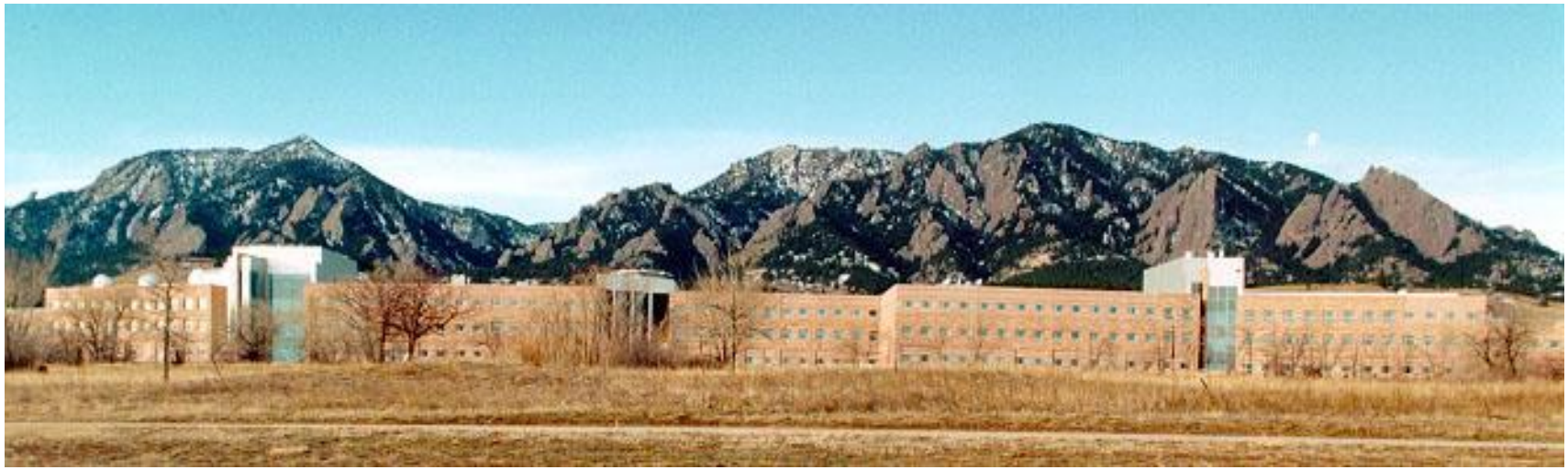


NOAA Operational Space Env Monitoring

Paper J1.2 - AMS

W.F. Denig[1] & P Mulligan[2]

[1]National Geophysical Data Center

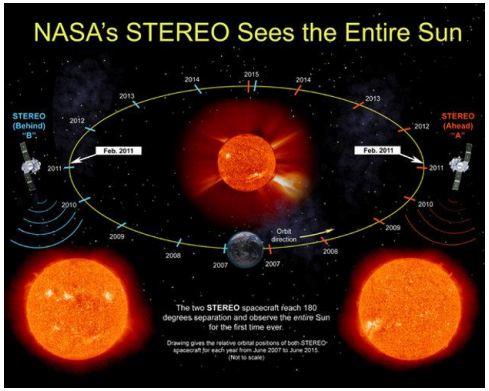
[2]Office of Systems Development

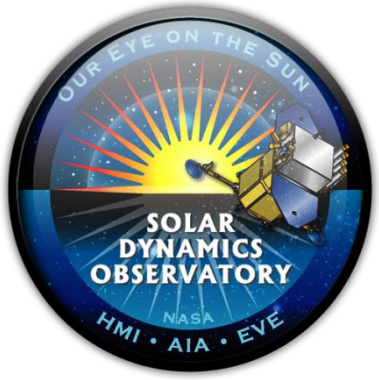
Wednesday, 05 Feb 14 / 4:15 PM / Rm C111

NOAA Operational Space Weather

Data Used in SWx Operations

The NOAA Space Weather program relies on a variety of NOAA (top) and non-NOAA (bottom) satellite assets to conduct its operational mission





GOES Environmental Data

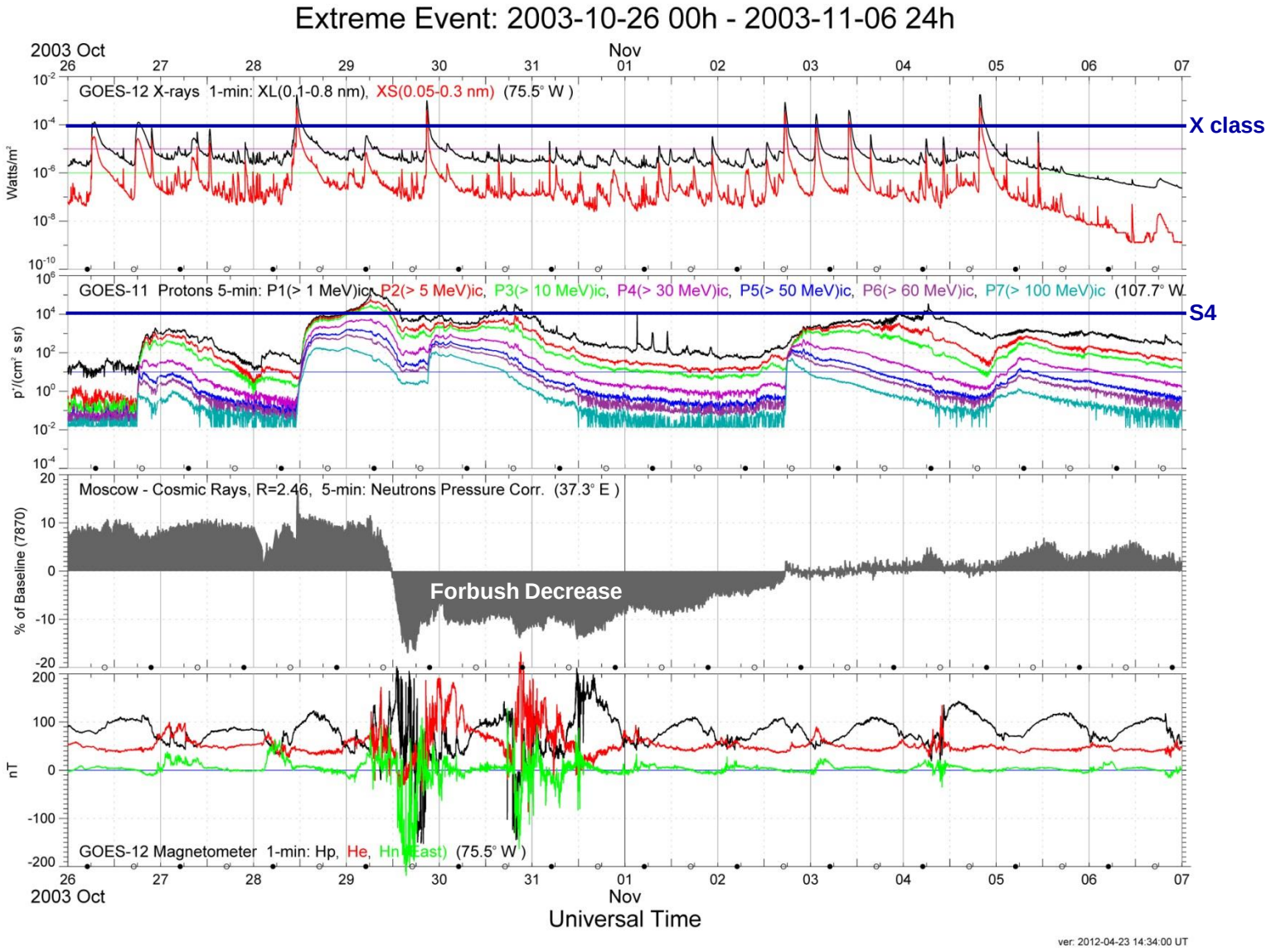
40 Years of Geostationary Measurements

Solar X-Rays

Proton Events

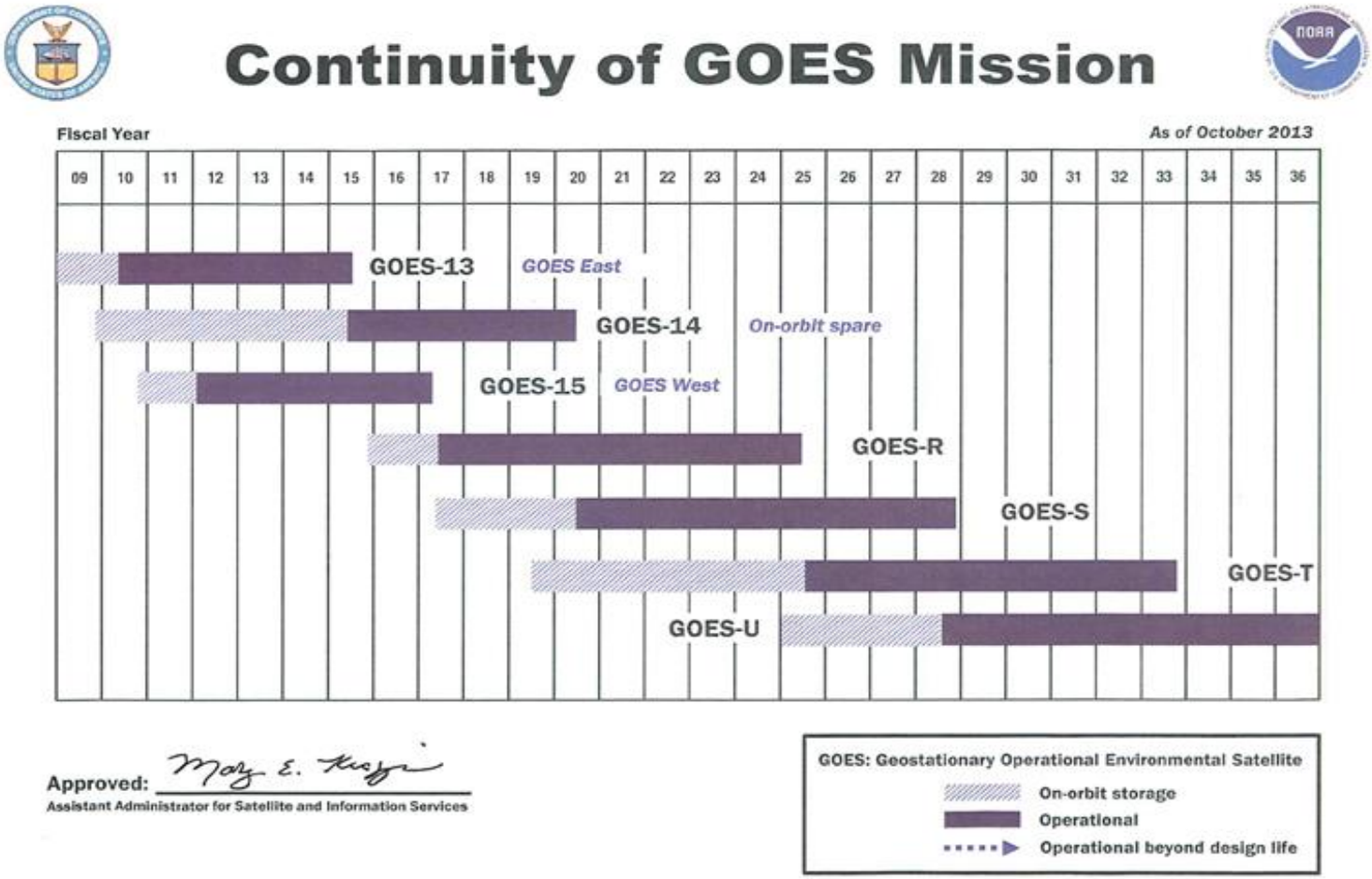
Cosmic Rays (non-GOES)

Magnetic Field



Continuity of GEO Measurements

Transitioning to GOES-R/S/T/U



GOES-R (R/S/T/U) Series
Improved SWx Capabilities

The GOES-R series space/solar sensors provide incremental improvements to current NOAA GEO space weather monitoring. First launch date of the GOES-R series is late 2015 / early 2016.

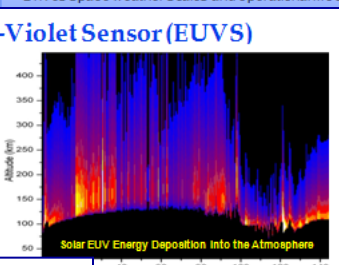
Credit: Lockheed-Martin

Solar X-Ray Sensor (XRS)

- Measures the irradiance (total brightness) of the sun in two x-ray channels
  - 0.05 to 0.4 nm
  - 0.1 to 0.8 nm
- Provides a first alert of impending solar storms and space weather events.
- Observes solar flares and provides absolute brightness information.
- Drives space weather scales and operational models.

Solar Extreme Ultra-Violet Sensor (EUVS)

- Observations of the Solar EUV Spectrum from 5 to 125 nm
- Provides solar EUV input to thermosphere and ionosphere models which provide specification and forecasts
- Models provide specification and



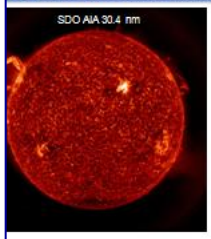
Solar Ultra-Violet Imager (SUVI)

Completely Different than GOES NOP:
- GOES NOP SXI observes in x-rays (0.6-6 nm)
- SUVI will observe in the Extreme Ultra-Violet (EUV) (10-30 nm)

Narrow band EUV Imaging: Permits better discrimination between features of different temperatures
- 30.4 nm band adds capability to detect filaments and their eruptions
- 6 wavelengths (9.4, 13.1, 17.1, 19.5, 28.4, and 30.4 nm) 2 minute refresh for full dynamic range

SUVI will provide
- Flare location information (Forecasting event arrival time and geo-effectiveness)
- Active region complexity (Flare forecasting)
- Coronal hole specification (High speed solar wind forecasting)

provides improved proxy data:
many pixels as SUVI
cadence
in 8 EUV bands, 5 of which match SUVI exactly



Space Environment In-situ Sensor Suite SEISS

Four Subsystems
Measuring Electrons, Protons, and Heavier Particles

MPS-Low: Spacecraft charging, ground-induced currents (electric power grid)
- 30ev-30keV electrons
- 30ev-30keV protons
- 14 angular bins

MPS-High: Spacecraft charging, deep dielectric charging
- 40keV-4MeV electrons
- 80keV-10MeV protons
- 10 energy bands at 5 angles

SGPS: Solar Energetic Particle events (SEP), solar radiation storms (protons), HF communication (airlines), astronaut radiation, satellite degradation.
- 1 MeV-500MeV protons
- 4MeV-500MeV alphas
- 10 energy bands at 2 angles

EHIS: Satellite single event upsets, astronaut radiation
- 10MeV/nucleon-200MeV/nucleon
- Distinguishes H, He, C-N-O, Ne-S and the Fe group, Z=17-28
- 5 energy bands

SEISS Algorithms
- **SEISS.16**: One-minute averages - all MPS channels
- **SEISS.17**: Five-minute averages - all MPS and SGPS channels
- **SEISS.18**: Convert differential proton flux values to integral flux values
- **SEISS.19**: Density & temperature moments & level of spacecraft charging
- **SEISS.20**: Event detection based on flux values

Increased # of wavelength bands

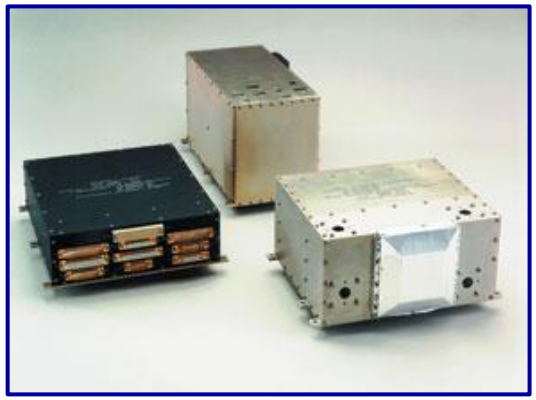
Solar UV imagery versus soft x-rays

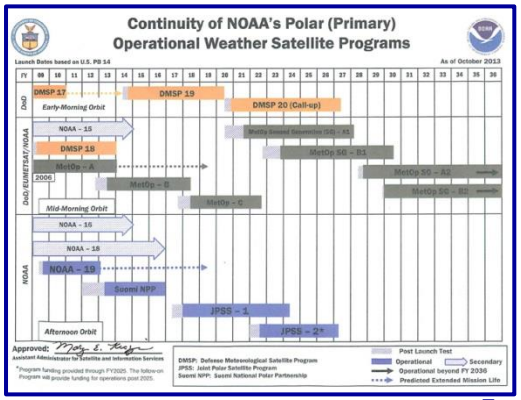
Improved particle energy coverage

Not shown: GOES-R Magnetometer

An End of an Era (since 1978)
LEO Space Environmental Monitor (SEM)

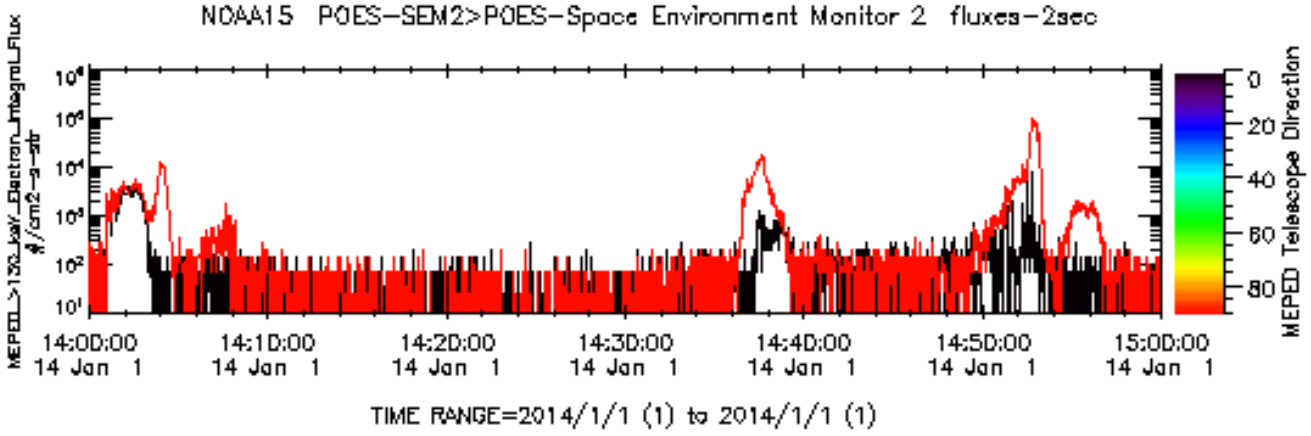
- NOAA-19 is the last NOAA satellite in polar LEO to provide operational SWx data
  - NOAA-19 Extended EOL – CY19
  - NOAA-15/16/18 still provide SEM data
- European MetOp satellites carry NOAA SEM-2 packages
  - MetOp A – CY2006 – 2014 (SEM-2)
  - MetOp B – CY2013 – 2018 (SEM-2)
  - MetOp C – CY2018 – 2022 (SEM-2)





http://www.ngdc.noaa.gov/stp/satellite/poes/index.html

Secondary Provider
Coordinated Data Analysis Web



New NOAA datasets will soon be available via CDAWeb

NOAA15/16/18/19; MetOp-A/MetOp-B

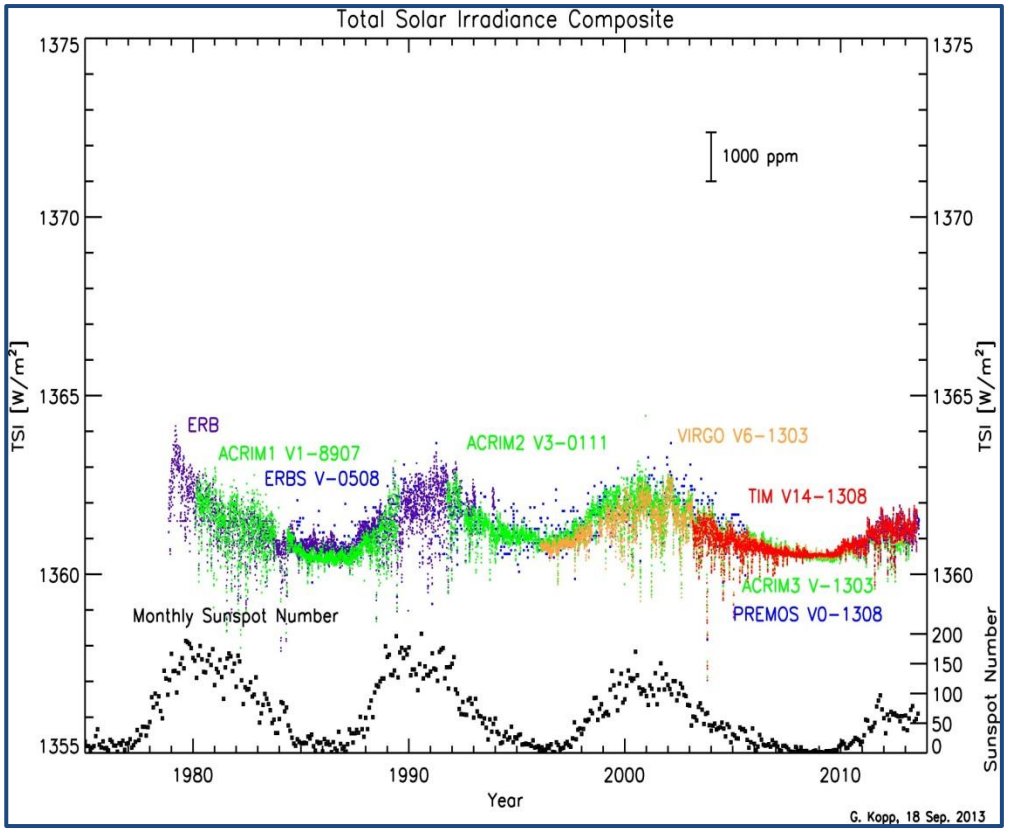
MEPED:	**e: >40; >130; >287; >612 keV**	**integral energy flux**
	p: 39; 115; 332; 1105; 2723 keV	**differential energy flux**
TED:	**e: 50 eV – 1 keV; 1 keV – 20 keV**	**channel energy flux**
	p: 50 eV – 1 keV; 1 keV – 20 keV	**channel energy flux**

Contact Rob Redmon or Bob McGuire for details

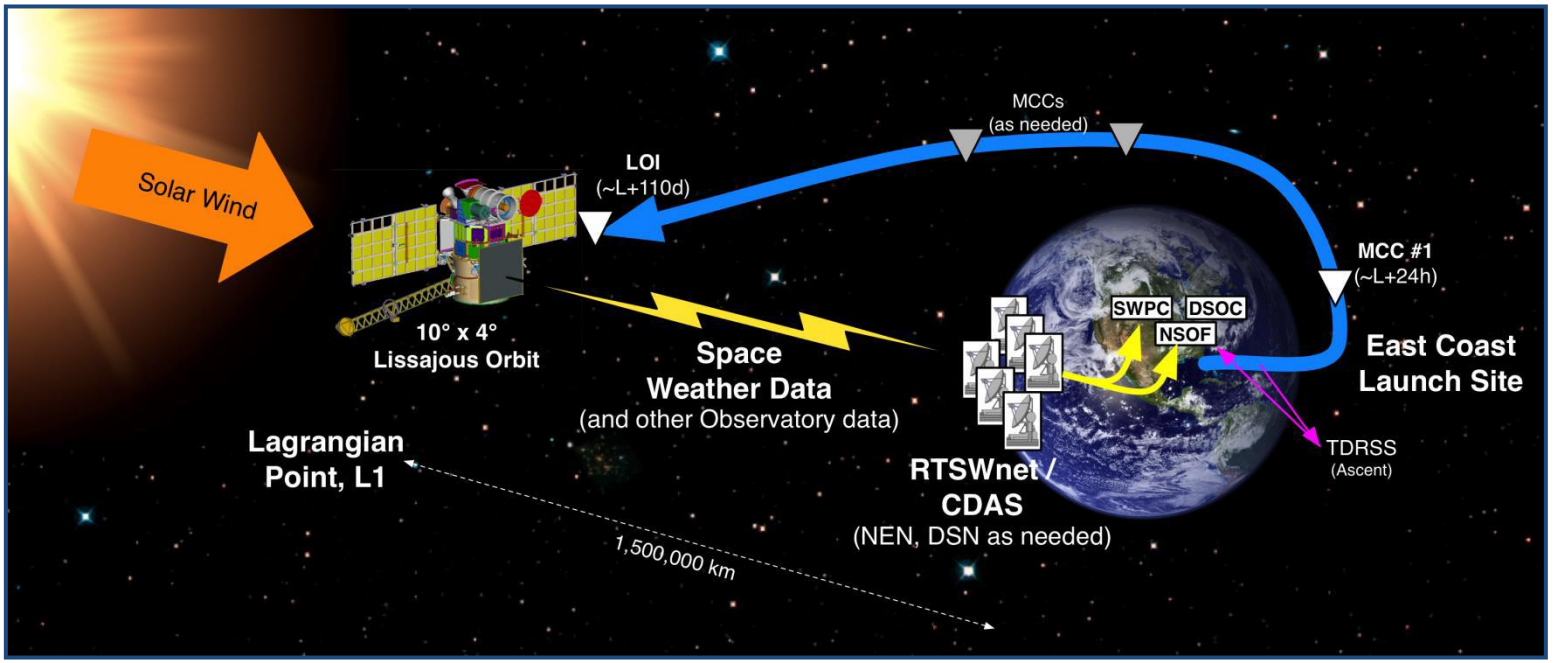
Total Solar Irradiance

TSI Calibration Transfer Experiment (TCTE)

TCTE was launched on the Air Force's STP-Sat3 on 19 Nov 2013 and put into a planned 500-km, 40-deg inclination orbit. After commissioning and outgassing, data acquisition started on 13-Dec with at least 1 orbit/day of solar observations. Overlapping Total Solar Monitor (TIM) measurements with SORCE were made in late December. Strategies for a F/O TSI mission under consideration.



New Capability
Operational SWx Data from L1

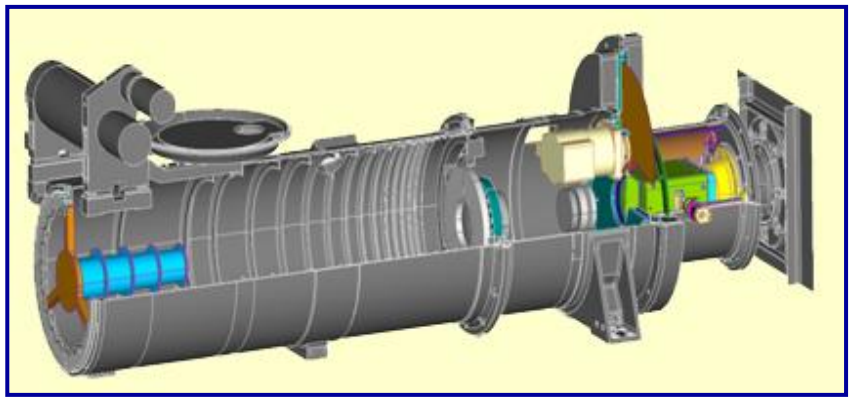


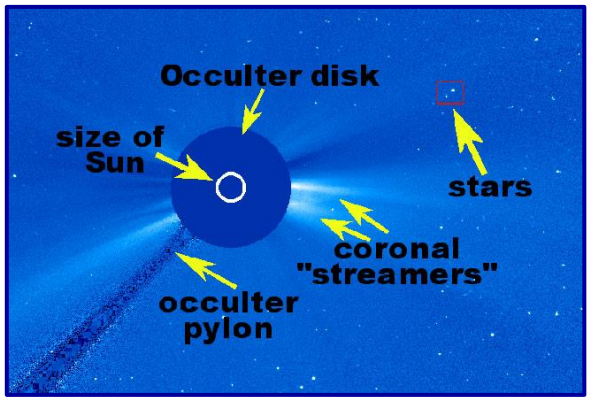
- The DSCOVR spacecraft will measure the solar wind (n_p, v_p, t_p) and the interplanetary magnetic field at 240 R_e forward of the earth
- Space-X Falcon 9 launch scheduled for 13 Jan 2015; DSCOVR on-station in 110 days
- DSCOVR solar wind/IMF data downlinked via the Real-Time Solar Wind Network (RTSWnet) as is currently done for ACE
- SWPC provides real-time data / NGDC provides retrospective data (>1 day)

SWPC plans to host a NOAA Solar Wind and L1 Requirements Workshop
06-07 April 2014 in conjunction with the Space Weather Workshop
Contact Doug Biesecker for details

Continuing Studies
Compact Coronagraph (CCOR)

NOAA currently uses SOHO coronagraph to detect and characterize coronal mass ejections (CMEs)



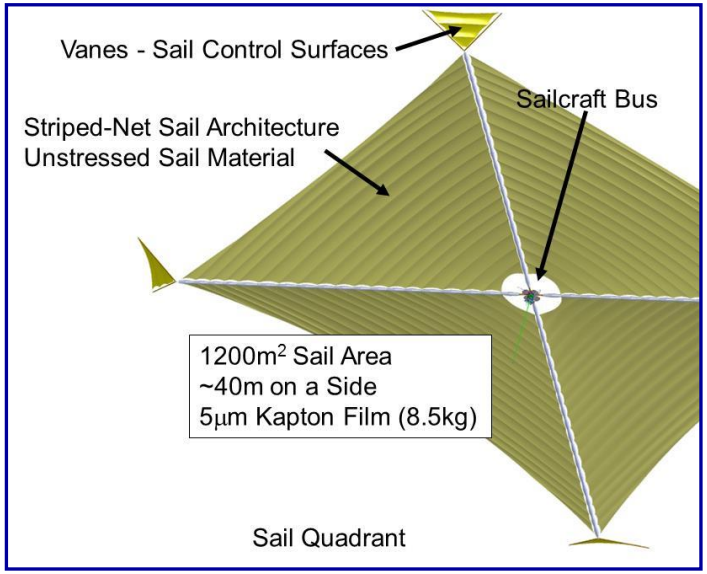


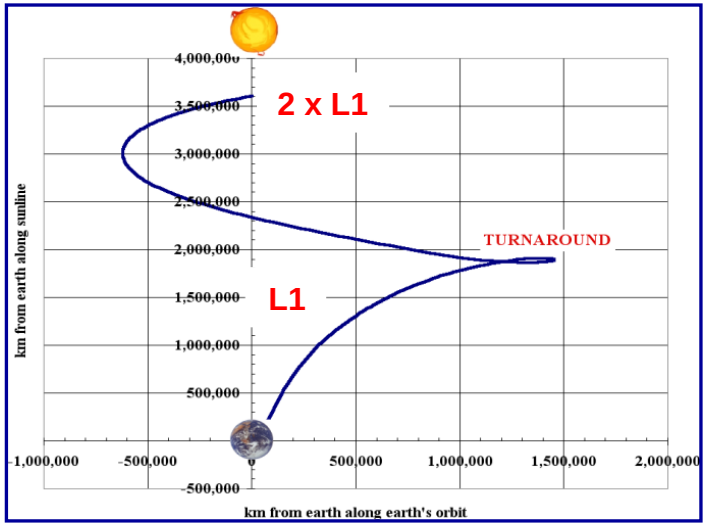
- CCOR design offers reduced sensor mass and volume at lower cost
  - 6 kg telescope, 17 kg for sensor
  - Optical train is 1/3 length of traditional coronagraphs & uses multiple occulters
- NRL completed Phase A study & successfully bench tested the optical design
- NOAA will continue to fund risk reduction studies at NRL during FY13-14
- CCOR ranked in DoD Space Experiments Review Board for STP launch
- CCOR under consideration for DSCOVR follow-on mission options

Technology Demonstration

Sunjammer – Solar Sail Demonstration

- Sunjammer is a NASA technology demonstration mission (TDM) to examine the propellantless propulsion potential of solar sails
- Mission will demonstrate sail maneuvers in its first 30 days – then fly to 2 x L1 and then out of the ecliptic plane if within orbital constraints
- NOAA plans to partner with NASA to provide data reception, analysis and archive
- Space weather instruments:
  - Particle spectrometer – MSSL
  - Magnetometer – Imperial College London
- Previously co-manifested with DSCOVR – now looking for a GEO-transfer launch





DSCOVR Follow-on

Operational Solar Wind / CME Imagery Missions

NOAA is committed to continued solar wind/CME monitoring

Solar Wind – Commercial and other options:

- Evaluate Sunjammer mission performance data for improved space weather forecasts
- Evaluate business case for Sunjammer commercial data buy option
- Examine sensor concepts for improved sensor performance
- Refresh cost estimates for other options such as government satellites

CME Imagery

- Continue CCOR risk reduction studies at NRL
- Pursuing STP launch option
- Include CME imagery option in DSCOVR follow-on studies

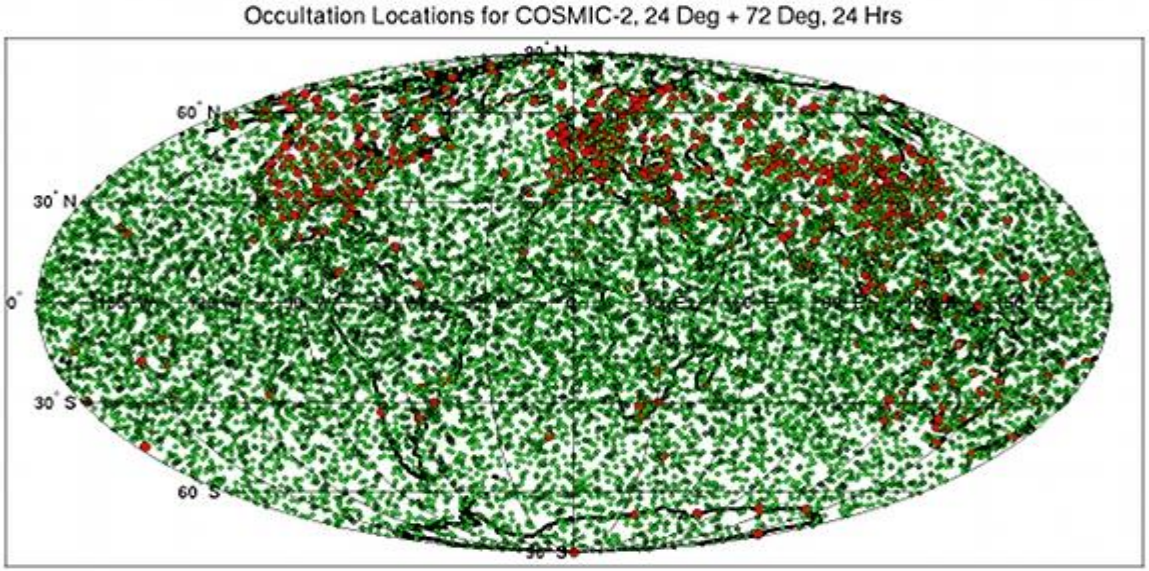
NOAA Solar Wind and L1 Requirements Workshop (Pre-announcement)

- 06-07 April 2014 – Boulder, Colorado (just before Space Weather Workshop)
- If interested, send an e-mail to Doug Biesecker (doug.biesecker@noaa.gov)

New Capability
GNSS Radio Occultation – COSMIC II

Constellation Observing System for Meteorology, Ionosphere & Climate

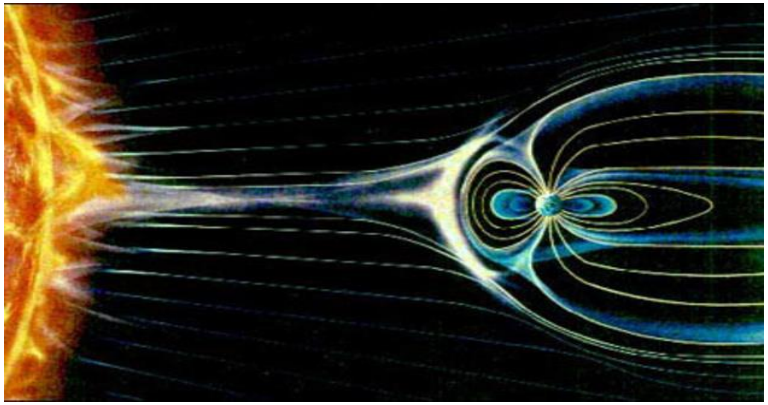
- Taiwan-USAF-NOAA Partnership
- 12 satellite constellation – 6 @ 24º inclination (low) / 6 @ 72º inclination (high)
- Phase 1 launch planned for March 2016 – low inclination; Phase 2 launch - >2018
- NOAA coordinating with international partners to host/operate ground receptors
- Full up constellation will acquire more than 8000 ionospheric soundings per day

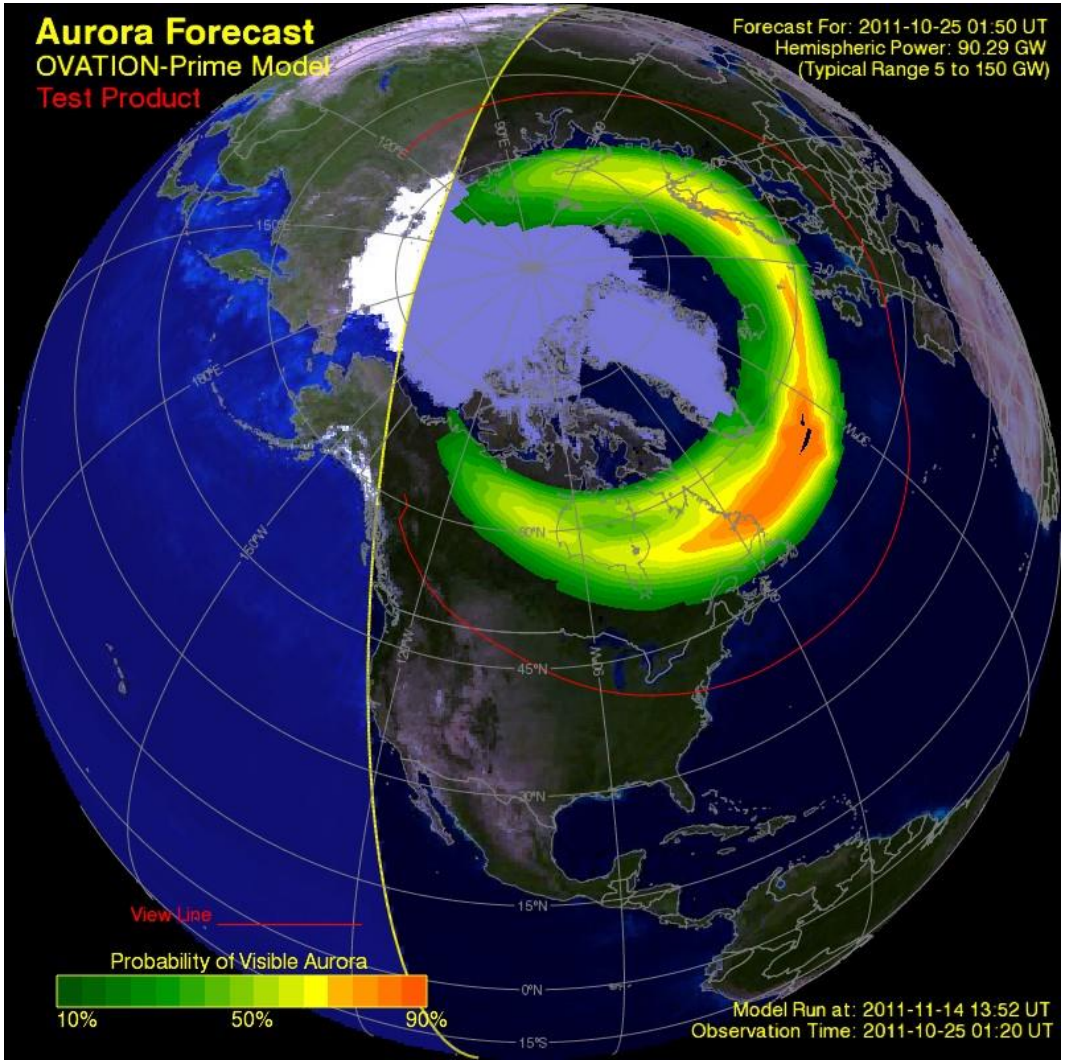


Expanded Products & Services

Ovation Auroral Forecast Model

- Methodology developed at JHU/APL
  - 30-40 min forecast driven by ACE solar wind and interplanetary magnetic field data – ops will transition to DSCOVR
  - Model currently running in real-time at NGDC – link
  - Customer products available from SWPC – link
- Plans:
  - Transition Ovation to full operations in March 2014
  - Test & implement model upgrades for reduced noise and capability to handle larger storms



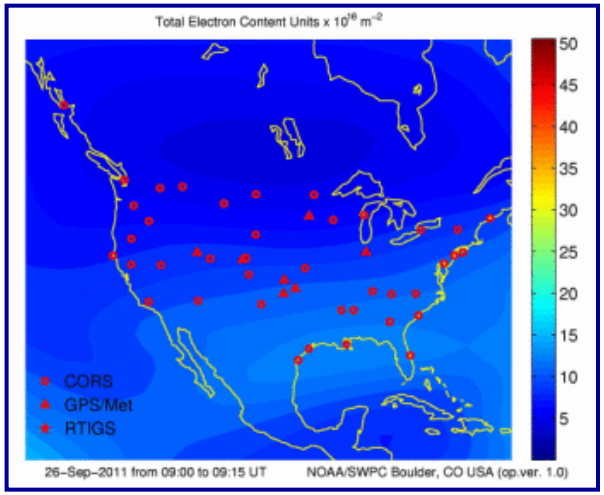


Send comments to Rod Viereck (SWPC)

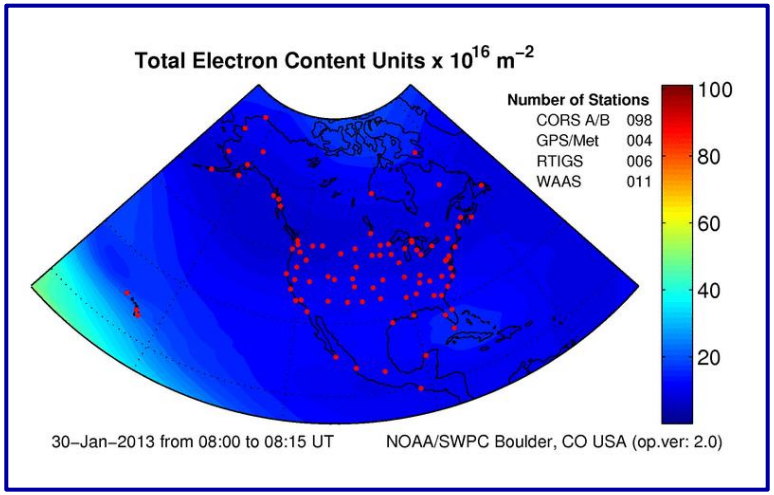
Expanded Products & Services

North America TEC

Extending current US-TEC product to NA-TEC

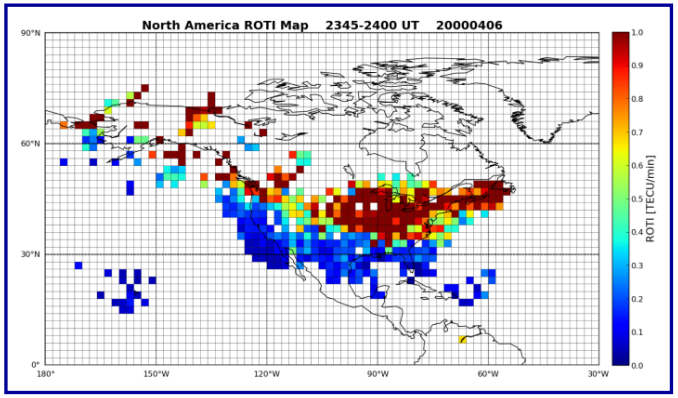


Research to Operations



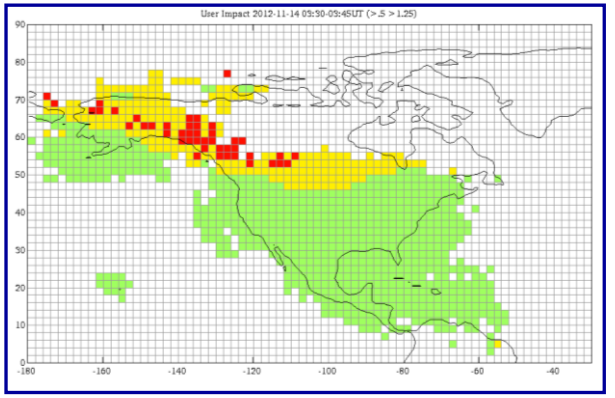
Related products

Rate of TEC Index Product



Research and Development

GPS Scintillation Specification

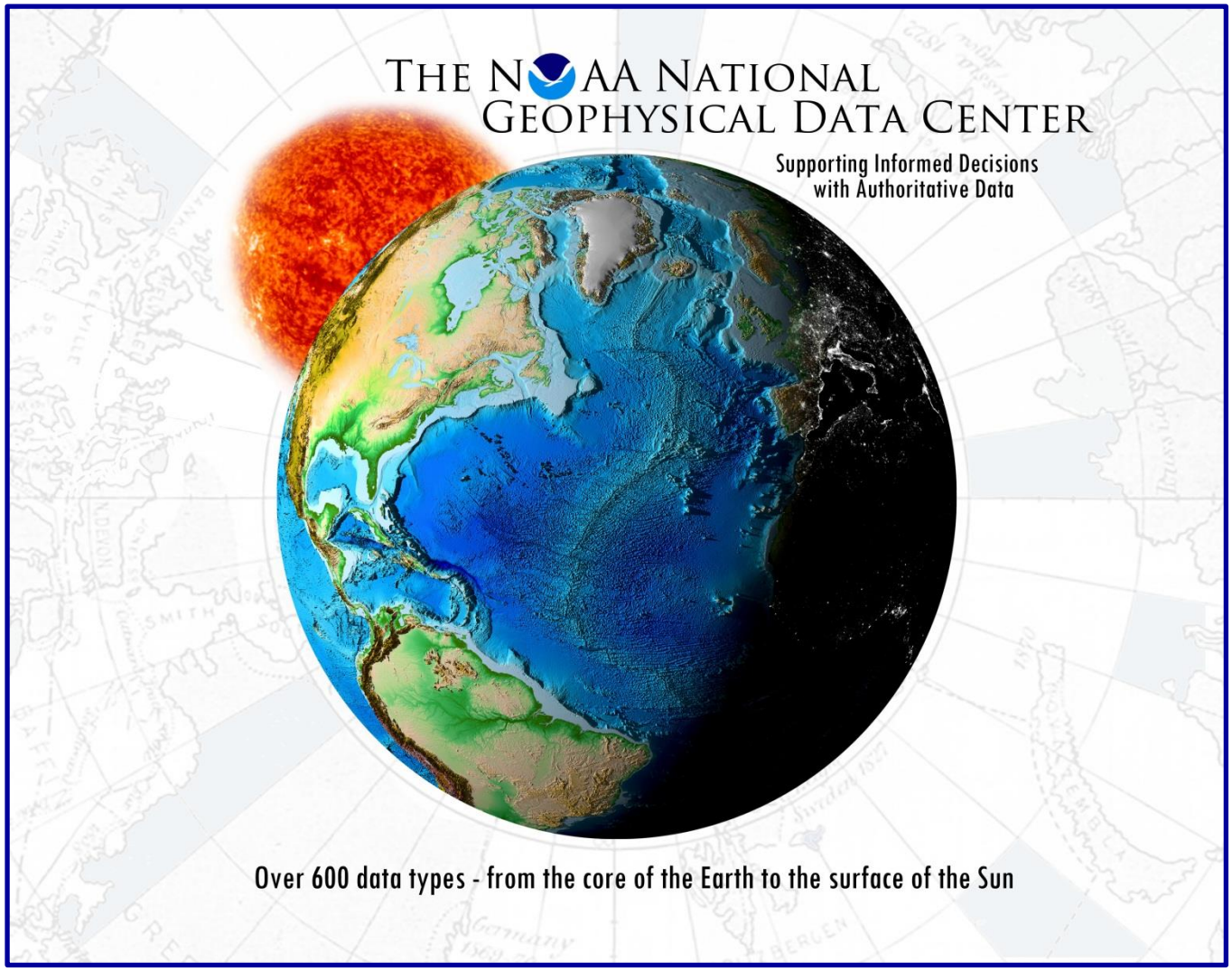


Expanded Products & Services

Summary – Take Aways

- NOAA currently provides a variety of operational space weather data and products from its existing fleet of environmental satellites (GOES and POES/MetOp)
- GOES-R/S/T/U will continue to acquire GEO measurements through 2036
- After POES/MetOp there are no planned operational (or otherwise) satellites acquiring particle/radiation data in LEO – possible AF initiative (HEALER – Joe Mazer/Aerospace)
- New near-term NOAA operational sources of space weather data include DSCOVR at the L1 Lagrange location and COSMIC-II in LEO – Sunjammer & DSCOVR follow-on are also in the mix
- NWS/SWPC has new products and services coming on line

Thank You!


THE NOAA NATIONAL
GEOPHYSICAL DATA CENTER
Supporting Informed Decisions
with Authoritative Data
Over 600 data types - from the core of the Earth to the surface of the Sun