



NASA Technical Fellow for Space Environments View of CCMC

Joseph Minow

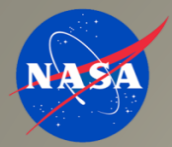
NASA, Langley Research Center

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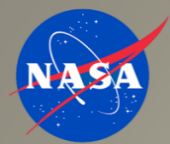


Introduction

CCMC Mission Statement

The CCMC is a multi-agency partnership to enable, support and perform the research and development for next-generation space science and space weather models.

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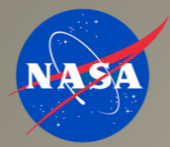


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- My comments today will focus on
 - Tech Fellow for Space Weather activities of general interest to the CCMC community
 - Space Environments TDT activities supported by the CCMC



Technical Assessment and Support Activities

- 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
- The Space Environments TDT currently has ten teams working on a variety of NESC funded space environment activities including
 - James Webb Space Telescope Space Environment Launch Constraints
 - Chandra X-Ray Observatory ACE Real-Time Solar Wind
 - ISS Plasma Interaction Model Independent Review
 - CubeSat Radiation Environments and ISS Dose Data
 - Southern Hemisphere Meteoroid Environment Measurements
 - Space Weather Architecture
 - NOVICE Support to Launch Services Program and Commercial Crew Program Radiation Assessment
 - Europa Lander Radiation Test Technical Support
 - DSCOVER Pulse Height Analyzer Data Analysis
 - Auroral Charging Threat Assessment

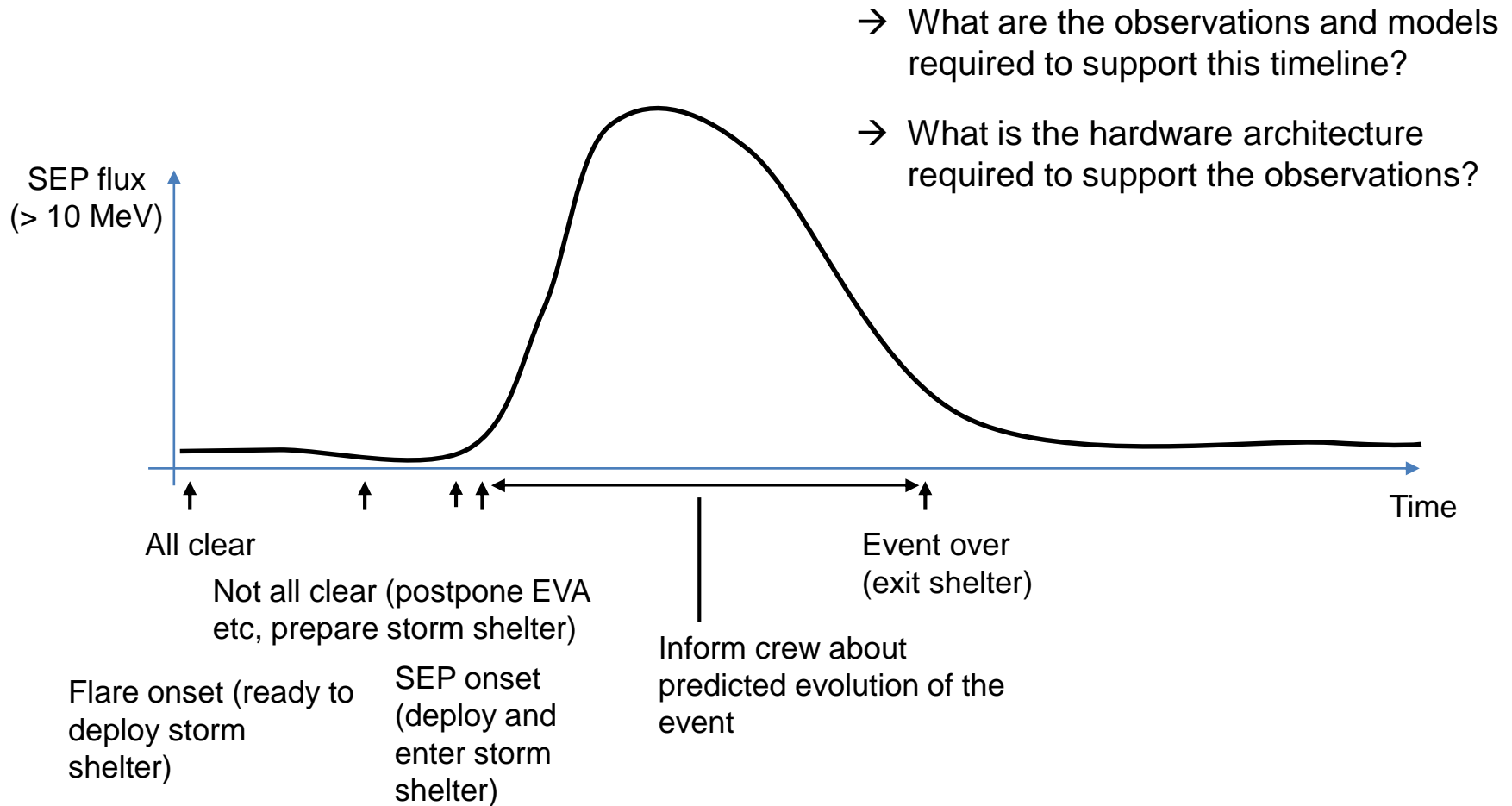
CCMC supported
activities



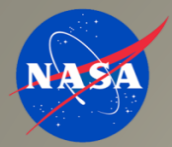
Space Weather Architecture Technical Assessment

- NESC is conducting an independent technical assessment of space environment monitoring and forecasting architecture options to support human and robotic deep space exploration
 - Antti Pulkkinen/CCMC brought the request for the study to the NESC
 - William Gerstenmaier, Associate Administrator for HEOMD serving as the primary stakeholder for the study
 - Evaluate near-real time monitoring assets, space radiation analysis tools, and forecast methods to support human exploration of the Moon and Mars
 - FY18 activity with final report due to NESC and stakeholder by the end of the fiscal year
- Assessment organized into six interconnect tasks:
 - Review of historical reports and documentation relevant to space weather monitoring
 - Assessment of operational response time for space weather monitoring
 - Review of relevant forecasting tools
 - Assessment of solar energetic particle operational alert threshold levels for exploration missions
 - Develop of space weather architectures
 - Space weather architecture cost estimates
- Team includes personnel from
 - NASA Centers (GSFC, JPL, JSC, LaRC, MSFC) and HQ
 - NOAA Space Weather Prediction Center
 - Air Force Research Laboratory

Con ops timeline

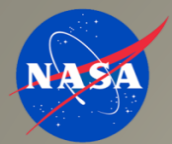


[adapted from A. Pulkkinen's presentation to the Deep Space Gateway Concept Science Workshop, 2018]



NASA Program Support

- CCMC provides both mission science and space weather support through its Runs on Request service, and also through real-time runs and data viewable via webpages and the integrated Space Weather Analysis system ([iSWA](#), [iSWA catalog description](#), [API access](#)).
- CCMC also provides a [searchable database \(DONKI\)](#), [API access](#) of space weather events, simulations, and notifications.
- NASA and international mission support
 - **Geocentric missions:** RHESSI, IRIS, ISS, CALIPSO, Terra, AURA, AQUA, TRMM, FASTSAT, EOS, SDO, Chandra, MMS, Van Allen Probes, THEMIS
 - **Near-Earth missions:** ACE, SOHO, Wind, JWST
 - **Heliospheric missions:** MESSENGER, STEREO, Spitzer Space Telescope, MAVEN, MSL, Dawn, Kepler, EPOXI, Juno, CASSINI, New Horizons, Voyager
 - **Sounding rockets:** Grand Challenge Sounding Rocket Campaign, STORM, VISIONS, VISIONS-2
 - **International:** SOTERIA, Venus

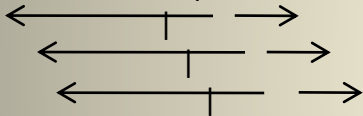


CCMC Real-time Ionosphere Ne, Te for ISS

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

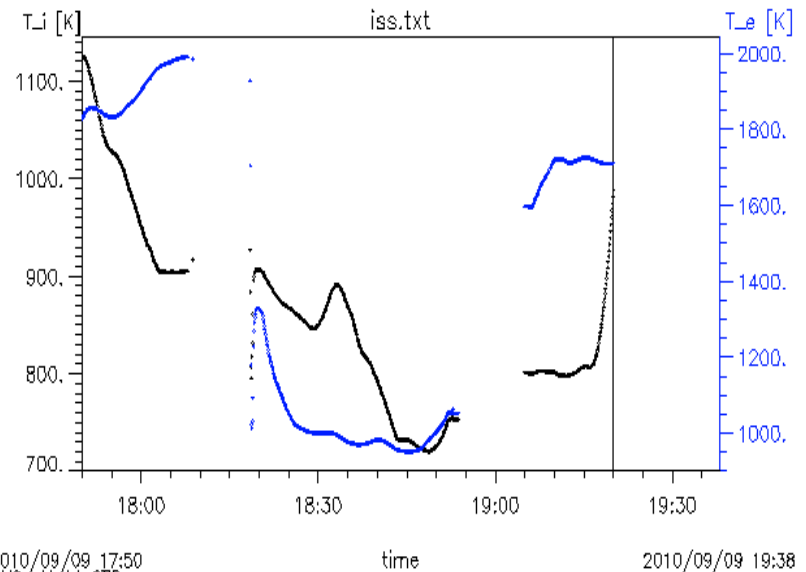
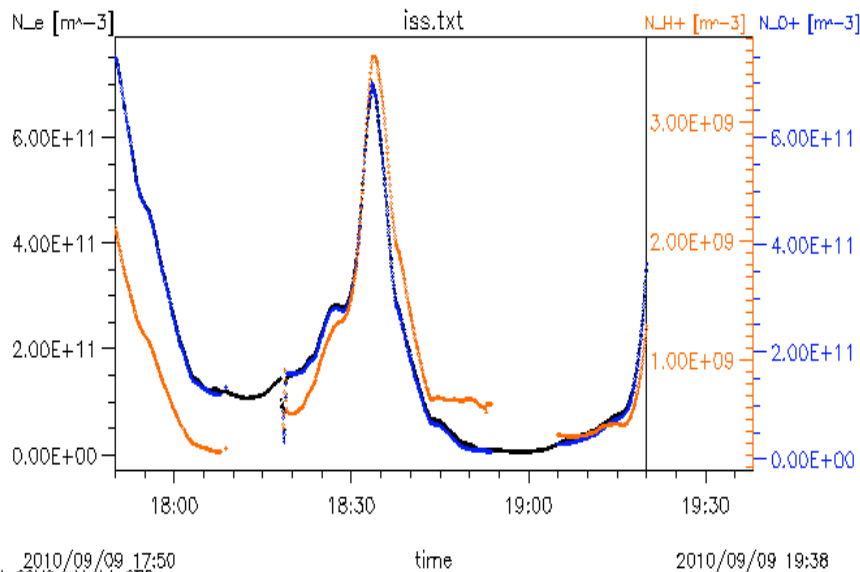
-70 min from file epoch to +20 min

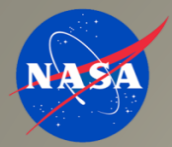


```

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 Ne 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.

```





ISS EVA Space Weather Support

- ISS FPMU measurements of Ne, Te obtained days to weeks in advance of an EVA are used for an assessment of spacecraft charging risks to crew during EVA assuming persistence of conditions
- Space weather is monitored for Earth directed fast CME's and high speed solar wind conditions that may invalidate the persistence of condition 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 on a reliable basis

```
## 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

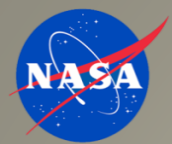
C-type: Common 500-999 km/s

O-type: Occasional 1000-1999 km/s

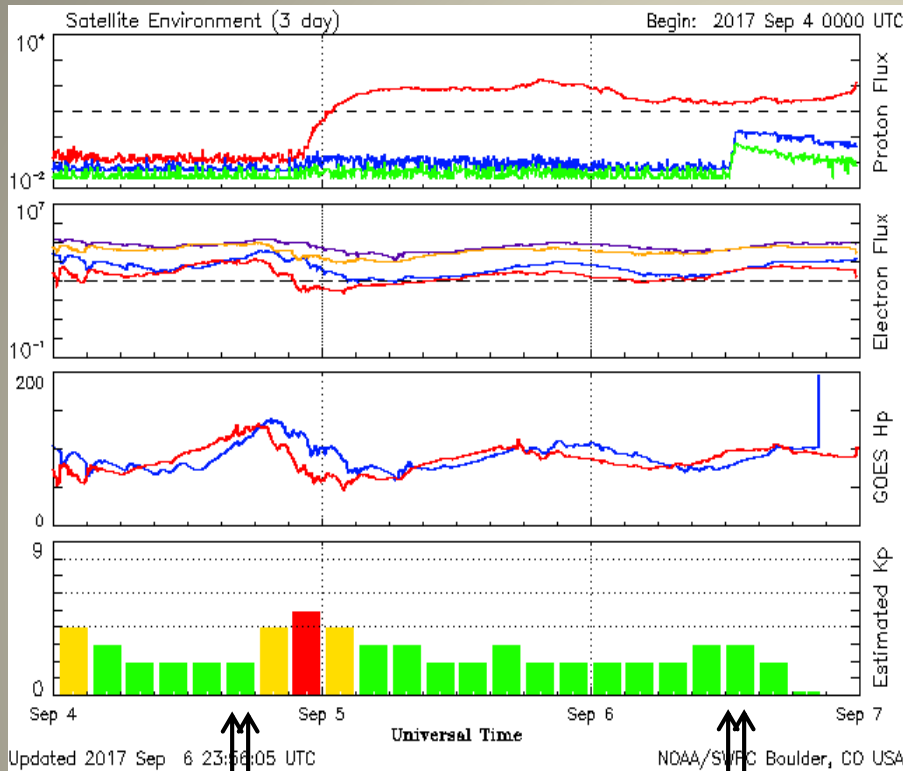
R-type: Rare 2000-2999 km/s

ER-type: Extremely Rare >3000 km/s

<http://swrc.gsfc.nasa.gov/main/score>

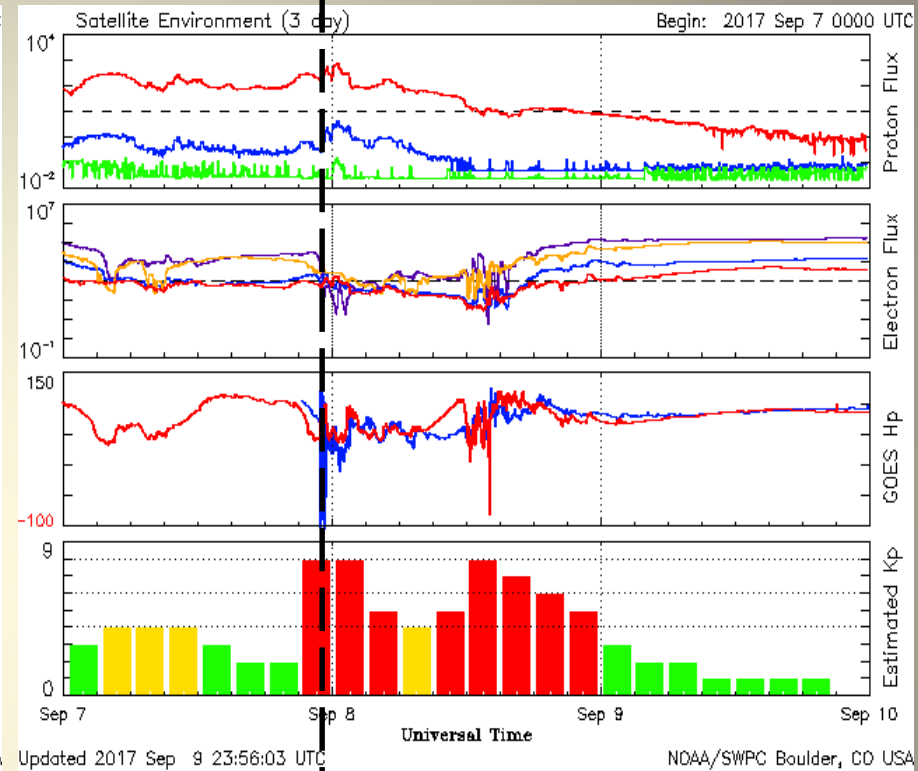


September 2017 Geomagnetic Storm



CMEs ~710 km/s, ~1114 km/s
 Start 19:39 UT, 20:36 UT

CME ~1238 km/s, ~1178 km/s
 Start 12:24 UT, 13:09 UT



CME impact 23:04 UT

- ISS FPMU downlink started 5 September at 18:28 with requests to operating into mid-September based on CCMC CME alerts
- FPMU data used for investigation of ionosphere response to geomagnetic storms and auroral charging of ISS



Questions?

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