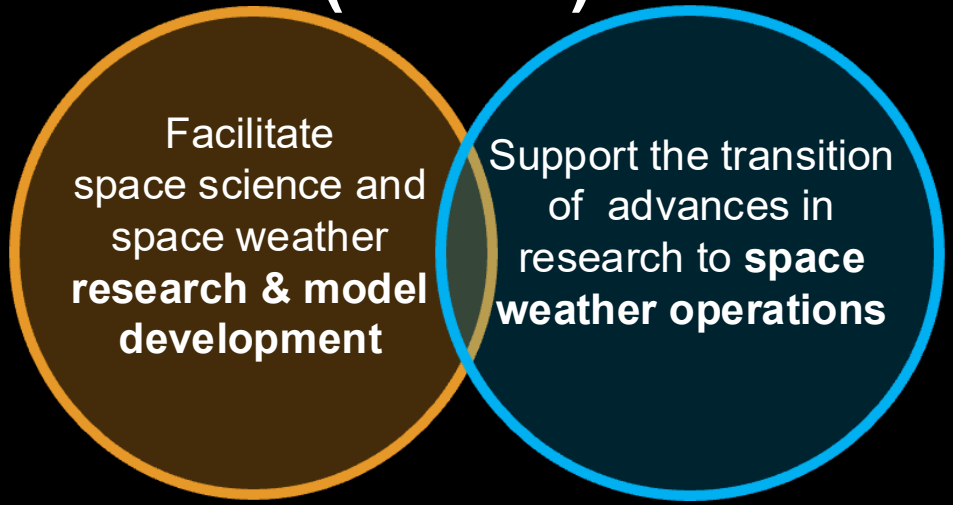
NASA GSFC & JSC Space Weather
Expertise & Resources

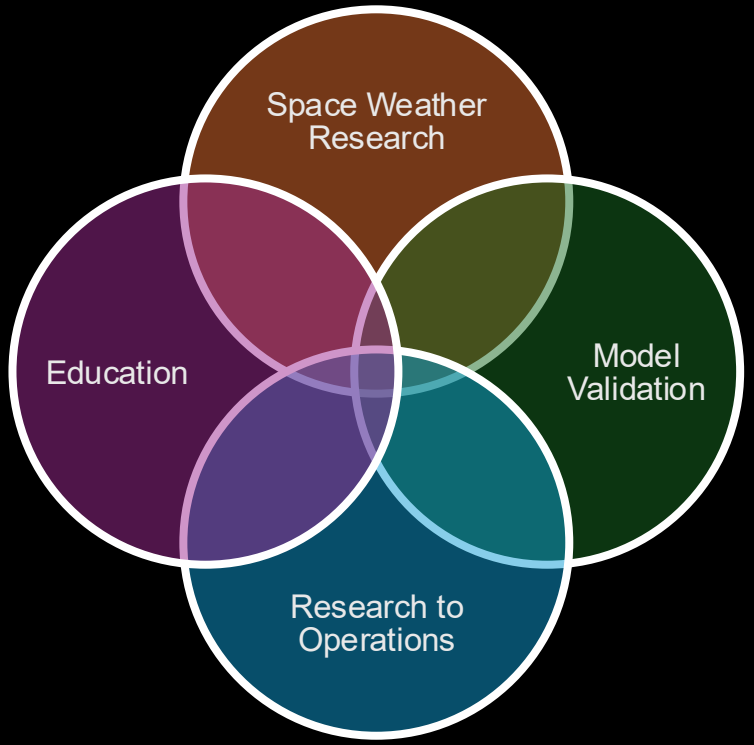
Elana Resnick
Carina Alden

Community Coordinated Modeling Center (CCMC)



Multi-agency strategic investment in US space weather program

Community Coordinated Modeling Center (CCMC)



Free access to space science research models via automated model run system, online visualization & analysis tools.

Test and evaluate models as an unbiased agent against standard metrics, through event studies and real-time calculations, in direct support of science users.

Support space weather forecasters through transitioning of research models to operations, model evaluation, and provisioning of forecasting tools.

Guide student researchers, create simulation and visualization resources for classrooms and summer schools, and host and train software interns.

Space Weather Models at the CCMC

Corona

- SWMF.SC+EEGGL+CME
- AWSoM
- EEGGL
- SRPM
- PFSS.Petrie
- ANMHD
- PFSS.Macneice
- SEPMOD
- PFSS.Luhmann
- SEPTSTER
- MAG4 UMASEP
- ASAP
- ASSA
- AMOS
- WSA
- NLFFF
- RELeSE
- MAGIC
- SNB3GEO
- GCR
- BON
- NOVICE

Heliosphere

- WSA-ENLIL
- WSA-ENLIL+Cone
- WSA-ENLIL+EPREM
- WSA-ENLIL+SEPMOD
- REleASE
- PREDDICS EMMREM
- CORHEL-CME
- CORHEL
- iPATH
- Heltomo SMEI
- Heltome IPS
- MAG4
- DBM
- SWMF-AWSoM
- DIPS

Magnetosphere

- GAMERA-RCM-REMIX
- OpenGGCM+CTIM
- SWMF+RCM
- SWMF+RCM+RBE
- SWMF+RCM+CRCM
- WINDMI
- LANLstar
- LFM-MIX-TIEGCM
- GRF
- Tsyganenko
- PS VP
- AACGM
- GUMICS
- Apex
- Weigel-deltaB
- GIC

Inner Magnetosphere

- RCM
- Fok.CIMI
- Li Rad Belt
- UPOS RB
- VERB
- AE-8/AP-8
- AE-9/AP-9
- SEAES-SP
- NAIRAS

Local Physics

- VPIC
- PAMHD
- PIC-Hesse

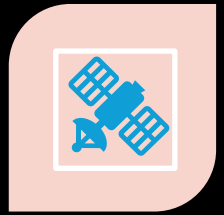
Ionosphere/ Thermosphere

- TIEGCM-X
- SAMI3
- SAMI3-TIEGCM
- GMAT
- GEODYN
- USA-GAIM
- SAM
- SWACI-TEC
- NRLMSISE
- Weimer IE
- Weimer-deltaB
- CTIPe
- GITM
- ABBYNormal
- PBMOD
- JB2008
- IRI-2020
- WACCM-X
- COSGROVE-PF
- Ovation Prime

Moon to Mars Space Weather Analysis Office (M2M SWAO)

SERVE AS A NASA PROVING GROUND

PROVIDE REAL-TIME SPACE WEATHER MONITORING



SUPPORT NASA ROBOTIC MISSIONS

SUPPORT HUMAN SPACEFLIGHT ACTIVITIES

NASA's strategic in-house R2O2R pipeline:

SERVE AS A NASA PROVING GROUND

Scientific Community

R2O Supporting Model Validation

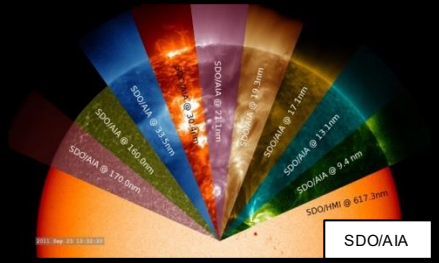
Cataloguing Events **O2R**

Operational Community

M2M SWAO Operational Activities

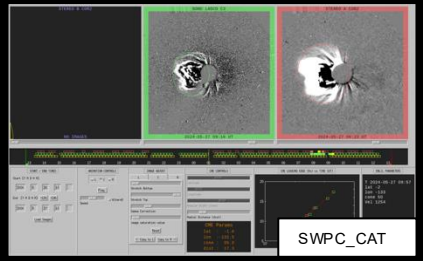
PROVIDE REAL-TIME SPACE WEATHER MONITORING

OBSERVATIONS



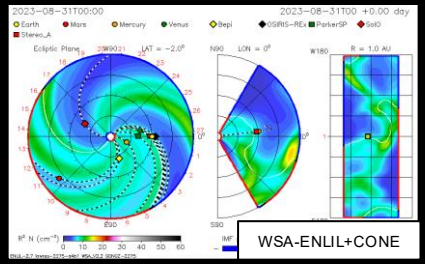
SDO/AIA

ANALYSIS



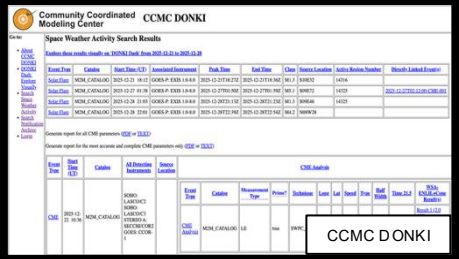
SWPC_CAT

MODELING



WSA-ENLIL+CONE

DOCUMENTATION



CCMC DONKI

M2M SWAO Robotic Missions Support

SUPPORT
NASA ROBOTIC MISSIONS

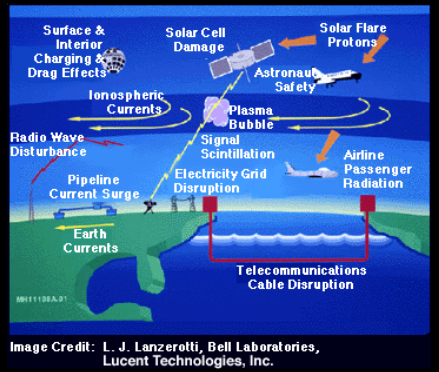
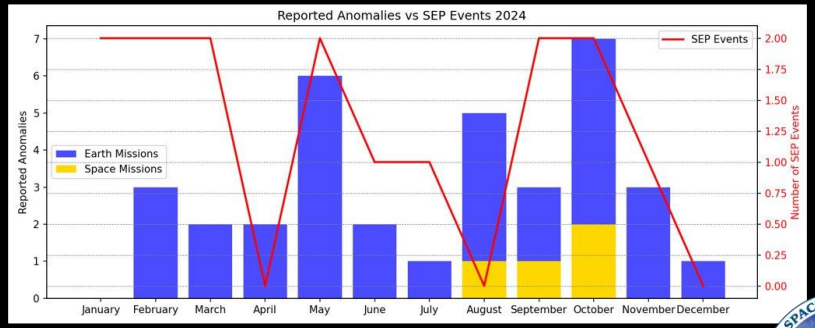


Image Credit: L. J. Lanzerotti, Bell Laboratories, Lucent Technologies, Inc.



M2M SWAO Human Spaceflight Support

SUPPORT HUMAN SPACEFLIGHT ACTIVITIES

International Space Station

Artemis Program

Space Radiation Analysis Group (SRAG)

How Does SRAG Protect the Crew?

- ***Mission Control support***
- ***Space weather modeling***
- Vehicle design
- In-situ radiation monitoring
- Individual astronaut cancer risk assessment
- Crew / team training

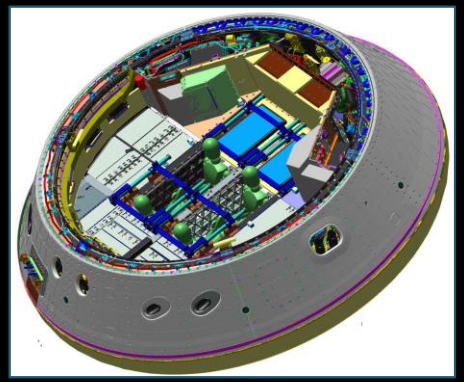
Space Radiation Analysis Group (SRAG)

Preparation of Radiation Console for Artemis-II

SRAG will provide 24/7 mission Artemis support concurrent with ISS support

SRAG preparation

- Concept of Operations
- Training Plan
- Mission simulation support
- Tool development
  - Acute Radiation Risk Tool
  - **Model Scoreboards (ISEP)**



Orion vehicle, mass stowed along the periphery in preliminary shelter concept. SRAG has updated concept to allow crew to move around the cabin during a contingency.

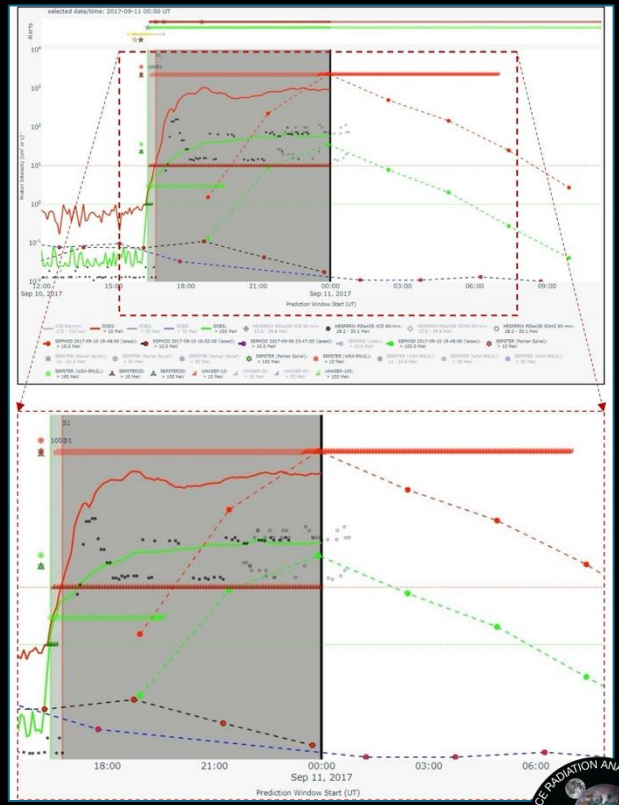
Flight Control Team support

- Product Development
  - Flight Rules
  - Crew/ground procedures
- Nominal task support
  - HERA (area radiation monitor)
  - CAD (crew radiation monitor)
  - Radiation Shelter
- Contingency task support
  - Radiation Shelter

ISEP: Space Weather Model Scoreboards

- ISEP collaboration
  - Multi-center, international
  - Transition SPE models from research to operations
- Improve SPE modeling to answer
  - Will an event occur?
    - Event Probability
    - All-Clear
  - How ‘bad’ will the event be?
    - Event Intensity - Peak Proton Flux
  - How long will the event last?
    - Event Intensity – Flux Time Series
- **Situational Awareness for real-time decision making**

Intensity Scoreboard compiling historical projections for Sept 2017 SPE



Space Radiation Analysis Group (SRAG)

SRAG Contacts:

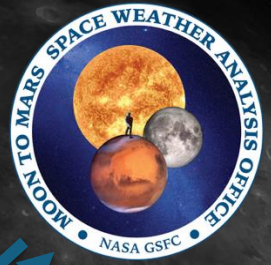
Eddie Semones: edward.j.semones@nasa.gov
Janet Barzilla: janet.barzilla@nasa.gov

Space Weather Teamwork Across Agencies During Artemis II

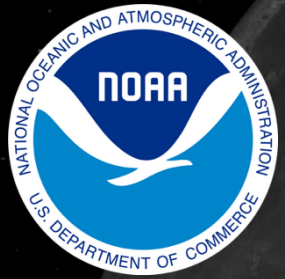
Model Developers at Research Institutions

SRAG, CCMC, M2M, SWPC points of contact

- Space Radiation operations
- Expert end users
- Validation
- Model development



- Human-in-the-loop expertise
- Providing, monitoring and evaluating CME inputs for SEP Scoreboard models
- Space weather monitoring, prototyping, and analyses



- Primary Support for SRAG
- Operational Support for the Nation
- Testbed & R2O2R

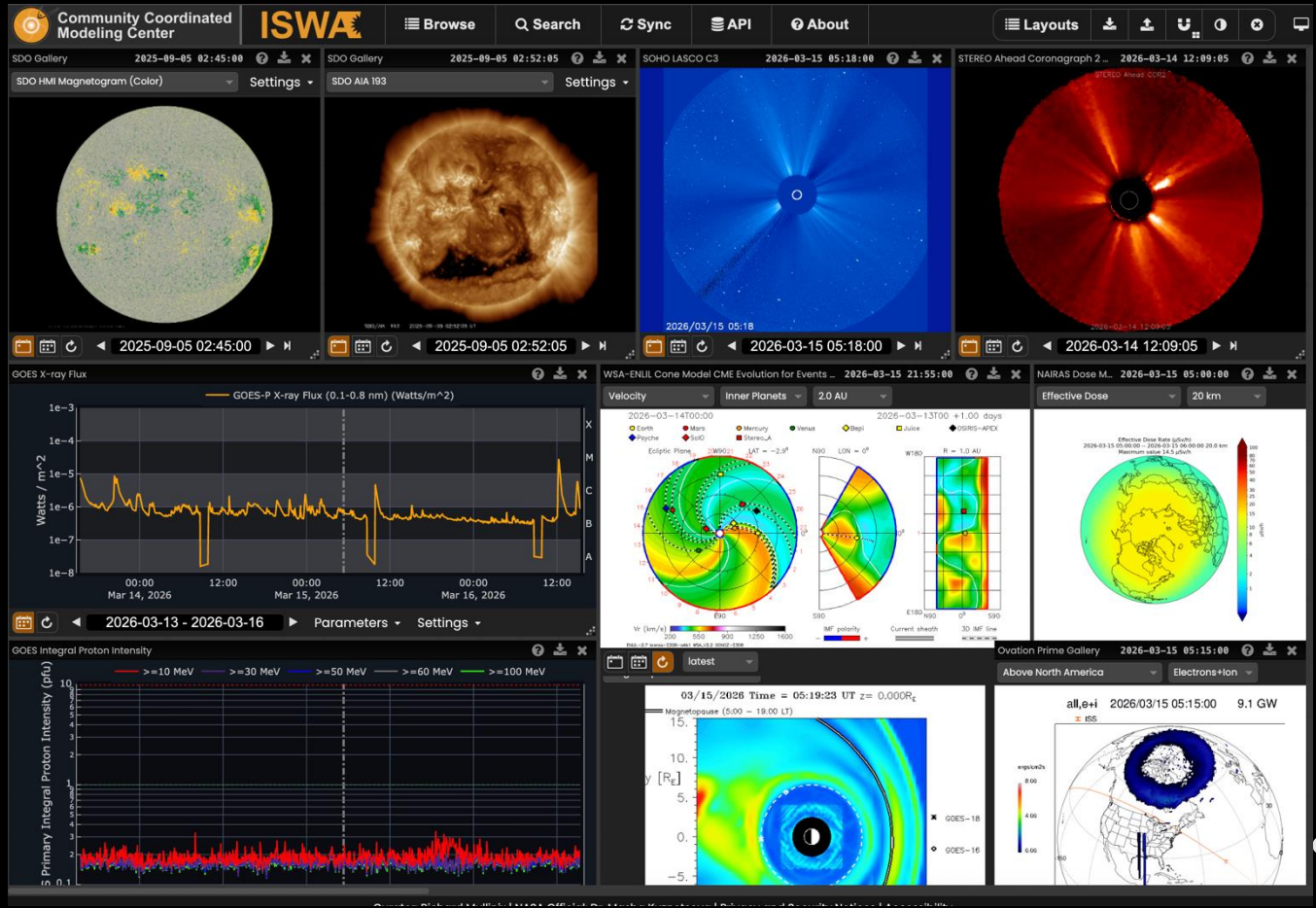
- Development of the SEP Scoreboards
- Onboarding and hosting models
- Technical expertise
- Model expertise
- Infrastructure

OpenSpace

Credit: Based on original Slide by Katie Whitman

ISWA Demo

bit.ly/CCMCISWA



CME Scoreboard

- Captures CME arrival time, error bar, confidence in arrival (hit likelihood), and peak geomagnetic storm strength (Kp/Dst).
- Inspired many retrospective publications of "problem" forecasts and workshop session discussions
- Forecast validation by Riley et al. (2018), updated by Kay et al. (2024)
- NEW: API Now Available
- Coming soon: JSON schema for automated submission/better metadata – coordinating with UK MetOffice and Royal Observatory of Belgium
- Related scoreboards in development: Geomagnetic Storm Scoreboard Solar Wind Scoreboard, Solar Indices Scoreboard
  - Mars CME Arrival Time Scoreboard: we invite the research and operational community to extend their Earth forecast methods to create a new forecast for Mars.

CME Scoreboard

CME: 2024-05-09T09:24:00-CME-001

Actual Shock Arrival Time: 2024-05-11T09:30Z

Observed Geomagnetic Storm Parameters:
Max Kp: 9.0
Dst min. in nT: -412
Dst min. time: 2024-05-12T12:00Z
CME Note: [IN REVIEW] Halo CME visible in SOHO LASCO C2, C3, and STEREO A COR2 imagery. This halo is associated with the X2.2 class flare from AR13664 peaking at 2024-05-09T09:13Z. A clear EUV wave is visible in SDO/AIA 193 and 211 crossing towards the central meridian and towards the limb in the southwest. Post-eruptive arcades are present in SDO/AIA 193 and 131. Brightening is visible in SDO/AIA 304. Possible arrival signature is characterized by an initial sheath/compression of magnetic field components with Btotal reaching a maximum of 28nT. A subsequent increase in solar wind speed was observed from 643 km/s at 09:32Z to 900 km/s at 11:25Z. An increase in density was observed from ~2 N/cm^3 at 09:01Z to ~26 N/cm^3 at 09:22Z, with temperature exhibiting a sharp increase starting around 09:50Z. Due to the high solar wind speed observed with this arrival, it is possible this signature is associated with the arrival of CME: 2024-05-08T22:24Z and/or CME: 2024-05-09T09:24Z.

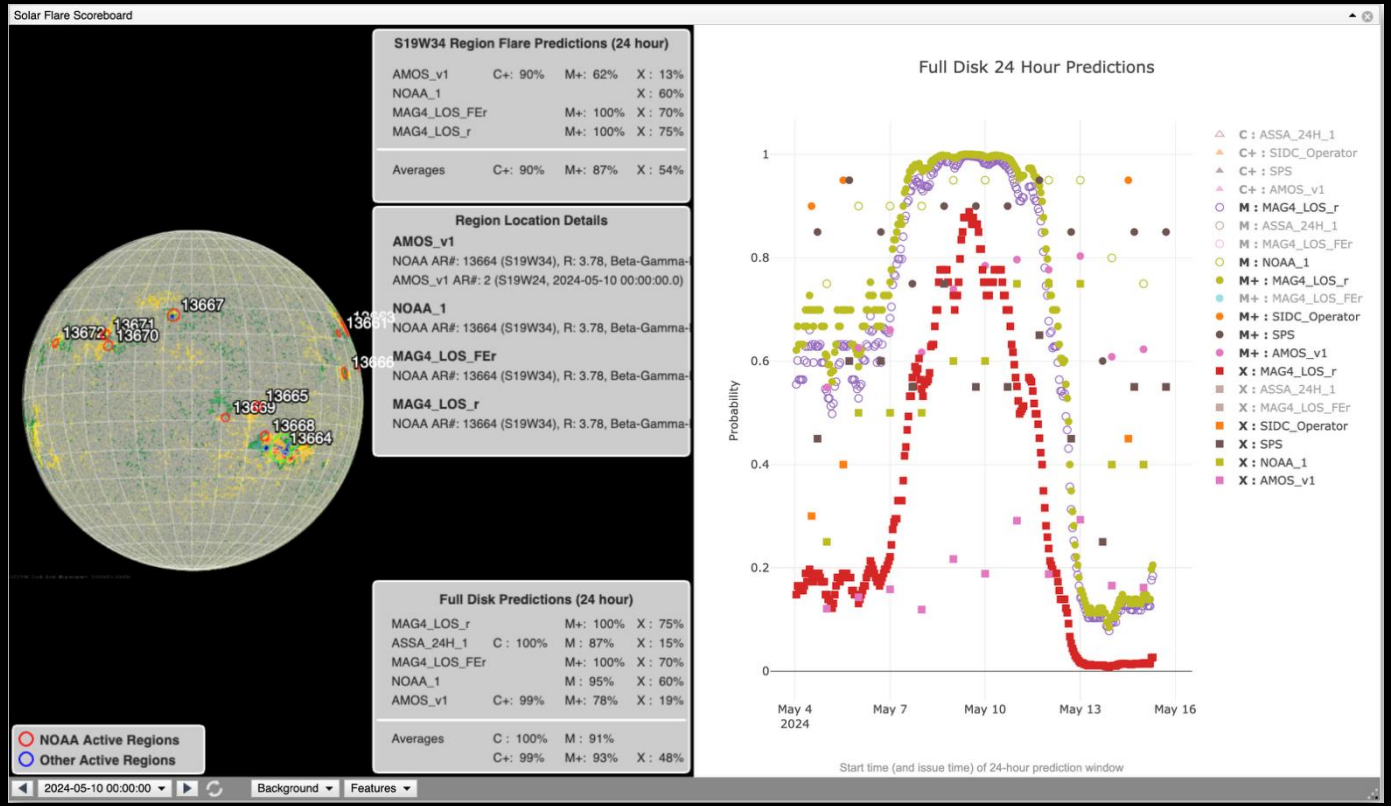
Edit CME

Predicted Shock Arrival Time	Difference (hrs)	Confidence (%)	Submitted On	Lead Time (hrs)	Predicted Geomagnetic Storm Parameter(s)	Method	Submitted By	
2024-05-10T13:03Z (-7.0h, +7.0h)	-20.45	----	2024-05-09T20:28Z	37.03	Max Kp Range: 8.0 - 9.0	WSA-ENLIL + Cone (NASA M2M)	Carina Alden (M2M Office)	Detail
2024-05-10T20:00Z (-7.0h, +7.0h)	-13.50	100.0	2024-05-09T20:30Z	37.00	Max Kp Range: 6.0 - 8.0	WSA-ENLIL + Cone (Met Office)	Met Office (Met Office)	Detail
2024-05-10T21:00Z	-12.50	80.0	2024-05-10T02:18Z	31.20	Max Kp Range: 5.0 - 8.0	Cone + HAF (SEPC, NSSC, CAS)	Jingjing Wang (NSSC SEPC)	Detail
2024-05-10T23:16Z (-7.0h, +7.0h)	-10.23	----	2024-05-10T15:18Z	18.20	----	EAM (Effective Acceleration Model)	Evangelos Paouris (UoA)	Detail
2024-05-10T23:48Z (-6.0h, +6.0h)	-9.70	----	2024-05-09T22:51Z	34.65	----	ELEvo	Eva Weiler (ASWO)	Detail
2024-05-11T03:05Z	-6.42	90.0	---	---	Max Kp Range: 6.0 - 8.2	Average of all Methods	Auto Generated (CCMC)	Detail
2024-05-11T03:51Z (-4.53h, +3.4h)	-5.65	----	2024-05-09T17:06Z	40.40	----	CMEFM v.0.1	Garrett Imhoff (Other)	Detail
2024-05-11T05:02Z (-7.0h, +7.0h)	-4.47	----	2024-05-09T17:04Z	40.43	Max Kp Range: 6.0 - 8.0	WSA-ENLIL + Cone (NASA M2M)	Carina Alden (M2M Office)	Detail
2024-05-11T18:00Z	8.50	----	2024-05-09T15:18Z	42.20	Max Kp Range: 5.0 - 8.0	WSA-ENLIL + Cone (NOAA/SWPC)	Hannah Hermann (M2M Office)	Detail
2024-05-11T19:45Z (-7.0h, +7.0h)	10.25	----	2024-05-10T15:23Z	18.12	----	EAM (Effective Acceleration Model)	Evangelos Paouris (UoA)	Detail

Flare Scoreboard

- Probabilistic flare forecasts for the next 24 hours.
- Forecasts received automatically
- Full disk forecast probability time series and table
- Interactive solar disk display where the user can click to see active region forecasts
- Began renovations to the Flare Scoreboard front-end display based on user feedback; adding more flare models

Flare Scoreboard



SEP Scoreboard

- Supports SRAG console operators and M2M analysts
- Forecasts are collected and displayed in real time
- Multiple models are shown on uniform displays, along with data

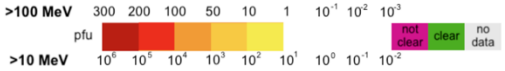
SEP Scoreboard

by the Community Coordinated Modeling Center at NASA

-1 week | -1 day | -1 hour | 2024-05-13 13:25 | +1 hour | +1 day | +1 week | Today | Refresh Plots | Auto Refresh

Proton Intensity Forecasts: 2024-05-13 13:25 UT

	GOES	ASPECS Forecast	ASPECS Nowcast	iPATH CME	SEPMOD	SEPSTER	SEPSTER2D	UMASEP
> 10 MeV	6.5	1.97 - 2.18	2.05 - 2.21	0.004	246.9	42.7	0.0 - 0.2	16.3 ± 3.7
> 100 MeV	0.15	0.09 - 0.1	0.09 - 0.1	0.0	4.844	0.43	0.0 - 0.0	Clear

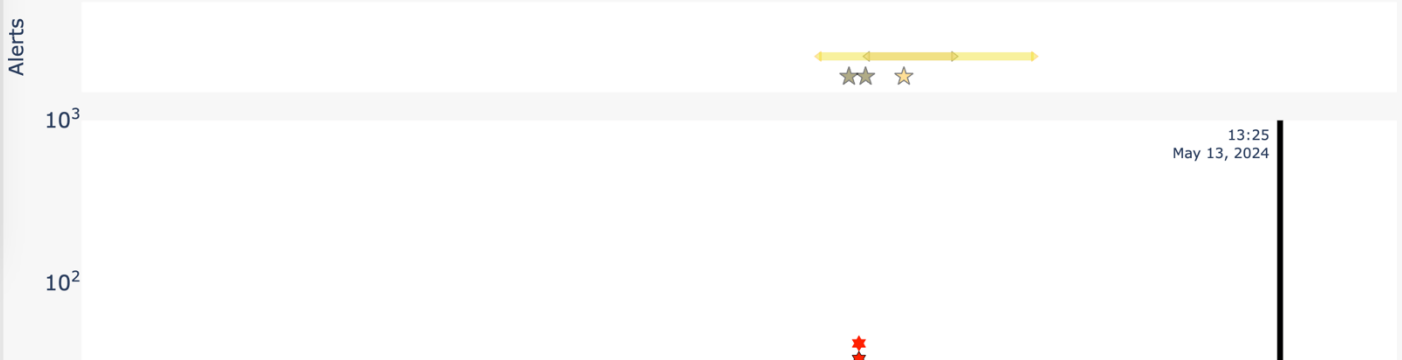


View the heat map guide

Proton All Clear Forecasts: 2024-05-13 13:25 UT

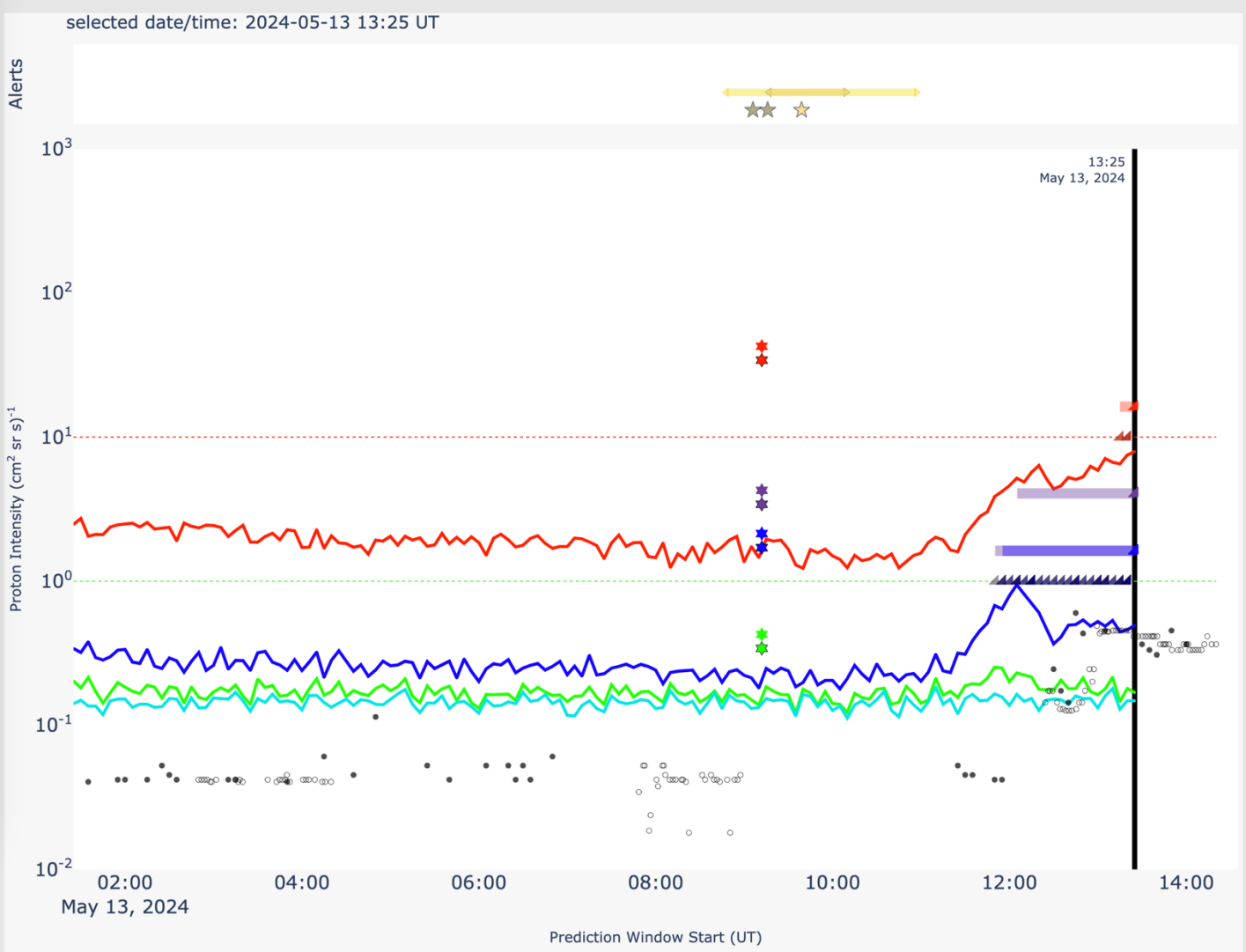
	GOES	ASPECS Forecast	ASPECS Nowcast	iPATH CME	SEPMOD	SEPSTER	SEPSTER2D	UMASEP
> 10 MeV	Clear	Clear	Clear	Clear	Not Clear	Not Clear	Clear	Not Clear
> 100 MeV	Clear	Clear	Clear	Clear	Not Clear	Clear	Clear	Clear
> 500 MeV	Clear	N/A	N/A	N/A	N/A	N/A	N/A	Clear

selected date/time: 2024-05-13 13:25 UT



Auto Refresh is turned off

REIeASE SOHO 60-min 28.2 - 50.1 MeV
0.365 pfu = 0.017 pfu/MeV * 21.9 MeV
issued 2024-05-13 13:24:59
prediction time: 2024-05-13 14:20:16



Auto Refresh is turned off

REIeASE SOHO 60-min 28.2 - 50.1 MeV
0.365 pfu = 0.017 pfu/MeV * 21.9 MeV
issued 2024-05-13 13:24:59
prediction time: 2024-05-13 14:20:16

Only iPATH, SEPMOD, SEPSTER, and SEPSTER2D data has links.

DONKI DASH Demo

bit.ly/ccmcdonkidash