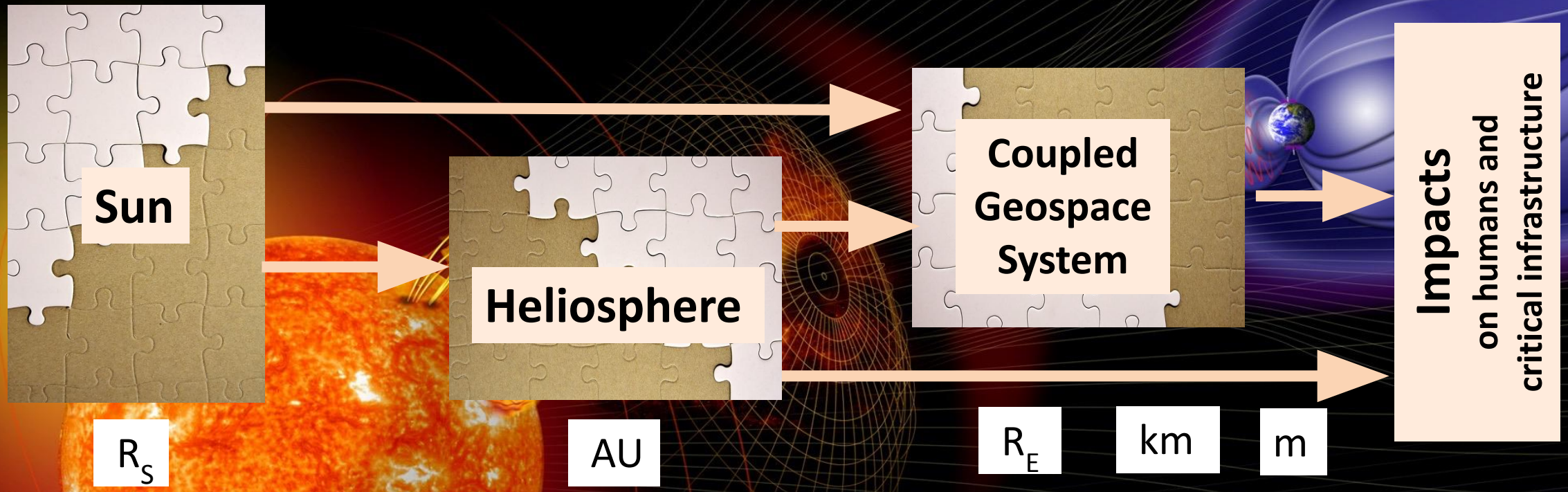
# Learn about the Heliophysics Big Year events such as the eclipse through NASA's Community Coordinated Modeling Center's (CCMC) tools

Presented by Elana Resnick with contributions from the CCMC Team
NASA/GSFC/CCMC

CS AAPT Spring 2024

Saturday, March 16, 2024

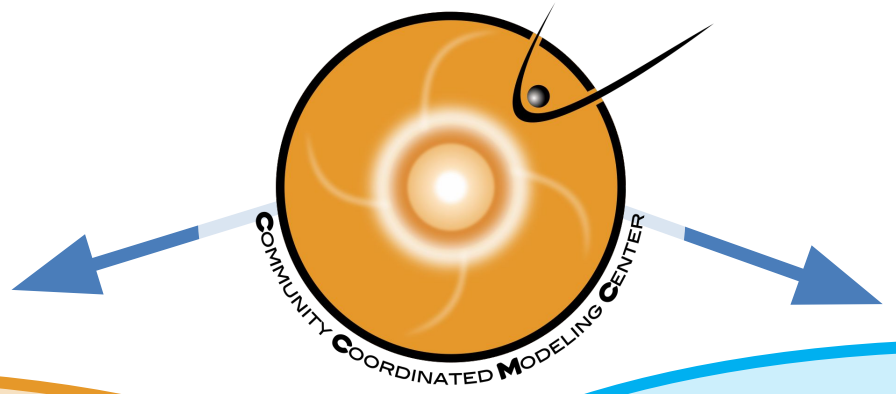
# Grand Challenge: Model Sun-to-Impact Flow of Space Weather Processes




**To build space weather predictive capabilities based on science we need to**

- assemble parts of the puzzle by solving problems focused on different physical domains with diverse spatial scales and underlying physical phenomena
- identify information passed between domains
- identify space environment quantities linked to impacts
- connect all validated solutions from space weather origins on the sun to impacts

Established in 2000 as multi-agency strategic investment in a national Space Weather program



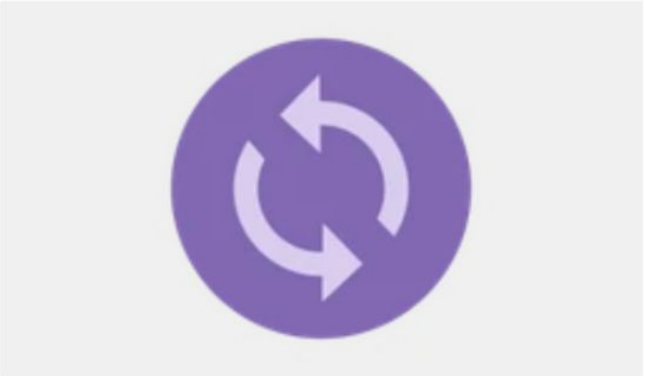

*Facilitate space weather* ***research and model development***

*Support transition of advances in research to* ***space weather operations***

# Simulation Services

## Runs on Request

Runs on Request is a free service open to any user interested in running the simulation models hosted by the CCMC.



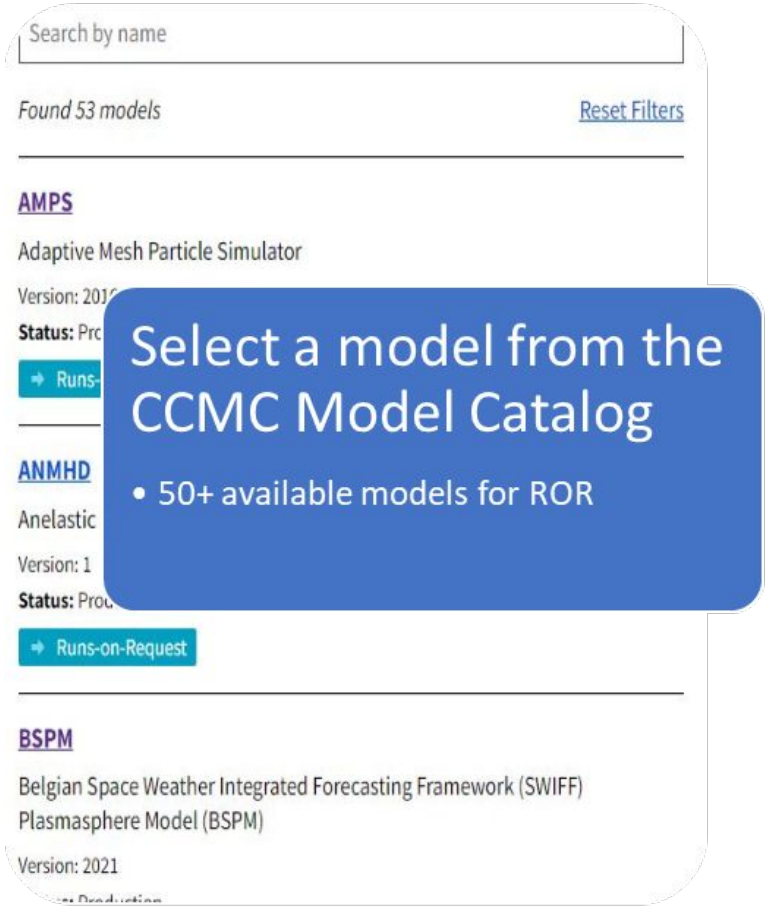
## Continuous/Real-time Run

Continuous/real-time runs are models that CCMC executes using near real-time observation data as inputs. Post processed results of such runs are sent to iSWA for display.

## Instant Run

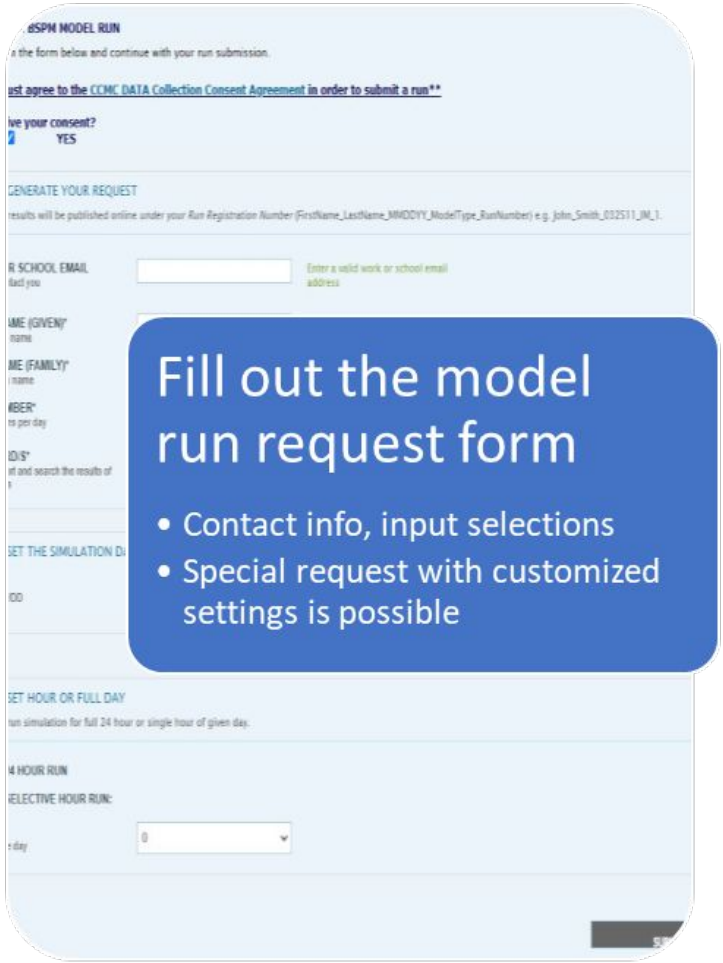
Simulation models that are available for instant execution and viewing of results online via the Instant-Run web app.

# Simulation Services: Runs-On-Request (ROR)



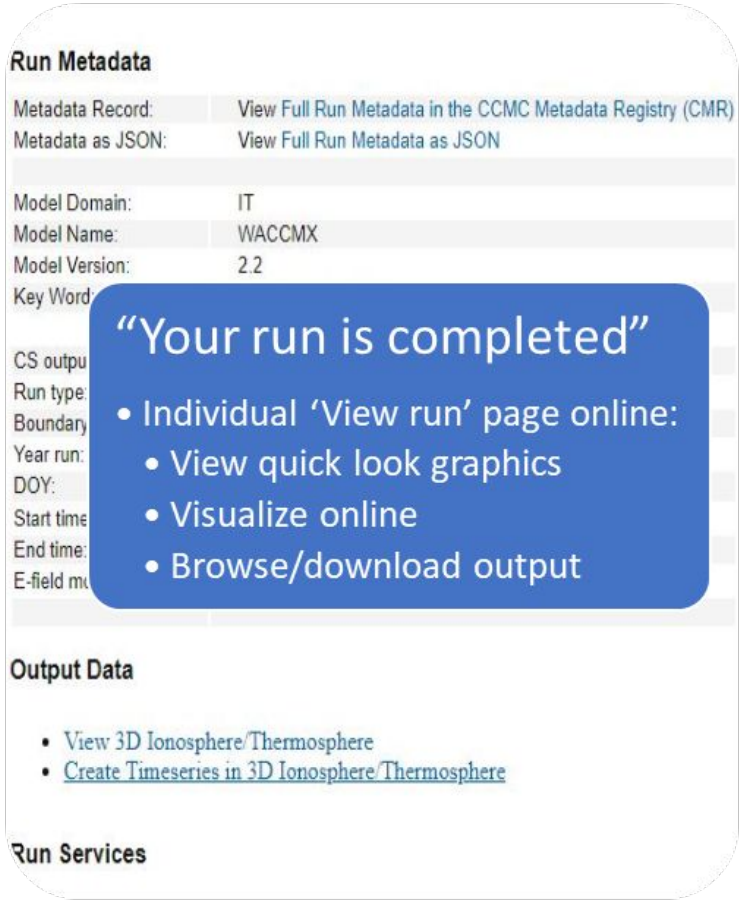

Select a model from the CCMC Model Catalog

- 50+ available models for ROR




Fill out the model run request form

- Contact info, input selections
- Special request with customized settings is possible




"Your run is completed"

- Individual 'View run' page online:
  - View quick look graphics
  - Visualize online
  - Browse/download output

# Simulation Services: Instant-Run (IR)

**IRI**

International Reference Ionosphere Model

Version: 2016

Runs-on-Request | Instant Run

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**IRI**

International Reference Ionosphere Model

Version: 2020

Instant Run | Runs-on-Request

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**NRLMSIS**

Mass Spectrometer and Incoherent Scatter model

Version: 00

Instant Run | Runs-on-Request

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**NRLMSIS**

Mass Spectrometer and Incoherent Scatter model

Version: 2.0

Instant Run | Runs-on-Request

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**SuperDARN Convection Models**

SuperDARN
(RST)

Version: 4.3.

Instant

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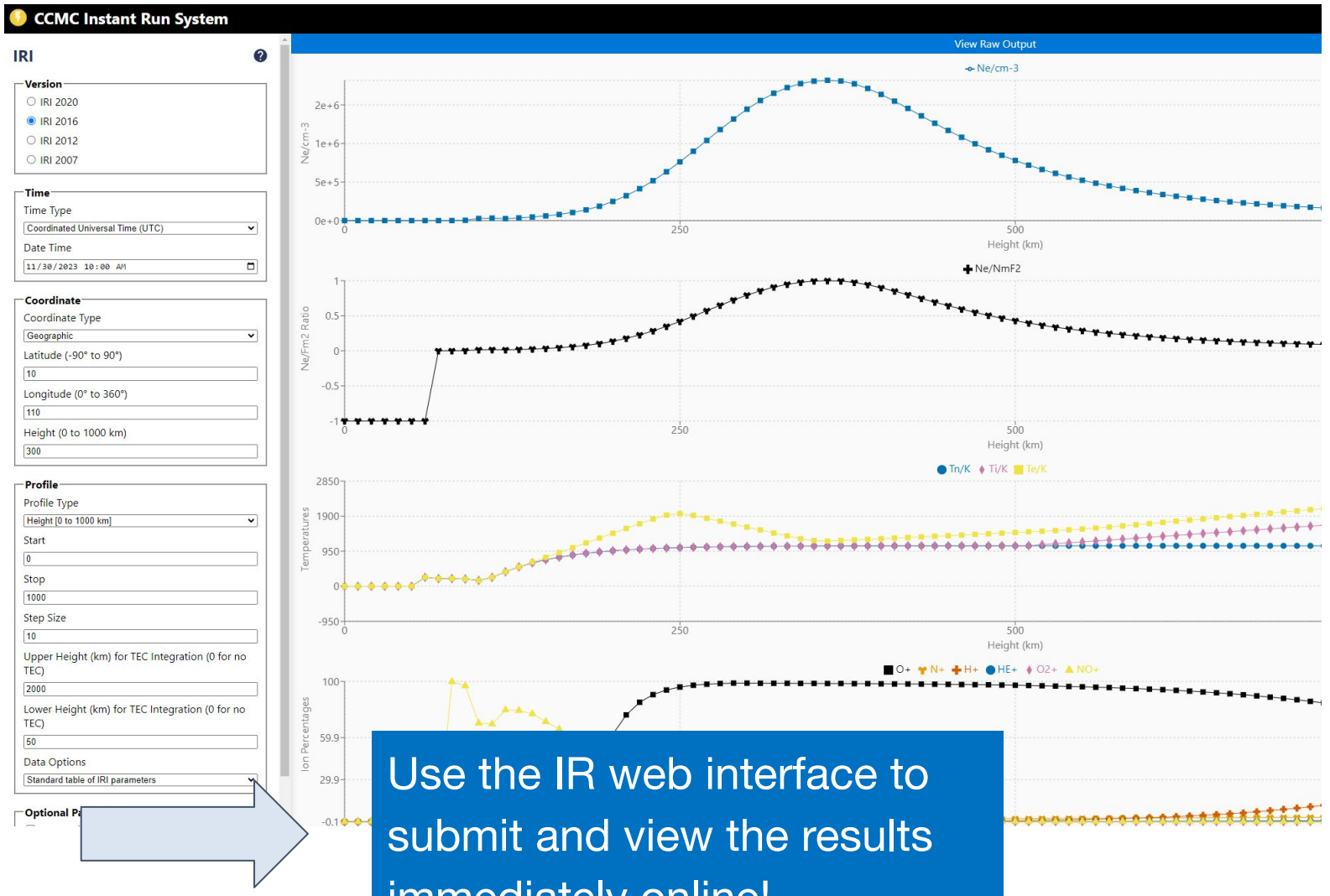
**Tsyganen**




Select a model from the CCMC Model Catalog

- 15+ available models for IR

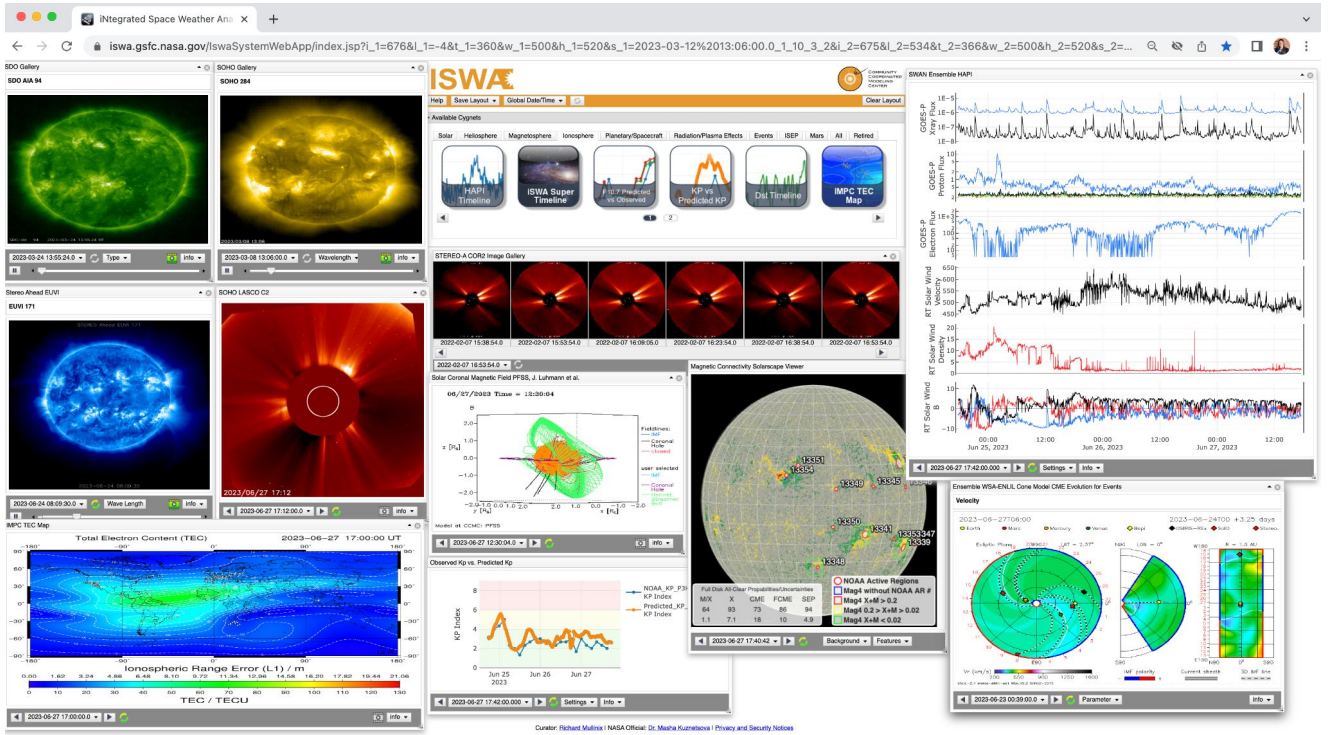
Use the IR web interface to submit and view the results immediately online!

# Space Weather Analysis

ISWA

## iSWA

iSWA serves CCMC real-time/continuous model outputs and observational data.




https://ccmc.gsfc.nasa.gov/tools/iSWA/

# Space Weather Analysis

## DONKI

DONKI is a comprehensive online database of space weather events for the community.

COMMUNITY COORDINATED MODELING CENTER

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

Go to:

- About DONKI
- DONKI Home
- Search Space Weather Activity
- Search Notification Archive
- Login

**Search Space Weather Activity Archive**

Space Weather Activity Type : --- ALL ---
Select Catalog : M2M_CATALOG
Optional start date in format (e.g. 2013-01-31) : 2023-12-05
Optional end date in format (e.g. 2013-06-30) : 2023-12-06
search

| Event Type | Start Time (UT) | Associated Instrument | Peak Time | End Time | Class | Source Location | Active Region Number | Directly Linked Event(s) |
|---|---|---|---|---|---|---|---|---|
| Solar Flare | 2023-12-05 06:39 | GOES-P: EXIS 1.0-8.0 | 2023-12-05T06:44Z | 2023-12-05T06:48Z | M1.5 | N18E73 | 13513 | |
| Solar Flare | 2023-12-05 06:48 | GOES-P: EXIS 1.0-8.0 | 2023-12-05T06:58Z | 2023-12-05T07:06Z | C5.3 | S18W90 | 13500 | 2023-12-05T07:48:00-CME-001 |
| Solar Flare | 2023-12-05 20:59 | GOES-P: EXIS 1.0-8.0 | 2023-12-05T21:10Z | 2023-12-05T21:17Z | M1.0 | N19E69 | 13513 | |
| Solar Flare | 2023-12-05 21:17 | GOES-P: EXIS 1.0-8.0 | 2023-12-05T21:20Z | 2023-12-05T21:25Z | M1.4 | N19E69 | 13513 | |
| Solar Flare | 2023-12-06 05:30 | GOES-P: EXIS 1.0-8.0 | 2023-12-06T05:41Z | 2023-12-06T05:52Z | M2.1 | N19E65 | 13513 | |
| Solar Flare | 2023-12-06 21:26 | GOES-P: EXIS 1.0-8.0 | 2023-12-06T21:44Z | 2023-12-06T21:55Z | M2.3 | N19E55 | 13513 | |

Generate report for all CME parameters (PDF or TEXT)

Generate report for the most accurate and complete CME parameters only (PDF or TEXT)

| Event Type | Start Time (UT) | Catalog | All Detecting Instruments | Source Location | CME Analysis |
|---|---|---|---|---|---|
| CME | 2023-12-05 00:12 | M2M_CATALOG | SOHO: LASCO/C2 SOHO: LASCO/C3 STEREO A: SECCHI/COR2 | S17W90 (13500) | Event Type: CME Analysis; Catalog: M2M_CATALOG; Measurement Type: LE; Prime?: true; Technique: SWPC_CAT; Long: 90.0; Lat: -27.0; Speed: 365.0; Type: S; Half Width: 29.0; Time 21.5: 2023-12-05T10:10Z; WSA-ENLIL+Cone Result(s): Result 1 (2.0 AU) Result 2 (5.5 AU) *Lucy = 2023-12-12T00:00Z* |
| CME | 2023-12-05 07:48 | M2M_CATALOG | SOHO: LASCO/C2 SOHO: LASCO/C3 STEREO A: SECCHI/COR2 | S17W90 (13500) | Event Type: CME Analysis; Catalog: M2M_CATALOG; Measurement Type: LE; Prime?: true; Technique: SWPC_CAT; Long: 95.0; Lat: -22.0; Speed: 619.0; Type: C; Half Width: 45.0; Time 21.5: 2023-12-05T14:08Z; WSA-ENLIL+Cone Result(s): Result 1 (2.0 AU) Result 2 (5.5 AU) *Lucy = 2023-12-12T00:00Z* |
| CME | 2023-12-05 10:00 | M2M_CATALOG | SOHO: LASCO/C2 SOHO: LASCO/C3 STEREO A: SECCHI/COR2 | | Event Type: CME Analysis; Catalog: M2M_CATALOG; Measurement Type: LE; Prime?: true; Technique: Plane-of-sky; Long: NONE; Lat: -59.0; Speed: 422.0; Type: S; Half Width: 22.0; Time 21.5: 2023-12-05T18:17Z; WSA-ENLIL+Cone Result(s): Not modeled |

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

# Validation & Scoreboards

## CAMEL

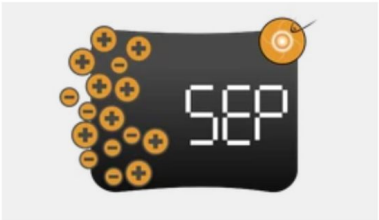
CAMEL is an integrated and flexible framework for comparing space weather and space science model outputs with observational data sets.

## Flare Scoreboard

Real-time Forecasting Methods Validation for predicting Solar Flare events.

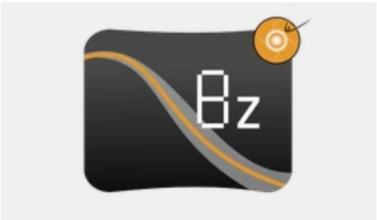
## CME Arrival Time Scoreboard

Real-time Forecasting Methods Validation for Coronal Mass Ejections arrival time at Earth.




## SEP Scoreboard

Real-time Forecasting Methods Validation for predicting Solar Energetic Particle (SEP) events.

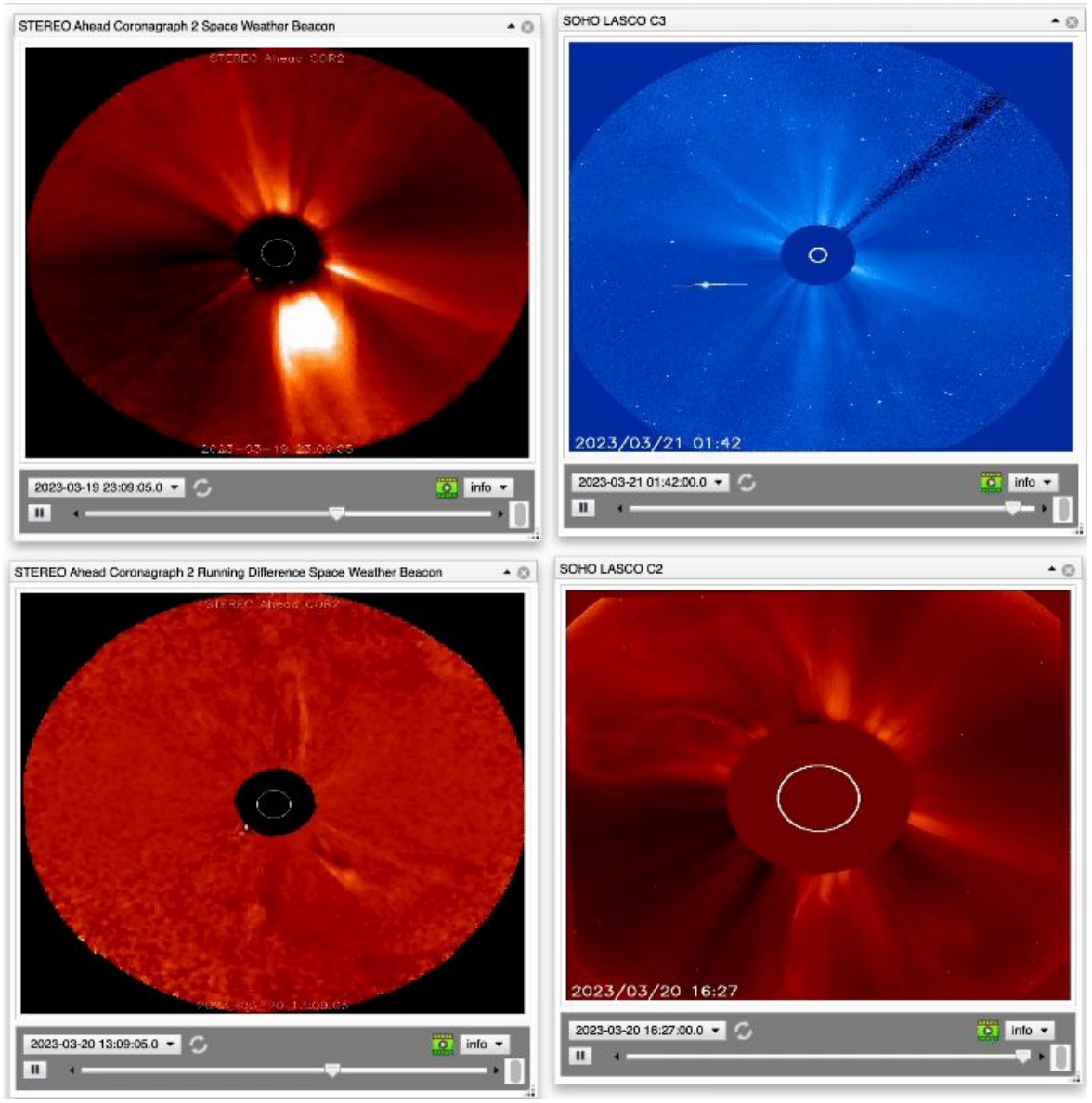



## IMF Bz Scoreboard

Real-time Forecasting Methods Validation for interplanetary magnetic field forecasts at L1.

# Space Weather Event Example

## iSWA



# Space Weather Event Example
## DONKI

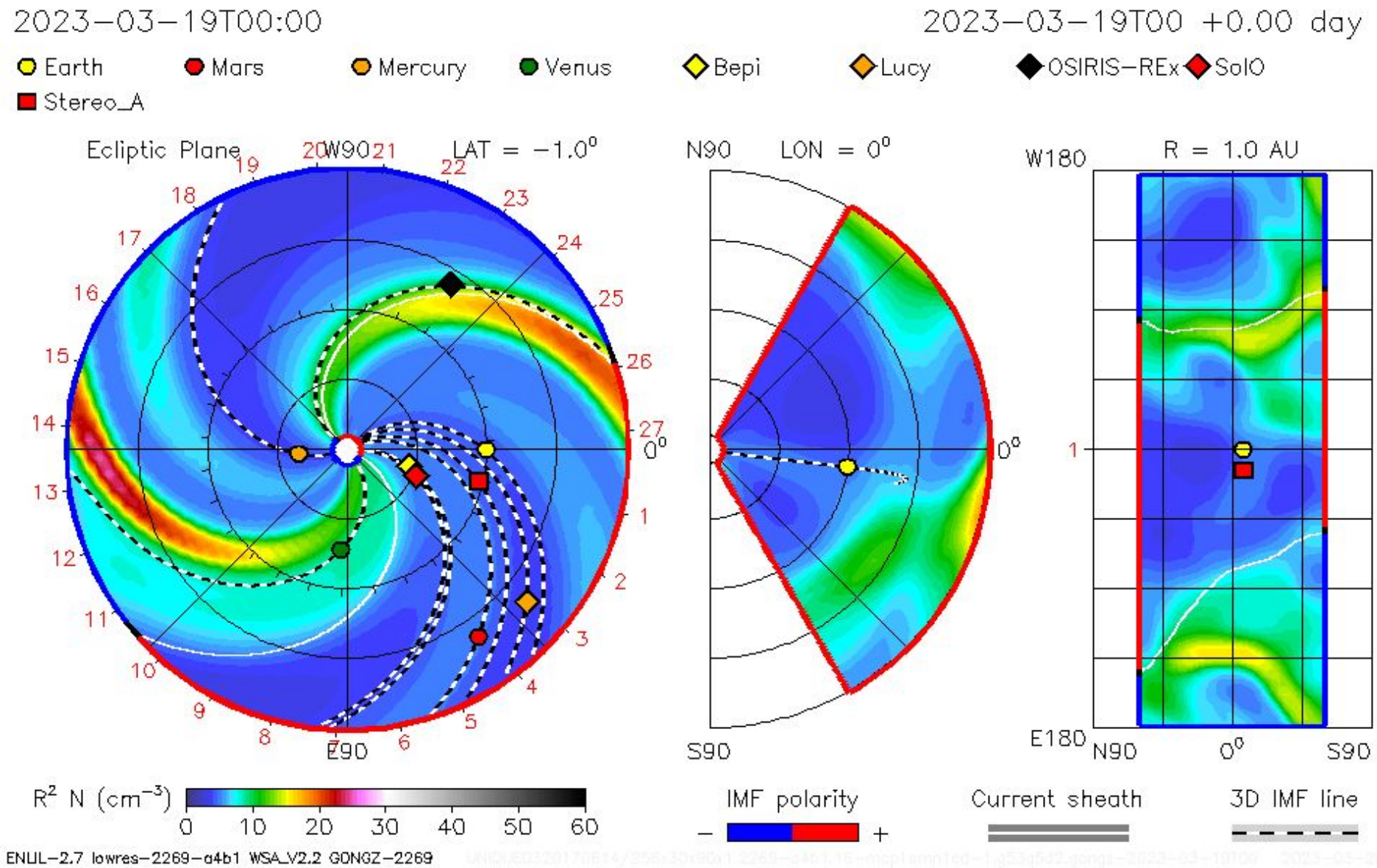
**Coronal Mass Ejection**
Catalog: M2M_CATALOG
Start Time: 2023-03-20T14:42Z ( SOHO: LASCO/C2 )
All Detecting Spacecrafts:
SOHO: LASCO/C2
STEREO A: SECCHI/COR2
Activity ID: 2023-03-20T14:42:00-CME-001 (version 1)
Source Location: N27E20
Note Keyword:
FOV: Front Bright front; may be evidence of pileup
GAP: Data gap
PRM: Prominence material (filamentary structures)
SUR: Surge-like eruption
Source Signature Keyword:
PEA: Post eruption arcade
FIL: Filament eruption
OFL: Moving/Opening field lines
BR: Brightening
EUVW: EUV Wave
Morphology Keyword:
F: Flux Rope
FS: Flux Rope and Shock Candidate
L: Loop
LS: Loop and Shock Candidate
Note: Bright, wide CME seen to the NE in SOHO and STEREO A coronagraphs. The eruption is characterized by an erupting sigmoid/S-shaped structure centered around N27E20, though dimming and an EUV wave signature is limited to longitudes closer to 30-50 degrees east.
*Submitted on 2023-03-20T16:44Z by Chris Stubenrauch*

A Notification with ID 20230320-AL-002 was sent on 2023-03-20T17:26Z
A Notification with ID 20230322-AL-001 was sent on 2023-03-22T13:05Z

# Space Weather Event Example
## DONKI

| Event Type | Catalog | Data Level | Prime? | Technique | Long | Lat | Speed | Type | Half Width | Time 21.5 | Note | WSA-ENLIL+Cone Result(s) | Submitted By |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CME Analysis | M2M_CATALOG | 0 | true | SWPC_CAT | -40.0 | 27.0 | 749.0 | C | 45.0 | 2023-03-20T19:41Z | Leading edge measurement with limited SOHO and STEREO A coronagraph imagery due to maneuver/campaign, respectively. | 1: Result 1 (2.0 AU) Earth = 2023-03-23T17:44Z (PE: 8.6 h) Mars = 2023-03-25T22:16Z Solar Orbiter = 2023-03-21T22:07Z STEREO A = 2023-03-23T11:42Z (PE: 7.7 h) *Lucy = 2023-03-25T23:00Z* 2: Result 2 (2.0 AU) Earth = 2023-03-23T18:50Z (PE: 9.7 h) Mars = 2023-03-26T00:51Z Solar Orbiter = 2023-03-21T21:49Z STEREO A = 2023-03-23T11:54Z (PE: 7.9 h) | Chris Stubenrauch on 2023-03-20T17:16Z |

# Space Weather Event Example



# Space Weather Event Example

## CME Scoreboard

**CME: 2023-03-20T14:42:00-CME-001**

Actual Shock Arrival Time: 2023-03-23T09:10Z

Observed Geomagnetic Storm Parameters:

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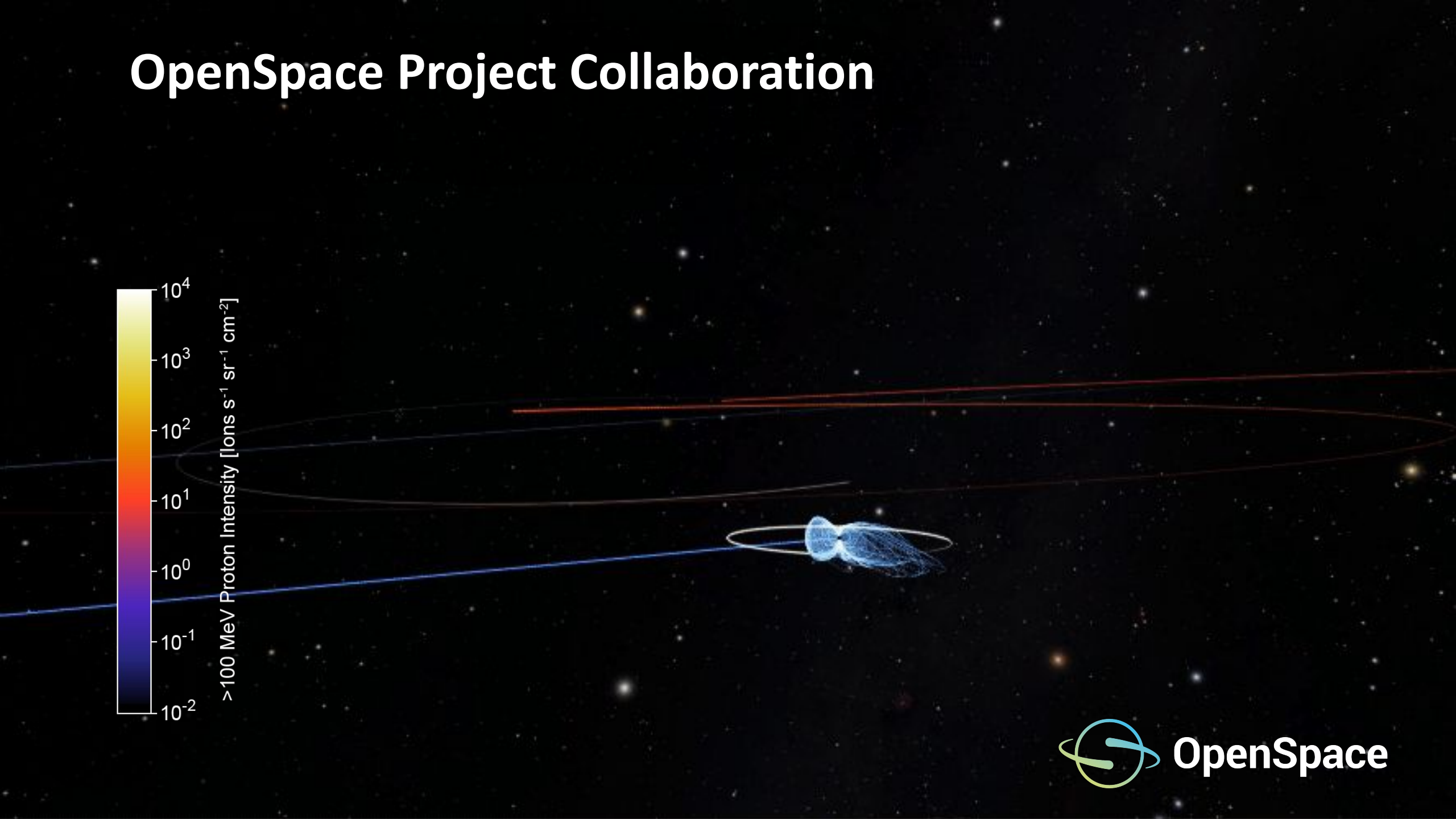
CME Note: Bright, wide and asymmetrical shape CME seen to the NE in SOHO and STEREO A coronagraphs. The eruption is characterized by an erupting sigmoid/S-shaped structure centered around N27E20, though dimming and an EUV wave signature is limited to longitudes closer to 30-50 degrees east. On arrival signature from Tarik Salman, LASSOS: background solar wind is quite different from normal levels with higher density (normal density around 5/cc) and speed (normal speed around 350-400 km/s)-a possible reason for this ICME not to have an associated shock. The start of the magnetic flux rope likely coincides with the enhancement in the total field and drop in density and the end of it is around 2023-04-24T09Z (based on an increase in temperature beyond this point and the field components becoming less coherent)

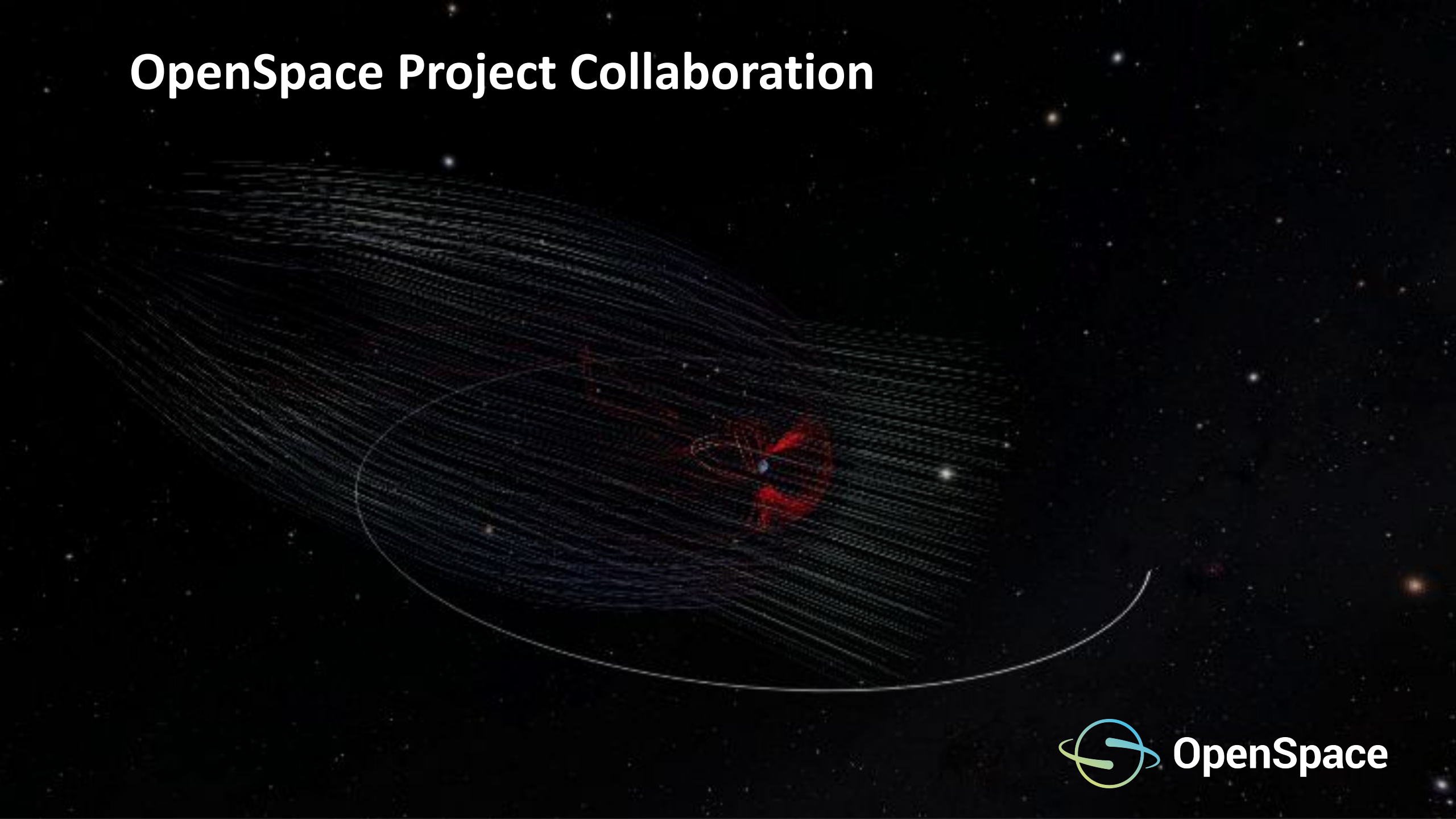
| Predicted Shock Arrival Time | Difference (hrs) | Confidence (%) | Submitted On | Lead Time (hrs) | Predicted Geomagnetic Storm Parameter(s) | Method | Submitted By | |
|---|---|---|---|---|---|---|---|---|
| 2023-03-23T17:44Z (-7.0h, +7.0h) | 8.57 | ---- | 2023-03-20T17:26Z | 63.73 | Max Kp Range: 3.0 - 5.0 | WSA-ENLIL + Cone (NASA M2M) | Chris Stubenrauch (M2M Office) | Detail |
| 2023-03-23T11:20Z (-5.0h, +7.0h) | 2.17 | 87.0 | 2023-03-20T17:45Z | 63.42 | Max Kp Range: 3.0 - 5.0 | Ensemble WSA-ENLIL + Cone (NASA M2M) | Anna Chulaki (M2M Office) | Detail |
| 2023-03-23T04:47Z | -4.38 | ---- | 2023-03-20T19:20Z | 61.83 | Max Kp Range: 4.0 - 6.0 | SARM | Marlon Nunez (UMA) | Detail |
| 2023-03-23T11:00Z (-9.0h, +9.0h) | 1.83 | 70.0 | 2023-03-21T02:15Z | 54.92 | Max Kp Range: 4.0 - 6.0 | WSA-ENLIL + Cone (Met Office) | Met Office (Met Office) | Detail |
| 2023-03-23T08:00Z (-12.0h, +12.0h) | -1.17 | 20.0 | 2023-03-21T15:43Z | 41.45 | Max Kp Range: 3.0 - 5.0 | Other (SIDC) | Anna Chulaki (M2M Office) | Detail |
| 2023-03-23T06:29Z (-7.0h, +7.0h) | -2.68 | ---- | 2023-03-22T10:41Z | 22.48 | ---- | EAM (Effective Acceleration Model) | Evangelos Paouris (UoA) | Detail |
| 2023-03-23T10:35Z (-7.0h, +7.0h) | 1.42 | ---- | 2023-03-22T10:42Z | 22.47 | ---- | EAM (Effective Acceleration Model) | Evangelos Paouris (UoA) | Detail |
| 2023-03-23T11:20Z (-5.1h, +7.1h) | 2.17 | 87.0 | 2023-03-22T13:06Z | 20.07 | Max Kp Range: 3.0 - 6.0 | Ensemble WSA-ENLIL + Cone (NASA M2M) | Chris Stubenrauch (M2M Office) | Detail |
| 2023-03-23T10:09Z | 0.98 | 66.0 | --- | --- | Max Kp Range: 3.33333 - 5.5 | Average of all Methods | Auto Generated (CCMC) | Detail |

# OpenSpace Project Collaboration




OpenSpace

# OpenSpace Project Collaboration



OpenSpace

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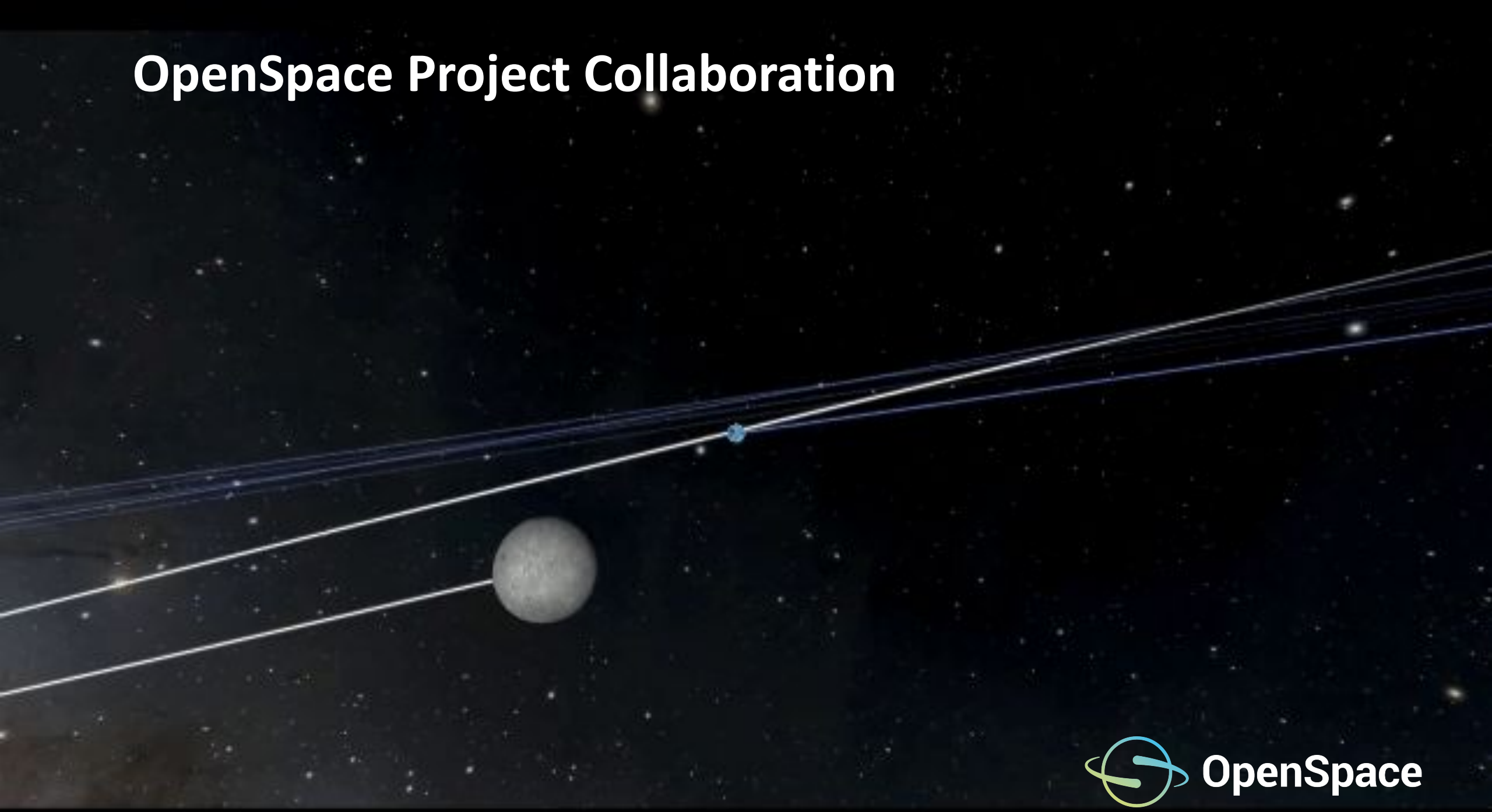


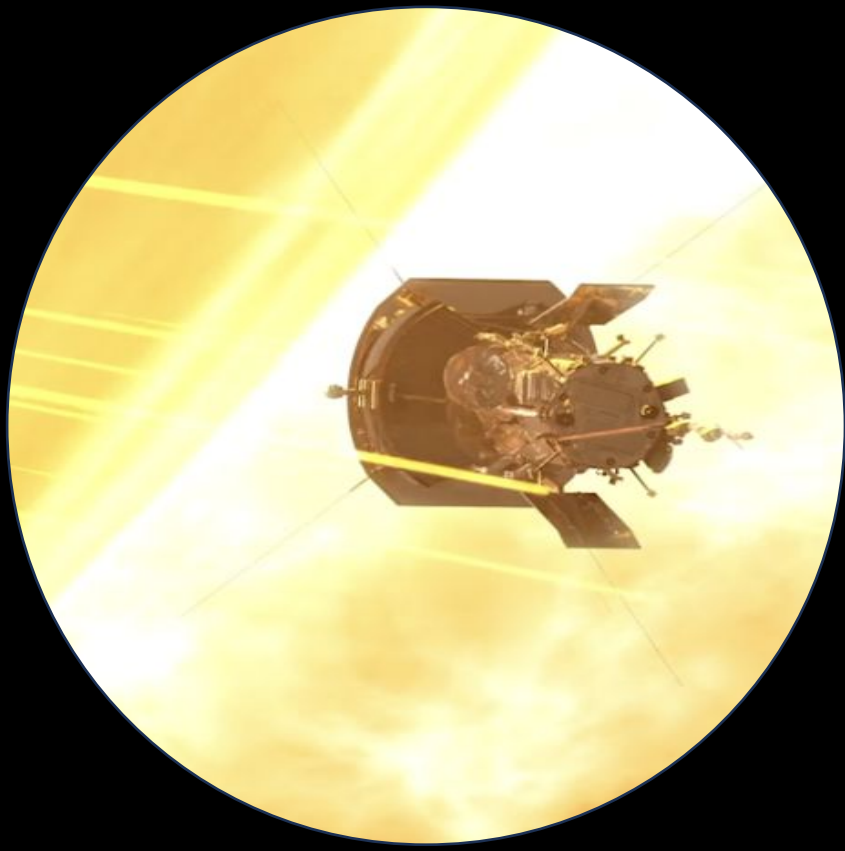
OpenSpace

# NASA SunSpots

https://science.nasa.gov/eclipses/

ANNULAR
SOLAR ECLIPSE
October 14, 2023

TOTAL
SOLAR ECLIPSE
April 8, 2024



PARKER CLOSEST
APPROACH TO SUN
December 24, 2024

https://science.nasa.gov/eclipses/

# Thank you!

# Questions?

**CCMC Website**

**Contact: elana.m.resnick@nasa.gov**

**Digital business card**