Planetary Radio Emissions as Remote Space Weather Probes

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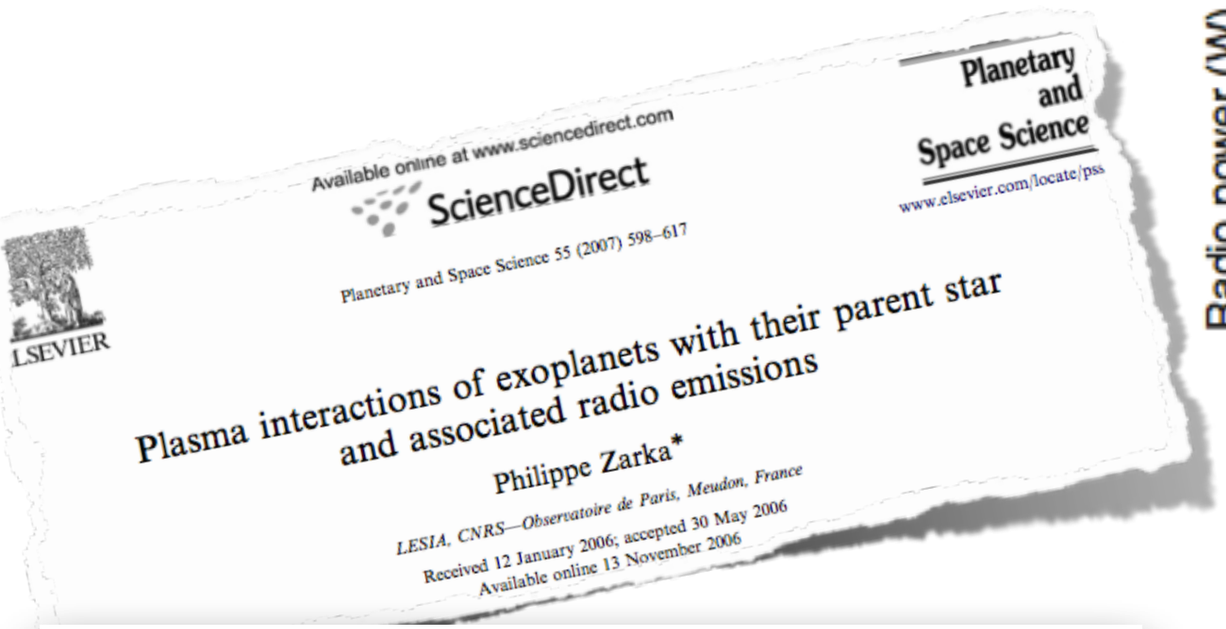
Radio «Bode's Law»



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Plasma interactions of exoplanets with their parent star and associated radio emissions

Philippe Zarka*
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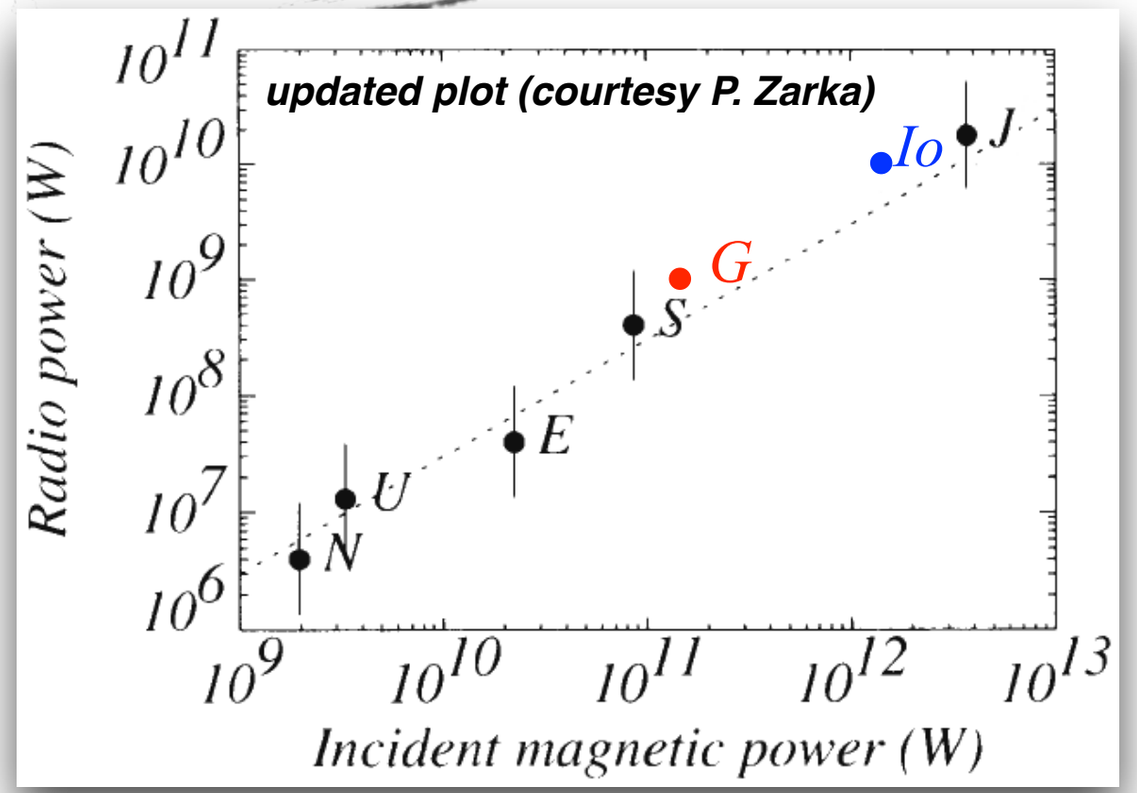


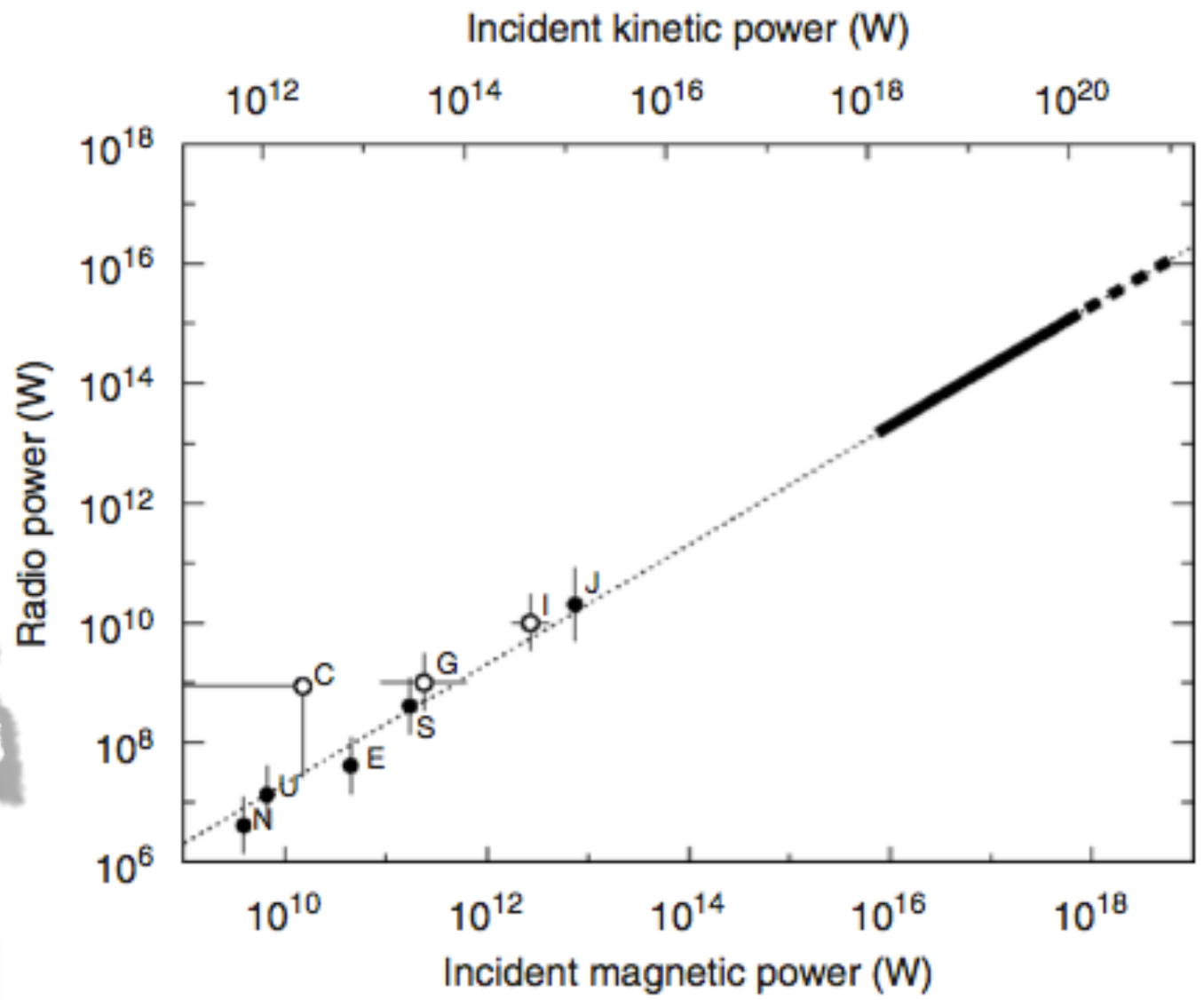
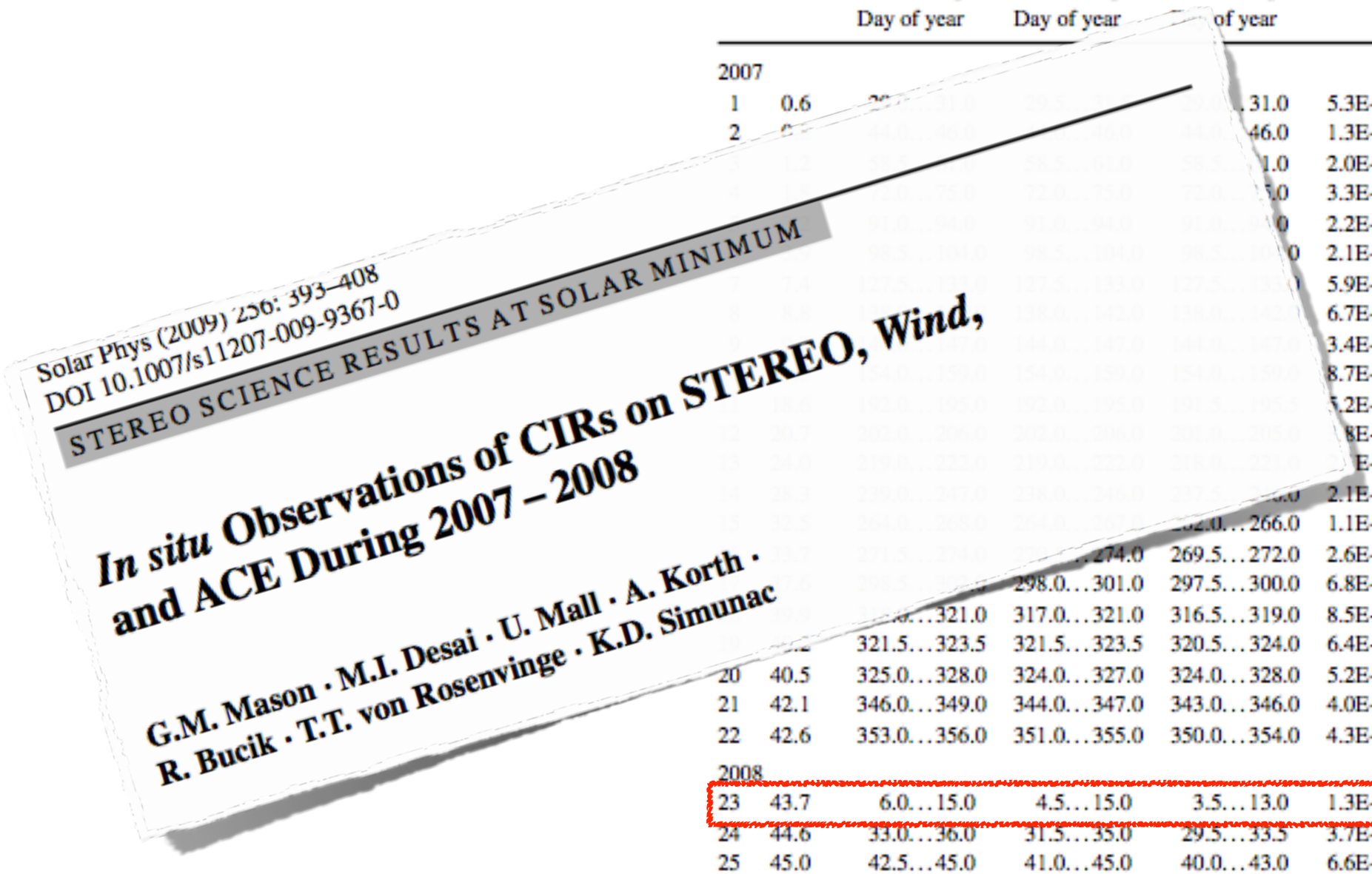


Fig. 6. Generalized "Radio Bode's laws" showing the proportionality (slope~1) between output planetary radio powers and the SW power (kinetic-upper horizontal scale- or magnetic-lower horizontal scale) incident on the magnetopause. E, J, S, U, N are the initials of the 5 radio planets. Kinetic-to-radio efficiency is $\sim 10^{-5}$, magnetic-to-radio efficiency is $\sim 2 \times 10^{-3}$. Open dots show the correlation between induced radio emissions from Io, Ganymede and an upper limit for Callisto, and dissipated magnetic power deduced from Eq. (8) and Table 2. The thick bar results from extrapolation to hot Jupiters of the SW–planet magnetospheric interaction (solid) and dipolar and unipolar star-planet interaction (dashed).

CIR List


Solar Phys (2009) 256: 393–408
DOI 10.1007/s11207-009-9367-0
STEREO SCIENCE RESULTS AT SOLAR MINIMUM

***In situ* Observations of CIRs on STEREO, Wind, and ACE During 2007 – 2008**

G.M. Mason · M.I. Desai · U. Mall · A. Korth · R. Bucik · T.T. von Rosenvinge · K.D. Simunac

Table 1 CIR events

CIR #	Angle ° (a)	SIT-A Start…Stop Day of year	ULEIS Start…Stop Day of year	SIT-B Start…Stop of year	ULEIS peak intensity (b)	ULEIS spectral index (c)	Notes
2007							
1	0.6			31.0	5.3E+1 ± 1.9E+0	2.56 ± 0.01	d, e
2				46.0	1.3E+1 ± 5.3E-1	2.28 ± 0.01	d, e
				1.0	2.0E+1 ± 6.8E-1	2.44 ± 0.01	d, e
				5.0	3.3E+1 ± 9.1E-1	1.72 ± 0.01	d, e
				0	2.2E+0 ± 2.2E-1	3.36 ± 0.03	
				0	2.1E+0 ± 2.1E-1	2.77 ± 0.02	
					5.9E+1 ± 1.8E+0	2.46 ± 0.01	d
					6.7E+0 ± 3.8E-1	2.00 ± 0.01	d
					3.4E+1 ± 1.4E+0	2.77 ± 0.01	
					8.7E+0 ± 4.4E-1	3.20 ± 0.02	
					5.2E+1 ± 2.1E+0	3.07 ± 0.01	
					8E-1 ± 9.0E-2	3.73 ± 0.08	f
					E+0 ± 2.1E-1	2.54 ± 0.02	
					2.1E+0 ± 2.2E-1	1.44 ± 0.03	
				266.0	1.1E+1 ± 4.8E-1	2.30 ± 0.02	
			274.0	269.5…272.0	2.6E+0 ± 2.4E-1	2.08 ± 0.02	
			298.0…301.0	297.5…300.0	6.8E+0 ± 4.1E-1	3.62 ± 0.02	
		…321.0	317.0…321.0	316.5…319.0	8.5E-1 ± 1.3E-1	3.86 ± 0.06	
		321.5…323.5	321.5…323.5	320.5…324.0	6.4E-2 ± 3.7E-2	3.76 ± 0.34	
20	40.5	325.0…328.0	324.0…327.0	324.0…328.0	5.2E+1 ± 2.4E+0	3.30 ± 0.01	
21	42.1	346.0…349.0	344.0…347.0	343.0…346.0	4.0E+0 ± 2.9E-1	3.05 ± 0.02	
22	42.6	353.0…356.0	351.0…355.0	350.0…354.0	4.3E+1 ± 1.8E+0	2.97 ± 0.01	
2008							
23	43.7	6.0…15.0	4.5…15.0	3.5…13.0	1.3E+1 ± 5.3E-1	1.88 ± 0.01	
24	44.6	33.0…36.0	31.5…35.0	29.5…33.5	3.7E+0 ± 2.8E-1	1.81 ± 0.02	
25	45.0	42.5…45.0	41.0…45.0	40.0…43.0	6.6E+1 ± 2.1E+0	2.46 ± 0.01	
26	45.7	61.0…63.0	58.0…62.0	57.5…60.0	7.7E+0 ± 4.1E-1	1.90 ± 0.02	
27	46.1	69.5…73.0	69.0…71.0	67.0…70.0	2.4E+0 ± 2.3E-1	3.05 ± 0.04	
28	47.2	88.0…91.5	86.0…90.0	85.0…87.0	5.4E+0 ± 3.5E-1	1.99 ± 0.02	
29	48.0	98.0…101.0	96.0…99.5	94.0…97.0	1.5E+0 ± 1.8E-1	2.85 ± 0.04	
30	49.5	115.5…117.4	113.5…115.5	112.0…114.5	6.2E-1 ± 1.2E-1	3.84 ± 0.08	g
31	57.1	168.5…171.0	167.0…171.0	165.5…169.0	7.2E-1 ± 1.2E-1	1.89 ± 0.05	
32	67.2	224.0…228.0	222.0…226.0	220.0…224.0	4.9E+1 ± 2.1E+0	3.43 ± 0.01	
33	69.1	234.0…238.0	231.0…237.0	229.0…232.0	2.4E-1 ± 7.1E-2	3.45 ± 0.08	h
34	71.9	250.5…254.0	247.5…250.5	245.5…249.0	4.9E-1 ± 1.0E-1	2.82 ± 0.07	
35	76.7	277.5…282.0	275.0…280.0	272.0…277.0	1.1E+1 ± 4.9E-1	1.76 ± 0.01	
36	80.6	305.5…309.0	302.5…305.0	299.0…305.0	1.4E+0 ± 1.7E-1	2.49 ± 0.04	

Propagation Model (HELIO)

SW Propagation model Output

INPUT

Start Time
2008-01-01T00:00:00.000

Longitude
0.00

SolarWind speed
400.00

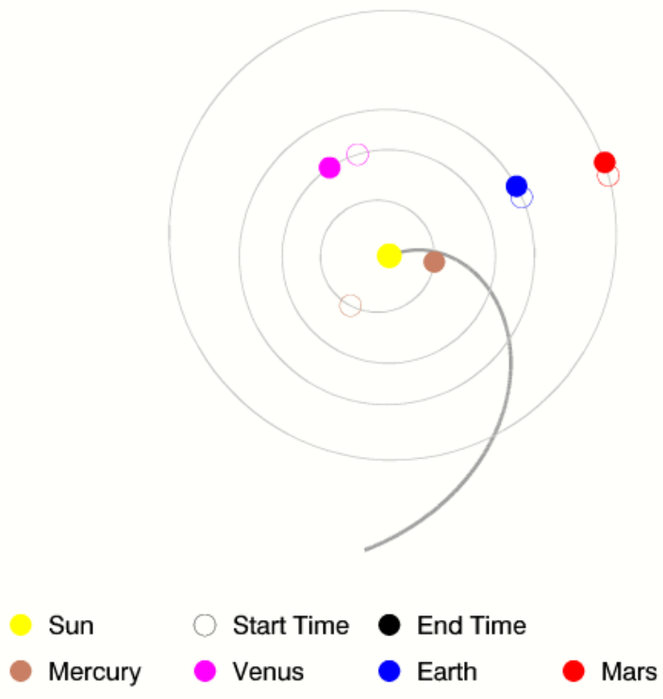
Reset

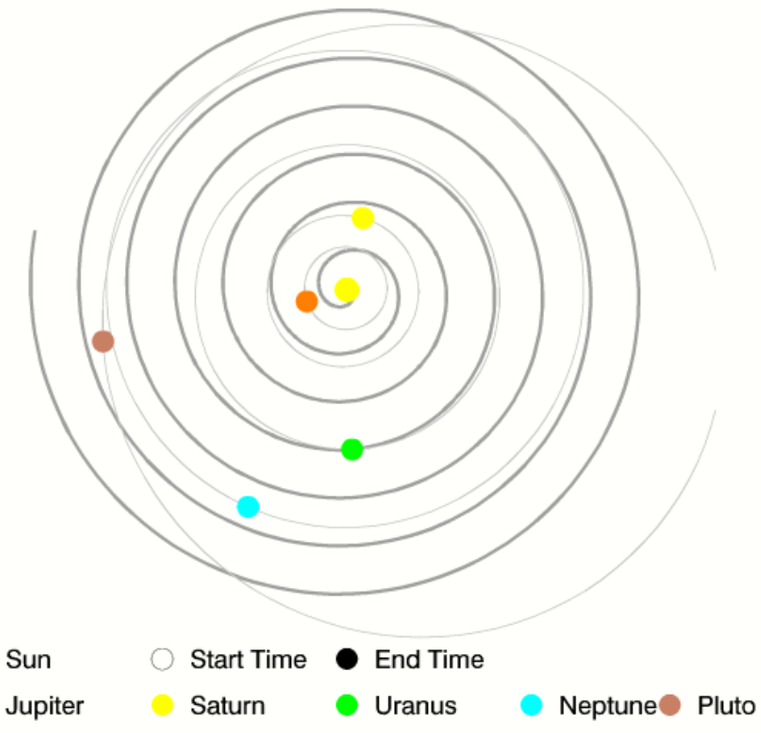
Output

Planet	ETA	Dt(days)
MERCURY	2008-01-26T06:12:16.634	25.26
VENUS	2008-01-11T10:13:43.215	10.43
EARTH	2008-01-05T14:20:41.951	4.60
MARS	2008-01-07T20:26:48.410	6.85
JUPITER	2008-01-10T00:58:26.463	9.04
SATURN	2008-01-18T18:57:25.199	17.79
URANUS	2008-01-01T01:45:48.616	0.07
NEPTUNE	2008-01-15T22:29:42.869	14.94
PLUTO	2008-01-17T22:21:42.437	16.93

Download VOTable

- GOES plotter
- Flare plotter
- Solar Monitor for 1-Jan-2008
- Space Weather for 1-Jan-2008





Propagation Model (HELIO)

SW Propagation model Output

INPUT

Start Time
2008-01-01T00:00:00.000

Output

Planet	ETA	Dt(days)
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- GOES plotter
- Flare plotter
- Solar Monitor for 1-Jan-2008
- Space Weather for 1-Jan-2008

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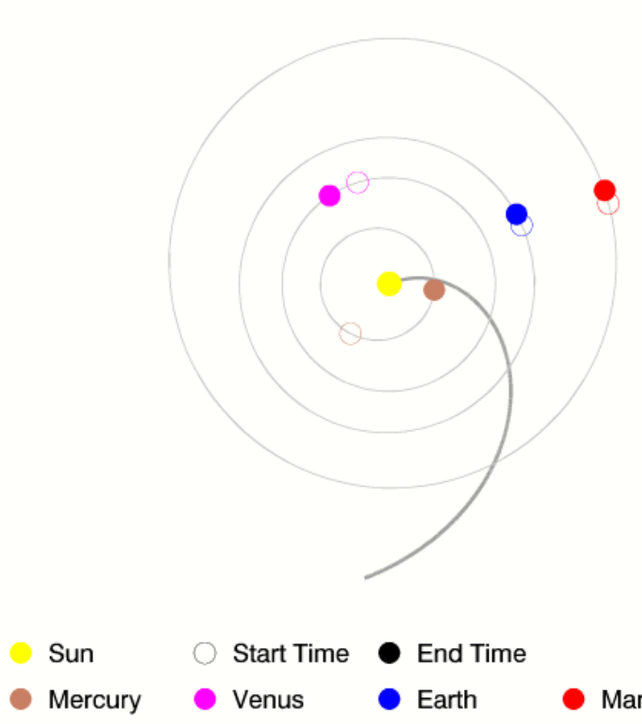
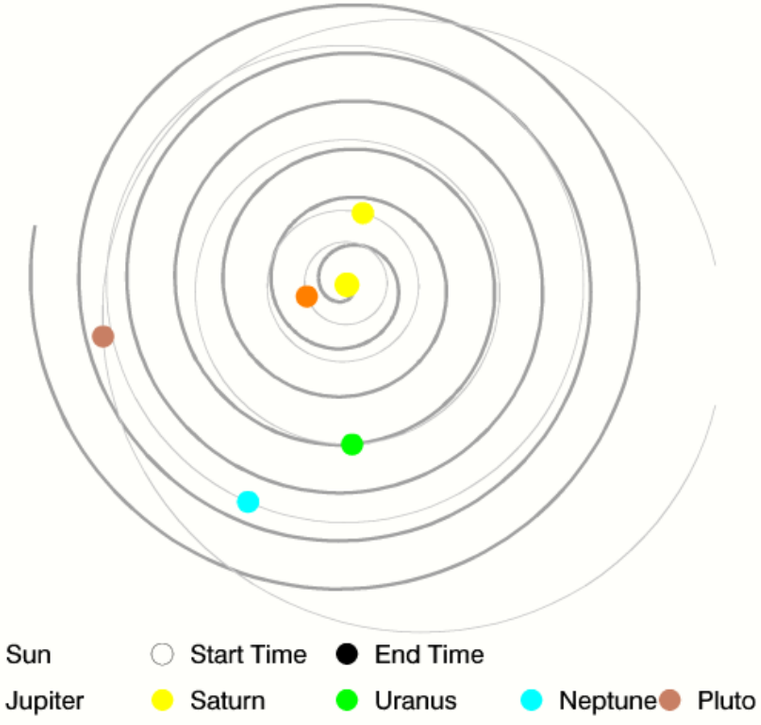




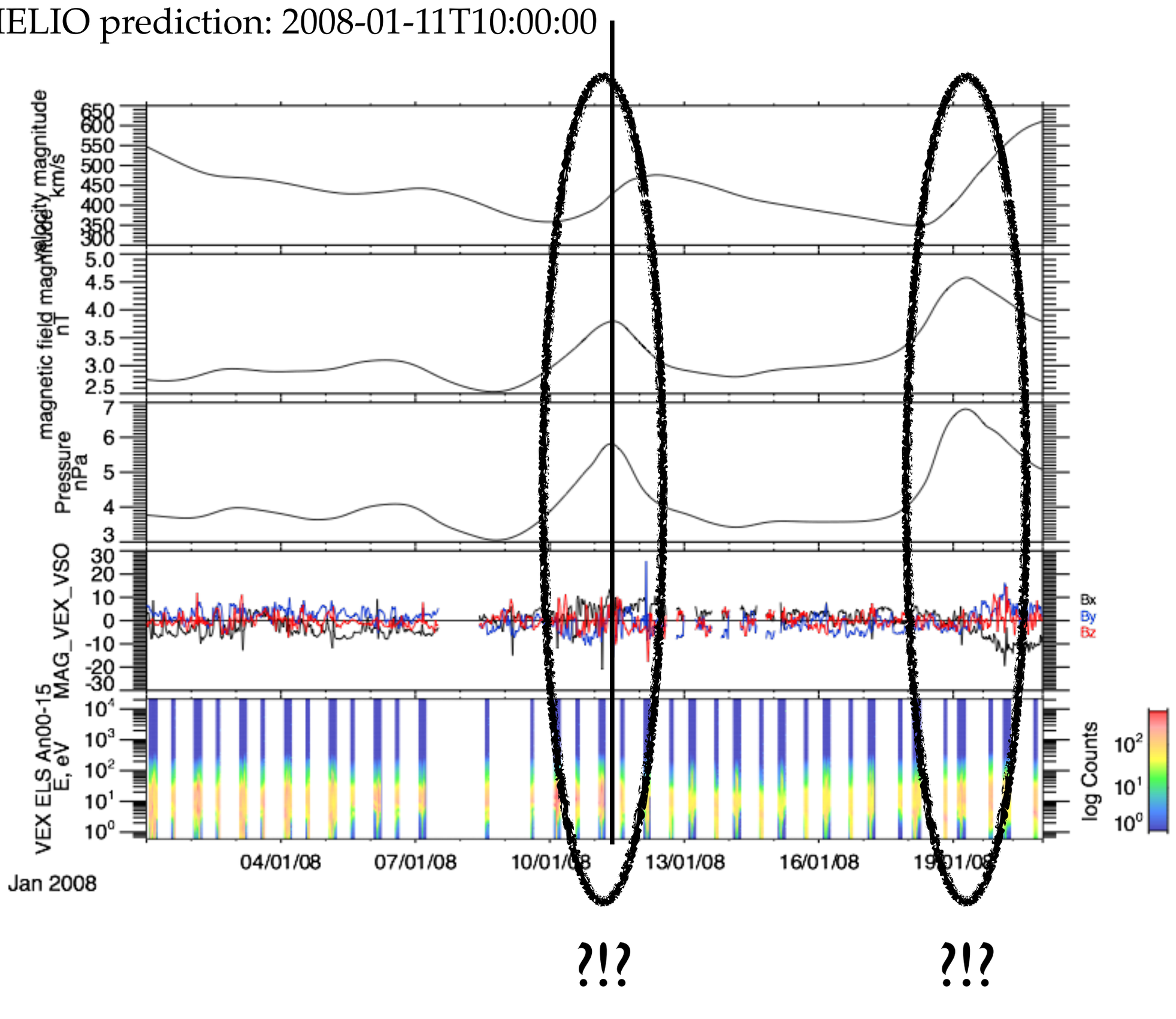
Data at Venus

Plots in AMDA

CCMC

VEx-Mag

VEx-ELS

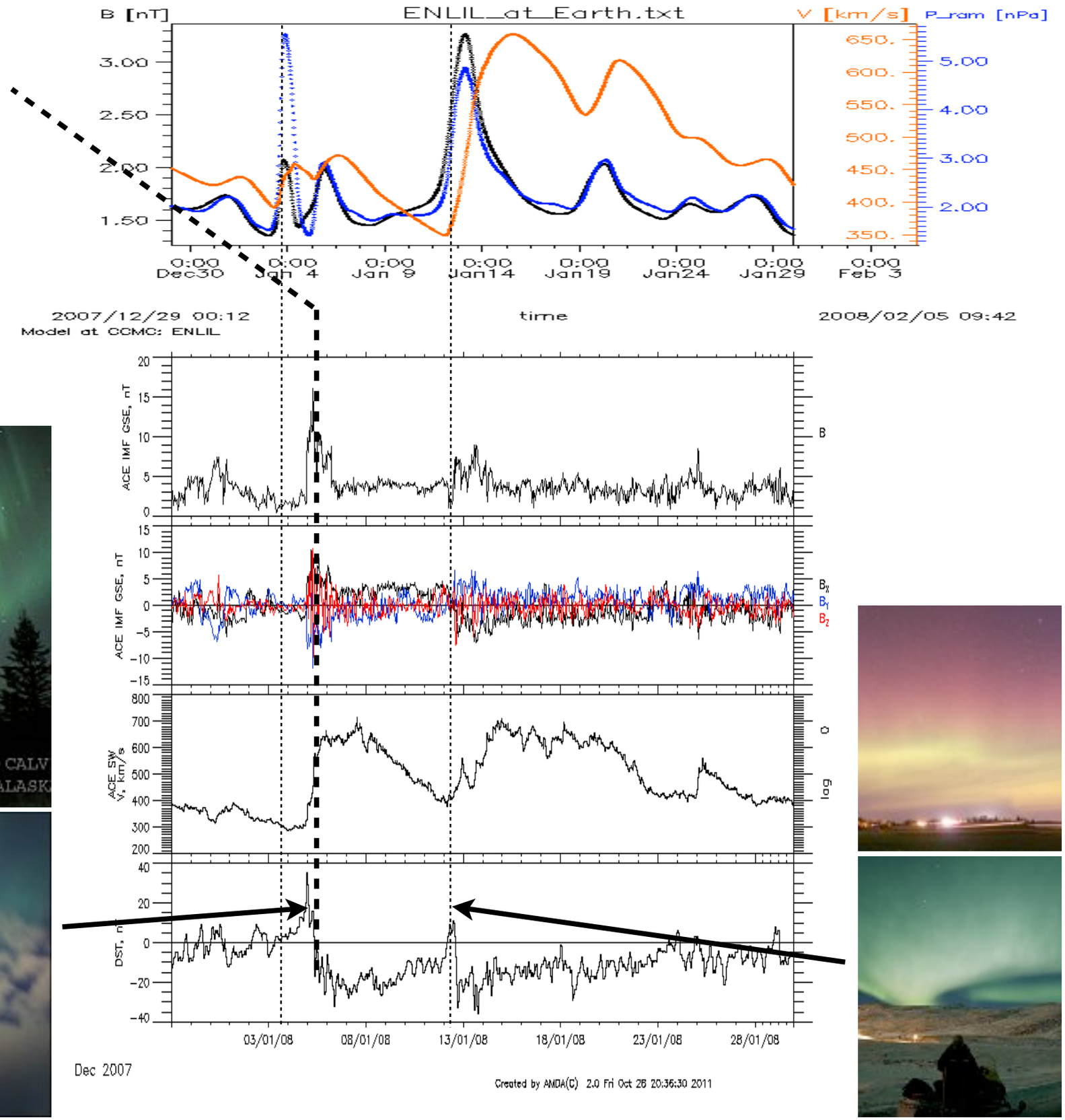


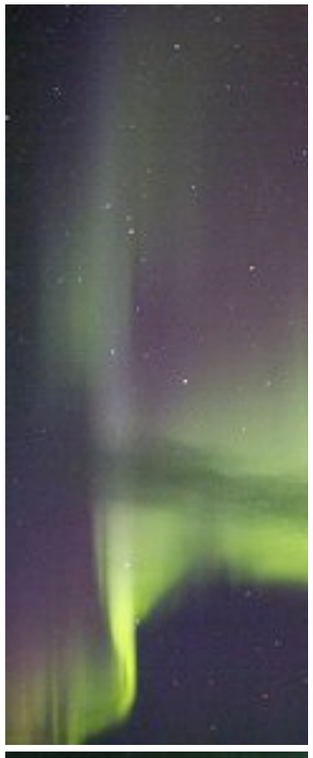
Data at Earth

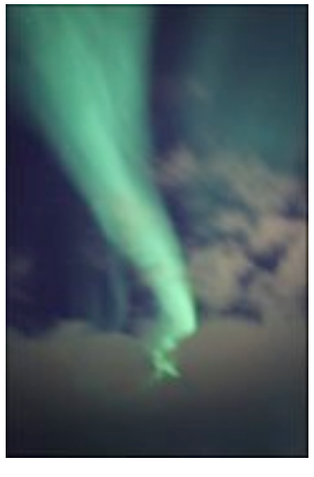
Plots in AMDA

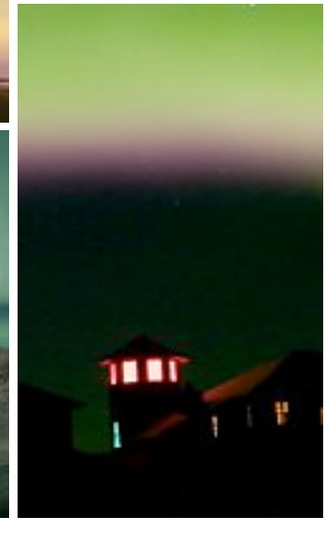
http://spaceweather.com/aurora/gallery_01jan08_page3.htm

HELIO prediction:
2008-01-05T14:30:00









Data at Mars

Plots in AMDA

MEx-ELS

CCMC

HELIO prediction:
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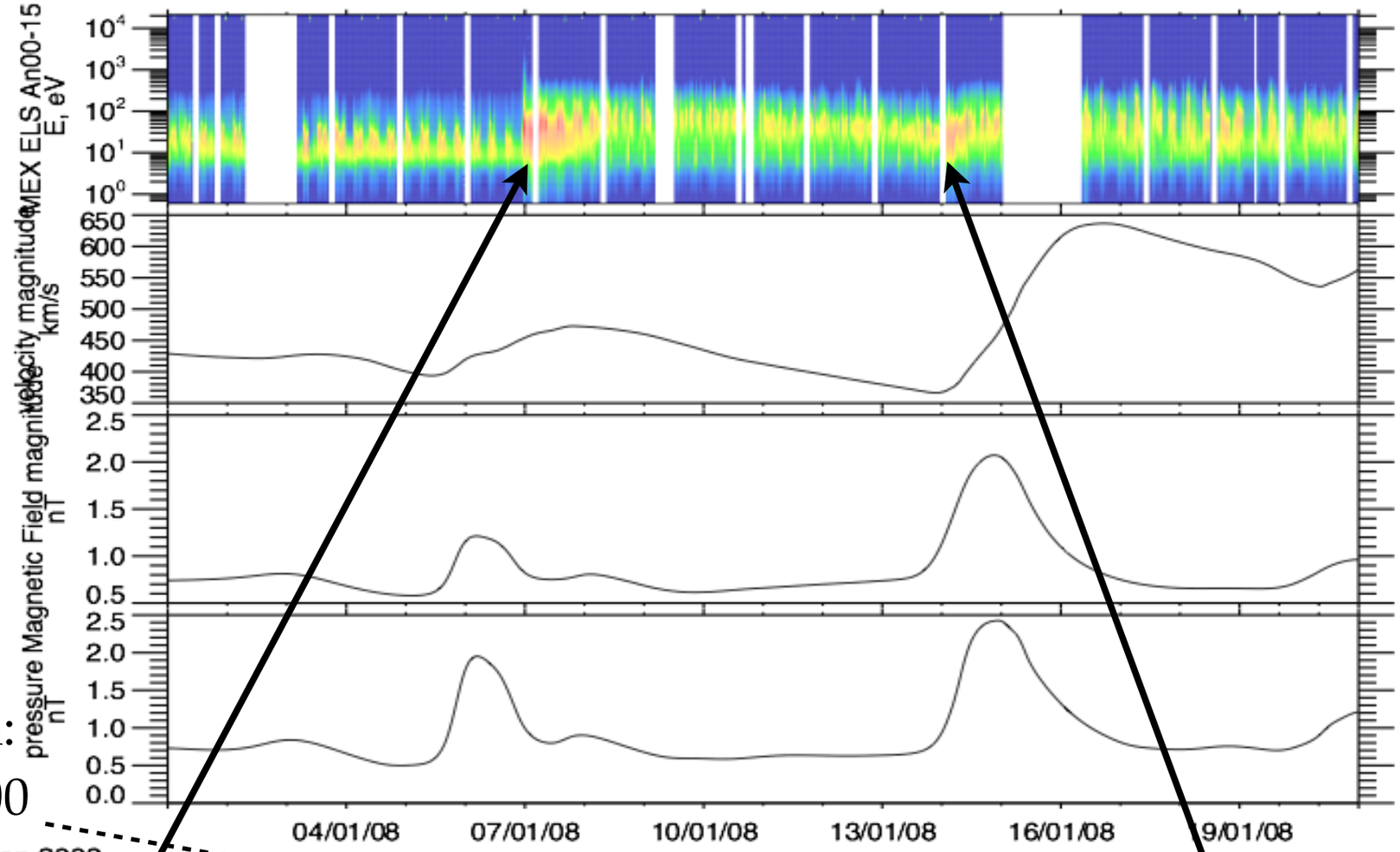
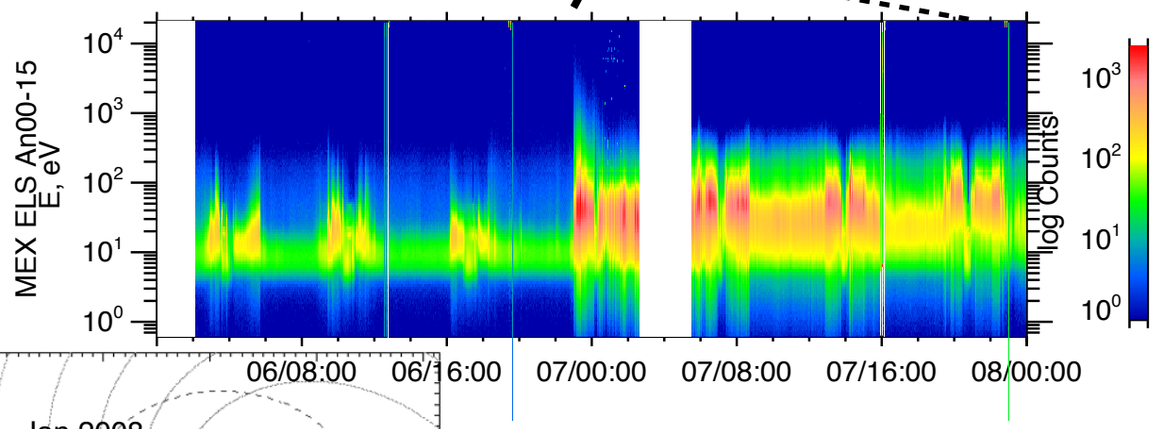
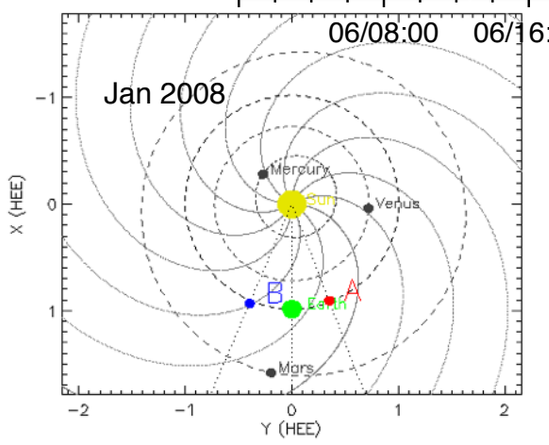


Jan 2008





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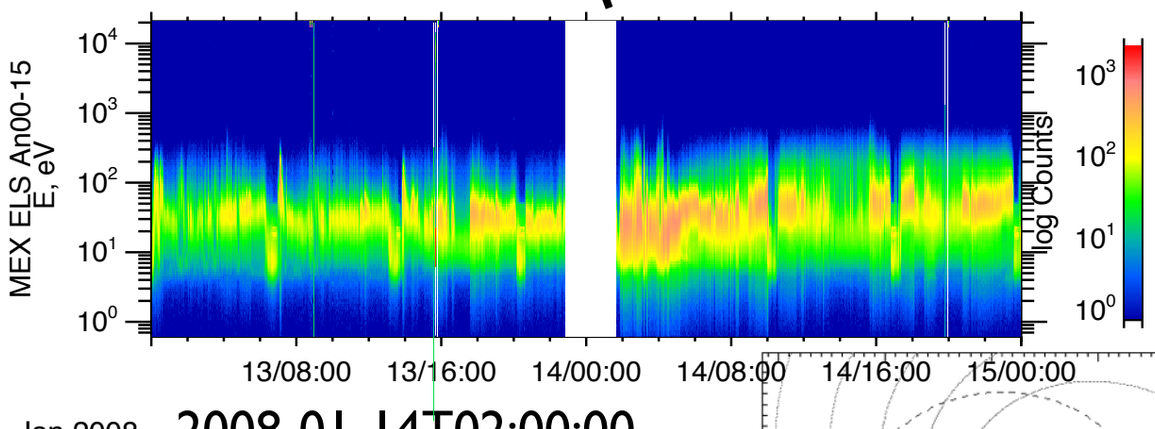
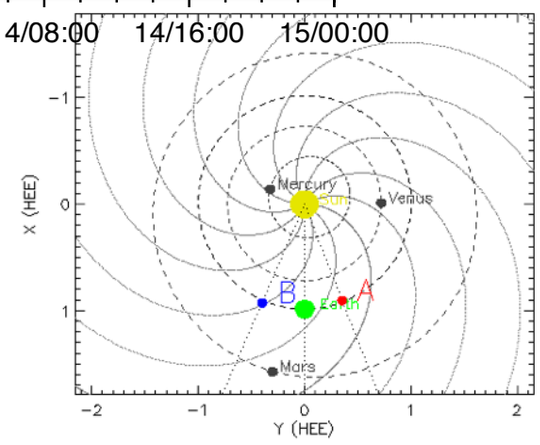
Jan 2008

2008-01-14T02:00:00





mSWiM : MHD Propagation to Jupiter

Date/Time

2 successive shocks

2008-01-09T12:00:00

2008-01-13T06:00:00

HELIO prediction:
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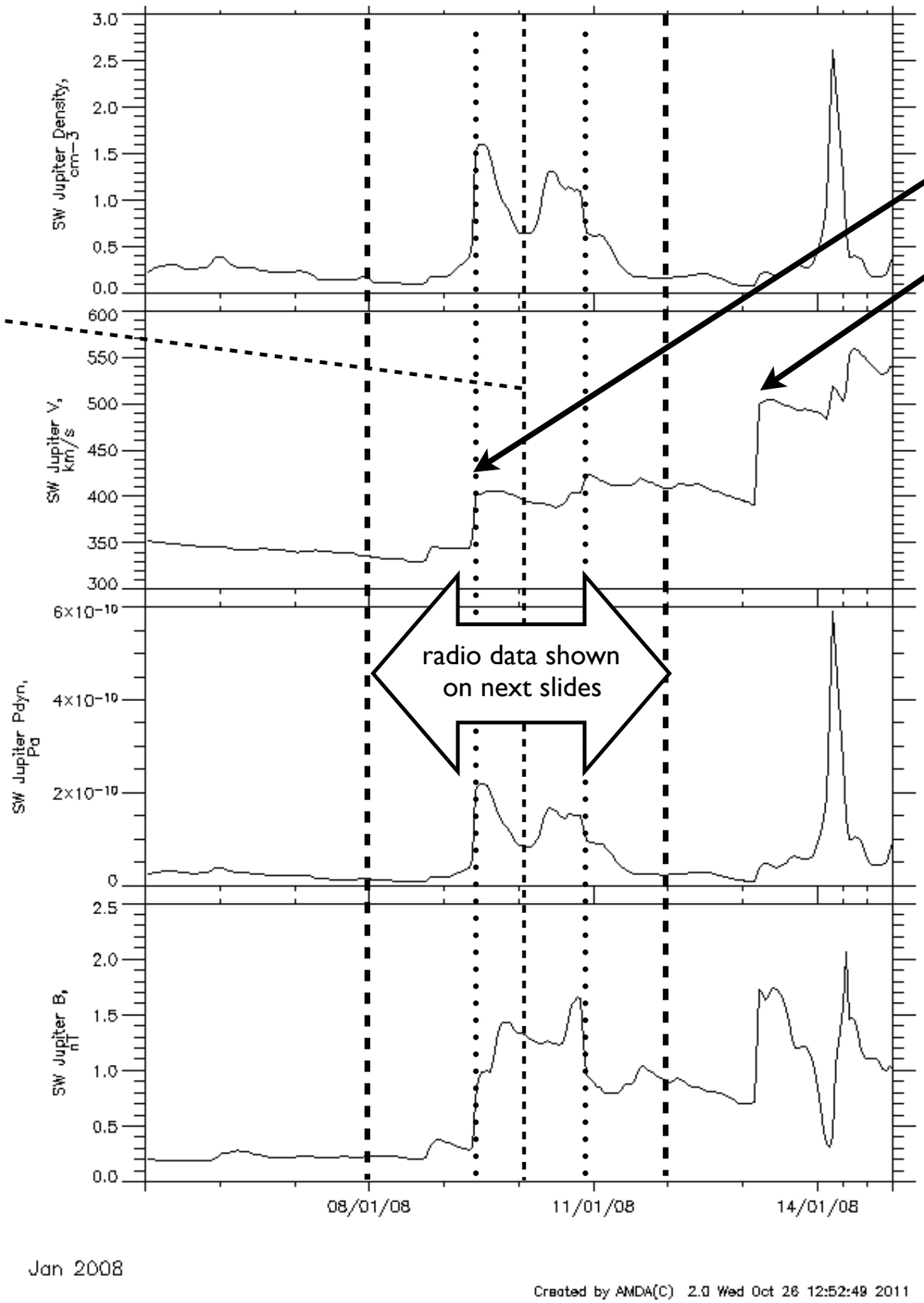
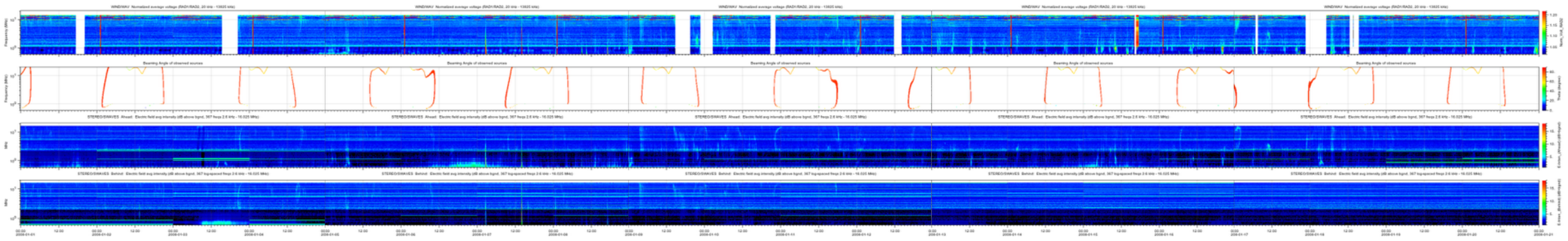
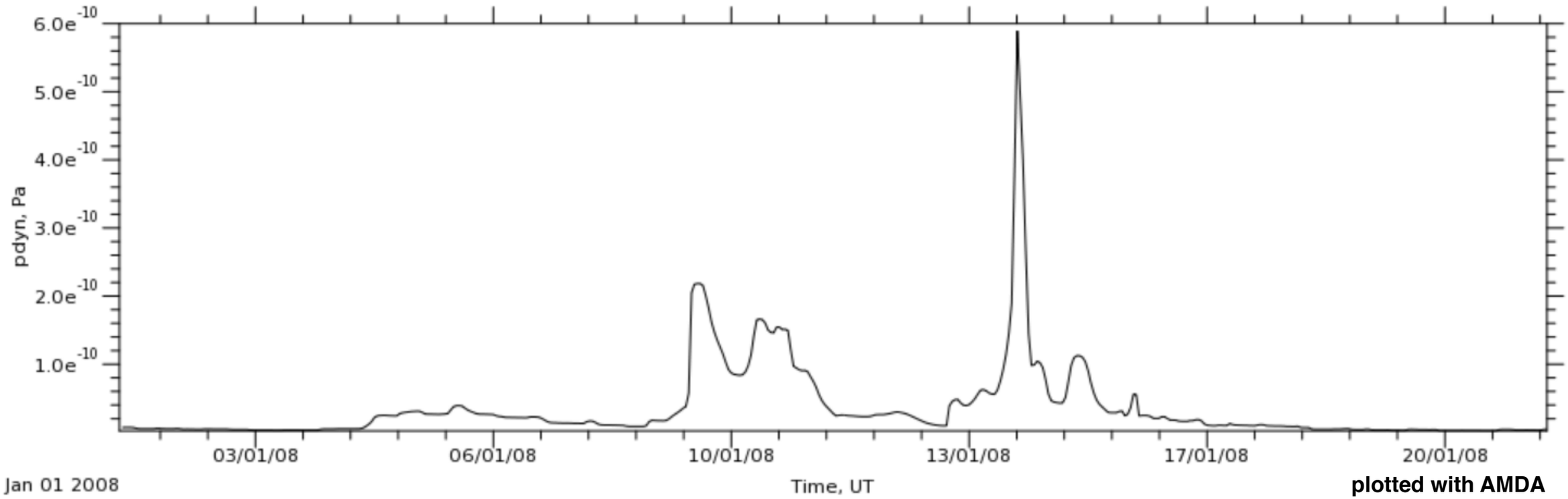


Jovian decametric Radio emission



plotted with Autoplot

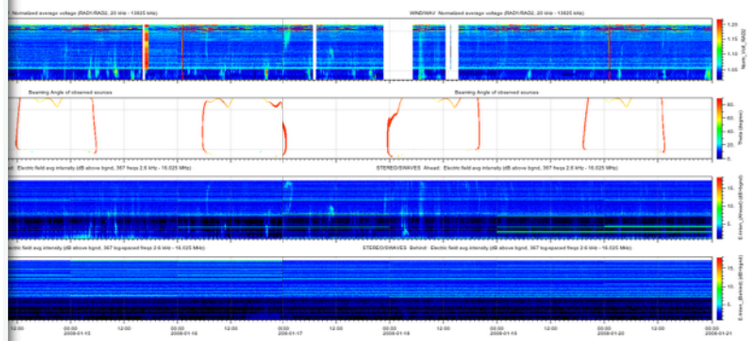


plotted with AMDA

mSWiM (Michigan)

Created by CDPP/AMDA(c) v3.5.0 10/10/2017 11:36:00

mission



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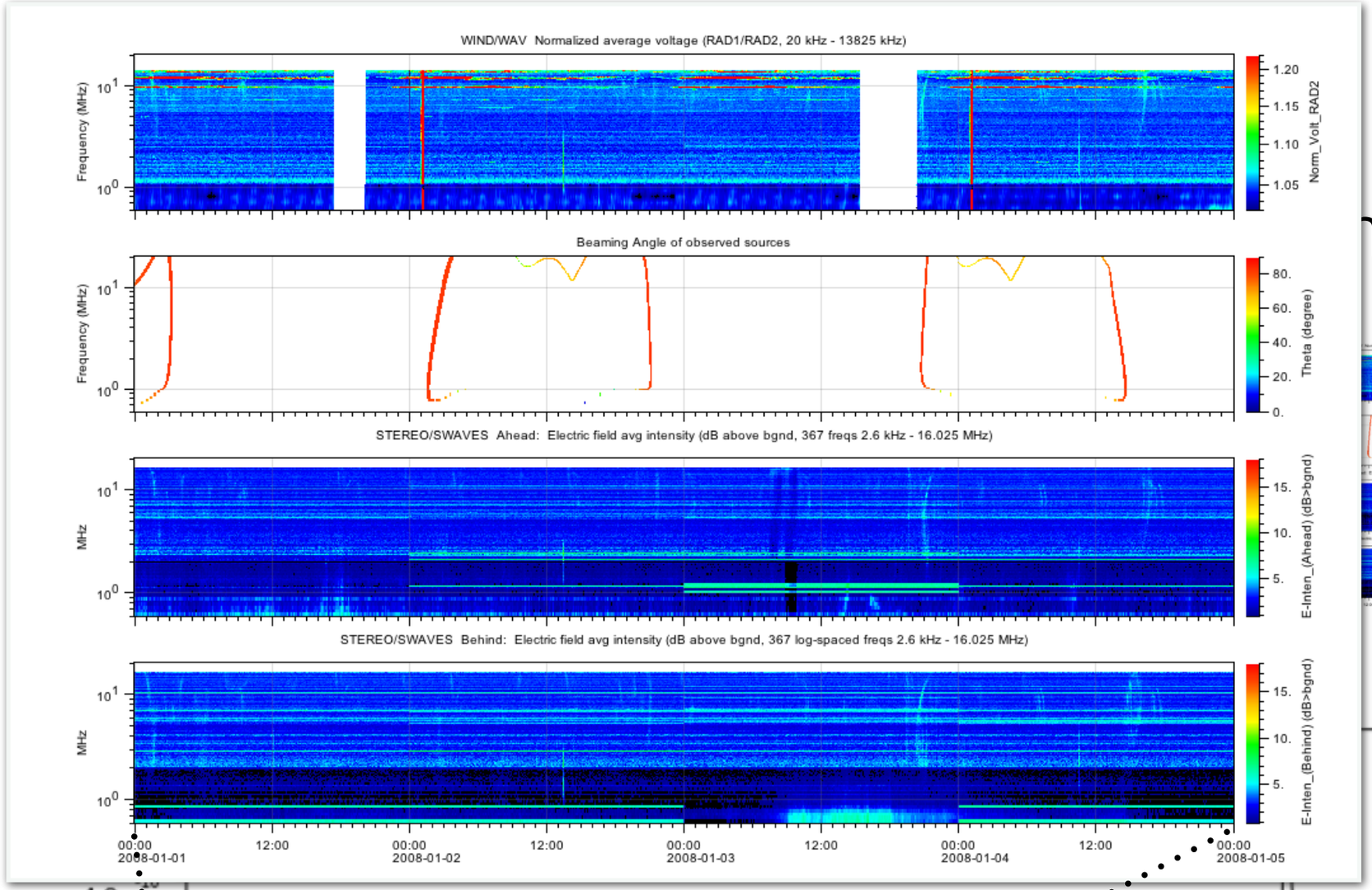
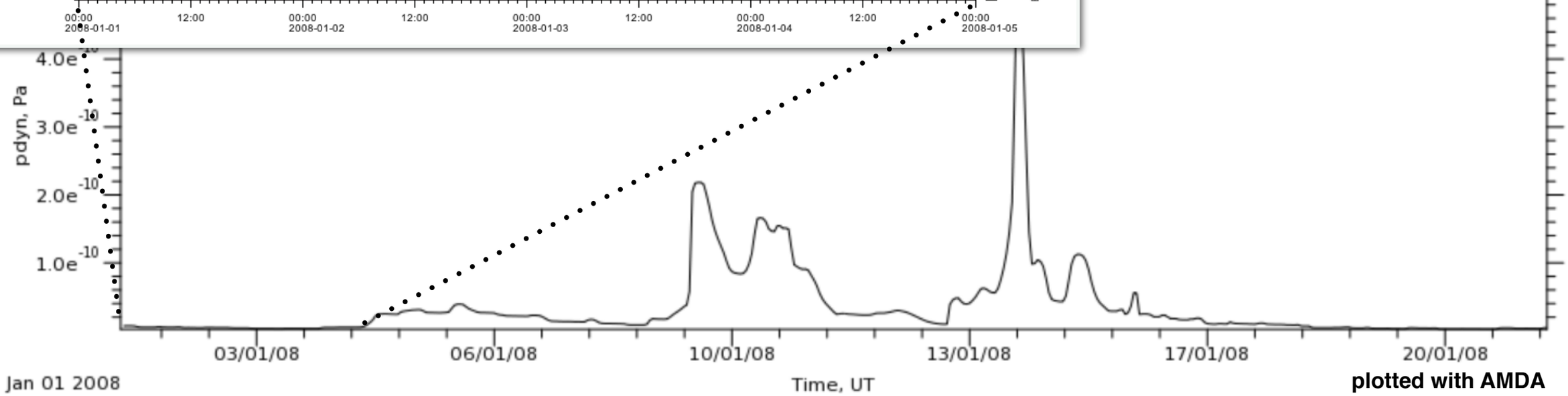
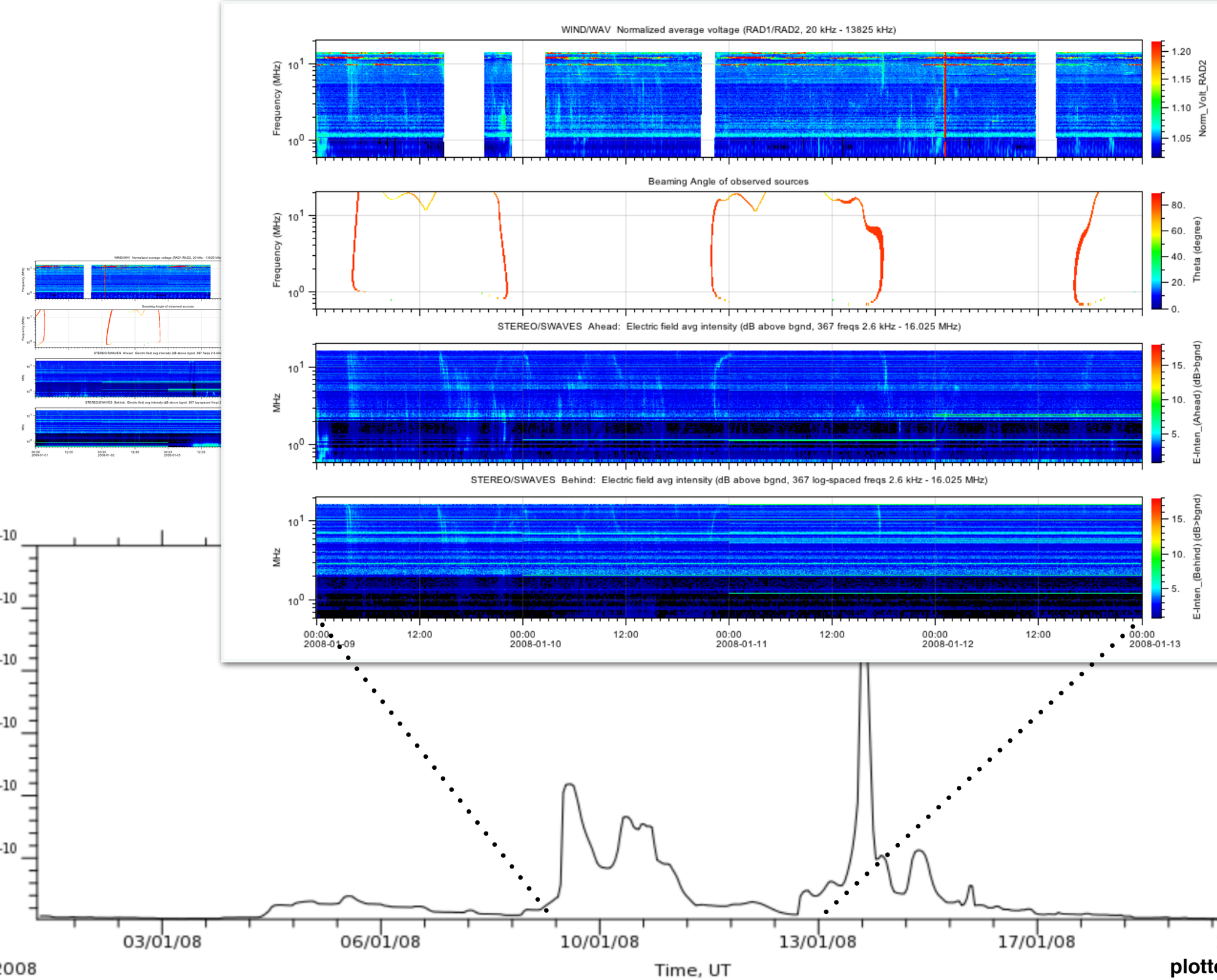




plotted with AMDA

mSWiM (Michigan)

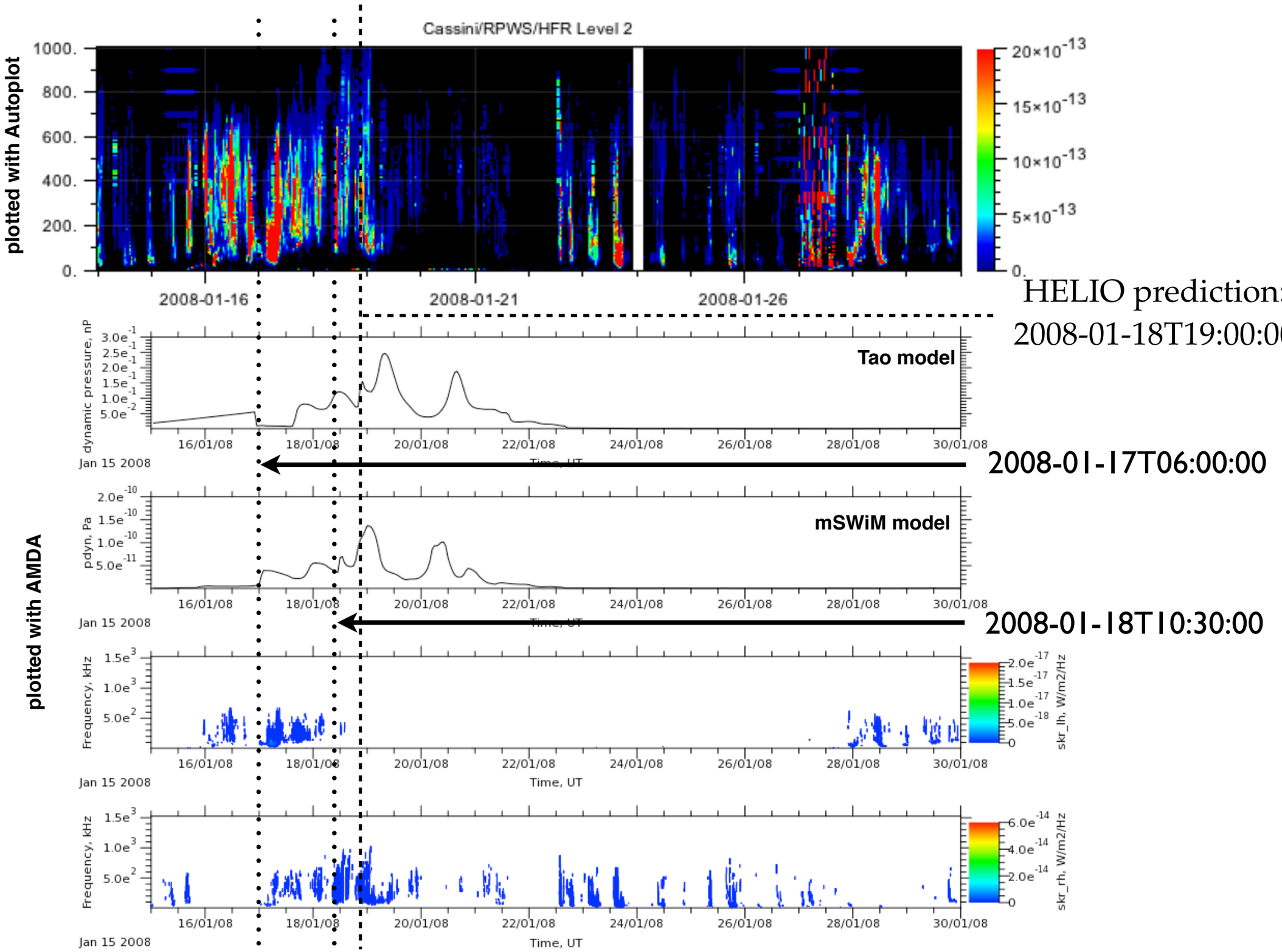
Created by CDPP/AMDA(c) v3.5.0 10/10/2017 11:36:00


WIND/WAV Normalized average voltage (RAD1/RAD2, 20 kHz - 13825 kHz)
Frequency (MHz)
Norm_Volt_RAD2
Beaming Angle of observed sources
Theta (degree)
STEREO/SWAVES Ahead: Electric field avg intensity (dB above bgnd, 367 freqs 2.6 kHz - 16.025 MHz)
E-Inten_(Ahead) (dB>bgnd)
STEREO/SWAVES Behind: Electric field avg intensity (dB above bgnd, 367 log-spaced freqs 2.6 kHz - 16.025 MHz)
E-Inten_(Behind) (dB>bgnd)
MHz
pdyn, Pa
Jan 01 2008
Time, UT
03/01/08
06/01/08
10/01/08
13/01/08
17/01/08
20/01/08
plotted with AMDA
with Autoplot
mSWiM (Michigan)
Created by CDPP/AMDA(c) v3.5.0 10/10/2017 11:36:00

mSWiM : MHD Propagation to Saturn

Date/Time

2 successive shocks



HELIO prediction:
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2008-01-17T06:00:00

2008-01-18T10:30:00