Satellite Data Services ***Program Review***

A review of the GOES and POES space weather data services from the inception to present. **Zero recycled slides**.

- **GOES** -- Geosynchronous Operational Environmental Satellites
  - History
  - Current Status
  - Future
- **POES** – Polar Operational Environmental Satellites
  - History
  - Current Status
  - Future

Daniel Wilkinson

November 3, 2010

GOES - History

- **SMS-1 (A)**: 1974-07 to 1974-10 (NASA)
- **SMS-2 (B)**: 1975-02 to 1976-04 (NASA)
- **GOES-01 (A aka SMS-C)**: 1976-01 to 1978-05
- **GOES-02 (B)**: 1977-08 to 1983-05
- **GOES-03 (C)**: 1978-07 to 1980-08

Philco-Ford

- **GOES-04 (D)**: 1980-09 data, failure 1982-11, no data archived
- **GOES-05 (E)**: 1983-01 to 1987-02
- **GOES-06 (F)**: 1983-05 to 1994-11
- **GOES-?? (G)**: 1986-05 to T+71 seconds
- **GOES-07 (H)**: 1987-03 to 1996-08

Hughes Corporation

⇧ Spin Stabilized

⇩ 3-axis Stabilized

- **GOES-08 (I)**: 1995-03 to 2003-06
- **GOES-09 (J)**: 1996-04 to 1998-08
- **GOES-10 (K)**: 1998-07 to 2009-12
- **GOES-11 (L)**: 2000-07 to present
- **GOES-12 (M)**: 2003-01 to 2010-09 (first Solar X-ray Imager)

Space Systems Loral

- **GOES-13 (N)**: 2010-04 to present
- **GOES-14 (O)**: 2009-12 to present, in storage mode.
- **GOES-15 (P)**: 2010-09 to present, in test mode.

The Boeing Company

GOES - History

SMS / GOES – Space Environment Monitor

- X-rays
- Energetic Particles
- Magnetic Field

- **Archive Structure**
  - Magnetic Tape
  - Display Code Header, Binary data blocks
  - Full Resolution, 3.06s
  - 60-bit data words, proprietary internal block formatting (F=I)
- **Data Services**
  - Data provider Responsible Scientist's reviewed each month's data.
  - Tape was the only delivery media, plots were available on microfilm.
  - Tape block structure required CDC computer system to read/write.
  - User cost was ~$100 per tape containing one instrument month.
  - User community was very small, ~dozen requests per year.

GOES - History

NGSCC Position re SMS/GOES Data – 1978, author unknown.

FEB 7 '78

REPORT ON NGSDC POSITION IN RE SMS/GOES SATELLITE DATA

INTRODUCTION

The SMS/GOES satellites are a series of spacecraft devoted to the practical applications of weather monitoring, of monitoring the near-earth space environment as it responds to solar activity, and serving as passive platforms for the collection and relay of a variety of information from earth-surface data collection platforms.

The first two satellites launched in this series were NASA experimental prototypes, Synchronous Meteorological Satellites SMS-1&2. Following the years of development and experience gained with the SMS spacecraft, the next two satellites launched in the series were NOAA-operated Geostationary Operational Environmental Satellites GOES-1&2. With the successful launch of GOES-2 on 18 July 1977, all four of these spacecraft were in geostationary (24-hour period) orbit at an altitude of roughly 6.6 earth radii (35,800 km) above the equator. By grouping the satellites in pairs at about 75 deg W. and 135 deg W. longitudes, it is possible to provide combined viewing coverage over most of N. and S. America, the N. Atlantic and the S. Pacific. Also, their longitudinal separation (covering about 4 hours of local time) enables them to span roughly one hemisphere for monitoring magnetospheric effects of solar activity. Currently, data of interest for NGSDC is being taken from only two of the widely separated satellites, SMS-2 and GOES-2; the others being held in operational reserve.

GOES - History

Provider Documentation Documentation – Tech Memo SEL-42, December 1975
SMS/GOES Space Environment Monitor Subsystem, R.N. Grubb

#230

NOAA TM ERL SEL-42

RECORD SET

DEPARTMENT OF COMMERCE ★ UNITED STATES OF AMERICA ★

NOAA Technical Memorandum ERL SEL-42

U.S. DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
Environmental Research Laboratories

The SMS/GOES

Space Environment Monitor Subsystem

GOES - History

Provider Documentation Documentation – Tech Memo SEL-48, June 1977 ,
Solar X-ray Measurements From SMS-1, SMS-2, and GOES-1,
R.F. Donnelly, R.N. Grubb, F.C. Cowley

NOAA Technical Memorandum ERL SEL-48

SOLAR X-RAY MEASUREMENTS FROM SMS-1, SMS-2, AND GOES-1
INFORMATION FOR DATA USERS

R. F. Donnelly
R. N. Grubb
F. C. Cowley

Space Environment Laboratory
Boulder, Colorado
June 1977

GOES - History

NGDC Develops First GOES Tape User's Guide - 1980

FLAG WORD STRUCTURE SMS-1, SMS-2, GOES-1, GOES-2, GOES-3

The flag word is a 60-bit CDC floating point representation of an integer into which is packed all of the information about the data sample according to the pattern ''VSSSEEEO''. Flag word elements may be recovered by using the Modulus fuction. MOD(A,B) is defined as the whole remainder resulting from the division A/B. More specifically MOD(A,B) = A-INTEGER(A/B)*B.

IFLAG	= INTEGER(flag word)
"O"	= MOD(IFLAG, 16)
"EEE"	= MOD(IFLAG/16, 256)
"SSS"	= MOD(IFLAG/4096, 1000)
"V"	= IFLAG/4096/1000

"O" : Offset flag for Magnetomter data:
- 0 = no correction applied.
- 1 = correction has been applied.

"O" :Offset flag for X-ray data:
- 0 = No flag
- 1 = Corrected single point error
- 2 = Calibration data
- 4 = Switch in X-ray instrument sensitivity
- 8 = Eclipse of the Sun by the Earth

"O" :Multiplex counter for Particle data.

Counter	2 Channel Multiplex	4 Channel Multiplex	8 Channel Multiplex	Channel Specifications for SMS 1, SMS 2, GOES 1	
0	E1	P6	P2	P1: 0.8- 4. MeV protons	A1: 4. - 10. MeV alpha part.
1	P1	P7	P3	P2: 4. - 6. MeV protons	A2: 10. - 16. MeV alpha part.
2	E1	A5	P4	P3: 6. - 10. MeV protons	A3: 18. - 56. MeV alpha part.
3	P1	A6	P5	P4: 18. - 38. MeV protons	A4: 71. -150. MeV alpha part.

GOES - History

Provider Documentation Documentation – Tech Memo SEL-56, June 1981, SMS-GOES Solar Soft X-ray Measurements, Part I. , R.F. Donnelly

DEPARTMENT OF COMMERCE
UNITED STATES OF AMERICA

NOAA Technical Memorandum ERL SEL-56

SMS-GOES SOLAR SOFT X-RAY MEASUREMENTS

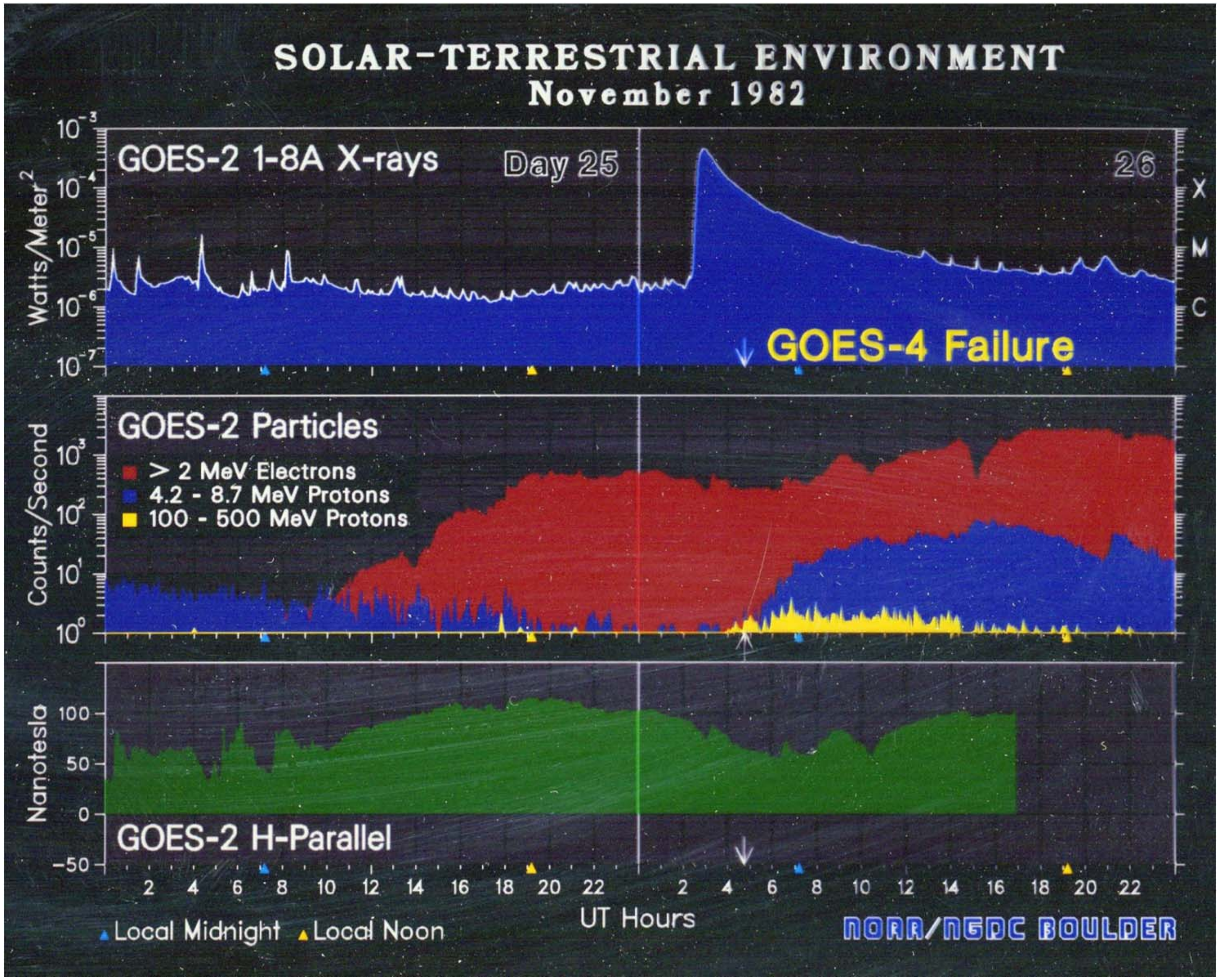
PART I. SMS-1, SMS-2, AND GOES-1 MEASUREMENTS

FROM JULY 1, 1974, THROUGH DECEMBER 31, 1976

R. F. Donnelly

GOES - History

GOES-4 Failure – NGDC's First Entry in Anomaly Database
NASA Tiger Team concluded environment not an issue, before they saw this …



GOES - History

GOES-4 Failure – EOS Article on NGDC study.

News

GOES-4 Failure Investigated

The Visual Infrared Spin-Scan Radiometer (VISSR) on board the western Geosynchronous Operational Environmental Satellite (GOES-4), failed at 0445 UT, November 26, 1982, as a series of intense storms descended on the California coast. The VISSR maps the earth and its cloud cover day and night and allows the tracking and forecasting of severe storm systems. This failure of the VISSR on board GOES-4 deprived weather forecasters of an important means of tracking the nighttime progress of life-threatening storms as they moved across the Pacific.

The cause of this critical satellite failure is of great interest to the National Oceanic and Atmospheric Administration (NOAA), operators of the GOES network. A study now in progress should resolve the reason for failure and determine whether solar activity caused it. Figure 1 was prepared at the National Geophysical Data Center in Boulder, Colo., in response to a call for information about the earth's space environment at the time of the GOES-4 failure.

All GOES spacecraft carry a Space Environment Monitor (SEM) instrument package containing an X ray sensor, a three-component magnetometer, and a particle detector. Together these instruments provide continuous monitoring of the space environment at the satellite's altitude. SEM data from selected satellites are received and processed for archiving at the Space Environment Laboratory in Boulder. When GOES-4 failed at 135°W longitude, the reference satellite for SEM archival purposes was GOES-2, located at 108°W longitude. The proximity of the two satellites suggested that their local environments were similar, and selected data from representative GOES-2 channels were reproduced for November 25–26, 1982.

The top frame of Figure 1 shows the prominent X4.5 solar flare reported by the Space Environment Services Center at 0229 UT. Owing to the intensity of the flare and the history of its associated sunspot region, forecasters at that center immediately posted a proton event warning.

Close inspection of the middle frame shows that indeed the fast, high energy protons in the 110–500 MeV range began arriving at the satellites approximately 45 minutes before failure, with slower protons arriving in quantity a few minutes after failure. Counts of electrons trapped at geostationary altitude, 6.67 earth radii, often show a quiet-time daily variation, a variation that produces lower electron counts in the UT morning than in the UT evening. The electron curve does not drop to quiet-time values on the morning of November 26, indicating the satellite environment contained a significant electron flux at the time GOES-4 failed. Lacking spectral information for electrons, however, we can give no detailed interpretation of their importance.

The magnetometer's three field components are defined as follows: H_p is parallel to the satellite spin axis and is perpendicular to the satellite's orbital plane; H_e lies parallel to the satellite-earth line and points earthward; H_n is perpendicular to both H_p and H_e, and points westward. No magnetic storm activity is indicated when GOES-4 failed. Note, however, the correlation between the H_p curve and the electron curve.

This display of the SEM data does not determine the cause of the GOES-4 failure. It does nevertheless raise the question of solar activity as a contributing factor. According to NASA Headquarters, there are currently 86 surveillance and communications satellites in geostationary orbit, representing a U.S. investment in the tens of billions of dollars. An investment of this size will eventually stir renewed interest in Solar-Terrestrial relationships.

Space environment data from the GOES

News *(cont. on p. 954)*

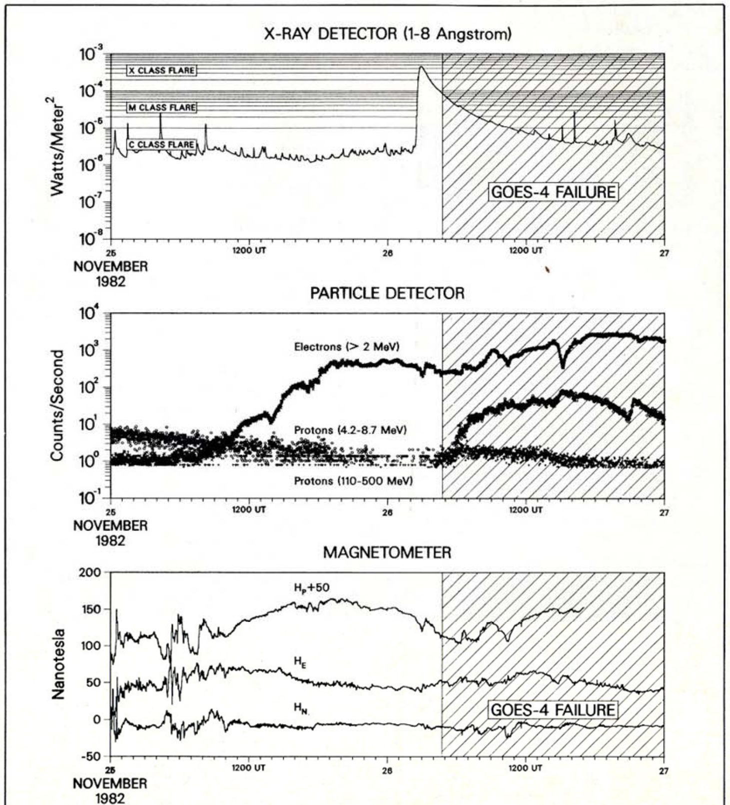
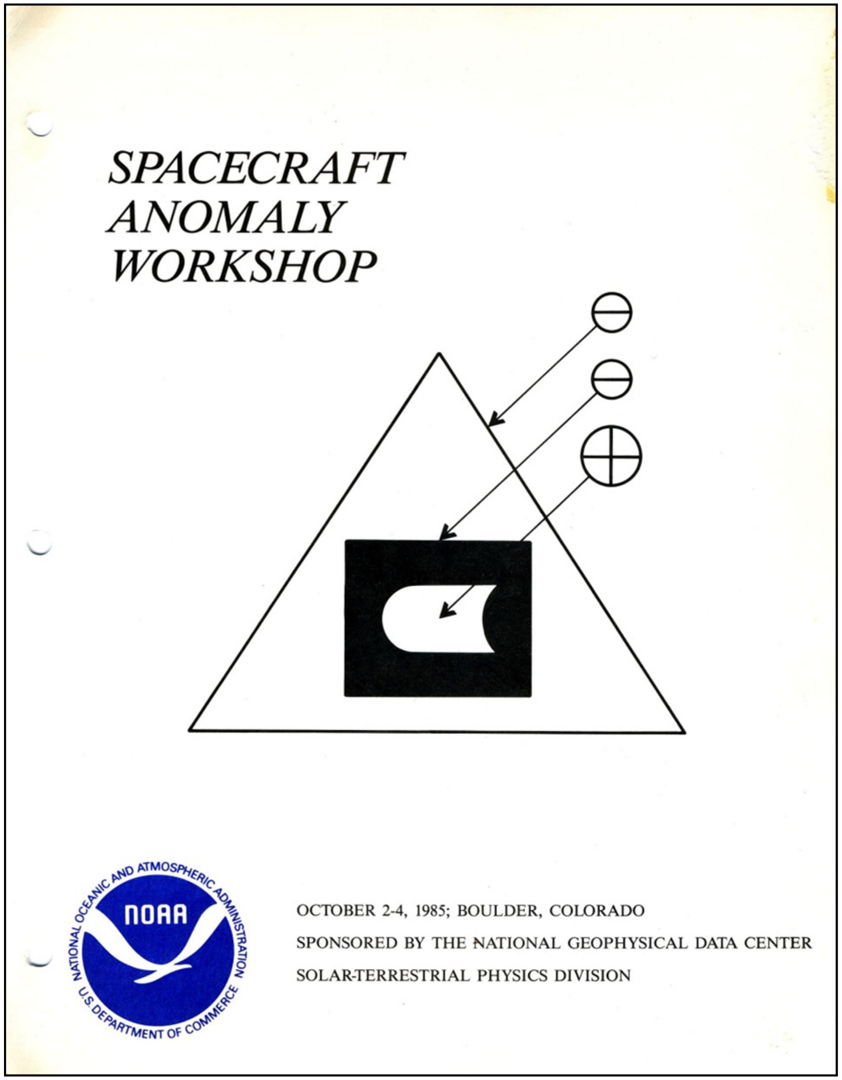


Fig. 1. Data from the GOES-2 Space Environment Monitor recorded November 25–26, 1982, at 108°W. The data are being studied for clues to the November 26 failure of the GOES-4 satellite, at 135°W.

GOES - History

Anomaly Activity Grows –NGDC's 1985 Anomaly Workshop attracts top players.



GOES - History

TDRS-1 – Most anomaly entries were subject to inconsistent historical reporting and therefore had limited statistical value. TDRS-1, however, had a complete SEU history making it an ideal case study.

1708 IEEE TRANSACTIONS ON NUCLEAR SCIENCE, VOL. 38, NO. 6, DECEMBER 1991

TDRS-1 SINGLE EVENT UPSETS AND THE EFFECT OF THE SPACE ENVIRONMENT

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Stuart C. Daughtridge, INTELSAT, 3400 International Dr. NW, Washington D.C. 20008-3098
John L. Stone, CONTEL Federal Systems, 1500 Conference Center Dr., Chantilly, VA 22021-0814
Herbert H. Sauer, NOAA / Space Environment Laboratory, 325 Broadway, Boulder, CO 80303
Phil Darling, CONTEL Federal Systems, P.O. Box 235, Las Cruces, NM 88004

Abstract

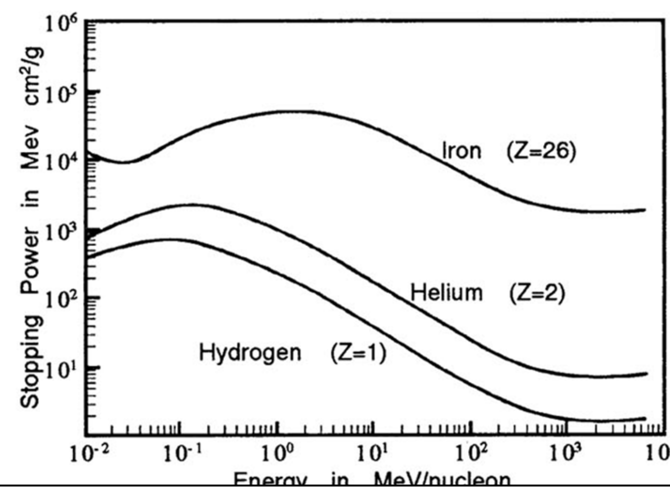
The systematic recording of Single Event Upsets on TDRS-1 from 1984 to 1990 allows correlations to be drawn between those upsets and the space environment. Ground based neutron monitor data are used to illustrate the long-term relationship between galactic cosmic rays and TDRS-1 upsets. The short-term effects of energetic solar particles are illustrated with space environment data from GOES-7.

A. Introduction

The Tracking and Data Relay Satellite System (TDRSS) was designed by NASA to provide communications and high data-rate transmissions for low Earth-orbiting satellites, such as the Space Shuttle, Hubble Space Telescope, Landsat, Cosmic Ray Background Explorer, etc., thereby eliminating the need for a cumbersome network of world-wide tracking stations.

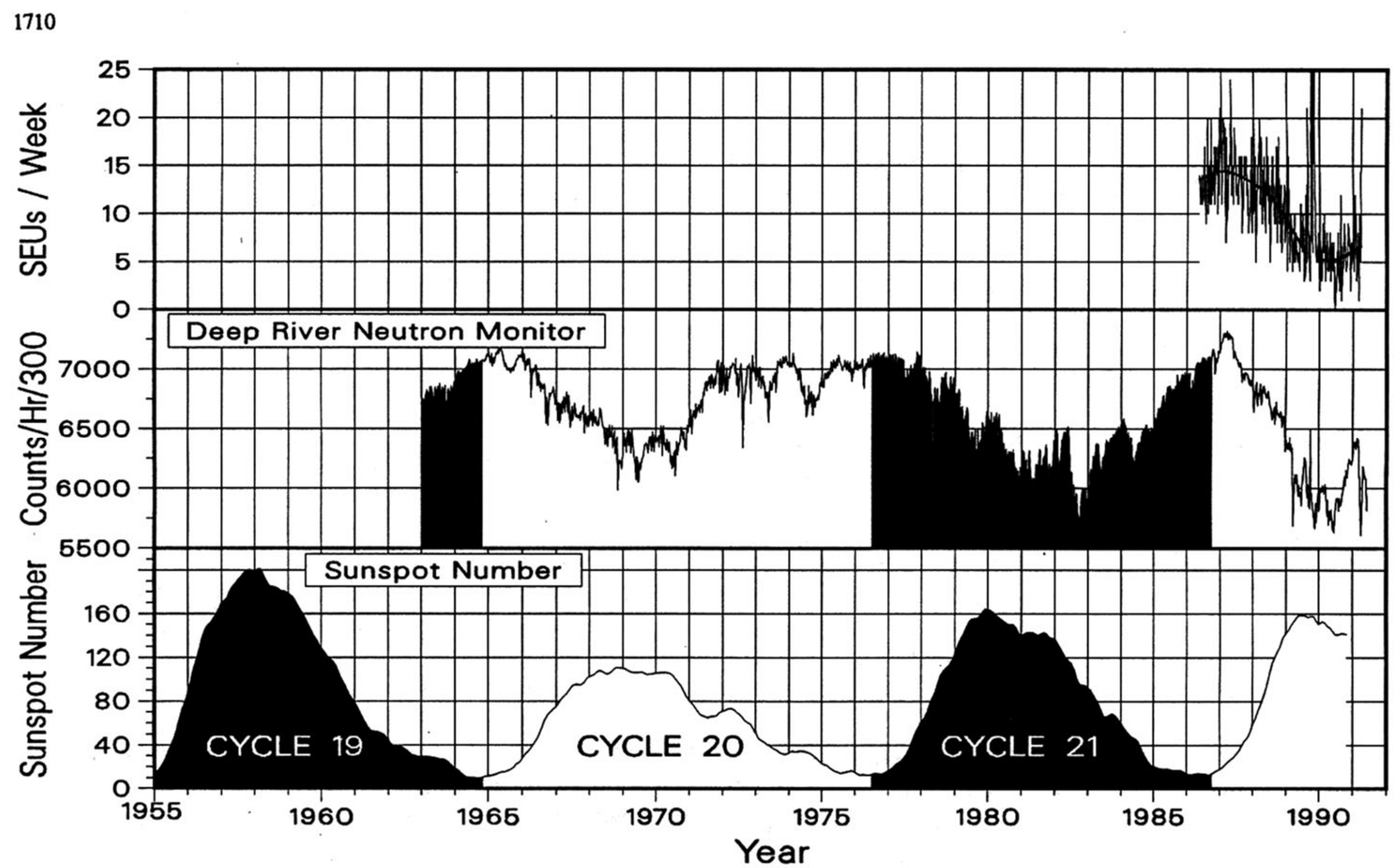
The first satellite in the system, TDRS-1, was launched

ergy to produce a SEU directly, protons with energies greater than 10-40 MeV (depending on the target device) can produce collisional products which can induce SEUs [4,5,6]. Figure 1 shows the energy deposition in Silicon for three energetic nuclei.



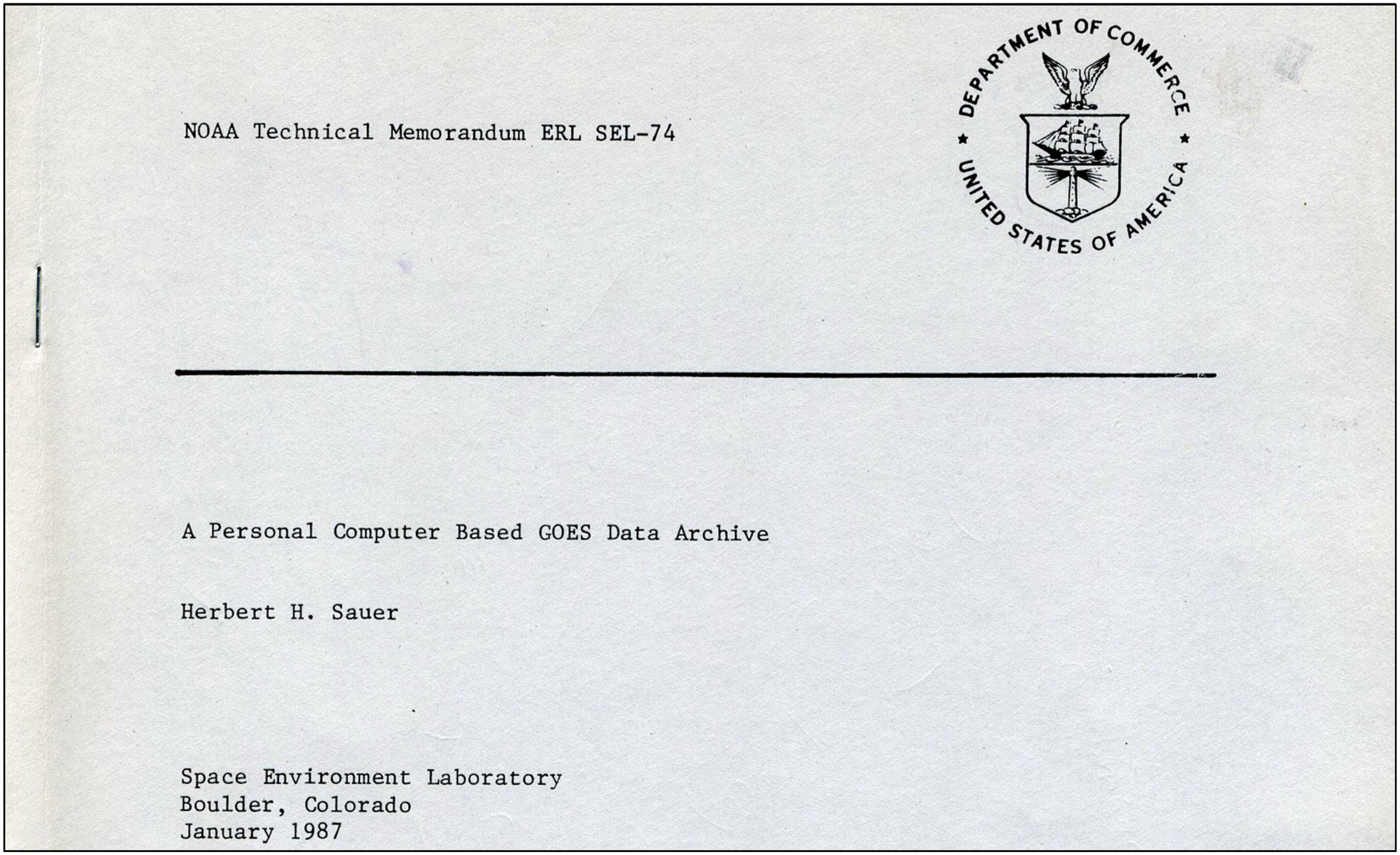
GOES - History

TDRS-1 – Operators were highly concerned with what appeared to be a steady change in SEU occurrence which NGDC demonstrated to be due to solar cycle cosmic ray variation.



GOES - History

1986 – Dr. Herb Sauer created GOES SEM products for broad audience.
Compact binary formatted 1-min & 5-min values (Designed to fit on 320Kb floppy).
User requests increased by ~30x.



NOAA Technical Memorandum ERL SEL-74

DEPARTMENT OF COMMERCE ★ UNITED STATES OF AMERICA ★

A Personal Computer Based GOES Data Archive

Herbert H. Sauer

Space Environment Laboratory
Boulder, Colorado
January 1987

GOES - History

Tape Migration – In 1990 the Boulder Labs decided to discontinue using CDC mainframe computers. The entire SMS/GOES archive was at risk because the tape format was in CDC floating point binary with internal block encoding. NGDC undertook this rescue effort that resulted in all full resolution archive tapes being converted to FITS binary table format using standard word types.

SE

Space Environment Laboratory. NOAA/ERL
US Department of Commerce. R/E/SE
325 Broadway, Boulder CO. 80303.
(303) 497-3284

To: Ernie Hildner
From: Richard N. Grubb. Chief Engineer
Date: May 19, 1992
Subject: NGDC use of SEL CYBER resources to rescue GOES data.

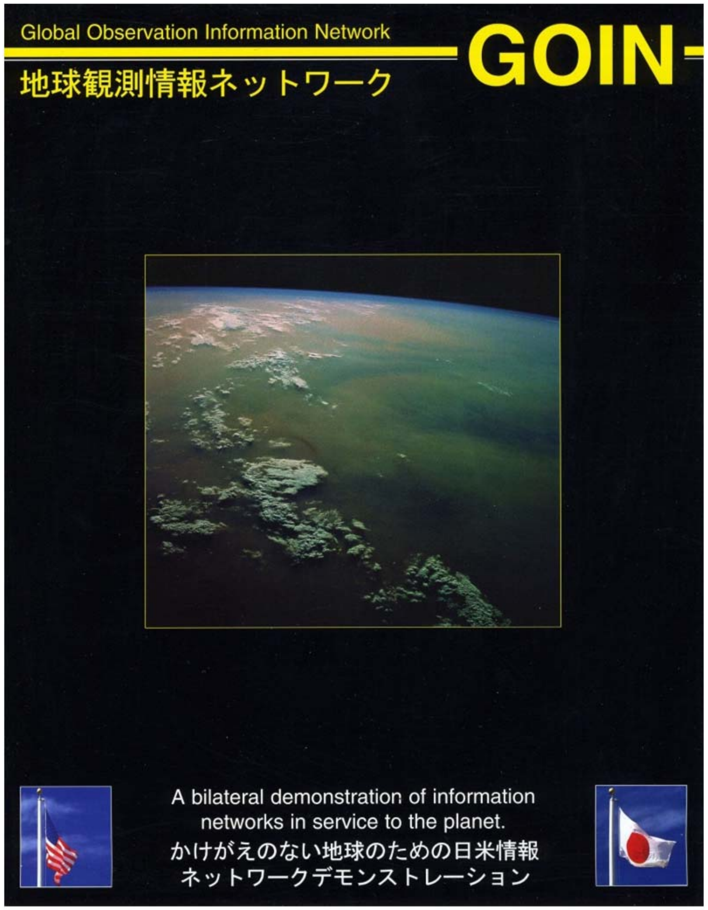
CC: Pat Bornmann, Dave Evans, Dave Lewis, Herb Sauer, Dan Wilkinson NGDC

The work that Dan Wilkinson is undertaking to transfer the raw GOES data archive from the half inch tapes in CYBER format to the IBM 3480 tapes in his proposed modified FITS format is of direct value to SEL. In particular it contributes directly towards our ESDIM and SELRAS program objectives by performing the 'rescue' from the CYBER format and allowing us to concentrate on the parallel task with the TIROS data.

GOES - History

GOIN – Global Observation Information Network

In 1993 President Clinton and Prime Minister Miyazawa of Japan implemented GOIN. NGDC's GOES and POES archives were high lighted as a major candidate for bilateral cooperation.



GOES - History

NGDC STP Division Hosted the 1997 GOIN Workshop utilizing NCAR facilities.

GOES - History

- 1992 First comprehensive GOES SEM CD issued.
- 1992 GOES SEM CD update issued.
- 1992 Anomaly submissions stopped.
- 1995 GOES I-M era begins with launch of GOES-8,
  - Data provider discontinues Responsible Scientist quality oversight.
  - Full-resolution data will not be archived for this series.
- 1997 SPIDR come online and becomes primary GOES SEM dissemination tool.
  - Plots generated via IDL CGI
  - Data selected from binary archive via CGI
- 1999 SPIDR upgraded
  - Plots generated via Java
  - Data stored in relational archive
- 2000 Many users request flat file access to GOES SEM
  - ASCII tables generated monthly with canned browse plots.

GOES - History

TO: John Kinsfather
FROM: Dan Wilkinson
DATE: June 18, 1991
SUBJECT: Write-Once CDROM

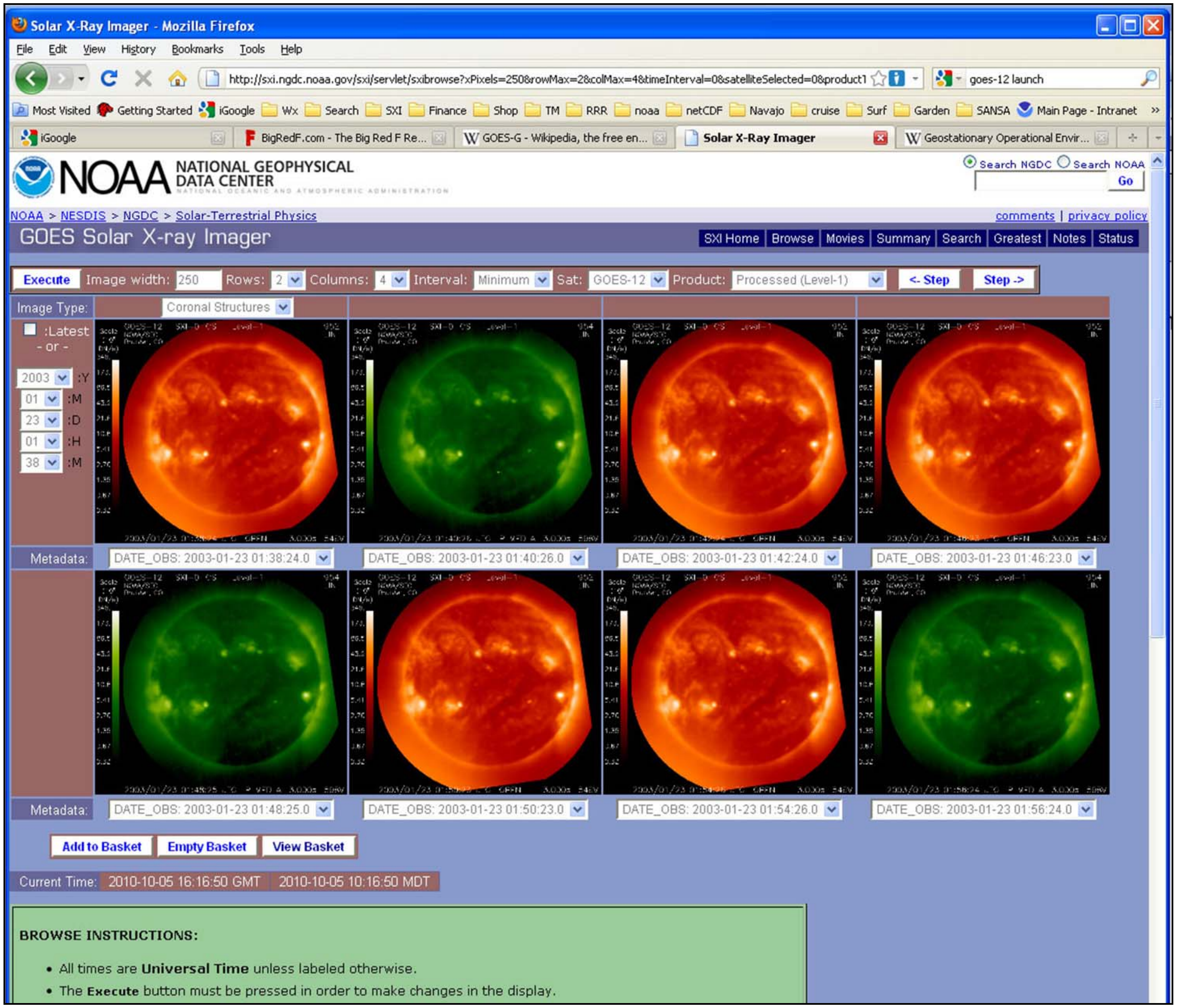
Optical Media International	$24,900
485 Alberto Way	$23,000 hardware only
Los Gatos, CA 95032	$1,900 pcTOPiX software
(408)376-3511	(upgrade cost, list $4,500)
(800)347-2664	Includes simulator, allows
Attn: Rick Wittwer	quality control and image modification.
Publishers Data Service Corporation	$24,990
One Lowe Ragsdale Drive	Includes ISO 9660 software
Bldg 12 Suite 163	One year warranty
Monterey CA 93942	$35 disks in quantity
(408)372-2810	ISA bus preferred
FAQ (408)372-7136	
Attn: Dean Quanstron	
Young Minds	$28,500
Redlands, CA	Includes sofware (support $950/yr)
(714)335-1350	Trantor SCSI extra
Attn: Tom Stapleton	UNIX and ULTRIX software coming

GOES - History

July 2001 GOES-12 & SXI were launched – Solar X-ray Imager reaches orbit after 20 years of planning, 2,275,821 images collected before being shutdown in April of 2007.

GOES - History

GOES-12 SXI – NGDC's Java Servlet driven interface was ready on day 1.



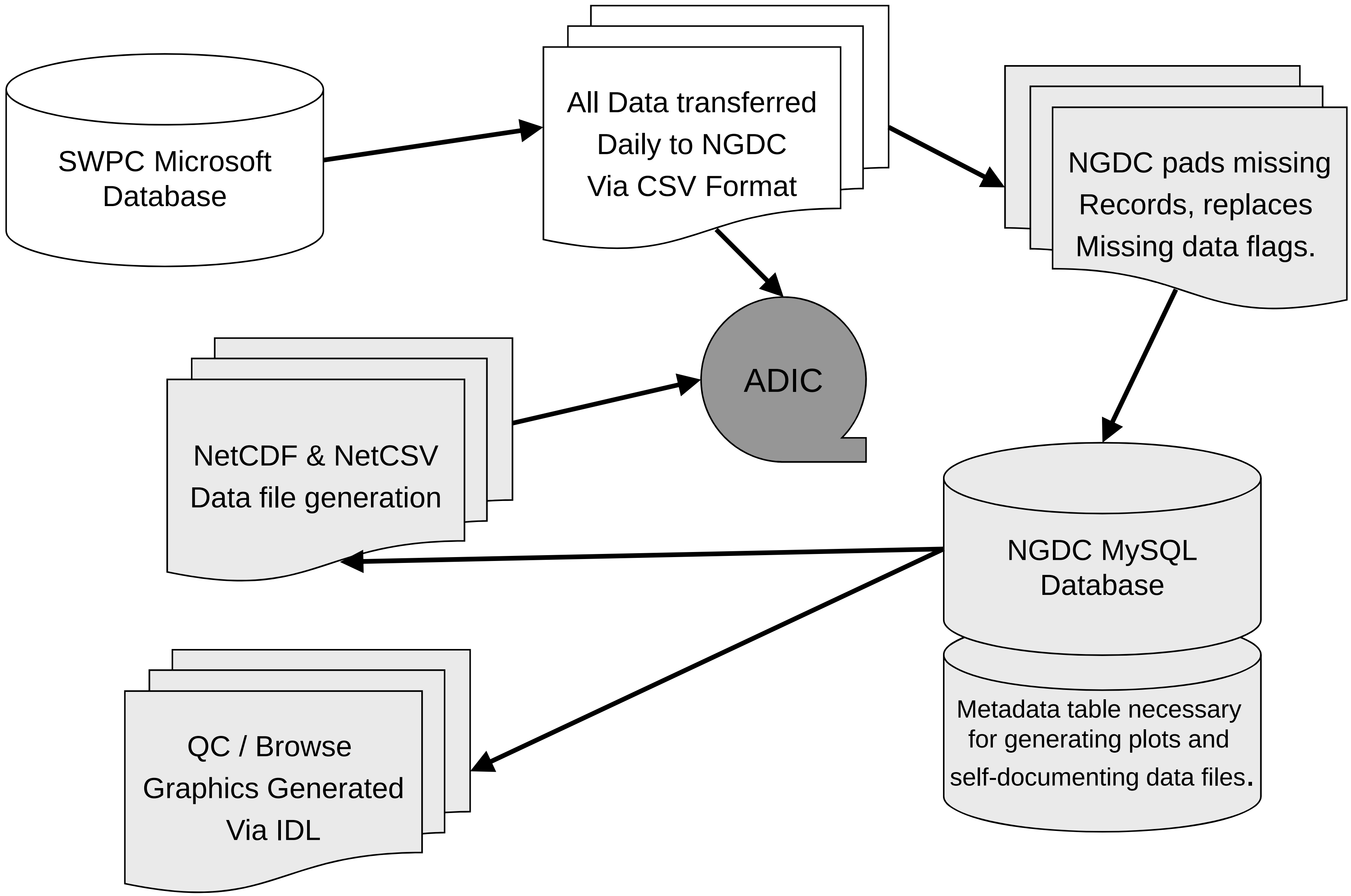
GOES – Current Status

GOES-NOP: GOES-13, GOES-14, GOES-15

- Vast array of new data as compared to previous GOES.
    - New Extreme Ultraviolet sensor (UVS) data.
    - New proton data - Magnetospheric protons, 5 channels, 9 look directions
    - New electron data - Magnetospheric protons, 5 channels, 9 look directions
    - Dual look directions for higher energy particles.
    - Dual Magnetometers
    - Expanded full-resolution capabilities for all data types.
- GOES-14 XRS is primary for SWPC operations.
- GOES-15 XRS is secondary for SWPC operations.

GOES – Current Status

GOES-NOP Data Flow



GOES – Current Status

GOES-NOP Tables -- One set for each satellite.

TIME AVERAGES

tb_g13_epead_a16ew_1m
tb_g13_epead_a16ew_5m
tb_g13_epead_cpflux_5m
tb_g13_epead_e13ew_1m
tb_g13_epead_e13ew_5m
tb_g13_epead_p17ew_1m
tb_g13_epead_p17ew_5m
tb_g13_eps_hskp_5m
tb_g13_euv_1m
tb_g13_euv_a_1m
tb_g13_hepad_ap_1m
tb_g13_hepad_ap_5m
tb_g13_hepad_s15_1m
tb_g13_hepad_s15_5m
tb_g13_maged_19me15_1m
tb_g13_maged_19me15_5m
tb_g13_magneto_1m
tb_g13_magneto_hskp_5m
tb_g13_magpd_19me15_1m
tb_g13_magpd_19me15_5m
tb_g13_sat_loc
tb_g13_sem_hskp_5m
tb_g13_xrs_1m
tb_g13_xrseuv_hskp_5m
tb_g13_xrseuv_imp_temp
tb_g13_zbgnd_e_hist
tb_g13_zbgnd_w_hist

FULL RESOLUTION

tb_g13_epead_a16e_32s
tb_g13_epead_a16w_32s
tb_g13_epead_e1ew_4s
tb_g13_epead_e2ew_16s
tb_g13_epead_e3ew_16s
tb_g13_epead_p1ew_8s
tb_g13_epead_p27e_32s
tb_g13_epead_p27w_32s
tb_g13_euv_a_10s
tb_g13_euv_b_10s
tb_g13_euv_c_10s
tb_g13_euv_d_10s
tb_g13_euv_e_10s
tb_g13_hepad_ap_32s
tb_g13_hepad_s15_4s
tb_g13_maged_19me1_2s
tb_g13_maged_19me2_2s
tb_g13_maged_19me3_4s
tb_g13_maged_19me4_16s
tb_g13_maged_19me5_32s
tb_g13_magneto_512ms
tb_g13_magpd_19me1_16s
tb_g13_magpd_19me2_16s
tb_g13_magpd_19me3_16s
tb_g13_magpd_19me4_32s
tb_g13_magpd_19me5_32s
tb_g13_xrs_2s

SXI HOUSEKEEPING

tb_g13_sxi_badpix
tb_g13_sxi_bpt_raw
tb_g13_sxi_cmptbl
tb_g13_sxi_evt_raw
tb_g13_sxi_exptbl
tb_g13_sxi_extt_raw
tb_g13_sxi_fdet
tb_g13_sxi_flttbl
tb_g13_sxi_hass_conv
tb_g13_sxi_hass_raw
tb_g13_sxi_hasscorr
tb_g13_sxi_head_raw
tb_g13_sxi_hhead_raw
tb_g13_sxi_hskp_conv
tb_g13_sxi_hskp_raw
tb_g13_sxi_hskp_raw_v1
tb_g13_sxi_imgsum_raw
tb_g13_sxi_levelone
tb_g13_sxi_levelzero
tb_g13_sxi_levelzero_v1
tb_g13_sxi_pcm_ccdtmp
tb_g13_sxi_pcm_cebtmp
tb_g13_sxi_pcm_debp3mon
tb_g13_sxi_pcm_debtmp
tb_g13_sxi_pcm_flags
tb_g13_sxi_pcm_hebtmp
tb_g13_sxi_pcm_mirtmp
tb_g13_sxi_pcm_mtrcurmon
tb_g13_sxi_pcm_p42curmon
tb_g13_sxi_pcm_pebtmp
tb_g13_sxi_pcm_telmnt1
tb_g13_sxi_pcm_telmnt2
tb_g13_sxi_sct_raw
tb_g13_sxi_seqmem

GOES – Current Status

GOES-NOP Sample Table Schema – 1 min Magnetometer

```
CREATE TABLE goes_13.tb_g13_magneto_1m (
time_tag datetime
insert_time timestamp
BX_1_QUAL_FLAG int
BX_1_NUM_PTS tinyint
BX_1 float
BY_1_QUAL_FLAG int
BY_1_NUM_PTS tinyint
BY_1 float
BZ_1_QUAL_FLAG int
BZ_1_NUM_PTS tinyint
BZ_1 float
BXSC_1_QUAL_FLAG int
BXSC_1_NUM_PTS tinyint
BXSC_1 float
BYSC_1_QUAL_FLAG int
BYSC_1_NUM_PTS tinyint
BYSC_1 float
BZSC_1_QUAL_FLAG int
BZSC_1_NUM_PTS tinyint
BZSC_1 float
BTSC_1_QUAL_FLAG int
BTSC_1_NUM_PTS tinyint
BTSC_1 float
BX_2_QUAL_FLAG int
BX_2_NUM_PTS tinyint
BX_2 float
BY_2_QUAL_FLAG int
BY_2_NUM_PTS tinyint
BY_2 float
BZ_2_QUAL_FLAG int
BZ_2_NUM_PTS tinyint
BZ_2 float
BXSC_2_QUAL_FLAG int
BXSC_2_NUM_PTS tinyint
BXSC_2 float
BYSC_2_QUAL_FLAG int
BYSC_2_NUM_PTS tinyint
BYSC_2 float
BZSC_2_QUAL_FLAG int
BZSC_2_NUM_PTS tinyint
BZSC_2 float
BTSC_2_QUAL_FLAG int
BTSC_2_NUM_PTS tinyint
BTSC_2 float
HP_1_QUAL_FLAG int
HP_1_NUM_PTS tinyint
HP_1 float
HE_1_QUAL_FLAG int
HE_1_NUM_PTS tinyint
HE_1 float
HN_1_QUAL_FLAG int
HN_1_NUM_PTS tinyint
HN_1 float
HT_1_QUAL_FLAG int
HT_1_NUM_PTS tinyint
HT_1 float
HP_2_QUAL_FLAG int
HP_2_NUM_PTS tinyint
HP_2 float
HE_2_QUAL_FLAG int
HE_2_NUM_PTS tinyint
HE_2 float
HN_2_QUAL_FLAG int
HN_2_NUM_PTS tinyint
HN_2 float
HT_2_QUAL_FLAG int
HT_2_NUM_PTS tinyint
HT_2 float
```

GOES – Current Status

GOES-NOP Metadata –
Data Attributes available for 1m, 5m, full-res, but not housekeeping

These values are included in NetCDF and NetCSV data table headers.
These values also control all aspects of QC/Browse plots.
There are currently 904 fields defined, SXI housekeeping not included.

- field_name
- instrument
- description
- long_label
- short_label
- plot_label
- lin_log
- units
- format
- nominal_min
- nominal_max
- valid_min
- valid_max
- missing_value

GOES – Current Status

GOES NOP Schema Changes and other challenges:

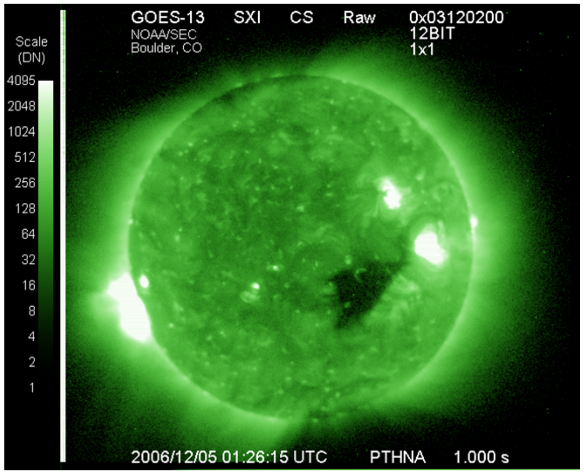
- The structure of tables will change from time to time as SWPC adds new data products. For example, the tables below had significant changes in October 2010. This requires the renaming of existing tables in order to preserve the old data and the creation of new tables in the new schema.
- Some new data will be processed retroactively for certain satellites, some satellite will not have this done which will create a discontinuity in the archive for those satellites.
- New fields do not logistically exist to plotting and data file generation systems until the new fields have been described in the metadata tables.
- SWPC renamed several tables in October 2010 in order to correct a typographical error. This type of change requires special case handling throughout the entire data processing scheme.

GOES – Current Status

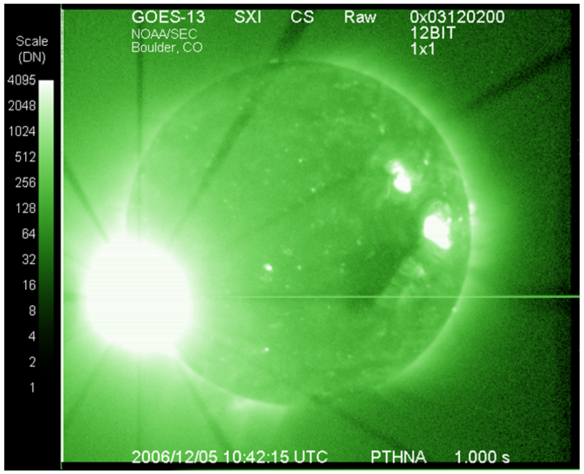
GOES-13 SXI

In December 2006 the GOES-13 SXI was in its final month of Post Launch Testing when a solar flare damaged the imaging array. This instrument has never gone operational.

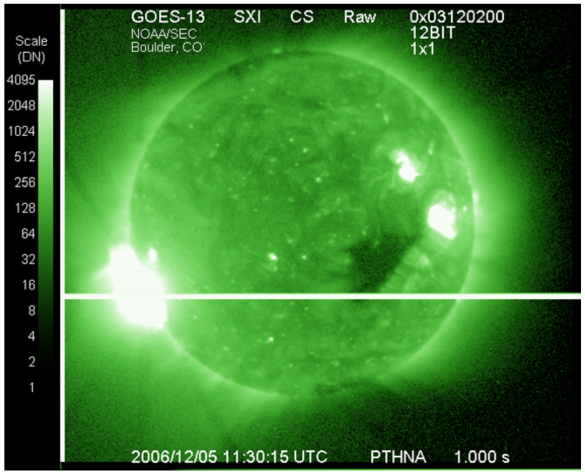
Before X9 Flare



During



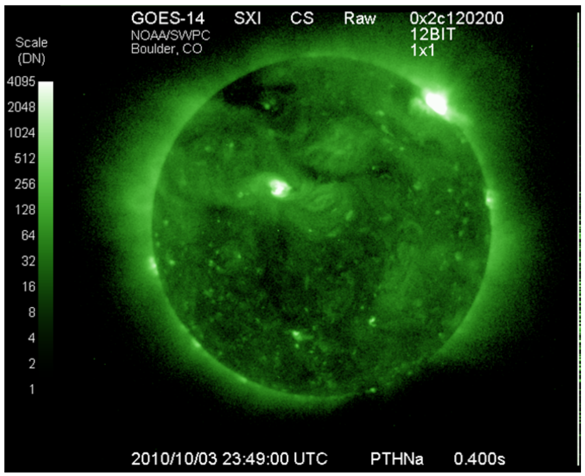
After



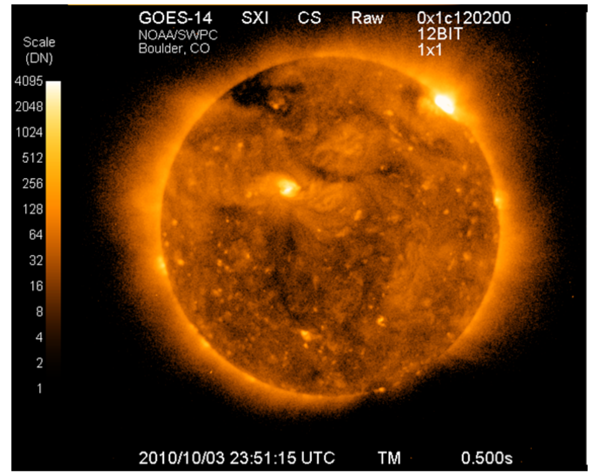
GOES – Current Status

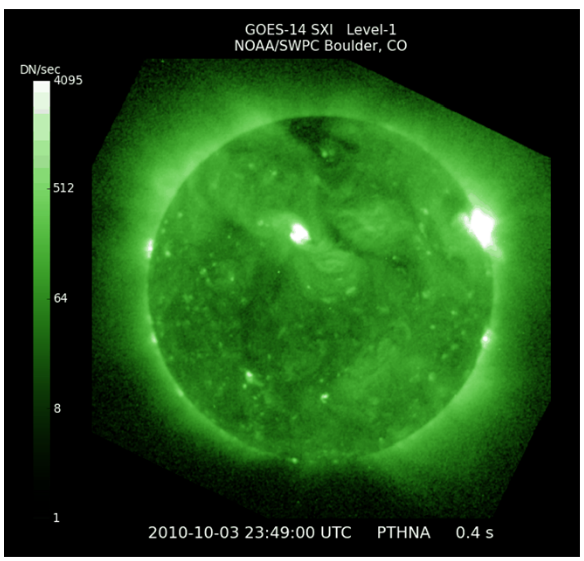
GOES-14 SXI

- GOES-14 is officially in storage mode however we continue to receive Level-0 and Level-1 images.

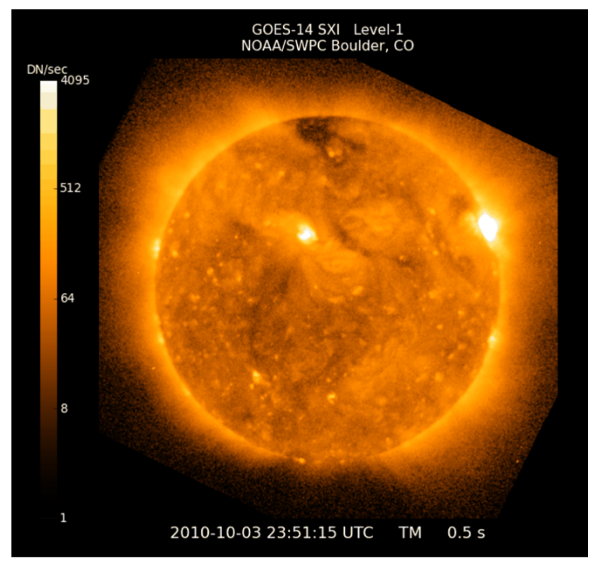


Level-0





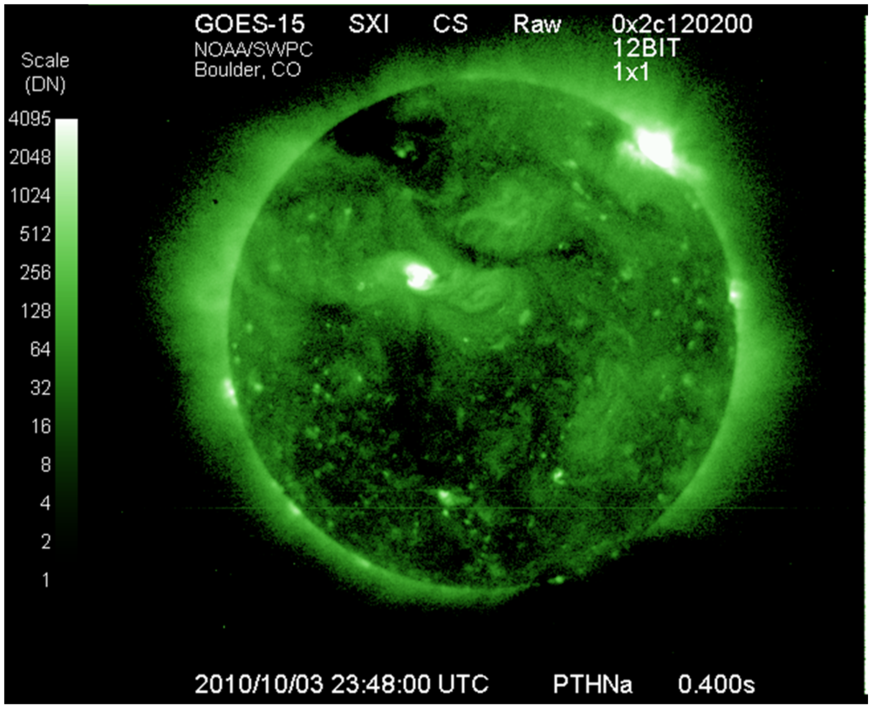
Level-1

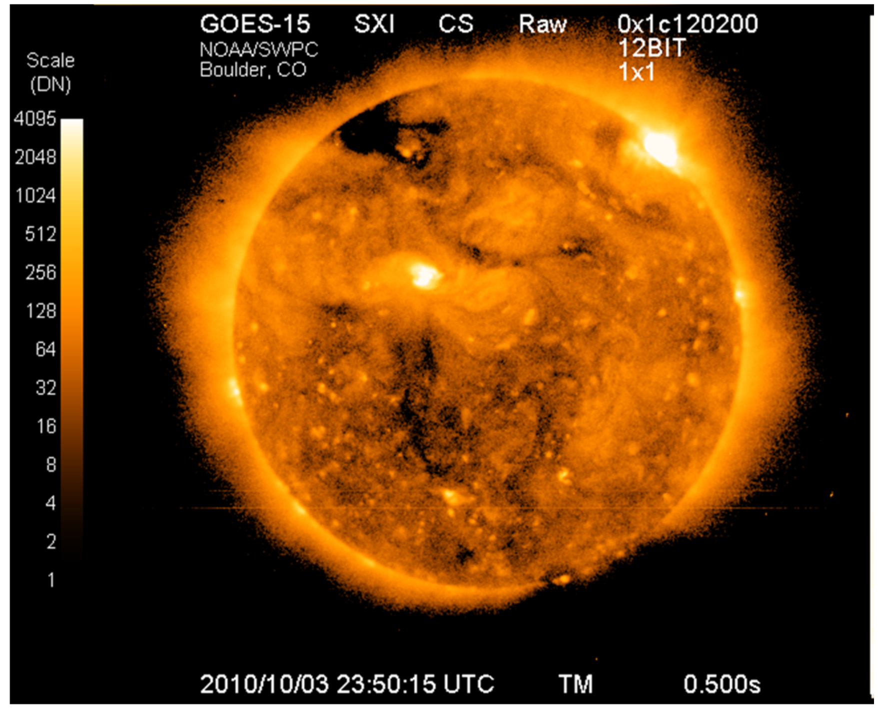


GOES – Current Status

GOES-15 SXI

- GOES-15 is in Post Launch Testing, we receive Level-0 images only.





GOES – Current Status

GOES-I-M Series coming to a close.

- GOES-11 is in last of the I-M series producing SEM data.
- 2010 user statistics for GOES SEM data.

Month	Data(GB)	Distinct Hosts
Jan	163	2,135
Feb	81	1,896
Mar	190	1,907
Apr	196	1,858
May	165	1,508
Jun	188	1,574
Jul	90	1,330
Aug	106	1,178
Sep	115	1,029
Average	144	1,602
Annual	1,725	19,220

GOES – Future

GOES-R

- The GOES-R series of satellites is scheduled for launch in 2014
- GOES-R Risk Reduction
  - NGDC is finishing a three year project to develop a prototype interface to GOES-R space weather data sets. Under this project GOES-NOP data have been converted to NetCDF to simulate the GOES-R archive format.
  - NGDC is proposing a new two year project that will apply the Rich Inventory to the GOES-R proxy data created in the previous project.
- GOES-R Integrated Product Team
  - OAIS compliance, submissions agreements, file naming, etc.
- GOES-R Data Engineering Working Group
  - Metadata planning for GOES-R

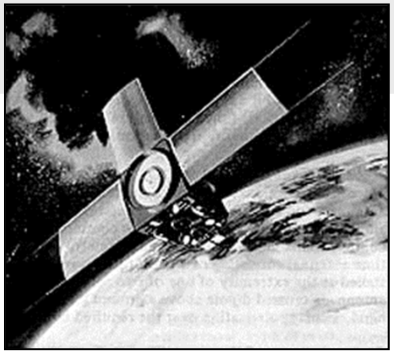
POES - History

- TIROS-N 1978-11 to 1981-02 (Introduction of SEM-1)
- NOAA-6 1979-06 to 1986-11
- NOAA-B 1980-05 Launch Failure, “It became space debris”
- NOAA-7 1981-07 to 1985-02
- NOAA-8 1983-05 to 1985-10
- NOAA-10 1986-10 to 1991-08
- NOAA-12 1991-06 to 2002-07
- NOAA-14 1995-01 to 2004-12

SEM-1
Space Environment Monitor

- NOAA-15 1998-07 to present (Introduction of SEM-2)
- NOAA-16 2001-01 to present
- NOAA-17 2002-07 to present
- NOAA-18 2005-06 to present
- METOP-02 2006-12 to present (aka METOP-A)
- NOAA-19 2009-02 to present

SEM-2



POES - History

POES – Space Environment Monitor

- Energetic Particles

- **Archive Structure** – Polar Operational Environmental Satellites
  - Custom packed binary files.
  - SWPC provides program sub function to unpack
  - Full Resolution, 2.0s
- **Data Services**
  - Tape was only delivery media.
  - No browse graphics were available
  - A small number of customers requested large quantities of data.
- **Documentation**
  - These data have always been well documented.

POES - History

POES – NGDC 1986 Data Flier

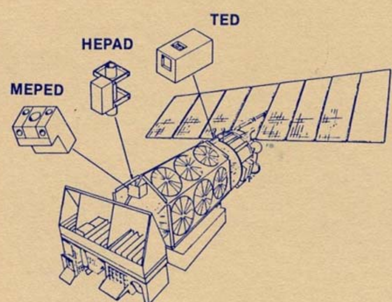
SAMPLE

STP-85-5
April 1985

DATA ANNOUNCEMENT

ENERGETIC PARTICLE DATA
from the
NOAA/TIROS POLAR ORBITING SATELLITES

The TIROS and NOAA satellites measure fluxes of electrons, protons and alpha particles resulting from solar and geomagnetic activity. The archive also contains several calculated quantities such as L values, pitch angles, and geomagnetic coordinates.



This unique archive began in 1978 with the launch of TIROS-N, which carried the three arrays of particle detectors described below. Similar detectors were later flown on the NOAA-6, NOAA-7, and NOAA-8 satellites. Two satellites gather data simultaneously in circular orbits of 850 km altitude and 99° inclination. The data are received continuously at the Space Environment Laboratory in Boulder, Colorado, where they are processed and stored on three magnetic tapes per month per satellite.

HIGH ENERGY PROTON AND ALPHA PARTICLE DETECTOR measures the flux of solar protons in four energy bands above 370 MeV and of solar alpha particles in two energy bands above 640 MeV per nucleon. All measurements are made in the direction of the local zenith.

MEDIUM ENERGY PROTON AND ELECTRON DETECTOR measures the flux of protons in 5 energy bands above 30 KeV and of electrons in 3 energy bands above 30 KeV. Ions with a Z number > 1 are measured in a single energy band of 6 – 55 MeV. Measurements are made in the direction of and at 80° to the local

POES - History

POES – 1985 Documentation SEM-1, valid for TIROS-N through NOAA-14.

TIROS/NOAA Satellites Space Environment Monitor Archive Tape Documentation

V. J. HILL, D. S. EVANS, H. H. SAUER

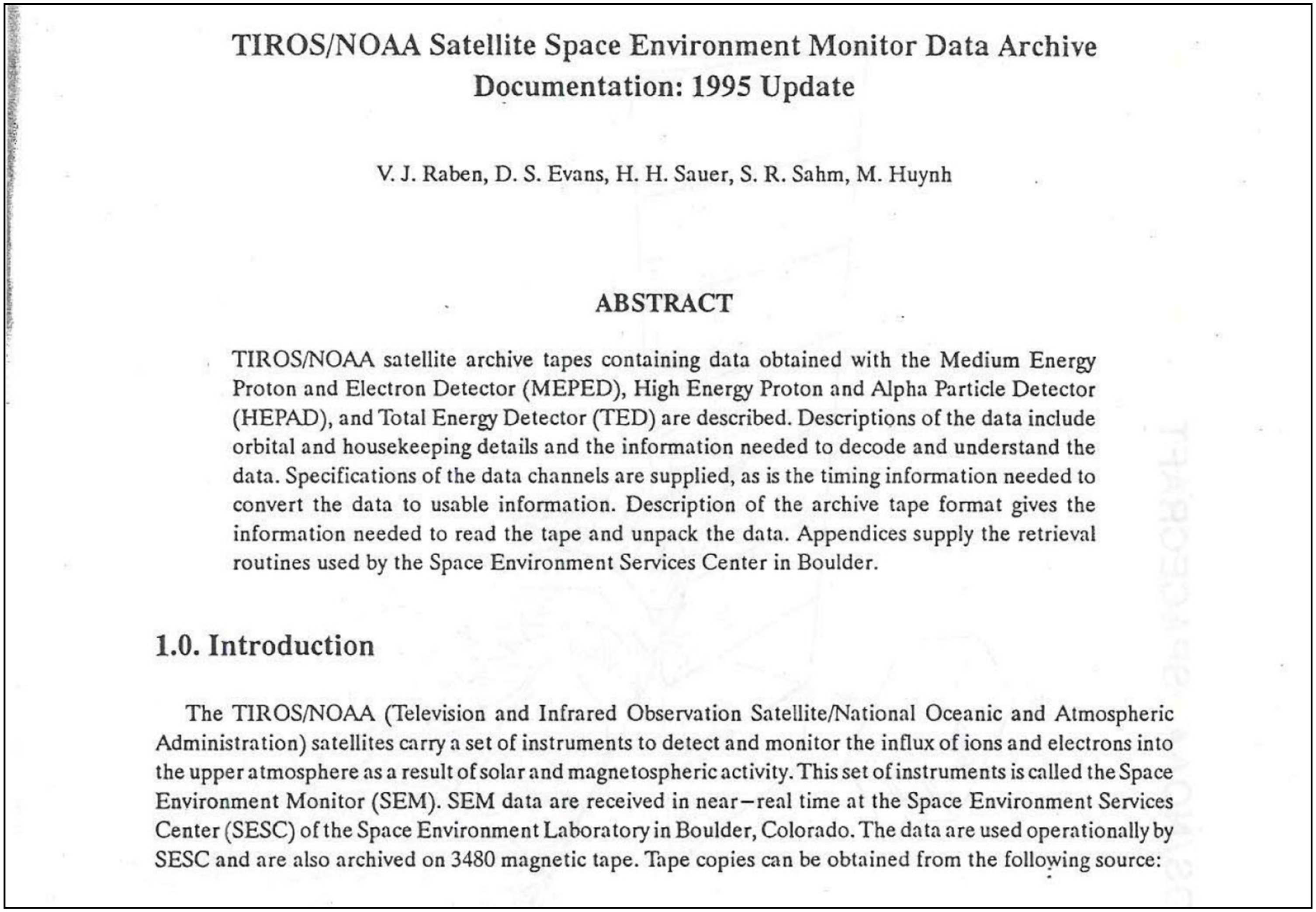
ABSTRACT. TIROS/NOAA satellite archive tapes containing data obtained with the Medium Energy Proton and Electron Detector (MEPED), High Energy Proton and Alpha Particle Detector (HEPAD), and Total Energy Detector (TED) are described. Descriptions of the data include orbital and housekeeping details and the information needed to decode and understand the data. Specifications of the data channels are supplied, with the timing information needed to convert the data to usable information. Description of the archive tape format gives the information needed to read the tape and unpack the data. Appendices supply the retrieval routines used by the Space Environment Services Center in Boulder.

1.0 INTRODUCTION

The TIROS/NOAA (Television and Infrared Observation Satellite / National Oceanic and Atmospheric Administration) satellites carry a set of instruments to detect and monitor the influx of ions and electrons into the upper atmosphere as a result of solar and magnetospheric activity. The set instruments is called the Space Environment Monitor (SEM). SEM data are received in near-real time at the Space Environment Services Center (SESC) of the Space Environment Laboratory in Boulder, Colorado. The data are used operationally by SESC and are also archived on magnetic tape. Tape copies can be obtained from the Laboratory:

POES - History

POES – 1995 Documentation SEM-1 **UPDATE**



TIROS/NOAA Satellite Space Environment Monitor Data Archive Documentation: 1995 Update

V. J. Raben, D. S. Evans, H. H. Sauer, S. R. Sahm, M. Huynh

ABSTRACT

TIROS/NOAA satellite archive tapes containing data obtained with the Medium Energy Proton and Electron Detector (MEPED), High Energy Proton and Alpha Particle Detector (HEPAD), and Total Energy Detector (TED) are described. Descriptions of the data include orbital and housekeeping details and the information needed to decode and understand the data. Specifications of the data channels are supplied, as is the timing information needed to convert the data to usable information. Description of the archive tape format gives the information needed to read the tape and unpack the data. Appendices supply the retrieval routines used by the Space Environment Services Center in Boulder.

1.0. Introduction

The TIROS/NOAA (Television and Infrared Observation Satellite/National Oceanic and Atmospheric Administration) satellites carry a set of instruments to detect and monitor the influx of ions and electrons into the upper atmosphere as a result of solar and magnetospheric activity. This set of instruments is called the Space Environment Monitor (SEM). SEM data are received in near–real time at the Space Environment Services Center (SESC) of the Space Environment Laboratory in Boulder, Colorado. The data are used operationally by SESC and are also archived on 3480 magnetic tape. Tape copies can be obtained from the following source:

POES - History

POES – Dr. Dave Evans also issued annual updates and status reports

To: Janet Green
Dan Wilkinson
SOCC Suitland
Fm: Dave Evans
Re: General update

I have finished the clean up and verification of NOAA-15, NOAA-16, NOAA-17, NOAA-18 and MetOp-02 SEM-2 data from 2007 and have some updated performance information and figures that may be of interest.

January 10, 2008

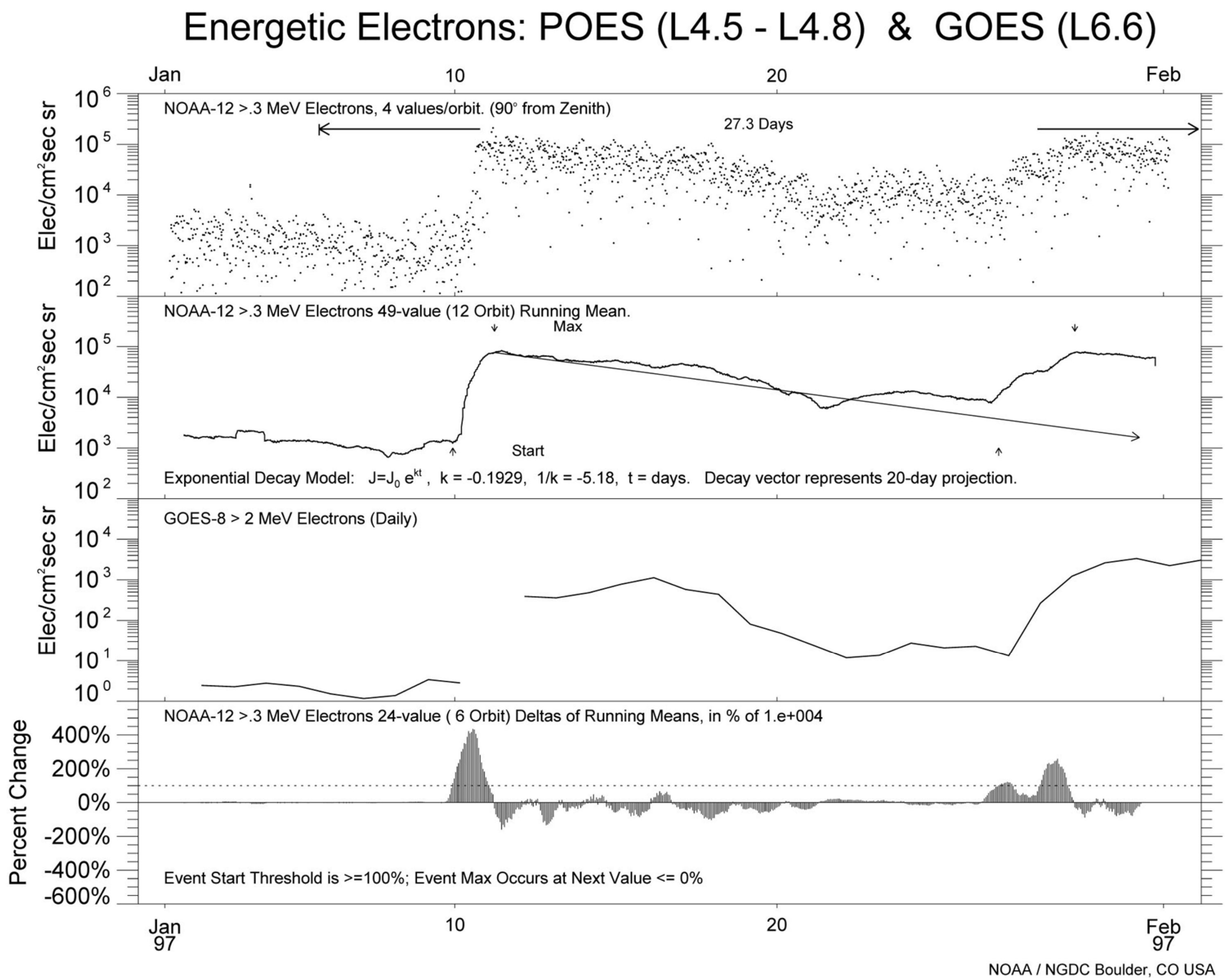
SEM-2 performance on the operating satellites during 2007.

General Comments:

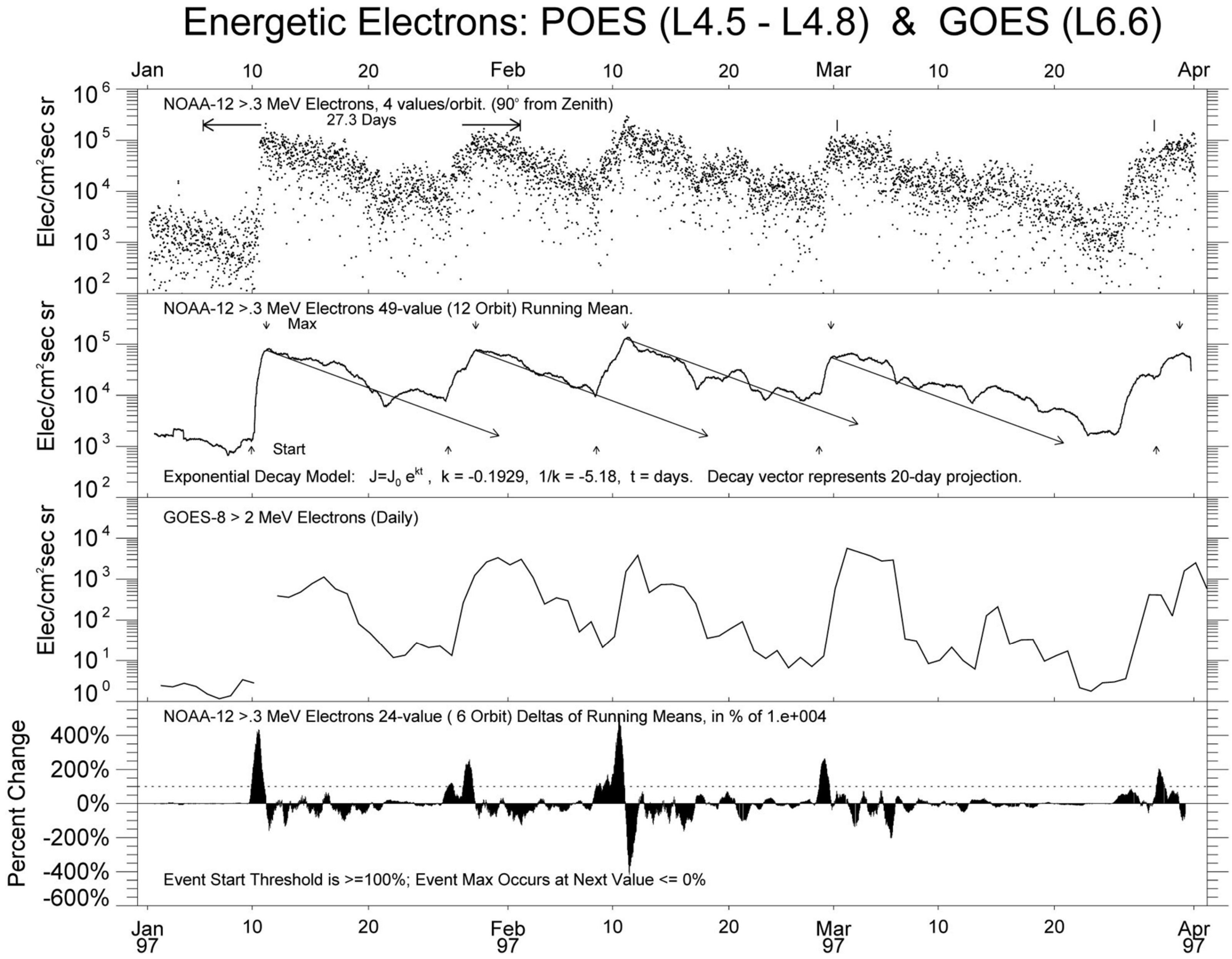
While it has been pointed out in the past, it is worth re-emphasizing the fact that the proton telescope instruments in SEM-2 are sensitive to electrons of energies greater than about 800 keV. This is because the sweeping magnetic field in the proton telescope apertures is not effective in suppressing very energetic electrons from reaching the detector and very energetic electrons are capable of depositing >30 keV energy in the front solid-state detector and >60 keV in the back detector, thus triggering an event in the 0P6 or 90P6 channels and mimicking an event from a >6.3 MeV proton. That same electron is, however, incapable of depositing enough energy in the front solid-state detector produce an event in either the P4 or P5 (800-2500 keV and 2500 to 6300 keV) proton telescope channels. Thus instances when the proton telescope detectors display

POES Supports ISS

POES – NASA Houston ISS program requested electron event study using POES



POES Supports ISS



POES - History

POES –JGR paper presents a detailed applications of SEM-2 data.

JOURNAL OF GEOPHYSICAL RESEARCH, VOL. 115, A04202, doi:10.1029/2008JA014023, 2010

Click Here for Full Article

Use of POES SEM-2 observations to examine radiation belt dynamics and energetic electron precipitation into the atmosphere

Craig J. Rodger,[1] Mark A. Clilverd,[2] Janet C. Green,[3] and Mai Mai Lam[2]

Received 26 December 2008; revised 2 August 2009; accepted 3 November 2009; published 3 April 2010.

[1] The coupling of the Van Allen radiation belts to the Earth's atmosphere through precipitating particles is an area of intense scientific interest. Currently, there are significant uncertainties surrounding the precipitating characteristics of medium energy electrons (>20 keV), and even more uncertainties for relativistic electrons. In this paper we examine roughly 10 years of measurements of trapped and precipitating electrons available from the Polar Orbiting Environmental Satellites (POES)/Space Environment Monitor (SEM-2), which has provided long-term global data in this energy range. We show that the POES SEM-2 detectors suffer from some contamination issues that complicate the understanding of the measurements, but that the observations provide insight into the precipitation of energetic electrons from the radiation belts, and may be developed into a useful climatology for medium energy electrons. Electron contamination also allows POES/SEM-2 to provide unintended observations of >700 keV relativistic electrons. Finally, there is an energy-dependent time delay observed in the POES/SEM-2 observations, with the relativistic electron enhancement (electrons >800 keV) delayed by approximately one week relative to the >30 keV electron enhancement, probably due to the timescales of the acceleration processes. Observations of trapped relativistic electron fluxes near the geomagnetic equator by GOES show similar delays, indicating a "coherency" to the radiation belts at high and low orbits, and also a strong link between trapped and precipitating particle fluxes. Such large delays should have consequences for the timing of the atmospheric impact of geomagnetic storms.

POES - History

POES – NGDC has received data from between one and six satellites simultaneously and an inventory program was written to automatically update the inventory after each ingest. Early data submissions contained several days per file. Beginning in 1996 all data were delivered in daily files.

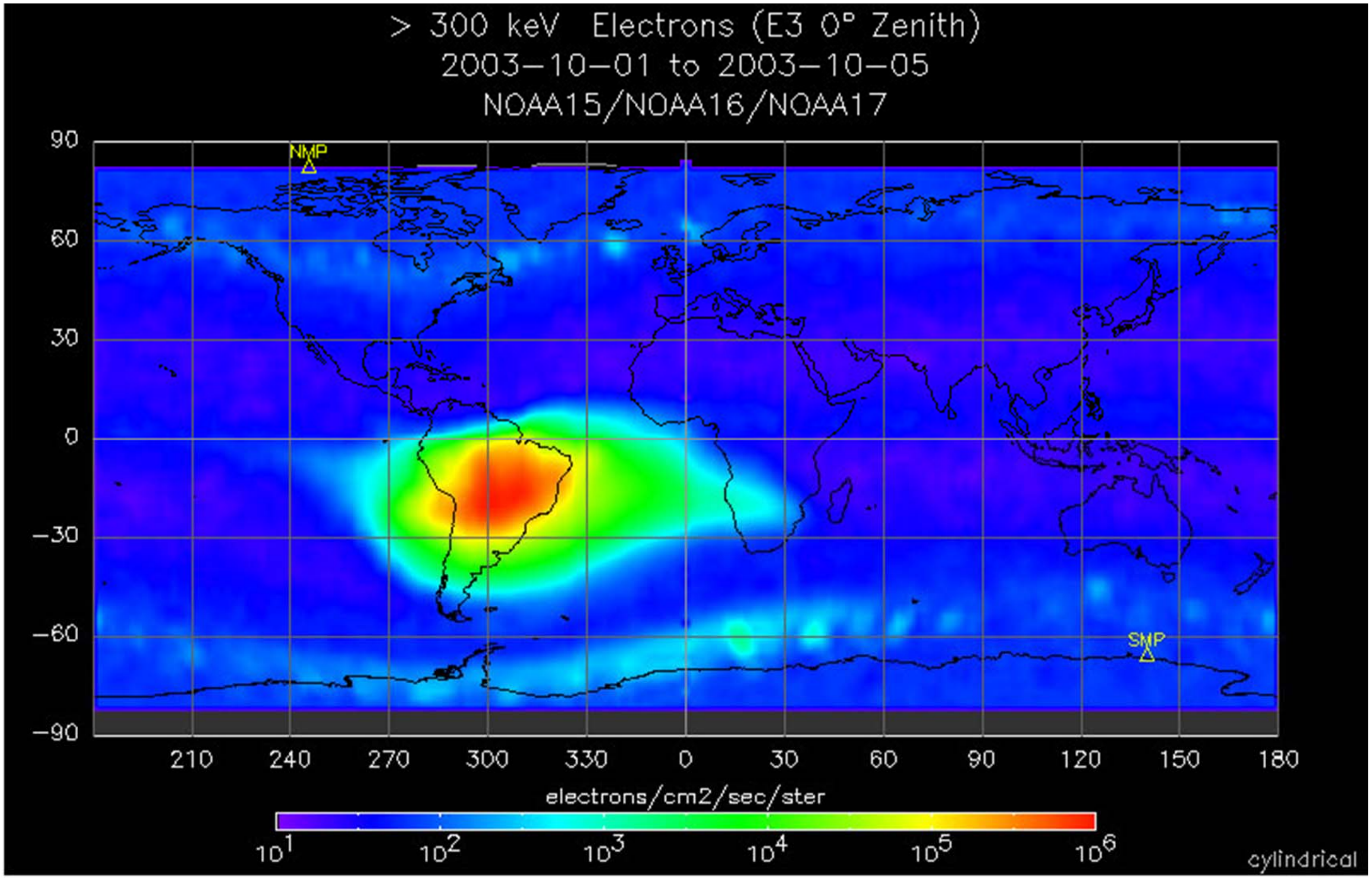
The inventory software sends e-mail notification if it identifies missing data.

POES – The first step in quality assurance was the generation of a set of QC plots. These plots would verify file integrity as well as data channel consistency and continuity.

POES – NGDC converted and ran Sue Greer code to generate 16s averages of SEM-2 data in CDF and ASCII table formats. Apparently many people had been intimidated with the need to unpack binary archive files and the ASCII tables soon became the most requested file type.

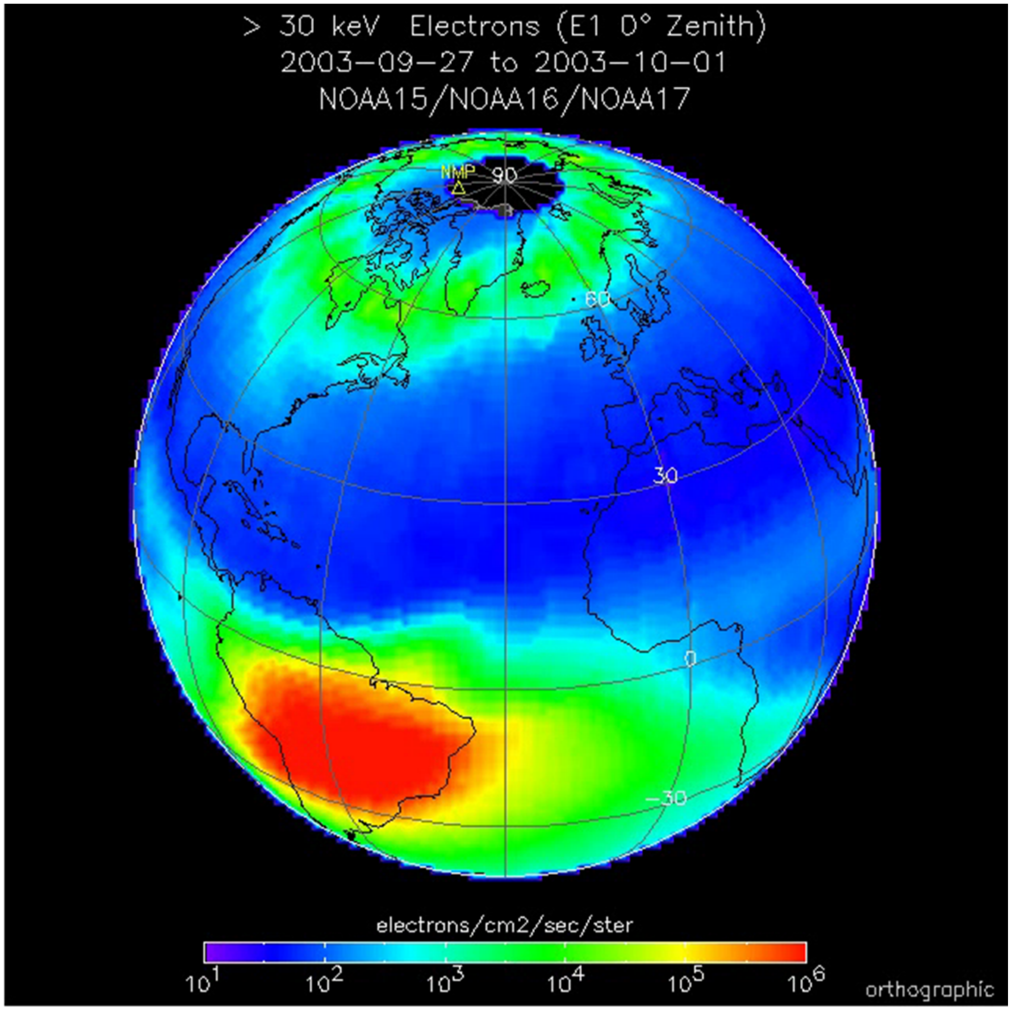
POES - History

POES – In 2008 NGDC began the routine generation of radiation maps. The accumulation of sufficient data bins to generate a full map requires data collection over several days from multiple satellites.



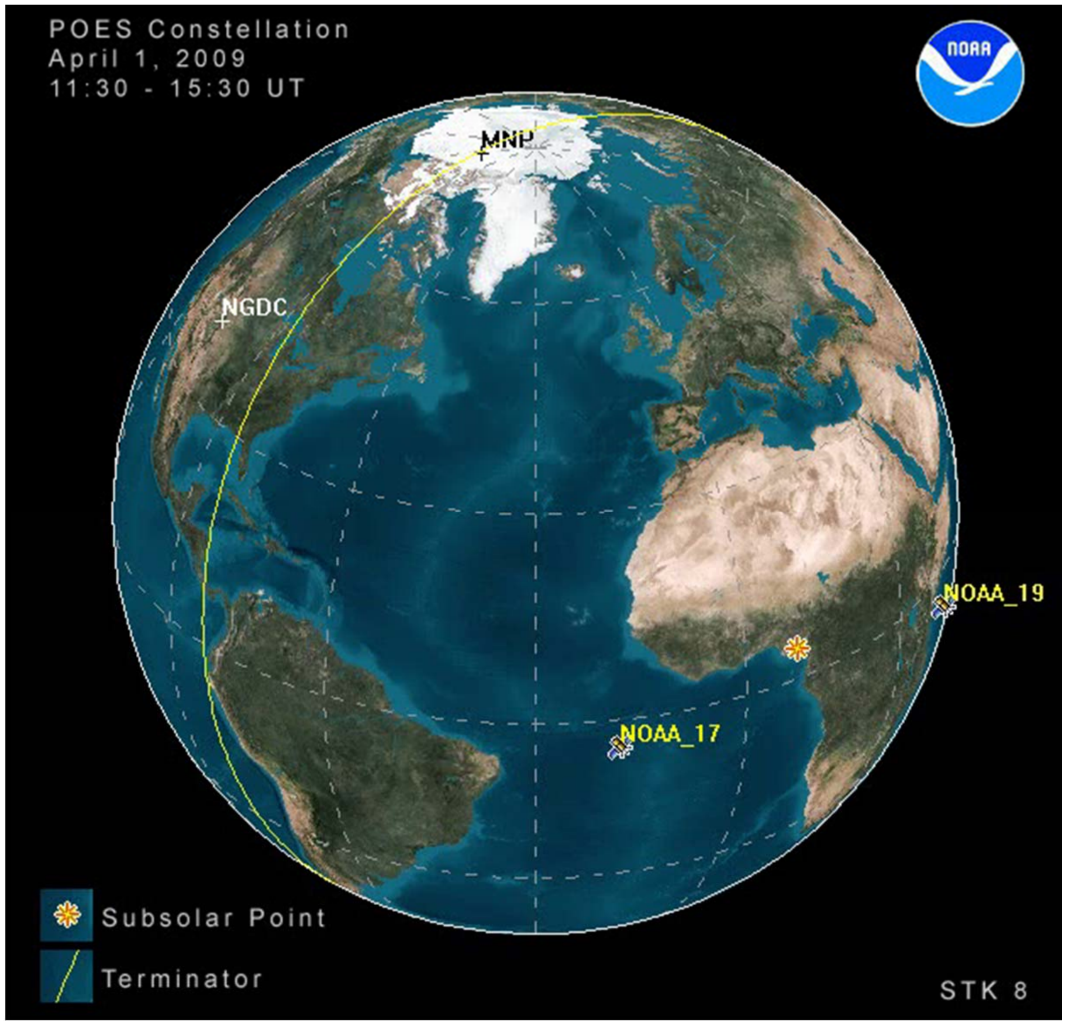
POES - History

POES – Radiation maps are updated after the daily data ingest. Maps are generated in Cylindrical and Orthographic projects included in 54 days movies.



POES – Current Status

POES – There are currently six POES in operation, each with a functioning SEM-2 sub-system delivering data to archive.



POES – Current Status

POES – 2010 user statistics:

Month	Data(GB)	Distinct Hosts
Jan	486.65	1,374
Feb	175,24	1,307
Mar	177.08	1,368
Apr	240.88	1,309
May	458.4	1,286
Jun	376.86	1,058
Jul	112.59	1,123
Aug	121.94	1,172
Sep	210.2	1,089
Monthly Avg	273	1,232
Annual	3,277	14,781

POES – Future

•**NOAA-19** is the last in the POES series.

•**SWPC** will only support data used in operations because POES series no longer needed for operations. Processing will be migrated to NGDC.

•**JPSS** is next…

March 19, 2010

As NPOESS prime contractor, Northrop Grumman Aerospace Systems of Los Angeles was to build the satellite platforms and also was responsible for overall integration of the system, including the instruments and ground segment.

Testifying before the House Appropriations commerce, justice, science subcommittee, Lubchenco said NASA will take over the instrument and ground-segment integration duties for what is now called the **Joint Polar Satellite System** as part of a transition plan being finalized by NOAA and the U.S. Department of Defense. NOAA’s budget request includes $1.06 billion for the Joint Polar Satellite System in 2011.