

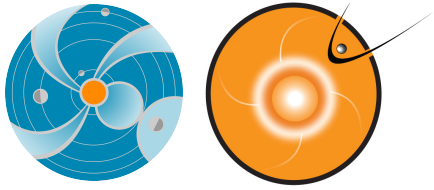
CCMC and SWRC space weather forecasting services for NASA robotic mission operators

Pulkkinen, A.

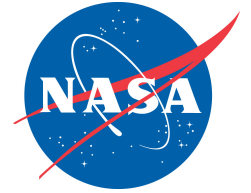
(antti.a.pulkkinen@nasa.gov), M.



Kuznetsova, Y. Zheng and M. Maddox

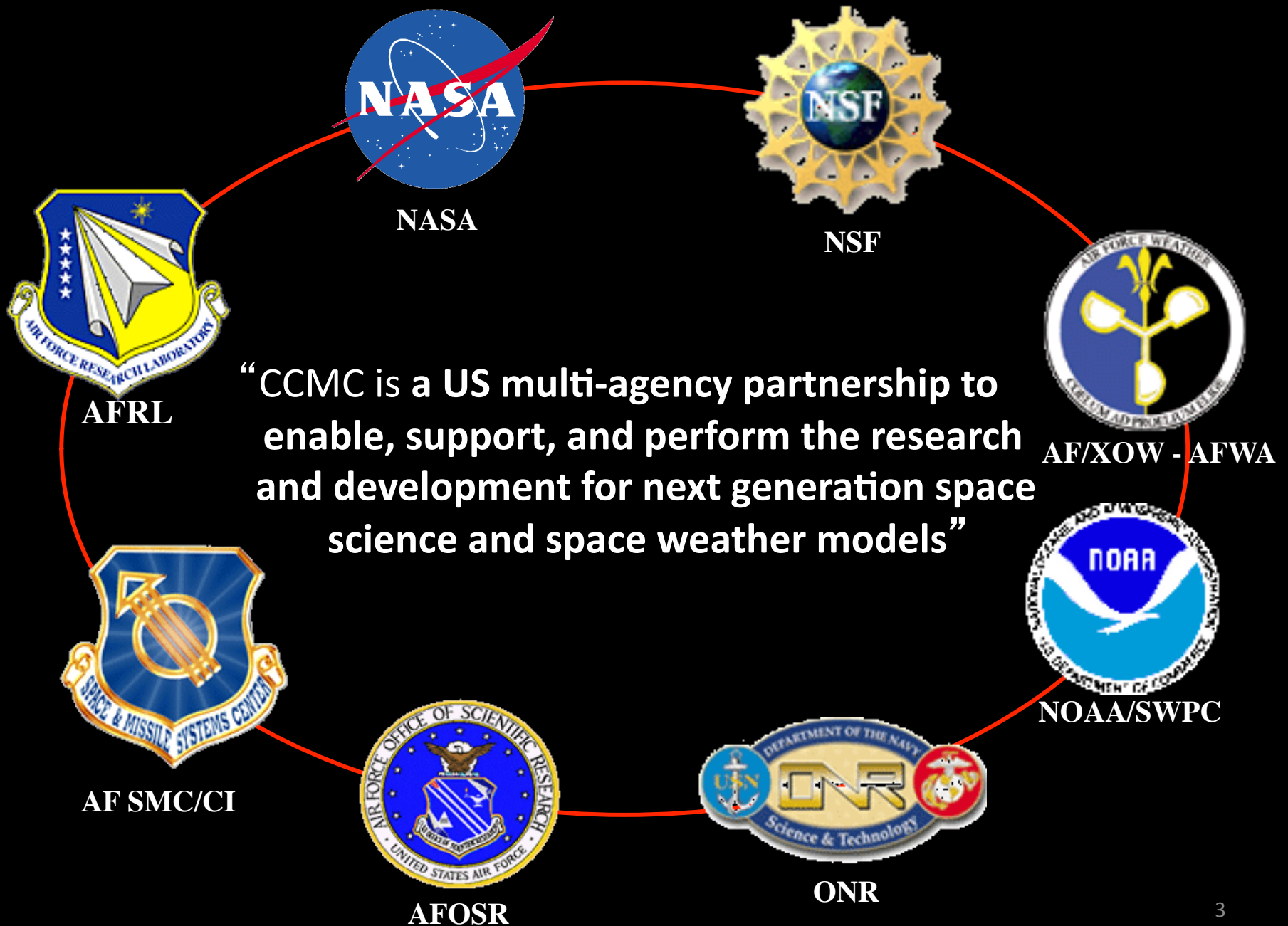
NASA Goddard Space Flight Center

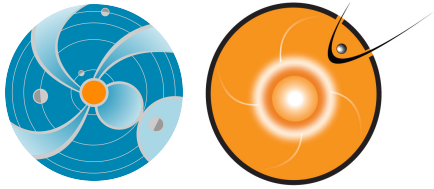


Activities behind the acronyms

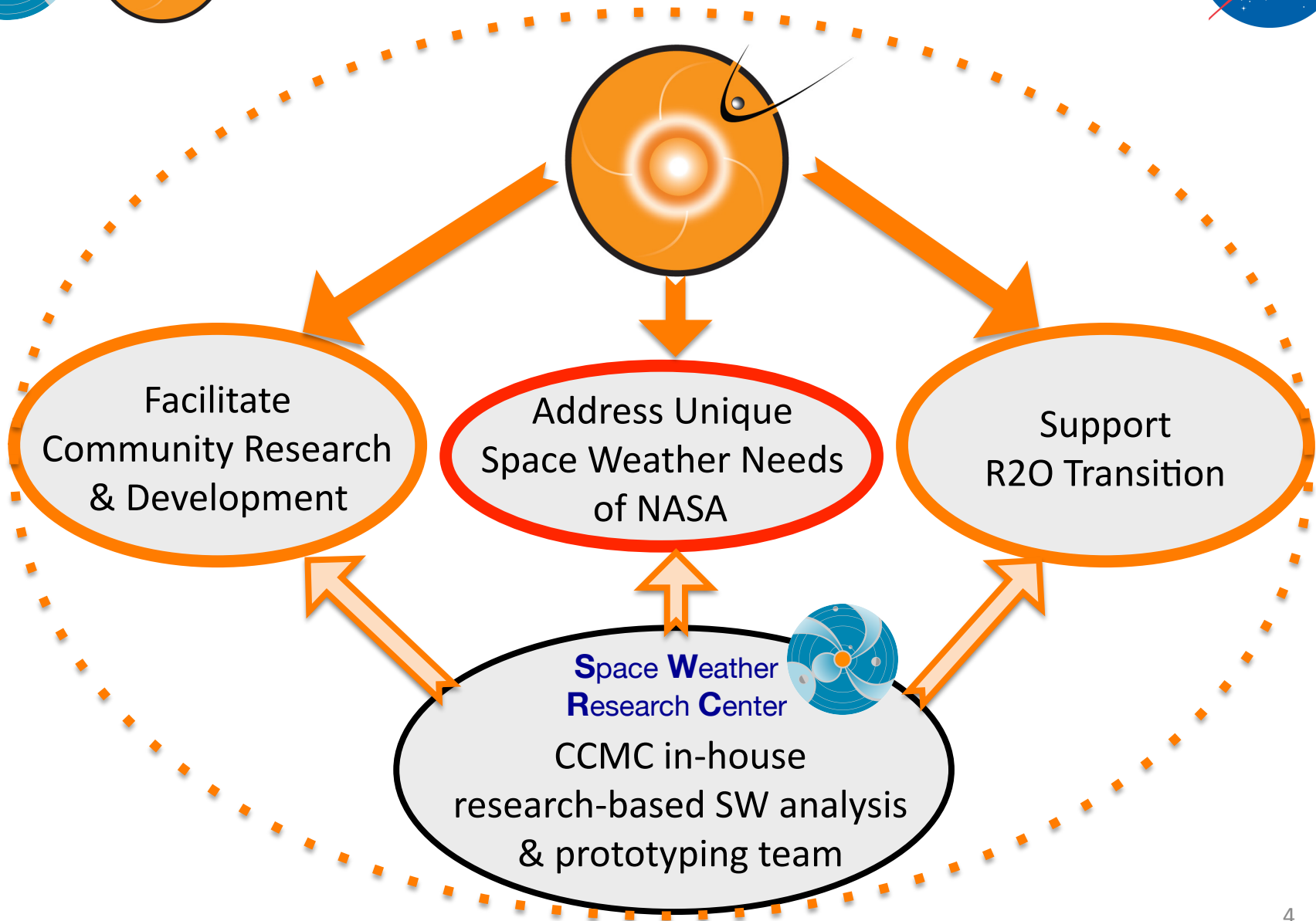
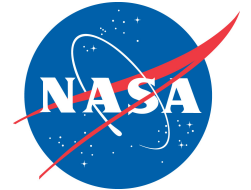


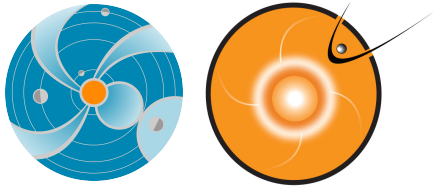
-  CCMC = Community Coordinated Modeling Center (<http://ccmc.gsfc.nasa.gov>)
-  SWRC = Space Weather Research Center (<http://swrc.gsfc.nasa.gov>)



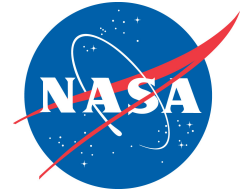


CCMC-SWRC relationship

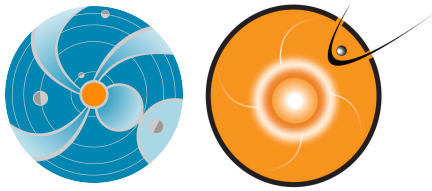




SWRC mission



“Addressing the space weather needs of NASA's robotic missions through experimental research forecasts, notification, analysis, and education. Bringing space weather knowledge to the public.”



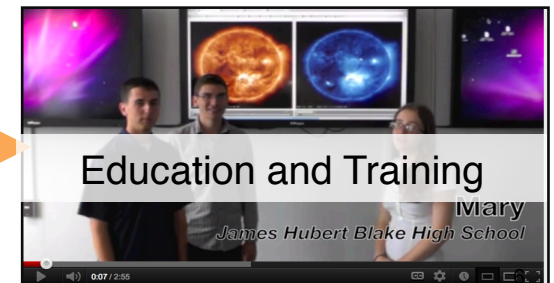
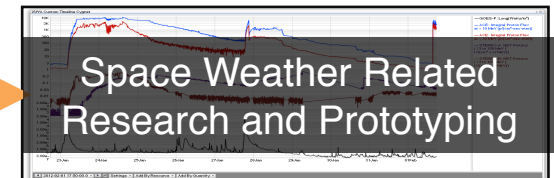
SWRC Concept of Operations

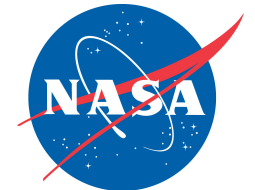
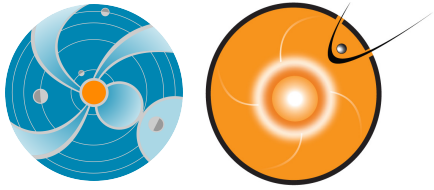


Partnering



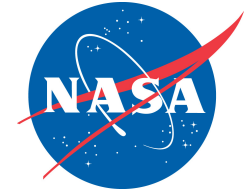
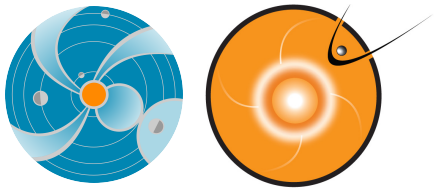
Notifications
Weekly Reports
Anomaly Analysis Support
Workshops
n Scientists





SWRC's NASA role

- Solar-system-wide space weather services for NASA missions = a unique need SWRC addresses
- Prototyping of new real-time models and analysis tools such as iSWA = a key element of R2O
- Space weather training for a broad spectrum of students and NASA personnel
 - Hands on real-time analysis is an important part of training.
- Building of space weather knowledge base for scientific discovery and anomaly resolution



Key services to NASA robotic missions

- Daily service to all NASA missions/centers
 - Real-time space weather analysis
 - Notifications
 - Weekly reports
- Since March 2010
 - 600+ forecaster generated notifications
 - 200+ weekly reports issued
- 3000+ individual entries into the DONKI space weather database since March 2010.

NASA Goddard Space Flight Center, Space Weather Research Center (SWRC)

- Message Type: Space Weather Alert - SEP
- Message Issue Date: 2013-08-21T13:07:00Z
- Message ID: 20130821-AL-001

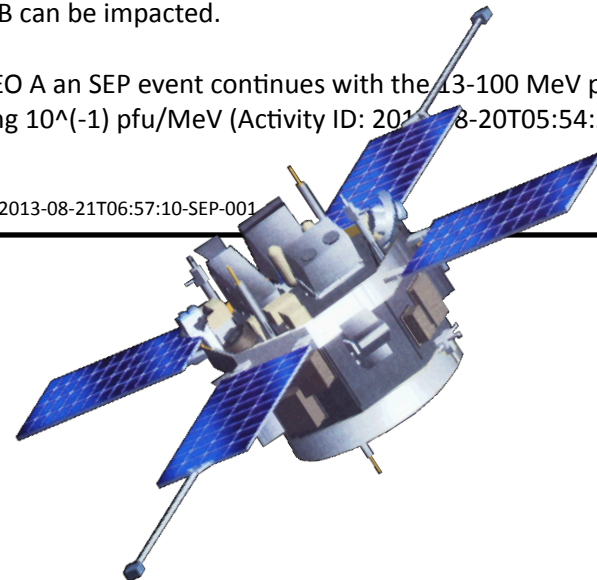
Summary:

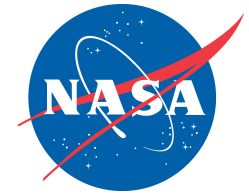
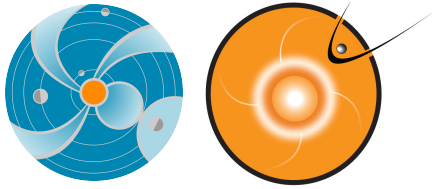
- Solar energetic particle event detected by STEREO B.
- The flux of 13-100 MeV protons exceeds 10^{-1} pfu/MeV starting at 2013-08-21T06:57Z.

STEREO B can be impacted.

At STEREO A an SEP event continues with the 13-100 MeV protons flux exceeding 10^{-1} pfu/MeV (Activity ID: 2013-08-20T05:54:24-SEP-001).

Activity ID: 2013-08-21T06:57:10-SEP-001





Key services to NASA robotic missions

- Spacecraft anomaly analysis support
 - Supported missions such as Dawn, EO-1, GALEX, MRO, SWIFT, IBEX, Kepler, SOHO and Fermi.
 - Quick and cost-effective assessment of space weather's role in the anomalies.

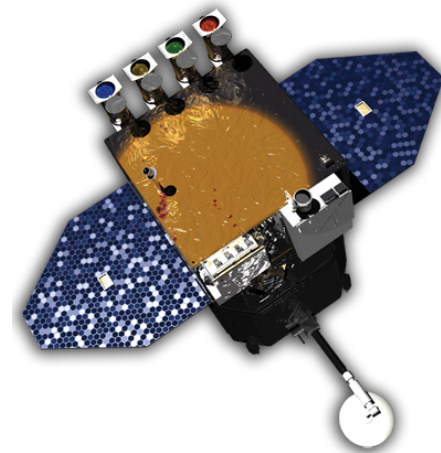
NASA Goddard Space Flight Center, Space Weather Research Center (SWRC)

- Message Type: SWRC response to S/C anomaly request.
- Message Issue Date: 2010-11-30T20:10:00Z.
- Message ID: 20101130-RE-001

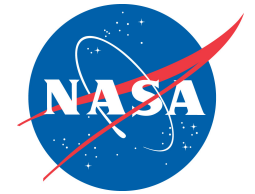
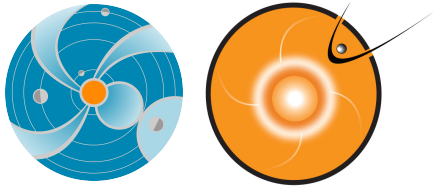
Summary.

- Impacted spacecraft: Fermi.
- Anomaly date and time:
- Association with space weather event (YES/POSSIBLE/NO):
POSSIBLE.

Supporting data:



- Conducted annual NASA Robotic Mission Ops & Space Weather Workshops since 2009
 - Facilitated agency-wide education about space weather and its impacts.
 - Allowed exchange of information between operators and tailoring of space weather services to meet the NASA robotic fleet needs.

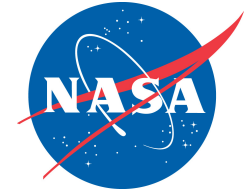
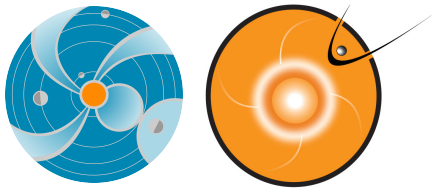


Key services to NASA robotic missions

- Space Weather Research, Education and Development Initiative (REDI) summer bootcamps 2013-2015.

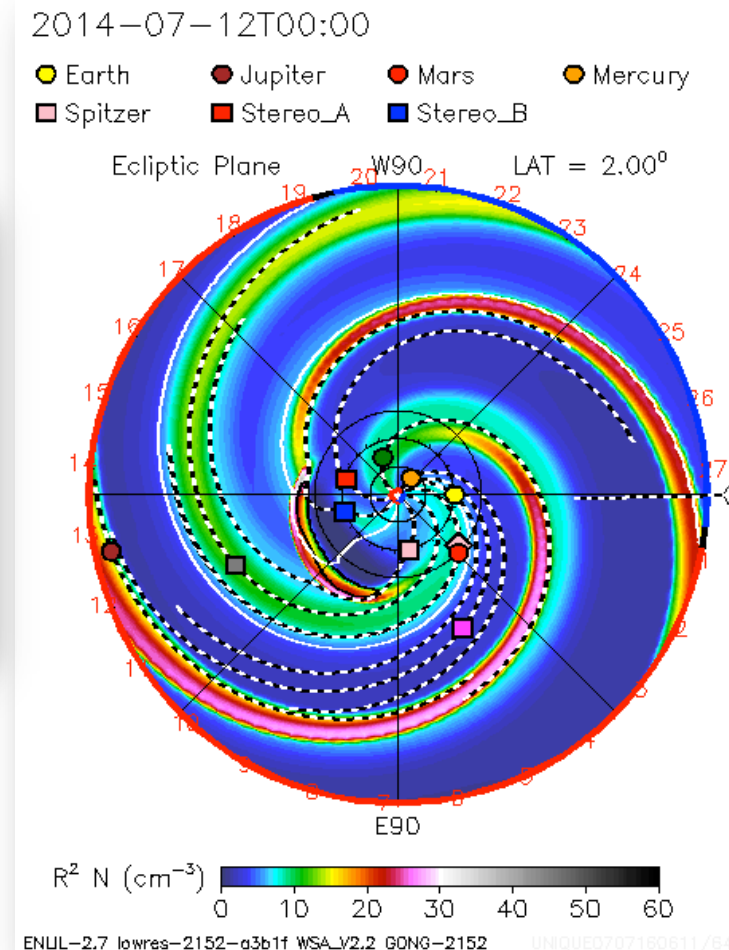
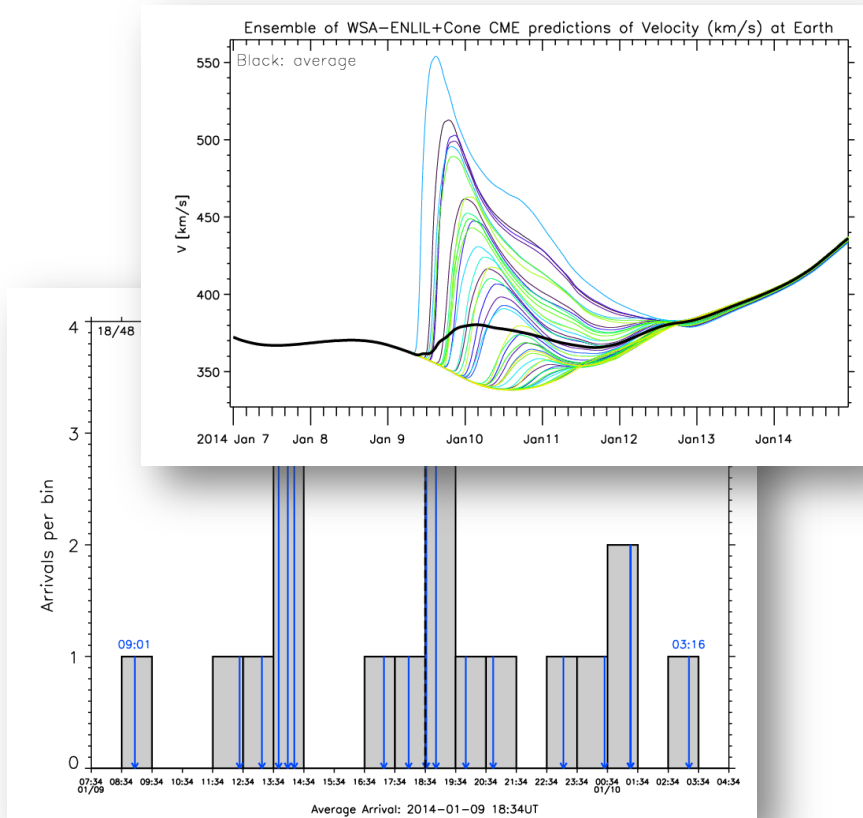


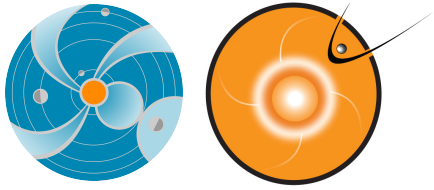
SW REDI
bootcamp 2015



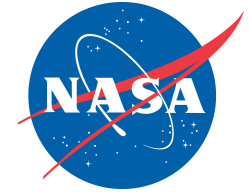
Examples of unique space weather products

- Ensemble CME modeling product.
- 5.5 AU CME products.



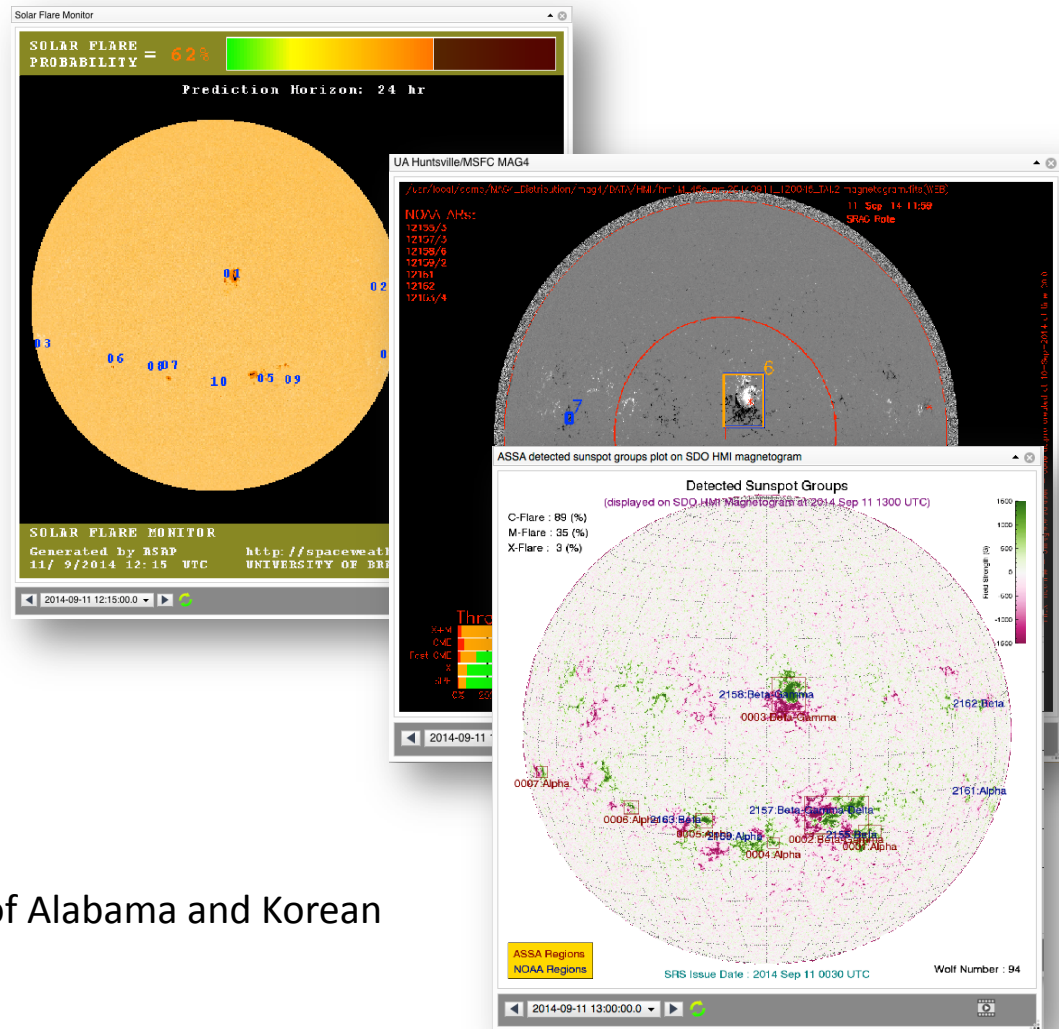


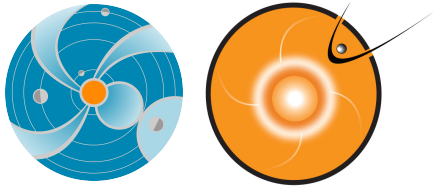
Examples of unique space weather products



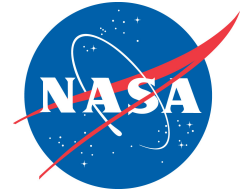
- A group of international flare models hosted at CCMC: ASAP, MAG4 and ASSA*.
- These model displays are available via iSWA.
- CCMC/SWRC is in the process of investigating how information from the models can be turned into a prototype ensemble flare product.

*by University of Bradford, University of Alabama and Korean Space Weather Center, respectively.



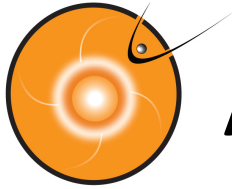
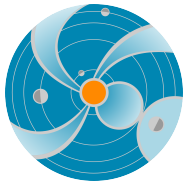


Examples of benefits beyond NASA

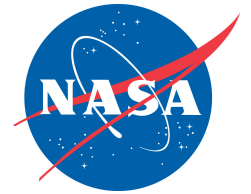


- CCMC/SWRC real-time analyses allow:
 - Space weather tool testing for the benefit of the entire community
 - Generation of public information into databases (DONKI and Space Weather Scoreboard)
- Large number of real-time WSA-Enlil simulation results submitted to US Air Force Weather Agency, per their requests.
- International real-time analysis partnering. Close collaboration, for example, with Technical University of Denmark.





Additional information and resources



- Space Weather REDI: <http://ccmc.gsfc.nasa.gov/support/SWREDI/swredi.php>
- DONKI space weather database: <https://kauai.ccmc.gsfc.nasa.gov/DONKI>
- Integrated Space Weather Analysis System (iSWA): <http://iswa.gsfc.nasa.gov>
- Space Weather Scoreboard: <https://kauai.ccmc.gsfc.nasa.gov/SWScoreBoard>