GOES-R Algorithm Working Group: Space Weather Team Update

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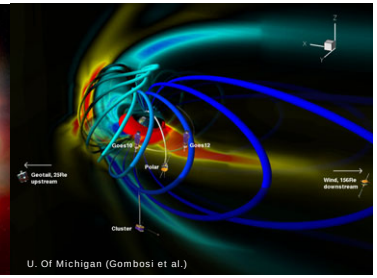
Abstract

The Space Weather (SWx) Team of the Algorithm Working Group (AWG) was formed in January 2006 to address algorithm development and readiness for the Solar Imaging Suite (SIS), Space Environment In Situ Suite (SEISS), and magnetometer. Membership draws on NOAA's Space Weather Program and includes representation from the NCEP Space Environment Center (SEC) and from the NESDIS National Geophysical Data Center (NGDC). Expertise spans the range from instrument scientists to forecasters to archivists. This poster presents an overview of current SWx forecasting and products based on GOES observations. It also addresses the Team's initial activities and plans to gather proxy data sets, fully document and review existing product algorithms, and to rigorously assess the accuracy of selected products through reanalysis.



GOES R Space Weather Instruments and Key Products

(Products Highlighted in Red are Depicted on the Right-Hand Panel of the Poster)

Sensor	Products	Proxy Data Sets
SUVI Solar Ultraviolet Imager	Coronal Movies Coronal Hole Images Bright Region Data Flare Location (XFL) reports Coronal Hole Boundaries Plasma Temperature and Emission Measure EUV Narrow Band Irradiance	GOES 12 SXI GOES NOP SXI SOHO EIT SDO AIA
EXIS/EUVS Extreme Ultraviolet Sensor	Time Averaged Irradiance EUV Event Detection EUV Multi-wavelength Proxy (Binned Spectra) EUV High-Resolution (Modeled) Spectrum	GOES NOP EUVS TIMED SEE SDO EVE
EXIS/XRS X-ray Sensor	3 Second Averages 1 Minute and 5 Minute Averages Channel Ratio (a measure of temperature) Flare Event Detection with high resolution data Flare Event Detection with 1-minute data D-Region Absorption	GOES 8-12 XRS GOES NOP XRS TIMED SEE SDO EVE
SIESS	5 minute averages - proton and electron channels Derived 'integral flux' - proton and electron Proton event detection (>10 MeV 5-minute data) Derived 'differential flux' – proton 5 minute data	GOES 8-12 GOES NOP LANL
MAG	1 minute averages Solar Wind Shocks Event Detection Magnetopause Crossing Event Detection Comparison to quiet fields Sudden Impulse (SI) Event Detection	GOES 8-12 MAG GOES NOP MAG

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Ongoing GOES-R Space Weather Work at NOAA/NWS/NCEP/SEC & NOAA/NESDIS/NGDC

GOES-R Algorithm Working Group (AWG) formed in November 2004

Space Weather (SWx) Team, part of the AWG, formed in January 2006

Current capabilities:

- »All data downlinked directly to SEC in Boulder, Colorado and processed and validated to support real-time SWx forecast operations & provided to NGDC
- »GOES 8-12 space weather sensors
  - –Space weather sensors on all GOES spacecraft
  - –Algorithms operating at SEC
- »GOES NOP
  - –Space weather sensors on all GOES spacecraft
  - –Algorithms being developed and implemented at SEC

Shortfalls

- »No EUVS on GOES 8-12, SXI only on GOES 12
  - –New sensors for GOES NOP. As yet, no NOAA proxy data.
- »Particle measurements
  - –No low or medium energy measurements on GOES 8-12
  - –No low energy measurements on GOES NOP
  - –Algorithms unable to correct for out of band contamination
- »SUVI
  - –Will have new spectral bands on GOES R compared to GOES 12, 13, O/P SXI

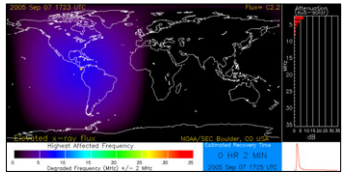
Overall Algorithm Development Strategy

- »Work with AWG and GOES R^3 program
- »Establish requirements for delivery of higher level (1,2,3,4) products to SEC
- »Undertake differing strategies for each component
- »Space Weather data sets and products have distinct characteristics
  - »XRS, EUVS, SEISS, & Magnetometer provide multi-channel time series data
    - –High cadence data, temporal averaging, & event detection are important to these data
    - –EUVS also has a component involving spectral irradiance monitoring
  - »SXI provides two-dimensional image data in multiple spectral bands
    - –Key to SXI is pointing and image navigation, image segmentation and ROI identification

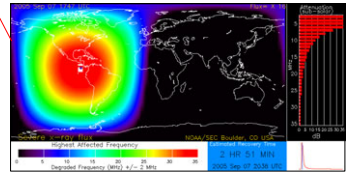
Version 1 Algorithm Delivery in 2008

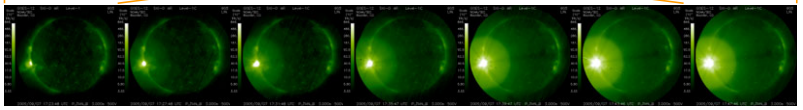
- »Current Algorithms documented and validated for GOES R usage

GOES Space Weather Product Synergy During the X17 Flare of 2005 Sep 07



D-Region Absorption





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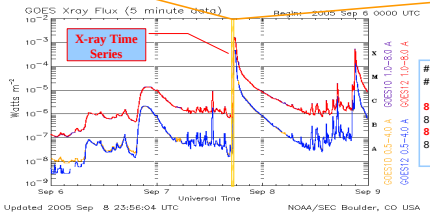
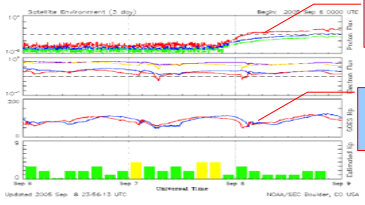


X-ray Time Series

X-ray Flare Detection

```
#Event Begin   Max   End   Obs  Q  Type Loc/Frq Particulars
#-----------------------------------------------------------
  .     .      .     .     .   .   .    .      .
8010 +  1717  1740  1803  G12  5  XRA  1-8A    X17.0
8010   B1720  ////  1821  HOL  3  EPL  ////    0.29
8010    1722  1751  1802  G12  5  XFL  S11E77  1.3E+05
8010 +  1723 U1736  1902  SAG  G  RBR  8800    23000
  .     .      .     .     .   .   .    .      .
```

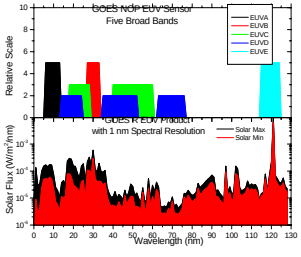
X-ray Flare Location



Proton Time Series

Magnetic Field Time Series

This event led to a rather slow rise in protons and little or no geomagnetic activity. The SEC's ability to forecast this outcome was in part due to the ability to detect and locate the solar flare within minutes.



When the EUVS instrument becomes operational, data products like those at left will become available.