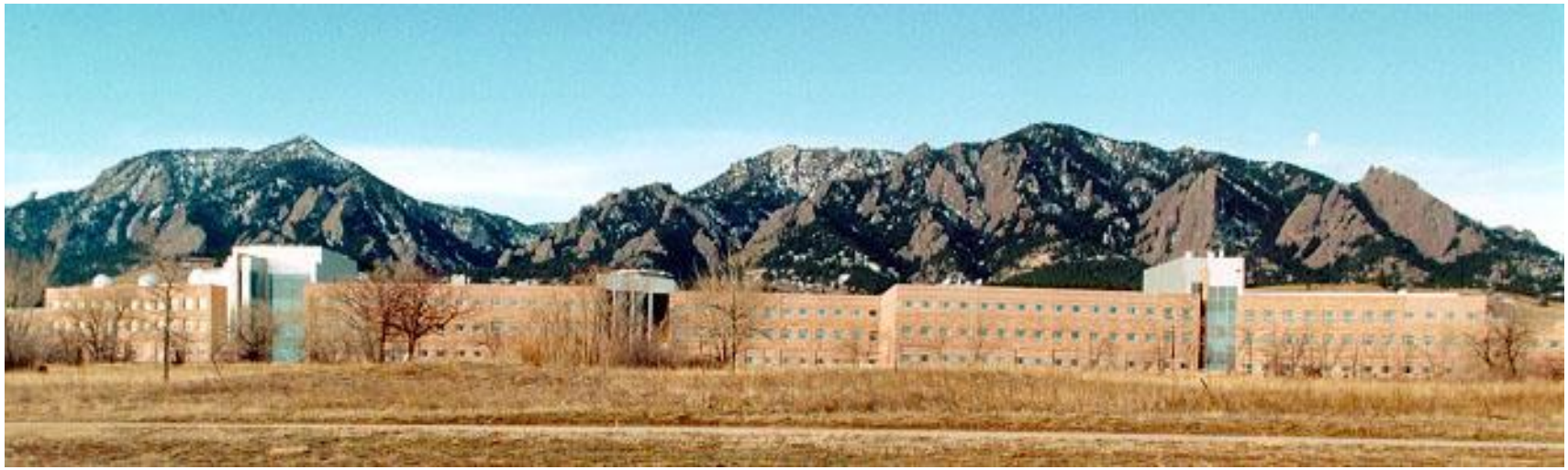

STP Quarterly Review

22 Jul 2011

3QFY11

William Denig

Solar & Terrestrial Physics Division

NOAA/NESDIS/NGDC

303 497-6323

William.Denig@noaa.gov

OUTLINE
Solar & Terrestrial Physics Division

- **STP Program Overview**
- **Milestones & Performance Measures**
- **Personnel Activities**
- **Accomplishments & Updates**
- **Special Interest Items**
- **NightSat Program Update**
- **Issues & Summary**

Solar & Terrestrial Physics Division
Personnel

Solar & Terrestrial Physics Division
Bill Denig, Chief
Janet Brown

Key
F – Federal
C – CIRES/CIRA
S – Student
G – Guest Scientist

Earth Observations

Chris Elvidge/F
Kim Baugh/C
Sharolyn Anderson/C
Daniel Ziskin/C
Tilo Ghosh/C (remote)

Space Weather

Dan Wilkinson/F
Rob Redmon/F
Janet Green/F
Pat Alken/C
Peter Elespuru/C
Dominic Fuller-Rowell/S

CORS

Fran Coloma/C
Rob Prentice/C
Ernie Joynt (ISD)

Ionospheric Sounding

Terry Bullett/C
Jim Manley/C (50%)
Preeti Bhaneja/C
Ray Conkright/C
John Schminsky/C

SEM-N

Pat Purcell/C
Jim Manley/C (50%)
Janet Machol/C
Paul Meade/C

Indices & Solar Images

Justin Mabie/C
Karen Horan/F
Craig Clark/F
Lisa Rizzo/S

GOES-R

Anu Sundaravel/C
Mary Shouldis, incoming
Juan Rodriguez, incoming
Vice Lotonuini, new hire
Vice Rigler, new hire

STP Division Overview
Personnel Changes

- **Gains**
  - Lisa Risso, Summer Intern
- **Losses**
  - None
- **Re-Assignments**
  - John Schminsky – Transitioned from student to PRA
- **Inbound**
  - Juan Rodriguez – GOES-R particle physicist
  - Mary Shouldis – GOES-R L2+ SWx algorithm program manager
- **Vacancies**
  - GOES-R solar imager physicist – CIRES new hire (with SWPC)
  - GOES-R magnetometer physicist – CIRES new hire (with SWPC)
- **Outbound**
  - Daniel Ziskin – to sell real estate and run for political office

STP Division Overview

Agreements – Status

Scope	Team	Type	Partner	NOAA Legal	DOC Legal	NGDC Signed	Partner Signed	Start	End	Status	
CORS Support	NTL	AGR	NGS	n/a	n/a			01-Oct-03	30-Sep-12	G	Extension now in place
SWx Climatology	NTL	MOU	AFCCC	X	X	X	X	27-May-04	01-Oct-14	G	In place - *no FY11 activity*
GPS Data (CORS)	NTL	MOA	Multi	n/a	n/a	X	X	20-Sep-04	*TBD*	Y	*Biannual Review - at NGS*
Outage Detection	NTL	MOU	NPS					*TBD*	*TBD*	G	*New MOU*
NASIC	NTL	MOU	NASIC	X	X	X	X	09-Mar-11	30-Jan-15	G	In place - nothing to report
Ionospheric Data	SWX	MOU	AFWA	X	X	X	X	21-Aug-06	21-Aug-11	G	In place - *no FY11 activity*
DMSP Archive	NTL	MOA	DMSP	X	X	X	X	30-May-07	30-Sep-09	Y	*Expired - Reconsidering need?*
ViRBO	SWX	MOA	NASA	X	X	X	X	15-Apr-09	n/a	G	In place - *no FY11 activity*
Ionosonde Sites	SWX	IA	USGS	X	X	X	X	03-Apr-09	03-Apr-14	G	In place - *no FY11 activity*
SEM-N - AFRL	SWX	MOA	AFRL	X	X	X	X	11-May-09	11-May-14	G	In place - nothing to report
Nighttime Lights	SWX	MOU	DOE	X	X	X	X	12-Aug-09	12-Aug-13	G	In place - nothing to report
Gas Flaring	NTL	SA	WBank	X	X			*TBD*	*TBD*	Y	*World Bank has not signed*
SEM-N Algorithms	SEG	MOU	SMC	X	X	X		*TBD*	*TBD*	Y	*SMC footdragging - funding at risk*

As of: 28 Jun 11

G	Good shape
Y	Watch Item
R	Action Required

STP Division Overview
External Funding – FY11

STP Funding Sources

Agency	Program	POC	Amount ($K)	Status
USAF	National Air & Space Information Center (NASIC)	Elvidge	100	Received
USAF	McMurdo Support	Elvidge	20	Received
NPS	California Earthquake Power Detection System	Elvidge	198	Confirmed
NASA	Carbon Project	Elvidge	25	Confirmed
World Bank	World Bank (Incrementally Billed)	Elvidge	92	Planned
JAPAN	Ministry of Agriculture, Forestry and Fisheries (MAFFIN)	Elvidge	18	Received
KOREA	National Fisheries Research and Development Institute (NFRDI)	Elvidge	7	Received
U-MICH	University of Michigan - DMSP	Elvidge	3	Received
SPAIN	Organization?	Elvidge	2	Received
NOAA	Comprehensive Large Array-data Stewardship System (CLASS)	*TBD*	-	*TBD*
USAF	SEM-N Algorithm Development (Denig)	Denig	160	Planned
NOAA	STAR - GOES-R Level 1 Advisory Support (Denig)	Denig	120	Received
NOAA	NOAA Virtual Data System (NVDS)	*TBD*	-	*TBD*
NOAA	NESDIS - POES Processing (Green)	Green	85	Received
NOAA	Continuously Operating Reference Stations (CORS) West Operations	Denig	249	Received
			1,079	
Status Key:			As of:	21-Jul-11
Received	Monies have been received in-house			
Confirmed	Funding agency has identified funds			
Planned	Identified funding amounts either proposed or planned			
Invoiced	Invoice sent or in process			
TBD	To be determined			

Fiscal Impact of canceled CDMP: $150K

Does not include: ***Forward-funded obligations for SEM-N (~$1M)***
Direct CIRES support to Terry Bullett (~$525K)

STP Division Overview
CDMP – Impact of Cancelation[1]

DMSP Film Scanning (L3) – Significant impact – Project was about half complete. Rescued records should be made publically available. Remaining records should be returned to the FRC.

Historical Ionosonde Records (L7) – Modest impact – Only a limited number of high priority film records were recovered. Remaining records are at high risk of being permanently lost. Seeking external funding (NSF).

Historical Solar Observations (L18) – Minor Impact – Program successfully digitized numerous records of historical interest. CDMP cancellation will not have a big impact going forward. Overall assessment: I think we got our money's worth out of the program. Future non-NOAA records should be carefully assessed before accepting into NGDC.

Cosmic Rays – Forbush Recorded (L42) – **Minor Impact** – Historical rescue ended at ~80% complete. Overall assessment: Continuation through completion should be considered as an in-house program – seek external funding.

Heat Capacity Mapping Mission (L44) – **No Impact** – Historical rescue complete. No further action required.

NGS Multi-Lens (L50) – **Significant Impact** – Rescue of irreplaceable historic records halted.

Ionosonde Paper Records (L55) – **Minor Impact** – Program was just starting. Recommend packing up the records and submitting to the Federal Records Center.

Geomagnetic Variation Digitization (L56) – **Minor Impact** – Program successfully digitized historical data from the IGY. Data archived in ADIC & copy delivered to GCRAS.

[1]Not considering loss of internal funding

STP Division Overview

GOES Spacecraft/Instrument Status

Spacecraft	Series	Operational Status	Status	Magnet1	Magnet2	Magnetometer 1	Magnetometer 2	MAG	XRS	XRS-EUV	EXIS	EPS	HEPAD	SEISS	XRP	SXI	SUVI
GOES 8	GOES I-M	Decommisioned	R	G	G				G			G	G		G		
GOES 9	GOES I-M	Decommisioned	R	G	G				G			G	G		G		
GOES 10	GOES I-M	Decommisioned	R	G	G				G			Y	G		G		
GOES 11	GOES I-M	Operational West	G	G	G				R			G	G		R		
GOES 12	GOES I-M	South America	G	G	G				R			Y	G		R	R	
GOES 13	GOES N-O-P	Operational East	G			G	G			Y		G	G			Y	
GOES 14	GOES N-O-P	Standby	G			G	G			G		G	G			G	
GOES 15	GOES N-O-P	Standby	G			G	G			G		Y	G			G	
GOES R	GOES R	On-orbit Standby						TBD			TBD			TBD			TBD
GOES S	GOES R	Acquisition						TBD			TBD			TBD			TBD

As of: 26 Jun 11

Operational (or capable of)	G
Operational with limitations (or Standby)	Y
Operational with Degraded Performance	O
Not Operational	R
Status Unknown	TBD

Note: SWPC operations use GOES-13 SEM & SXI; GOES-15 XRS-EUV & SXI currently used for SWPC operations. All available GOES and POES Space Weather data flowing into the archive[1].

[1]Some GOES data awaiting final SWPC OK.

Information

STP Data Ingest -

	CY10	CY11 YTD	CY12 TBD
GOES SEM	71 GB	35 GB	-
GOES SXI	870 GB	887 GB	-
POES SEM	14 GB	7 GB	-
DMSP OLS	5 TB	2.5 TB	-
CORS GPS	5.9 TB	2.9 TB	-
Ionosonde	1.4 TB	475 GB	-

OUTLINE
Solar & Terrestrial Physics Division

STP Program Overview

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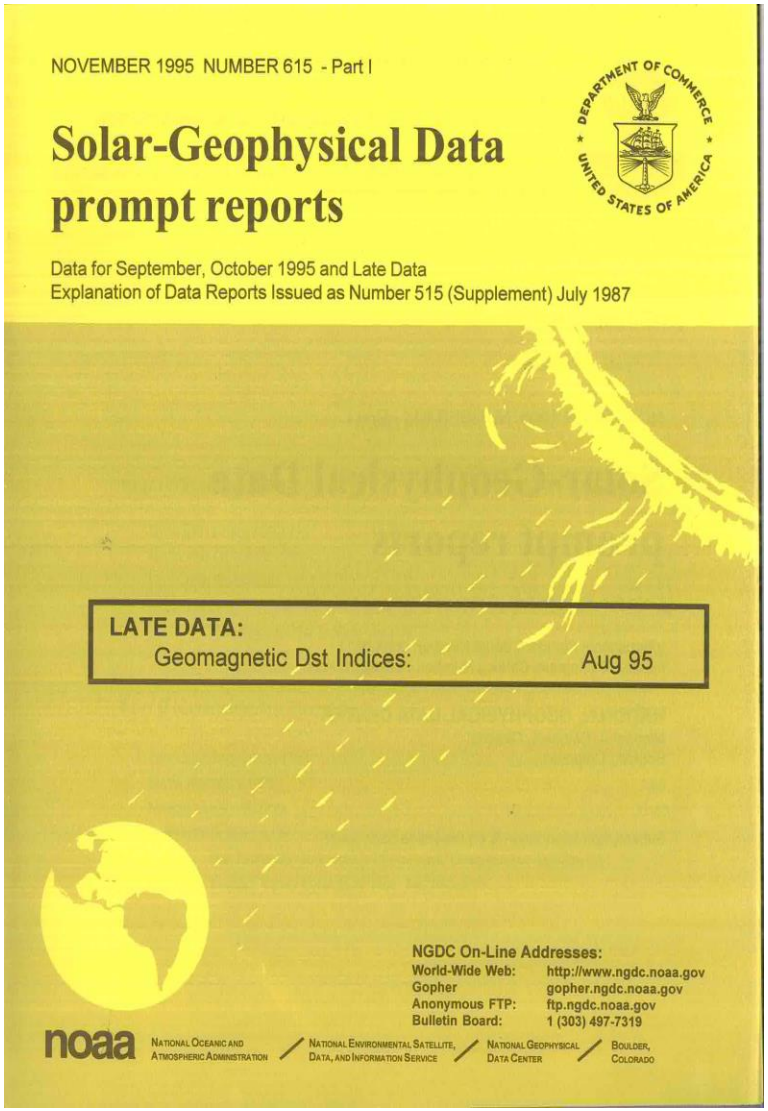
FY11 Milestones
STP

LO	Goal	Objective	Milestone			Due	Completed	POC
NOS	Resilient Coastal Communities and Economies (NOS)	Safe, Efficient and Environmentally Sound Marine Transportation	Acquire available definitive geomagnetic data from the INTERMAGNET consortium for 2009 including data from over 100 magnetic observatories	G		4QFY11 30-Sep-2011		Mabie
CS	Climate Adaptation and Mitigation (CS)	Improved Scientific Understanding of the Changing Climate System and Its Impacts	Prepare and submit a white paper to the National Research Council on the need for continuous satellite measurements to maintain the Total Solar Irradiance (TSI) Climate Data Record (CDR)	C		1QFY11 30-Dec-2010	1QFY11 12-Nov-2010	Denig
			Calculate national and global gas flaring volumes for 2010 using available imagery data from the Defense Meteorological Satellite Program (DMSP)	C		2QFY11 31-Mar-2011	2QFY11 23-Feb-2011	Elvidge
			Complete and release the year 2010 radiance calibrated nighttime lights product	C		3QFY11 30-Jun-2011	3QFY11 30-Jun-2011	Elvidge
NWS	Weather-Ready Nation (NWS)	A More Productive and Efficient Economy Through Environmental Information Relevant to Key Sectors of the U.S. Economy	Complete the historical data rescue of solar synoptic drawings for years 1972 to 2009 prepared by the NOAA Space Weather Prediction Center and predecessor organizations.	C		1QFY11 30-Dec-2010	1QFY11 01-Nov-2010	Horan
			Deliver to the NWS Space Weather Prediction Center a transition ready version of the Ovation Prime aurora product	C	AOP	1QFY11 30-Dec-2010	1QFY11 10-Dec-2010	Redmon
			Produce a Concept of Operations for the archive, access and assessment of the GOES N-O-P Space Environment Monitor (SEM) data from the NESDIS OSDPD	Y		2QFY11 31-Mar-2011	CR/Budget Impacted	Wilkinson
			Develop and deliver a science-grade software product to compute ionospheric electric fields for the Swarm satellite constellation mission	C		2QFY11 31-Mar-2011	2QFY11 04-Mar-2011	Alken
			Develop a master plan for the NGDC solar program identifying all current organizational interfaces tied to the NMMR metadata repository	C		3QFY11 30-Jun-2011	3QFY11 30-Jun-2011	Denig
			Release new Auroral Resources page facilitating visualization of and access to space weather datasets available through NGDC	C		3QFY11 30-Jun-2011	3QFY11 30-Jun-2011	Redmon
			Deliver to the Defense Weather Satellite System (DWSS) Progam Office updated Algorithm Theoretical Basis Documents for the Space Environment Monitor - Next (SEM-N) sensor	G		4QFY11 30-Sep-2011		Purcell
			Digitize and make available on-line the complete set of Solar-Geophysical Data reports for 1955 to 2009 prepared by the NGDC Solar Data Services group	C	AOP	4QFY11 30-Sep-2011	3QFY11 22-Apr-2011	Clark

As of 30 Jun 11

C Complete
Y Watch Item
G On-track
R Issue

AOP Milestone
50 Years of Solar-Geophysical Data



The full record of Solar-Geophysical Data (SGD) reports from 1955 to 2009 have been digitized and are being made available to the public. The purpose of the these reports was to provide the scientific community with a comprehensive record of data and information related to the sun and related geophysical activity. The complete fifty-four year SGD record of is available online through NGDC at:

ftp://ftp.ngdc.noaa.gov/STP/SOLAR_DATA/SGD_PDFversion

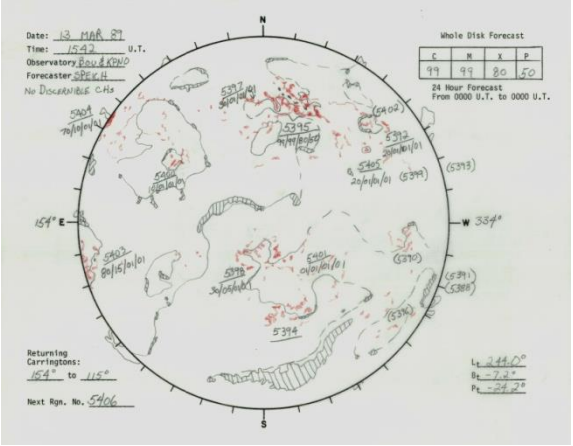
AOP Milestone: Digitize and make available on-line the complete set of Solar Geophysical Data reports for 1955 to 2009 prepared by the NGDC Solar Data Services group.

NGSP Goal: Weather Ready Nation

- Planned Completion:

  4QFY11 (30 Sep 11)
- Actual Completion:

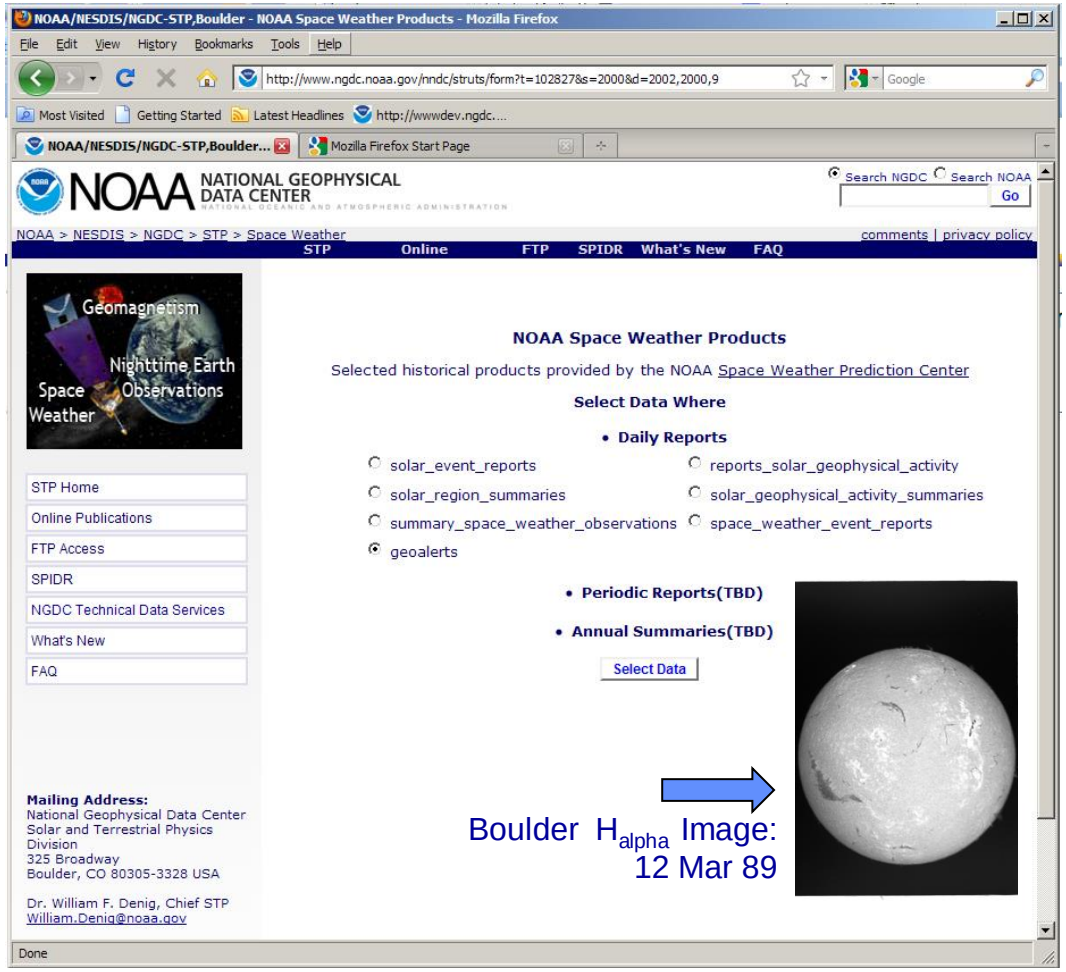
  3QFY11 (22 Apr 11)



Solar synoptic drawing from NOAA: 13 Mar 89

Milestone
Solar Program Master Plan

Milestone: Develop a master plan for the NGDC solar program identifying all current organizational interfaces tied to the NMMR metadata repository.



The STP solar program has been re-focused towards managing NOAA's solar and related geophysical data products. Daily SWx products are acquired and placed on-line by Craig Clark. Karen Horan is reconciling the existing archive and on-line holdings of Boulder H_{alpha} solar images (1967-94).

NGSP Goal: Weather Ready Nation

- Planned Completion:

  3QFY11 (30 Jun 11)
- Actual Completion[1]:

  3QFY11 (30 Jun 11)

[1]Existing NMMR records are being converted to ISO-19115 WAF meta-data records

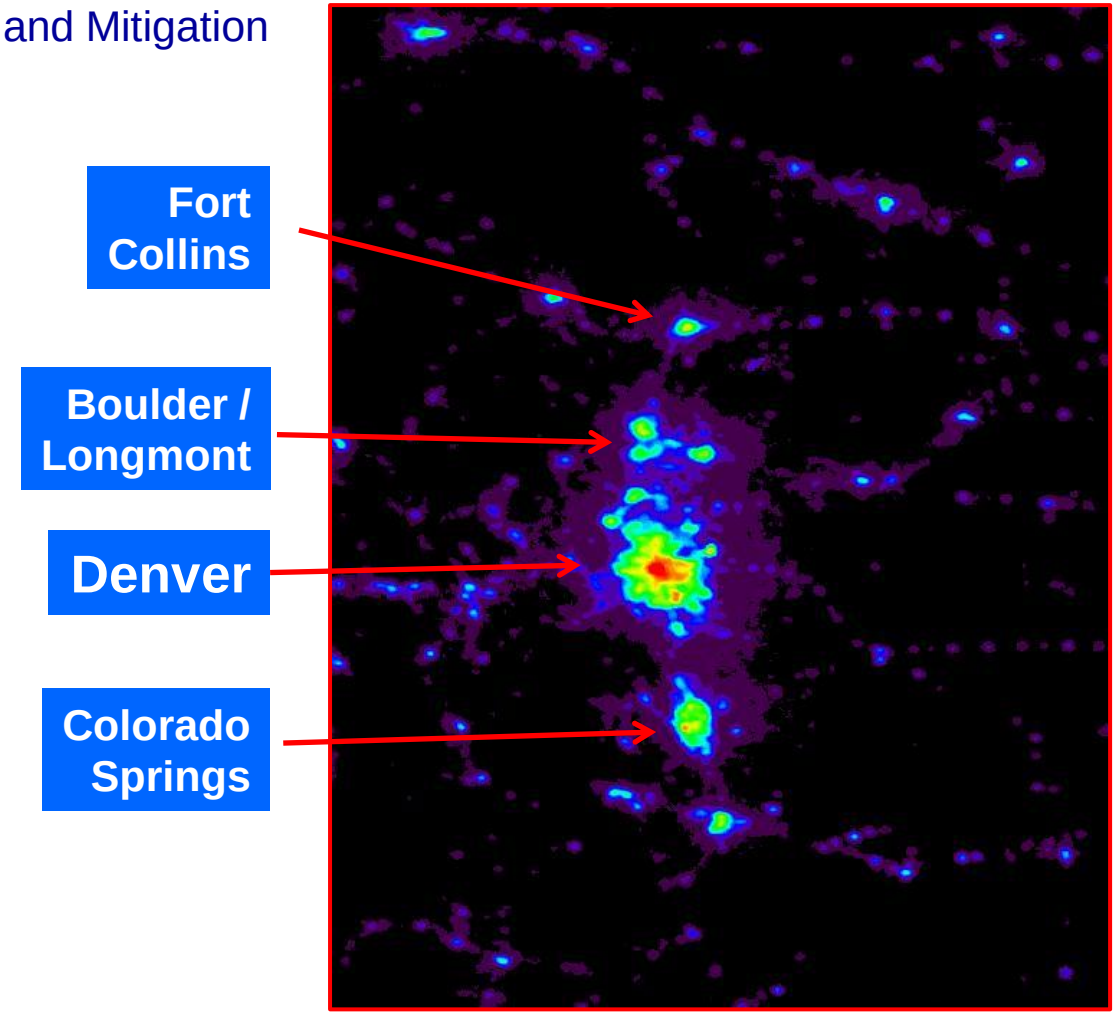
Milestone
2010 Nighttime Lights Product

Milestone: Complete and release the year 2010 radiance calibrated nighttime lights product

NGSP Goal: Climate Adaptation and Mitigation

- Planned Completion:
  3QFY11 (30 Jun 11)
- Actual Completion:
  3QFY11 (30 Jun 11)

Radiance calibrated nightime lights for cities in Colorado (2010). Defense Meteorological Satellite Program (DMSP) Operational Linescan System (OLS) imagery used for the global product from which this was derived.



Milestone
Auroral Resources Toolkit (ART)

Milestone: Release new Auroral Resources page facilitating visualization of and access to space weather datasets available through NGDC

Status: A new ART capability has been now release for initial test and comment by the space physics community. The announcement below was timed for release just prior to the CEDAR/GEM workshop in Santa Fe (NM) where Rob Redmon will engage the community .

SPA Newsletter Announcement – 23 Jun 11

```
-----------------------------------------------------------------------------
6. Auroral Resources Toolkit
-----------------------------------------------------------------------------
From: Rob Redmon <rob.redmon at noaa.gov>

Heliophysics data users are invited to interact with the new Auroral Resources
Toolkit (ART) rich user interface. ART is being made available by the Solar and
Terrestrial Physics division within the National Oceanic and Atmospheric
Administration's National Geophysical Data Center. With this first release, ART
provides visualizations and data access to a demonstrative sampling of NOAA,
CDAWeb, ACE Science Center, LASP/LISIRD and other space environmental data sets
and services. ART's primary goals are visualization, collaboration and
publication. With ART, the user can build an informative display of space physics
parameters, retrieve authoritative data and metadata, and easily share a
customizable display with collaborators. To get started, please visit
http://spidr.ngdc.noaa.gov/art/. For those attending the upcoming joint CEDAR-GEM
conference, an Auroral Resources Toolkit self-titled poster presentation will be
available. To offer comments or request assistance, please contact the ART project
managers Rob Redmon ((303) 497-4331; Rob.Redmon@noaa.gov) or Peter Elespuru
(Peter.Elespuru@noaa.gov).

-----------------------------------------------------------------------------
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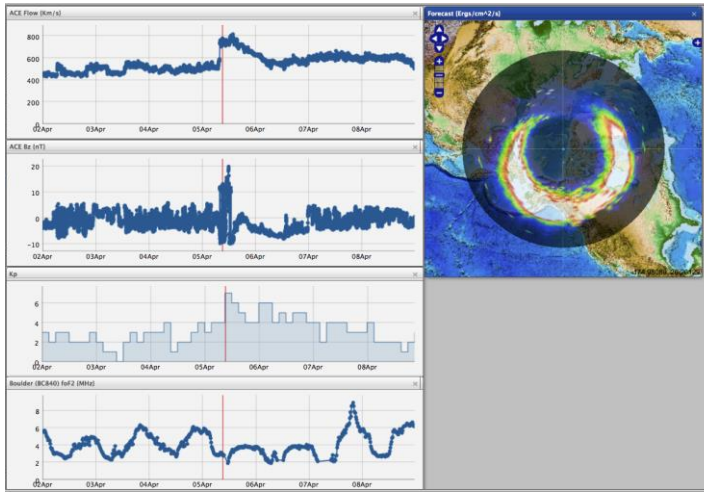
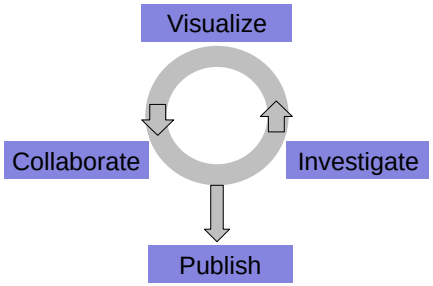


NGSP Goal: Weather Ready Nation

- Planned Completion:
  3QFY11 (30 Jun 11)
- Actual Completion:
  3QFY11 (30 Jun 11)



Milestones & Performance Measures

FY11 Performance Measures

STP Annual Performance Measures

Space Weather Metric

LO	Goal	Objective	Performance Measure	POC	1QFY11	2QFY11	3QFY11	4QFY11
NWS	Weather-Ready Nation (NWS)	A More Productive and Eficient Economy Through Environmental Information Relevant to Key Sectors of the U.S. Economy	Greater than 95% (2 sigma) of available Space Environment Monitor satellite data are archived on an annual basis	Wilkinson	100%	100%	100%	

Nightime Lights Metric

LO	Goal	Objective	Performance Measure	POC	1QFY11	2QFY11	3QFY11	4QFY11
CS	Climate Adaptation and Mitigation (CS)	Improved Scientific Understanding of the Changing Climate System and Its Impacts	Acquire, process and disseminate >2 sigma (95%) of available real-time nighttime lights imagery within 3 hours of receipt	Elvidge	100%	100%	100%	

CORS

LO	Goal	Objective	Performance Measure	POC	1QFY11	2QFY11	3QFY11	4QFY11
NOS	Resilient Coastal Communities and Economics (NOS)	Resilient Coastal Communities That Can Adapt To The Impacts Of Hazards And Climate Change	Provide a >2 sigma (95%) availability for Continuously Operating Reference Station (CORS) near-real-time data to the NWS Space Weather Prediction Center as per the '4-way' Memorandum of Agreement and subject to normal business-hour response times.	Coloma	100%	100%	99.8%	

As of 26 Jun 11

- Greater than 99% (3-sigma) Cumulative Distribution
- Greater than 97% (2-sigma) Cumulative Distribution
- Greater than 84% (1-sigma) Cumulative Distribution
- Below 84.1% (1-sigma) Cumulative Distribution

Note: On 03 Jun 11 CORS-West experienced an unanticipated 5-hour break in service while CORS-East was undergoing maintenance. SWPC operations for US-TEC fell back on non-CORS data to maintain continuity with a likely degradation. There were no customer impacts reports during this blackout period.

OUTLINE
Solar & Terrestrial Physics Division

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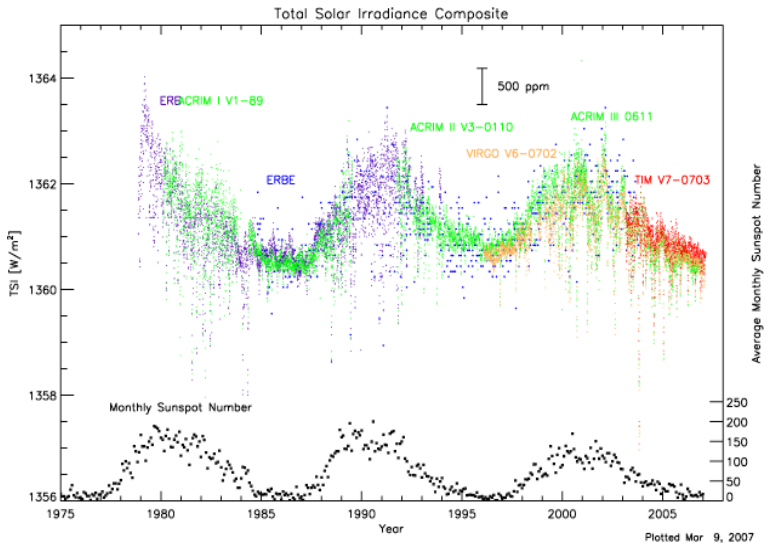
WELCOME
Hail and Farewell

Lisa Rizzo is interning with STP this summer looking into the existing data records related to global climate change. She is working within NOAA with Bill Denig and Rod Viereck and externally with Greg Kopp (LASP). Lisa will provide recommendations on available datasets (Total Solar Irradiance, Magnesium Core-to-Wing) to update STP's records and suggestions on improving web access.



Information
Site Visit from Australia's IPS

Bill Denig, Phil Wilkinson, Rob Redmon & Terry Bullett

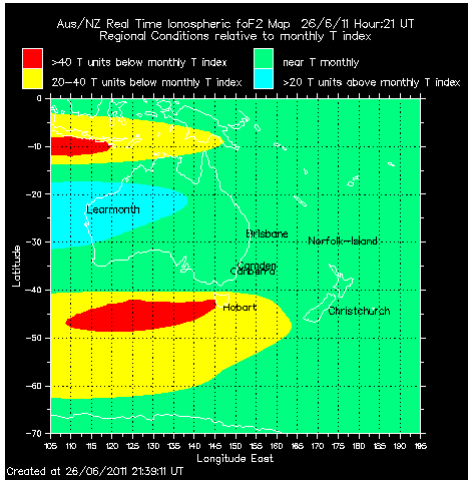
A new WDC (2000) – David Cole, Joe Allen, Brian Anderson & Phil Wilkinson

Dr. Phil Wilkinson site visit – 02 May 2011

- Director of the *Ionospheric Prediction Service (IPS) Radio and Space Services*, Australia

Discussion Topics

- WDS timeline (Dave Clark & Bill Denig)
- Status of IPS SPIDR node (Peter Elespuru)
- Exchanged software tools for ionosonde data analysis (Rob Redmon)
- Advanced ionospheric sounding techniques (T. Bullett)



OUTLINE
Solar & Terrestrial Physics Division

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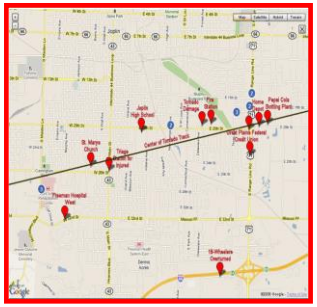
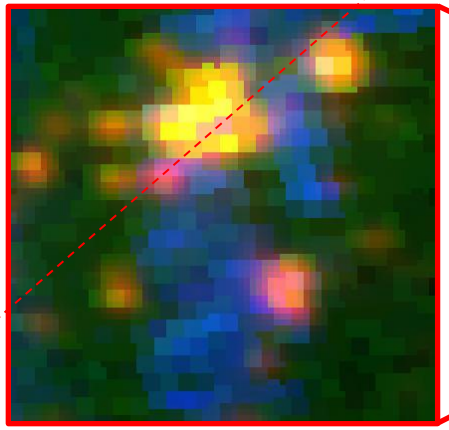
Accomplishments & Updates
Devastating Joplin Tornado – 2011

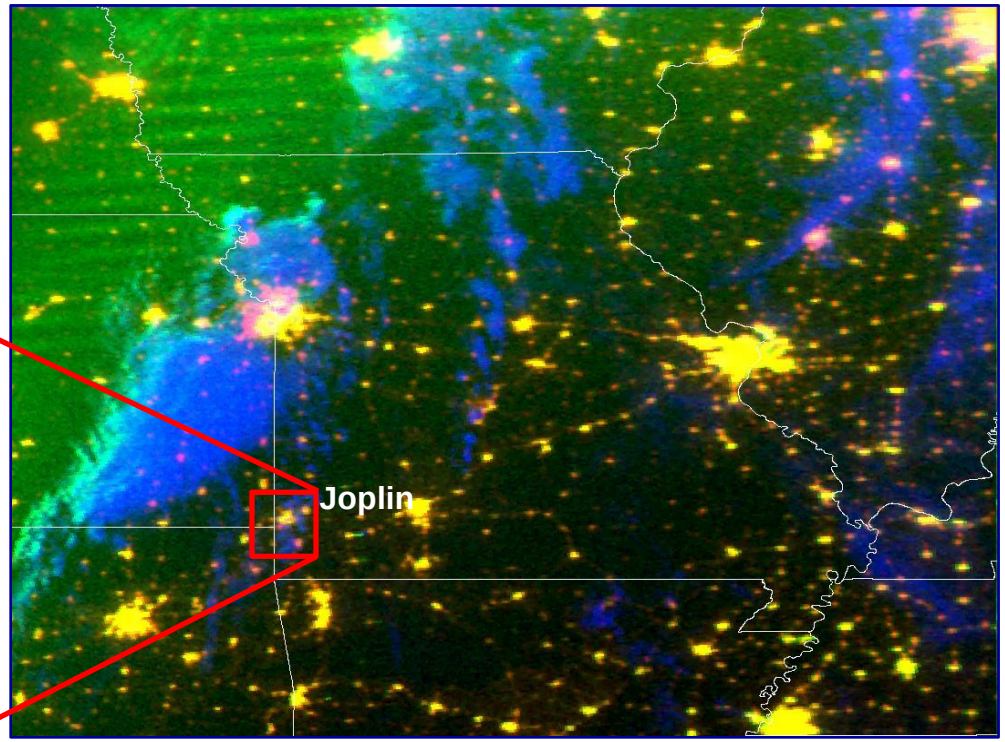
Associated Press / 25 May 11 / Joplin, MO – "A massive tornado plowed through the southwest Missouri city of Joplin on Sunday evening, killing at least 116 people and significantly damaging several school buildings."

DMSP Nighttime Lights were used to monitor power outages in the aftermath of the storm.





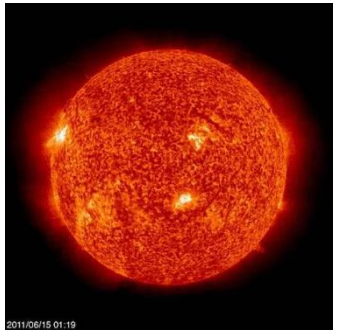
Observed
Storm Track



Accomplishments & Updates

Solar News – 16 May 2011

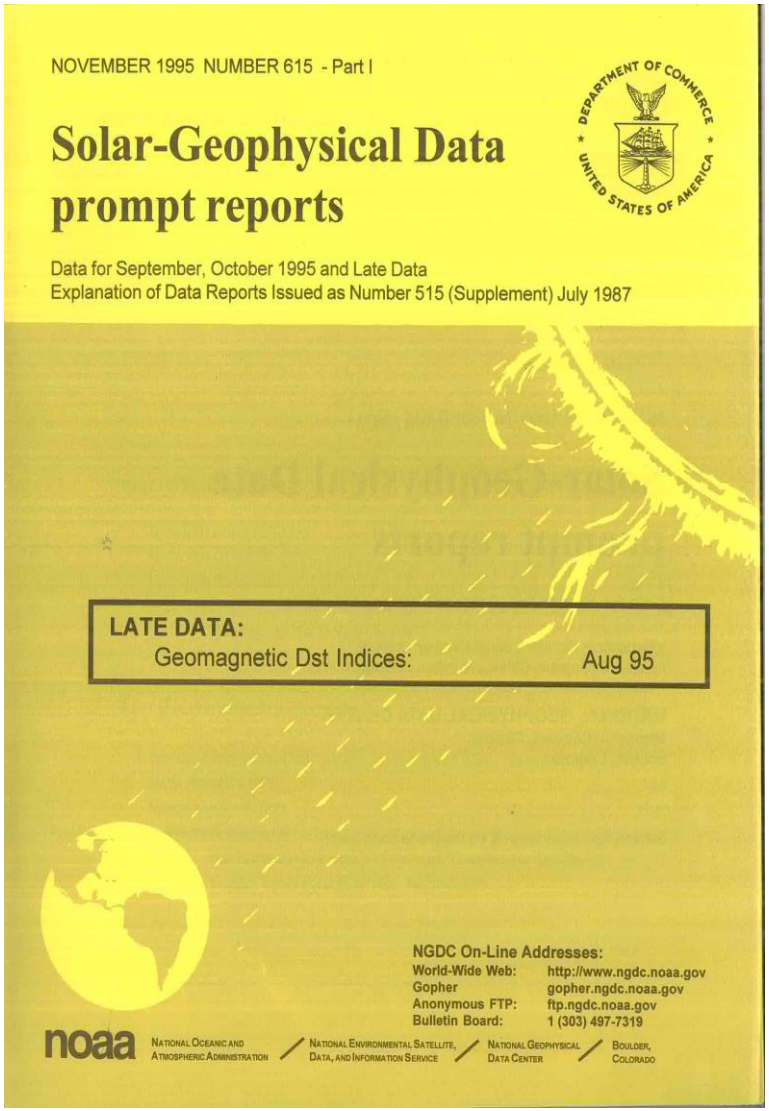
american astronomical society
SOLAR PHYSICS DIVISION



Historical Solar-Geophysical Data (SGD) Series Available Online from NGDC

Craig Clark
2 May 2011

The National Geophysical Data Center (NGDC) is pleased to announce the online availability of the historical Solar-Geophysical Data (SGD) report series published from November 1955 through September 2009. SGD was originally produced as Part B of an existing geophysical report series published in Boulder, CO by the Central Radio Propagation Laboratory within the National Bureau of Standards. The purpose of these geophysical reports was to provide researchers a comprehensive record of data and information related to solar activity and the ionosphere. In January 1966, the SGD reports were produced separately and then later divided, in July 1969, into a Part 1 Prompt Report and a Part 2 Comprehensive Report. At its peak in the 1980s the printed SGDs were provided to over 500 monthly subscribers. The complete fifty-four year record of SGD reports is now accessible online at ftp://ftp.ngdc.noaa.gov/STP/SOLAR_DATA/SGD_PDFversion.



NOVEMBER 1995 NUMBER 615 - Part I

Solar-Geophysical Data prompt reports

Data for September, October 1995 and Late Data
Explanation of Data Reports Issued as Number 515 (Supplement) July 1987

LATE DATA:
Geomagnetic Dst Indices: Aug 95

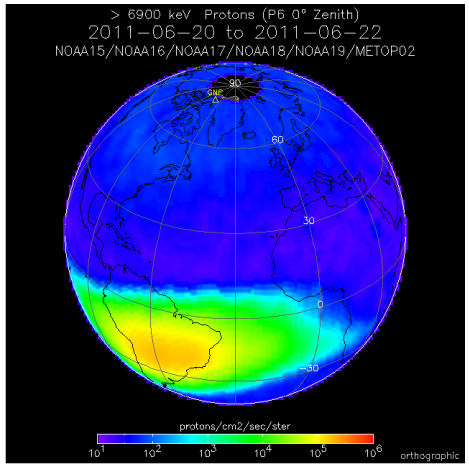
NGDC On-Line Addresses:
World-Wide Web: http://www.ngdc.noaa.gov
Gopher gopher.ngdc.noaa.gov
Anonymous FTP: ftp.ngdc.noaa.gov
Bulletin Board: 1 (303) 497-7319

noaa National Oceanic and Atmospheric Administration / National Environmental Satellite, Data, and Information Service / National Geophysical Data Center / Boulder, Colorado

Accomplishments & Updates

POES and MetOp Data Ingest

Particle data from the operational polar orbiting satellites, POES and MetOp-A, are ingested and processed by SWPC and then forwarded to NGDC for archive and dissemination. All of these functions planned to transfer to NGDC during the next FY year.



Current Status:

- SWPC continues to receive the POES/MetOp data steam for SEM processing but does not archive these raw inputs
- NGDC now receives SEM raw data files directly from OSPO (per C. Fox request)
- SWPC continues to process these data but does not guarantee continuity or recovery
- NGDC will process/reprocess the POES and MetOp data – future capability

Next Steps – Write code to process, archive and disseminate data

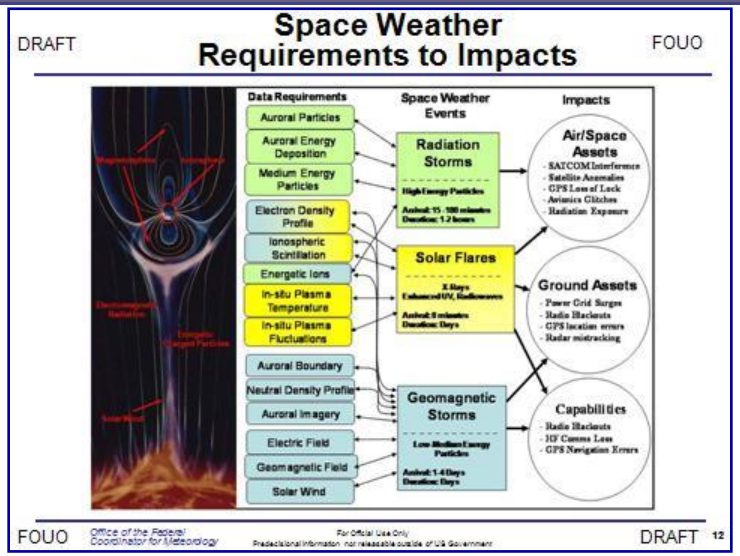
Planned Completion Date – 3QFY12

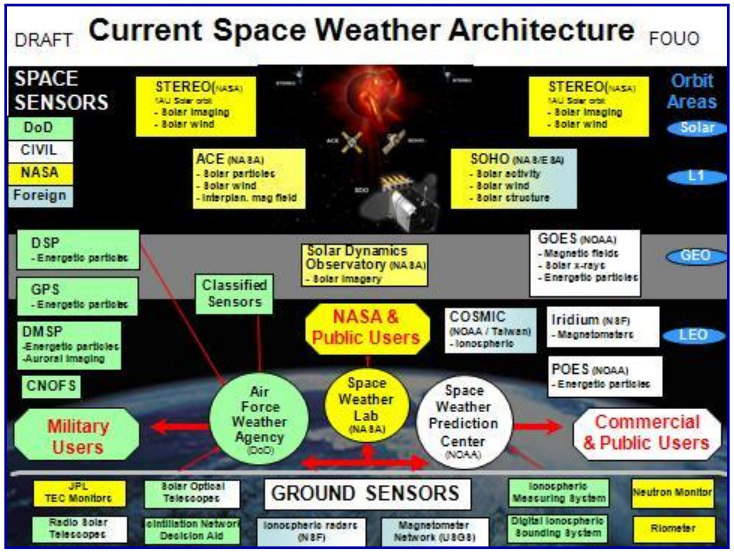
Thanks to Tom & Ernie (ISD) for setting up the ingest scripts

Accomplishments & Updates

Space Environment Capabilities Analysis

Dr. William Denig along with Col John Egentowich, Deputy Director of Weather, HQ USAF are the co-chairs of the SECA assessment team for the Office of the Federal Coordinator for Meteorology (OFCM). This study specifically addresses the 2010 NASA Authorization Act wherein the Director of the **Office of Science and Technology Policy** (OSTP) is required to submit a report to the appropriate committees of Congress that: "(A) details the current data sources, both space- and ground-based, that are necessary for SWx forecasting and (B) details the space- and ground-based systems that will be required to gather data necessary for space weather forecasting for the next 10 years."





Accomplishments & Updates

RSS Feeds to Notify Users of Product Changes

Coming soon!

What is an RSS?

RSS is an anonymous subscription service that allows a website to disseminate information. It is an alternative to an email subscription service.

A subscriber to RSS automatically retrieves and aggregates information from selected websites. The RSS feeds (in XML format) are collected with an RSS reader such as Google Reader.

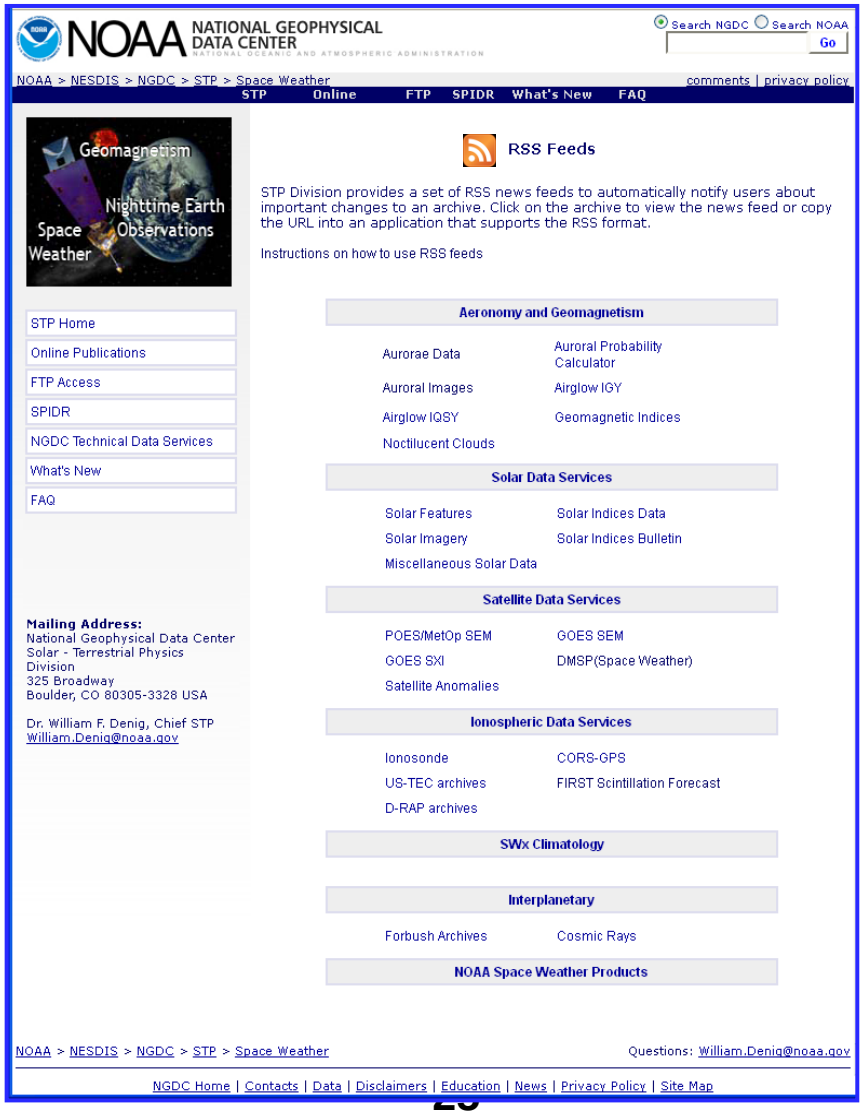
How will RSS feeds be used in STP?

Users subscribe to RSS feeds for specific data products and receive automatic alerts for:

- Format changes
- Reprocessed data sets
- New data sets

RSS stands for a Really Simple Syndication

Dominic Fuller-Rowell and *Janet Machol* are coordinating this implementation with the ARC



OUTLINE
Solar & Terrestrial Physics Division

STP Program Overview

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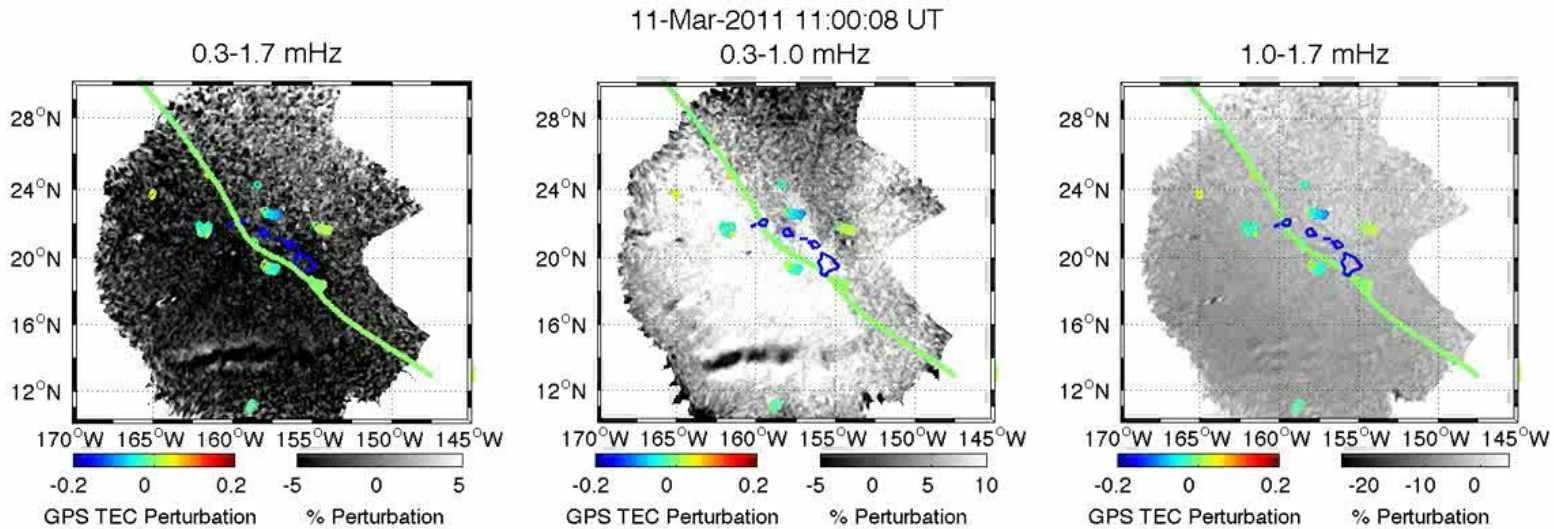
→ **Special Interest Items**

NightSat Program Update

Issues & Summary

Special Interest Item
GPS TEC Observations - 11 Mar Tsunami



Measurements of atmospheric airglow emissions recorded within the Hawaiian sector during the passage of the 11 March tsunami. The line is DART data projected along the tsunami propagation path using estimated tsunami propagation times. The moving dots are GPS TEC measurements. The red line represents the motion of the ocean-level tsunami. These data illustrate the generation of upward propagating atmospheric gravity waves caused by the passage of the tsunami.

Acknowledgements: Makela, J.J., P. Lognonné, H. Hébert, T. Gehrels, L. Rolland, S. Allgeyer, A. Kherani, G. Occhipinti, E. Astafyeva, P. Coïsson, A. Loevenbruck, E. Clévédé, M. C. Kelley, and J. Lamouroux. Imaging and modeling the ionospheric airglow response over Hawaii to the tsunami generated by the Tohoku Earthquake of 11 March 2011, *Geophys. Res. Lett.*, doi:10.1029/2011GL047860, in press, 2011.

Special Interest Item
SWx on President Obama's Agenda

The White House

Office of the Vice President

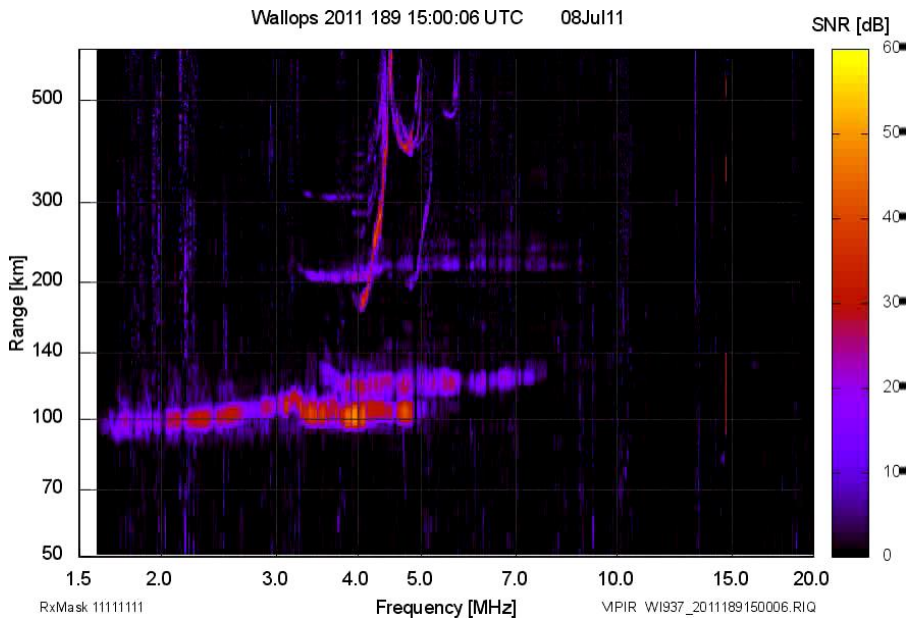
For Immediate Release **May 25, 2011**

Joint Fact Sheet: U.S.-UK Higher Education, Science, and Innovation Collaboration

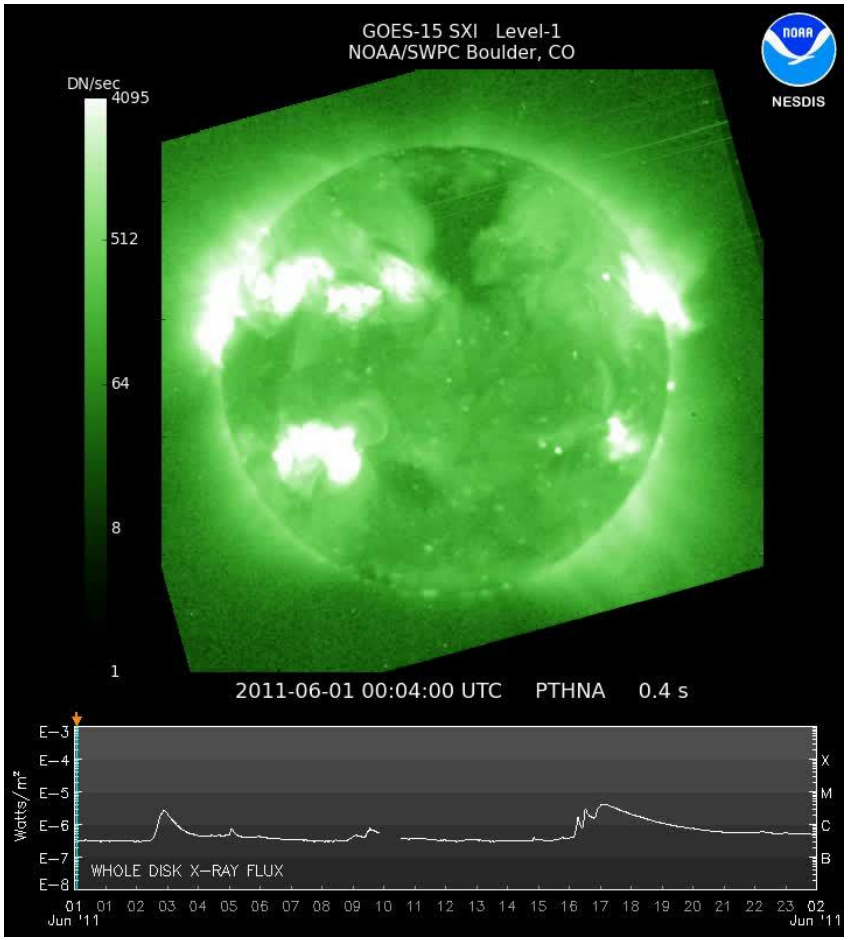
Prime Minister Cameron and President Obama agree . . .

The leaders welcomed in particular the growing partnership between the UK Meteorological Office (Met Office) and the U.S. National Oceanic and Atmospheric Administration's (NOAA) National Weather Service, codified with the signing of an historic Memorandum of Agreement in February 2011. *This agreement provides for a coordinated U.S.-UK partnership in the delivery of space weather alerts to help provide critical infrastructure protection around the globe.* The two governments announced today that they will embark together on an ambitious program to create the world's first combined space weather model capable of forecasting terrestrial weather with great accuracy and also indicating where, when, and for how long space weather effects will persist in our upper atmosphere and whether these anomalies are likely to disrupt and degrade GPS-enabled positioning, navigation, and timing capabilities.

Special Interest Item
More to Come – 4QFY11

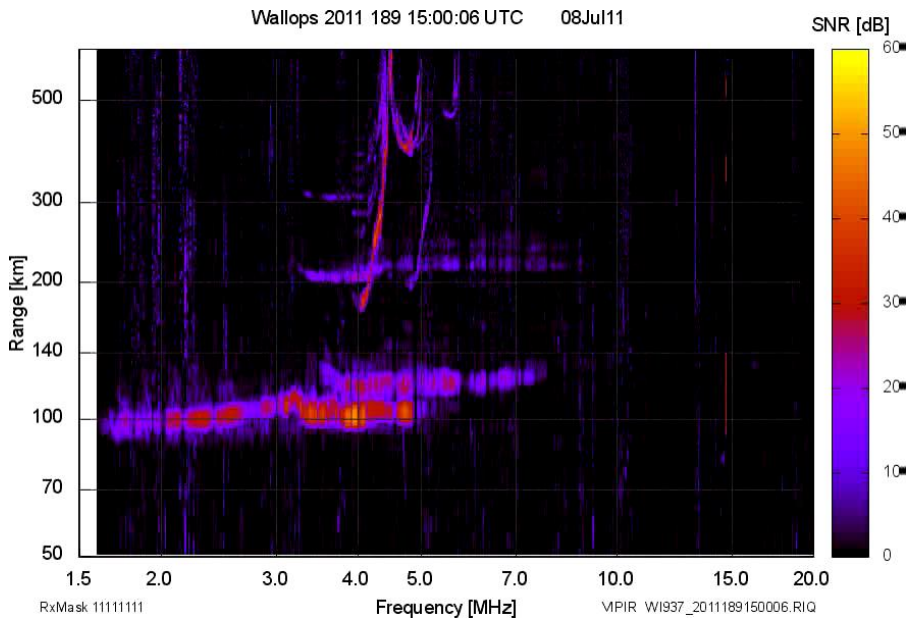


Shuttle impacts on the ionosphere

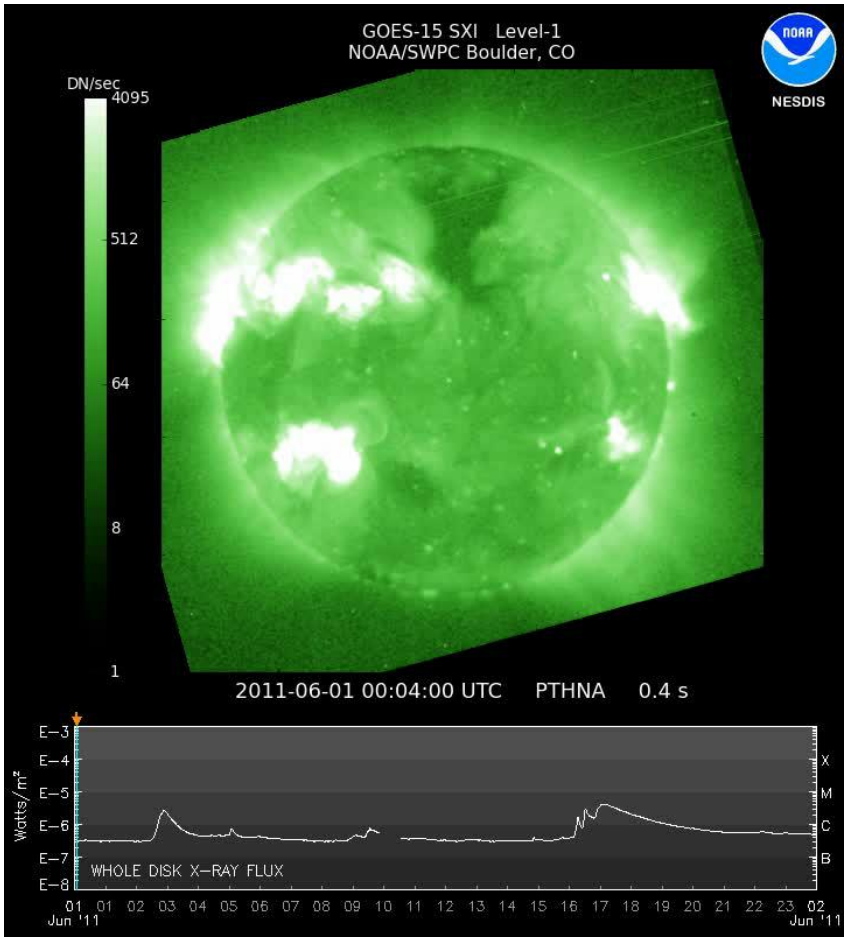


Composite GOES XRS & SXI Movie

Special Interest Item
More to Come – 4QFY11



Shuttle impacts on the ionosphere



Composite GOES XRS & SXI Movie

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→ **NightSat Program Update**

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NightSat Program Update
Earth Observations Group

ISS026E028792

NightSat Program Update
Earth Observations Group

NightSat – Quad Chart

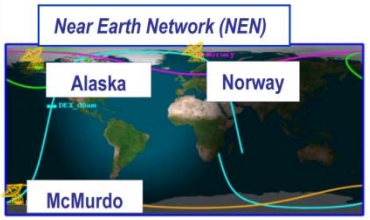
Science

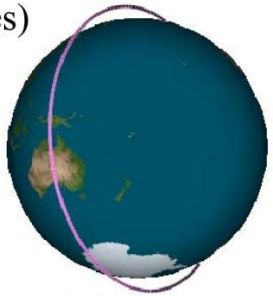
Nightsat addresses 4 of the 6 Science Focus Areas for Earth Science: Atmospheric Composition, Carbon & Ecosystems, Water & Energy Cycle and Climate Variability and Change.

Global spatial distributed CO2 estimate and uncertainties

Mission design

Sun-synch 600 km, I 97.8°
Local: 21:30 (+/- 30 minutes)
Global coverage in 17 days

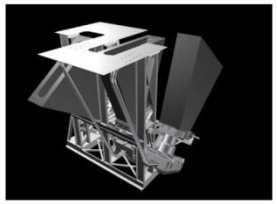




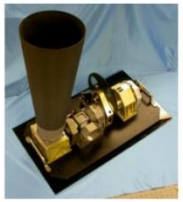
2 Year Science Ops

Payload / Instrument

BALL LLI



SAIC



Low Light Imager:
3.6E-8 to 2.5E-2 Watts/(cm2.sr)
GSD: 50m, Swath: 200km, 0.4 to 1µm

Management & Cost

PM, SE, SMA: NASA ARC
Science: NOAA, ASU, NASA ARC uses NEX and NAS
Spacecraft: IRIS based Lockheed Martin
Mission Ops: IRIS based NASA ARC
Ground Seg: IRIS based NASA ARC
System I&T: IRIS based Lockheed Martin
Life cycle estimate: ~$142M FY14

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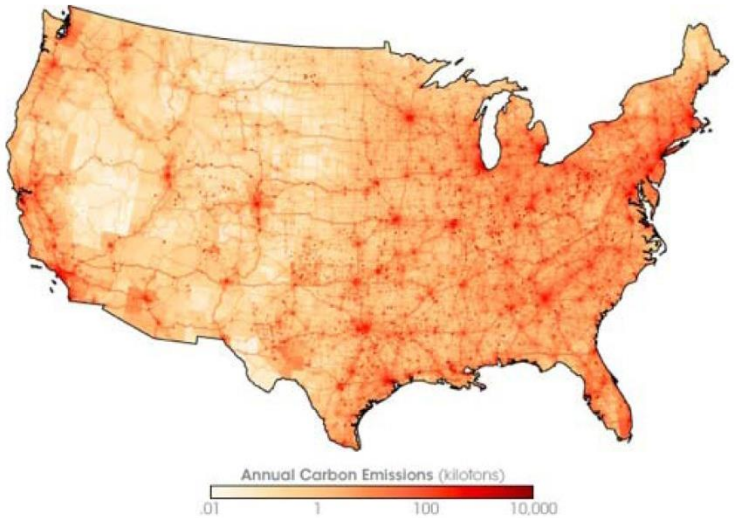
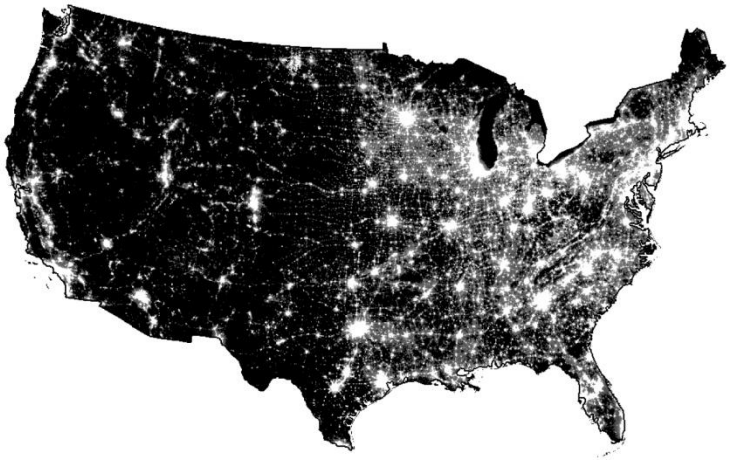
NightSat Program Update
Earth Observations Group

There is strong correlation between nighttime lights and fossil fuel CO_2 emissions.

Vulcan*: Bottom-up view of CO_2 emissions



DMSP: Top-down view of nighttime lights**



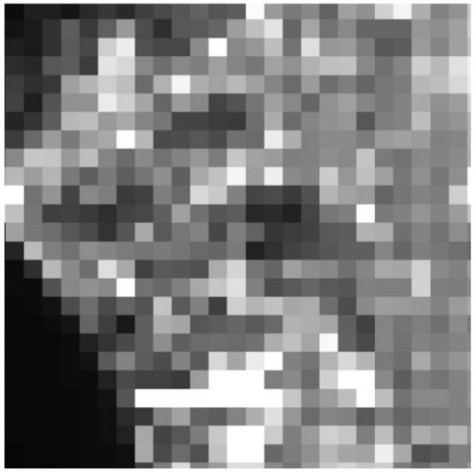
*National CO2 Emission Grid at 10 km

** Defense Meteorological Satellite Program at 1 km

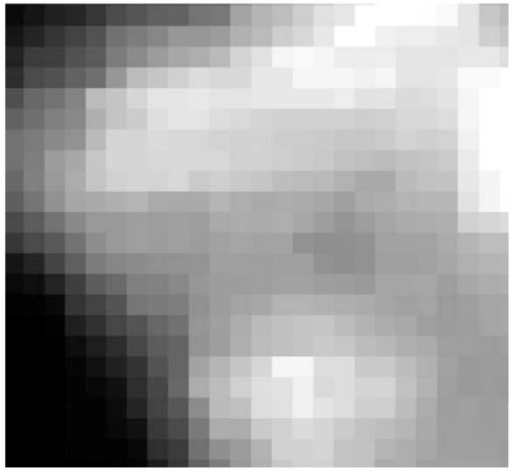
NightSat Program Update
Earth Observations Group

Comparing Spatial Detail From Nightsat, VIIRS and DMSP

50 meters
Nightsat



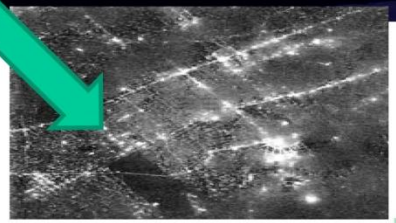
742 meters
VIIRS



2.7 km DMSP

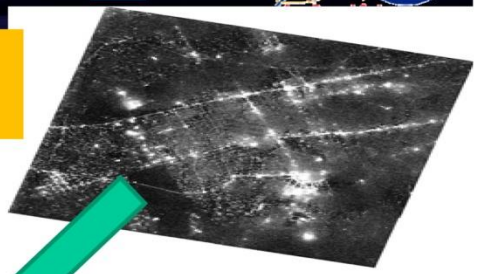
NightSat Program Update
Earth Observations Group

From an orbit strip to a global mosaic



Level 1A – L0 data, reformatted into scenes with calibration data and other ancillary data included.

Geolocate (AIG algorithm development)



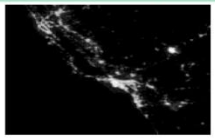
FEATURE PROCESSING
1. Extract coverage outline
2. Estimate solar and lunar radiance.
3. Detect lights
4. Determine background radiance* and subtract
5. Rate image sharpness
6. Identify blur

(NGDC algorithm development)

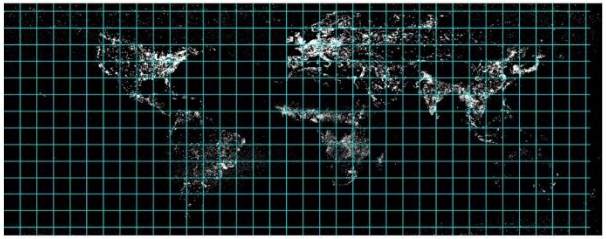
Level 2G – Pool of image segments with blurred and poor quality data are masked. Each pixel has associated quality flags.

Align image segments based on ground control points from road vectors or other sources. (Ames Intelligent Systems Division algorithm development)

Selection of best pixels - mosaic / composite generation (NGDC algorithm development)



Cloud Free Mosaic / Composites in Tiles



Tiled Global Mosaic Composite

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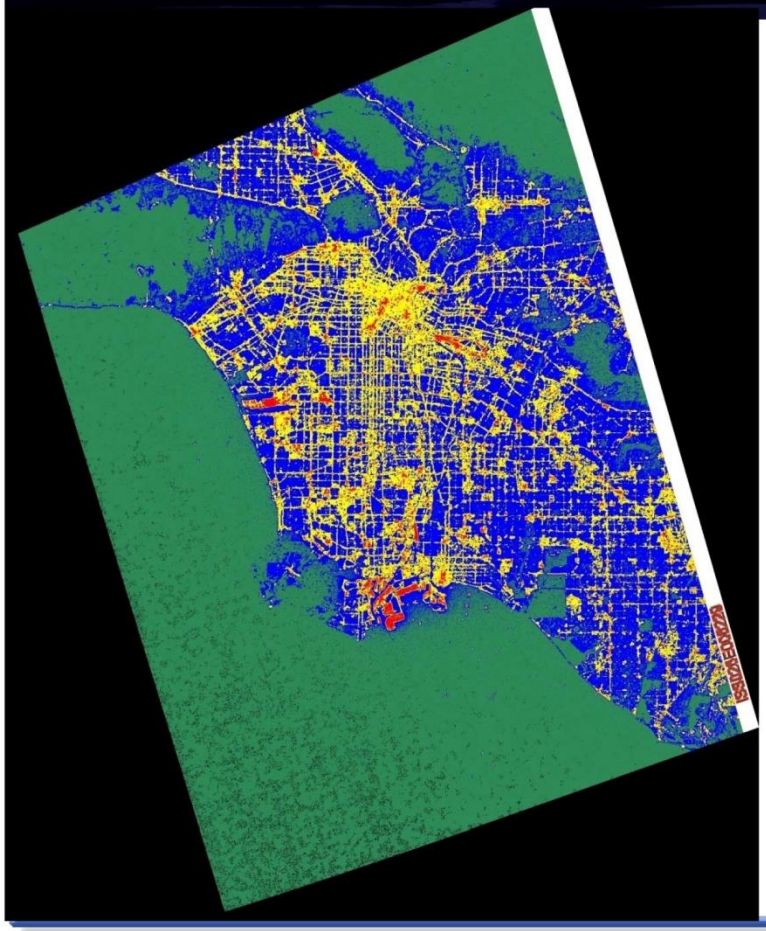
NightSat Program Update
Earth Observations Group

NightSat: CO_2 Emission Sector Map
(simulated product)



Green = Vacant or Undeveloped - 25% of the land area and 0% of the fossil fuel CO_2 emissions.

Blue = Residential 48% of the area and 6% of the of the fossil fuel CO_2 emissions.

Yellow and Red = High CO_2 emission areas – commercial, industrial, transportation – 16% of the area and 55% of the fossil fuel CO_2 emissions.

The remaining 39% of the emissions are from power plants with known locations and probable magnitudes.

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OUTLINE
Solar & Terrestrial Physics Division

STP Program Overview

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NightSat Program Update

Issues & Summary

Action for the Director
Sci2Ops for GOES-R SWx L2+ Products

Issue – The Sci2Ops transition of the GOES-R L2+ SWx products is currently a proposed unfunded option (#3) for the GOES-R ground segment contract (Harris Corp)

Background – As a part of the SWPC transfer of function, NGDC will assume responsibility for the continued development of L2+ science-grade algorithms for the GOES-R SWx sensors (EXIS, SUVI, MAG). Overall, there are 31 discrete L2+ products that have been delivered to STAR, currently under development or planned for development (slides 2 & 3). In FY11 the product developmental team (including Shouldis, Rodriguez, Lotoaniu, and Rigler) was awarded a 3-year contract for the development of the Version 3 science-grade algorithms through the GOES-R Risk Reduction program (Ingrid Guch). Currently the sci2ops path for these L2+ products is via a proposed (undefined and unfunded) "Option 3" contract mod for the GOES-R ground processing segment. Internal NOAA cost estimates for the development, integration and test, transition to operations, and sustainment (modification & upgrades) are at the level of $33M (FY09$) for 10 years (slide 4). Without a clear sci2ops transition path the L2+ product developments remain at risk and are not optimally aligned to the GOES-R ground segment development.

Recommendation – Recommend that Chris Fox engage Greg Mandt (and perhaps Tom Bogdan) in discussions regarding how to define the “sci2ops” path for the GOES-R L2+ SWx products.

Issues & Summary

STP FY11 Publications – YTD: 15

Araujo-Pradere, E.A., R.J. Redmon, M. Fedrizzi, R. Viereck, and T.J. Fuller-Rowell, (2011), Some Characteristics of the Ionospheric Behavior During Solar Cycle 23/24 Minimum, Solar Physics http://www.springerlink.com/content/m65x78114p285346/ .

Aubrecht, C., M. Stojan-Dolar, A. de Sherbinin, M. Jaiteh, T. Longcore, and **C. Elvidge** (2010), "Lighting governance for protected areas and beyond – Identifying the urgent need for sustainable management of artificial light at night", *Earthzine*, IEEE, 20 December 2010.

Denig, W., D. Cooke, and D. Ferguson (2010), Spacecraft Charging and Mitigation, *Space Weather, 8, S10007,* doi:10.1029/2010SW000632.

Eakin, C.M., C.J. Nim, R.E. Brainard, C. Aubrecht, **C.D. Elvidge**, K. Gledhill, F. Muller-Karger, P.J. Mumby, W.J. Skirving, A.E. Strong, M. Wang, S. Weeks, F. Wentz, and **D.C. Ziskin** (2010), "Monitoring Coral Reefs from Space", *Oceanography, 23*, pp 118-133.

Earle, G.D., **P. Bhaneja**, P.A. Roddy, C.M. Swenson, A. Barjatya, R.L. Bishop, **T.W. Bullett**, G. Crowley, **R. Redmon**, K. Groves, R. Cosgrove and S.L. Vadas (2010), A comprehensive rocket and radar study of midlatitude spread *F*, *J. Geophys. Res.*, 115, A12339, doi:10.1029/2010JA015503.

Ferguson, D.C., **W.F. Denig** and J.V. Rodriguez (2011), Plasma Conditions During the Galaxy 15 Anomaly and the Possibility of ESD from Subsurface Charging, Proceedings of the 49th AIAA Aerospace Sciences Meeting in Orlando, Florida, 04-07 January 2011.

Ghosh, T., R. Powell, **C.D. Elvidge**, **K.E. Baugh**, P.C. Sutton and **S. Anderson** (2010), "Shedding light on the global distribution of economic activity", The Open Geography Journal , 3, 147-160, doi: 10.2174/1874923201003010147.

Ghosh, T., **C.D. Elvidge**, P.C. Sutton, **K.E. Baugh**, **D. Ziskin** and B.T. Tuttle (2010), "Creating a Global Grid of Distributed Fossil Fuel CO2 Emissions from Nighttime Satellite Imagery", Energies, 3(12), 1895-1913.

Newell, P. T., T. Sotirelis, K. Liou, A. R. Lee, S. Wing, J. Green, and **R. Redmon** (2010), Predictive ability of four auroral precipitation models as evaluated using Polar UVI global images, *Space Weather, 8*, S12004, doi:10.1029/2010SW000604.

Redmon, R. J., D. Anderson, R. Caton, and **T. Bullett** (2010), A Forecasting Ionospheric Real-time Scintillation Tool (FIRST), Space Weather, 8, S12003, doi:10.1029/2010SW000582.

Redmon, R. J., W. K. Peterson, L. Andersson, E. A. Kihn, **W. F. Denig**, M. Hairston, and R. Coley (2010), Vertical thermal O+ flows at 850 km in dynamic auroral boundary coordinates, *J. Geophys. Res., 115*, A00J08, doi:10.1029/2010JA015589.

Small, C., **C.D. Elvidge**, D. Balk and M. Montgomery (2011), Spatial scaling of stable lights, *Remote Sensing of the Environment, 115*, 269-280.

Sutton, P.C., M.J. Taylor and **C.D. Elvidge** (2010), Using DMSP OLS Imagery to Characterize Urban Populations in Developed and Developing Countries, in “Remote Sensing of Urban and Suburban Areas”, *Volume 10*, Part 2, Eds. Rashed, Tarek, Jürgens, Carsten, Springer, 329-348, doi: 10.1007/978-1-4020-4385-7_17.

Takahashi, K.I., R. Terakado, J. Nakamura, Y. Adachi, **C.D. Elvidge** and Y. Matsuno (2010), In-use stock analysis using satellite nighttime light observation data, *Resources, Conservation and Recycling, 55 (2)*, 196-200, doi:10.1016/j.resconrec.2010.09.008.

Zhao, N., **T. Ghosh**, N.A. Currit and **C.D. Elvidge** (2011), Relationships Between Satellite Observed Lit Area and Water Footprints, *Water Resource Management*, 11 March 2011, doi 10.1007/s11269-011-9804-3.

Issues & Summary

Solar & Terrestrial Physics Division

- ✓ **GOES-R L2+ space weather data processing (3QFY11) – new**
- ✓ Loss of key personnel has a severe mission impact (3QFY10) - *NLAI*
- **Satellite processing transition from SWPC (4QFY09) – active**
- ✓ Continuity of solar data services (1QFY09) – *NLAI*
- ✓ *Refocus of NWS/SWPC Objectives (2QFY08) – NLAI*
- **NightSat Mission Concept (1QFY08) – active**
- ✓ *NGS Aerial Photography (1QFY08) – NLAI*

Metrics (FY11 YTD)

Papers Published: 15

Reports Published:18

Papers presented: 47

Supporting Materials in Backup Slides

- **STP FY11 Presentations (YTD)**
- **Meetings 3QFY11 (TBD)**
- **Upcoming Meetings/Travel – 4QFY11 (TBD)**

QUESTIONS?

Issues & Summary

STP FY11 Presentations – Pg 1 – YTD: 37

CIRES Innovative Research Program, 17 November 2010, Boulder, CO

– Passive Radio Imaging in Water Resource Management, Glaciology and Space Weather Monitoring (Poster), N.A. Zabotin, G. Godin and **T.W. Bullett.**

Space Research Institute of the Russian Academy of Science, 10 November 2010, Moscow, Russia

– Web Service Access to NOAA/NGDC Space Weather Data (Oral), **P. Elespuru.**

– Overview of the Colorado Student Space Weather Experiment (CSSWE) CubeSat Satellite (Oral), **P. Elespuru.**

International School for Atmospheric Radars, 15-26 November 2010, Chung-Li, Taiwan

– High Frequency Radars and Ionospheric Sounding (Invited Lecture), **T. Bullett.**

US-India US-India Network Enabled Research Collaboration Workshop, 05-07 December 2010,New Delhi, India.

– Potential for Expanded Exchange of Earth Observation Satellite Data for Climate, Weather and Environmental Studies (Oral), **C.E. Elvidge.**

Indian Space Research Organization (ISRO) National Remote Sensing Centre, 09 December 2010, Hyderabad, India

– Nighttime Lights of India: 1992-2010 (Oral), **C.E. Elvidge.**

Indian Space Research Organization (ISRO) Space Science Institute, 10 December 2010, Trivandrum, India

– Nighttime Lights of India: 1992-2010 (Oral), **C.E. Elvidge.**

Loreta College, 13 December 2010, Kolkata, India

– Nighttime Lights of India: 1992-2010 (Oral), **C.E. Elvidge.**

Presidency College, 13 December 2010, Kolkata, India

– Nighttime Lights of India: 1992-2010 (Oral), **C.E. Elvidge.**

American Geophysical Union (AGU) Fall Meeting, 13-17 December 2010, San Francisco, CA

– A global view of O+ upwelling and outflow rates between DMSP and POLAR (Poster), SM33B-1894, **R.J. Redmon**, W.K. Peterson, L. Andersson, E.A. Kihn and **W.F. Denig.**

– A Prototype Web-based system for GOES-R Space Weather Data (Poster), IN43A-1374**, A. Sundaravel** and **D.C. Wilkinson.**

– Auroral Resources: Dataset Access and Interactive Visualization (Poster), IN43A-1395, **P. Elespuru**, **R.J. Redmon**, E.A. Kihn, M. Zhizhin and D. Medvedev.

– Current Operations and Future Plans for Forecasting Products Based on NOAA LEO Satellite Observations (Oral), SM54A02, **J.C. Green**, J.L Machol, **W.F. Denig**, R.A. Viereck, R. Rutledge and J. Kunches .

Issues & Summary

STP FY11 Presentations – Pg 2 – YTD: 37

American Geophysical Union (AGU) Fall Meeting, 13-17 December 2010, San Francisco, CA – *Continued*

– Enhancing Natural Hazards Data with Photographs (Poster), IN33B1304, H.L. McCullough, J.D. Varner and **R.J. Redmon.**

– Gas Flaring Volume Estimates with Multiple Satellite Observations (Poster), A43D-0271, **D.C. Ziskin**, **C. Elvidge**, **K. Baugh**, **T. Ghosh** and F.C. Hsu.

– Modeling the gravity and magnetic pressure driven currents in the F-region ionosphere (Poster), SA51B-1631, **P. Alken**, S. Maus, A. Richmond and A. Maute.

– Multipoint Observations of the Large Substorm Associated with the Galaxy 15 Anomaly (Oral), SM22B-05, H.J. Singer, P.T. Loto'aniu, J.C. Green, J.V. Rodriguez, B.J. Anderson, J.J. Love, V. Angelopoulos, D.N. Baker, M.G. Connors, **W.F. Denig**, E.F. Donovan, O. LeContel, T.G. Onsager, T. Nagatsuma, A. Runov and E.L. Spanswick.

– New Operational Algorithms for Particle Data from Low-Altitude Polar-Orbiting Satellites (Poster), SM51A-1766, **J.L Machol**, **J.C. Green**, J.V Rodriguez, T.G. Onsager and **W.F. Denig.**

– New Products from New Satellites - GOES NOP Satellite Series Space Weather Data and Their Archive for Retrospective Access (Poster), SM51A-1767, **D.C. Wilkinson.**

– NGDC Geomagnetic Observatory Holdings (Poster), GP11A-0749, **J.J. Mabie.**

– Space Weather Conditions at the Time of the Galaxy 15 Spacecraft Anomaly (Oral, Invited), SH31D03, **W.F. Denig**, **J.C. Green**, **D.C. Wilkinson**, J.V. Rodriguez, H.J. Singer, P.T. Loto'aniu, D.A. Biesecker and W. Murtagh.

– The Future of Space Environment Monitoring in Low Earth Orbit (Poster), IN31A1271, **W.F. Denig**, M. Bonadonna, K.D. Scro and J.C. Green.

49th American Institute of Aeronautics and Astronautics (AIAA) Aerospace Sciences Meeting, 04-07 January 2011, Orlando, FL

– Plasma Conditions During the Galaxy 15 Anomaly and the Possibility of ESD from Subsurface Charging (Oral), D.C. Ferguson, **W.F. Denig** and J.V. Rodriguez

National Radio Science Meeting, 05-08 January 2011, Boulder, CO

– New Ionosonde Observations from Puerto Rico, **T.W. Bullett**

– Spatial Effects of HF Multiple Sscatterin in the Ionosphere: Experimental Observations (Oral), N.A. Zabotin and **T.W. Bullett**

– Equatoral Dynamics and Scintillation, **R.J. Redmon**, **D. Anderson**, **R. Caton**, and **T. Bullett**

– Comparison of Statistical Analysis of Midlatitude Spread F for vfarious Sites Including Wallops Island (Virginia), Boulder (Colorado), Vandenberg AFB (California) and Dyess AFB (Texas) (Oral), **P. Bhaneja** and **T.W. Bullett**

Issues & Summary

STP FY11 Presentations – Pg 3 – YTD: 37

Geospatial World Forum, Hyderabad, India, January 18-21, 2011

– Ghosh, T., C. D. Elvidge, P. C. Sutton, K. E. Baugh, B. T. Tuttle, and D. Ziskin. Using the nighttime satellite imagery to create a global grid of distributed fossil fuel CO2 emissions (poster), **T. Ghosh**, **C.D. Elvidge**, P.C. Sutton, **K.E. Baugh**, B. T. Tuttle, and **D. Ziskin**

American Meteorological Society (AMS) Annual Meeting, 23-27 Jan 2011, Seattle, WA

– Space Weather from the SEM-N Sensor Suite for Operational Use (Oral), **W. Denig**, **P. Purcell** and C.D. Reimer

South China Sea Fisheries Research Institute, 24 Jan 2011, Guangzhou, China

– A Nineteen Year Record of Lit Fishing Boat Activity (Oral), **C.D. Elvidge**, **K.E. Baugh**, **T. Ghosh**, **S. Anderson** and **D. Ziskin**

Artificial Intelligence in the Earth's Magnetic Field Study, 26-28 January 2011, Uglich, Yaroslavl Region, Russia

– Geomagnetic Data in the World Data Center Archives (Oral, Invited), **J. Mabie**

NRC Heliophysics Decadal Survey "Research to Operations/Operations to Research Town Hall", 7-8 February 2011, Irvine, CA

– On the Utility of Operational Satellite Data to Solar & Space Physics Research (Oral), **W.F. Denig**

The Relationship Between Auroral Phenomenology and Magnetospheric Processes, 27 February - 04 March 2011, Fairbanks, AK

– A Global View of O+ Upward Flows and Outflow Rates Between DMSP and POLAR (Oral), **R. Redmon**, W. Peterson, L. Andersson and **W. Denig**

Boulder Solar Day, 18 March 2011, Boulder, CO

– Space Environmental Conditions at the Time of the Galaxy 15 Anomaly (Oral), **W.F. Denig**, **J.C. Green**, J.V. Rodriguez

31st Asia Pacific Advanced Network Meeting, 21-25 Feb 2011, Hong Kong, China

– Examination of Gas Flares in THEOS Satellite Data (Oral), **C.D. Elvidge**, **K.E. Baugh**, **T. Ghosh**, **S. Anderson** and **D. Ziskin**

– Satellite Observed Nighttime Lights of China (Oral), **C.D. Elvidge**, **K.E. Baugh**, **T. Ghosh**, **S. Anderson** and **D. Ziskin**

National Air and Space Information Center (NASIC), 14 Mar 2011, Wright-Patterson AFB, OH

– Operational Linescan System (OLS) Products Prepared by the NGDC Earth Observations Group (Oral), **K.E. Baugh**

Nightsat Proposal Workshop, 22 Mar 2011, NASA Ames Research Center, Moffett Field, CA

– Nightsat Design Considerations (Oral), **C.D. Elvidge**, **K.E. Baugh**, **T. Ghosh**, **S. Anderson** and **D. Ziskin**

Global Vulcan Project Kickoff Meeting, 30 Mar 2011, Arizona State University, Tempe, AZ

– DMSP Nighttime Lights (Oral), **C.D. Elvidge**, **K.E. Baugh**, **T. Ghosh**, **S. Anderson** and **D. Ziskin**

Issues & Summary

STP FY11 Presentations – Pg 4 – YTD: 47

Space Weather Workshop, 24-27 Apr 2011, Boulder, CO

– Space Weather Conditions at the Time of the Galaxy 15 Spacecraft Anomaly (Invited), **W. Denig**

– AuroralResources Toolkit (ART) (Poster), **R.J. Redmon**, **P. Elespuru**, E.A. Kihn, M. Zhizhin, D. Medvedev, A. Godunov

– Improving Access to Space Weather Data via Workflows and Web Services (Poster), **A.Sundaravel,** E.A.Kihn and **P.Elespuru**.

Coupling, Energetics, and Dynamics of Atmospheric Regions (CEDAR)/Geospace Environment Modeling (GEM) Joint Workshop, June 26 – July 1, 2011, Santa Fe, NM

– The Importance of Field Line History in Ion Outflow (Poster), **R.J. Redmon**, W.K. Peterson, L. Andersson, P. Richards and **W.F. Denig**

– Auroral Resources Toolkit (ART) (Poster), **W.F. Denig**, **R.J. Redmon**, **P. Elespuru**, E.A. Kihn, M. Zhizhin, D. Medvedev and A. Godunov

– A Tutorial on Ion Outflow (Tutorial), **R.J. Redmon**

High Energy Particle Precipitation into the Atmosphere (HEPPA), 09-11 may 2011, Granada, Spain

– Measurements of Energetic Particles (Invited Oral), **W.F. Denig**

International Union of Geodesy and Geophysics (IUGG), 28 Jun – 07 Jul 2011, Melbourne, Australia

– Ground Systems Data in the World Data Center Archives (Oral), **J. Mabie**, A. Soloviev, D. Herzog and **W.F. Denig**

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Issues & Summary
Upcoming Meetings/Travel – 3QFY11

Upcoming Meetings (3QFY11):

- Global Assimilation of Ionospheric Measurements – xx-xx April 2011, Omaha, NE (*T. Bullett*)
- CIRES Rendezvous – 22 April 2011, Boulder, CO (*Multiple*)
- Space Weather Workshop (SWW) – 26-29 Apr 2011, Boulder, CO (*Multiple*)
- High Energy Particle Precipitation in the Atmosphere (HEPPA) Workshop – 09-11 May 2011, Granada, Spain (*W. Denig*)
- Joint Polar Satellite System/Defense Weather Satellite Systems (JPSS/DWSS) Common Ground System Forum – 25-26 May 2011, Asheville, NC (*P. Purcell*)
- Joint Urban Remote Sensing Event – 11-13 April 2011, Munich, Germany (*C. Elvidge*) - ????
- Ionosperic Effects Symposium – 16-19 May 2011, Alexandria, VA (T. Bullett)
- Joint Coupling, Energetics and Dynamics of Atmospheric Regions (CEDAR) – Geospace Environment Modeling (GEM) Workshop – 26 Jun – 01 Jul, Santa Fe, NM (*R. Redmon. W. Denig*) – *tentative*
- Space Weather Enterprise Forum – 21 Jun 2011, Washington, D.C. (W. Denig) – *tentative*
- International Union of Geodesy and Geophysics (IUGG) – 26 Jun - 08 Jul 2011, Melbourne, Australia - *tentative*

Other Planned Travel (3QFY11):

- Ionosonde Installation – xx-xx April 2011, *city?*, Puerto Rico
- Ionosonde Installation – xx-xx May 2011, *city?*, Ethiopia
- Sounding Rocket Launch – 13-30 June 2011, Wallops Island, VA

Not Updated

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Meetings – 2QFY11

Supported Meetings (2QFY11)

- National Radio Science Meeting (URSI) – 05-08 Jan 2011, Boulder, CO (*R. Redmon, T. Bullett, P. Elespuru*)
- Geospatial World Forum – 18-21 Jan 2011, Hyderabad, India (*Tilo Ghosh*)
- Algorithm Development Language (ADL) 2.0 Technical Interchange Meeting – 19-20 Jan 2011, Madison, WI (*P. Meade*)
- American Meteorological Society (AMS) – 23-27 Jan 2011, Seattle, WA (*W. Denig*, *E. Erwin, P. Purcell*)
- Artificial Intelligence in the Earth's Magnetic Field Study, 26-28 Jan 2011, Uglich, Russia (*J. Mabie*)
- NRC Decadal Survey R2O-O2R Working Group Meeting – 07-08 Feb 2011, Irvine, CA (*W. Denig*)
- JPSS Users' Meeting – 09-10 Feb 2011, Aurora, CO (*P. Purcell, P. Meade*)
- 31th Asia-Pacific Advanced Network (APAN) – 21-24 Feb 2011, Hong Kong, China (*C. Elvidge*)
- Chapman Conference: Relationship between Auroral Phenomenology and Magnetospheric Processes – 27 Feb – 04 Mar 2011, Fairbanks, AK (*R. Redmon*)
- SEM-N Technical Interchange Meeting, 15 Mar 2011, Boulder, CO (*Multiple*)
- Boulder Solar Day Workshop – 18 Mar 2011, Boulder, CO (*W. Denig, J. Machol*)
- Nightsat Proposal Workshop – 22 Mar 2011, Moffett Field, CA (*C. Elvidge*)
- Joint Polar Satellite Systsem (JPSS) GRAVITE Workshop – 23-23 March 2011, Greenbelt, MD (*P. Meade*)
- Global Vulcan Project Kickoff Meeting – 30 Mar 2011, Tempe, AZ (*C. Elvidge*)

Not Updated