Improved Space Weather Monitoring

Paper J2.4 - AMS

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[1]National Geophysical Data Center

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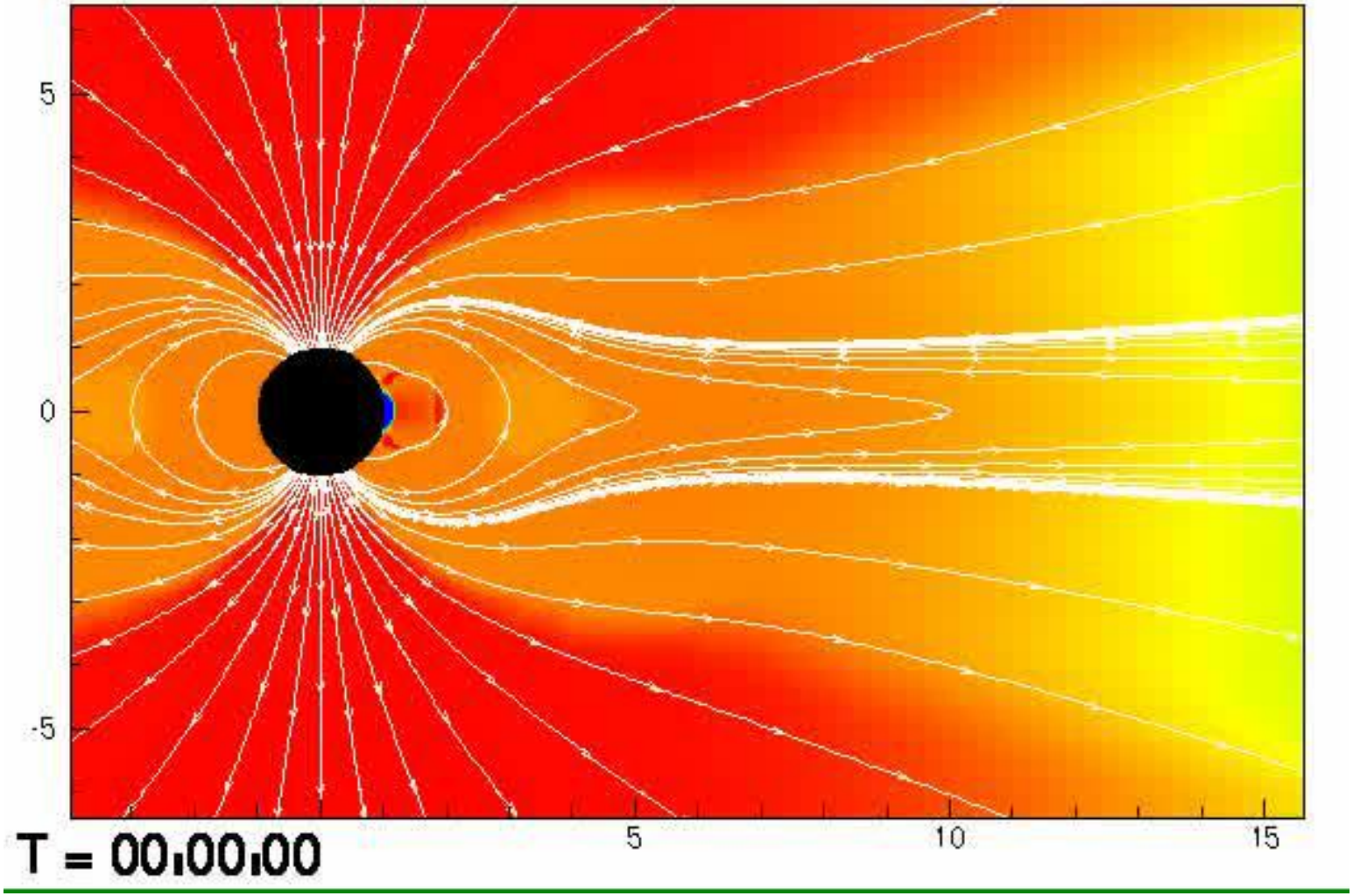
Improved SWx Monitoring

The Solar-Terrestrial Environment

Center for Space Environment Modeling
University of Michigan



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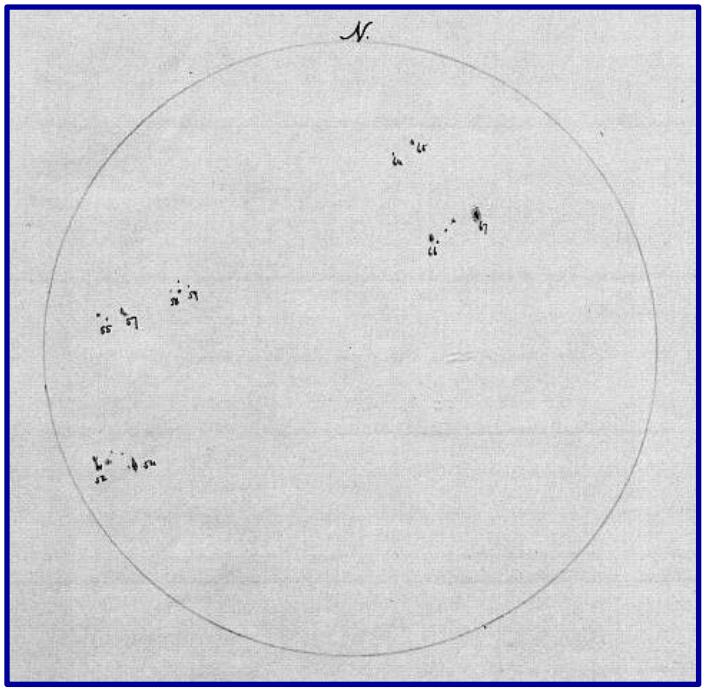
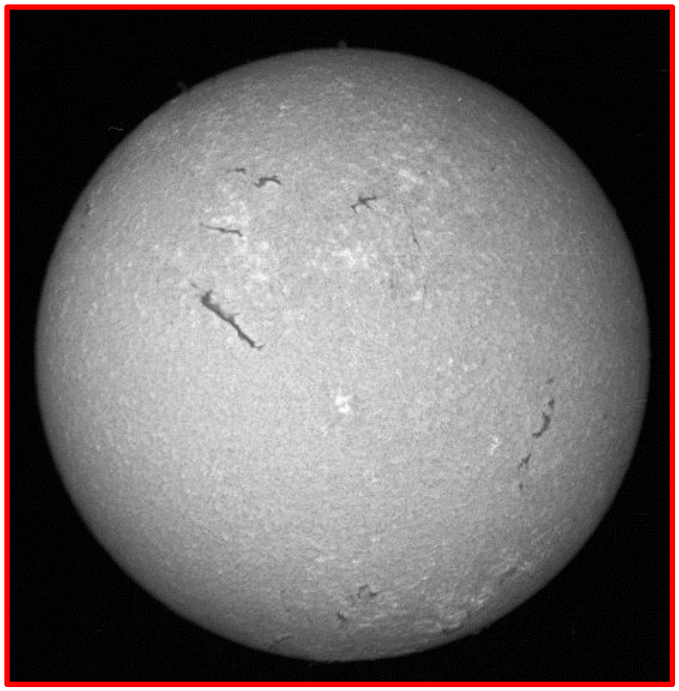
NOAA Historical Solar Observations



Observations of sunspots in white light made by Charles Anthony Schott of the Coast Survey, 1859-1860. White-light observations are of the solar photosphere. The daily sunspot number (SSN) has been a consistent solar index from the early 1800's to present.



From 1967 to 1994 the NOAA Space Environment Center observed the sun in H-alpha (656.3 nm). Chromospheric observations of prominences, filaments, plague and the chromospheric network. The USAF continues to make daily observations.

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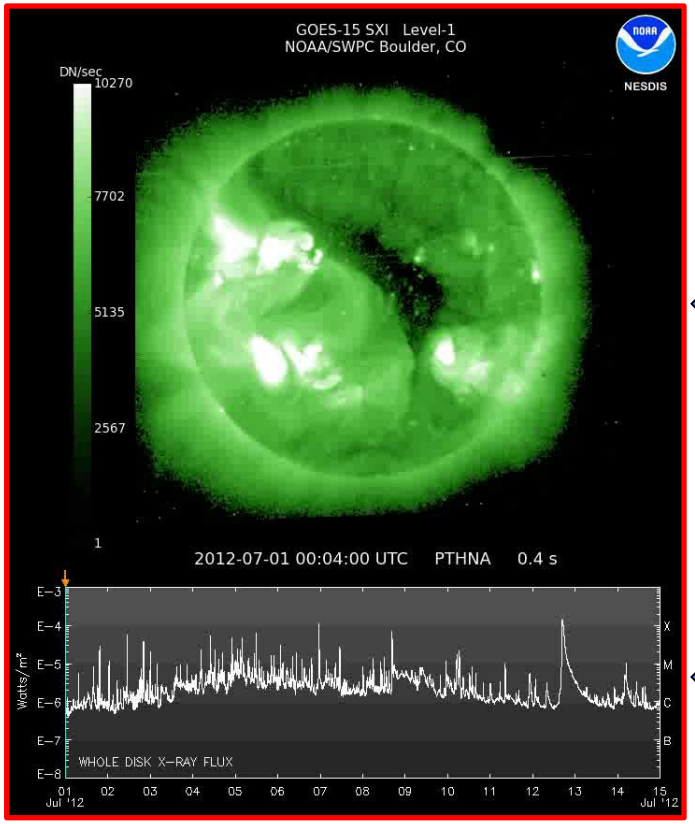
GOES Solar Imagery

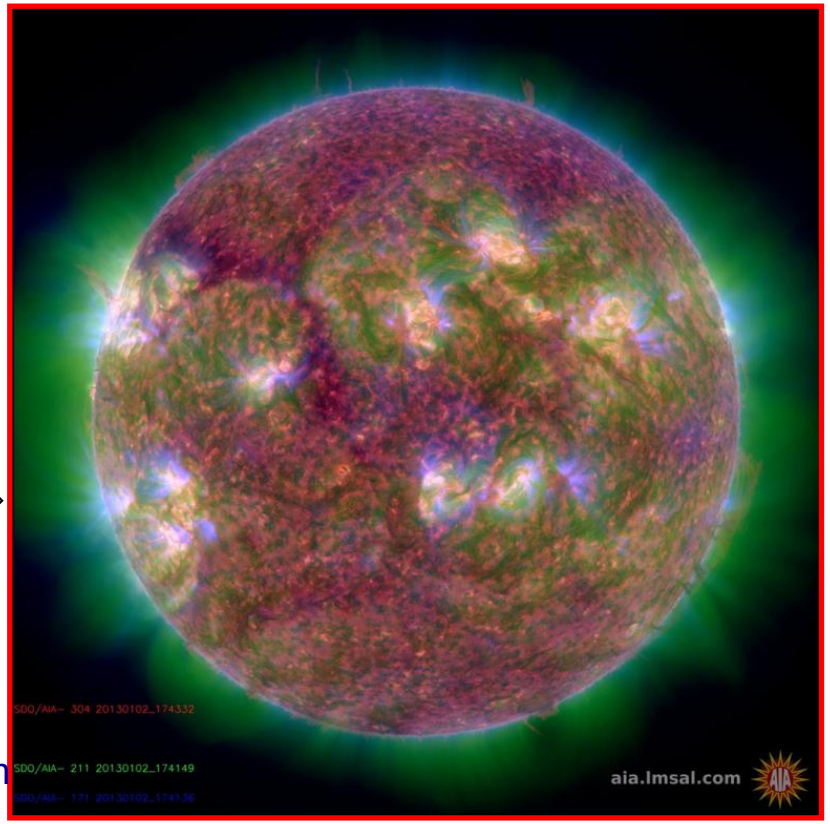


SXI

XRS

Flare Classification

AIA



The GOES 12 through 15 spacecraft each carry a sophisticated Solar X-ray Imager (SXI) to monitor the Sun's X-rays for the early detection of solar flares, coronal mass ejections, and other phenomena that impact the geospace environment.

Heritage sensor for the Solar Ultra-Violet Imager (SUVI) is the SDO Atmospheric Imaging Assembly. Various filters of SUVI monitor the solar chromosphere, corona, and the transition region.

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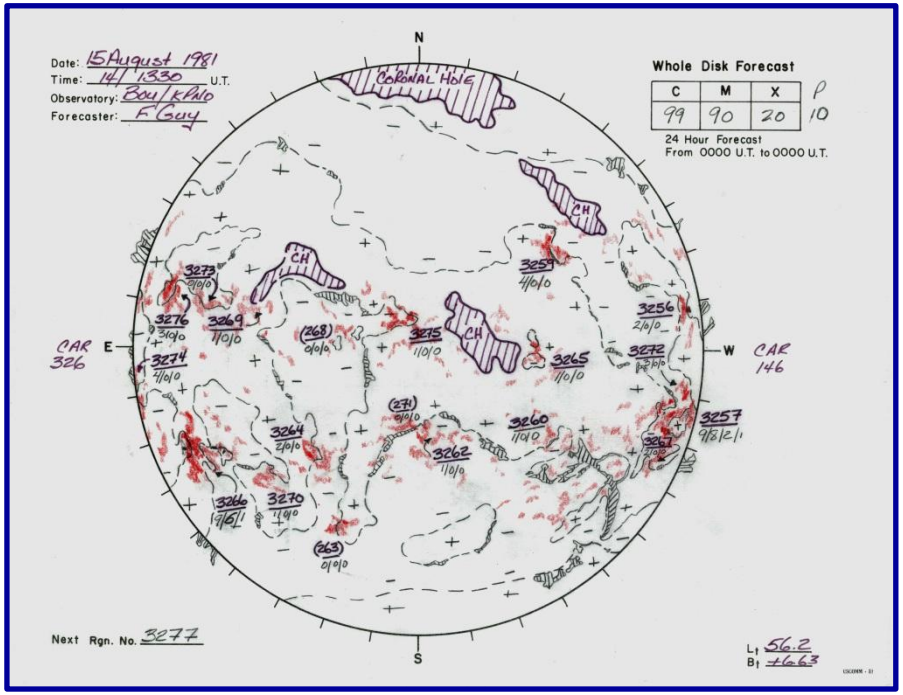
NOAA Daily Solar Synoptic Drawings

Each day the NOAA Space Weather Prediction Center (SWPC) produces a synoptic drawing highlighting solar areas of interest to space weather. Data for these drawings are assembled from a variety of ground-based and space sources. Future SUVI observations will provide much of the details needed by SWx operators (see slide #13)



Solar synoptic maps identify features such as neutral lines, coronal hole boundaries, active regions, plage, filaments and prominences. Also included is information about the coronal hole polarity, active region numbers, flare probabilities for each region and the proton event probabilities for each region.

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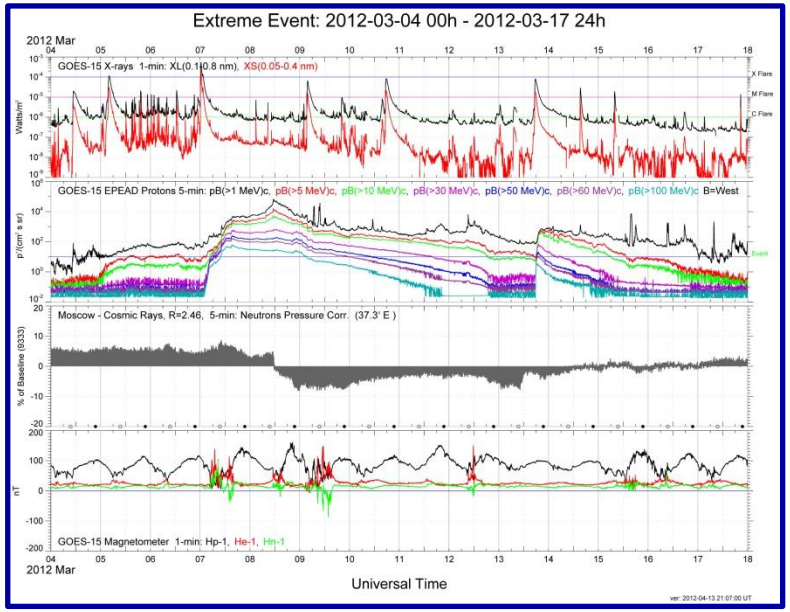
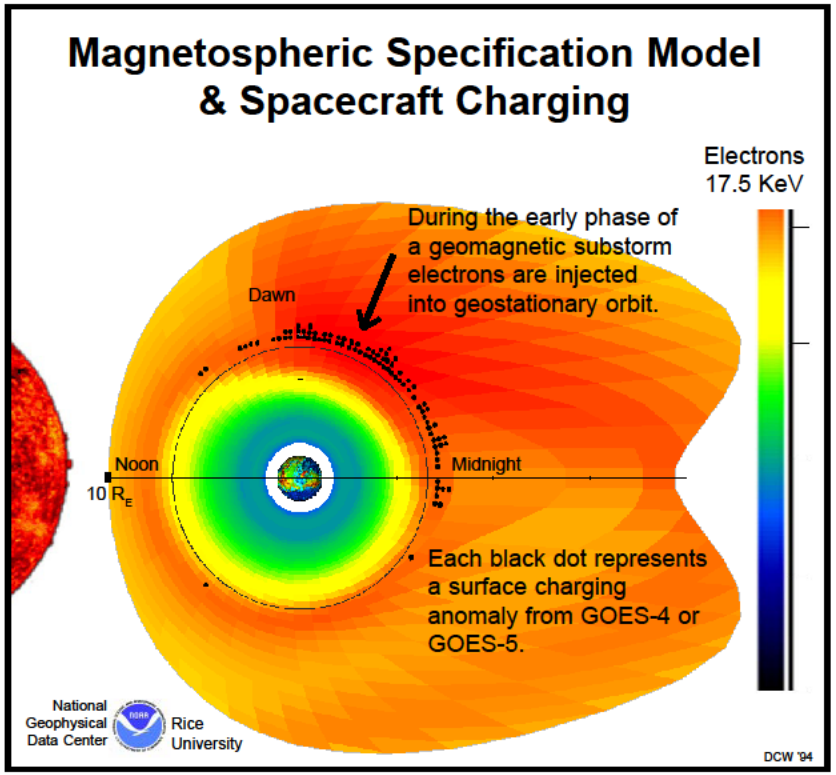
GOES Space Environment Monitor

"My God, Space is Radioactive!"

In 1958 Dr James Van Allen discovered that the near-earth space environment was populated by energetic charged particles. NOAA has continually monitored the space environment since 1974. The early GOES-4 and -5 spacecraft experienced numerous anomalies due to space particle effects.





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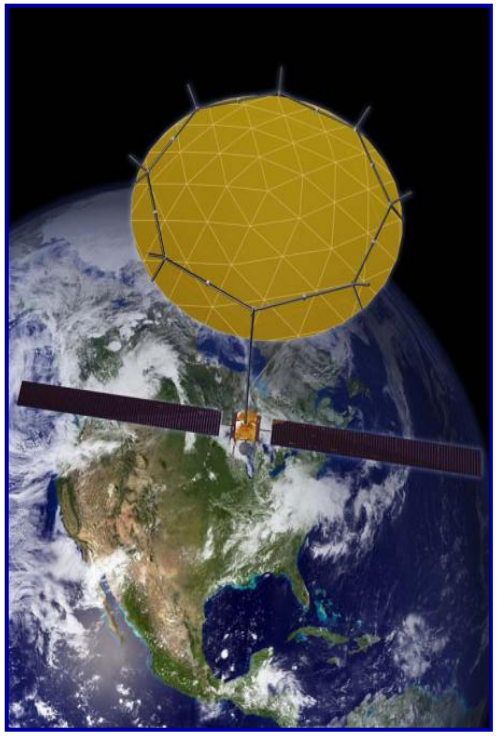
Space Environmental Assessments

Example 1 – Galaxy-15[1]

Orbit: Geosynchronous

Anomaly Date:
05 April 2010 @09:48

Probable Cause:
Internal Charging/ESD

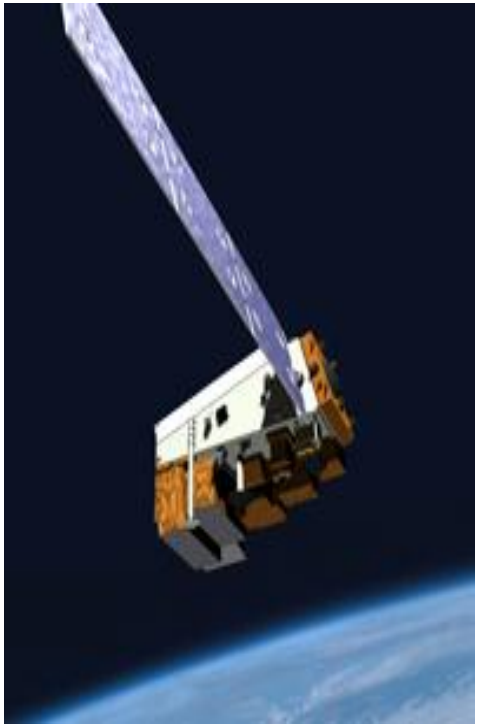


Example 2 – SkyTerra-1

Orbit: Geosynchronous

Anomaly Date:
07 March 2012 @14:43

Probable Cause:
Single-Event Upset



Example 3 – NPP/VIIRS

Orbit: Polar LEO

Anomaly Date:
Various

Probable Cause:
Single-Event Upsets

[1]Analysis limited by lack of low-energy measurements – GOES-R corrected

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GOES-R SWx Poster Presentations

GOES-R/JPSS Posters (Part 1) – Exhibit Hall 3

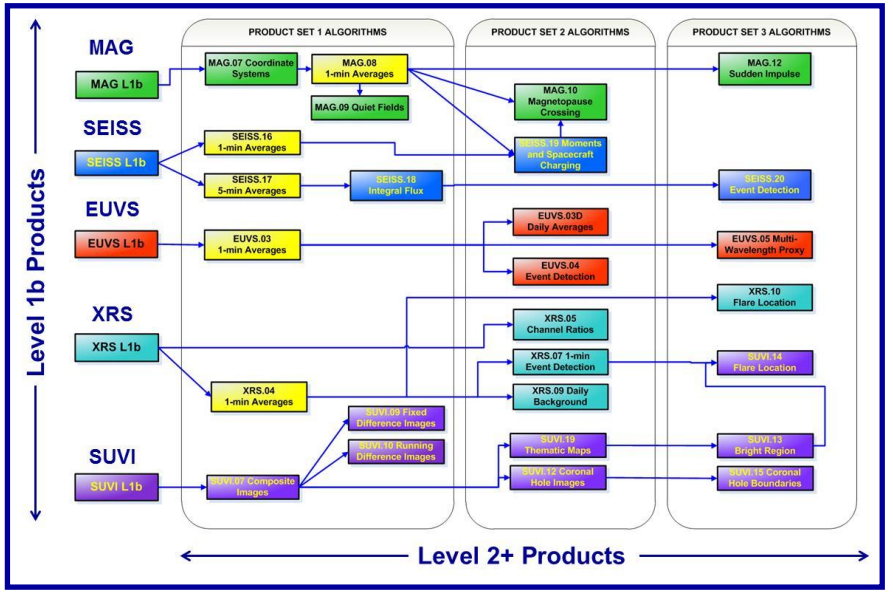
Paper 296 (SEISS) – *Development of a Proxy Data Set for the Energetic Heavy Ion Sensor in the GOES-R Space Environment In-Situ Suite*

Paper 304 (EXIS) – *GOES-R Solar Extreme Ultraviolet Irradiance: Requirements, Observations and Products*

Paper 315 (MAG) – *The GOES-R Sudden Impulse Detection Algorithm*

GOES-R/JPSS Posters (Part 2) – Exhibit Hall 3

Paper 660 (SUVI) - *Automatic Analysis of EUV Solar Features using Solar Imagery for the GOES-R SUVI*



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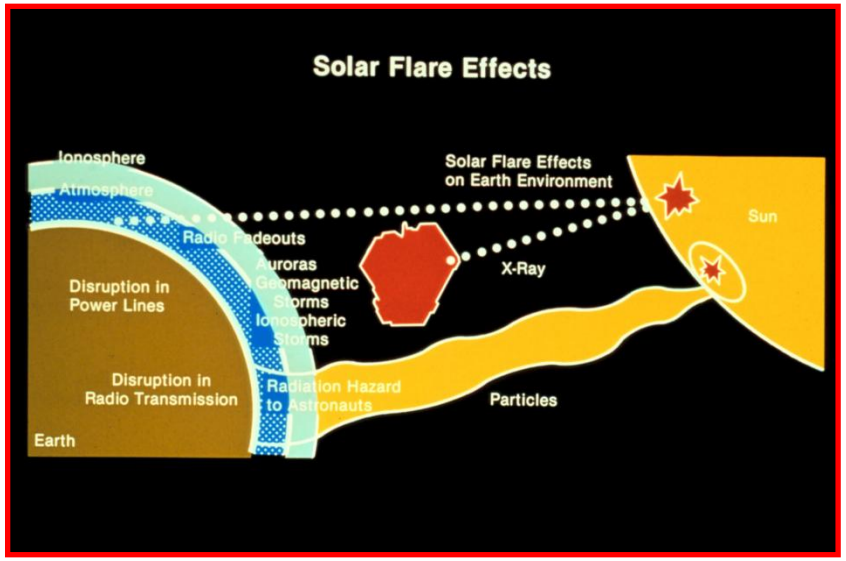
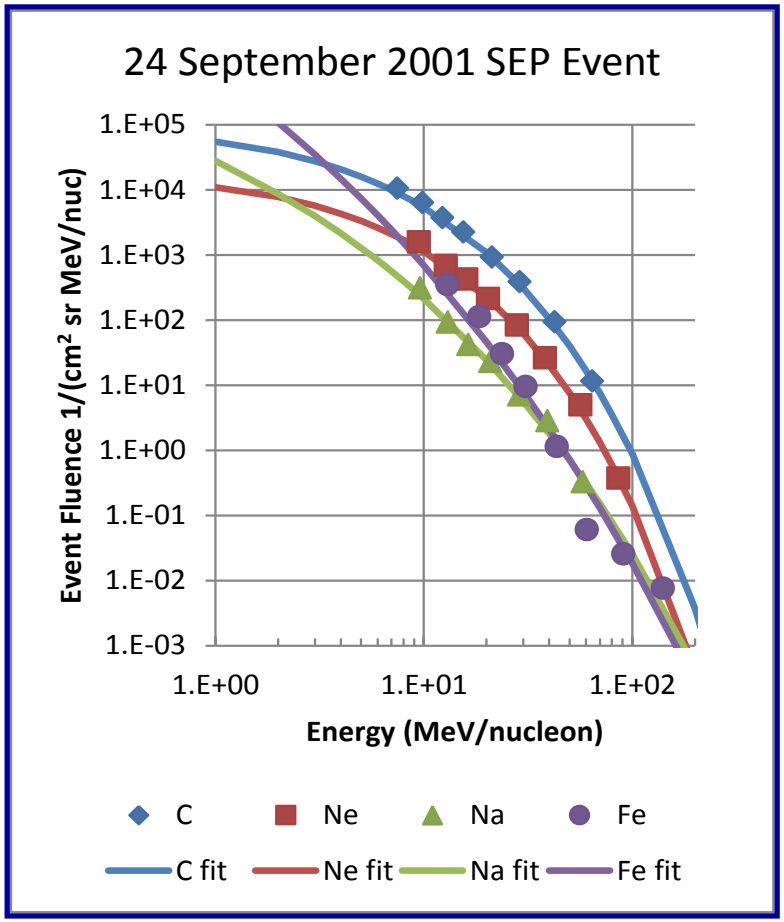
Poster 296 – SEISS

Development of a Proxy Data Set for the Energetic Heavy Ion Sensor in the GOES-R Space Environment In-Situ Suite

Authors: **Ranjeetha Bharath**, J.V. Rodriguez, J.C. Green and W.F. Denig



Space particle measurements from the NASA ACE satellite used to create sets of particle fluence curves for modeling the EHIS response to solar energetic particle events. Information used to support satellite design and anomaly resolution.



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Poster 304 – EXIS

GOES-R Solar Extreme-Ultraviolet Irradiance: Requirements, Observations and Products

Authors: **Janet L. Machol**, R.A Viereck, A. Reinard, F.G. Eparvier, M. Snow, A.R. Jones, T.N. Woods, W.F. Denig, D.L. Woodraska, and S.W. Mueller

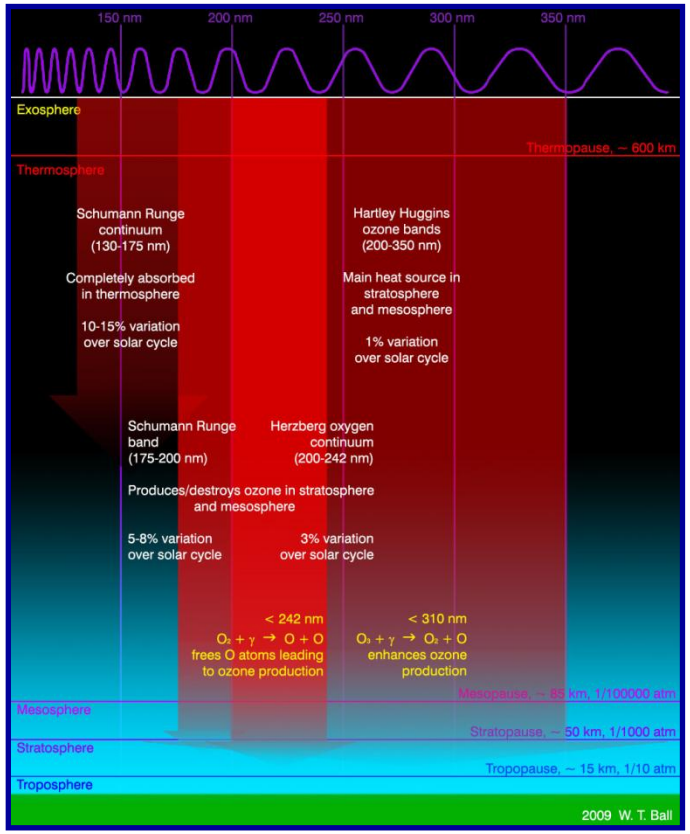
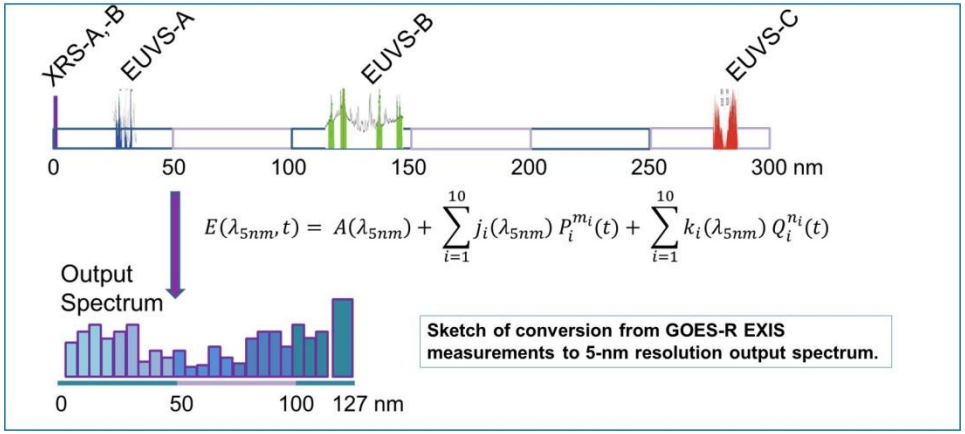


Photo credit: CU/LASP



Solar forcing on Earth's atmosphere is wavelength dependent. Solar extreme ultraviolet (EUV) photons and x-rays are primary energy sources to the upper atmosphere affecting satellite drag, radiowave communications and navigation, and upper atmospheric chemistry.

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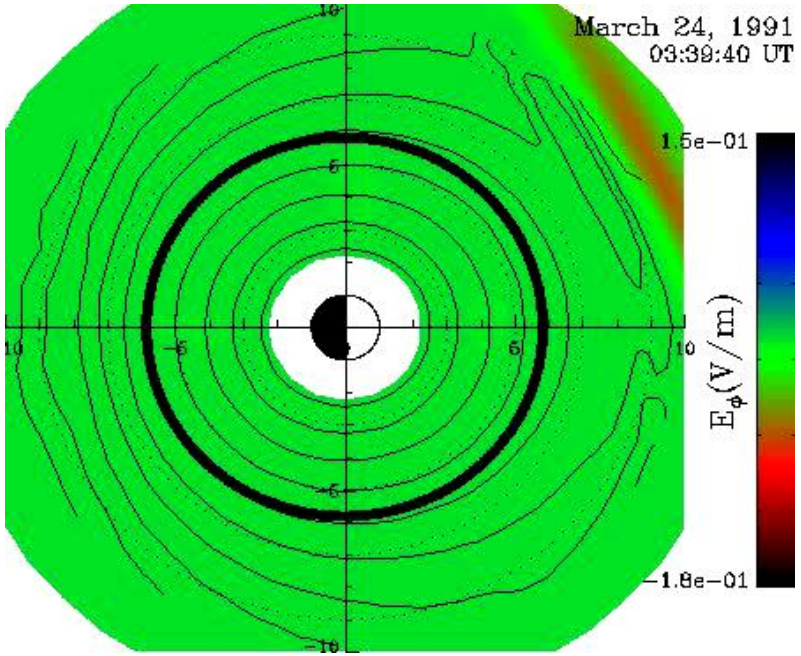
Poster 315 – MAG

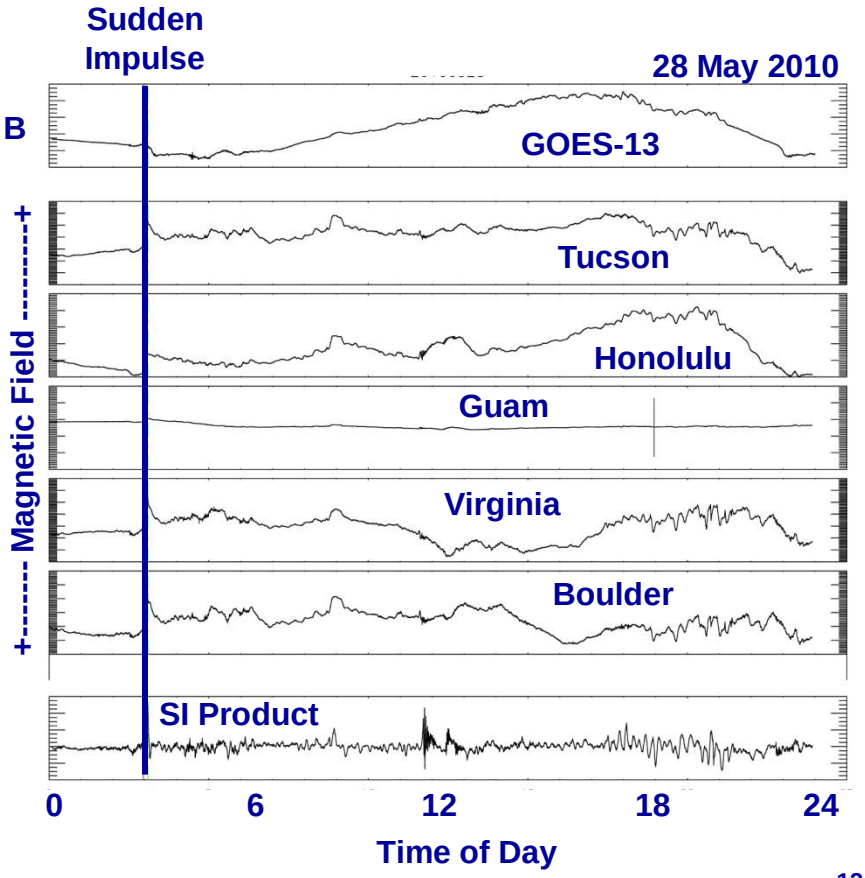
The GOES-R Sudden Impulse Detection Algorithm

Authors: **William Rowland**, R. Redmon and H.J. Singer



Results of MHD/particle simulations showing the prompt injection of energetic electrons into the inner magnetosphere during sudden commencement phase of the March 1991 superstorm. (after Elkington)

Goal – GOES-R measurements used to reliably detect sudden impulses (SI)

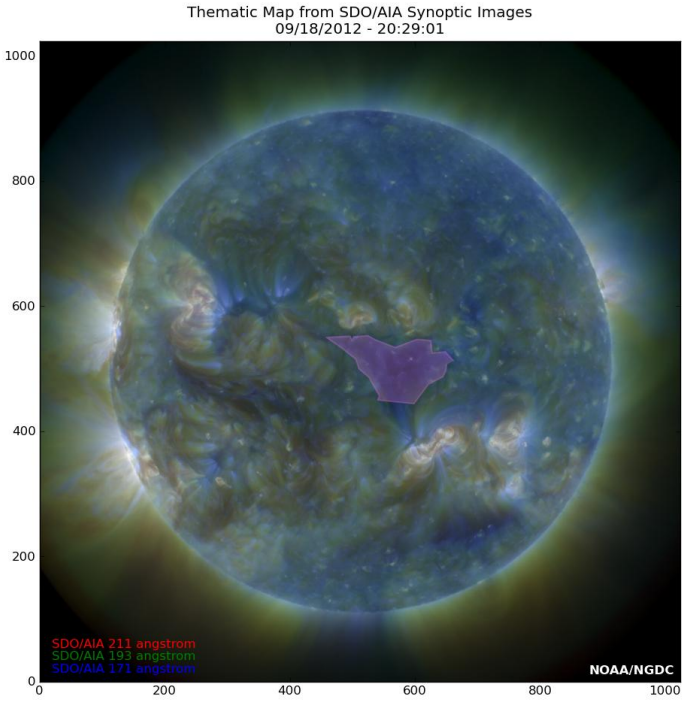


Improved SWx Monitoring
Poster 660 – SUVI

Automatic Analysis of EUV Solar Features using Solar Imagery for the GOES-R SUVI

Authors: **Jonathan Darnel**, S.M. Hill and W.F. Denig

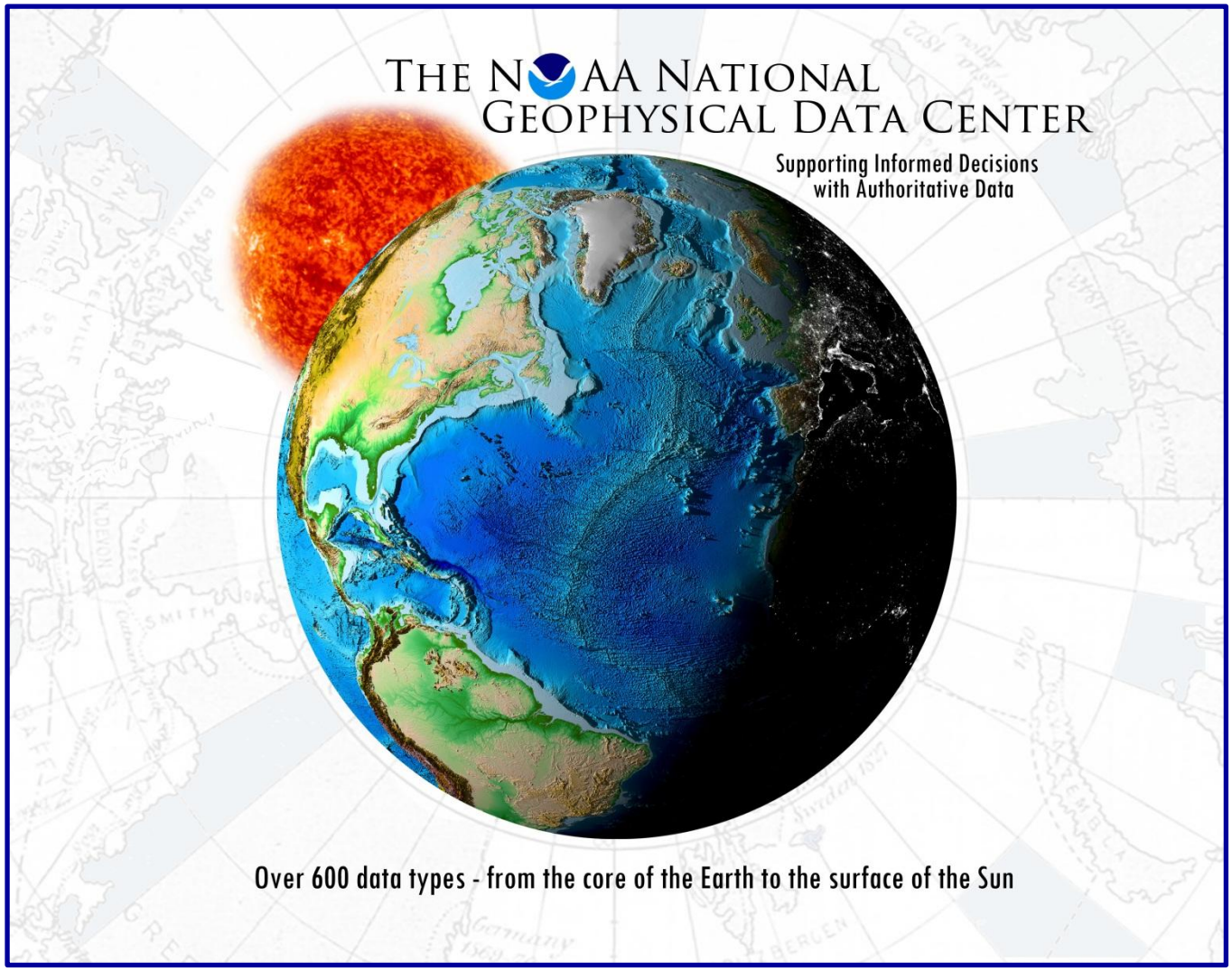
Coronal Holes are the source of the high-speed solar wind. One of the SUVI L2+ products will automatically determine the boundaries of the coronal holes classified from the Thematic Map product and produce a list of vertices to describe each Coronal Hole. This list of vertices will aid forecasters in the prediction of changes to the solar wind speeds. Other SUVI L2+ products are maps and shapefiles of bright regions and solar flare locations.



Coronal Hole Data	
Vertices (Heliographic Latitude/Longitude)	
-14.93	19.29
-12.38	17.9
-11.5	14.54
-8.76	15.27
-7.27	12.06
-6.96	6.2
-3.57	2.36
-1.89	0.88
-0.82	-2.37
-1.41	-3.13
-0.32	-3.17
1.77	-8.7
-1.73	-6.3
-2.37	-5.9
-5.68	-3.94
-7.94	-4.07
-10.74	-2.55
-15.66	-1.73
-16.25	-2.51
-20.52	6.02
-17.78	11.14
-17.47	15.35
-16.41	16.61
-15.27	17.2

Coronal Shapefile

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