

This briefing is: **UNCLASSIFIED**

The 557th Weather Wing

2d Weather Squadron (2 WS) The USAF Space Weather Operations Center

Lt Col William Ryerson
Commander
2d Weather Squadron

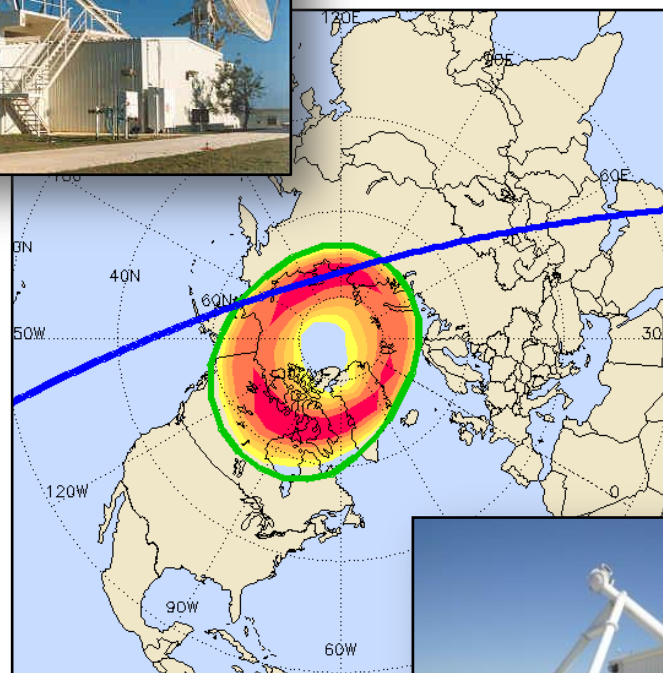




Overview



- Mission & Mandate
- Warfighter Impacts
- Partnerships
- Products & Services
- Modernization





2 WS Mission



Delivers specialized airpower -- DoD-unique environmental capabilities -- to the Joint Force, Defense and Intelligence Community (IC) Agencies



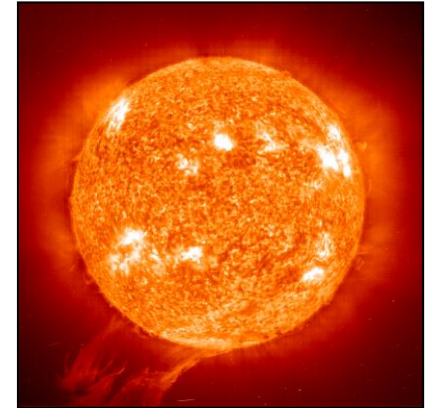
Media

- AFN Weather Center



Intelligence (WXI)

- Global volcanic ash monitoring
- Global snow & ice analysis
- Hourly global cloud analysis & forecasts
- 24/7 Weather at TS/SCI enclave



Space (WXZ)

- 24/7 Space Weather Operations Center (SpaceWOC)
- Global Solar Electro-Optical Network (SEON)
- Satellite Anomaly Assessments

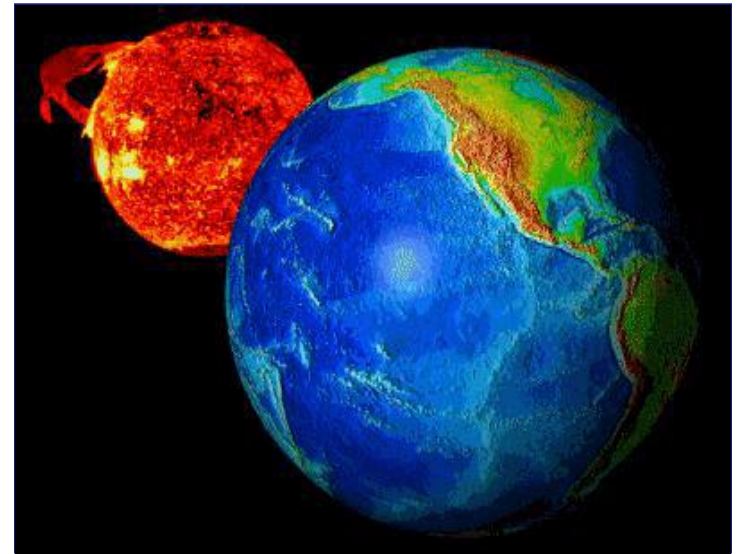
Eight DoD-Unique Strategic Capabilities



Space Weather Mission



- Provide Mission-Tailored Analyses, Forecasts, and Warnings of system-impacting Space Weather to DoD Operators, Warfighters, and Decision-makers, and the Intelligence Community
- The DoD's only 24/7 Space Weather Operations Center (SpaceWOC)
- Three Primary Mission Areas:
 - Space Situational Awareness
 - Solar Event Forecasting/Warning
 - Anomaly Assessment Support

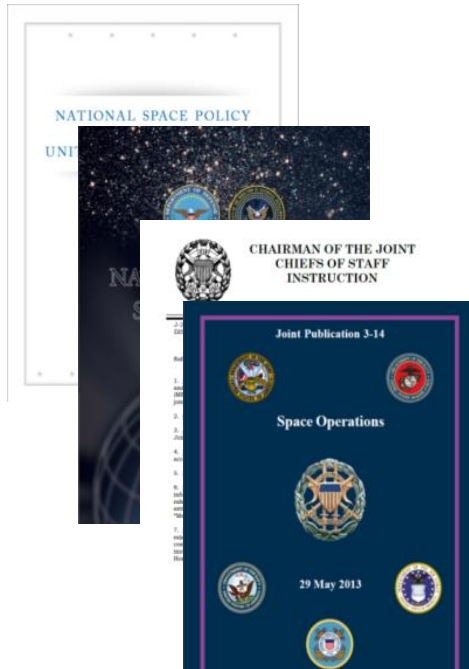




The Mandate

“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.”

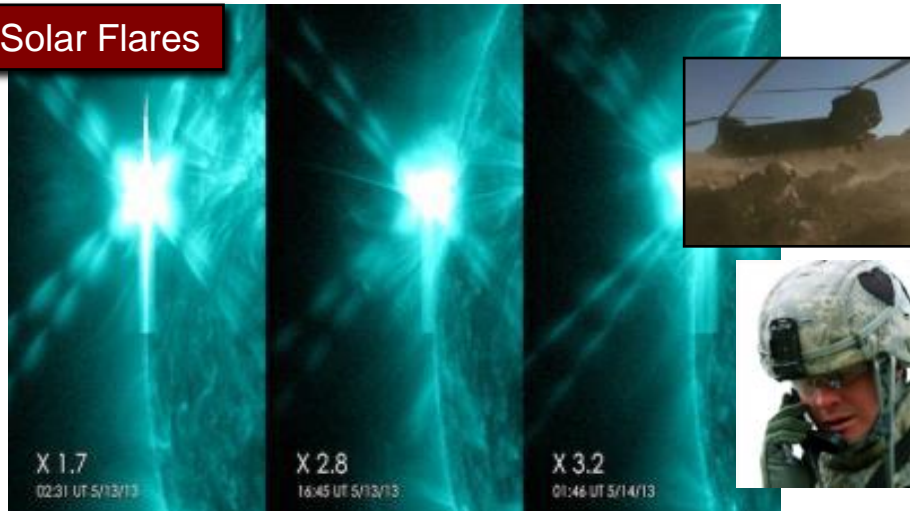
– NDAA FY18



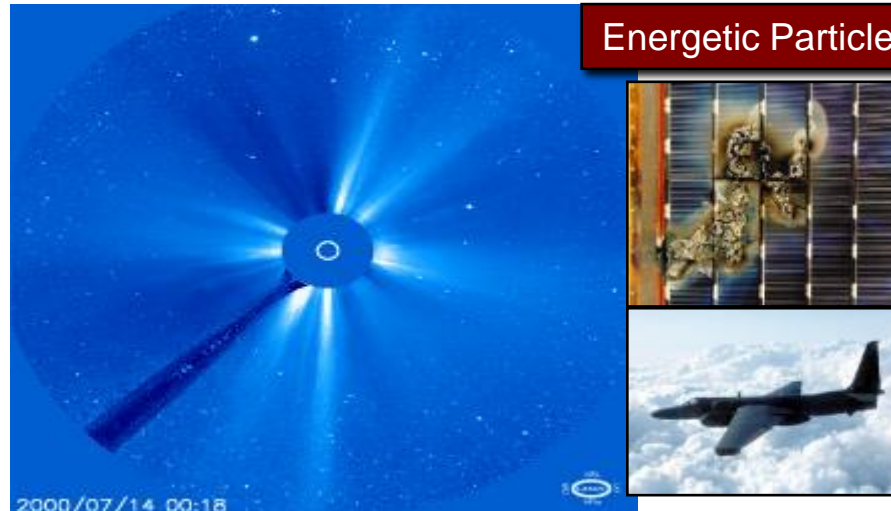
Space Weather Phenomena



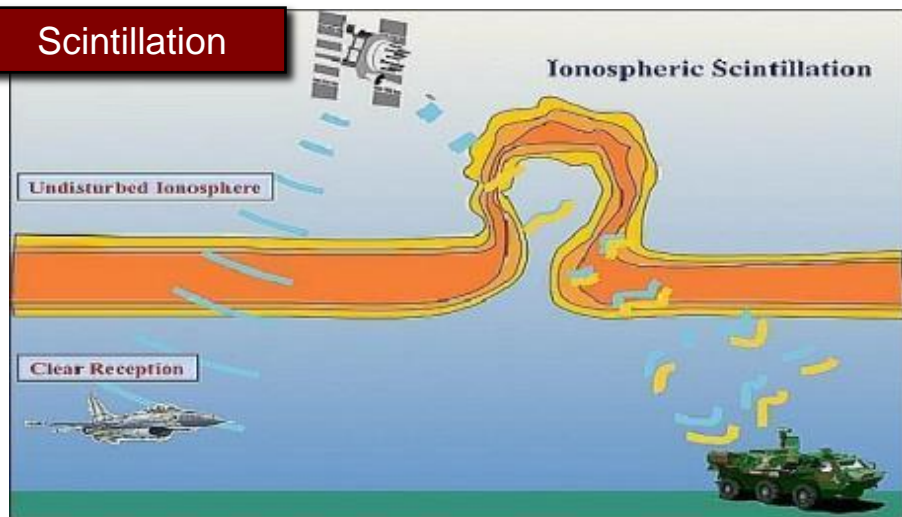
Solar Flares



Energetic Particles



Scintillation



Geomagnetic Storms





Warfighter Impacts

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

X-Rays, EUV, Radio Bursts

Arrival: 8 min / Duration: 1-2 hours

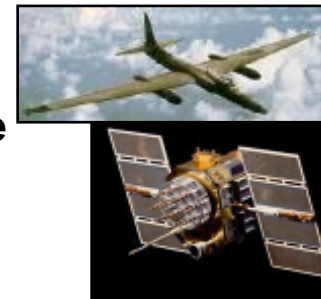
- SATCOM Interference
- Radar Interference
- HF Radio Blackout
- Geolocation Errors
- Satellite Orbit Decay



Energetic Particle Events

Arrival: 15 min to hours / Duration: days

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



Scintillation

Daily / Ionospheric Disturbance

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



Geomagnetic Storms

Arrival: 1-3 days / Duration: days

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





Space Weather Enterprise



- AF Provides Space Environmental Situational Awareness to the DoD and National Security Community





AF – SWPC Partnership



■ Data flows

AF → SWPC



RSTN:
Radio Burst & Sweep
Reports

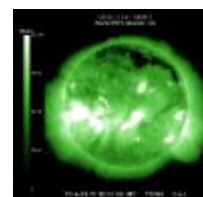


SOON:
Sunspot Analysis &
Flare Location

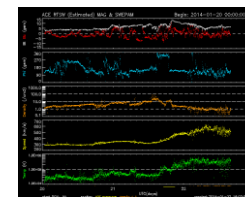
External Space Weather
Data Store (E-SWDS)



SWPC → AF



GOES:
X-Ray and Particle Data

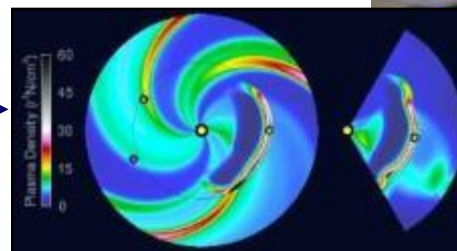
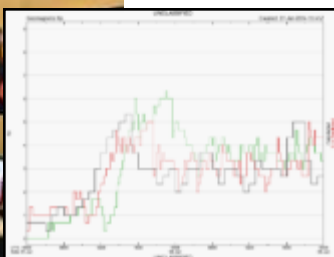


ACE/DSCOVR:
Solar wind Data

■ Collaboration with AF forecasters



AF



SWPC

■ Joint Products with AF

AXXX01 KWNP 220245
Joint USAF/NOAA Solar and Geophysical Activity Summary
SGAS Number 022 Issued at 0245Z on 22 Jan 2014
This report is compiled from data received at SWO on 2

AXXX02 KWNP 220030
Joint USAF/NOAA Solar Region Summary
SRS Number 22 Issued at 0030Z on 22 Jan 2014
Report compiled from data received at

FXXX01 KWNP 212200
Joint USAF/NOAA Solar Geophysical Activity Report and Forecast
SDF Number 21 Issued at 2200Z on 21 Jan 2014



2 WS Space Situational Awareness



■ Solar Electro-Optical Network (SEON)—Sunrise to Sunset Patrol

- Monitor the Space Environment
- Record and Analyze observed Data
- Disseminate data to AF and Space Weather Prediction Center (SWPC)



Radio (RSTN)



Optical (SOON)

UNCLASSIFIED

CHOOSE THE WEATHER FOR BATTLE



Solar Event Forecasting / Warning



- **2 WS SpaceWOC:** DOD's only space environment observing, analysis, and forecast capability
- **Dissemination:** AFW-WEBS-U/S/SCI, e-mail, phone
- **Volume:** ~35,000 products per day (~34,500 automated)
- **Manning:** 24/7 Operation (1 shift lead, 1 forecaster, 1 analyst)

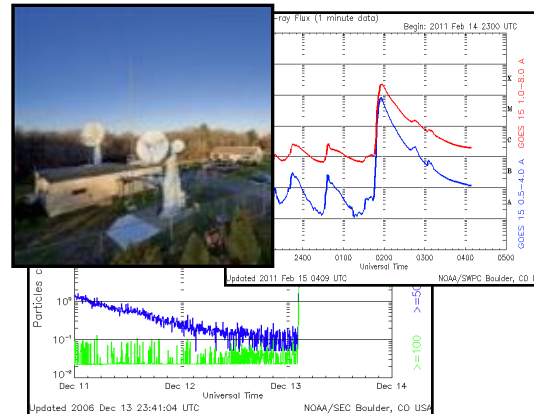


5.2.1. DOC and DOD, in coordination with DHS, will assess best practices across the Federal Government to identify and document the most effective means to produce and deliver space weather alerts, warnings, and notifications.

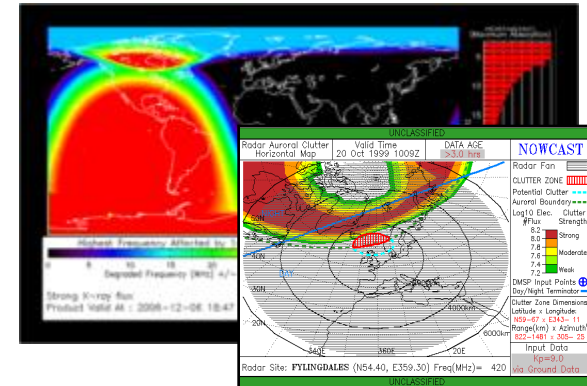
~NSWAP



2 WS solar Dets Measures Event; transmit data to SpaceWOC



Data ingest into Space Wx Anal/Fcst System (SWAFS); SpaceWOC analyst Issues Alerts to users

[illegible]

End users exploit AF Space Environmental Intelligence to Mitigate Effects

SpaceWOC forecaster Produces multitude of Tailored Decision Aids

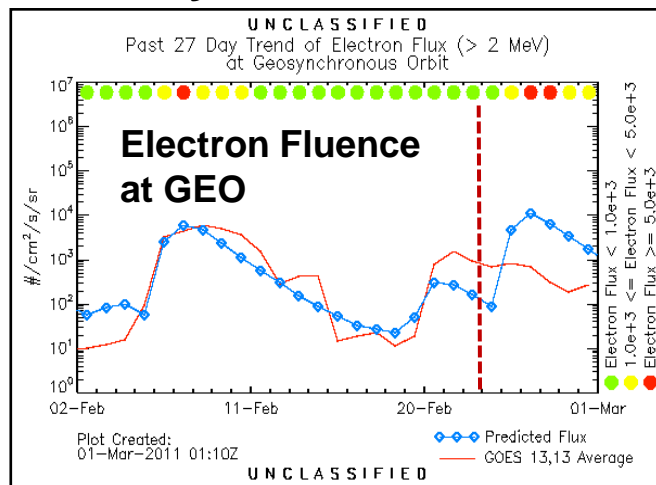
SWAFS models initiated simultaneously to Predict Impacts at Earth



Anomaly Assessments

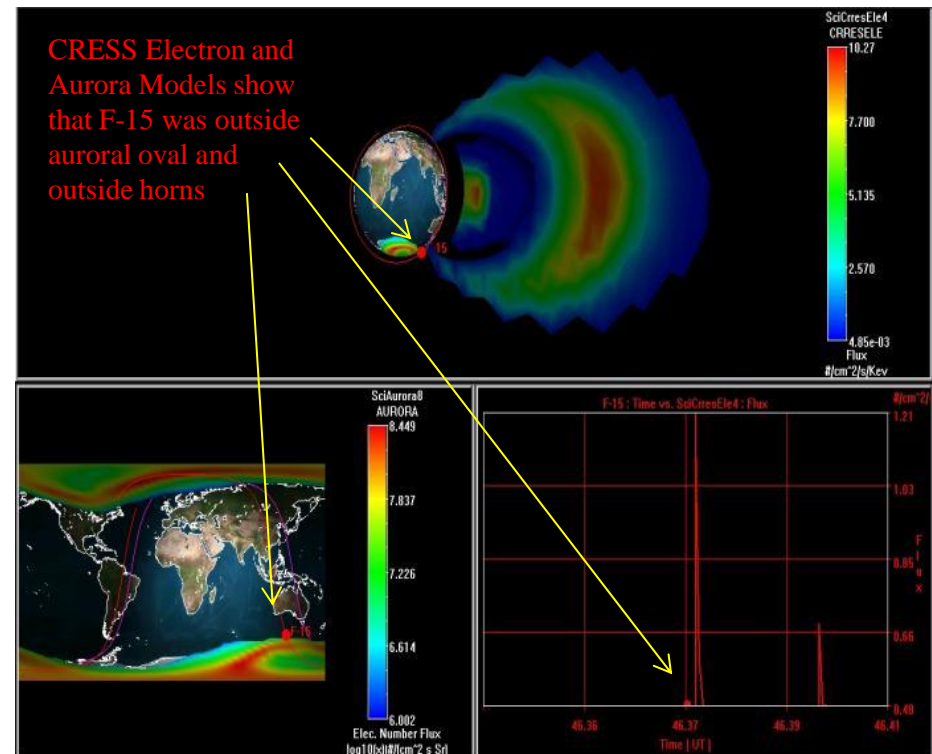


- **Assessment of Space Weather Environment in support of Spacecraft Anomaly Resolution-** Quick-look minutes; Detailed Study follows days/weeks later



Assessments Completed by 2 WS

Year	Number	Increase
2014	92	
2015	175	87%
2016	281	63%
2017	382	27%



Global Radiation Belt Model



SpaceWOC Next - Modernization



...FOR YESTERDAY'S FIGHT:

- *MODEST TAILORING OF IMPACTS FOR JSPOC, NORAD, SPACE OPERATORS, HF, AND GPS USERS*
- *~150 ALERTS & WARNINGS / MONTH*
- *~35 ANOMALY ASSESSMENTS / MONTH; 2-4 HR TURNAROUND TIME*
- *UNCLASS IONOSPHERIC DA*
- *LIMITED REAL-TIME CHAT CAPABILITY*



...FOR TODAY'S & TOMORROW'S FIGHT:

- *MORE TAILORING FOR WIDER GROUP OF USERS: NSDC, SAT Ops; STRATCOM, NRO, CIA, THAAD, GPS PI*
- *MORE TAILORING + MORE USERS → MORE ALERTS & WARNINGS W/ MSN-SPEC THRESHOLDS*
- *WARTIME SURGE LIKELY; TURN TIME IN MINS; REQ T AT TS/SCI*
- *CLASSIFIED IONOSPHERIC DA (SWAFS...W/16 WS)*
- *MORE CHAT AT CLASSIFIED DISCUSSION LEVELS FOR MORE MSN INTEGRATION*
- *WHSR SUPPORT (CLASSIFIED / FOREIGN COUNTRY IMPACTS)*



Modernize: Manning & Training



■ **Revamp SpaceWOC Manning**

■ **Additional Duty Positions Focused on**

- **Spacecraft & Orbital Products, Impacts, Exploitation**
- **Electromagnetic Spectrum Monitoring, Products, Impacts, Exploitation**
- **Contingency/Exercise Support, Assistance Requests**
- **Senior Duty Officer (oversight & SSA from “Mud to Sun”)**

■ **Anomaly Assessments Require SME Expertise**

- **24/7 Support in the Works (3 positions hired)**
- **Standard Product Template Complete**

■ **Overhaul SpaceWOC Training & Expertise**

- **2 WS Training Flt**
- **Nat'l Security Space Institute (NSSI) courses (100-300)**
- **Additional contractors, civ SMEs**
- **5x Space Wx AAD Officers**



Modernize: Data & Processing



- **Data Sources Aging/Limited**
 - RSTN & SOON need technological / scientific updates
 - NEXION and ISTO are sparse (low horizontal res)
 - Aging research satellites (ACE, SOHO, STEREO)
- **Energetic Charged Particles (ECP)**
 - Data from only 2-6 satellites (2 GEO (real-time), 4 LEO (delayed)) being applied to all satellites in all orbits
 - Dozens (and growing) of in-situ sensors (e.g., GPS, commercial, TS platforms, etc.) not being utilized
- **Consolidated Space Wx Database Needed (in-works)**
- **Infrastructure not in place for storing/processing classified Data**



Modernize: Products

Orbit-Specific Stoplight Chart

Valid: 19-Oct-2017 1800Z

Today
19-Oct

3 - Day Forecast
21-Oct

22-Oct

Low Earth Orbits
Medium Earth Orbits
Geosynchronous Equatorial Orbits
Highly Elliptical Orbits

night	day	day	night
Green	Green	Green	Green
Yellow	Yellow	Yellow	Yellow
Red	Red	Red	Red
Yellow	Yellow	Yellow	Yellow

night	day	day	night	night	day	day	night	night	day	day	night
Green	Green	Green	Green	Green	Green	Green	Yellow	Yellow	Yellow	Yellow	Yellow
Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Green	Green	Green	Green	Green
Red	Red	Red	Red	Red	Red	Red	Green	Green	Green	Green	Green
Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Green	Yellow	Yellow	Yellow	Yellow

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 with 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.

UHF	Green	Yellow	Yellow	Yellow	Yellow	Yellow	Green	Yellow	Yellow	Green	Green	Green	Yellow
L Band / GPS Single Freq	Yellow	Green	Green	Green	Yellow	Yellow	Green	Yellow	Yellow	Green	Green	Green	Yellow
SHF (S, C, X, Ku)	Orange	Orange	Orange	Orange	Orange	Orange	Green	Green	Green	Green	Green	Green	Green
EHF (Ka, V)	Orange	Orange	Orange	Orange	Orange	Orange	Green	Green	Green	Green	Green	Green	Green
	Green	Yellow	Orange	Red	Green	Yellow	Orange	Red	Green	Yellow	Orange	Red	Green
	Favorable	Marginal	Degraded	Unfavorable	Favorable	Marginal	Degraded	Unfavorable	Favorable	Marginal	Degraded	Unfavorable	Favorable





Modernize: Products



"Space Weather Warning 02-98 – HF Radio Blackout

***"HF radio blackout conditions are
expected between 28/0430Z –
28/1030Z at latitudes above
approximately 60° N due to a M1
solar flare. Please visit
www.spaceweather.af.mil/warning02-98
for precise locations."***



**Degraded
SATCOM**



HF Radio Blackout



**High-Altitude
Radiation Hazard**



GPS Error



Questions?



“The sun never sets on the 2d Weather Squadron”