Paper J1.2 - AMS

W.F. Denig\(^1\) & P Mulligan\(^2\)

\(^1\)National Geophysical Data Center
\(^2\)Office of Systems Development
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

Extreme Event: 2003-10-26 00h - 2003-11-06 24h

- **Solar X-Rays**
- **Proton Events**
- **Cosmic Rays (non-GOES)**
- **Magnetic Field**

[Graphs and charts showing GOES-12 X-rays, GOES-11 Protons, Moscow Cosmic Rays, and GOES-12 Magnetometer data during the event.]

Forbush Decrease

http://www.ngdc.noaa.gov/stp/satellite/goes/index.html
Continuity of GEO Measurements
Transitioning to GOES-R/S/T/U

Continuity of GOES Mission

Fiscal Year

09 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36

GOES-13
GOES East

GOES-14
On-orbit spare

GOES-15
GOES West

GOES-R

GOES-S

GOES-U

GOES-T

Approved: [Signature]
Assistant Administrator for Satellite and Information Services

GOES: Geostationary Operational Environmental Satellite

- On-orbit storage
- Operational
- Operational beyond design life

AMS – 02-06 Feb 2014
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.

**Improved SWx Capabilities**

- **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 0.2 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 EUV input to thermosphere and ionosphere models which provide specification and forecasts
  - Models provide specification and observations

- **Solar Ultra-Violet Imager (SUVI)**
  - Measures EUV flux in selected wavelength bands
  - Provides improved proxy data for GOES-SWx models
  - Increased # of wavelength bands

- **Space Environment In-situ Sensor Suite (SEISS)**
  - Measures electrons, protons, and heavy particles
  - Improved particle energy coverage
  - Improved SWx capabilities

- **GOES-R Magnetometer**

Credit: Lockheed-Martin
An End of an Era (since 1978)
LEO Space Environmental Monitor (SEM)

NOAA-19 (POES)
Launched: 08 Feb 2009

• 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 C – CY2018 – 2022 (SEM-2)

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

AMS – 02-06 Feb 2014
New NOAA datasets will soon be available via CDAWeb

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

MEPED:  
- $e$: >40; >130; >287; >612 keV  
- $p$: 39; 115; 332; 1105; 2723 keV

TED:  
- $e$: 50 eV – 1 keV; 1 keV – 20 keV  
- $p$: 50 eV – 1 keV; 1 keV – 20 keV

integral energy flux
differential energy flux
channel energy flux
channel energy flux

Contact Rob Redmon or Bob McGuire for details
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.
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
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.
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-USAFA-NOAA Partnership
- 12 satellite constellation – 6 @ 24° inclination (low) / 6 @ 72° 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

Rate of TEC Index Product

Related products

GPS Scintillation Specification

Research to Operations

Research and Development

AMS – 02-06 Feb 2014
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!

Over 600 data types - from the core of the Earth to the surface of the Sun