CCMC Workshop
Annapolis, MD

Relativistic Electron Alert System for Exploration (REleASE) at CCMC and CCMC User Report

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Outline

- REleASE at CCMC
- User Report: REleASE and Hohmann-Parker Effect
- User Report: HP Effect and Science from New Missions
- User Report: Space Weather Hardware and Modeling

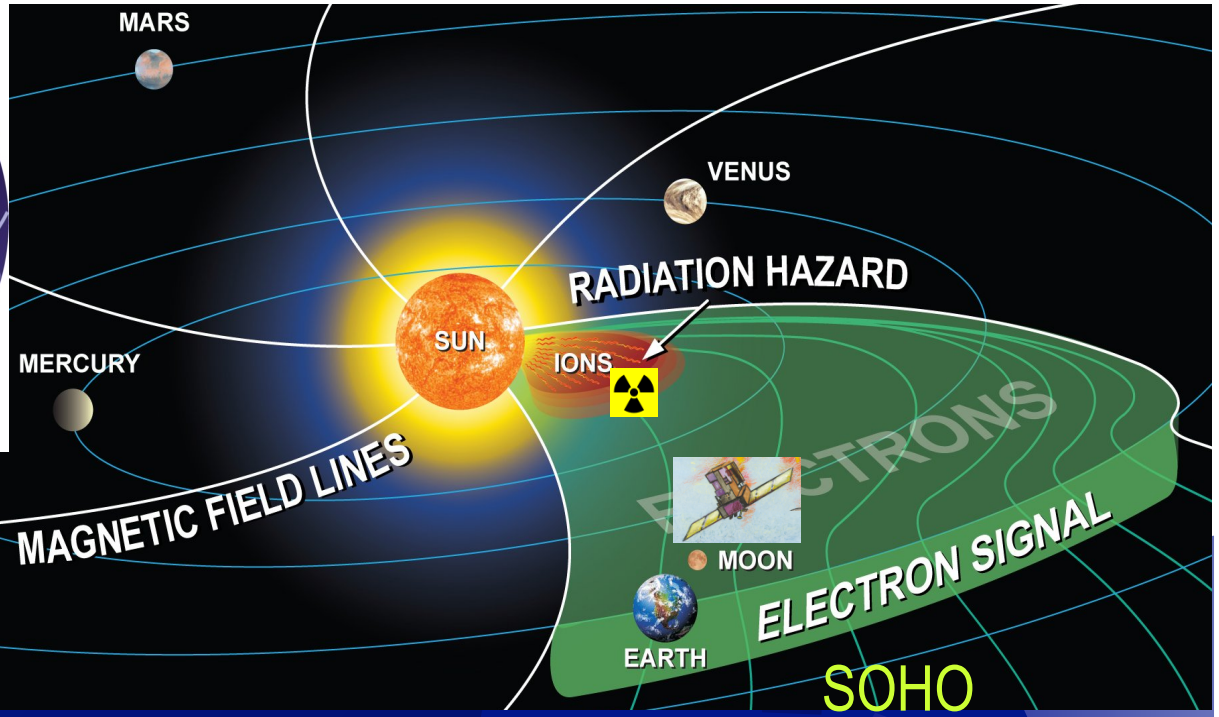
- REleASE at CCMC

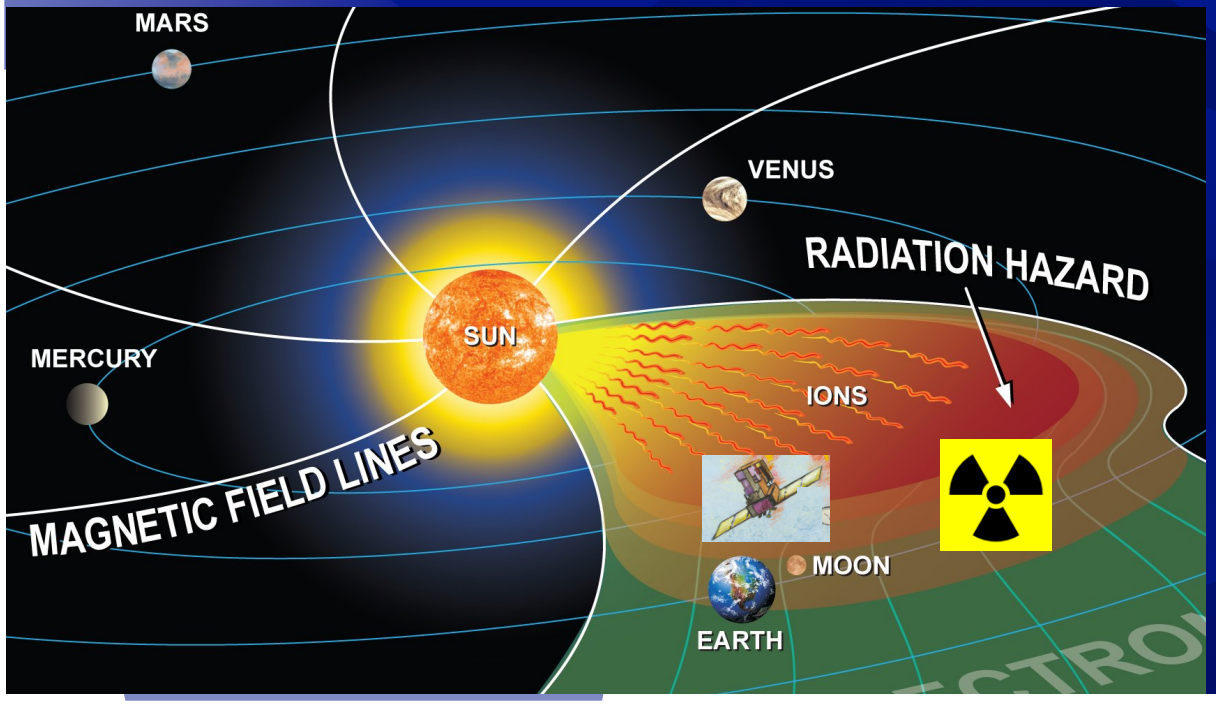
REleASE

Relativistic Electron Alert System for Exploration

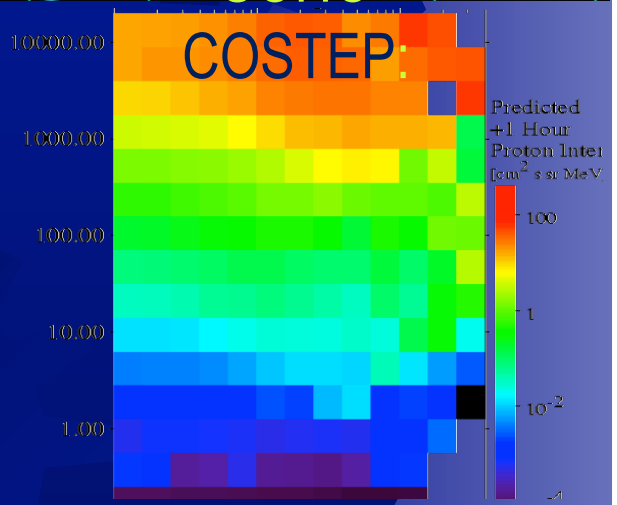
Empirical Method:

- e vs p Speed Difference
- 1+ AU Distance





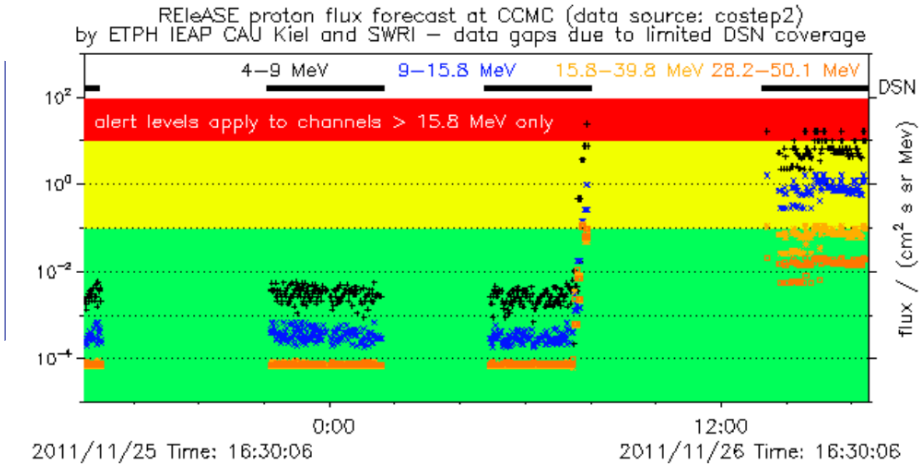
SOHO COSTEP:

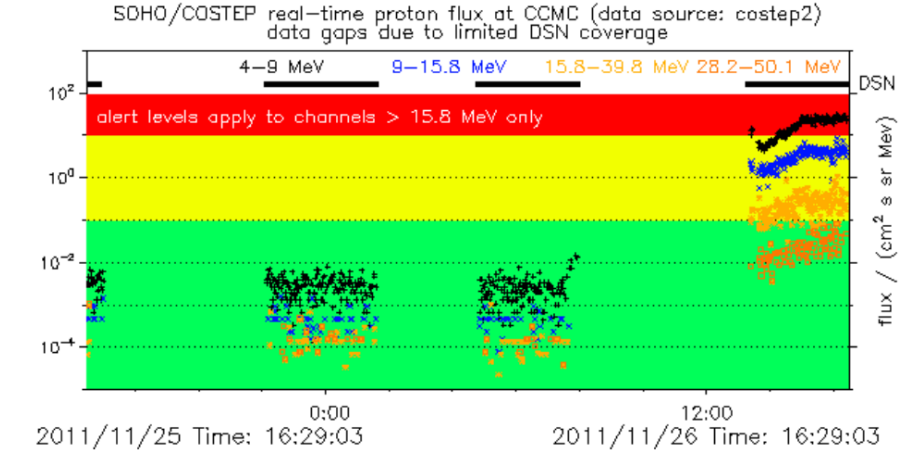


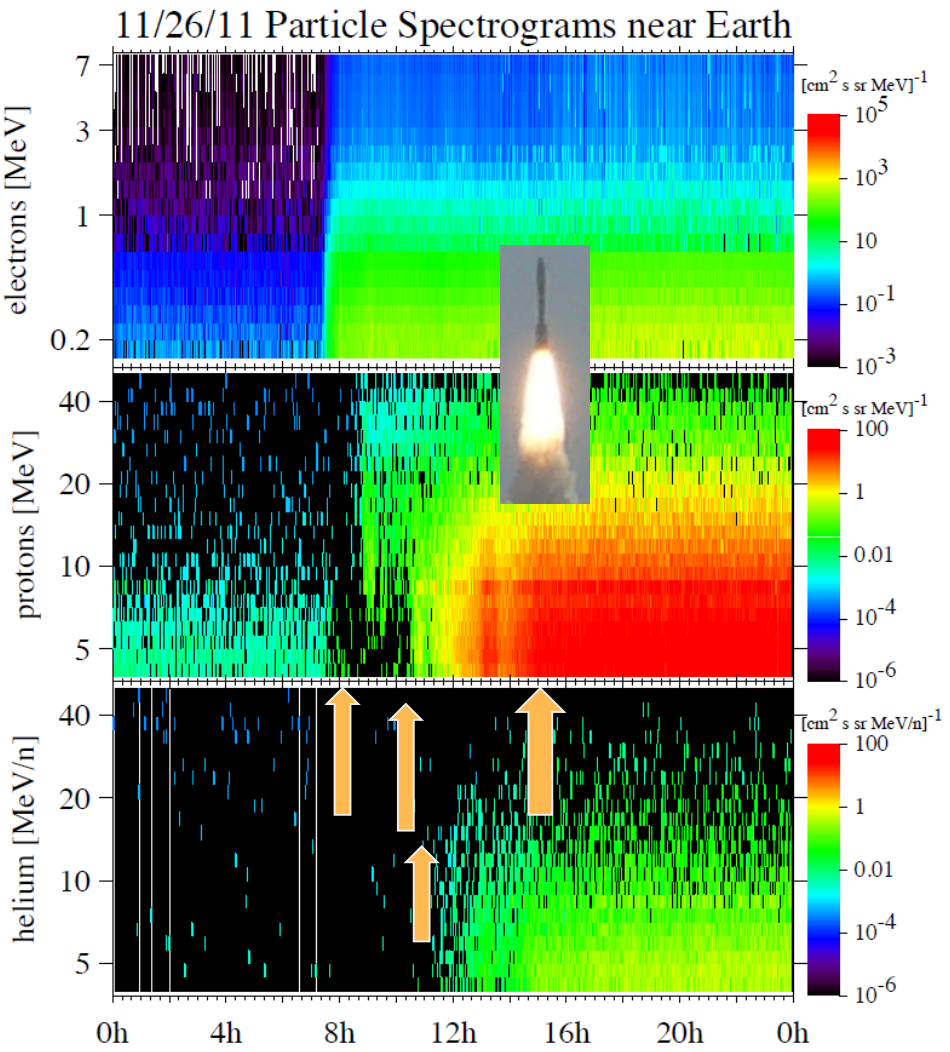
Electron Rise Parameter

Empirical Forecasting Matrix Translates Solar Electron Data into +1h Proton Hazard Forecast

(Posner, *Space Weather*, 2007)







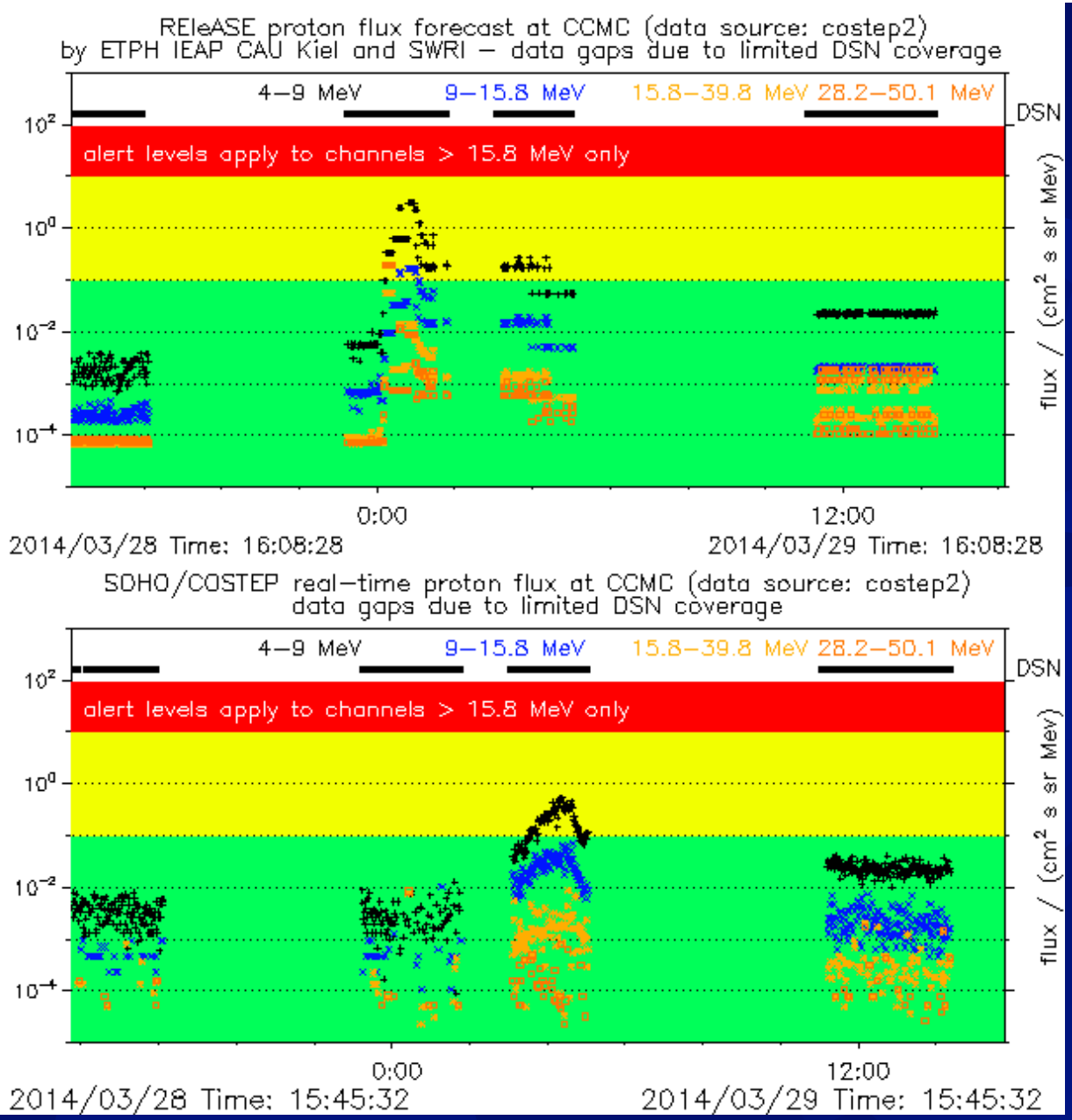
0800UT REleASE FC Crosses 10 pfu

1113UT SWD Alert Based on REleASE

1125UT GOES >10pfu Event Detected

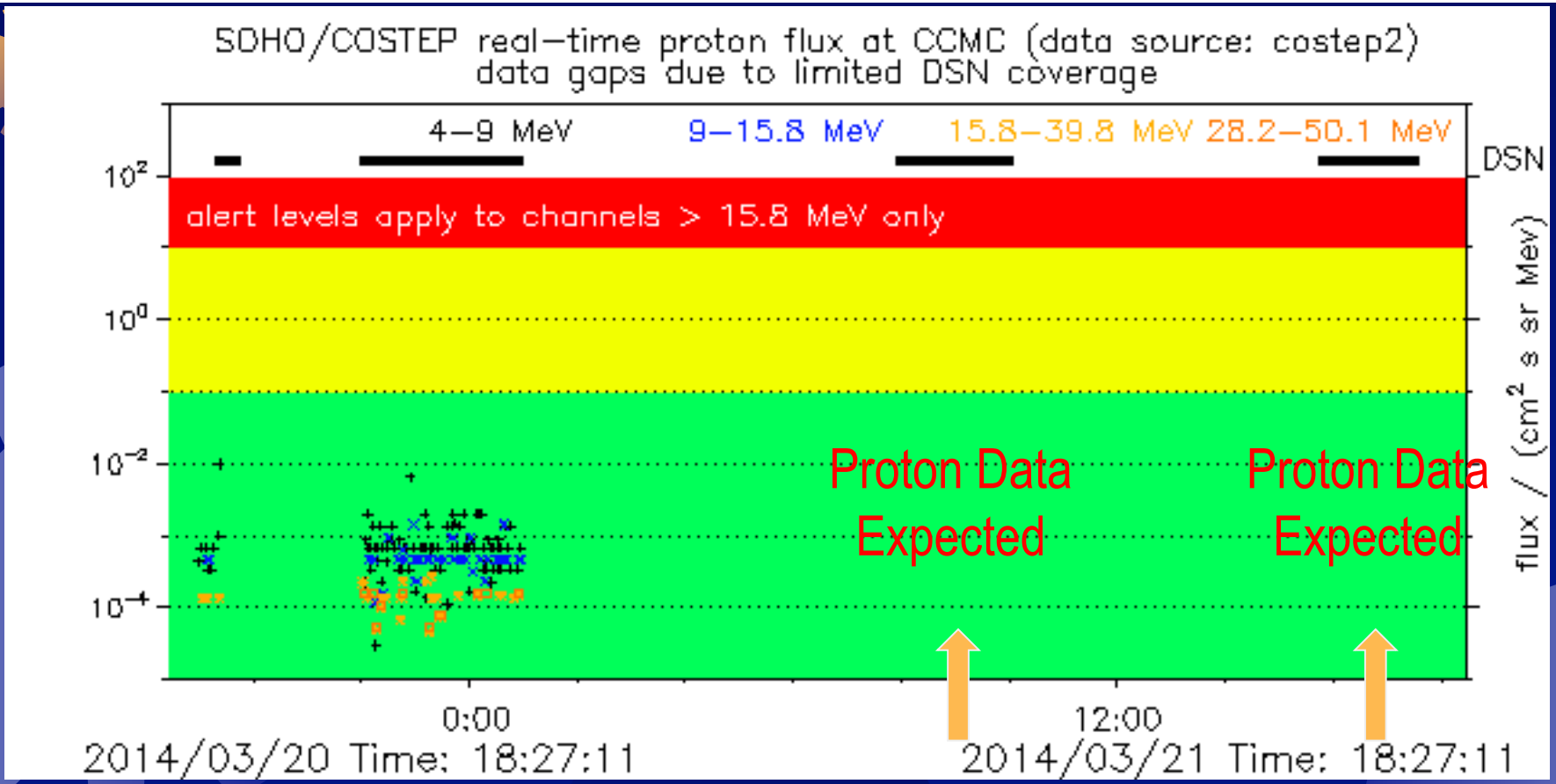
(~1300UT A Well-Informed MSL/RAD Team)

1502UT MSL Launch



REleASE Forecast Still Active and Output Available on iSWA

SEP Forecast from Friday/ Saturday, March 28/29, 2014



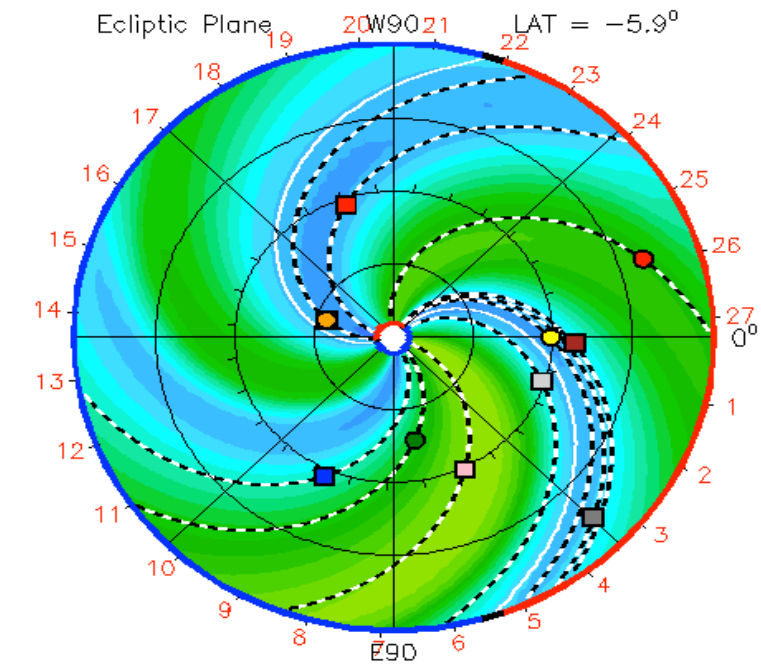
REleASE/CCMC Partnership Helps Immediately Identify and Resolve Technical Problems with Forecast or Upstream Downlink or Instrument Issues

Proton Realtime Data Outage on Friday, March 21, 2014

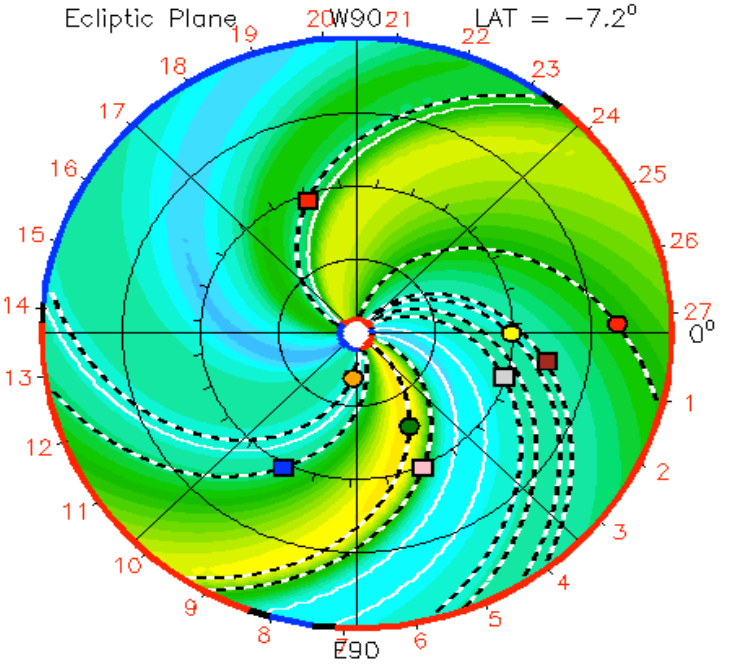
REleASE and SOHO/COSTEP Teams are Grateful to L. Rastaetter, A. Forinash, B. Fleck, J. Gurman

User Report: REleASE and Hohmann-Parker Effect

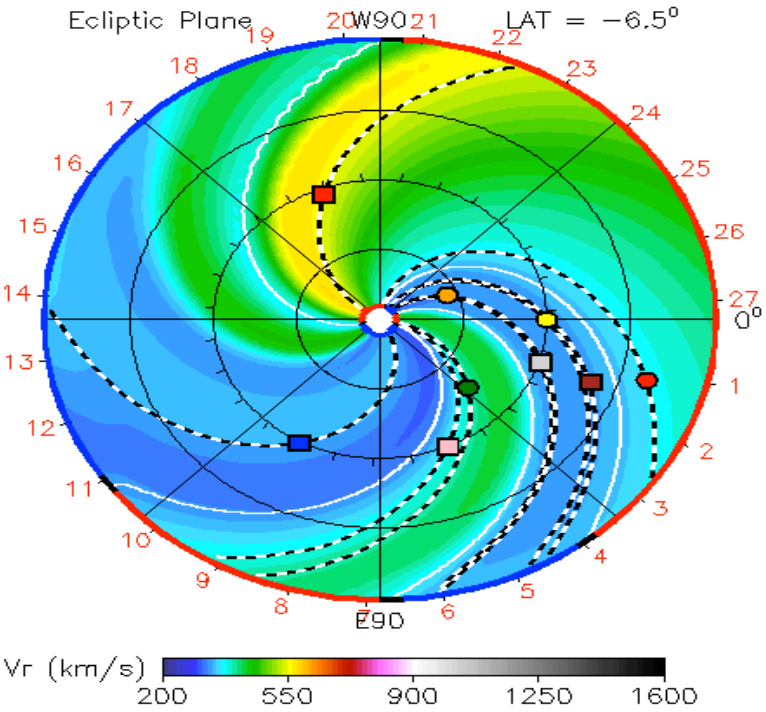
MSL


Ecliptic Plane
LAT = −5.9°
W90
E90

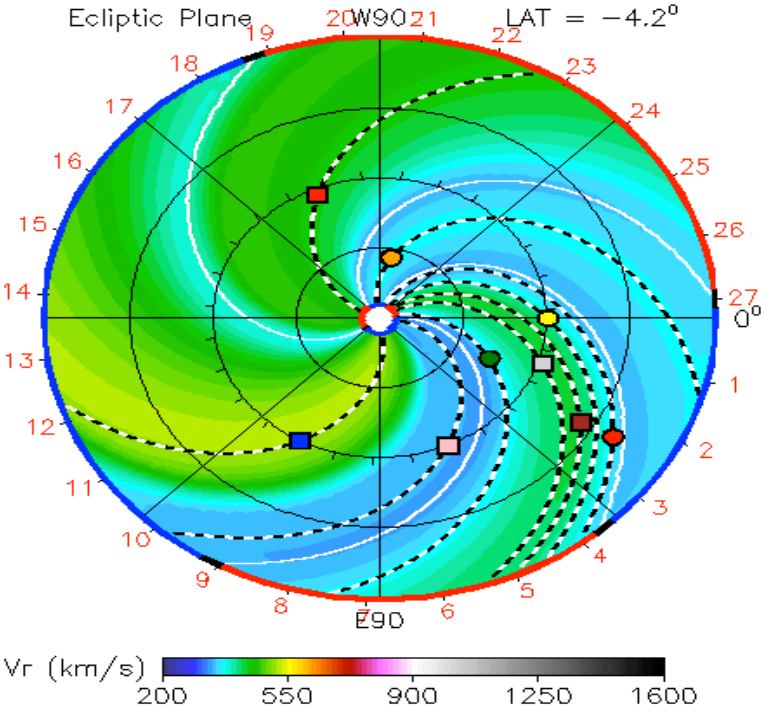
1


Ecliptic Plane
LAT = −7.2°
W90
E90

2

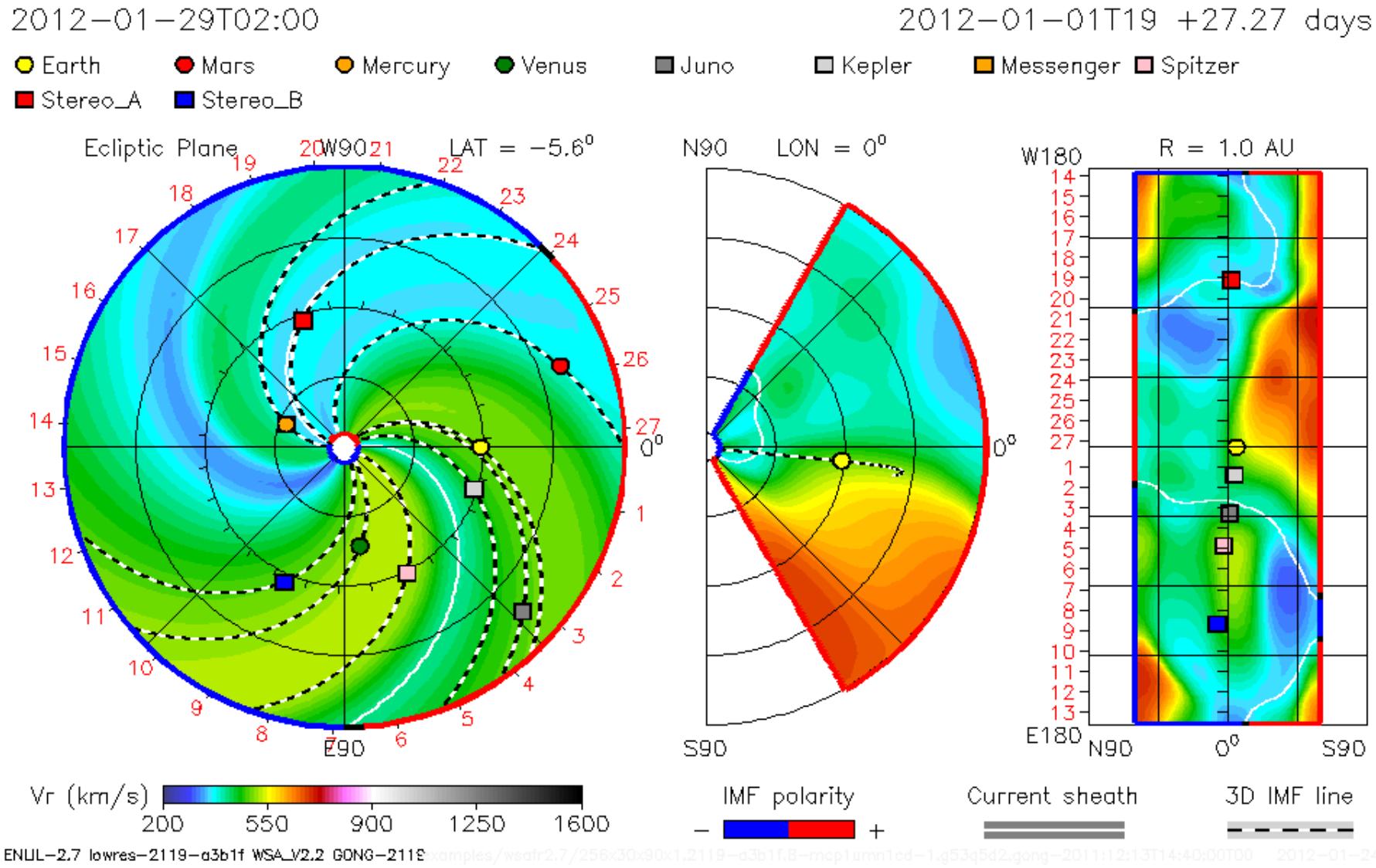

Ecliptic Plane
LAT = −6.5°
W90
E90
Vr (km/s)
200
550
900
1250
1600

3

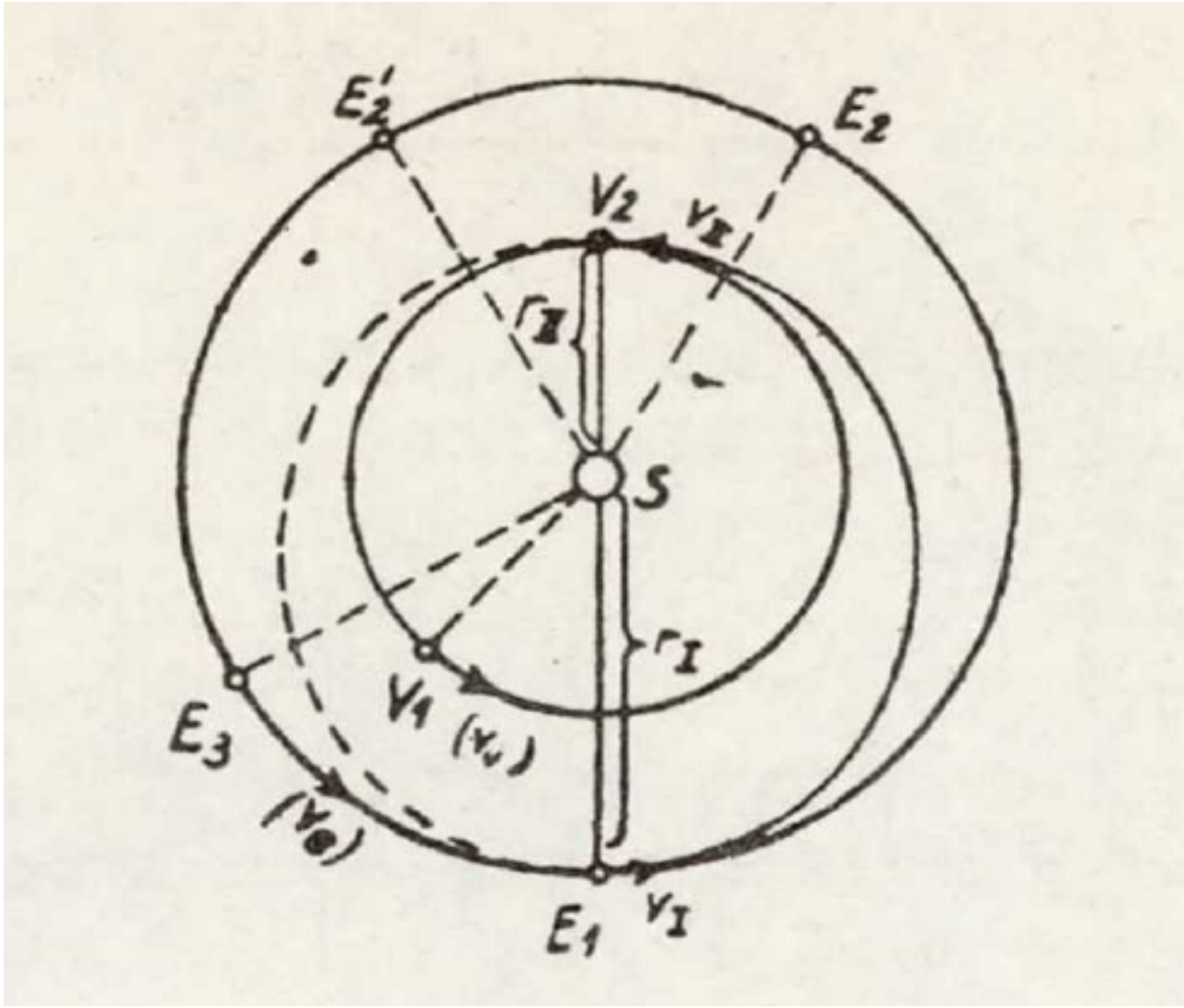

Ecliptic Plane
LAT = −4.2°
W90
E90
Vr (km/s)
200
550
900
1250
1600

4

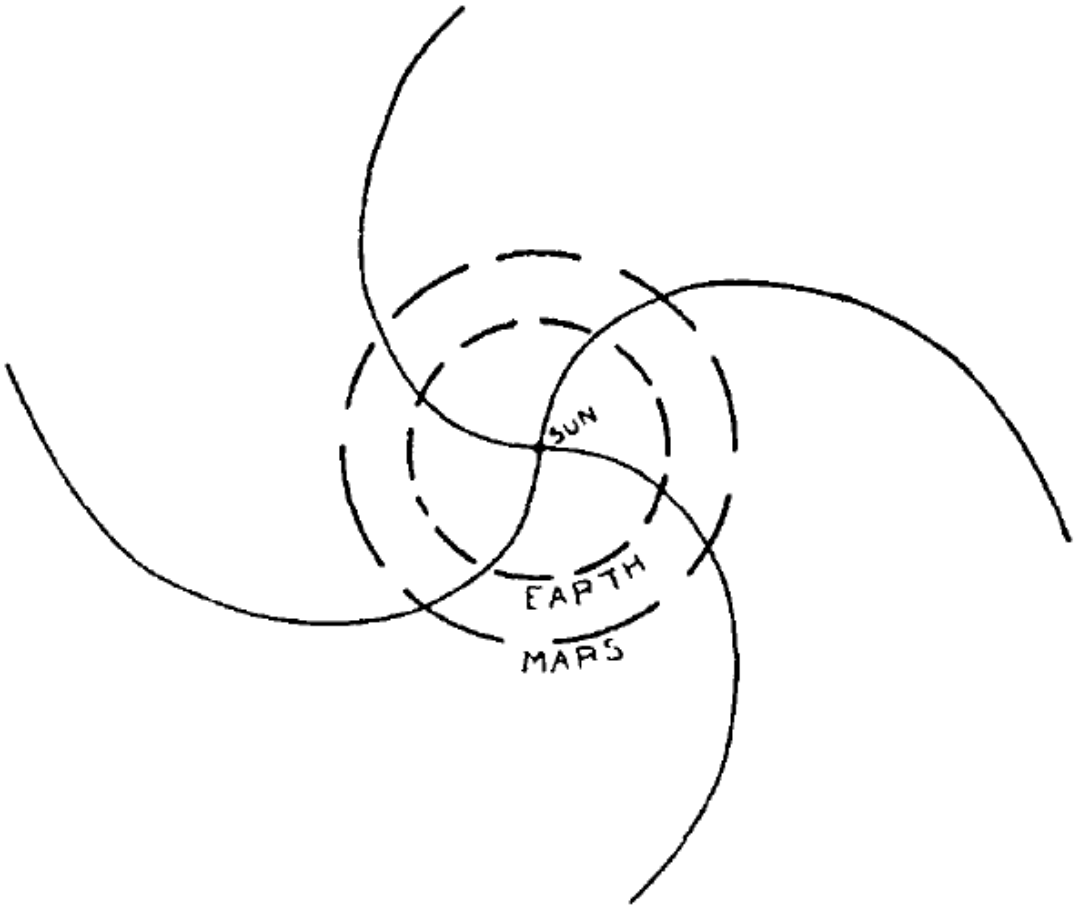
WSA-ENLIL & MSL Cruise Phase



c/o D. Odstrcil



Hohmann, 1925



Parker, 1958

Maximum Connection Distances in Constant-Speed SW Scenario

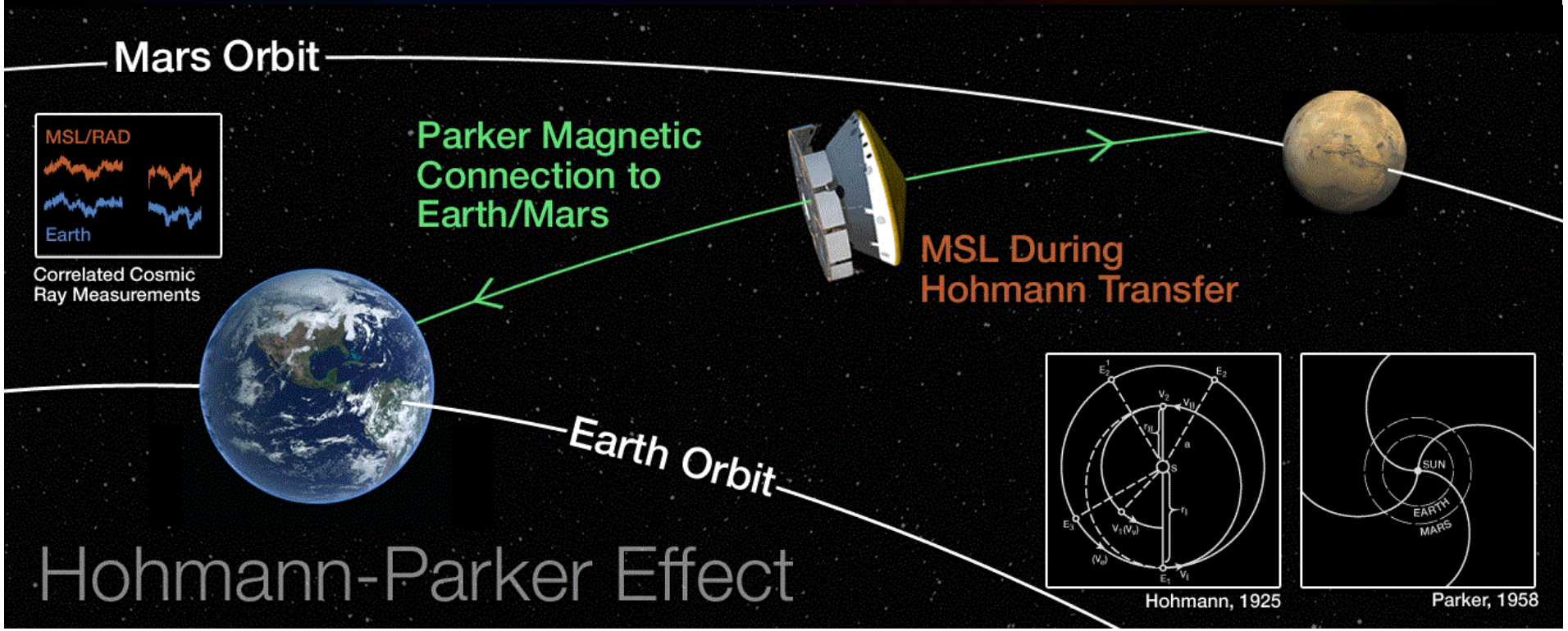
Transfer	Solar Wind at 300 km/s [deg]	Solar Wind at 400 km/s [deg]	Solar Wind at 500 km/s [deg]	Semimajor Axes Ratio (outer vs inner planet)
Mercury Venus	10	9	9	1.85
Venus Mercury	13	10	9	1.85
Venus Earth	7	5	5	1.39
Earth Venus	10	7	6	1.39
Earth Mars	13	9	8	1.52
Mars Earth	22	15	12	1.52

The Hohmann-Parker Effect

and its Consequences Measured by the Mars Science Laboratory on the Transfer from Earth to Mars

A. Posner, D. Odstrĉil , P. MacNeice, L. Rastaetter, C. Zeitlin, B. Heber, H. Elliott, R. A. Frahm, J.J.E.Hayes, T. T. von Rosenvinge, E. R. Christian, J. P. Andrews, R. Beaujean, S. Böttcher, D. E. Brinza, M. A. Bullock, S. Burmeister, F. A. Cucinotta, B. Ehresmann, M. Epperly, D. Grinspoon, J. Guo, D. M. Hassler, M.-H. Kim, J. Köhler, O. Kortmann, C. Martin Garcia, R. Müller-Mellin, K. Neal, S. C. R. Rafkin, G. Reitz, L. Seimetz, K. D. Smith, Y. Tyler, E. Weigle, and R. F. Wimmer-Schweingruber

Planetary and Space Sci., doi: 10.1016/j.pss.2013.09.013.

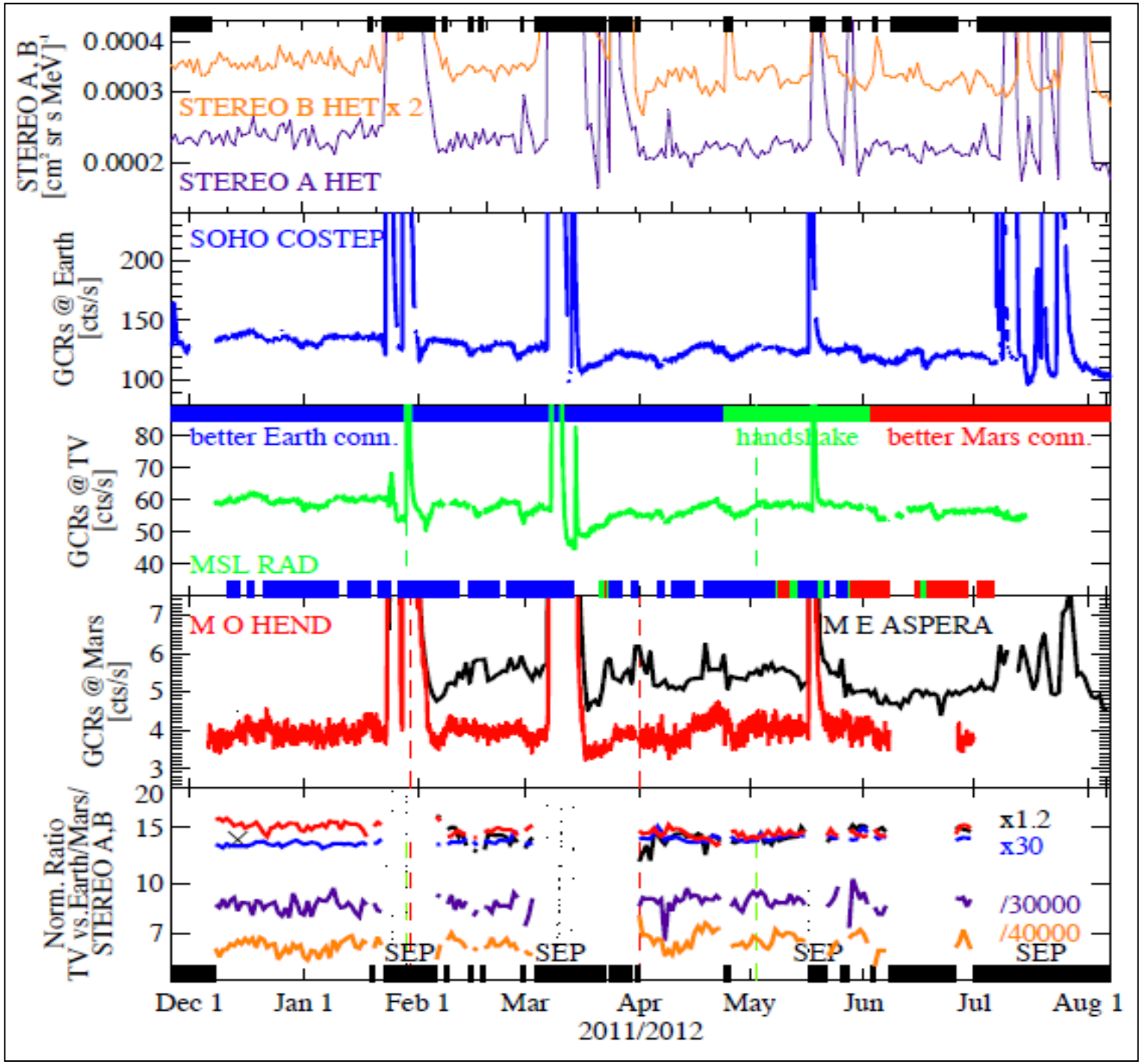


STEREO

Earth

Mars

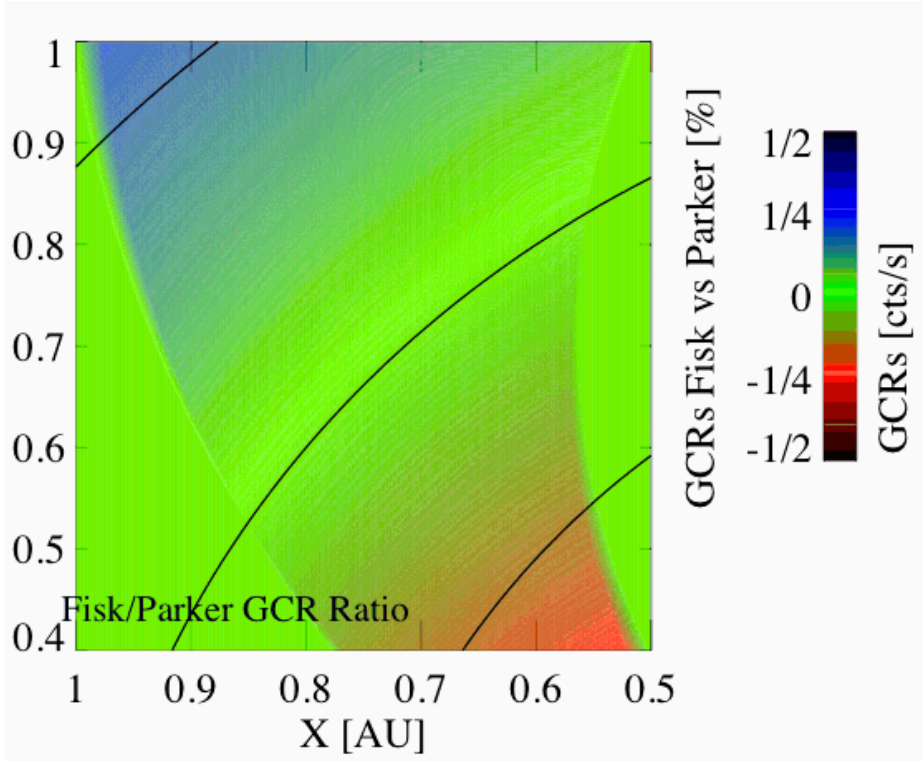
Ratios



- User Report: HP Effect and Science from New Missions

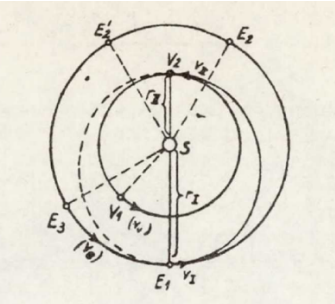
MAVEN Cruise Phase Science

A. Posner, W. Dröge, R. Wicks

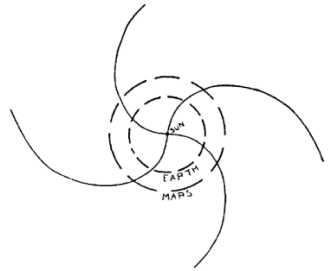


Solar Orbiter Early Mission Science

A. Posner (NASA/HQ)
W. Dröge (Univ. Würzburg)
R. Wicks (NASA/GSFC)



MAVEN and Solar Orbiter Early Mission Science



Science Opportunity with MAVEN and Solar Orbiter Early Mission Phase Observations:

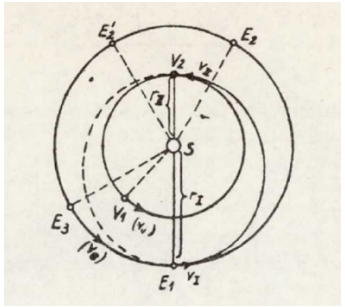
MAVEN and Solar Orbiter Cruise Phase Energetic Particle, Solar Wind Ion and Magnetic Field Observations in the Time Frame **Soon after Launch** are Critical for Heliospheric Science with SOHO, Wind, and ACE at Earth under **Hohmann-Parker Effect Conditions**

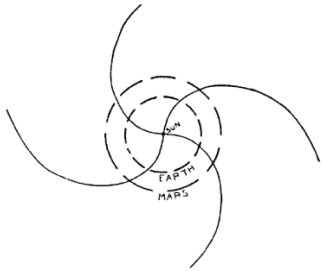
Three Examples:

(1) **Solar Wind Turbulence Studies:** Interplanetary Magnetic Field Foot Points almost Co-Located at the Sun: Solar Wind Speed, Composition, Magnetic Field Properties Correlated; Deduce Source of Turbulence, Temporal Evolution of Solar Wind at Sun and from ~0.7 AU to 1 AU

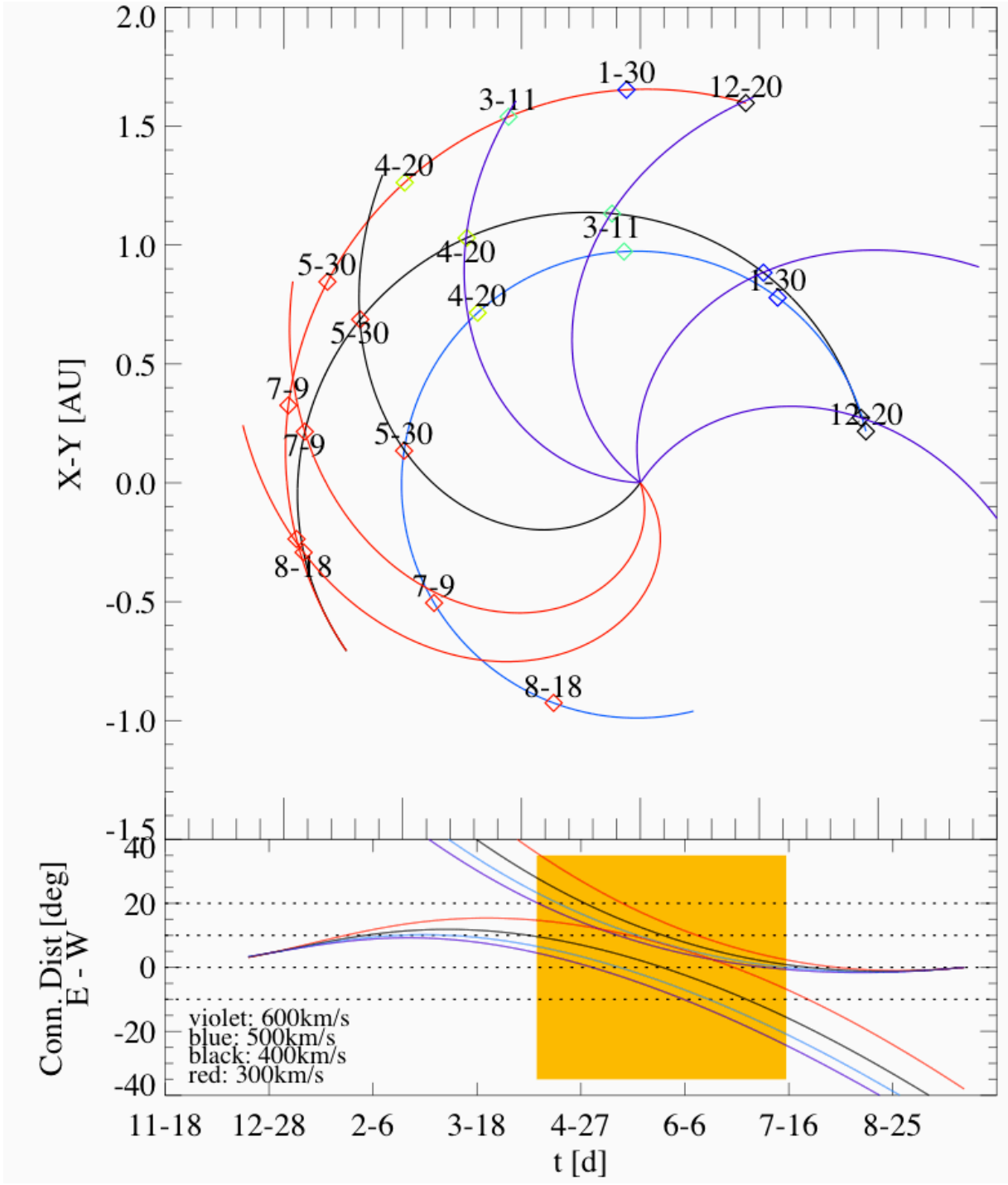
(2) **Particle Transport:** Solar Energetic Particle Event Intensities, Onsets Correlated; Deduce Basic SEP, GCR Particle Transport Parameters, Acceleration Mechanisms

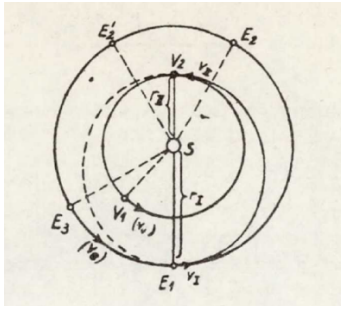
(3) **Interplanetary Magnetic Field Structure:** Large-Scale Structure Correctly Described by Parker (1958) or Fisk (1996) Model?

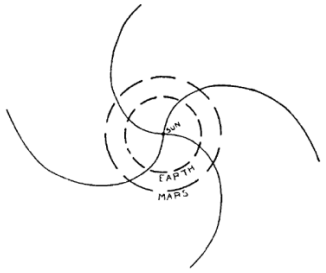




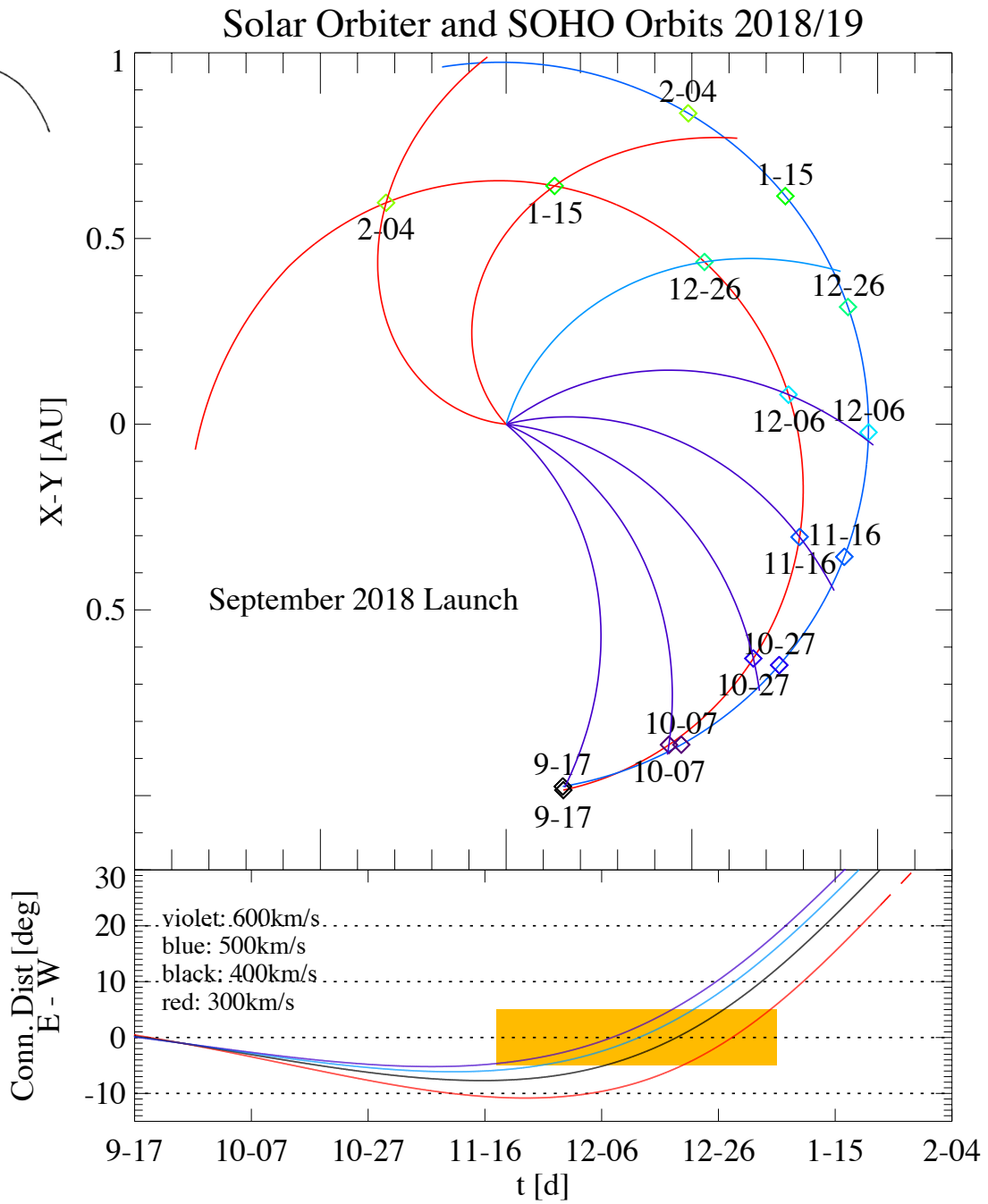
MAVEN Cruise Phase







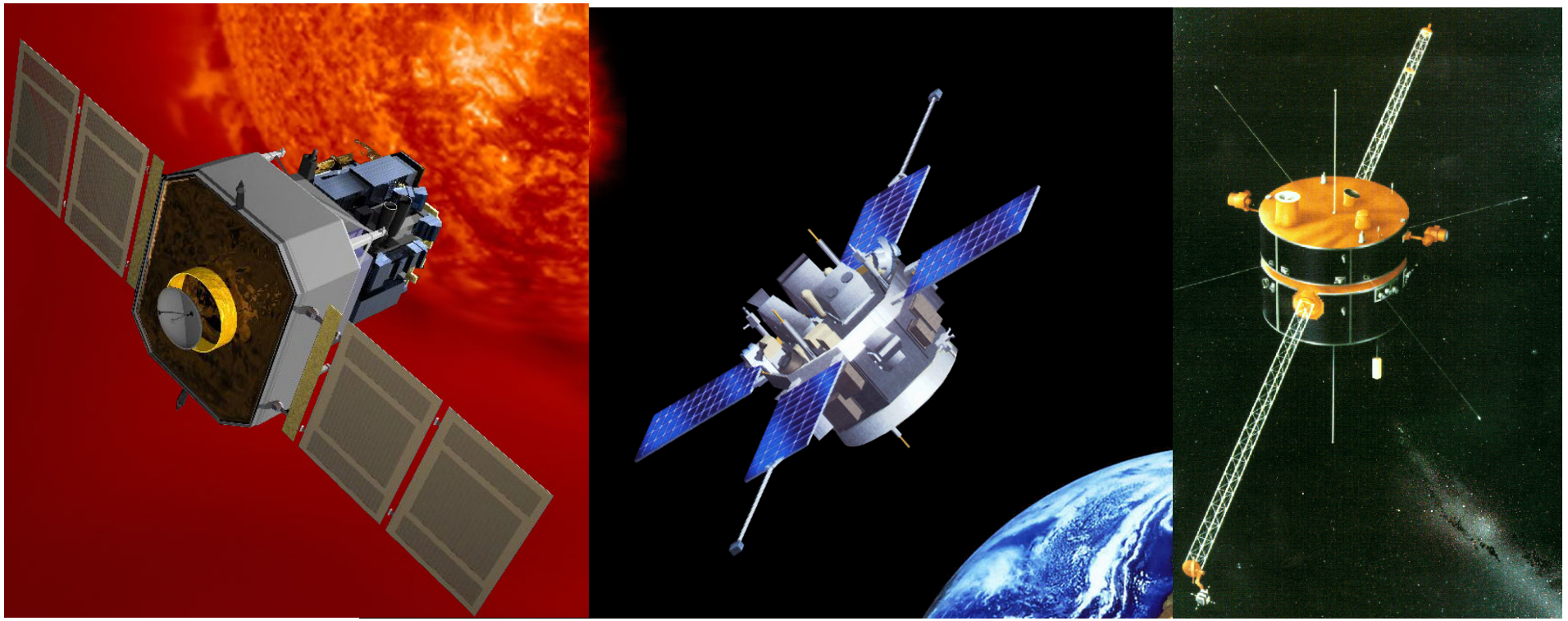
Solar Orbiter Launch Sep. 2018



Solar Orbiter HP-Effect Early-Mission Science Opportunities

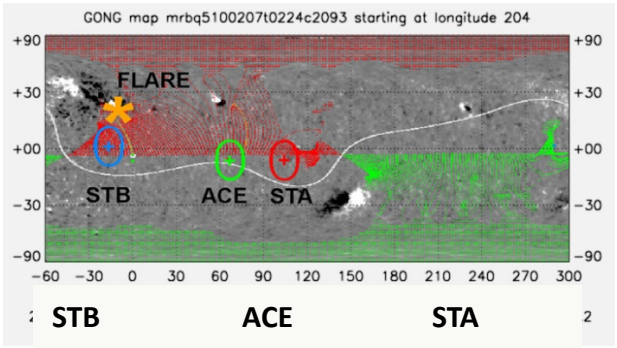
Launch Date	HP Effect Period	Days after Launch	Approx. Duration	Radial Distance SO
Jan. 02, 2017	Mar. 06, 2017– May 12, 2017	~63	~63 days	0.7 – 0.85 AU
March 2, 2017	May 25, 2017 – July 1, 2017	~84	~38 days	0.65 – 0.8 AU
July 27, 2017 (I) July 27, 2017 (II)	July 27, 2017- Nov. 4 2017 after Earth enc.	0 >365	~100 days	1.0 - 1.2 AU
Sept. 17, 2018	Nov. 18, 2018- Jan. 05, 2019	~62	~48 days	0.7 – 0.85 AU

- SOHO, ACE and Wind at L1 Carry Solar Wind, Magnetic Field, Plasma Wave, and Energetic Particle Instrumentation for HP Science with MAVEN and Solar Orbiter
- Recognition: REleASE Alerts from L1 Cover Major Fraction of Human Transfers From/To Mars

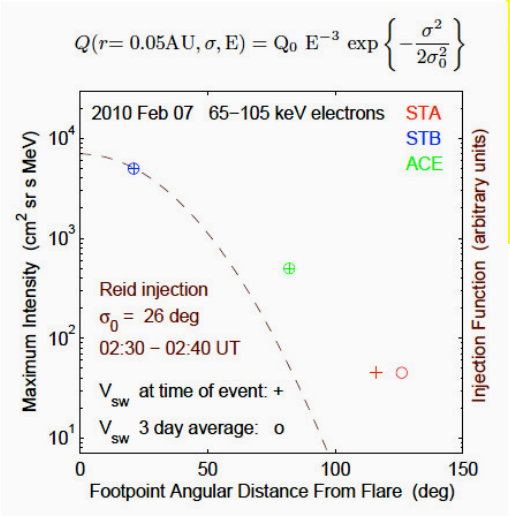


Transport Modeling of STEREO-A/B and ACE Electron Observations on 7 Feb 2010:
2b. Combination of Extended Injection at the Sun and 3-D Interplanetary Tranport
const/exp Injection and Classical Backmapping of Connecting Field Line (V_{SW} around Onset)

from Dröge et al (2014)



STB	ACE	STA
-16.4°	67.0°	104.4°

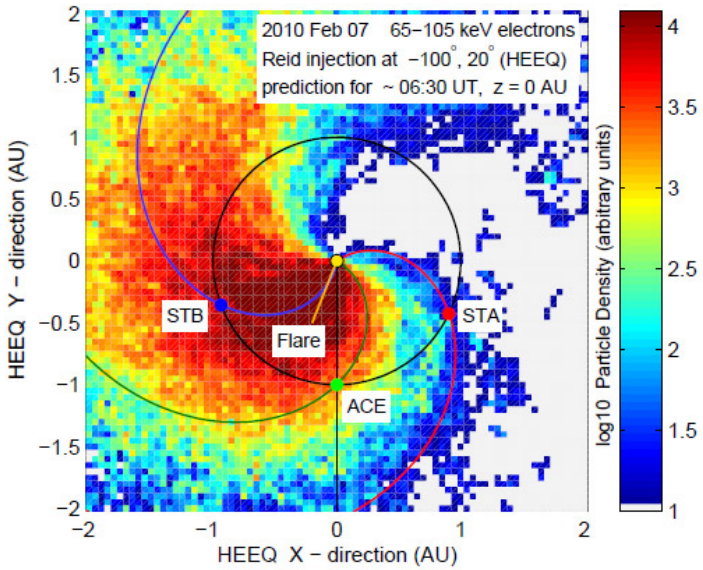


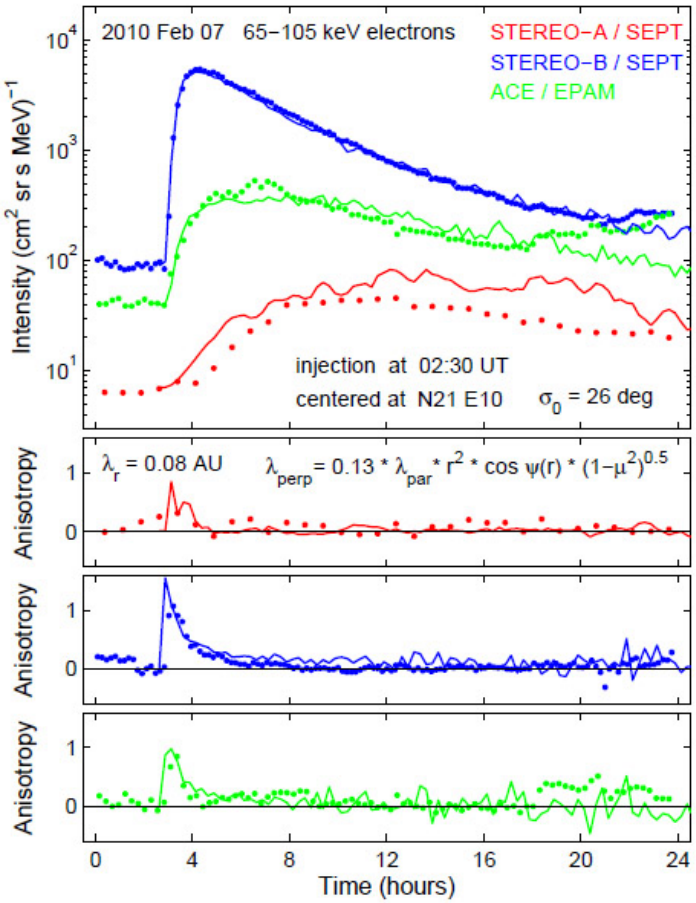
V_{SW} = 413 km/s (3 s/c average)

$\lambda_{\parallel}$ = 0.08 / cos^2(ψ) AU

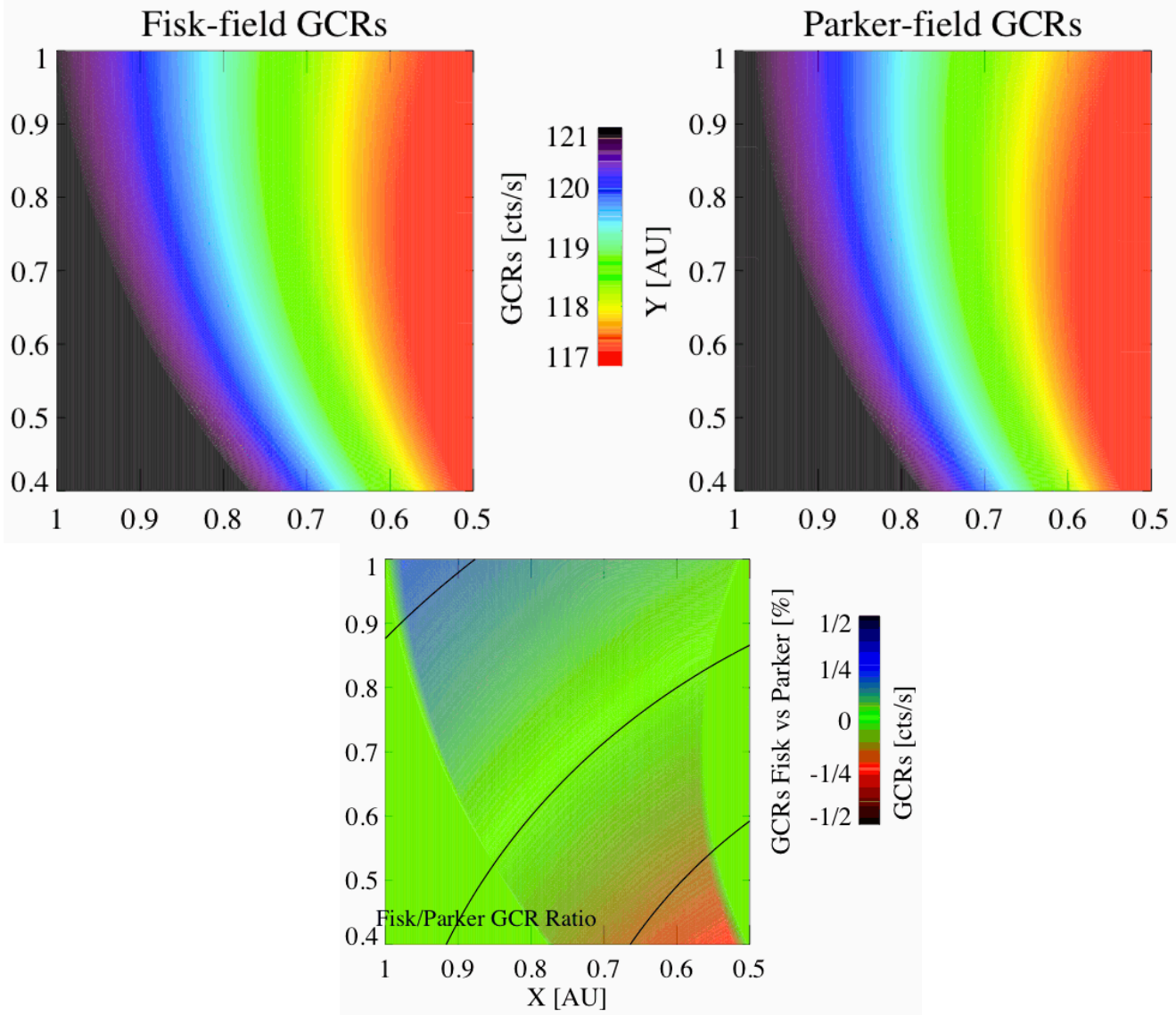
$\lambda_{\perp}$ = 0.13 * $\lambda_{\parallel}$ * (r/1 AU)^2 * cos(ψ) * (1-μ^2)$^{0.5}$

Scales with Gyroradius (B and sin(θ))





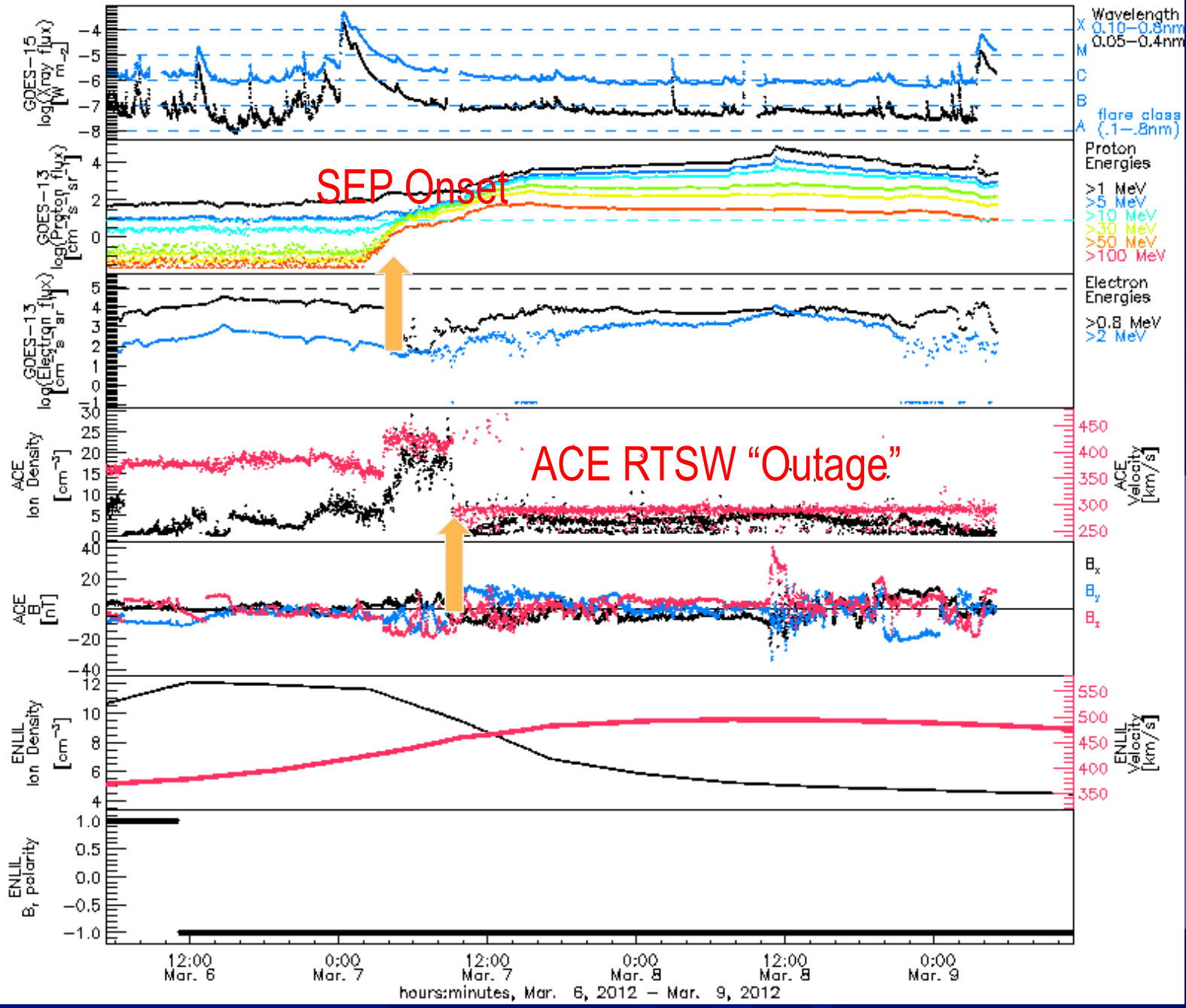
HP Effect Application: Example of Parker vs. Fisk Field



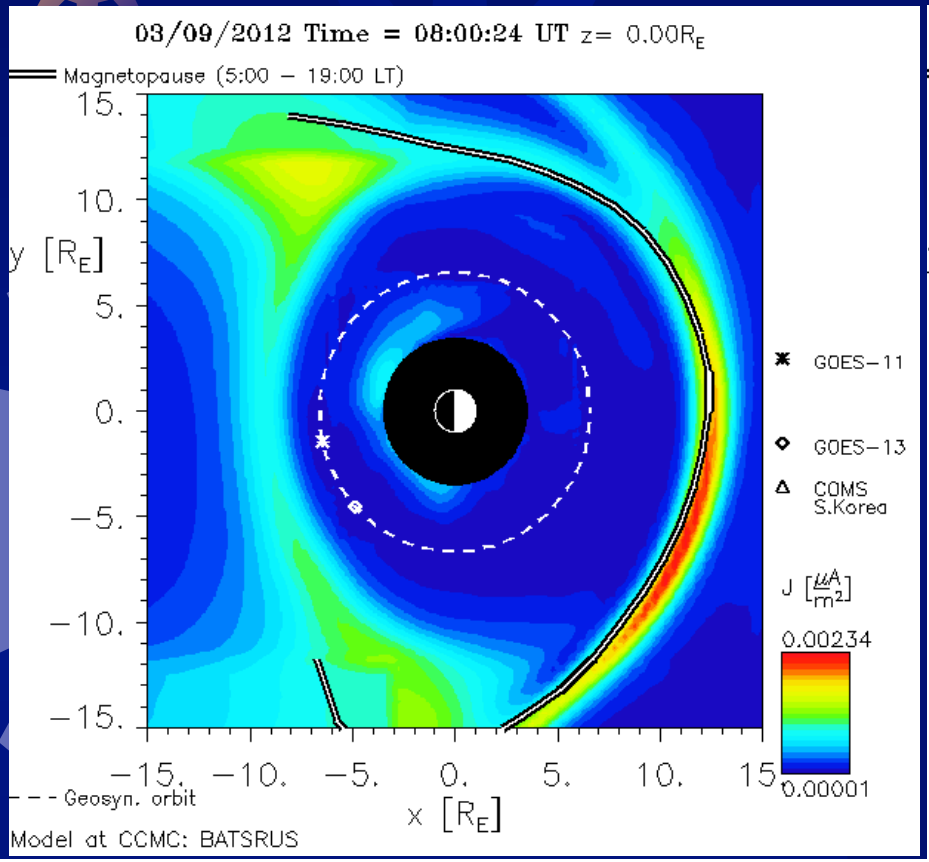
REleASE

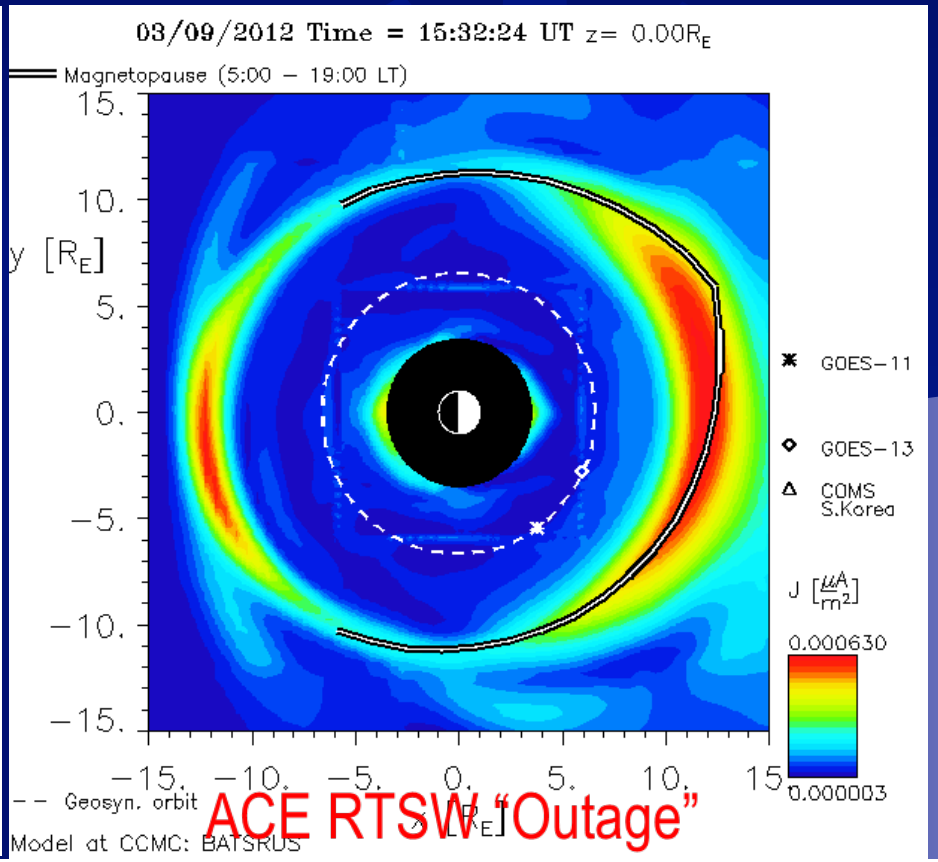
Relativistic Electron Alert System for Exploration

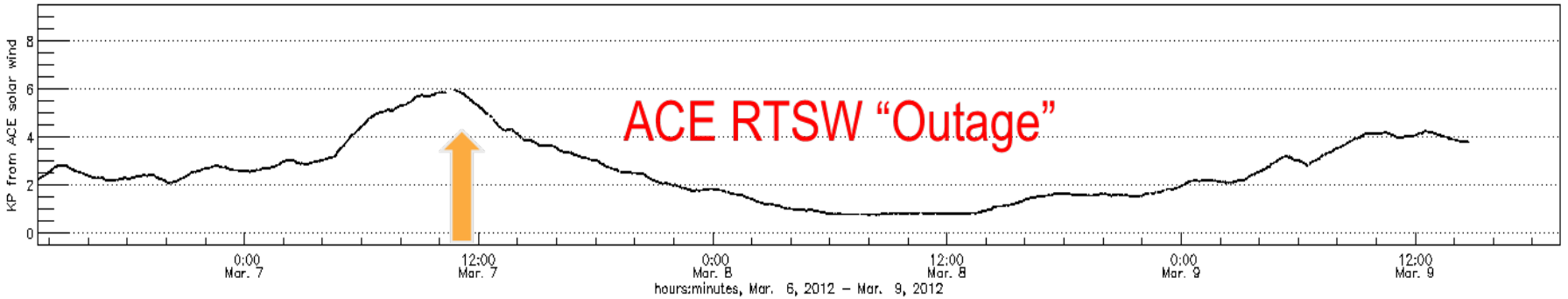
User Report: Space Weather Hardware and Modeling

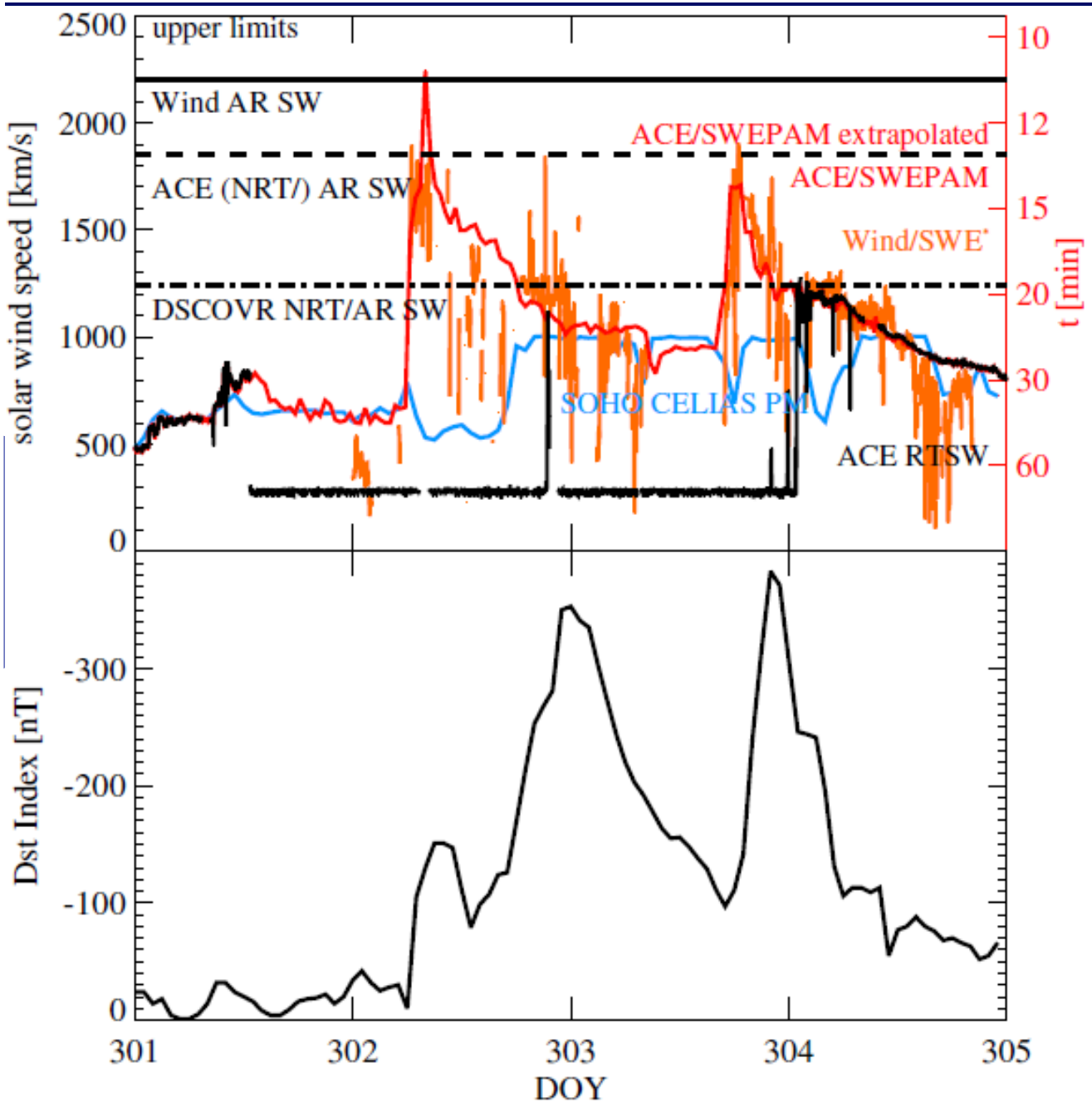

SEP Onset
ACE RTSW "Outage"
GOES-15 log(X-ray flux) [W m-2]
Wavelength
X 0.10–0.8nm
0.05–0.4nm
M
C
B
A
flare class (.1–.8nm)
GOES-13 log(Proton flux) [cm-2 s-1 sr-1]
Proton Energies
>1 MeV
>5 MeV
>10 MeV
>30 MeV
>50 MeV
>100 MeV
GOES-13 log(Electron flux) [cm-2 s-1 sr-1]
Electron Energies
>0.8 MeV
>2 MeV
ACE Ion Density [cm-3]
ACE Velocity [km/s]
ACE B [nT]
Bx
By
Bz
ENLIL Ion Density [cm-3]
ENLIL Velocity [km/s]
ENLIL Br polarity
12:00 Mar. 6
0:00 Mar. 7
12:00 Mar. 7
0:00 Mar. 8
12:00 Mar. 8
0:00 Mar. 9
hours:minutes, Mar. 6, 2012 – Mar. 9, 2012

Model Confusion Due to Hardware Issues



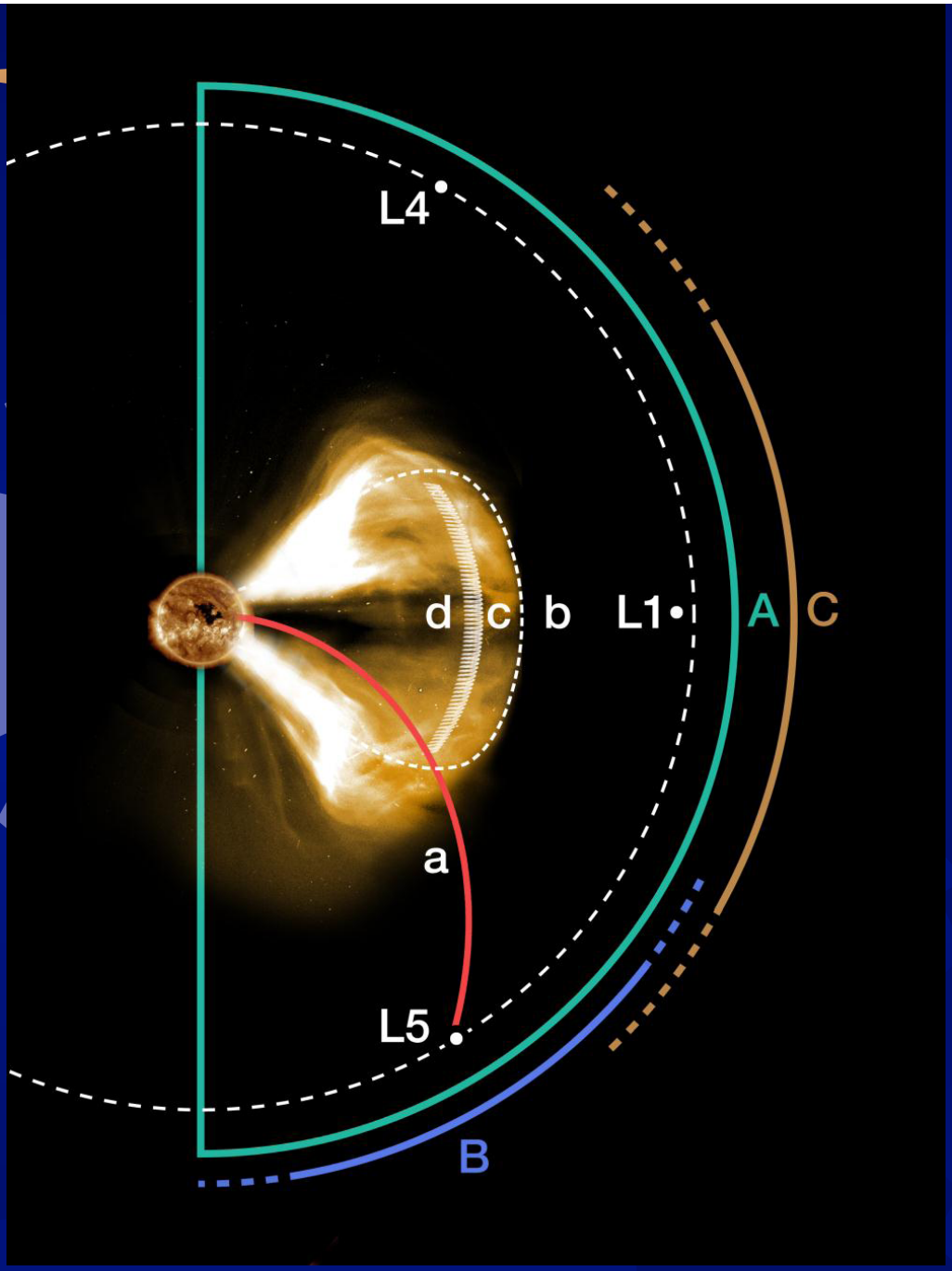






Solar Wind "Outages" Expected Now and in Future

Posner, Hesse, StCyr, The Main Pillar: Assessment of Space Weather Observational Asset Performance Supporting Nowcasting, Forecasting, and Research to Operations, *Space Weather J., in press*, 2014.



L4 vs L5:
For Earth-Directed CMEs:
L5 Position Exposed to
Fast-Rising SEPs

Consider L4 as Better Option

Discussed in Posner, Hesse, StCyr, *SWJ*, 2014.

Backup Charts