NASA Technical Fellow for Space Environments View of CCMC

Joseph Minow
NASA, Langley Research Center

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joseph.minow@nasa.gov
• 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.
  – CCMC: 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

![FPMU operation days chart]

~920 op days through 1 Sep 2014
~8.1 years on-orbit
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

joseph.i.minow@nasa.gov, CCMC Workshop, 19 Jan 2012
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.

joseph.i.minow@nasa.gov, CCMC Workshop, 19 Jan 2012
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

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

ISS engineering activity support

Space weather operations
March 2012 Geomagnetic Storm

FPMU activated based on CME alerts
9 March 2012

ISS crew imagery

\( \Phi_{s/c} \)

\( N_e \)

\( T_e \)

Lat/Lon

mlat

Hour (UTC)
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

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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

F18 Disk – 2015/100
Orbits 28229–28243

SSUSI JHU/APL

OI 1304  (blue, 4207 R max (data), 5000 R max (color scale))
OI 1356  (green, 2137 R max (data), 400 R max (color scale))
LBH short (red, 2420 R max (data), 1000 R max (color scale))
10 April 2015 Equatorial Plasma Depletions

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LBH short (red, 2420 R max (data), 1000 R max (color scale))
10 April 2015 Equatorial Plasma Depletions

ISS plasma depletion

iSWA PBMOD

PBf20150410 mjd: 57122 UT: 9.75

ISS plasma depletion

SSUSI JHU/APL

F18 Disk – 2015/100
Orbits 28229–28243
Auroral Flux Models, Charging Environments

2012-07-16

\[ f_{16} \text{ charging} \]
CCMC Ovation Prime

CCMC: Lutz Rastaettner

Model at CCMC: Ovation-Prime
iSWA Ovation Prime, ISS Charging

ISS/FPMU 2013/06/28 (2013/179)

<table>
<thead>
<tr>
<th>Lat (deg)</th>
<th>Lon (deg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>16:00:00</td>
<td>15:00:00</td>
</tr>
</tbody>
</table>

Hour (UTC)

FP (volts)

ISM: 2013/06/28 16:30:00 34.5 GW
ISM: 2013/06/28 16:05:00 46.4 GW
ISM: 2013/06/28 19:40:00 45.9 GW
CCMC DONKI

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
- Edit Personal Profile
- Change Password

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 K顾问ova

http://kauai.ccmc.gsfc.nasa.gov/DONKI/
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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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NASA Official: Maria Kuznetsova
<table>
<thead>
<tr>
<th>Activity ID</th>
<th>Project Name</th>
<th>System</th>
<th>Effect Time in UT</th>
<th>Orbit Type</th>
<th>Effect Type</th>
<th>Effect Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>2012-02-27T03:24:00-CHANDRA-RAD-001</td>
<td>CHANDRA</td>
<td>instrument</td>
<td>2012-02-27T03:24:00Z</td>
<td>Elliptical</td>
<td>radiation event</td>
<td>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.</td>
</tr>
<tr>
<td>2012-03-07T05:30:00-CHANDRA-RAD-001</td>
<td>CHANDRA</td>
<td>instrument</td>
<td>2012-03-07T05:30:00Z</td>
<td>Elliptical</td>
<td>radiation event</td>
<td>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.</td>
</tr>
<tr>
<td>2012-03-09T12:00:00-ISS-CHRG-001</td>
<td>ISS</td>
<td>vehicle</td>
<td>2012-03-09T12:00:00Z</td>
<td>Inclined</td>
<td>spacecraft charging</td>
<td>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.</td>
</tr>
<tr>
<td>2012-03-10T10:00:00-ISS-CHRG-001</td>
<td>ISS</td>
<td>vehicle</td>
<td>2012-03-10T10:00:00Z</td>
<td>Inclined</td>
<td>spacecraft charging</td>
<td>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.)</td>
</tr>
<tr>
<td>2012-05-17T02:18:00-CHANDRA-RAD-001</td>
<td>CHANDRA</td>
<td>instrument</td>
<td>2012-05-17T02:18:00Z</td>
<td>Elliptical</td>
<td>radiation event</td>
<td>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.</td>
</tr>
<tr>
<td>2012-07-12T19:59:00-CHANDRA-RAD-001</td>
<td>CHANDRA</td>
<td>instrument</td>
<td>2012-07-12T19:59:00Z</td>
<td>Elliptical</td>
<td>radiation event</td>
<td>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.</td>
</tr>
<tr>
<td>2012-07-14T21:08:00-CHANDRA-RAD-001</td>
<td>CHANDRA</td>
<td>instrument</td>
<td>2012-07-14T21:08:00Z</td>
<td>Elliptical</td>
<td>radiation event</td>
<td>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</td>
</tr>
</tbody>
</table>
Space Environment Effect Report

Activity ID: 2012-03-09T12:00:00-00:00-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 14:30 UTC. Maximum frame potentials ~6 to 14 V. Rp=5.7 to 6.7 at times of significant charging. Charging levels from ISS Floating Potential Measurement Unit.

Image file: FPMJ 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:

- 2012-03-09T03:00:00-00:00-GST-001
- NOAA Kp: 7 (2012-03-09T06:00Z)
- NOAA Kp: 6 (2012-03-09T12:00Z)
Space Environment Effect Report
Questions?