

Headquarters U.S. Air Force

Fly – Fight – Win

Space Weather Workshop 2010

**Year of the Air Force
Family**



AF/A3O-W
Col Mark Zettlemoyer



- Preparing for solar max ... and beyond
- OFCM, NOAA, NASA, DoD, and other National Partners working to determine way forward to support national space wx needs and SSA ... CSESMO and other efforts
- Increased investment in ground-based sensor, modeling and exploitation capabilities

Working with National Partners to support National Space Wx needs – TEAM BALL!



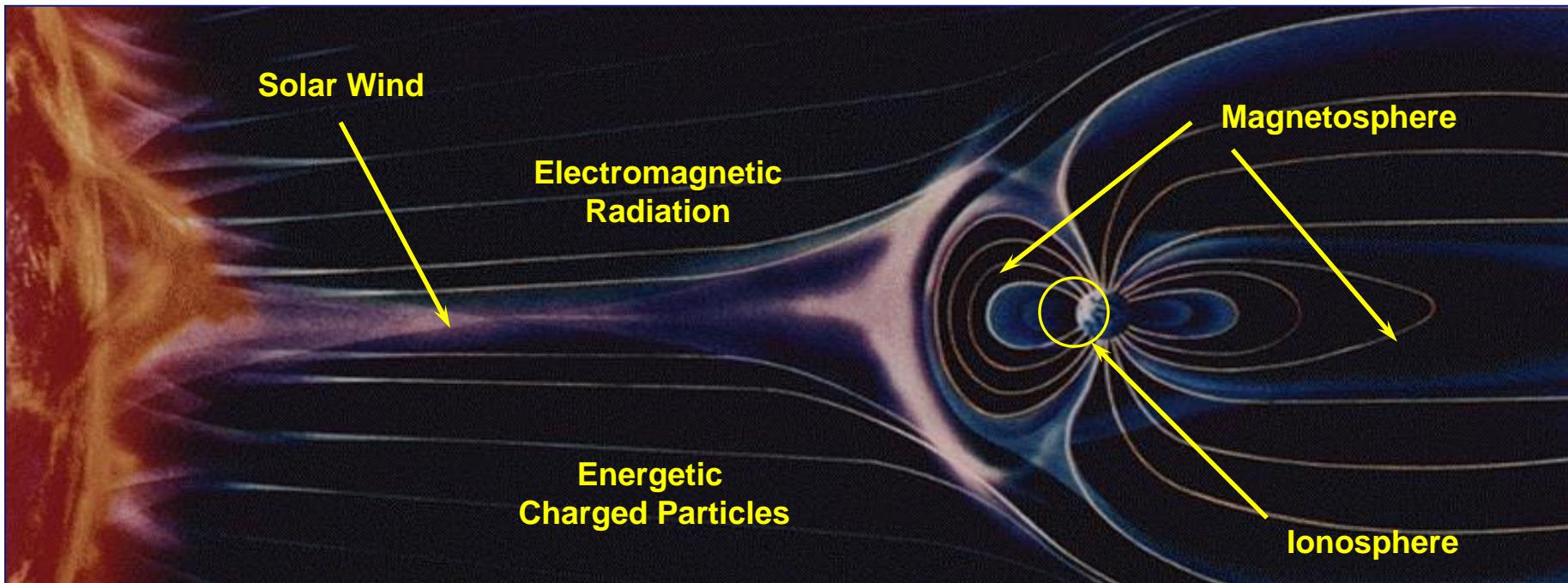
- **Space-Based Collections Modernization**
- **Ground-Based Collections Modernization**
- **Modeling Efforts**
- **Other Partnerships**

National Partners working to provide timely & actionable space weather support for the warfighters and the Nation



AF Space Weather Mission

Provide mission-tailored analyses and forecasts of the solar environment and warnings for mission limiting space weather events to Department of Defense warfighters and decision makers

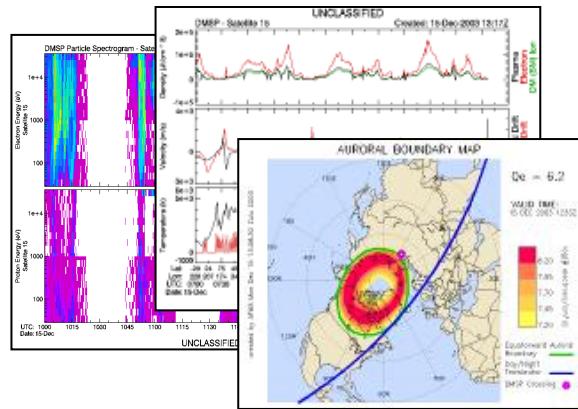




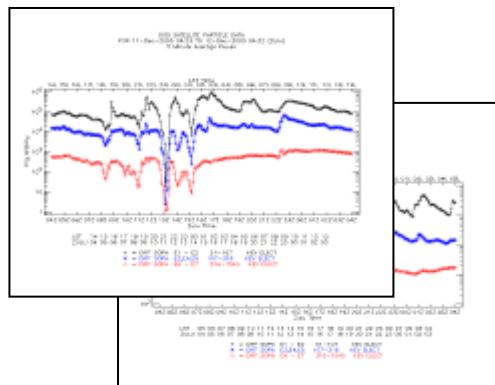
Space Weather

Space-Based Sensing

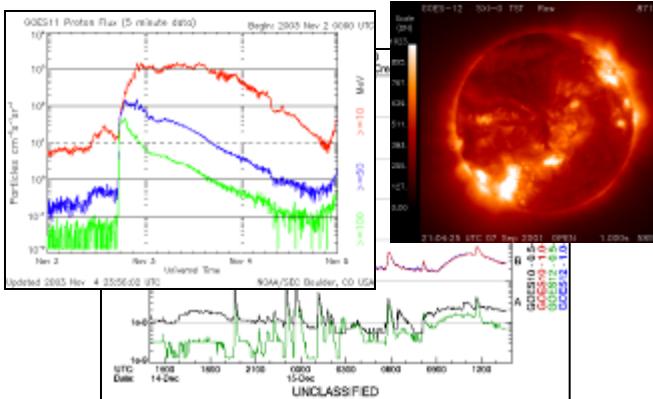
Defense Meteorological Satellite Program (DMSP) – particles/field



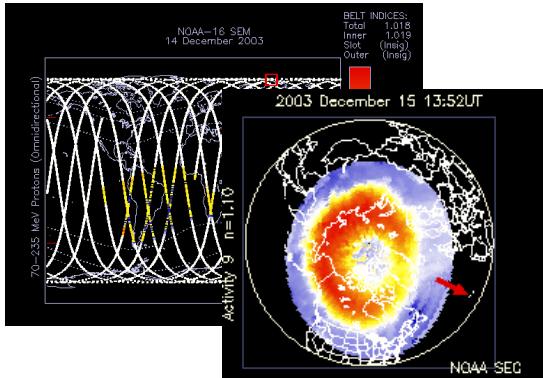
Defense Support Program (DSP) - particles



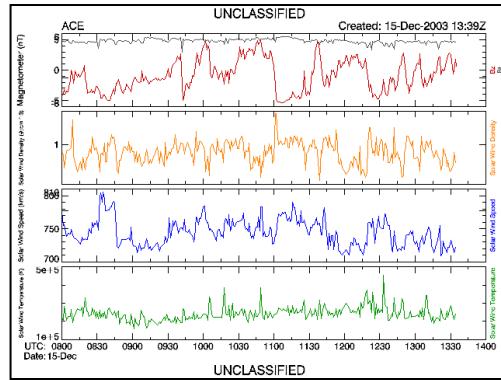
Geostationary Operational Environment Satellite (GOES) – X-ray, particles and fields



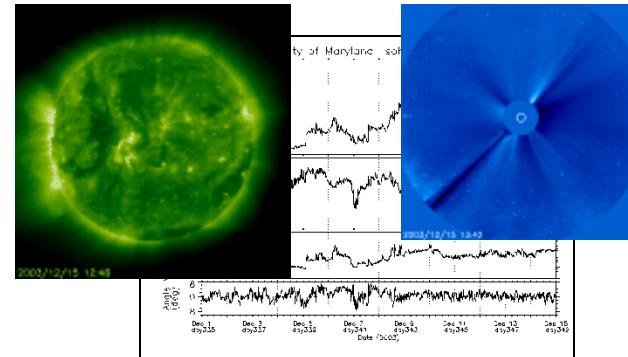
Polar-Orbiting Environmental Satellite (POES) - particles



Advanced Composition Explorer (ACE) – solar wind



Solar Heliospheric Observatory (SOHO) - solar wind/radiation





Space-Based Sensor Options

Exploit Current Capabilities

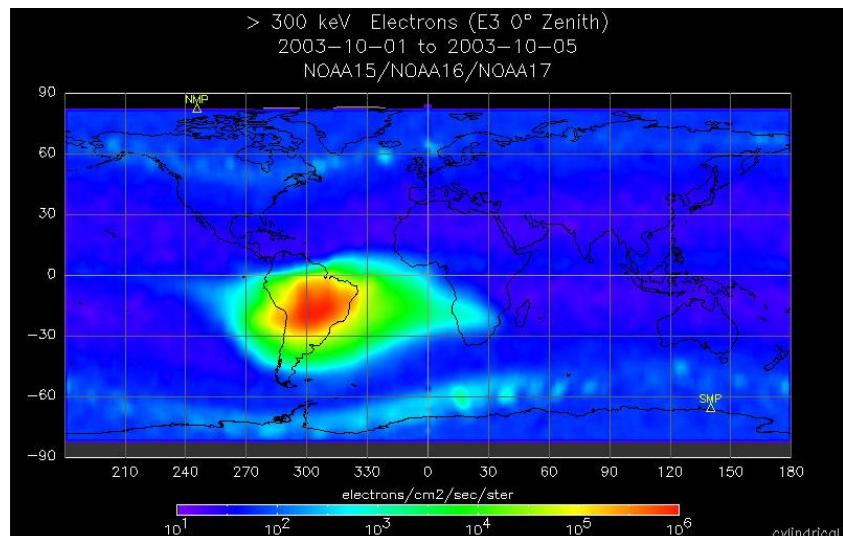
- GOES, GPS, and other satellites
- C/NOFS, SDO and COSMIC
- Non-traditional sources?

Future Options

- SEM-N?
- COSMIC-II?
- DSCOVR?
- SSAEM
- Radiation Belt Storm Probe
- AMPERE
- DoD continuity mission or DMSP follow-on

Advocacy and Partnering

- Need partnerships to collect from the space domain!
- CSES/MO ... proposed national space-based sensing architecture



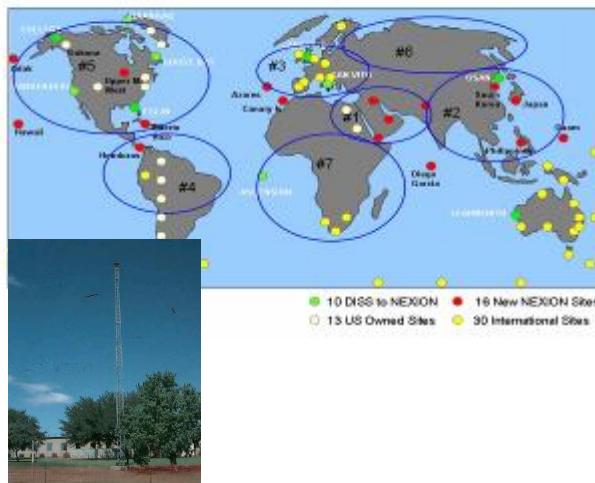


Space Weather Ground-Based Sensing

AF and other agencies collect space weather data from ground-based sensors

- Sensors include SOON, RSTN, DISS, NEXION, USGS Magnetometer, SCINDA, TEC, and others
- Data from many government & non-government sources ... Data partnerships are crucial

All Sites



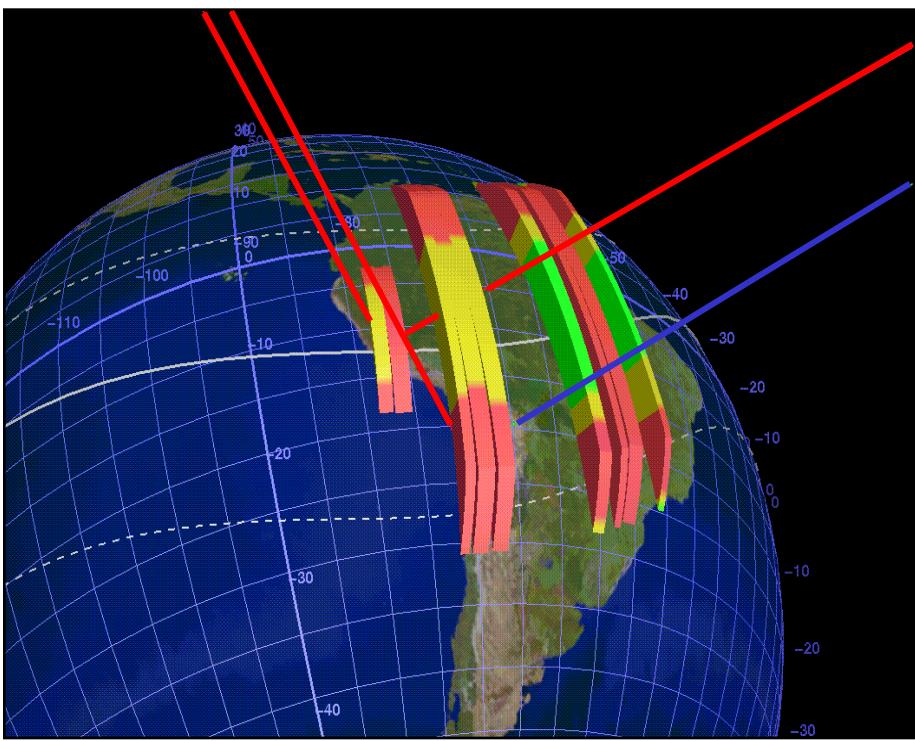
DISS





SCINTILLATION NETWORK DECISION AID (SCINDA)

A regional nowcasting system to support users of space-based communication and navigation systems



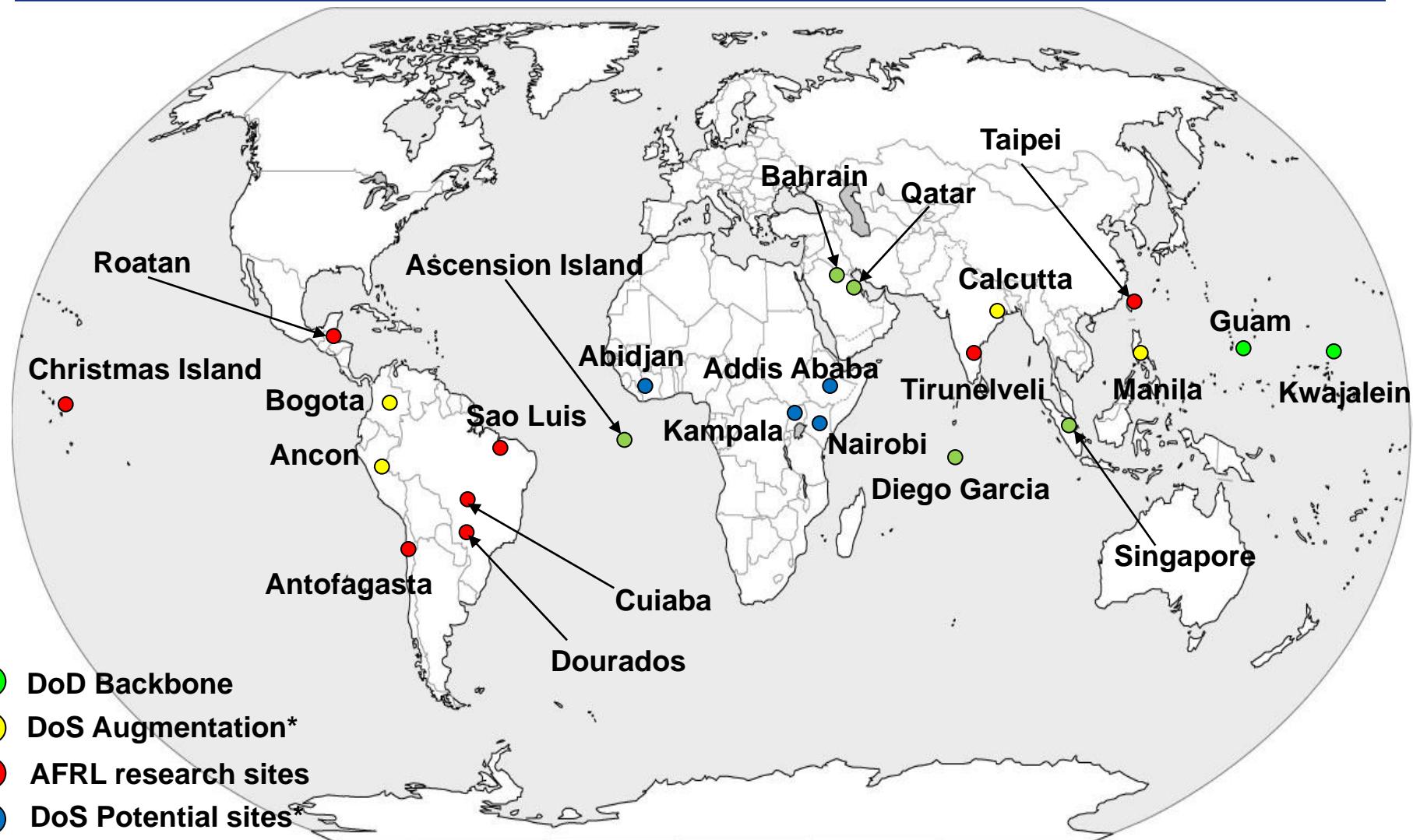
Real-time to 2-Hr Forecasts

- **Ground-based sensor network**
 - Passive UHF / L-band / GPS scintillation receivers
 - Measures scintillation intensity, eastward drift velocity, and TEC
 - Automated real-time data retrieval via internet
- **Data supports SATCOM users**
 - In theater and reach back support
- **Future work**
 - C/NOFS and its follow-on (SSAEM)
 - Multi-frequency GPS error work

Partners: AFRL, SMC

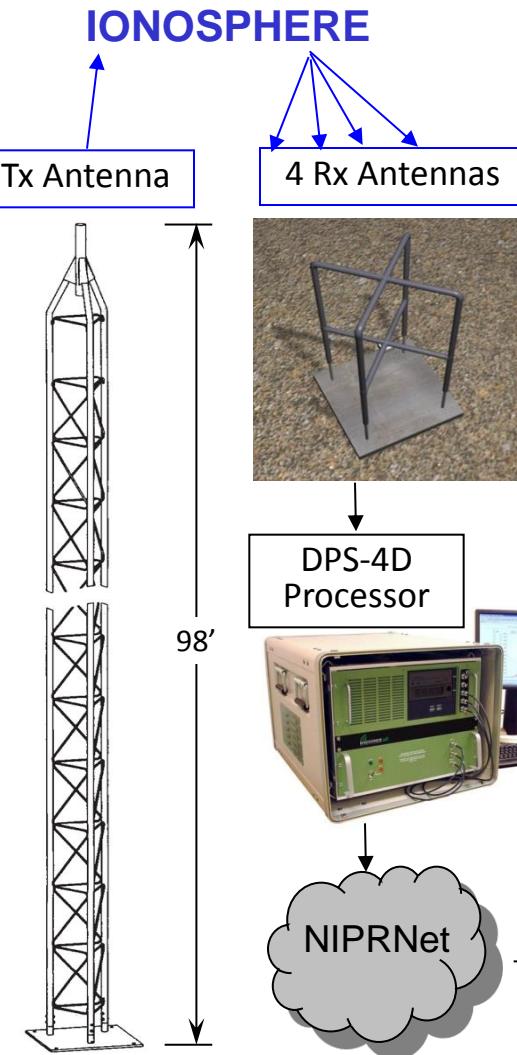


SCINDA Locations



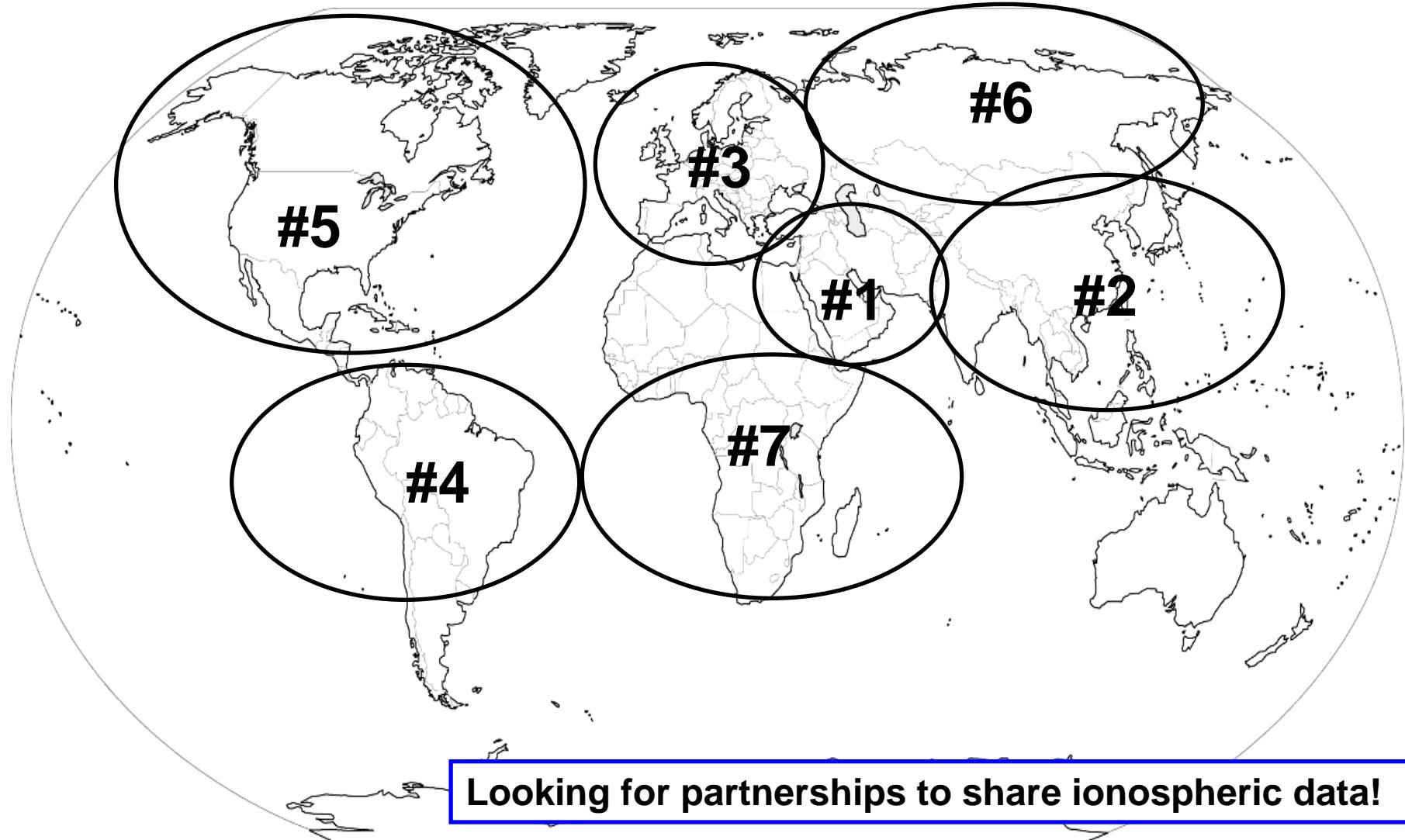


Next Generation Ionosonde NEXION



- Replacement for Digital Ionospheric Sounding System (DISS)
 - Ionospheric data feeds AFWA's ionospheric model
 - Generates products critical to space situational awareness
- Advantages
 - Reduced footprint -- 5 acres for DISS/1 acre for NEXION
 - Characterizes ionosphere over 1000 km radius
 - Improved spatial resolution
 - Modernized network and remote sustainment functions
- NEXION network will consist of at least 30 sites
 - 2 sites currently operational
 - Install 3 sites per year

Partners: UMass - Lowell, SMC





Improved Optical Observations

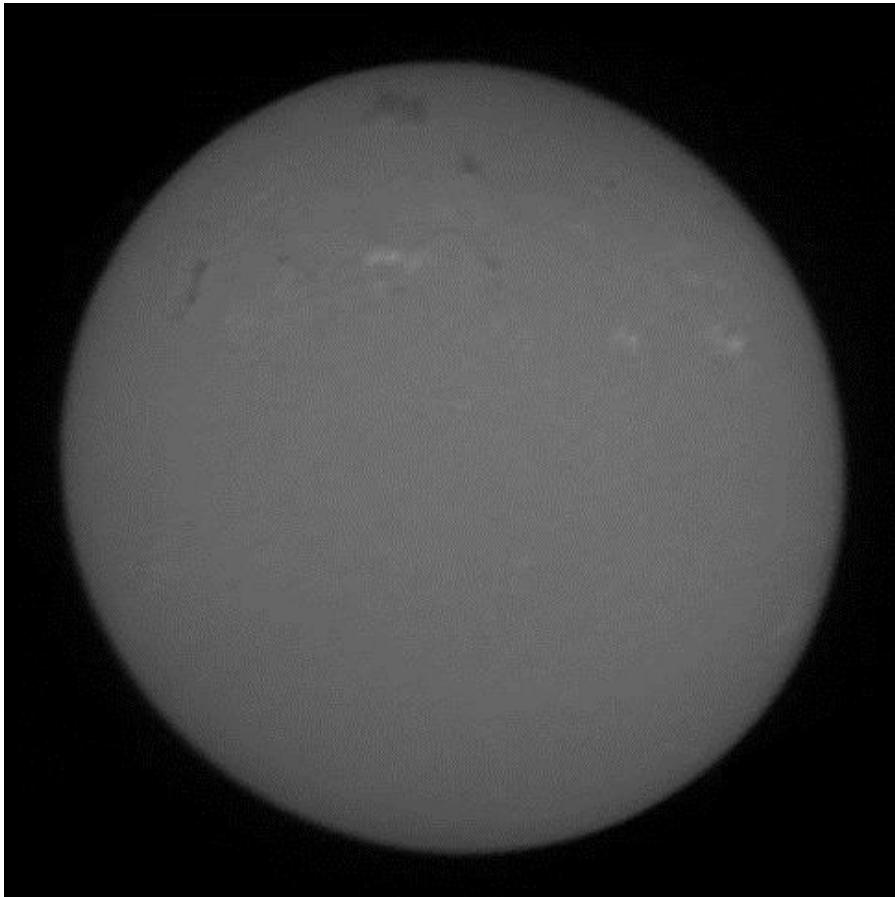
SOON vs ISOON

08 Apr 2010

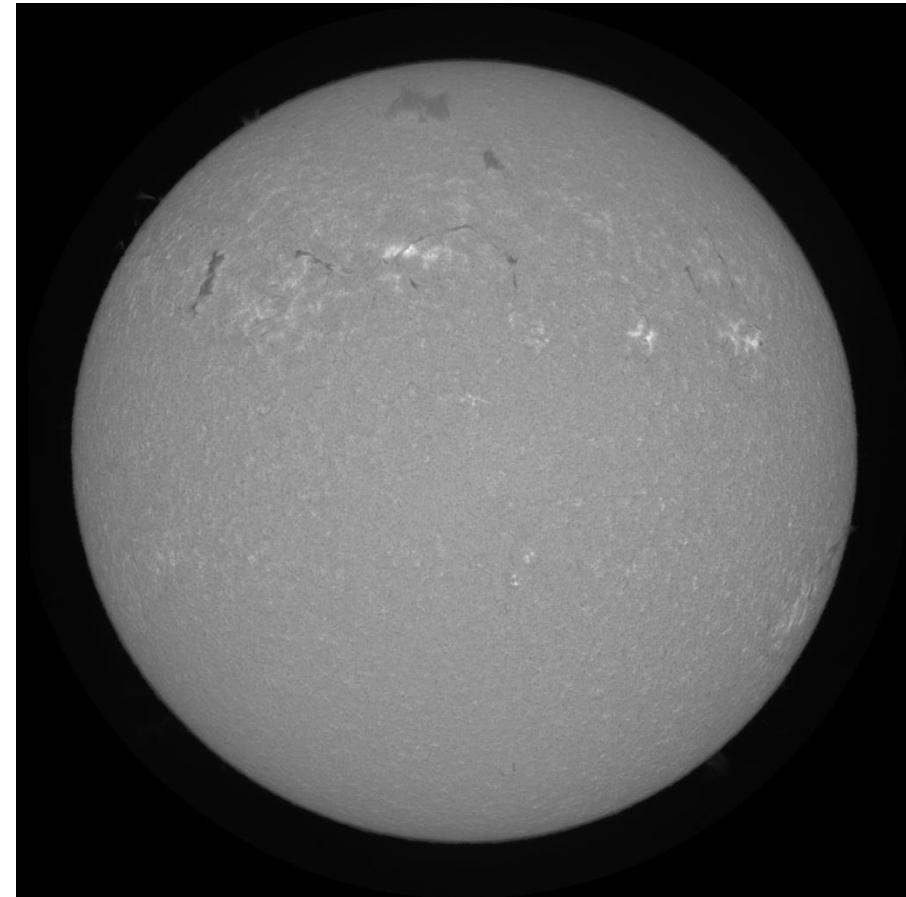
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Partners: AFRL, SMC

SOON

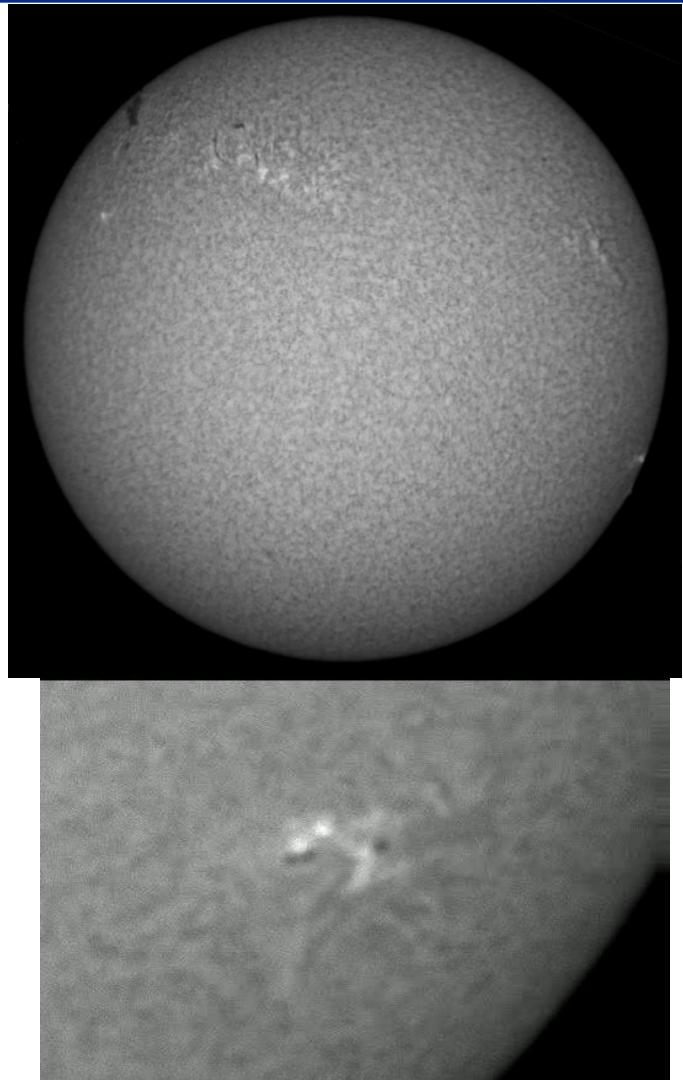
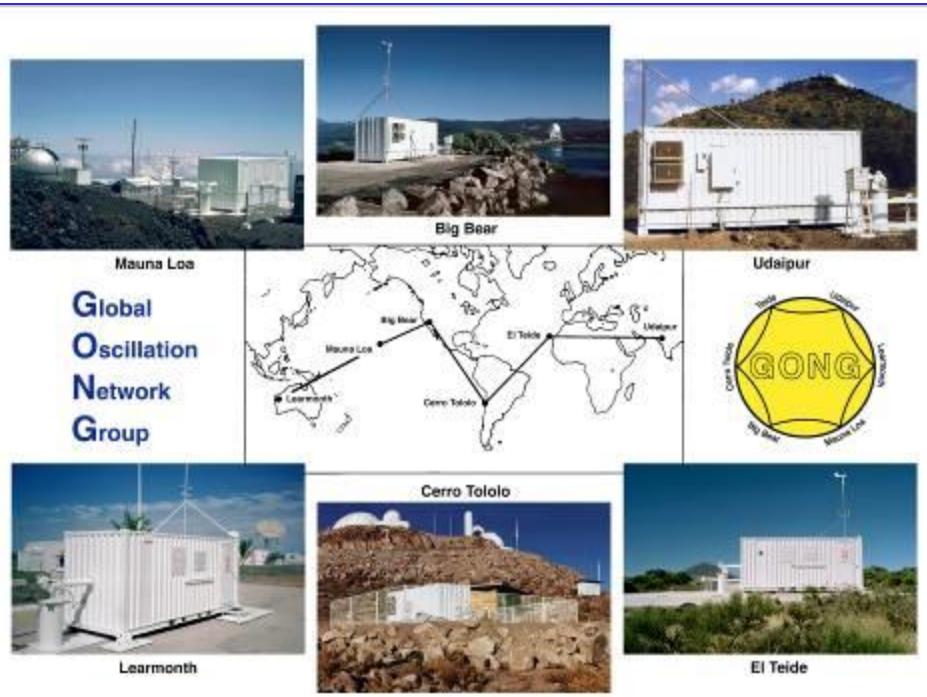


ISOON





USAF Cooperation with Global Oscillation Network Group (GONG)



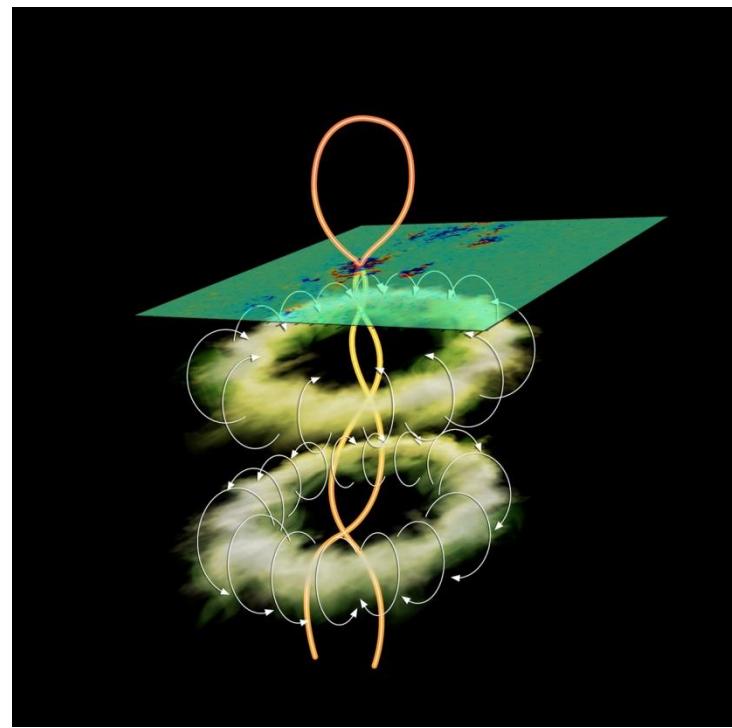
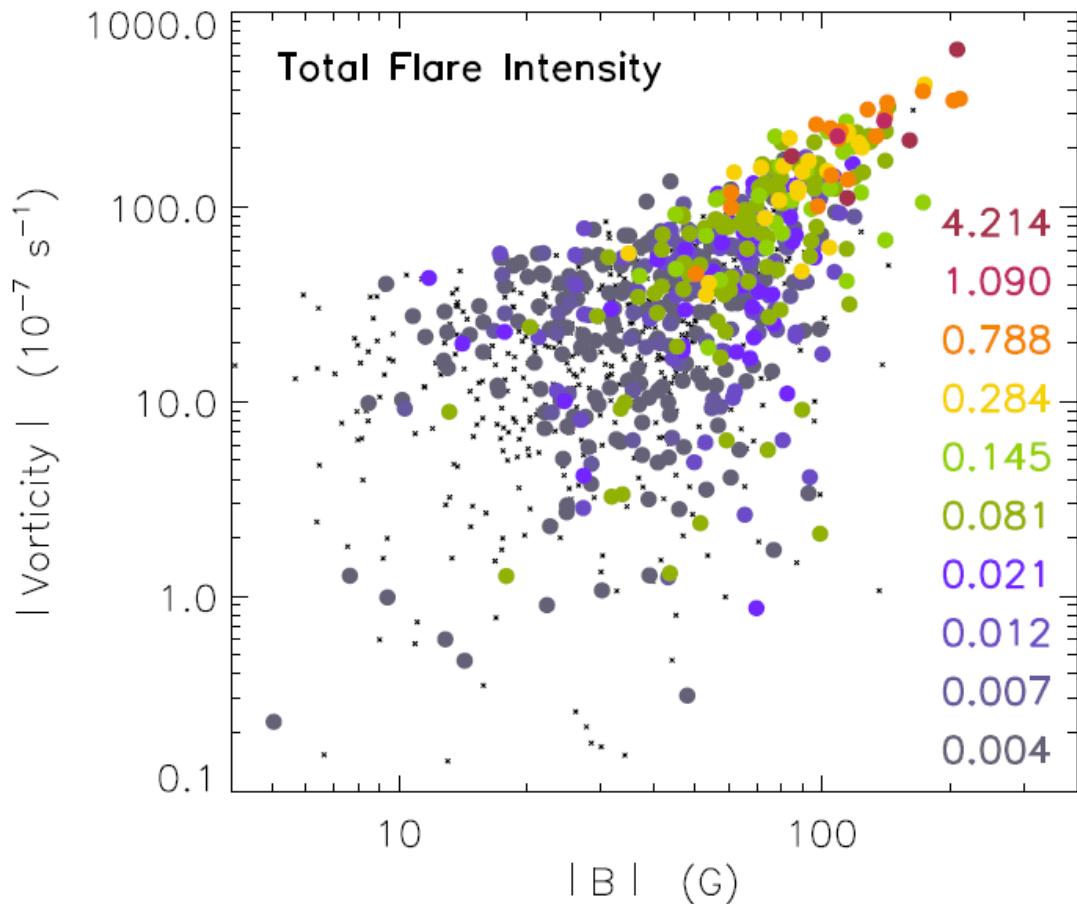
GONG

Upgrading to provide H-alpha capability to USAF...
data products every minute



Development of New Flare Prediction Algorithms

Large magnetic field + large vorticity = larger flares

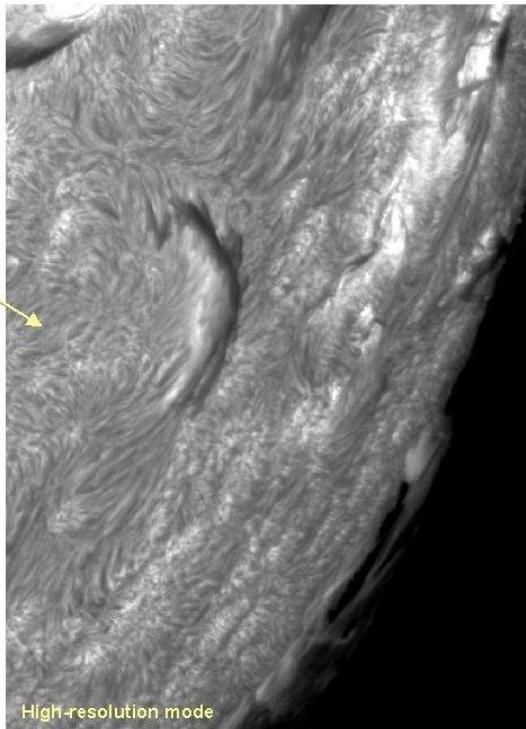
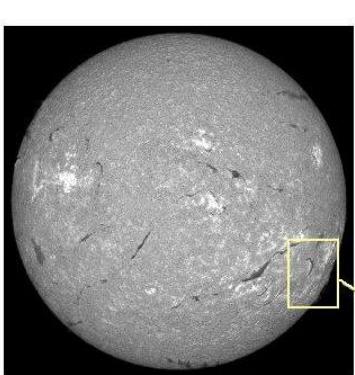


Courtesy of GONG



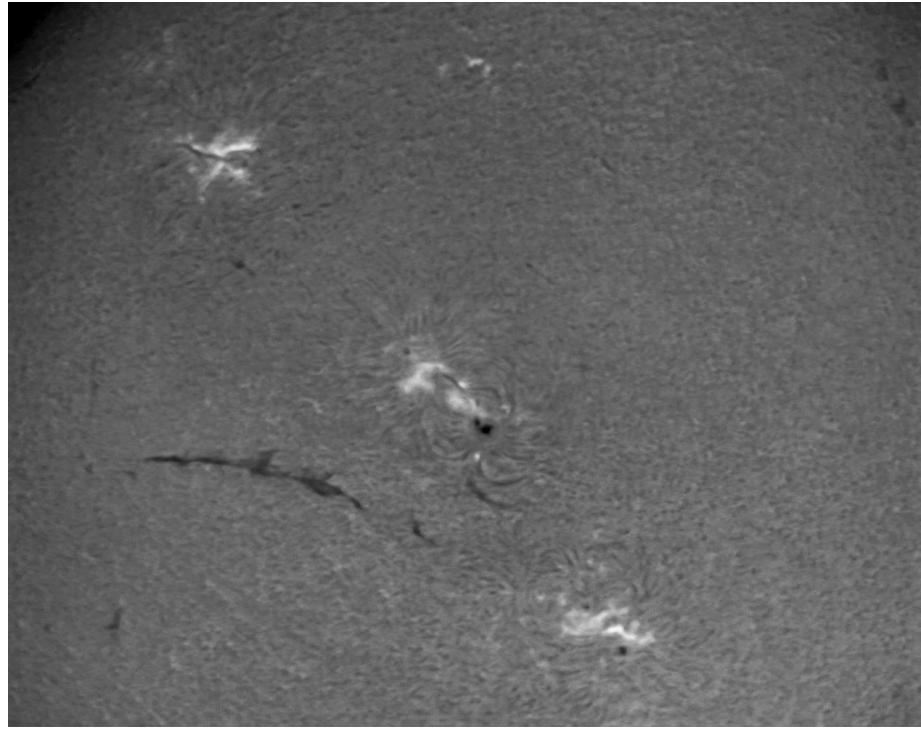
ISOON – GONG Operational Integration

ISOON



- 1 arc/sec resolution
- Meets AFSPC and NEPC requirements
- Remote operation will collocate solar analysts with space wx forecasters

GONG



- 2.5 arc/sec resolution
- Flare patrol during gaps in ISOON coverage
- 6-site network assures eyes on Sun
- Data to be integrated into analyst workstation at AFWA



Investing in a Global Observing Network





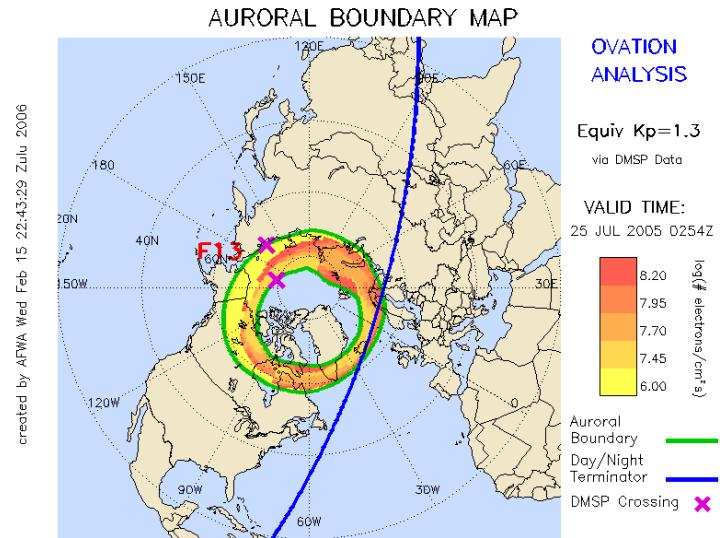
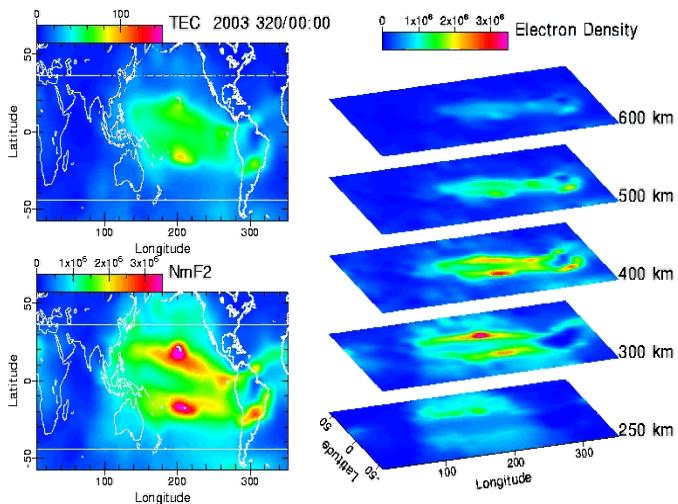
Space Weather Analysis and Forecast System (SWAFS)

Dec 09

- Add NEXION SAO V4.3 data
- Replace SWPC IDS Adapter with E-SWDS
- Add GOES 13 & 14 Data – **Delayed**

Jun 10

- Add NEXION SAO V5.0 XML data
- *Implement real-time Dst*
- Integrate non-SWAFS applications
- ICF (Pave Paws, ROTHR & IONPRO)
- *Integrate regional Gauss-Markov GAIM*
- Add DMSP F-17 SSUSI disk & limb data



FY10-11 (Planned)

- *Begin development of net - centric JMSESS (JMBL)*
- Add DMSP F-18 SSM/J/IES & SSUSI data
- Add Radio Occultation data to GAIM
- Continue re-engineering of non-SWAFS spreadsheets
- Integrate remaining non-SWAFS applications
- Engineering studies: ISOON & GONG

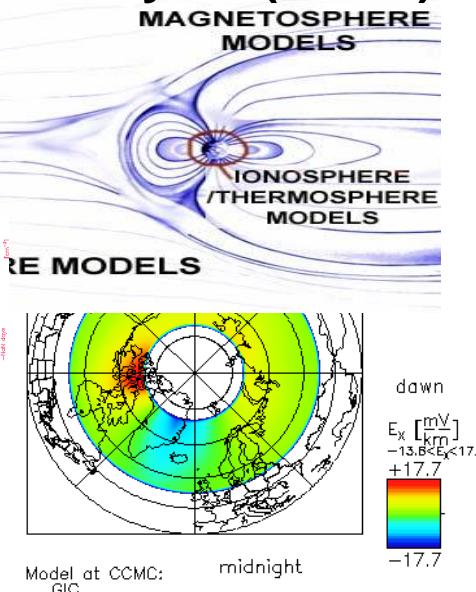
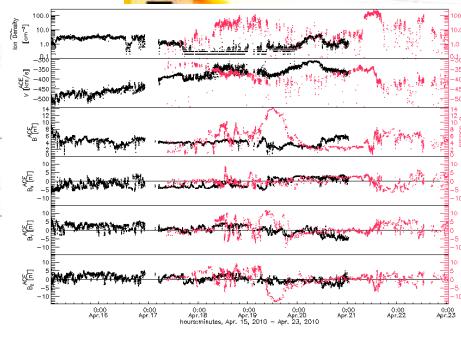
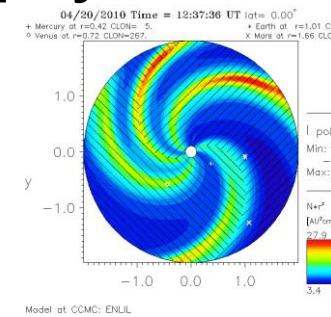


Other Partnerships

- Collaboration with CCMC: Integrated Space Weather Analysis (iSWA)
 - User-friendly data/model displays
 - Model Comparisons/Validation
 - “Ensemble” displays



COMMUNITY
COORDINATED
MODELING
CENTER



- Collaboration with AFRL Space Wx Forecast Laboratory, NRL

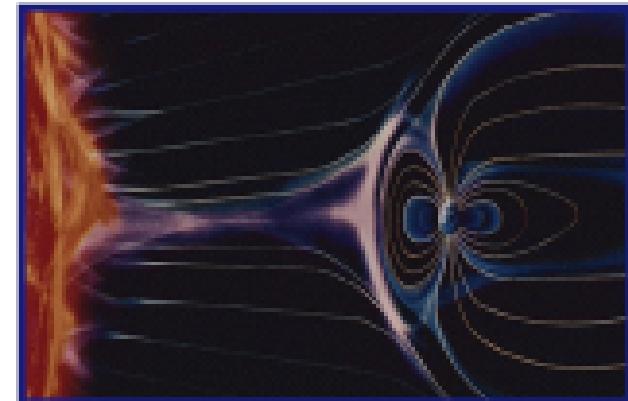
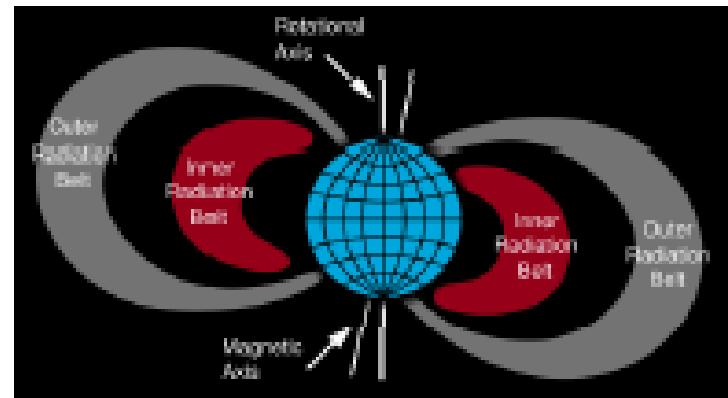


- AFWA, AFSPC/A3, SMC, AFRL, and ESC IPT – one voice



What We Still Need

- Physics-based models for scintillation, magnetosphere
- ✓ Improved flare forecast tool/model
- Improved CME forecast tool/model
- Improved proton prediction and dual frequency GPS error models
- Improved radiation exposure model
- Needed collections:
 - ✓ Top-side ionosphere
 - ✓ Solar wind (ACE follow-on)
 - ✓ Radiation belt storm probe and SDO



Headquarters U.S. Air Force

Integrity - Service - Excellence

Questions?



U.S. AIR FORCE



Rising Sun Over Pyramid (painting) – Paul Greco, 2009



Space Weather Warfighter Impacts

X-Rays, EUV, Radio Bursts

Arrival: 8 min / Duration: 1-2 days

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



Scintillation

Daily / ionospheric disturbance

- **Degraded SATCOM**
- **Dual Frequency GPS Error**
 - Positioning
 - Navigation
 - Timing



Proton 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)**



Geomagnetic Storms

Arrival: 2-3 days / Duration: days

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





GAIM Plan & Deliverables

Global Assimilation of Ionospheric Measurements (GAIM) – 8-9 year effort

- FY 04: Cost Benefit Analysis
- FY 05 - 06: USU Gauss-Markov (Dec 06 IOC)
- FY 07: UV-Capable Gauss-Markov F-16 SSUSI Disk, Speed-up/restart
- FY 08: F-16 SSUSI Limb
- FY 09: GAIM/HAF Coupling, Optimized/multi-region GAIM, F-17 SSUSI, NEXION
- FY 10: F-18 SSUSI & (SSULI?), NEXION
- FY 11: F-18 SSULI (TBD)
- FY 12-13: Full Physics GAIM

Removed in FY07 (S2I5)

