



Solar & Terrestrial Physics

27 February 2014

AFWA – 2WS Director of Ops



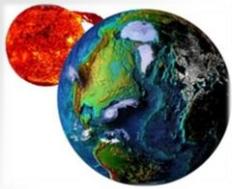
William Denig

Solar & Terrestrial Physics Division

NOAA/NESDIS/NGDC

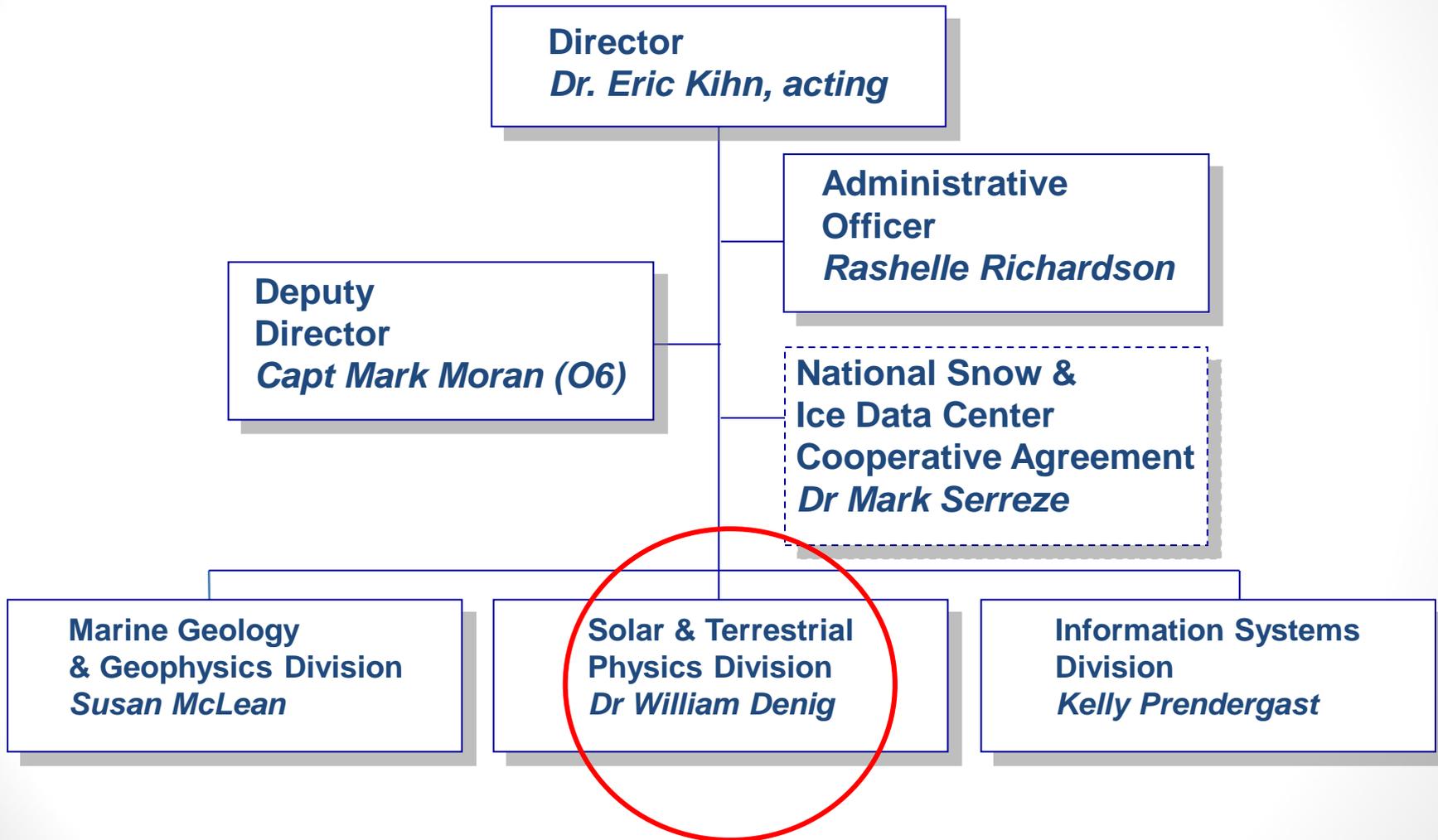
303 497-6323

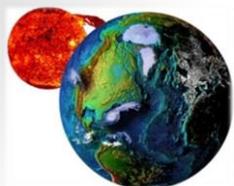
William.Denig@noaa.gov



NGDC Organizational Chart

National Geophysical Data Center





Space Weather Team

Mission: *Provide Long-Term Scientific Stewardship for NOAA Space Weather (SWx) Data and Information*

Supporting NOAA's satellite acquisition, pre/post launch operations and space environmental monitoring program

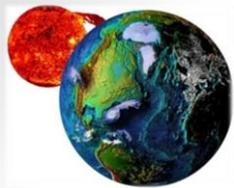
Actions:

- Manage the 30+ year historical record of space environmental data from GOES and POES (also DMSP).
- Develop ground processing algorithms for producing operational space weather products for GOES-R.
- Assume responsibility for the satellite sensor cal-val and monitor in-flight performance and calibration (SWx).
- Plan for the acquisition and archive of DSCOVR space weather products.
- Cross-LO team – NESDIS/NGDC and NWS/SWPC.



Supporting Satellite Programs:

- GOES I-M / NOP / RSTU
- POES/MetOp
- DSCOVR
- DMSP ←
- Related ground observations



Space Weather Team

Current Satellite Programs

Archiving Operational Space Weather Satellite Data

GOES Space Environment Monitor

- Geosynchronous Orbit, Since 1974
- Elements: In Situ Magnetic Fields
Whole Sun X-ray Flux
Energetic Particles

GOES Solar X-ray Imager – GOES 12-15

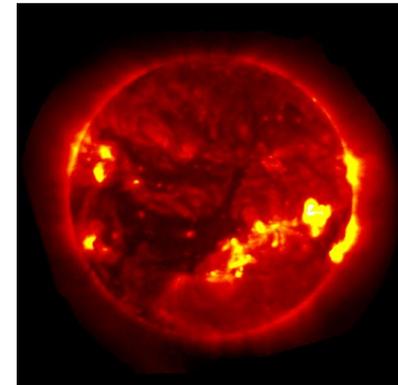
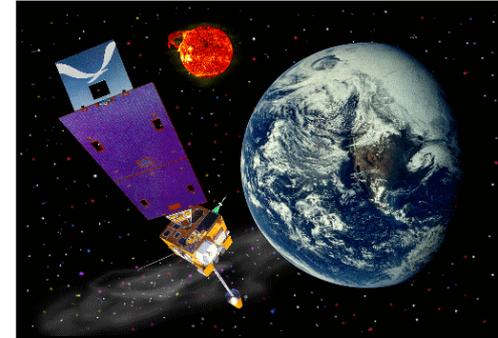
- X-ray Images taken every minute

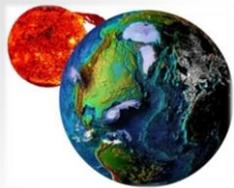
POES/MetOp Energetic Particle Detector

- Polar Low Earth Orbit
- Energetic Particles Archived Since 1979

Also DMSP Space Weather Sensors

- F16-18, SSIES/SSJ/SSM
- Processed data received from AFRL





Space Weather Team

Next Generation GOES-R/S/T/U

Improved SWx Capabilities



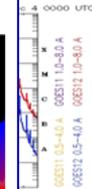
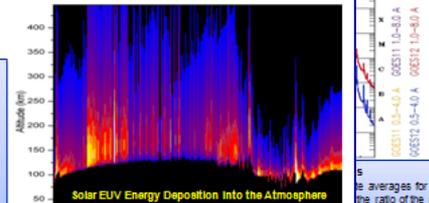
Credit: Lockheed-Martin

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)

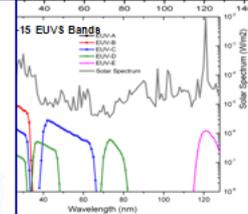
- Observations of the Solar EUV Spectrum from 5 to 125 nm
- Provides solar EUV input to thermosphere and ionosphere models which provide specification and forecasts
- Models provide specification and



averages for both long and short channels the ratio of the short over long channels action with one-minute data ground station

Solar Ultra-Violet Imager (SUVI)

- Completely Different than GOES NOP:
- GOES NOP SXI observes in x-rays (0.5-6 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
 - 5 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)



Increased bands

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

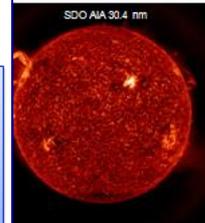
EHSI: Satellite single event upsets, astronaut radiation

- 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

provides improved proxy data: many covers as BUVI (reference to 8 BUVI bands, 5 of which match BUVI exactly)

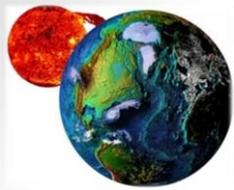


Solar UV imagery versus soft x-rays

Improved particle energy coverage

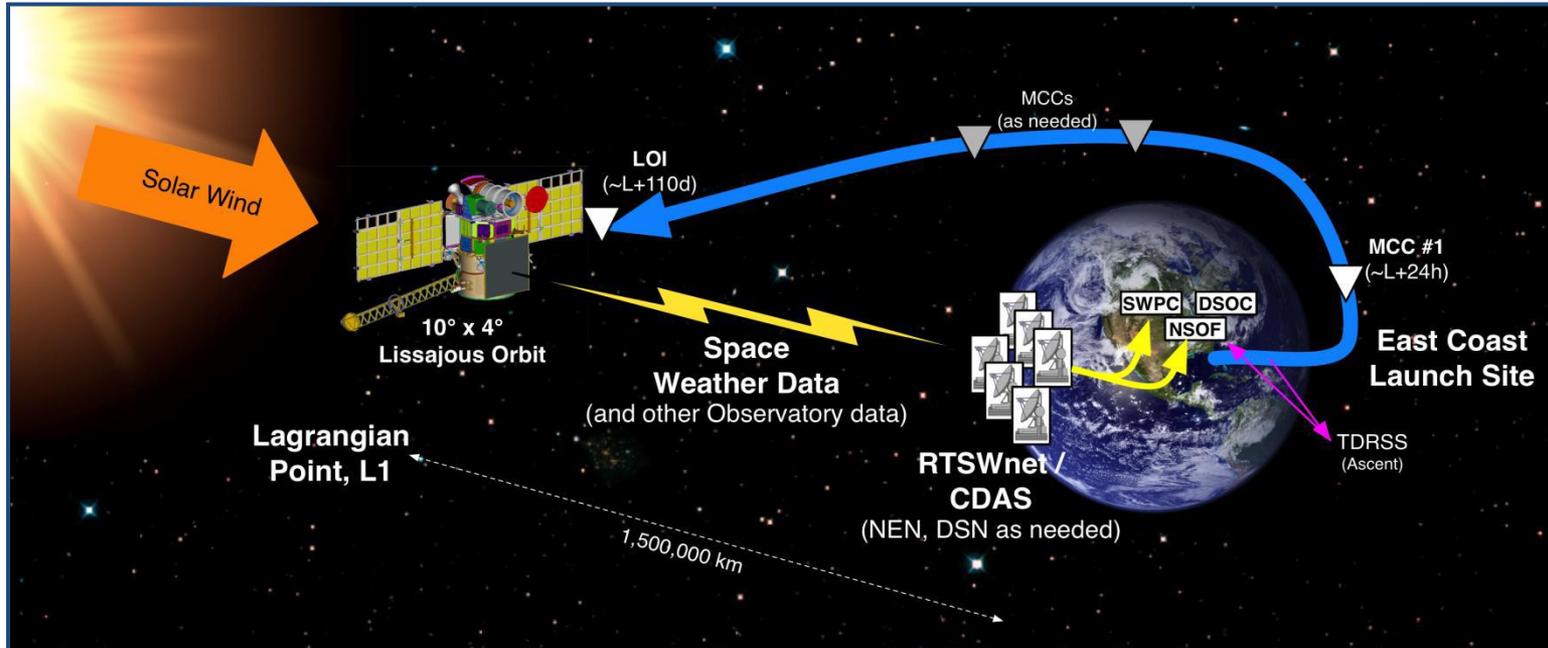


Not shown: GOES-R Magnetometer

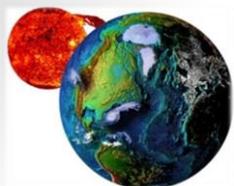


Space Weather Team

Deep Space Climate Observatory



- 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.



Space Weather Team

Satellite Anomaly Assessments



Case 1 – Galaxy-15

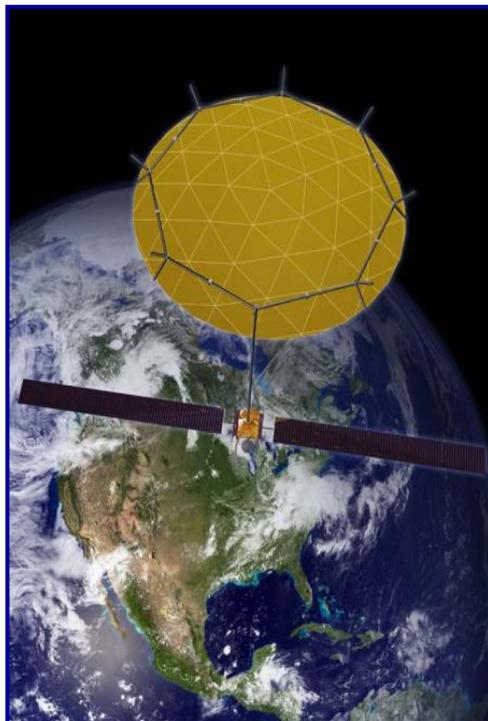
Orbit: Geosynchronous

Anomaly Date:

05 April 2010 @09:48

Probable Cause:

Internal Charging/ESD



Case 2 – SkyTerra-1

Orbit: Geosynchronous

Anomaly Date:

07 March 2012 @14:43

Probable Cause:

Single-Event Upset



Case 3 – NPP/VIIRS

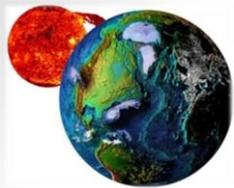
Orbit: Polar LEO

Anomaly Date:

Various

Probable Cause:

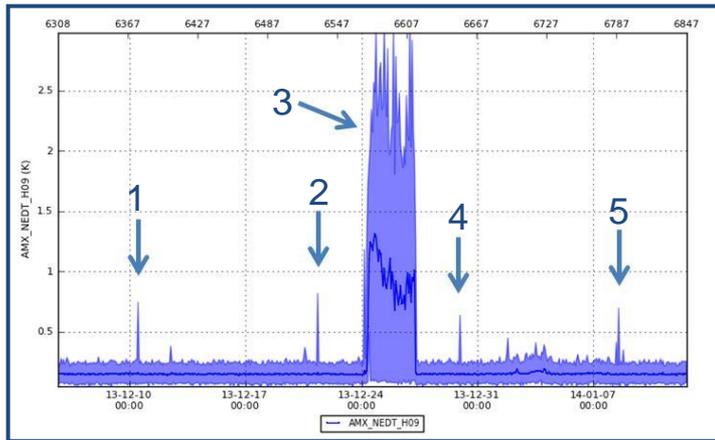
Single-Event Upsets



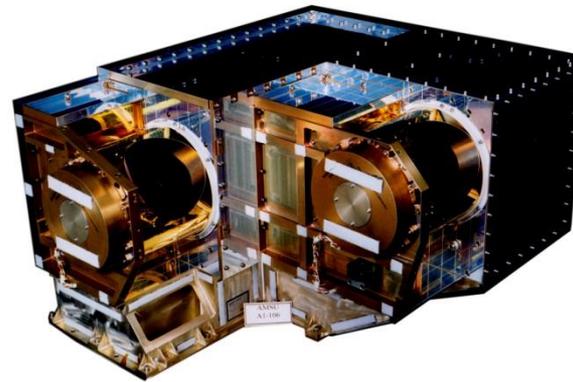
Space Weather Team

MetOp-B Microwave Anomalies

5 AMSU anomaly events occurred on Metop-B from 12/2013 through 01/2014.



Advanced Microwave Sounding Unit A1

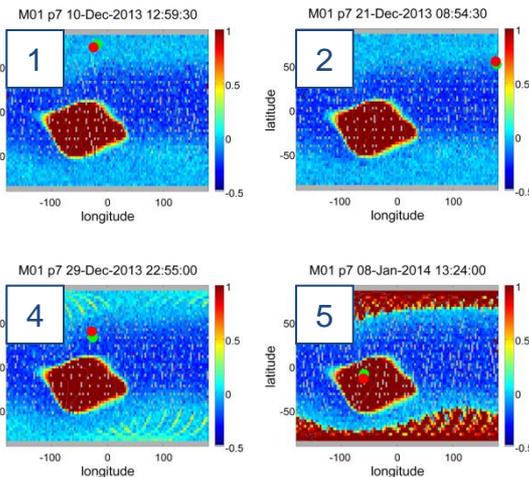


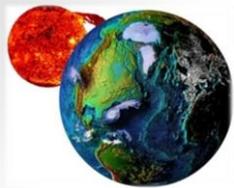
Conclusion

It is possible that the MetOp-B AMSU anomalies are related to SEU's caused by high energy protons and galactic cosmic rays; however, there is considerable uncertainty to this conclusion:

- One event occurred in a region where an SEU is a low probability.
- It is not clear how an SEU could cause a problem that persists for days without further engineering analysis.
- Analysis of more events could clarify the cause.

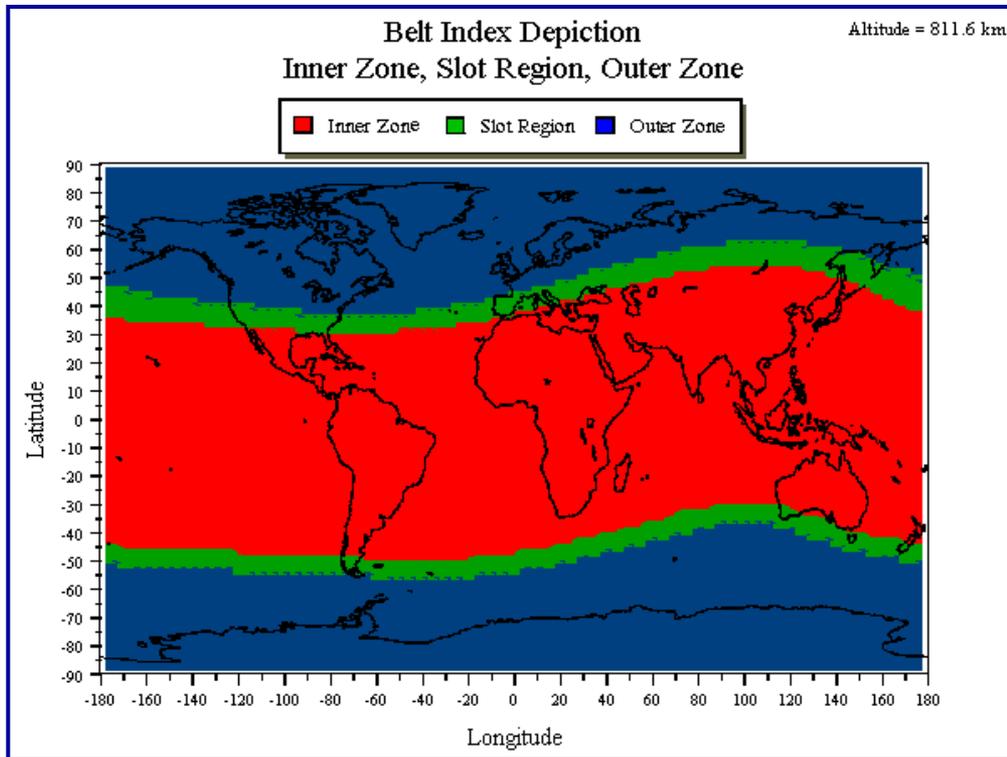
Locations overlaid on SEM energetic particle flux data. Green (Red) dot is start (end).



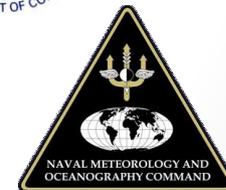


Space Weather Team Radiation Belt Indices (AFWA)

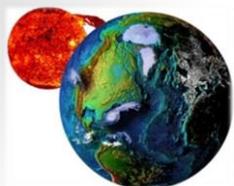
As a part of the POES re-processing NGDC is now producing a set of radiation belt indices. The indices identify times when distinct regions are above or below normal. The Air Force Weather Agency (**AFWA**) is a designated user of the belt indices.



The NOAA availability of these indices will likely be included in Environmental Satellite Data Annex to the MOA on Data Acquisition, Processing & Exchange (**DAPE**).



[Link](#)

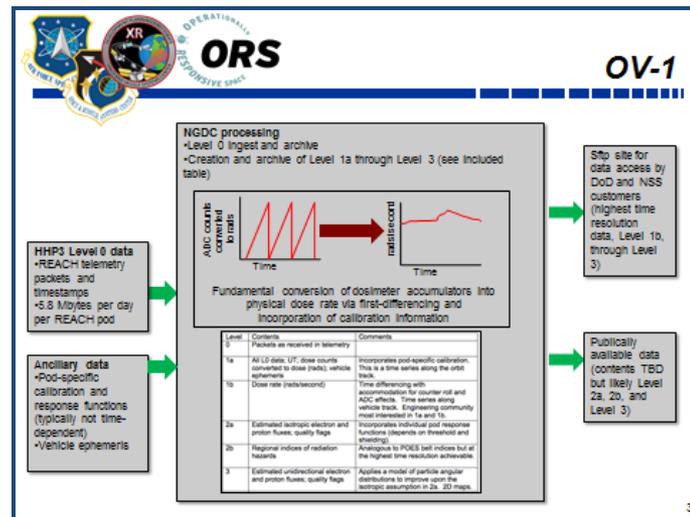
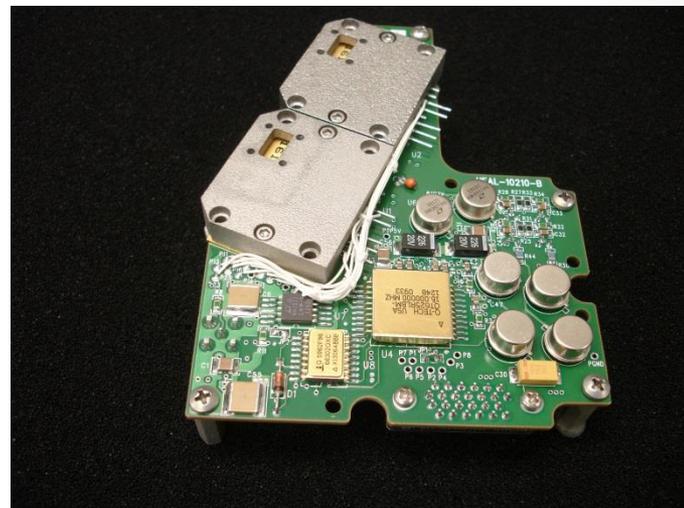


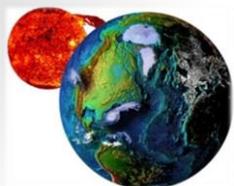
Space Weather Team

USAF ORS – REACH/HEALER

SMC/XR (Aerospace) is planning to fly a series of dosimeters on the Iridium satellite constellation. The USAF is soliciting NOAA participation, specifically NGDC, in the program presumably under the auspices of the DAPC MOA. A coordination meeting (AFWA, FNMOC, NOAA, OFCM) is planned for the near future.

Current Status is Unknown





Ionospheric Sounding Team

Mission: *Develop and Field Revolutionary Technologies for Advanced Ionospheric Sounding*

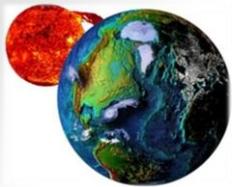
NGDC innovated the new-technology Vertical Incidence Pulsed Ionospheric Radar (VIPIR)

Actions:

- Acquire & disseminate to SWPC/AFWA real-time, ionospheric soundings from a global network of ground sensors. Data *also disseminated to domestic and international partners.*
- Demonstrate advanced capabilities for ionospheric sounding by VIPIR.
- Field new ground-based sensors in U.S., Africa and the Antarctic.
- Manage 70+ years of ionospheric sounding data. Key to understanding climate change impacts to geospace.



- ✓ Supporting AFWA needs for real-time ionospheric data (GAIM).
- ✓ New Korean VIPIR at Jang Bogo Station, Antarctica (FY15 installation).
- ✓ Continued support to the Low latitude Ionospheric Sounding Network (LISN).



Ionospheric Sounding Team Scintillation Forecast Tool

Forecasting Ionospheric Real-time Scintillation Tool (FIRST)

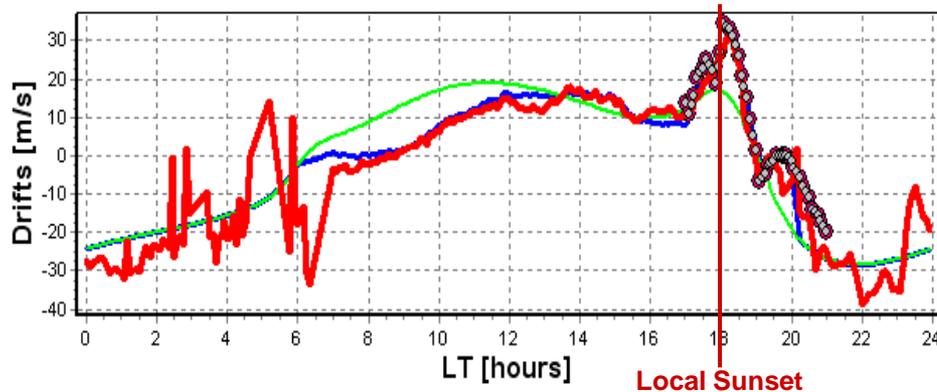
A scintillation forecast tool has been developed for Jicamarca and Kwajalein using the F10.7 normalized parameters.

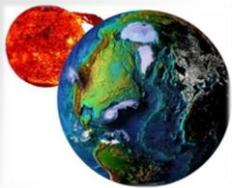


Jicamarca Scintillation Forecast (FIRST):

h'F time history (19:30LT previous day):

DOY (UT)	35	34	33	32	31	30	29
19:30LT	255.0	247.0	245.0	242.5	237.5	257.0	260.0



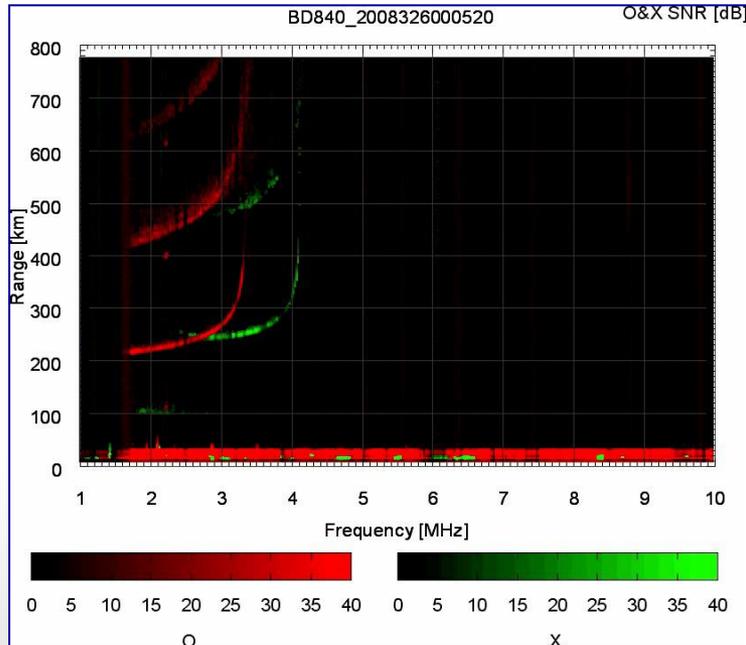


Ionospheric Sounding Team

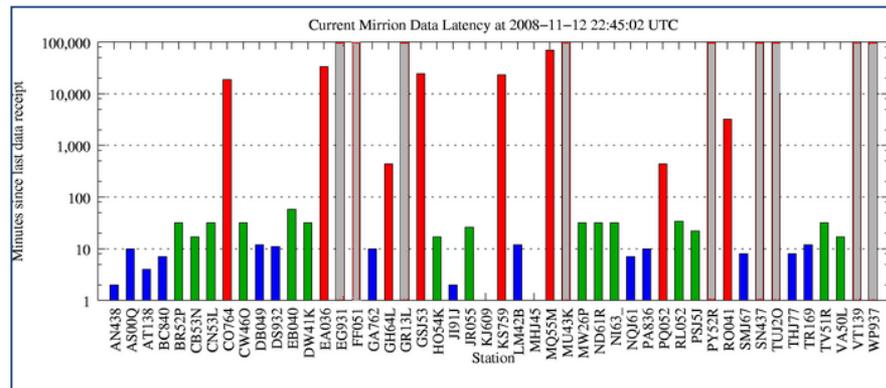
New Ionospheric Sounder

VIPIR – Vertical Incidence Pulsed Ionospheric Radar

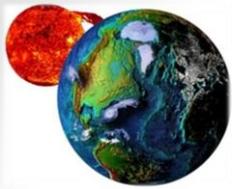
- Ionospheric sounder based on engineering designs pioneered within NOAA.
- Developed under a USAF Small Business Innovative Research (SBIR).
- Offers improved ionospheric characterization using less emitted power.
- Installed at NOAA/Boulder, Wallops, Texas and in South America.
- Data included in NGDC's Mirrion real-time ionosonde collection system.



← Swept frequency radiowave echos from the ionosphere above Boulder.



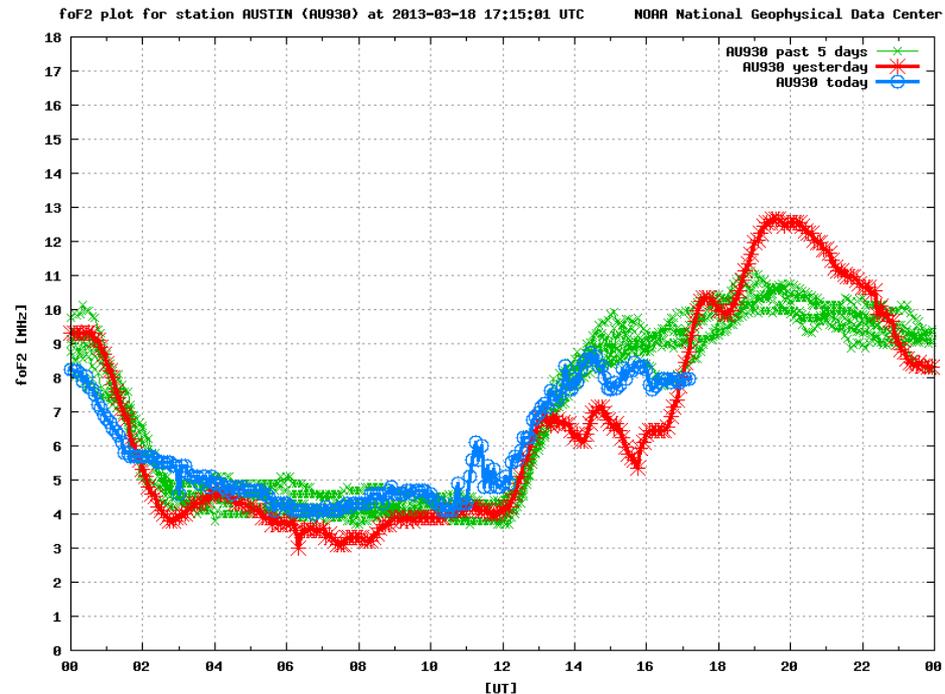
Mirrion station status chart



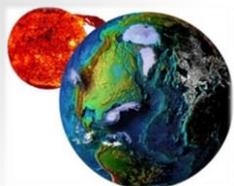
Ionospheric Sounding Team

Military Auxiliary Radio System

The Texas Army MARS unit has included one of our in-house displays (Austin, TX) used for monitoring data. This provides users with current trends in ionospheric variations to assist in frequency management by regional communicators and disaster relief organizations. See: <https://www.txarmymars.org/resources/solarweather.php>



The *Military Auxiliary Radio System* is a DoD sponsored emergency communications program. The program consists of licensed amateur radio operators who provide auxiliary (adjunct) communications on local, national and international levels.



WDS for Geophysics



Mission: *Acquire, Manage and Disseminate Solar-Terrestrial Data as a Member of the World Data Service*

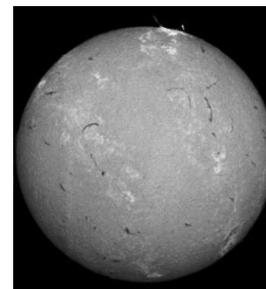
NGDC is responsible for a variety of environmental datasets from the sun's surface to the upper atmosphere

Actions:

- Preserve NOAA's historical solar/space environmental datasets and products (non-satellite).
- Acquire processed environmental datasets from solar observatories and the INTERMAGNET consortium.
- Manage and publish solar and geomagnetic indices from the 1600's to the present.
- Create metadata records for solar-terrestrial datasets in compliance with the ISO 19115 standard.

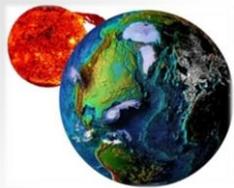


Historical H_{α} photos from the Boulder Solar Observatory (1967 – 1994) and other relevant datasets



Monthly Geophysical & Solar Indices Bulletins (pre 1985 – present) and other historical reports

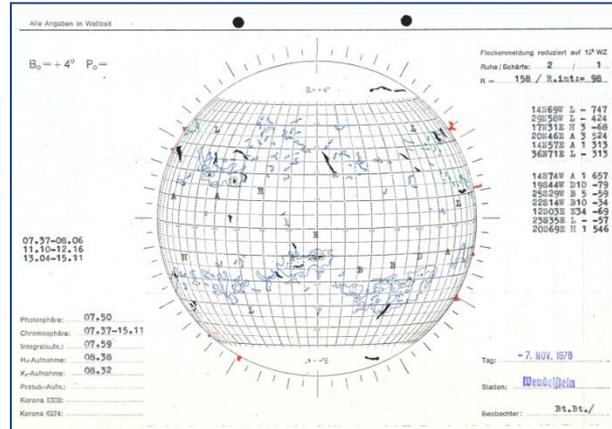




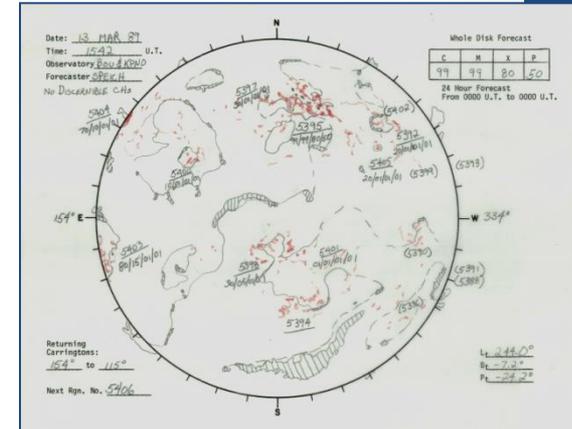
WDS for Geophysics

A Legacy from the 1957-58 IGY

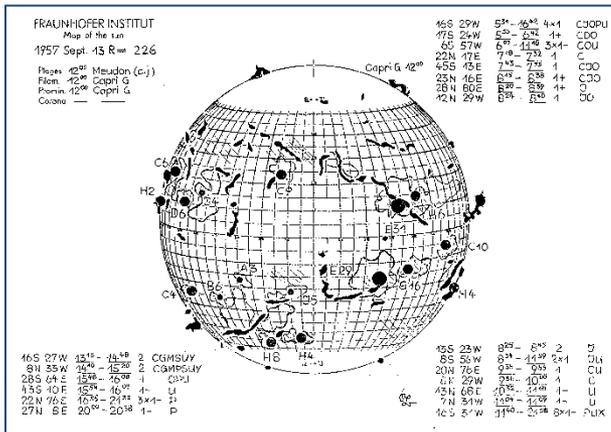
Under the auspices of the former World Data Center for Solar-Terrestrial Physics (now the [World Data Service for Geophysics](#)) NGDC assumed responsibility for numerous datasets related to solar phenomena, the ionosphere, cosmic rays, geomagnetic field, aurora and airglow. Included here is a sample of available solar composite drawings.



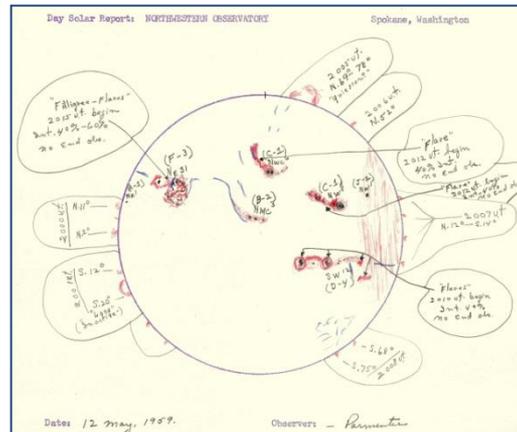
[Wendelstein Observatory](#)
(1947-1987)



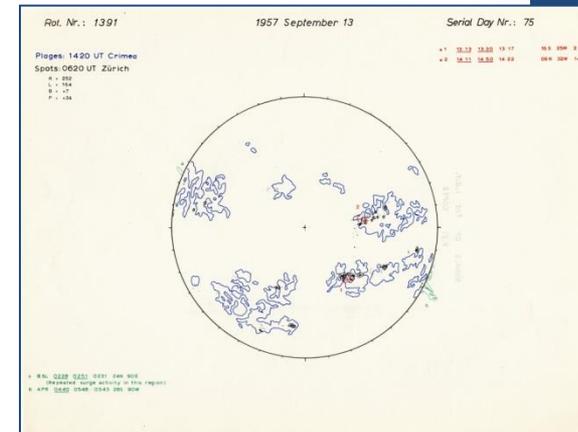
[Boulder Daily Composites](#)
(1972-present)



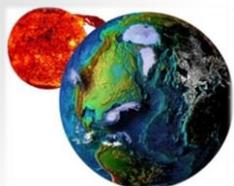
[Fraunhofer Institute](#)
(1956 - 1973)



[Northwestern Observatory](#)
(1958 - 1970)



[Drawings from the IGY](#)
(1957 - 1958)



Earth Observation Group

Mission: *Global Mapping of Nighttime Lights and Combustion Sources Using VIIRS Imagery Data*

Multispectral VIIRS detections are used to map lights and combustion sources worldwide

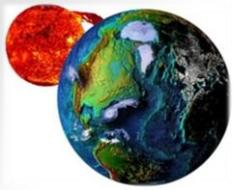
Actions:

- Construct research quality monthly/annual maps of nighttime lights – change detection, socio-economic, and ecological studies.
- Provide nightly, global data on the location, temperature, source size and radiant heat of infrared emitters such as gas flares, biomass burning, volcanos and industrial sites.
- Detect and characterize anomalous events worldwide:
 - Lac-Mégantic Rail Disaster – 06 Jul 13
 - Hercules 265 Platform Fire – 23 Jul 13
 - Erie Gas Pipeline Explosion – 13 Aug 13
 - Mt Sakurajima Eruption – 18 Aug 13



Recent Accomplishments:

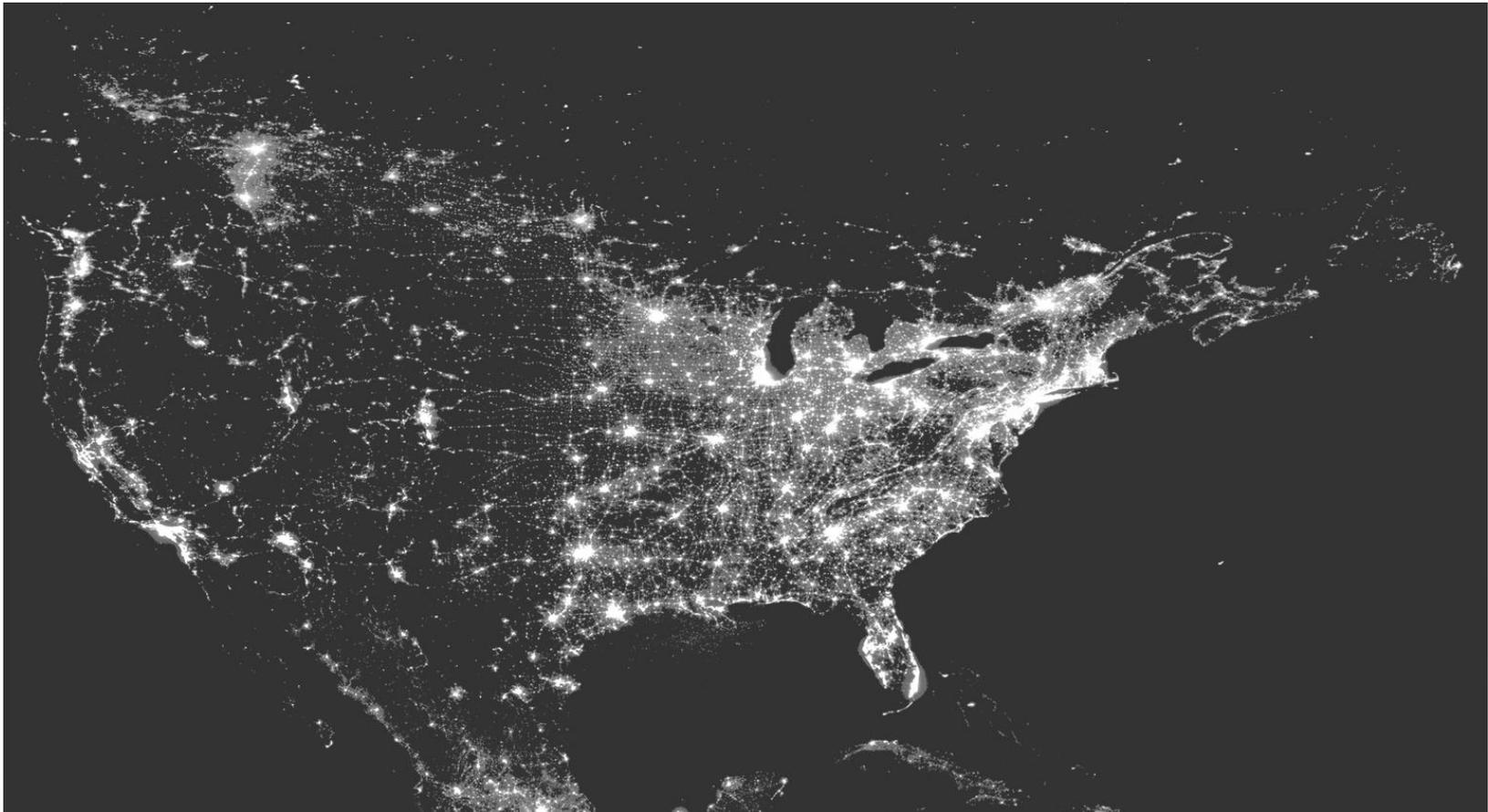
- NRT VIIRS Nightfire product.
- VIIRS fire pixel detection
- Dual Planck curve fit procedure
- Top 100 gas flares worldwide



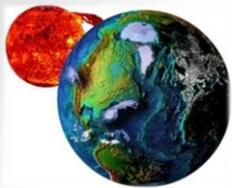
Earth Observations Group

Nighttime Lights of the U.S.A.

DMSP/OLS – Annual Cloud-free Mosaic



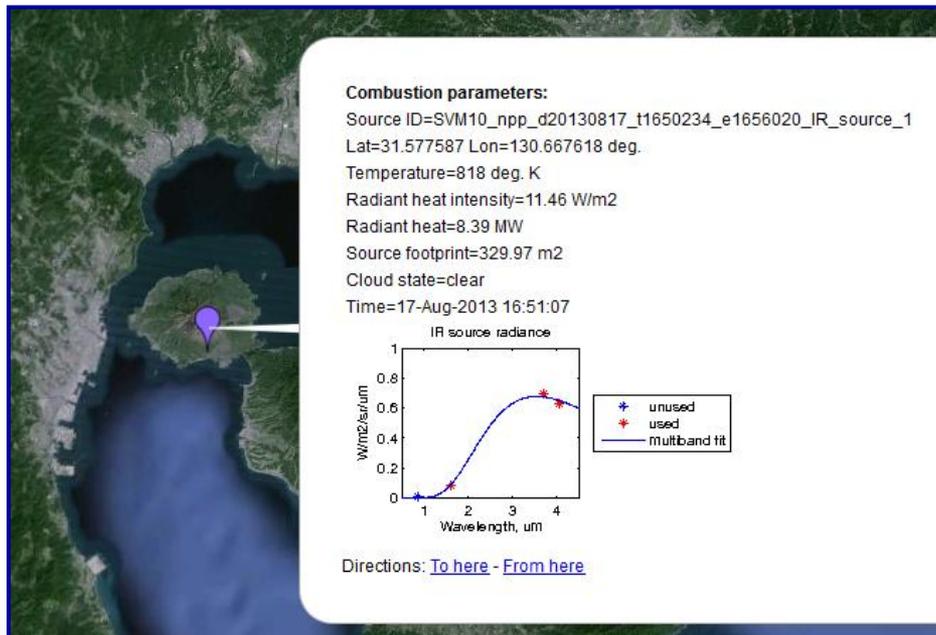
Source: DMSP F15 – 2003 composite



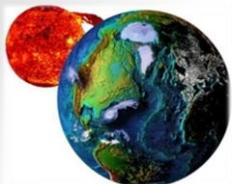
Earth Observations Group

Mount Sakurajima Eruption

At 16:31 (local time) on 18 Aug 2013 the Japanese volcano on Mt Sakurajima had a significant eruption resulting in a 5,000-m ash plume and causing darkness and significant ash falls on the central part of Kagoshima city. The volcano's thermal anomaly was detected by the Visible Infrared Imaging Radiometer Suite (VIIRS) fourteen hours before the eruption. The detection temperature was 818 °K with a source footprint of 330 m².



As reported in the [NESDIS News Archive](#)



Earth Observations Group

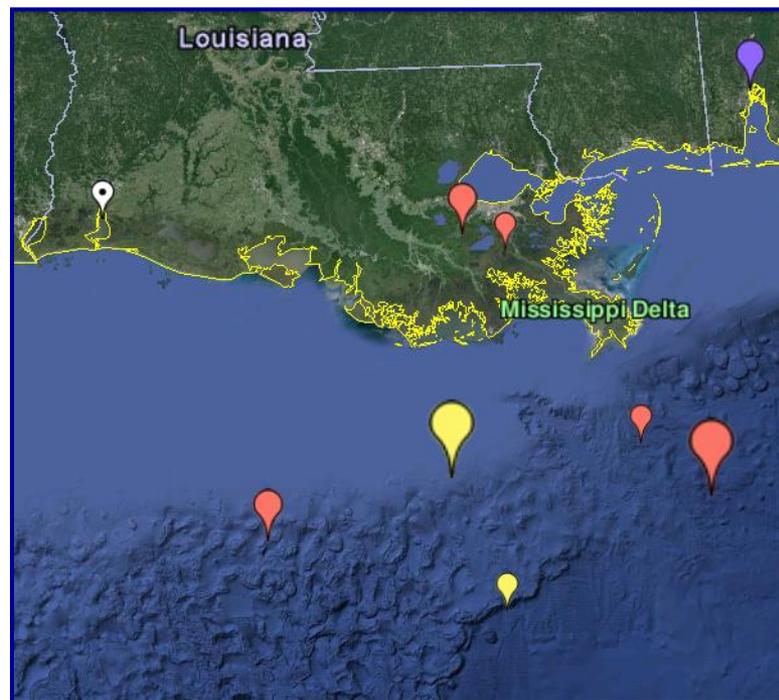
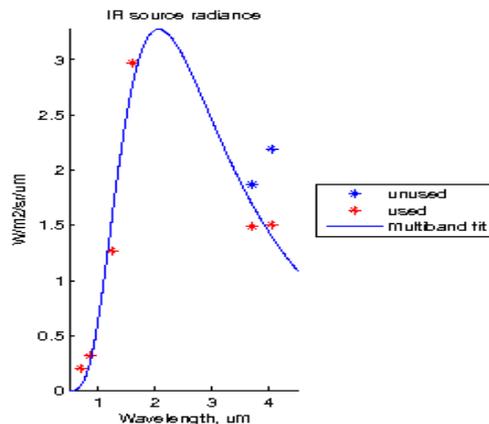
Natural Gas Platform Blaze

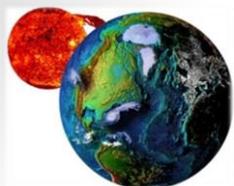
Fire broke out on the Hercules 265 gas platform around 10:50 p.m. (CDT) on 23 Jul 2013. The platform is located around 55 miles off the Louisiana coast in the Gulf of Mexico. The blaze was detected by the NPP VIIRS at 02:33 on 24 Jul and processed by the EOG real-time system with data available online by 04:26.



Combustion parameters:

Source ID=SVM10_npp_d20130724_t0731420_e0733062_IR_source_28
Lat=28.381493 Lon=-90.528130 deg.
Temperature=1402 deg. K
Radiant heat intensity=32.36 W/m²
Radiant heat=23.84 MW
Source footprint=108.87 m²
Cloud situation=cloudy
Time=24-Jul-2013 07:33:14





Remember STP

Solar & Terrestrial Physics Division

- National Archive for America's Operational SWx Data
- Maintainers of Global Ionospheric/Ionosonde Datasets
- Providers of CLASS Application Program Interfaces (APIs)
- Mirror for NGS Continuously Operating Reference System
- Developers of the DMSP Nighttime Lights Product
- World Data Service for Geophysics

