NASA Technical Fellow for Space Environments View of CCMC

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Outline

- Introductory comments
- Examples of CCMC benefit to NASA
  - CTIPe for ISS, ionospheric drivers of rapid charging
  - Geomagnetic storm impact on F2-region Ne, Te
  - ISS auroral charging
  - ISS EVA hazard assessments and CME speed
  - Real time effects tools
  - Equatorial plasma depletions
  - Auroral models and DMSP, ISS charging environments
  - DONKI

Value of CCMC to NASA

- The CCMC is an in-house NASA organization with flexibility to develop and implement experimental program specific space weather applications tailored to NASA needs

- NASA spacecraft operations and space environment engineering teams will continue to rely on NOAA SWPC real time space weather products (e.g., GOES, ACE/DSCOVR) and NOAA NGDC historical data records (e.g., GOES, POES, DMSP)

- NOAA SWPC and CCMC provide complementary services with different approaches
  - SWPC: official US space weather reporting authority, incorporation of new tools and modification of infrastructure is necessarily conservative and slow to change
  - SWRC: experimental and educational emphasis allows for rapid incorporation of new low TRL tools and models for testing, rapid support to NASA needs

Value of CCMC to NESC

- NASA's Engineering and Safety Center (NESC) is an independent technical authority in NASA reporting to the Office of the Chief Engineer

- CCMC personnel experienced in space physics research and space weather monitoring are a valuable resource for NESC technical assessment activities related to space environments and effects
  - Y. Zheng member of NESC team evaluating space weather launch constraint options for upcoming NASA mission
  - A. Pulkkinen leading development of NESC proposal for space weather architecture study

- CCMC runs-on-request and instant-run models are useful for space environment engineering community to obtain quick results from sophisticated space science models in support of technical analyses

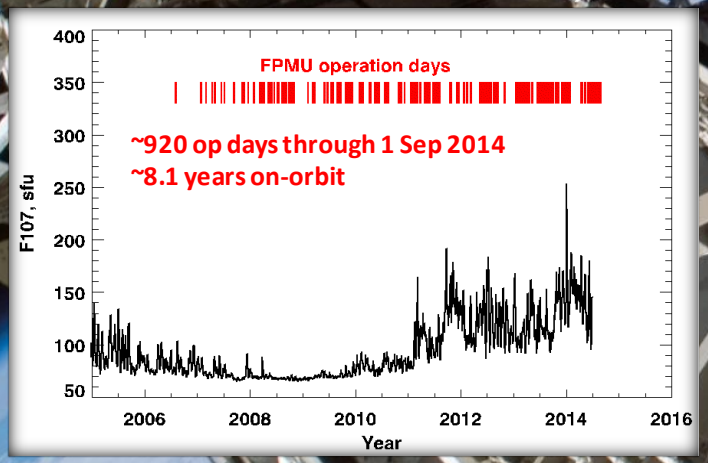
- Future NESC technical assessments are likely to generate effects tools and other products that will be of interest to the space weather community, these will be provided to GSFC where appropriate to incorporate into the CCMC products

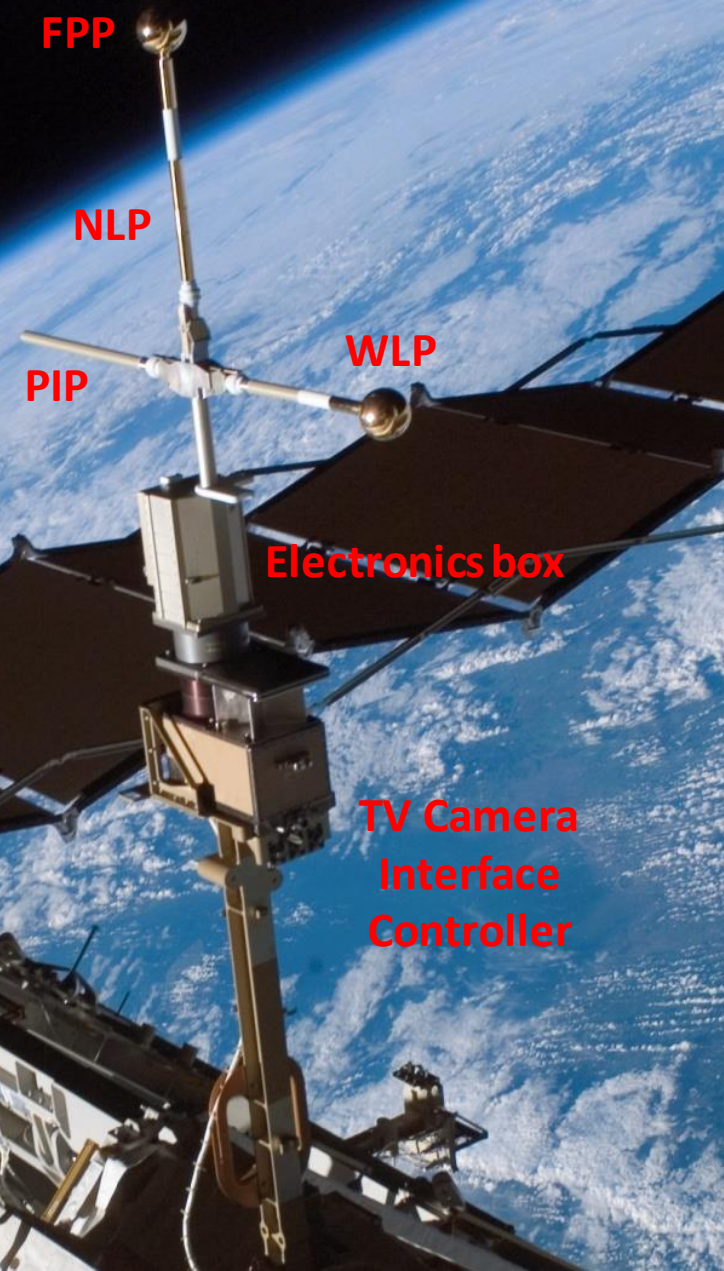
Floating Potential Measurement Unit (FPMU)

MSFC/EV44 Natural Environments Branch

Ne, Te, ISS frame potential measurements used for:

- ISS EVA plasma hazard environments and vehicle charging
- Plasma interactions with ISS high voltage (160 V) solar arrays
- Anomaly investigations
- Collaborations with ISS science payloads
- Auroral charging, space weather studies
- Equatorial F2-region plasma instabilities
- CTIPe, GAIM, IFM, and IRI ionospheric model validation
- Incoherent Scatter Radar World Days
- High latitude ion troughs
- Conjugate photoelectron heating



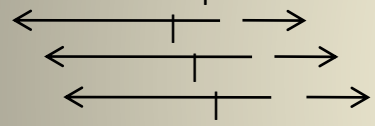


CCMC Real-time Ionosphere Ne, Te for ISS

Coupled Thermosphere Ionosphere Plasmasphere Electrodynamics (CTIPe) Model

- CCMC implemented real time CTIPe model in spring 2010 (CTIPe_RT) with output specific for ISS orbit
- ISS ephemeris from GSFC/SSCWeb
- New record every 10 minutes gives 90 minutes of data at 5 sec time steps

-70 min from file epoch to +20 min



```
CTIPe_at_ISS_20100909_192000.txt                                   09/09/2010  07:01PM
# Data printout from CCMC-simulation: version 1.1
# Data type:  CTIP  ionosphere/thermosphere
# Run name:   2010-09 Missing data:   -1.100E+12
# Coordinate System: GEO
# fixed dipole tilt angles used: SM-GSM:       0.00000 GSM-GSE:       0.00000
# Satellite Track: iss
# Output data: field with 1x1081=1081 elements
#YYYYMM DD HH MM   Sec    lon    lat    IP       N_e        N_O+       N_H+      T_i   T_e
# year month day  h m s  [deg]  [deg]  [km]    [m^-3]     [m^-3]     [m^-3]     [K]   [K]
2010 09 09 17 50  0.000  254.4 -9.250  351.5  7.522E+11  7.501E+11  2.108E+09  1125. 1828.
2010 09 09 17 50  5.000  254.6 -8.994  351.5  7.494E+11  7.473E+11  2.089E+09  1125. 1831.
2010 09 09 17 50 10.000  254.8 -8.738  351.4  7.465E+11  7.444E+11  2.069E+09  1125. 1834.
2010 09 09 17 50 15.000  254.9 -8.483  351.4  7.434E+11  7.414E+11  2.050E+09  1125. 1837.
2010 09 09 17 50 20.000  255.1 -8.227  351.3  7.402E+11  7.382E+11  2.030E+09  1124. 1840.
2010 09 09 17 50 25.000  255.3 -7.971  351.3  7.366E+11  7.346E+11  2.010E+09  1124. 1843.
2010 09 09 17 50 30.000  255.5 -7.715  351.2  7.312E+11  7.292E+11  1.989E+09  1123. 1844.
2010 09 09 17 50 35.000  255.7 -7.459  351.1  7.259E+11  7.239E+11  1.968E+09  1122. 1846.
2010 09 09 17 50 40.000  255.9 -7.203  351.1  7.205E+11  7.186E+11  1.947E+09  1120. 1848.
2010 09 09 17 50 45.000  256.1 -6.947  351.0  7.151E+11  7.132E+11  1.927E+09  1119. 1850.
                    ----------------  (records deleted)  ------------------------
2010 09 09 19 20  0.000  227.5 -14.02  352.8  3.634E+11  3.621E+11  1.289E+09  989.1 1710.
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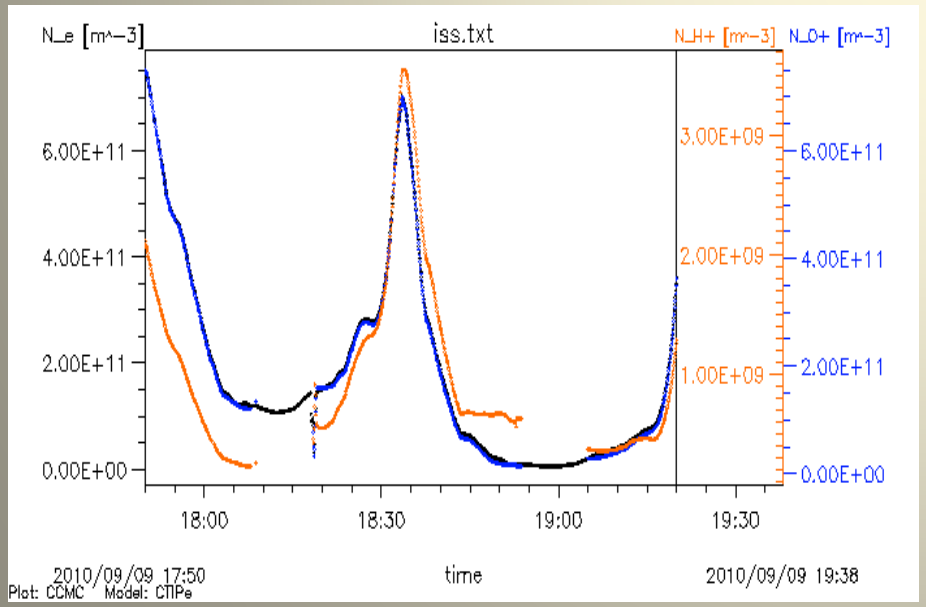
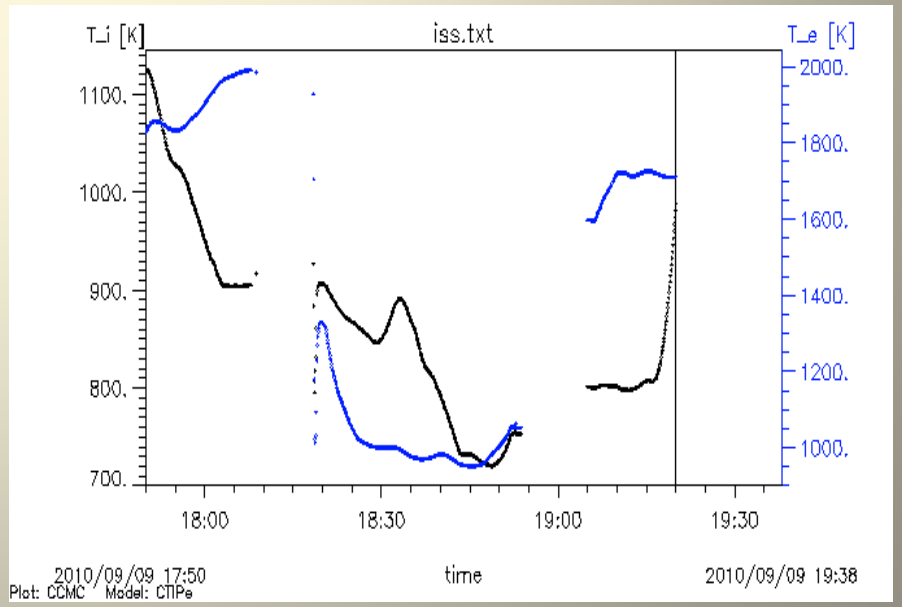
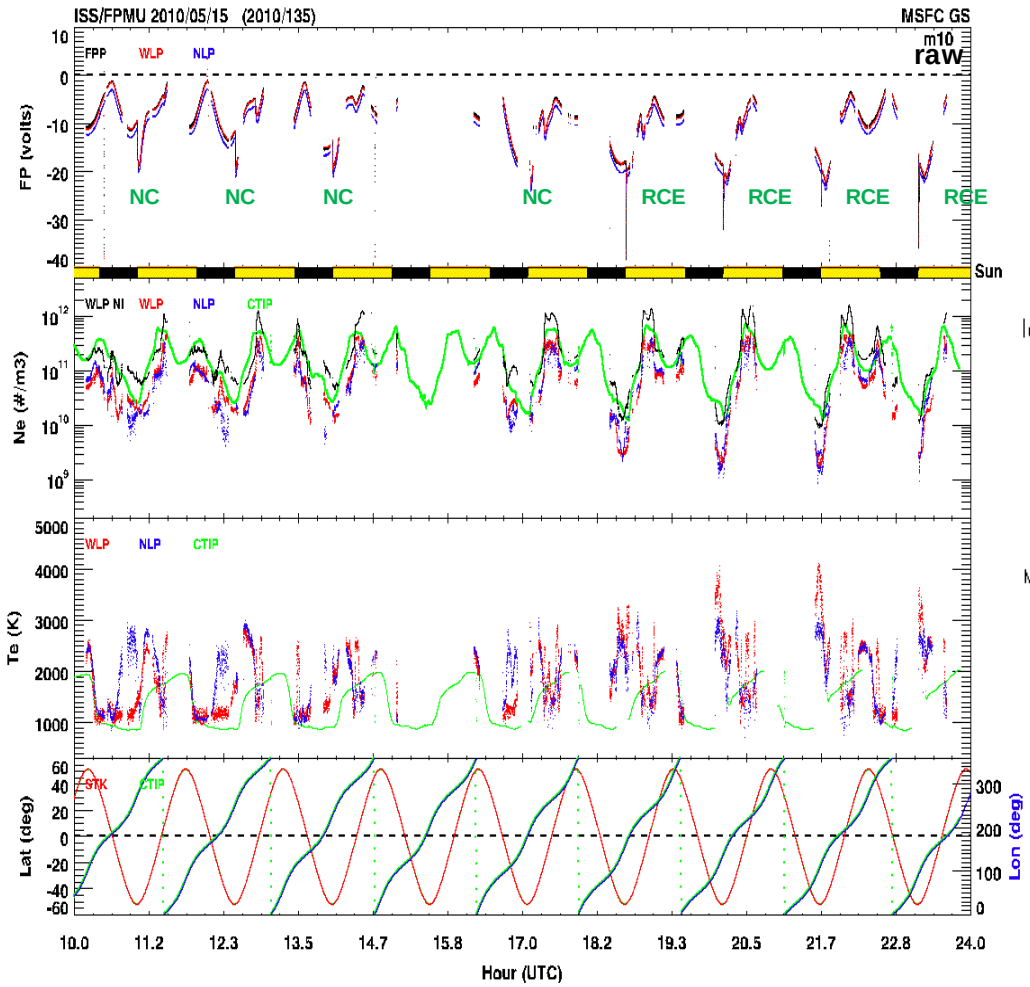
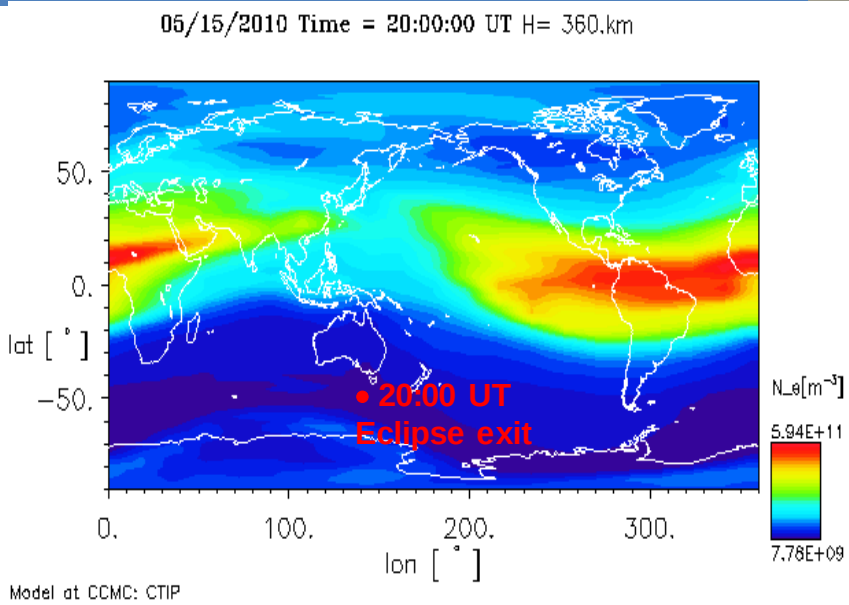




Characterizing High Latitude Charging Environment

- ISS environments teams are investigating variations in physics of eclipse exit charging
- CTIPe_RT model confirmed physical origin of the plasma depletions for charging events observed at high latitudes, allows us to predict periods for studying charging phenomenon



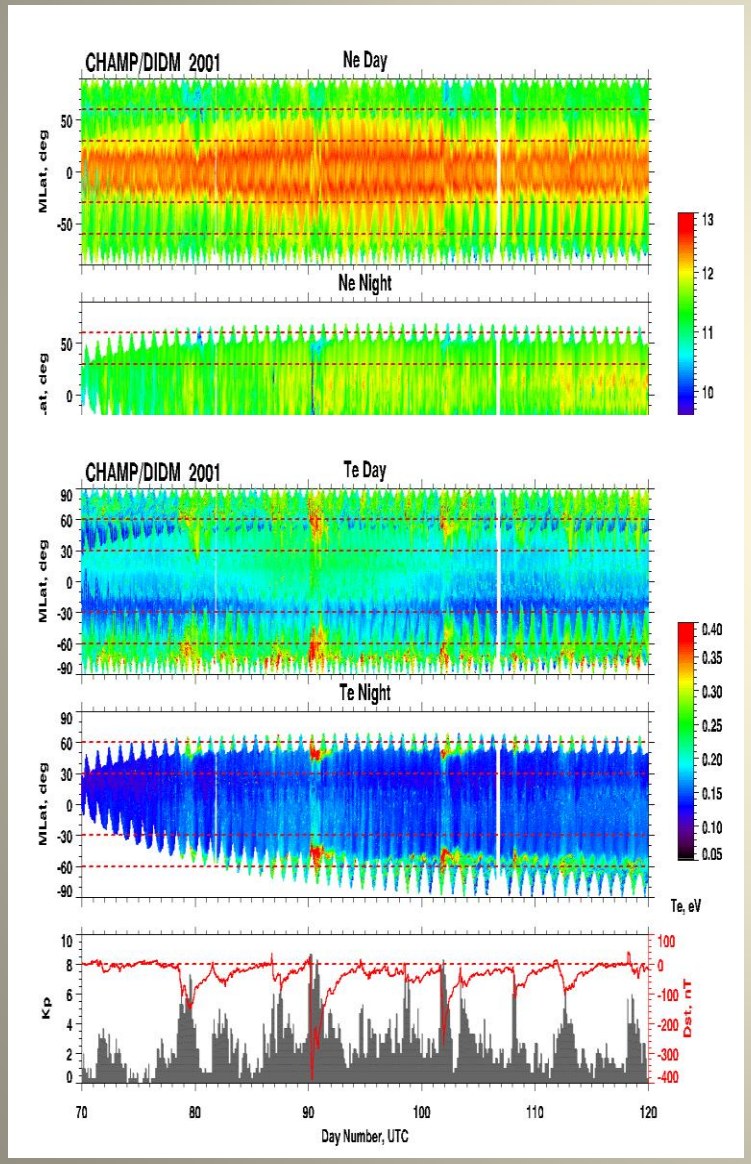


10-17 UT Eclipse Exit
Normal charging (NC) events observed at eclipse exit

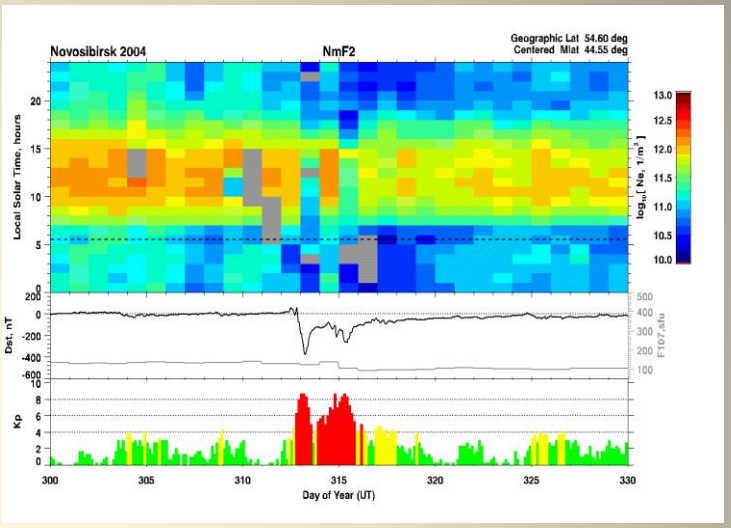
17 – 24 UT Eclipse Exit
Rapid charging (RC) events observed when eclipse exit occurs in low density plasma troughs

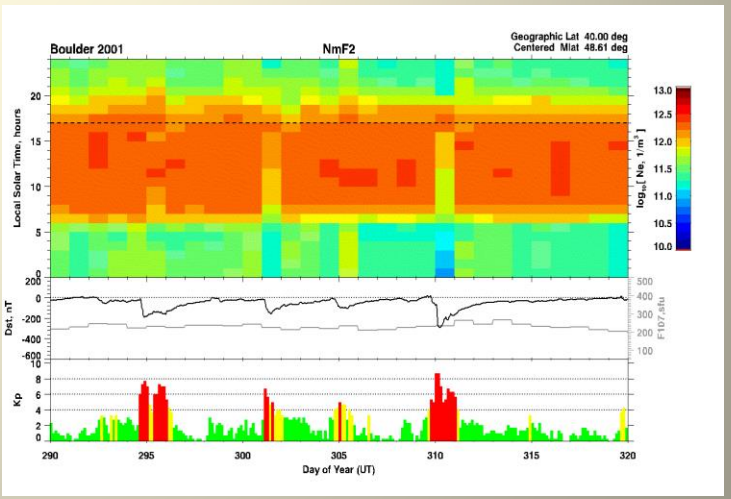
Storm Effects on F2 Plasma Ne, Te

CHAMP DIDM ~400 km, 70 deg

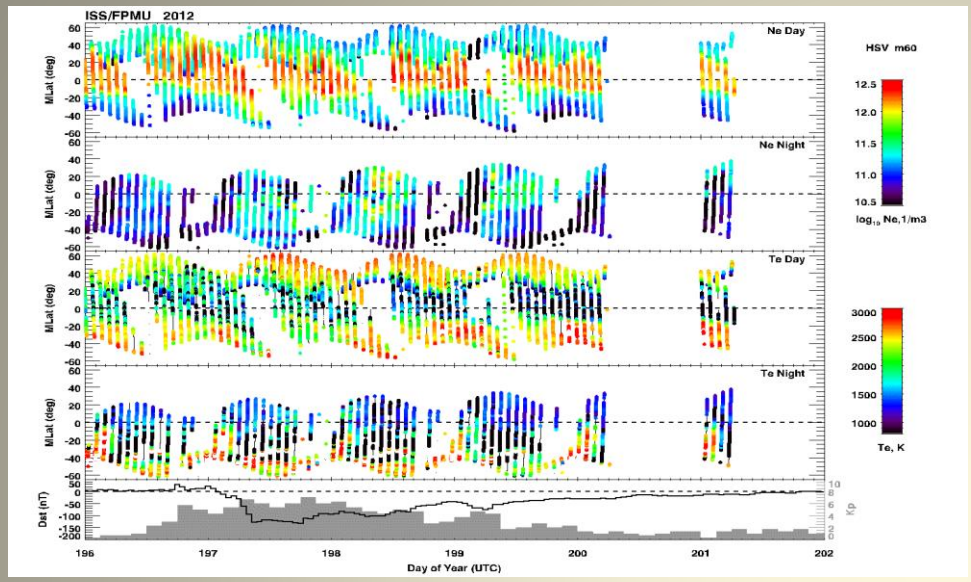


Ionosonde NmF2

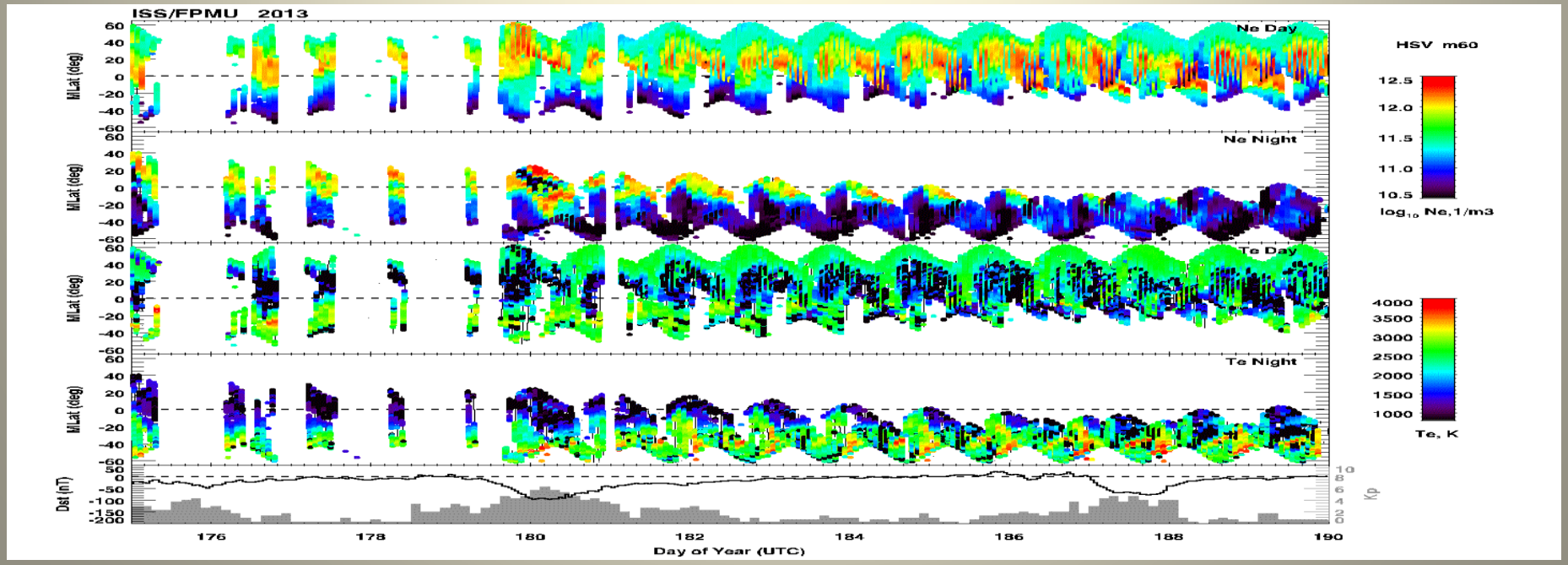




Storm Impact on FPMU Ne, Te



- Storm effects not so clear in FPMU records…..
- Plan to use CCMC CTIPe results along ISS trajectory to help understand the FPMU results



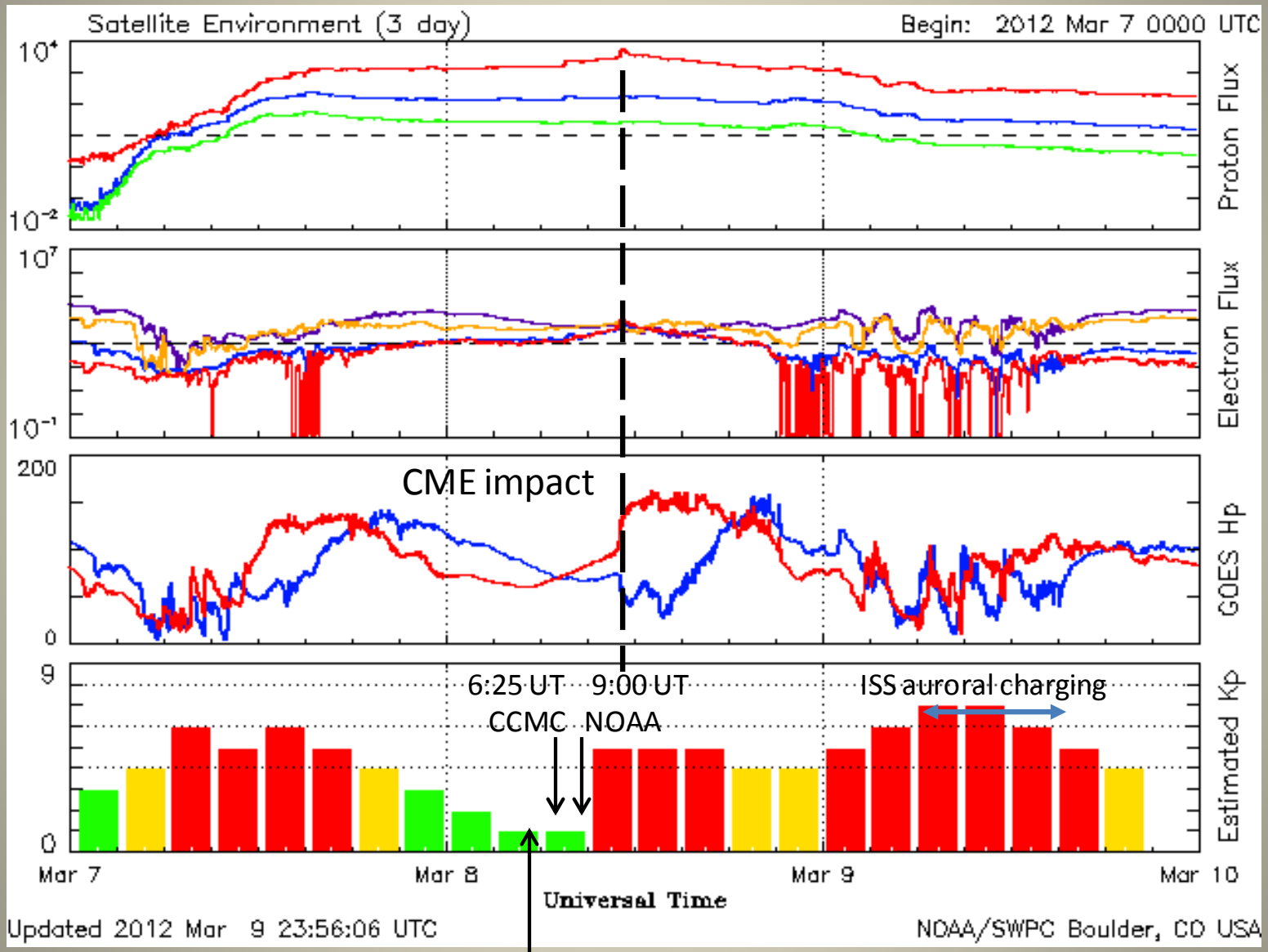
ISS Auroral Charging Periods

ISS Auroral Charging Periods	FPMU Operations
26 March 2008 (GMT 086)	STS-123/ESA ATV-001 docking
5-6 April 2010 (GMT 095-096)	STS-131/19A
22,23,25 January 2012 (GMT 025)	SWx: M8.7 flare, CME ~2211 km/s
9-11 March 2012 (GMT 069-071)	SWx: X5.4 flare, CME ~2200 km/s X1.3 flare, CME ~1800 km/s
23 May 2012 (GMT 144)	SpaceX Dragon berth/unberth
15-16 July 2012 (GMT 197-198)	SWx: X1.4 flare, CME ~1400 km/s
3 September 2012 (GMT 247)	US EVA 19
20 January 2013 (GMT 020)	Solar Cycle 24 Solar Maximum Conditions
17 March 2013 (GMT 076)	SWx: M1.1 flare, CME ~1400 km/s
28,29 June 2013 (GMT 179,180)	US EVA 22,23
7 November 2013 (GMT 311)	RS EVA 36
19 August 2014 (GMT 231)	SSU POR monitoring
27-29 August 2014 (GMT 239-341)	SSU POR monitoring
17-18 March 2015 (GMT 76,77)	SWx, C9.1 flare, CME ~750 km/s
10 April 2015 (GMT 100)	SWx: XX flare, CME ~917 km/s
23-23 April 2015 (GMT 173-174)	SWx: M2.0, M2.6, flare and CME ~1250 km/s

ISS engineering activity suppport

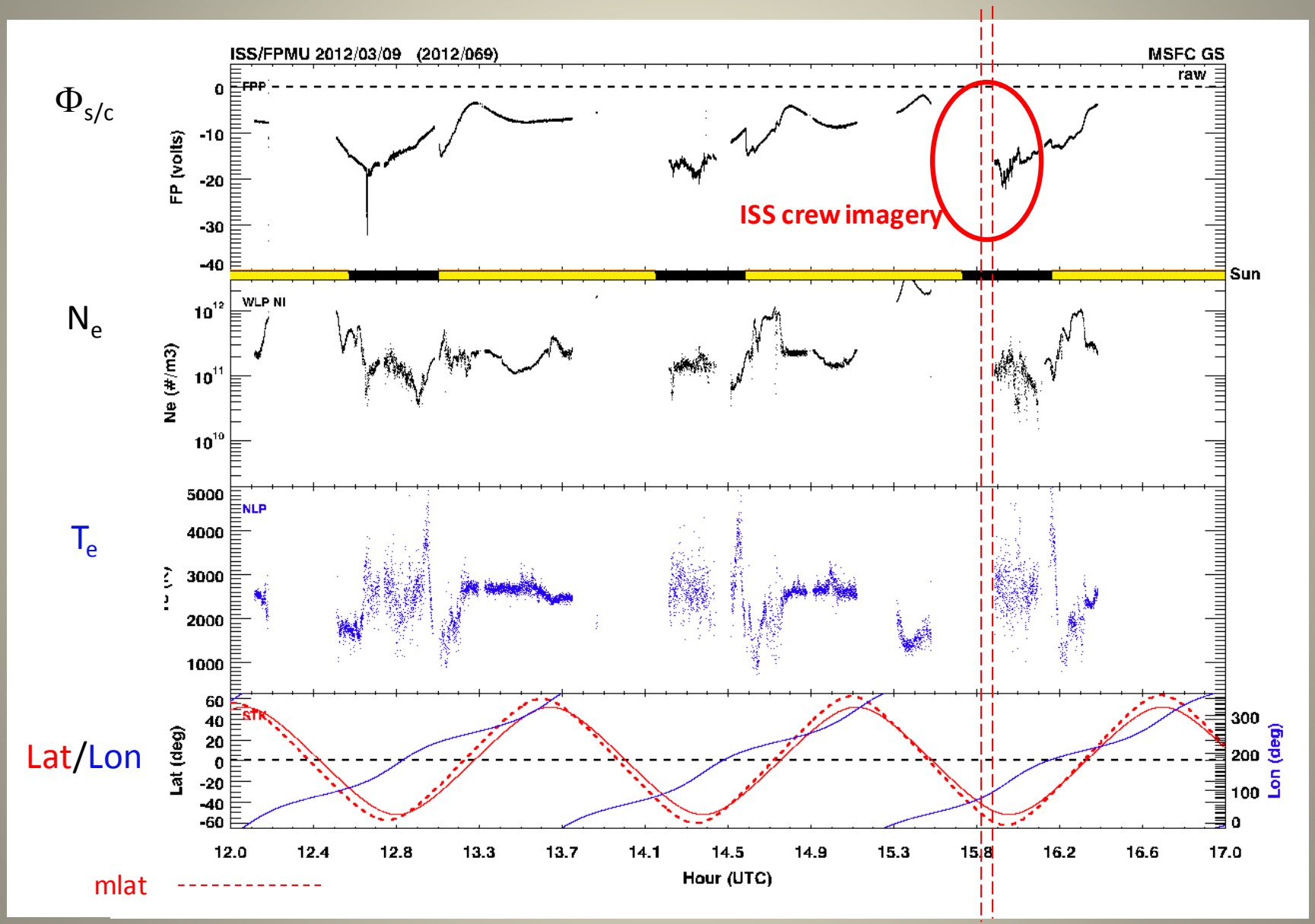
Space weather operations

March 2012 Geomagnetic Storm



FPMU activated based on CME alerts

9 March 2012

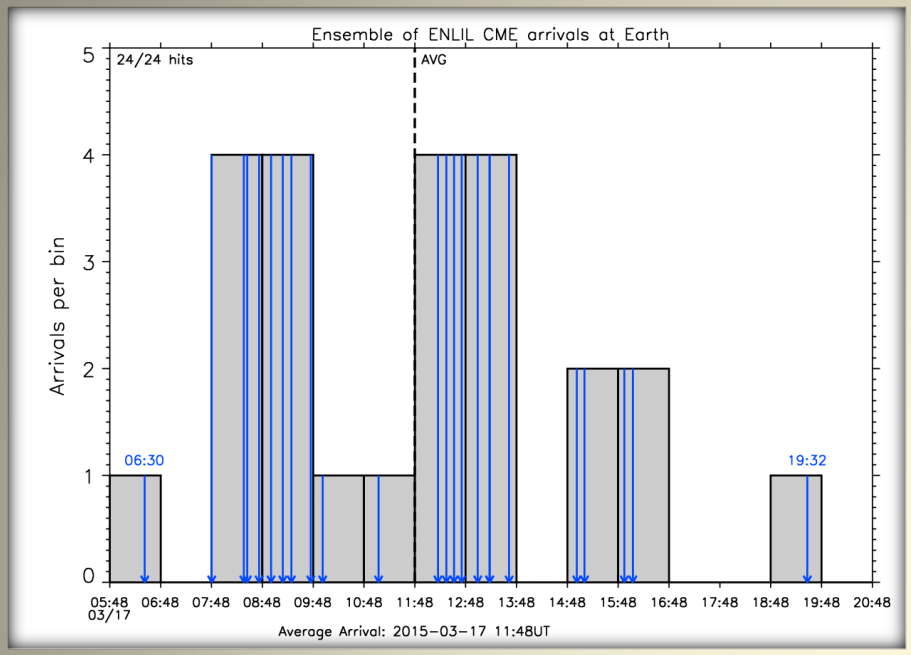

ISS/FPMU 2012/03/09 (2012/069)
MSFC GS
raw
$\Phi_{s/c}$
FPP
FP (volts)
ISS crew imagery
Sun
N_e
WLP NI
Ne (#/m3)
T_e
NLP
Lat/Lon
STK
Lat (deg)
Lon (deg)
Hour (UTC)
mlat

Auroral Images

Aurora images using wide angle lens on digital camera through ISS Cupola (Don Pettit, Exp 30/31) show aurora in nadir and ahead of ISS immediately before FPMU records of auroral charging

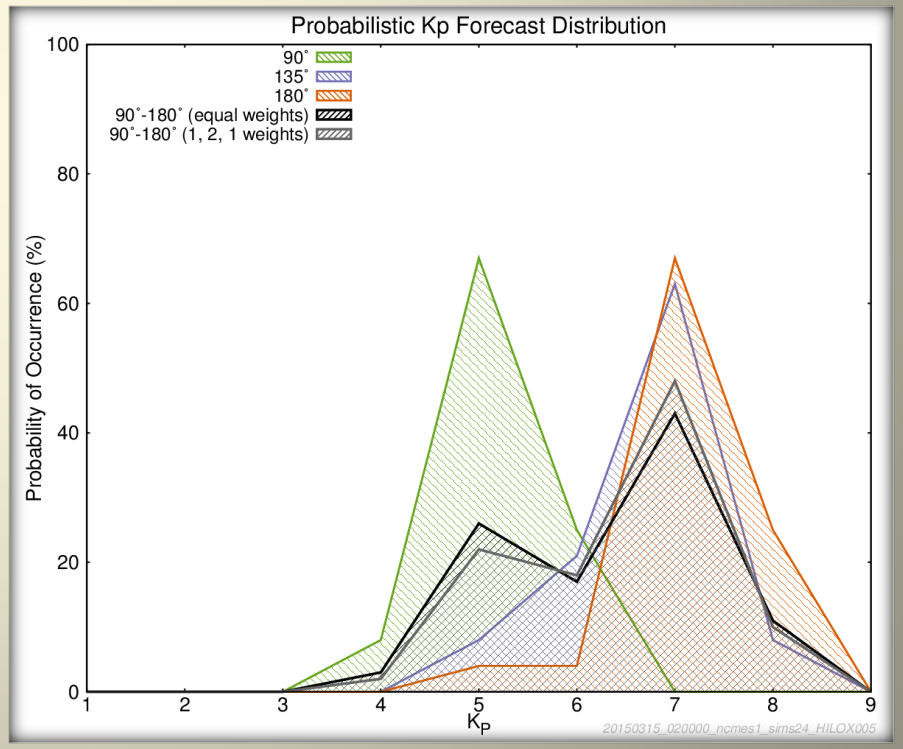
Documents ISS passing through auroral arc!

CCMC Ensemble Products



CME arrival at Earth

Predicted Kp



ISS Space Weather

- FPMU Ne, Te measurements obtained days to weeks in advance of an EVA are used in analysis of ESD threat to crew during EVA assuming persistent of conditions
- Space weather is monitored for Earth directed fast CME's that invalidate the environment assumptions if they exceed a speed threshold
- CCMC Earth directed CME alerts are now the primary source of CME initial speed data since SWRC is the only space weather monitoring organization regularly providing this information

NASA Goddard Space Flight Center, Space Weather Research Center (SWRC)
Message Type: Space Weather Notification - CME (Missions Near Earth) ## ## Message Issue Date: 2015-03-15T19:20:25Z
Message ID: 20150315-AL-001
Disclaimer: NOAA's Space Weather Prediction Center (http://swpc.noaa.gov) is the United States Government official source for space weather forecasts. This "Experimental Research Information" consists of preliminary NASA research products and should be interpreted and used accordingly.

Summary:
C-type CME detected by SOHO.
Start time of the event: 2015-03-15T02:00Z.
Estimated speed: ~750 km/s.
Estimated opening half-angle: 45 deg.
Direction (lon./lat.): 32/-12 in Heliocentric Earth Equatorial coordinates (see [1] in Notes).

Activity ID: 2015-03-15T02:00:00-CME-001

Based on preliminary heliospheric modeling carried out at NASA GSFC Space Weather Research Center, it is estimated that this CME may impact NASA missions near Earth. Simulations indicate that the leading edge of the CME will reach NASA missions near Earth at about 2015-03-17T11:39Z (plus minus 7 hours). The roughly estimated expected range of the maximum Kp index is 5-7 (minor to strong).

Links to the movies of the modeled event (includes CME(s): 2015-03-15T02:00:00-CME-001):

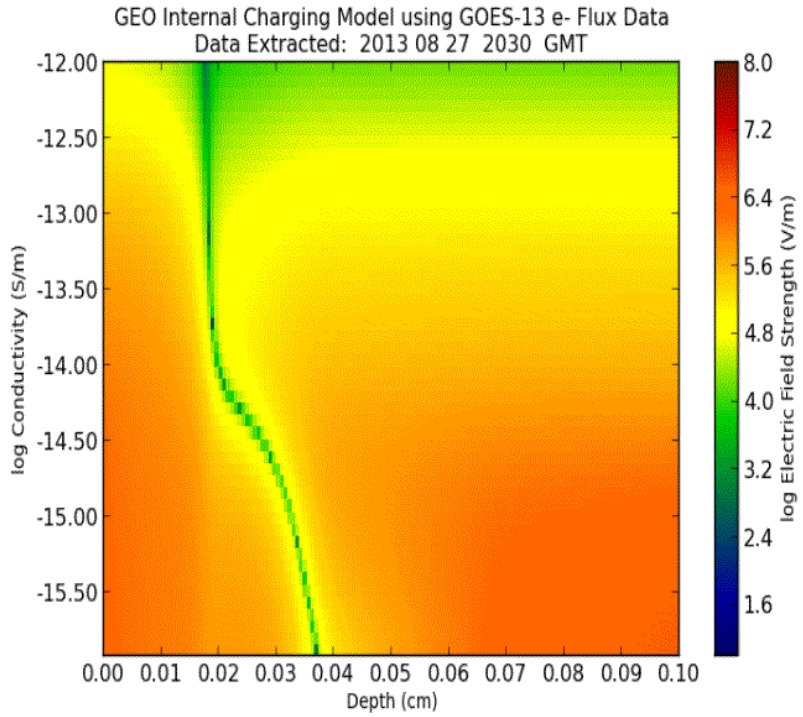
http://iswa.gsfc.nasa.gov/downloads/20150315_064500_2.0_anim.tim-den.gif
http://iswa.gsfc.nasa.gov/downloads/20150315_064500_2.0_anim.tim-vel.gif
http://iswa.gsfc.nasa.gov/downloads/20150315_064500_2.0_anim.tim-den-Stereo_A.gif
http://iswa.gsfc.nasa.gov/downloads/20150315_064500_2.0_anim.tim-den-Stereo_B.gif
http://iswa.gsfc.nasa.gov/downloads/20150315_064500_2.0_anim.tim-vel-Stereo_A.gif
http://iswa.gsfc.nasa.gov/downloads/20150315_064500_2.0_anim.tim-vel-Stereo_B.gif

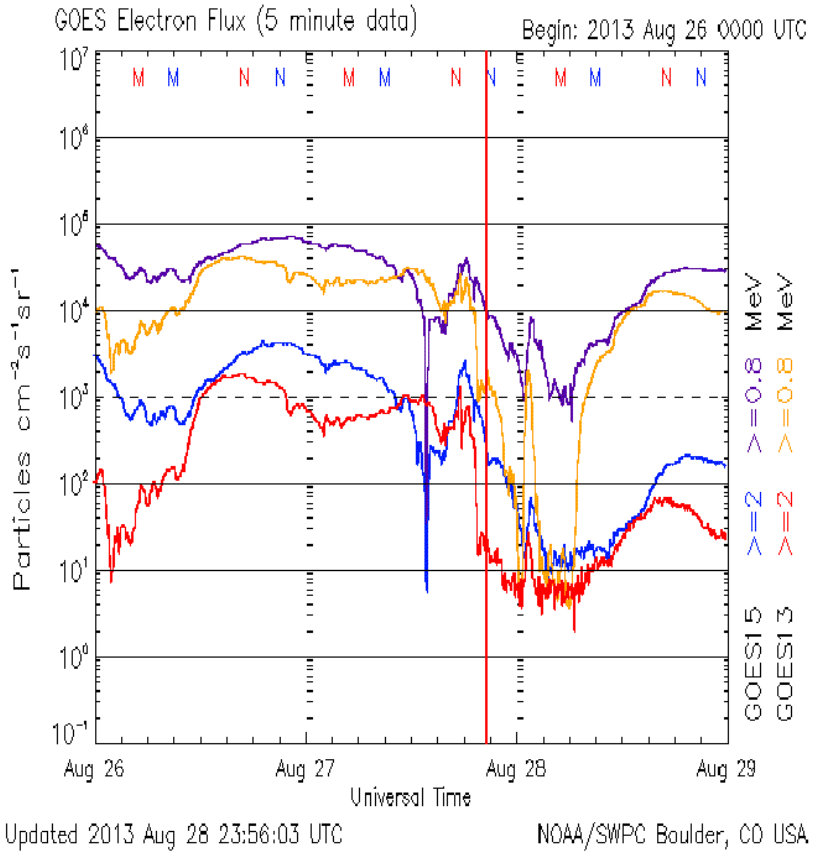
Notes:
This CME event (2015-03-15T02:00:00-CME-001) is associated with C9.1 flare with ID 2015-03-15T01:15:00-FLR-001 which peaked at 2015-03-15T02:13Z.

[1] http://iswawiki.gsfc.nasa.gov/wiki/index.php/Glossary/Heliospheric_Earth_Equatorial_coordinates

SCORE CME typification system:
S-type: CMEs with speeds less than 500 km/s
C-type: Common 500-999 km/s
O-type: Occasional 1000-1999 km/s
R-type: Rare 2000-2999 km/s
ER-type: Extremely Rare >3000 km/s
http://swrc.gsfc.nasa.gov/main/score

Real-time GEO Internal Charging Tool

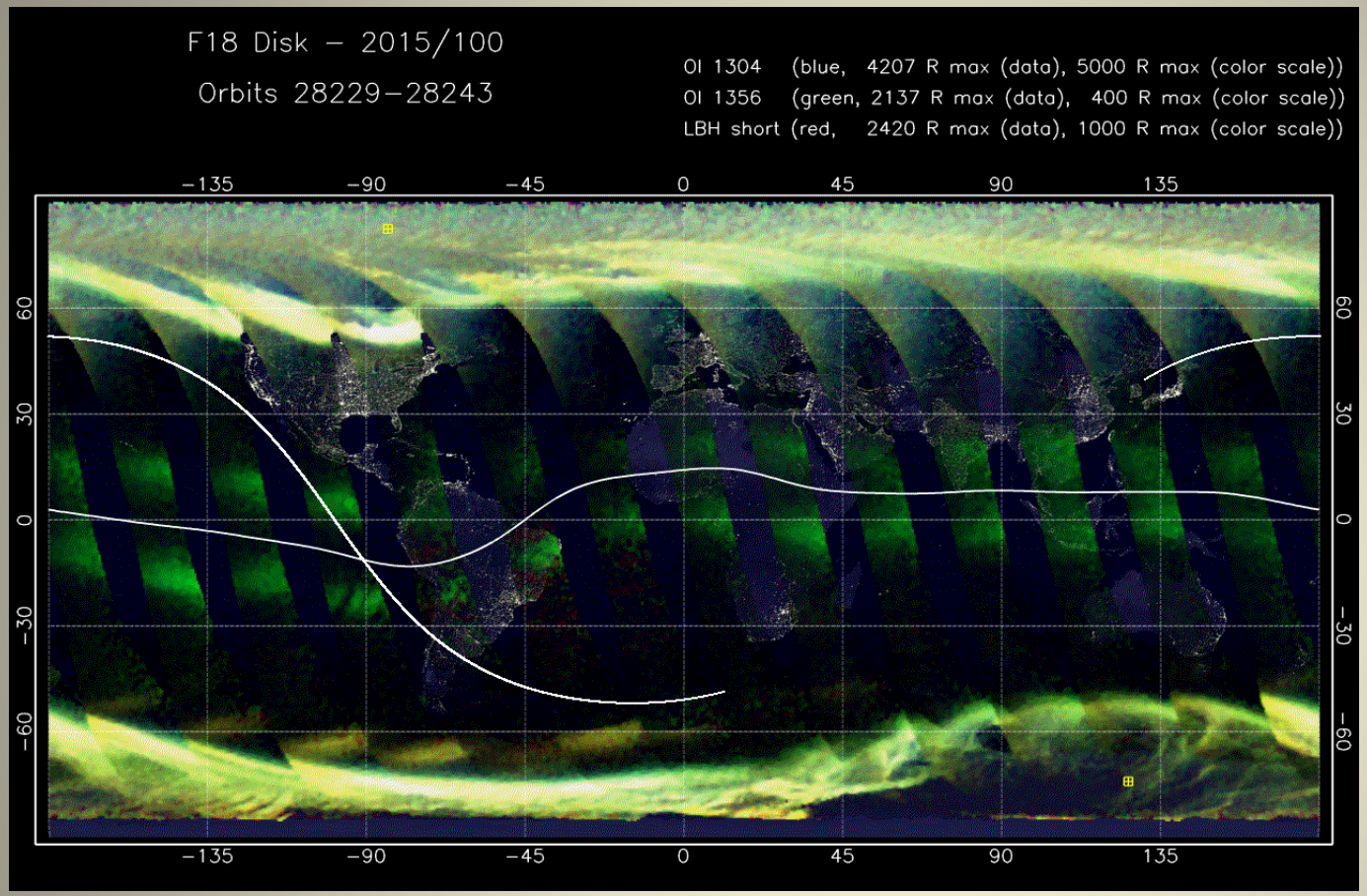




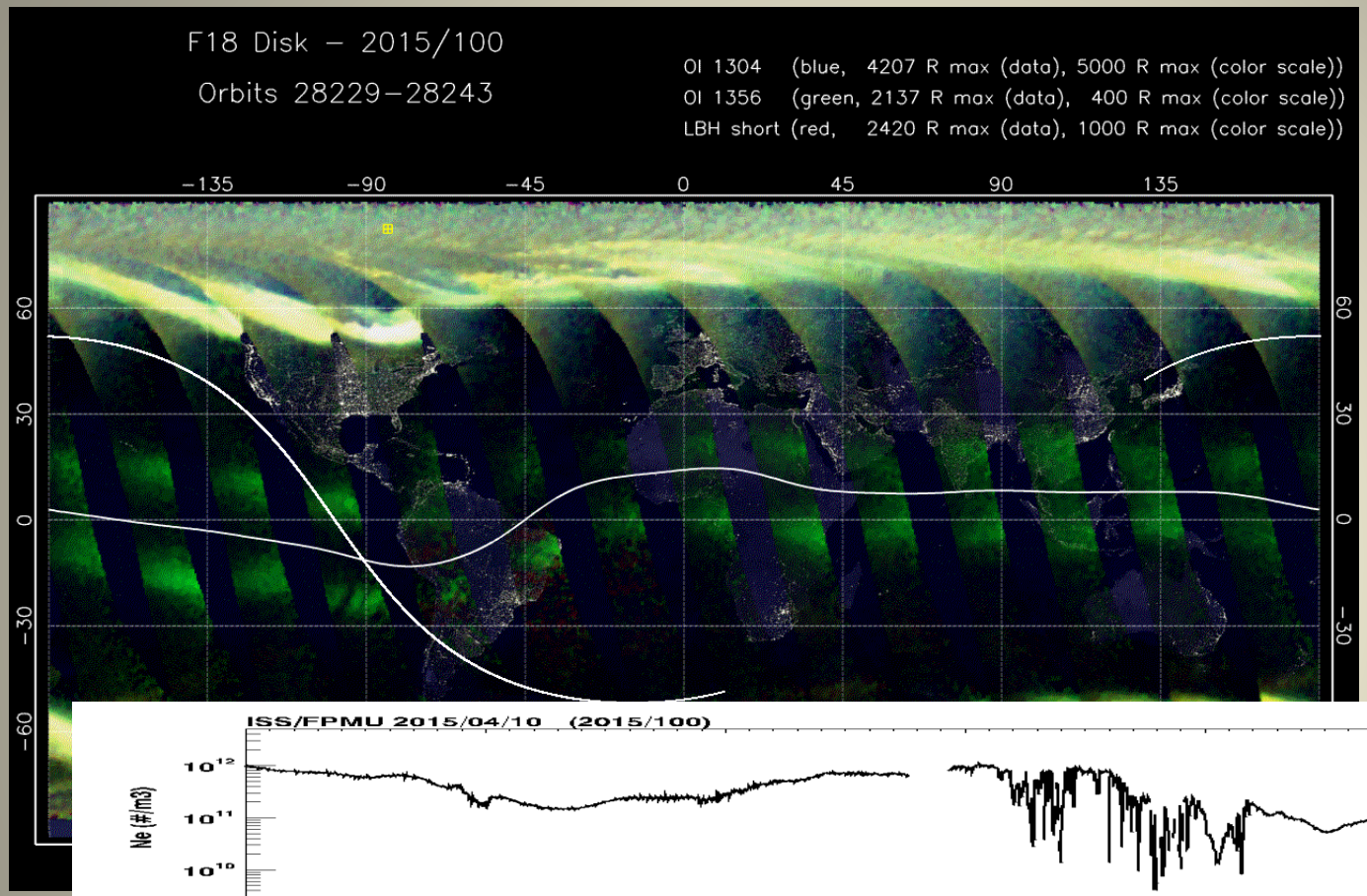
Current: GOES >0.8 MeV, >2.0 MeV electrons

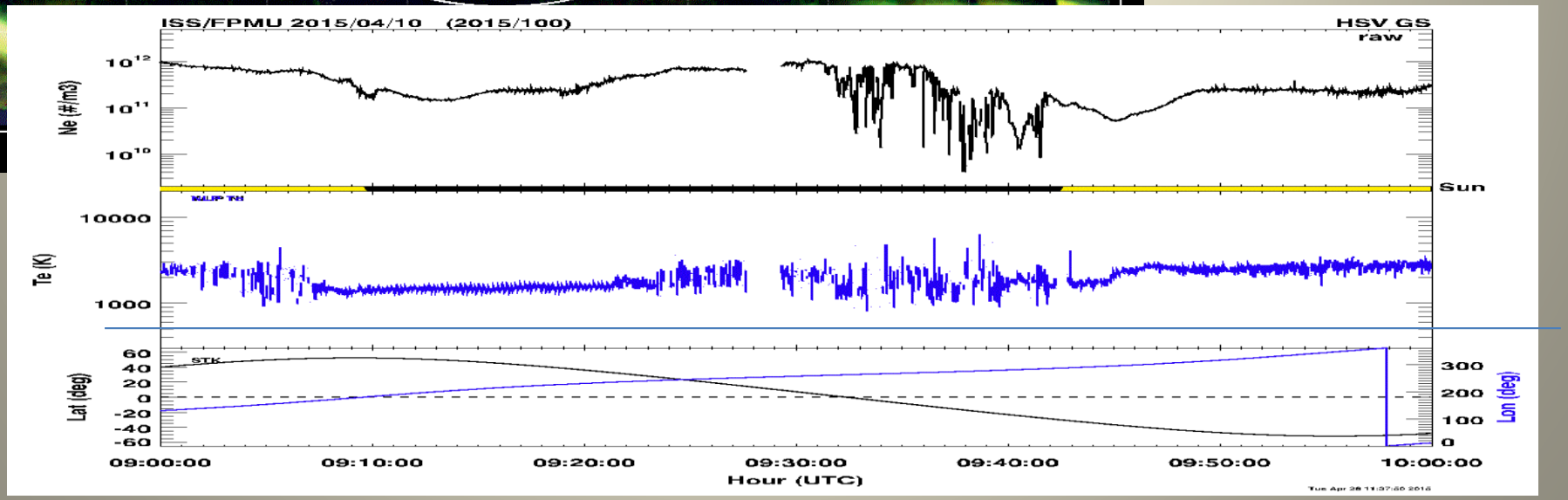
Future: GOES >4.0 MeV, 30-50 keV, 50-100 keV, 100-200 keV, 200-350 keV, 350 – 600 keV

10 April 2015 Equatorial Plasma Depletions

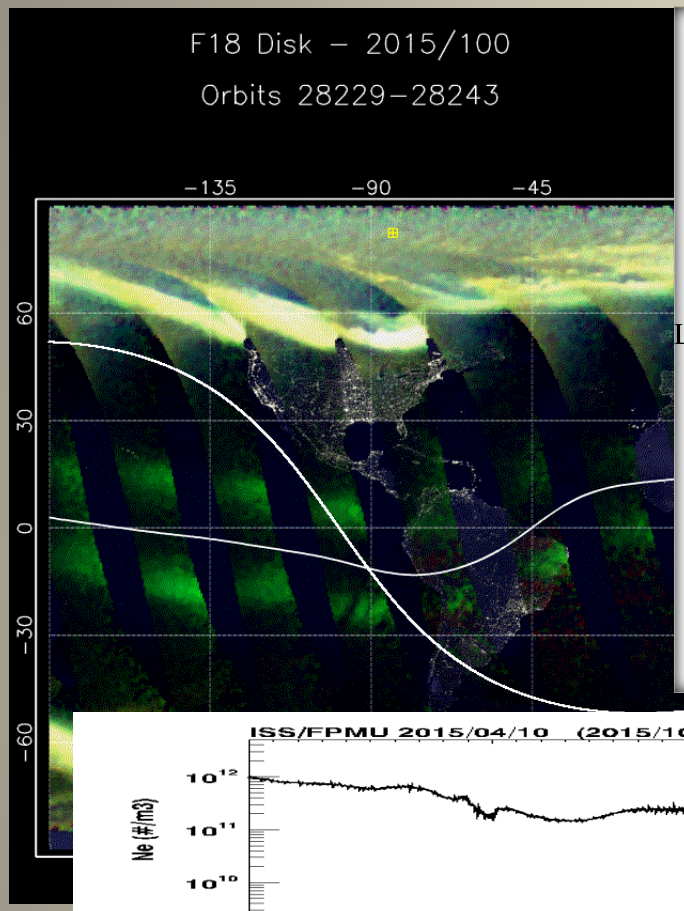


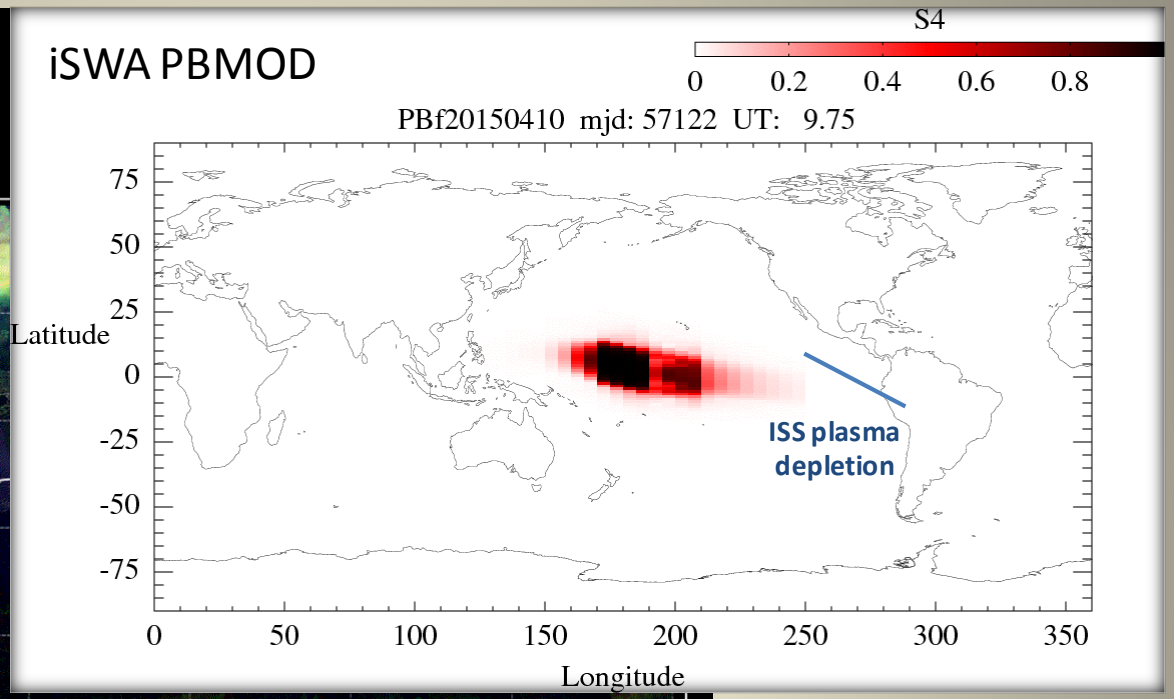
10 April 2015 Equatorial Plasma Depletions

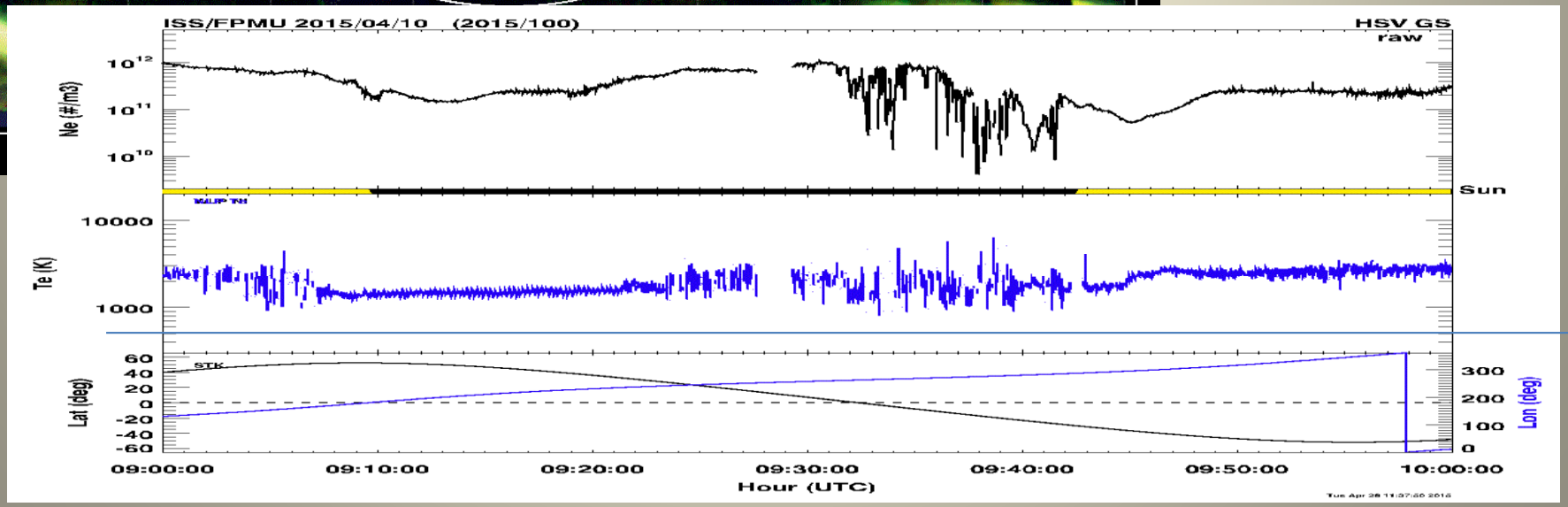




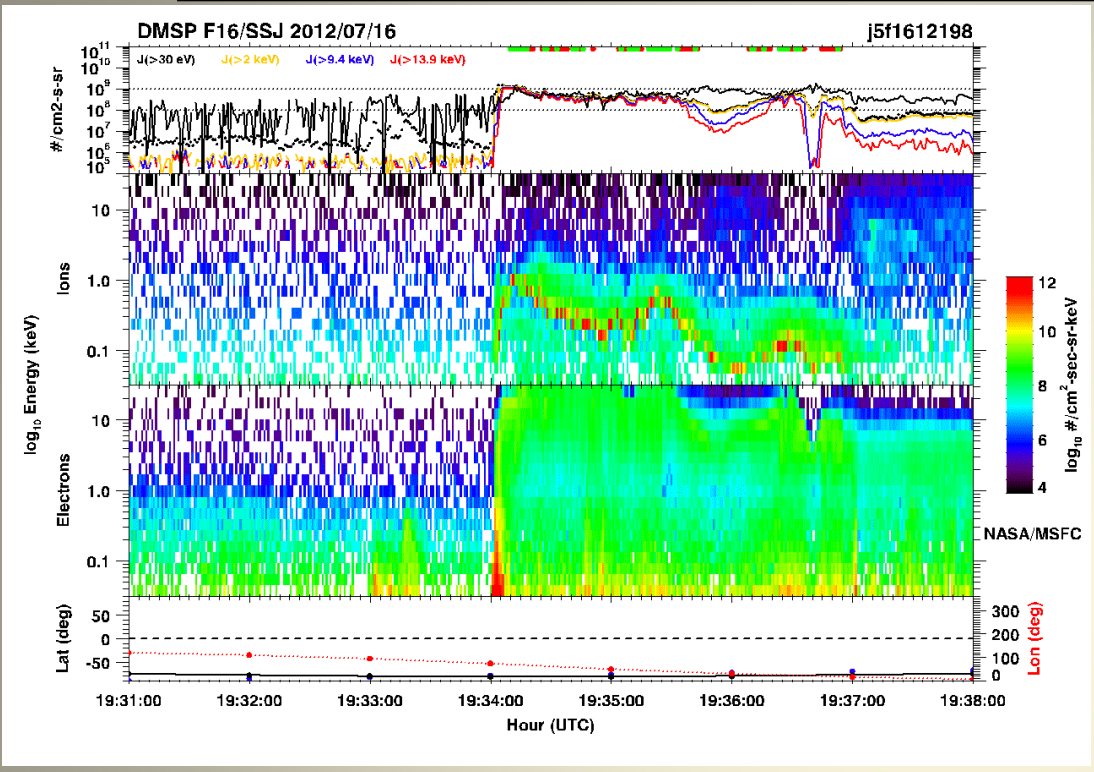
10 April 2015 Equatorial Plasma Depletions

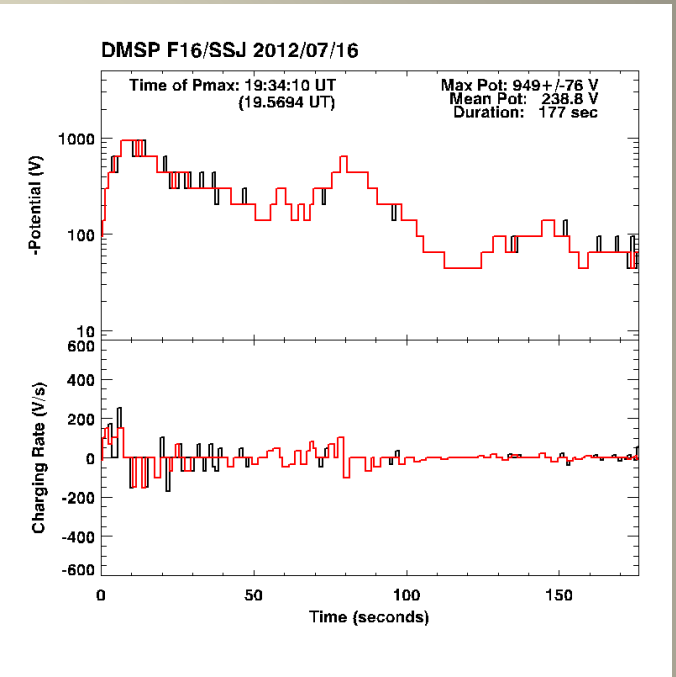


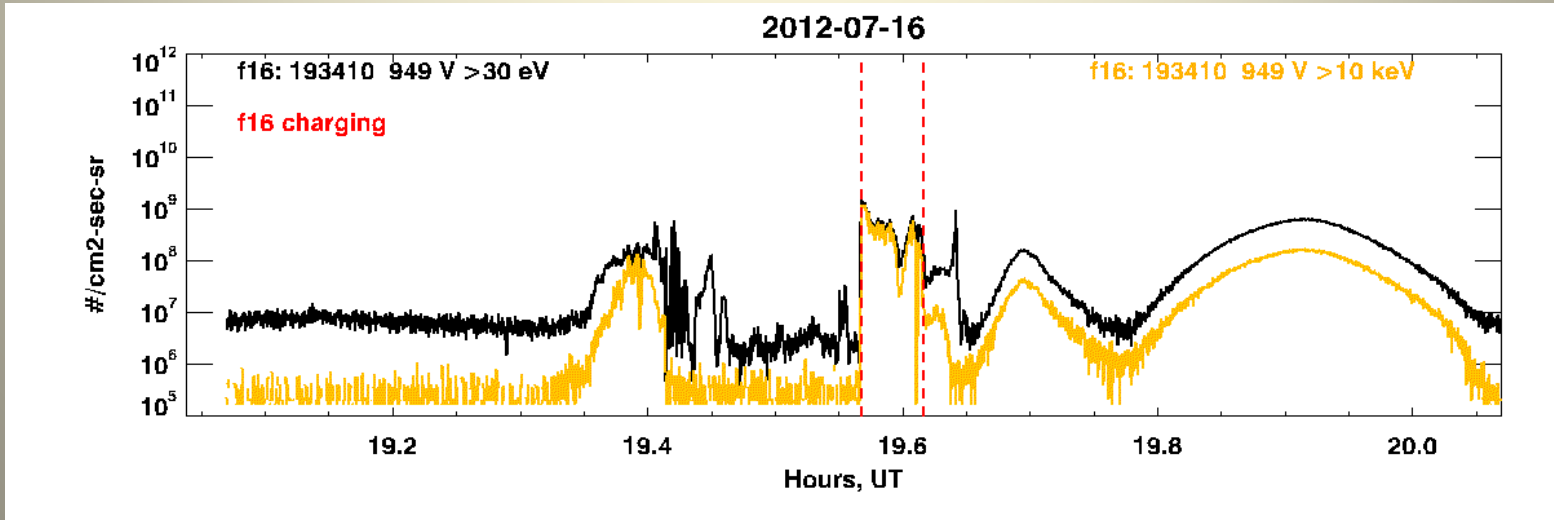




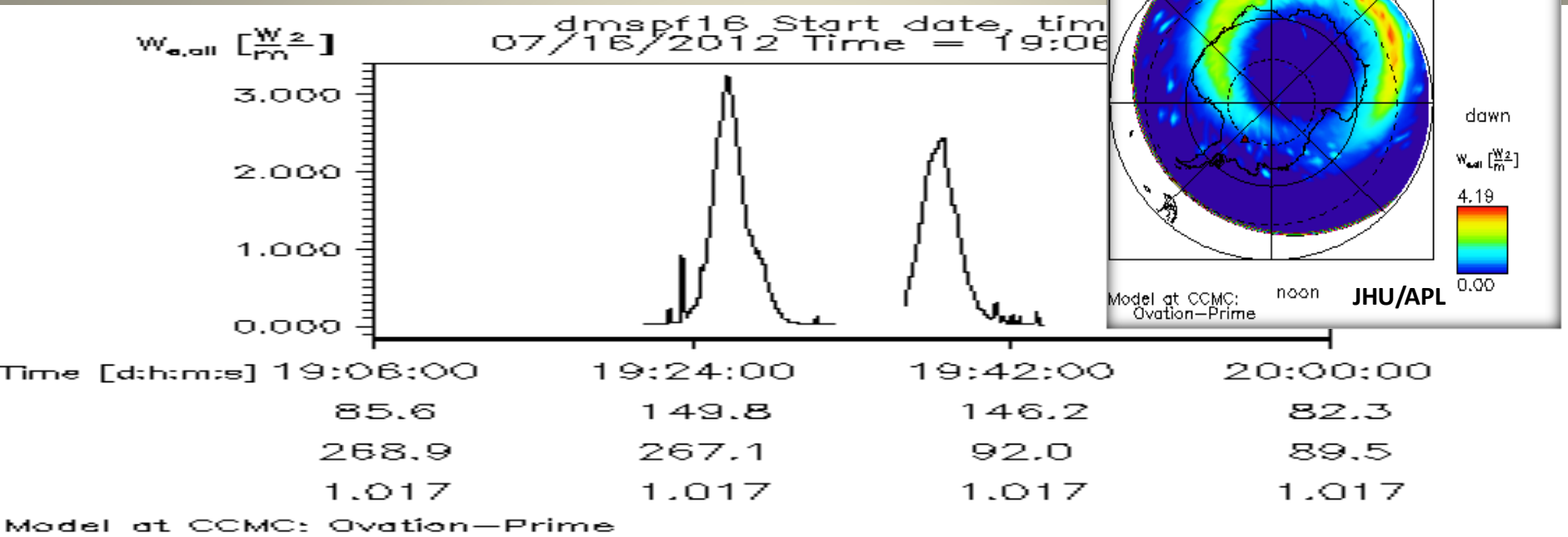
Auroral Flux Models, Charging Environments

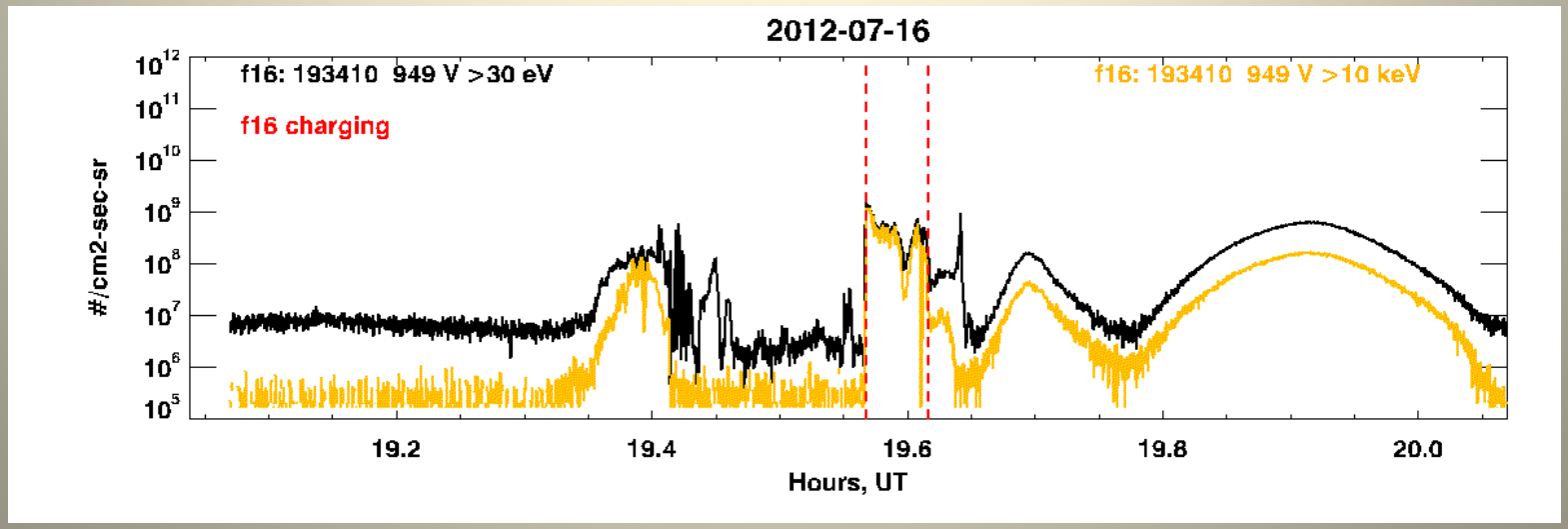




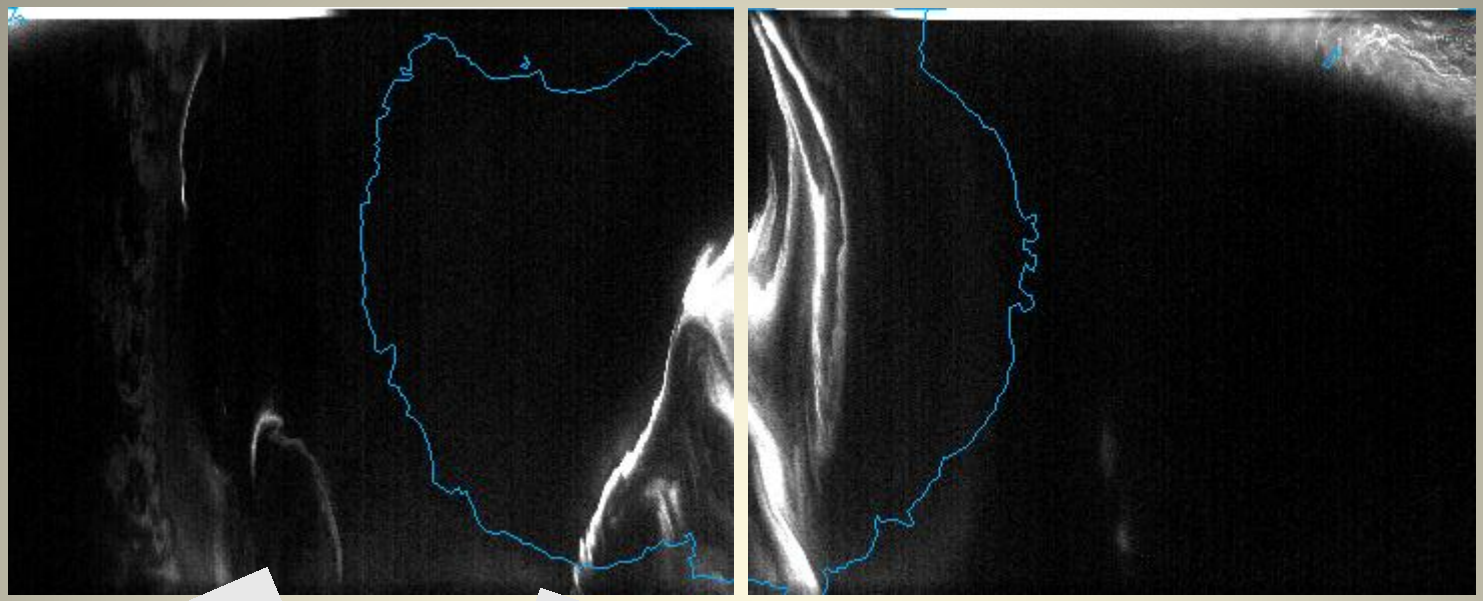


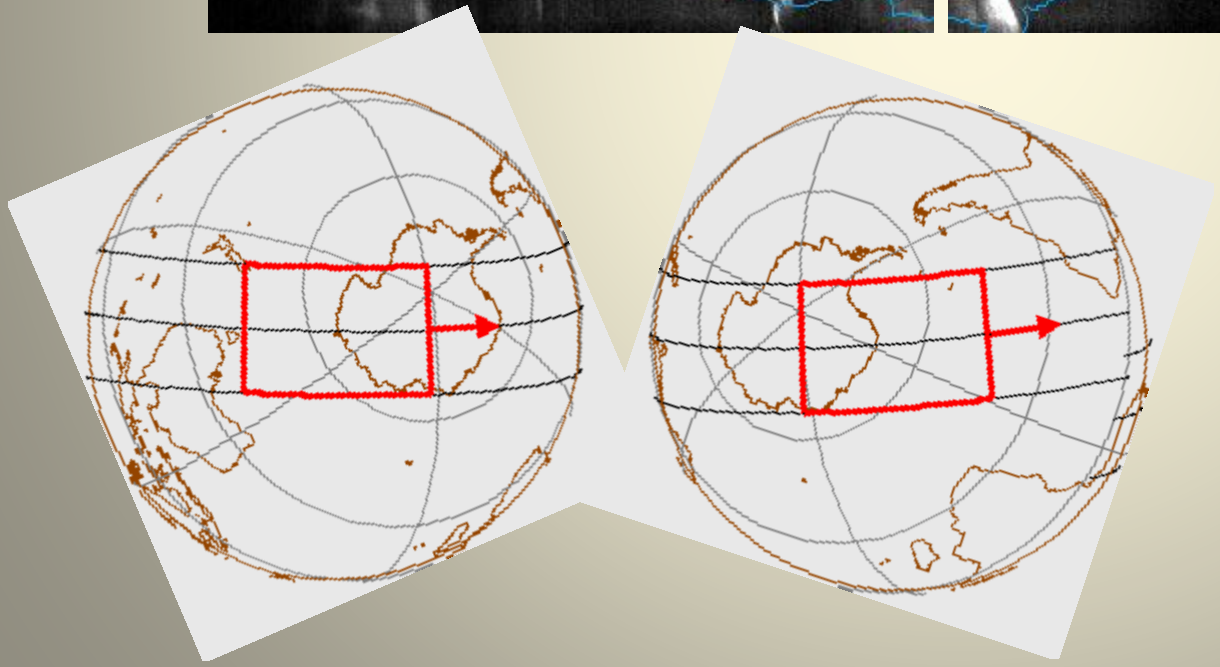
CCMC Ovation Prime

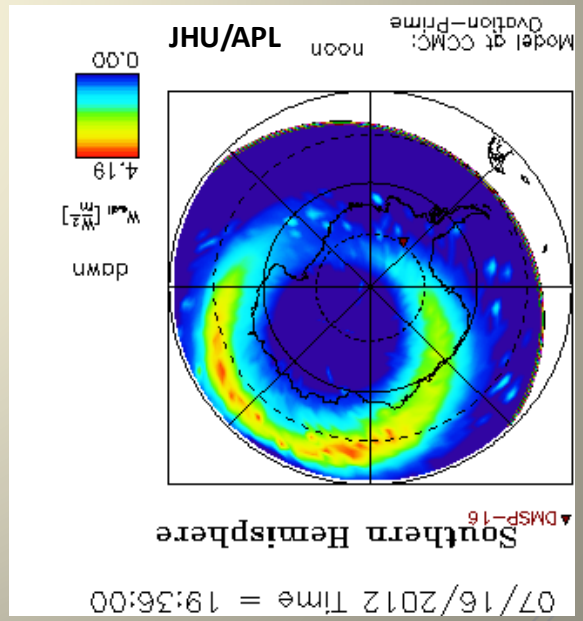




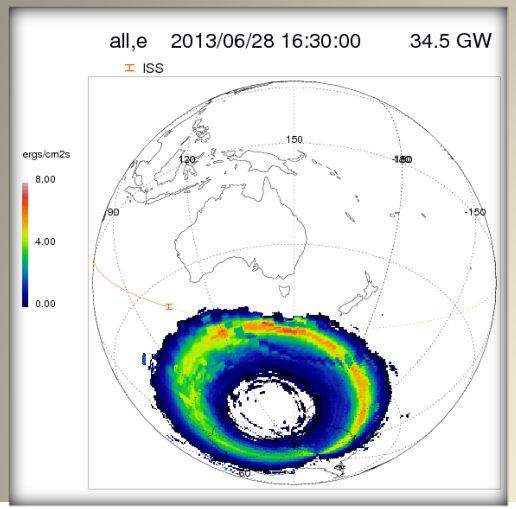
DMSP OLS

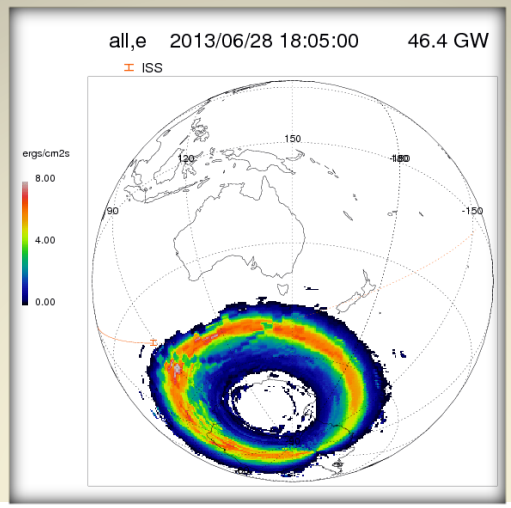


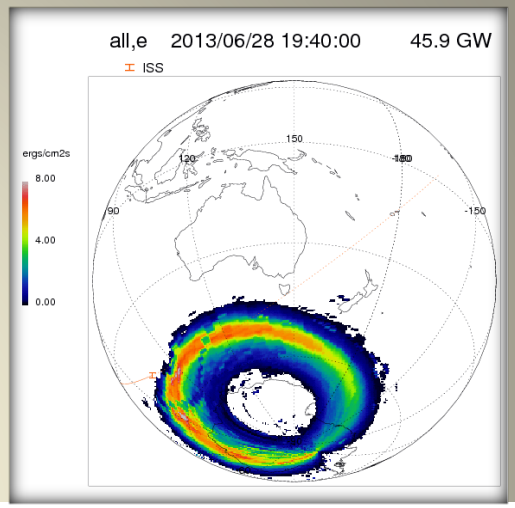


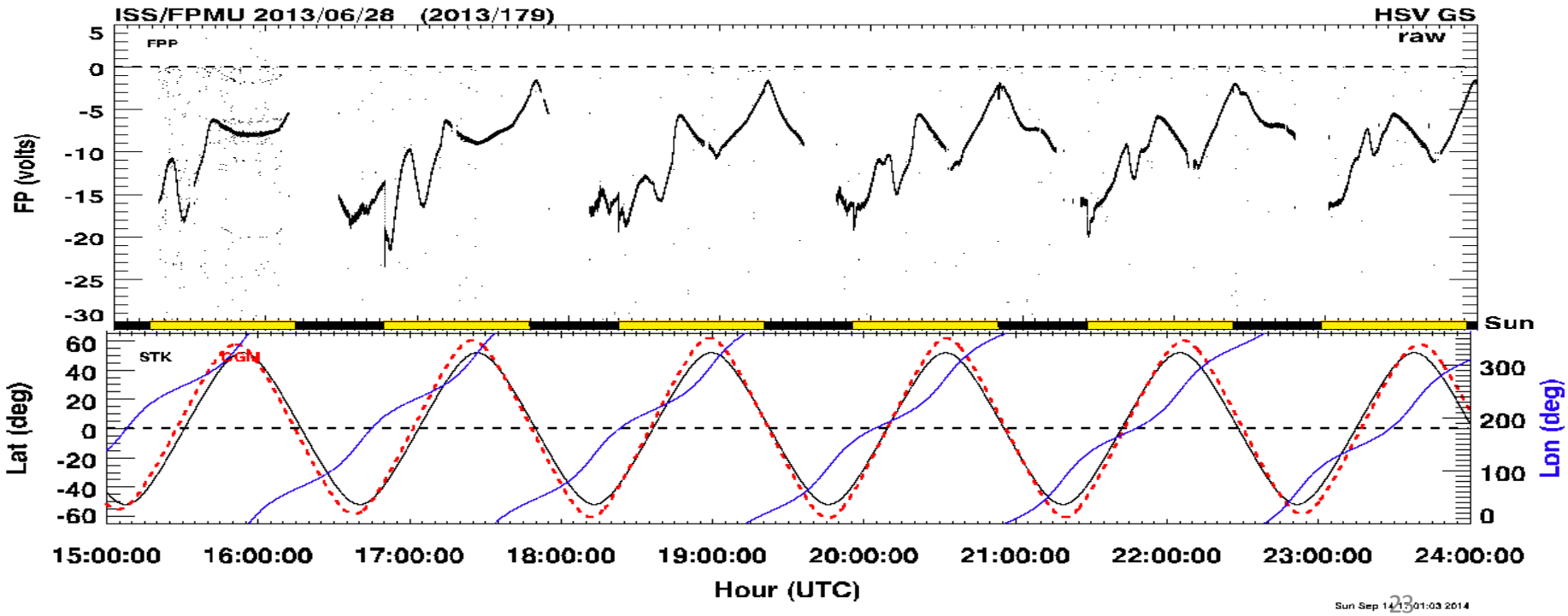

07/16/2012 Time = 19:36:00
Southern Hemisphere
DMSP-16
dawn
4.19
0.00
noon
Model at CCMC:
Ovation-Prime
JHU/APL

iSWA Ovation Prime, ISS Charging









CCMC DONKI

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SW DONKI

https://kauai.ccmc.gsfc.nasa.gov/DONKI/

donki ccmc

Space Weather Database Of Notifications, Knowledge, Information (DONKI)

Go to:

- DONKI Home
- DONKI Documentation
- Search Space Weather Activity
- Search Notification Archive
- Space Environment Effects and Anomalies
- Logoff
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Space Weather Database Of Notification, Knowledge, Information (DONKI) (developed at the Community Coordinated Modeling Center, CCMC) is a comprehensive on-line tool for space weather forecasters, scientists, and the general space weather community.

DONKI provides:

- Chronicles the daily interpretations of space weather observations, analysis, models, forecasts, and notifications provided by the Space Weather Research Center (SWRC).
- Comprehensive knowledge-base search functionality to support anomaly resolution and space science research.
- Intelligent linkages, relationships, cause-and-effects between space weather activities.

DONKI Goals:

- One-stop on-line tool for space weather forecasters.
- Gathers and organizes space weather scientists interpretations and daily activities with correlations and direct links between relevant space weather observations.
- Enables remote participation by students, world-wide partners, model and forecasting technique developers.

Using DONKI (see menu on the left):

- Anyone can search/view data already stored on DONKI.
- Registered Users can make comments on any SW Activity.
- Power Users can enter data into DONKI (Click here to request power user privileges).

Important Disclaimer Notice

If you are looking for the official U.S. Government forecast for space weather, please go to NOAA's Space Weather Prediction Center (http://swpc.noaa.gov). This "Experimental Research Information" consists of preliminary NASA research products and should be interpreted and used accordingly.

NASA Official: Maria Kuznetsova

http://kauai.ccmc.gsfc.nasa.gov/DONKI/

Space Environment Effect and Anomalies Archive

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Spacecraft Space Environm...

https://kauai.ccmc.gsfc.nasa.gov/DONKI/SSEA/

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Space Environment Effect and Anomalies Archive

click on the link below to generate/search reports in the archive

- Report Space Environment Effect
- Report Spacecraft Anomaly
- Search Archive

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If you are looking for the official U.S. Government forecast for space weather, please go to NOAA's Space Weather Prediction Center (http://swpc.noaa.gov). This "Experimental Research Information" consists of preliminary NASA research products and should be interpreted and used accordingly.

NASA Official: Maria Kuznetsova

CCMC SSEA

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Search SSEA data

https://kauai.ccmc.gsfc.nasa.gov/DONKI/search/SSEA

donki ccmc

Anomalies
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Activity ID	Project Name	System	Effect Time in UT	Orbit Type	Effect Type	Effect Description
2012-02-27T03:24:00-CHANDRA-RAD-001	CHANDRA	instrument	2012-02-27T03:24:00Z	Elliptical	radiation event	2012/058: Chandra X-Ray Observatory (CXO) Advanced CCD Imaging Spectrometer (ACIS) instrument radiation intervention. Science observations interrupted 27 Feb at 03:24 UTC to 27 Feb 20:23 UTC (16.9 hours) by a manual event due to ACE P3' (soft) particle signature.
2012-03-07T05:30:00-CHANDRA-RAD-001	CHANDRA	instrument	2012-03-07T05:30:00Z	Elliptical	radiation event	2012/067: Chandra X-Ray Observatory (CXO) Advanced CCD Imaging Spectrometer (ACIS) instrument radiation intervention. Science observations interrupted 7 Mar at 05:30 UTC to 13 Mar 05:14 UTC (122.2 hours) by an auto event due to HRC (hard) particle signature.
2012-03-09T12:00:00-ISS-CHRG-001	ISS	vehicle	2012-03-09T12:00:00Z	Inclined	spacecraft charging	2012/069: ISS auroral frame charging observed at high southern latitudes in period 12:00 UTC to 16:30 UTC. Maximum frame potentials ~6 to 14 V. Kp=5.7 to 6.7 at times of significant charging. Charging levels from ISS Floating Potential Measurement Unit.
2012-03-10T10:00:00-ISS-CHRG-001	ISS	vehicle	2012-03-10T10:00:00Z	Inclined	spacecraft charging	2012/070: Possible ISS auroral frame charging at high southern latitudes in period 10:00 UTC to 14:00 UTC. Maximum frame potentials ~1 to 2 V. Kp=2.0 to 2.7 at times of significant charging. Charging levels from ISS Floating Potential Measurement Unit. (Note: Additional verification required due to low Kp.)
2012-03-13T22:41:00-CHANDRA-RAD-001	CHANDRA	instrument	2012-03-13T22:41:00Z	Elliptical	radiation event	2012/073: Chandra X-Ray Observatory (CXO) Advanced CCD Imaging Spectrometer (ACIS) instrument radiation intervention. Science observations interrupted 13 Mar at 22:41 UTC to 14 Mar 13:57 UTC (14.8 hours) by an auto event due to HRC (hard) particle signature.
2012-05-17T02:18:00-CHANDRA-RAD-001	CHANDRA	instrument	2012-05-17T02:18:00Z	Elliptical	radiation event	2012/138: Chandra X-Ray Observatory (CXO) Advanced CCD Imaging Spectrometer (ACIS) instrument radiation intervention. Science observations interrupted 17 May at 02:18 UTC to 18 May 04:52 UTC (26.1 hours) by an auto event due to E1300 (hard) particle signature.
2012-07-12T19:59:00-CHANDRA-RAD-001	CHANDRA	instrument	2012-07-12T19:59:00Z	Elliptical	radiation event	2012/194: Chandra X-Ray Observatory (CXO) Advanced CCD Imaging Spectrometer (ACIS) instrument radiation intervention. Science observations interrupted 12 Jul at 19:59 UTC to 14 Jul 00:09 UTC (17.1 hours) by an auto event due to E1300 (hard) particle signature.
2012-07-14T21:08:00-CHANDRA-RAD-001	CHANDRA	instrument	2012-07-14T21:08:00Z	Elliptical	radiation event	2012/196: Chandra X-Ray Observatory (CXO) Advanced CCD Imaging Spectrometer (ACIS) instrument radiation intervention. Science observations interrupted 14 Jul at 21:08 UTC to 16 Jul 05:16 UTC (22.3

Space Environment Effect Report

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View Space Weather Activity

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Space Environment Effect Report
Activity ID: 2012-03-09T12:00:00-ISS-CHRG-001
Project/Spacecraft Name: International Space Station
System: vehicle
Orbit Type: Inclined
Effect Time (UTC): 2012-03-09T12:00:00Z
Effect Time (MLT):
Effect Type: spacecraft charging
Location Info: LON=None Entered LAT=None Entered ALT=None Entered (undefined)
Effect Duration: None Entered
Effect Magnitude: undefined
Allow Public Access: false
Description:

```
2012/069: ISS auroral frame charging observed at high southern latitudes in period 12:00 UTC to 16:30 UTC.
Maximum frame potentials ~6 to 14 V.
Kp=5.7 to 6.7 at times of significant charging.
Charging levels from ISS Floating Potential Measurement Unit.
```

Image file:FPMU summary data

Submitted on 2014-09-30T19:42Z by Joseph Minow

Edit This SE Effect Report

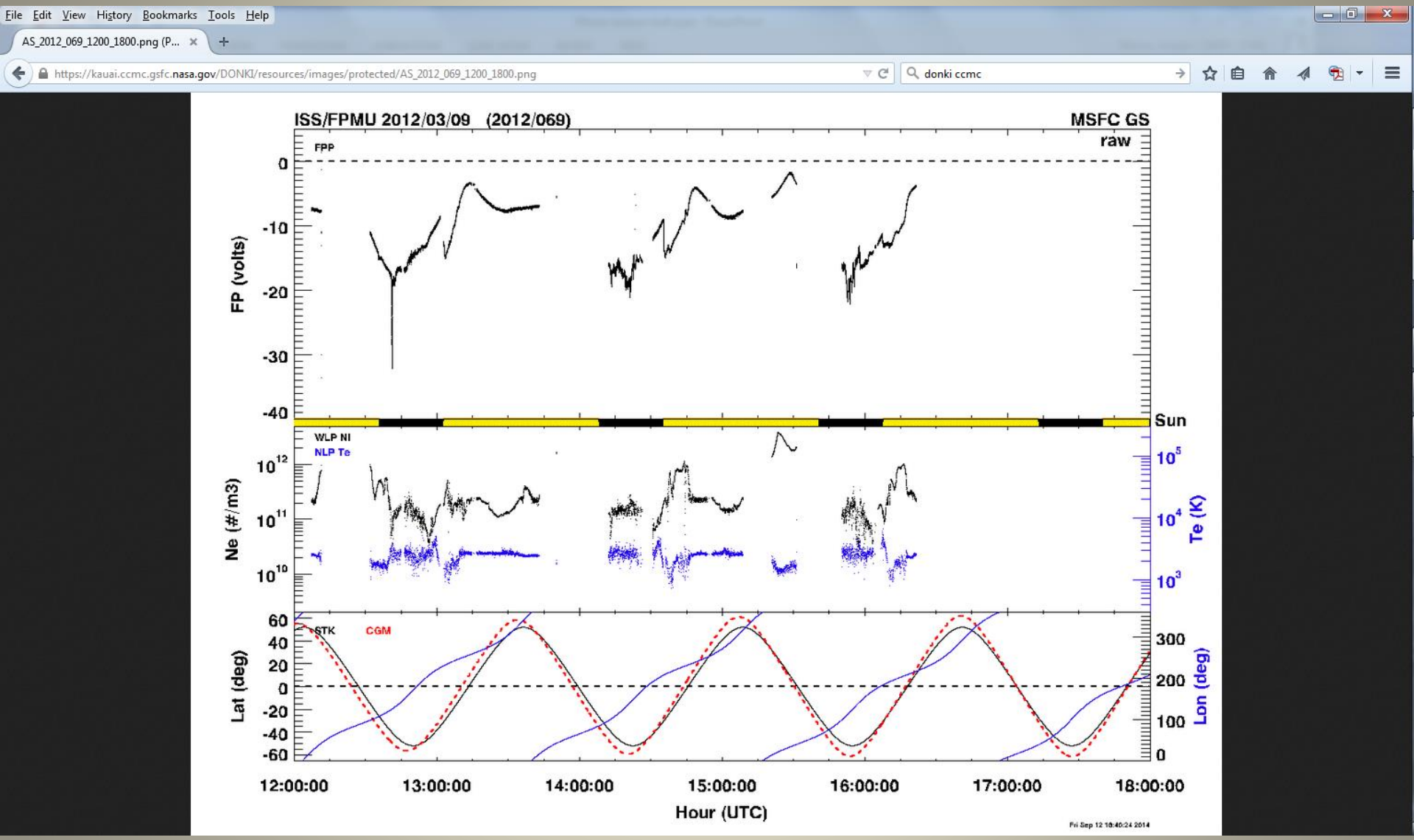
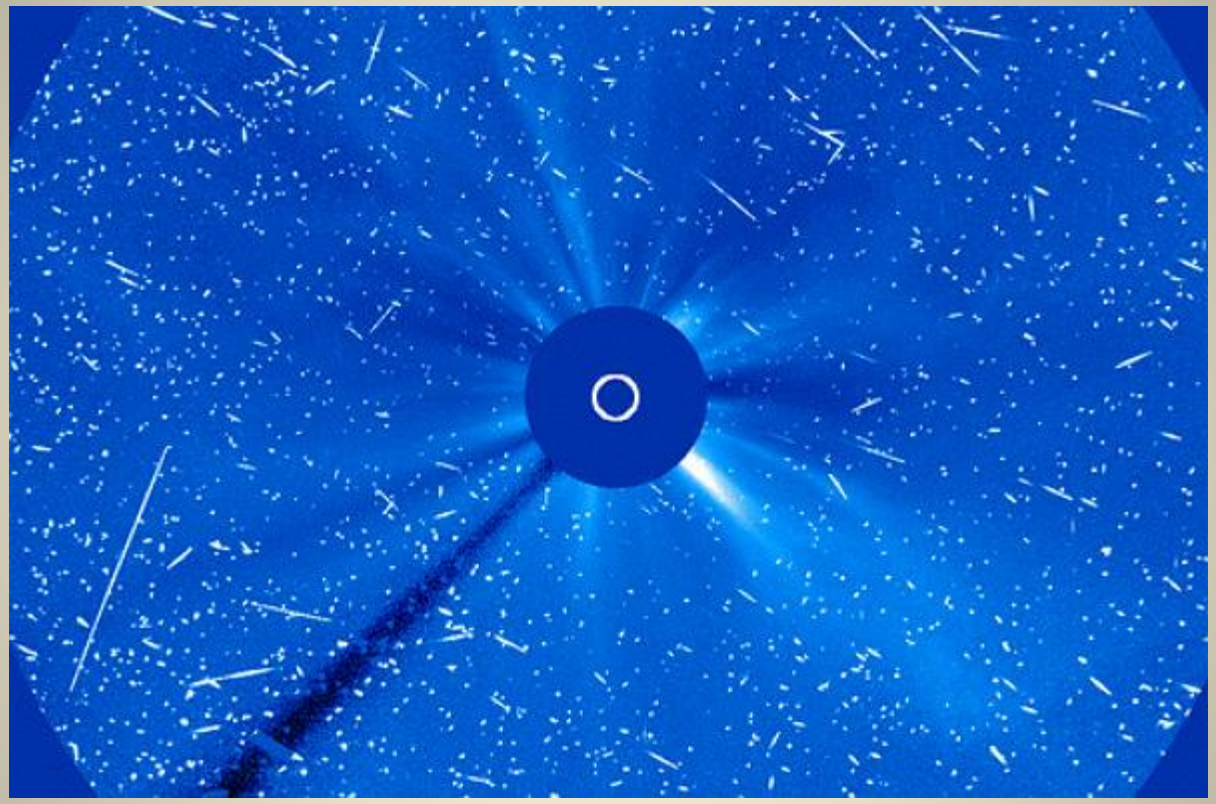
Add Related Space Weather Activity

All directly linked activities:

2012-03-09T03:00:00-GST-001 NOAA Kp: 7 (2012-03-09T06:00Z) NOAA Kp: 6 (2012-03-09T12:00Z)	DELETE

Post a Comment:

Space Environment Effect Report



Questions?