Future, Solar Flare & CMEs

- Operational data from upgraded RSTN
- Operational data from SOON (hopefully SOON follow-on)
- Close in CME observations from Parker Probe and Solar Orbiter
- Non-operational research data from NASA Parker Probe
- Non-operational research data from ESA Solar Orbiter
Air Force committed to space weather observing...now & future

Team with national & international community for DoD support

Sensor-to-shooter – accurate, timely, relevant effects delivered for warfighting operations

“Air Force weather enables Joint Warfighters to anticipate and exploit the weather...for air, ground, space, cyberspace and intel operations.”

– AFW Mission

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Current AF Current Space Wx Capabilities

Defense Meteorological Satellite Program (DMSP): F16, F17, F18, Constellation Observing System for Meteorology, Ionosphere, and Climate (COSMIC-2): Low Inclination All AF Space-based Platforms (2021)

I n t e g r i t y - S e r v i c e - E x c e l l e n c e