

COMPARATIVE AUTOMATED MULTI-DATASET ANALYSIS OF THE MARTIAN AND VENUSIAN TIME-VARIABLE PLASMA ENVIRONMENTS

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OUTLINE

1. Context

CDPP, the french Space Plasma Physics Data Center
AMDA, Automated Multi-Dataset Analysis
Europlanet IDIS and Planetology VO
AMDA VEX and MEX Data Prototype
Venus, Earth and Mars magnetospheres

2. A Few Scientific Illustrations (Method)

Boundary Identification
Current Sheet Crossings
Planetary Space Weather



CDPP, the french Plasma Physics Data Center (CNRS/CNES)

Hosted at CESR, Toulouse, France

<http://cdpp.cesr.fr>

Its Missions:

1) Data Archive (long-term preservation)

2) Data Valorization

- Making data easy to use
- Providing **tools and services**

3) Participation to **Virtual Observatories**

The screenshot shows the homepage of the CDPP (Centre de Données de la Physique des Plasmas) website. At the top, there is a navigation bar with icons for back, forward, search, and refresh, followed by the URL http://cdpp.cesr.fr/. Below the URL is the CDPP logo, which includes a stylized plasma sphere icon and the text "Centre de Données de la Physique des Plasmas" and "Plasma Physics Data Centre". A banner below the logo displays several space-related images, including a solar flare, a comet, and auroras. To the right of the banner is a "Welcome to CDPP" message and a paragraph of text about the center's history and mission. On the left side, there is a vertical "MAIN MENU" sidebar with links to Home, About the CDPP, CDPP Team, Educational links, Useful Servers, Documents, News, Search articles, Contact, DATA (which is highlighted with a red box), Full archive, and Mirror Themis database. Below the menu is a section titled "SERVICES" with links to AMDA (also highlighted with a red box), Forum, and Twiki. At the bottom of the page, there are logos for CNRS, INSU, and CNES.

AMDA (Automated Multi-Dataset Analysis) Functionalities

Web-based facility for online analysis of space physics data

<http://cdpp-amda.cesr.fr>

Prototype

Automated access to data

⇒ the user plays with **parameters**, not with data files

Produces and exploits **time-tables**

Its **7 functionalities** allow to use and couple these two objects

1. Visualization editor

2. Download data

3. Parameter editor

4. External data

5. Visual search

6. Conditional search

7. Time-Table manager

Europlanet IDIS (Integrated & Distributed Information System)

5 **thematic nodes** and 1 technical node

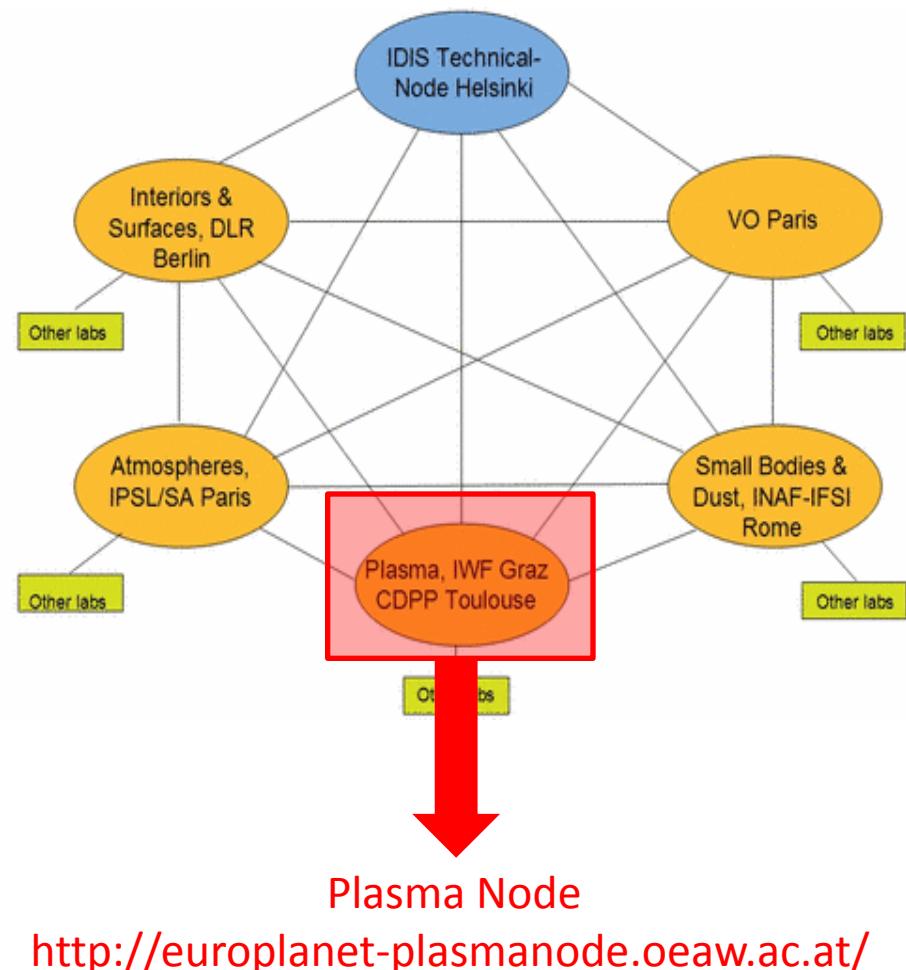
Its objective:

Develop Virtual Observatory tools

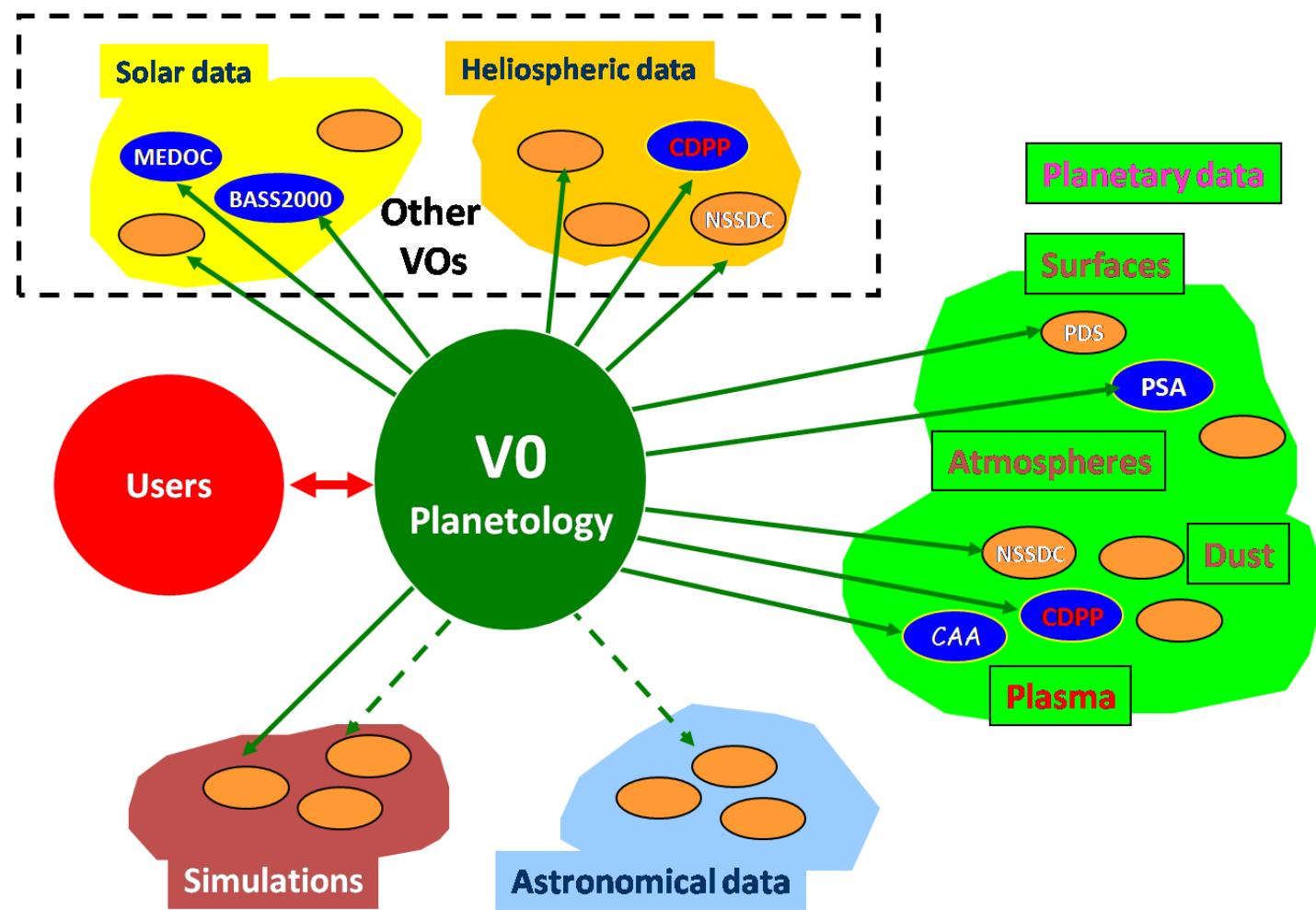
In order to access data from

laboratory measurements
ground+spaced-based observations
modeling results

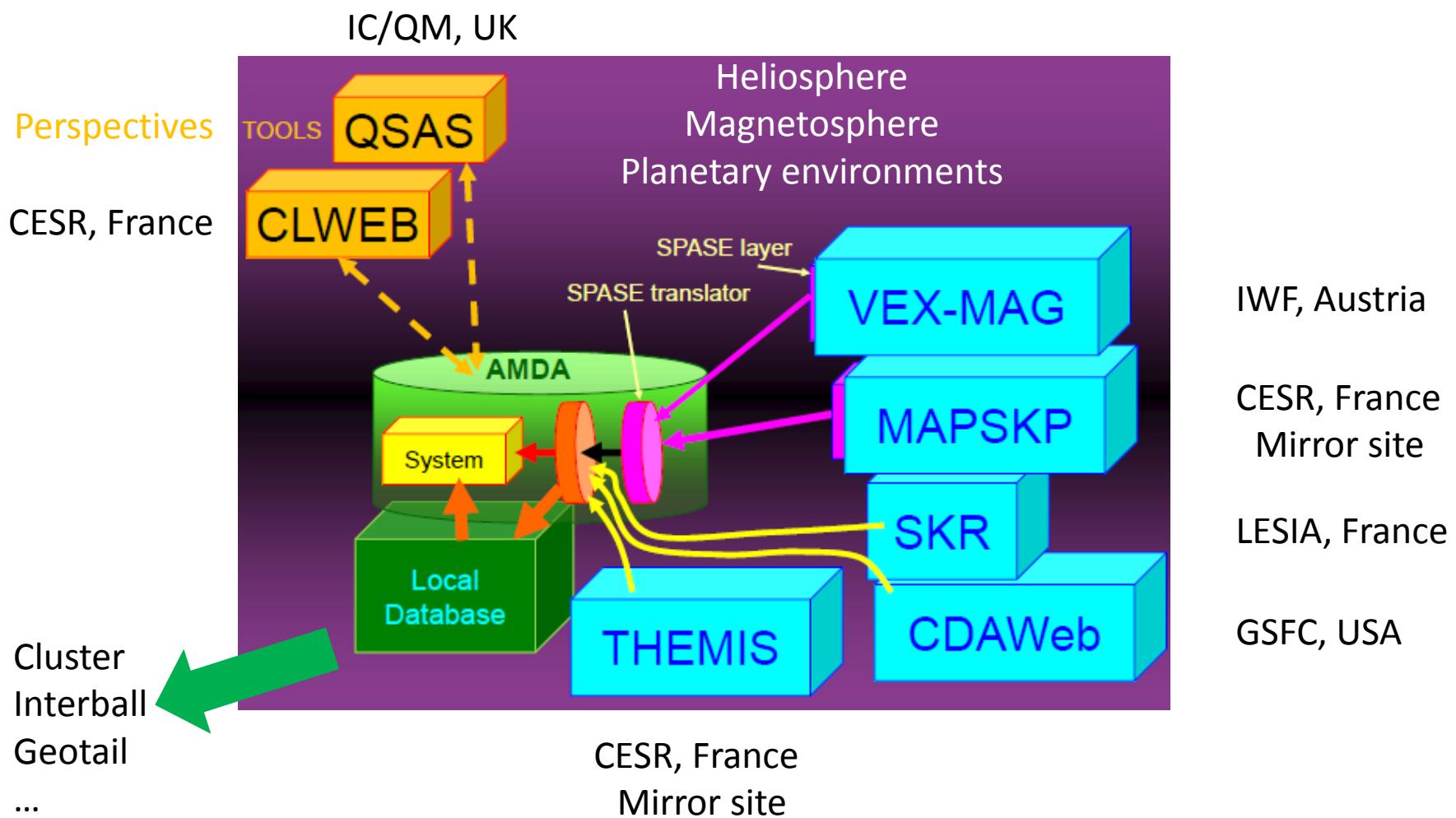
allowing comparative and pluri-disciplinary studies of planetary objects and environments



Towards a prototype of Virtual Observatory in Planetology?



CDPP/AMDA Local and Remote Data Access



AMDA VEX/MEX Data Prototype

Rules of the road apply !

VEXGRAZ (remote, from *Tielong Zhang*)

Caution!
(cleanliness)

MAG (Bx, By, Bz) VSO 4 s

VEX/ ASPERA (local, from *Andrei Fedorov*)

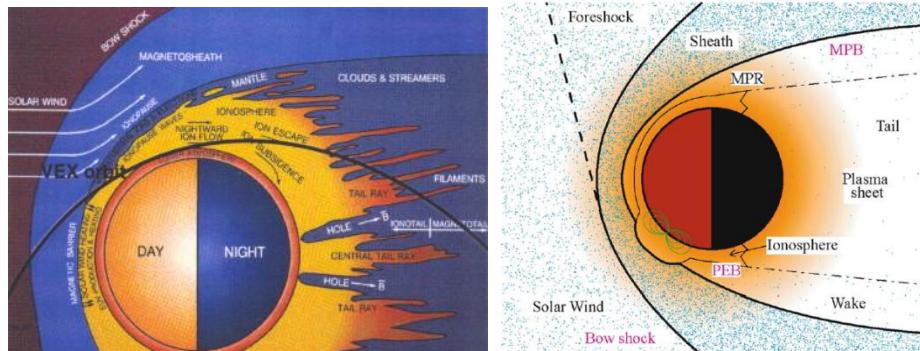
Caution!
(3-axis stabilized)

TRAJ	(X, Y, Z) VSO	60 s
IMA	spectra heavy ions	192 s
	spectra protons	192 s
	moments heavy ions	192 s
	moments protons	192 s
ELS	spectra	4 s

MEX/ ASPERA (local, from *Andrei Fedorov*)

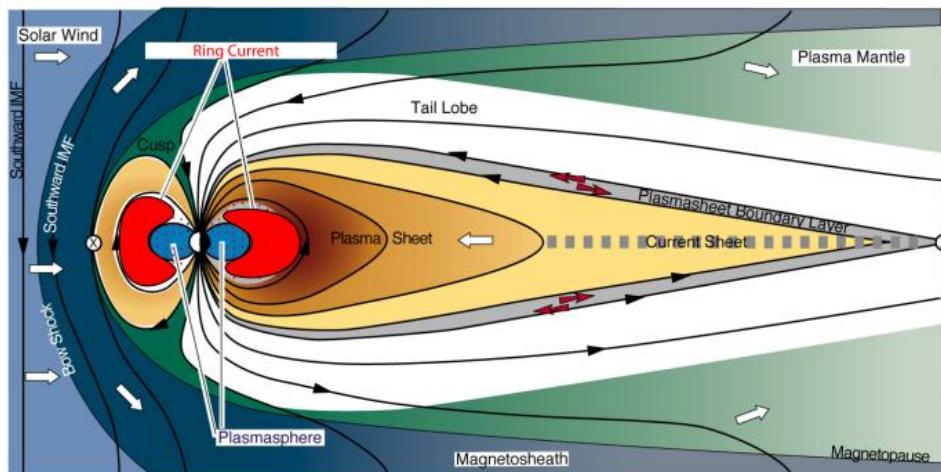
TRAJ	(X, Y, Z) MSO	60 s
IMA	spectra heavy ions	192 s
	spectra protons	192 s
ELS	spectra	4 s

Venus, Earth, and Mars Magnetospheres



	Venus / Earth / Mars
Magnetic field	no
Atmosphere	yes

Solar wind properties @ **0.72, 1 & 1.5 UA**



Key Features:

- 1) Various plasma populations (E/compo)
⇒ Different regions/boundaries
- 2) 'Universal' structure (e.g., current sheet)
- 3) SW / magnetosphere interactions

AMDA Functionality #1: Visualization Editor

Parameter Selection

Welcome to AMDA - Mozilla Firefox

Fichier Édition Affichage Historique Marque-pages Outils 2

http://manunja/~budnik/AMDA/NEW/DDHTML/HTML/loginreq.php

Les plus visités Débuter avec Firefox À la une

Welcome to AMDA Chargement...

Help Feedback Logout

My Parameters My Time Tables Plot Data Download Data Search in Data External Data

Select parameters to plot

Add to Request Reset

- close all open all
- AMDA
- CASSINI
- VEX
- ephemeris
- orbit
- xyz_vso
- IMA
- imaextra_spectra_prelim
- protons
- heavy_ions
- imaextra_mom_prelim
- ELS
- elsspec
- spectra
- MEX
- THEMIS-A
- THEMIS-B
- THEMIS-C
- THEMIS-D
- THEMIS-E
- CLUSTER1
- CLUSTER2

Parameter Name	Plot Region				X Data Range		Y Data Range	
	XPmin	YPmin	XPmax	YPmax	Xmin	Xmax	Ymin	Ymax
xyz_vex(0:2)	0	0.1	0.9	0.21	0	0	0	0
vex_h_spec	0	0.21	0.9	0.32	0	0	0	0
vex_o_spec	0	0.32	0.9	0.43	0	0	0	0
vex_els_spec	0	0.43	0.9	0.54	0	0	0	0
VEXGRAZ:MAG_VSO	0	0.54	0.9	0.65	0	0	0	0
VEXGRAZ:MAG_VSO	0	0.65	0.9	0.76	0	0	0	0
WS_bm_venus	0	0.76	0.9	0.87	0	0	0	0
WS_ration_bx_bm_ye	0	0.87	0.9	0.98	0	0	0	0

Start Time Time Interval

Year / Mon / Day Hour : Min : Sec Day / Hour : Min : Sec

2006 / 09 / 10 00 : 00 : 00 002 / 00 : 00 : 00

Reset

Plot PNG Plot PostScript Save Request To request

Plot PNG for My Times SearchTable Plot PNG for Standard Times

démarrer Oral_Andre ... Poster_Andr... Referee_Re... Courier ent... Welcome to ... themis_amda... 3.6-Fiches A... STEREO - M... 17:51

Plot Composer

AMDA Functionality #1: Visualization Editor

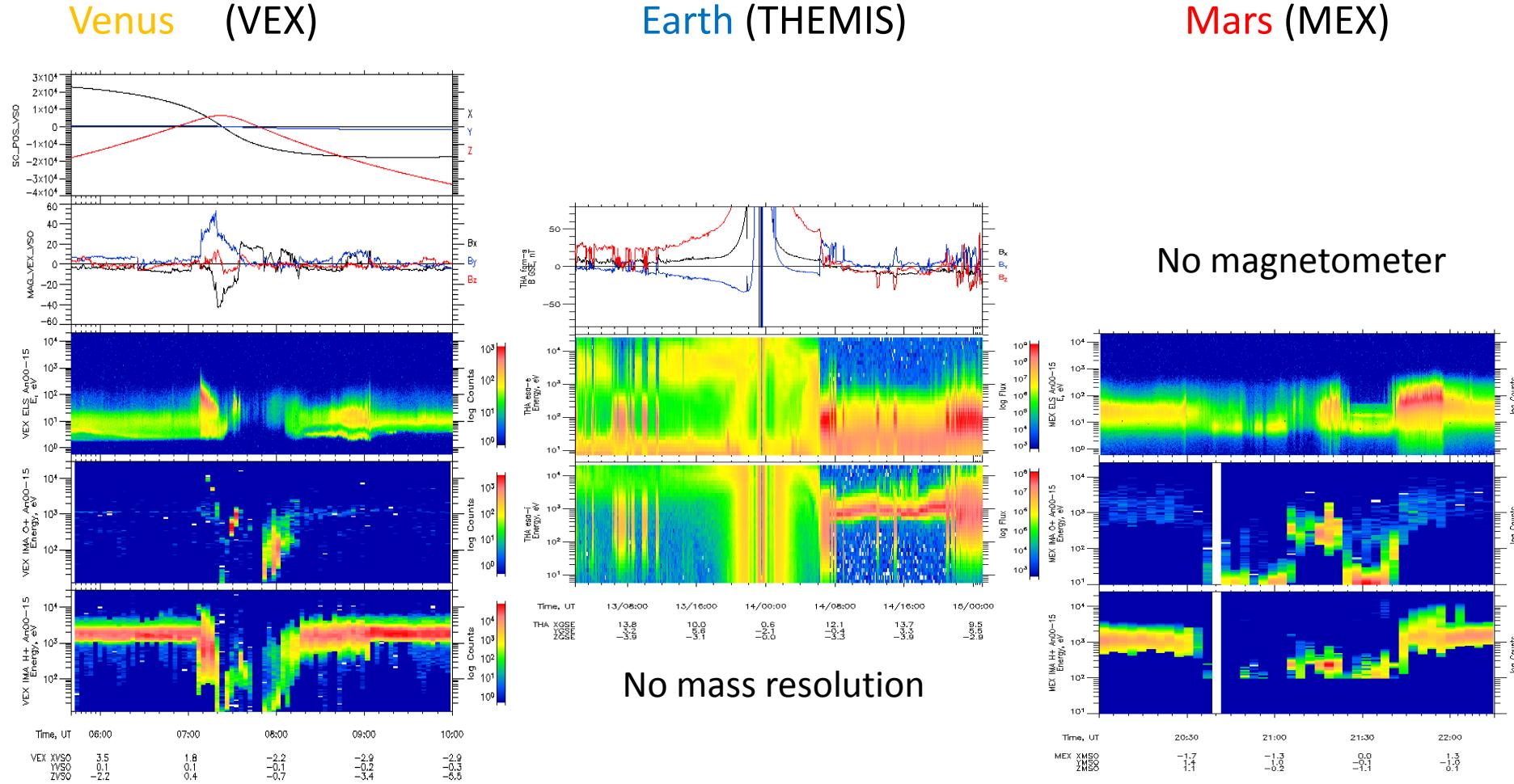


Illustration 1: Boundary Detection

Bow Shock (BS)

Where the solar wind is slowed down and heated

Ion Composition Boundary (ICB)

Where the thermal plasma of the ionosphere is separated from the hot magnetosheath plasma

- Vanishing of solar wind protons
- Appearance of planetary ions
- Disappearance of energetic electrons
- Presence of a Magnetic 'barrier'

Magnetopause (MP)

Where the geomagnetic field and plasma of primarily terrestrial origin are separated from solar-wind plasma

Venus

Earth

Mars

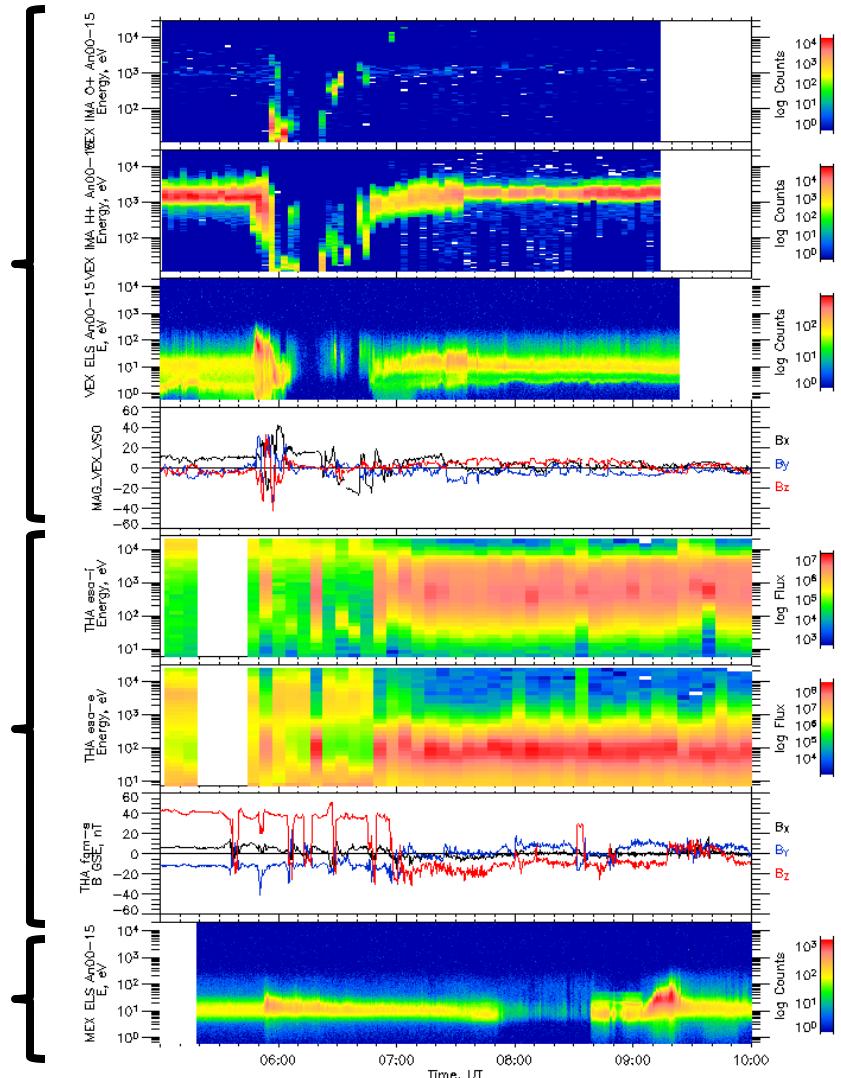


Illustration 1:

BS Detection at the Earth

Jacquey et al., 2008

Building parameters:

$$\chi_B = \left(\frac{d}{dt} \langle B \rangle_{60} \right)^2$$

$$\chi_V = \left(\frac{d}{dt} V \right)^2$$

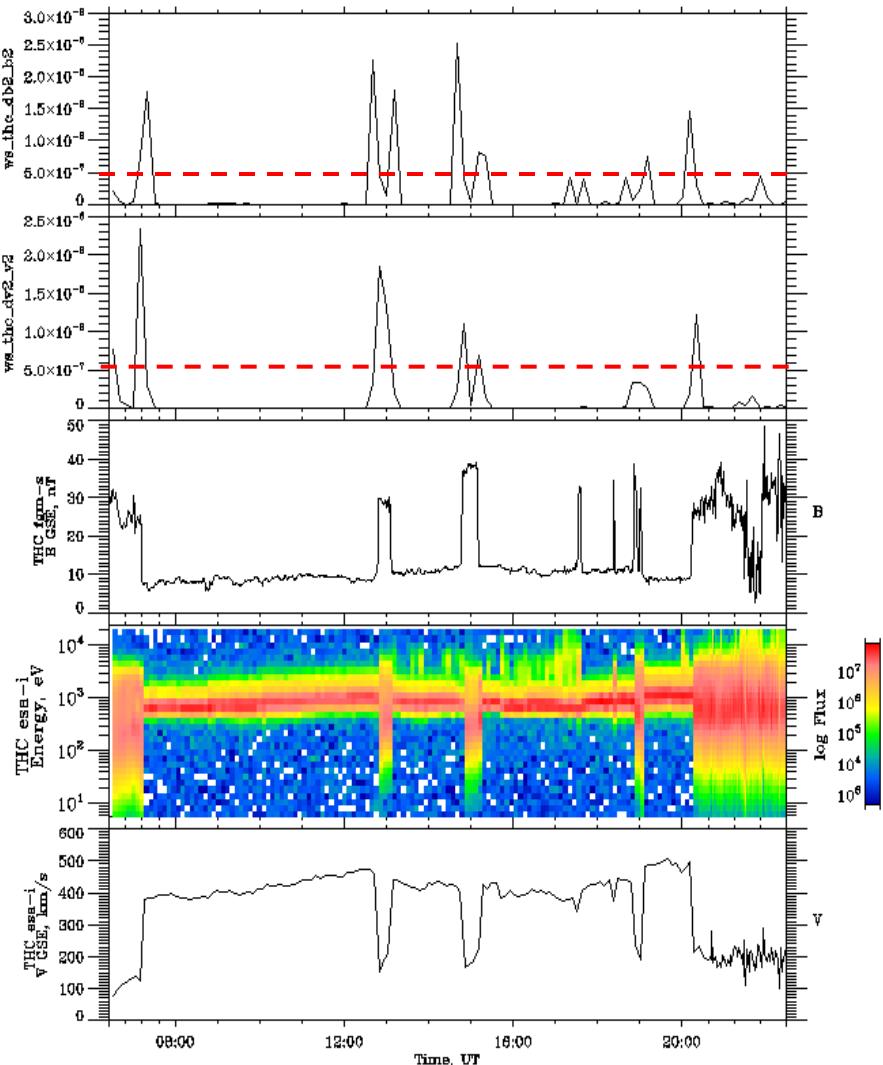
Conditional search:

$$\chi_B > 5.10^{-7}$$

$$\text{AND } \chi_V > 5.10^{-7}$$

$$\text{AND } R > 10 R_E$$

Time Table of BS crossings



AMDA Functionality #3: Parameter Editor

Welcome to AMDA - Mozilla Firefox

Eichier Édition Affichage Historique Marque-pages Outils ?

http://manunja.cesr.fr/~budnik/AMDA/HTML/HTML/loginreq.php

Logout

Help Feedback My Parameters My Time Tables Plot Data Download Data Search in Data External Data

Select parameters to construct new Workspace parameter

AMDA CASSINI VEX ephemeris IMA ELS elsspec spectra Total Cnts: anod5 6-10; energy range Emin-Emax [eV]

Construct Parameter

```
(deriv_(vex_elsspec_100_200))^2
/
vex_elsspec_100_200^2
```

HOWTO

Bricks for construction :

- AMDA parameters from left-frame tree or your aliases
- Operators: +, -, *, /, ^ and brackets: (), []
- Constants, IDL and AMDA functions

Example: $\sin(\text{param1})^2 + \sqrt{|\text{param2}|}^5$

IDL Functions AMDA Functions

mean_(.)	smooth_(.)	vari_(.)
kurt_(.)	skew_(.)	shiftN_(.)
shiftT_(.)	deriv_(.)	gsegsm_(.)
gsegm_(.)		

My Parameter Name Time Step (secs) Units (optional) My Parameter

deriv_vex_e_100_200 60 Time-derivative of counts

Save My Parameter Reset

Define an Alias for AMDA Parameter (optional)

AMDA Parameter	My Alias	Save Alias

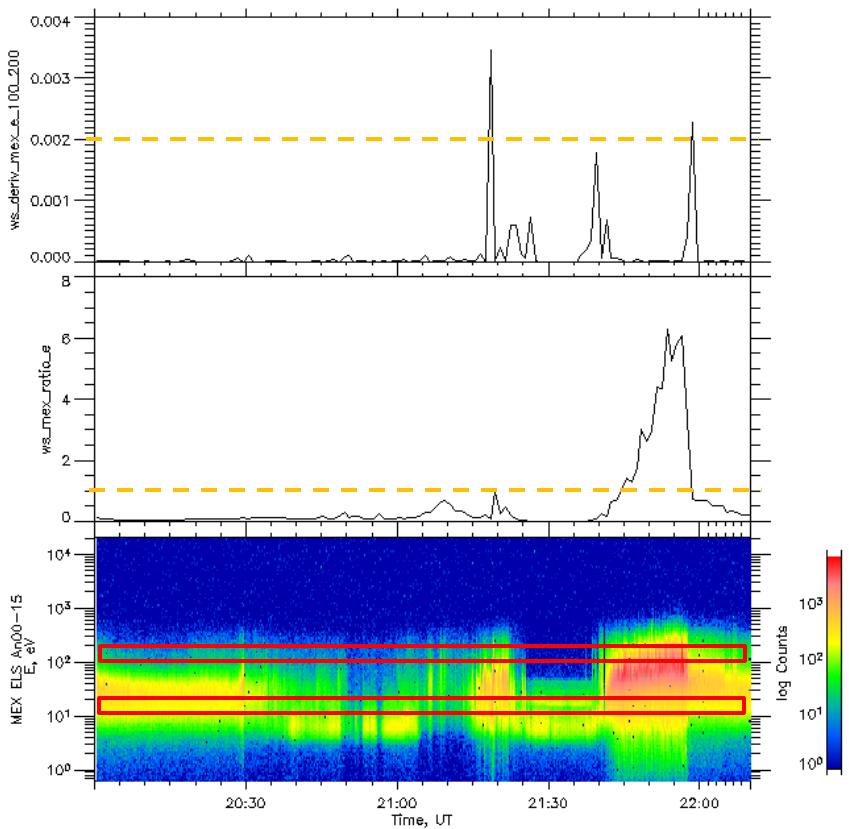
$\chi_C = \left(\frac{\frac{d}{dt} C}{C_{E1_E2}} \right)$

http://manunja.cesr.fr/~budnik/AMDA/HTML/operations.php#

démarre MAPS Microsoft PowerP... Nicolas_Ande_M... 1Andre_Nicolas_... Courier :: Boîte d... Welcome to AMDA...

Illustration 1:

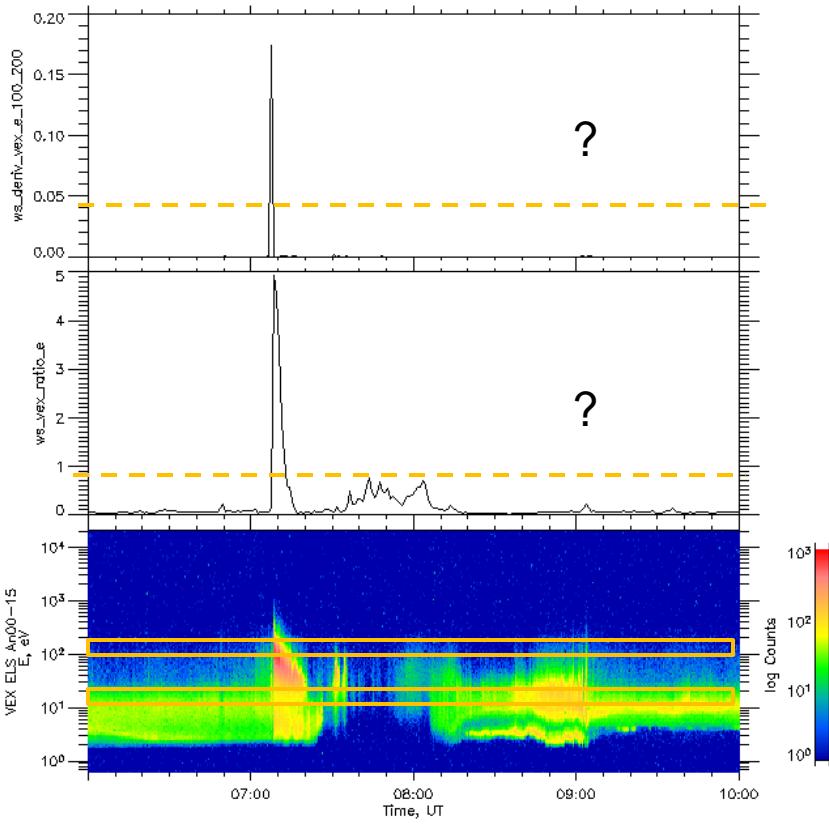
BS Detection at Mars/Venus



Aug 30 2007

Created by AMDA(C) 2.0 Wed May 13 09:23:19 2009

Finding the ‘ultimate’ criteria!



Dec 12 2006

Created by AMDA(C) 2.0 Tue May 12 18:06:39 2009

AMDA Functionality #6: Conditional Search

Mozilla Firefox

Fichier Édition Affichage Historique Marque-pages Outils ?

http://manunja.cesr.fr/~budnik/AMDAWEB/DDHTML/USERS/nandre/TT/cs_crossing_vex.xml

Les plus visités Débuter avec Firefox À la une

Welcome to AMDA http://manunja...rossing_vex.xml

Time Table :

cs_crossing_vex

generated Tue May 12 15:08:46 2009

```
under conditions sqrt(xyz_vex(0)^2+xyz_vex(1)^2+xyz_vex(2)^2)<3 & sqrt(xyz_vex(0)^2+xyz_vex(1)^2+xyz_vex(2)^2)>1.5 &
VEXGRAZ_MAG_VSO_SC_POS_VSO(0)<0 & abs(VEXGRAZ_MAG_VSO_SC_POS_VSO(0))/abs(VEXGRAZ_MAG_VSO_SC_POS_VSO(1))<0.5 &
VEXGRAZ_MAG_VSO_MAG_VEX_VSO(0)*shiftT_(VEXGRAZ_MAG_VSO_MAG_VEX_VSO(0),60)<0
```

AMDA Search: Time_Step: 600.0s; Data_absence_is_gap_for_gaps > 5 Data_Sampling_Times; Start_Time:2006-12-15T00:00:00 Time_Interval:015d00h00m

StartTime	StopTime
2006-12-17T08:00:00	2006-12-17T08:10:00
2006-12-17T08:20:00	2006-12-17T08:30:00
2006-12-19T08:10:00	2006-12-19T08:40:00

Time Table cs_crossing_vex created

Terminé

démarrer Mozilla Firefox

AMDA Functionality #7: Time-Table Manager

Welcome to AMDA - Mozilla Firefox

Fichier Édition Affichage Historique Marque-pages Outils ?

AM DA http://manunja.cesr.fr/~budnik/AMDAWEB/DDHTML/HTML/loginreq.php

Les plus visités Débuter avec Firefox À la une

Help Feedback Logout

My Parameters My Time Tables Plot Data Download Data Search in Data External Data

My WorkSpace

TIME TABLES

- nicolas_venus
- SearchTable
- test
- cs_crossing_vex

Operations

Union Intersection

Download

Time format: YYYY-MM-DDThh:mm:ss File format: plain text

Compression: targz zip Download

Upload

Time format: YYYY-MM-DDThh:mm:ss File format: plain text

From local machine: Parcourir...

From url:

Construct/Modify the Time Table

Table Name: cs_crossing_vex

Date of Generation: Tue May 12 15:08:46 2009

Description: $\sqrt{xyz_vex(0)^2+xyz_vex(1)^2+xyz_vex(2)^2}$

Source: AMDA Search: Time_Step: 600.0s; Data_absence_is_gap_for_gaps > 5 Data_Sampling_Times; Start_Time: 2006-12-15T00:00:00 Time_Interval: 015d00h00m

Number of Intervals: 3

Extend Intervals (min): 10

Shift Intervals (min): 0

Save to WS Reset

Terminé

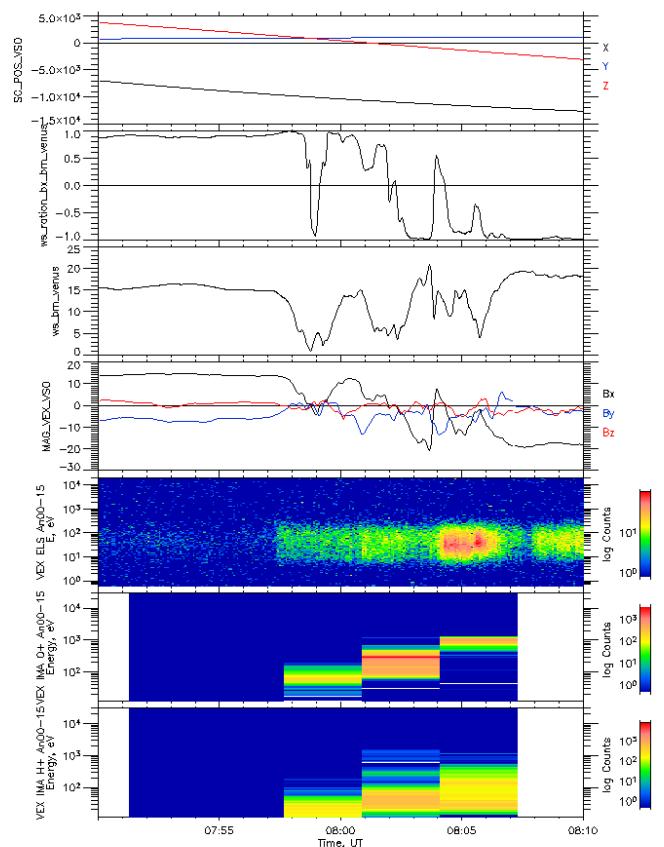
démarrer Oral_Andre [Mode de... themis_amda [Mode ... Welcome to AMDA - ...

15:33

Illustration 2: Current Sheet Crossings

One of the 3 time intervals in the Time Table

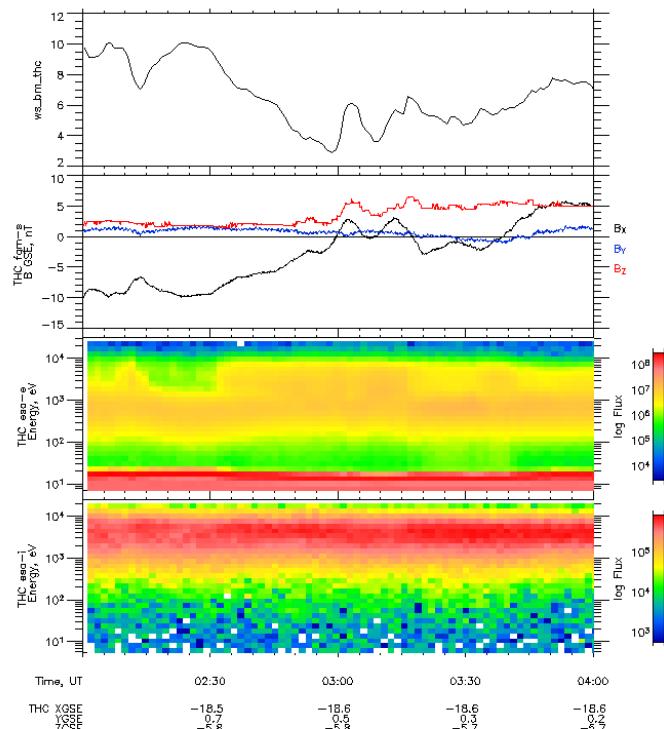
Venus



Dec 17 2006

Created by AMDA(C) 2.0 Tue May 12 15:55:37 2009

Earth

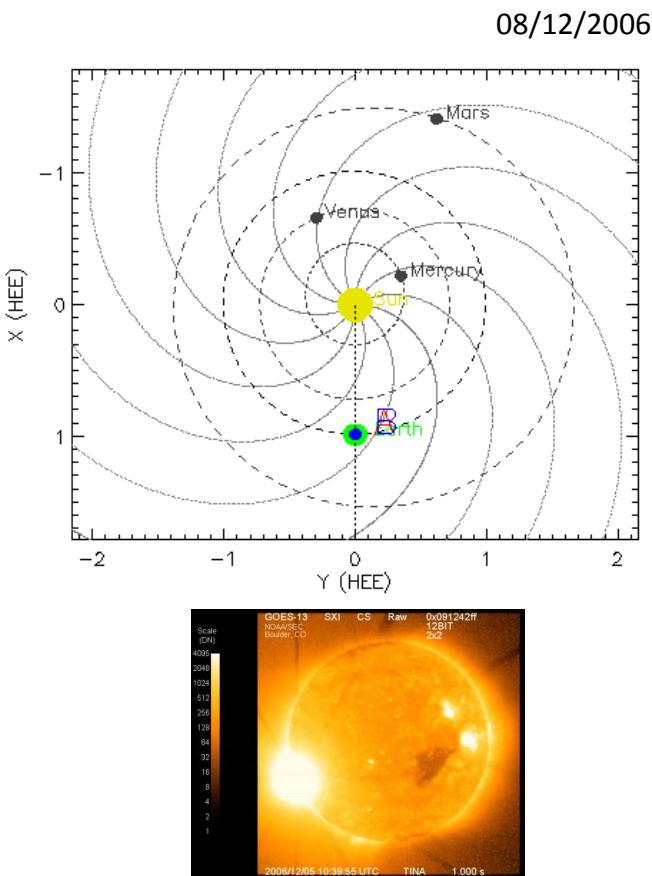


$R > 6.6$ & $X < 0$ & $\text{abs}(Y)/\text{abs}(X) < 0.5$
 $B_x(t)$ times $B_x(t+60s) < 0$

Feb 6 2008

Created by AMDA(C) 2.0 Tue May 12 17:12:27 2009

Illustration 3: SEP Events



The X9-class solar flare of Dec. 5, 2006, observed by the Solar X-Ray Imager aboard NOAA's GOES-13 satellite

AMDA Functionality #4:
External Data

CDAweb

Event from Futaana et al., 2008

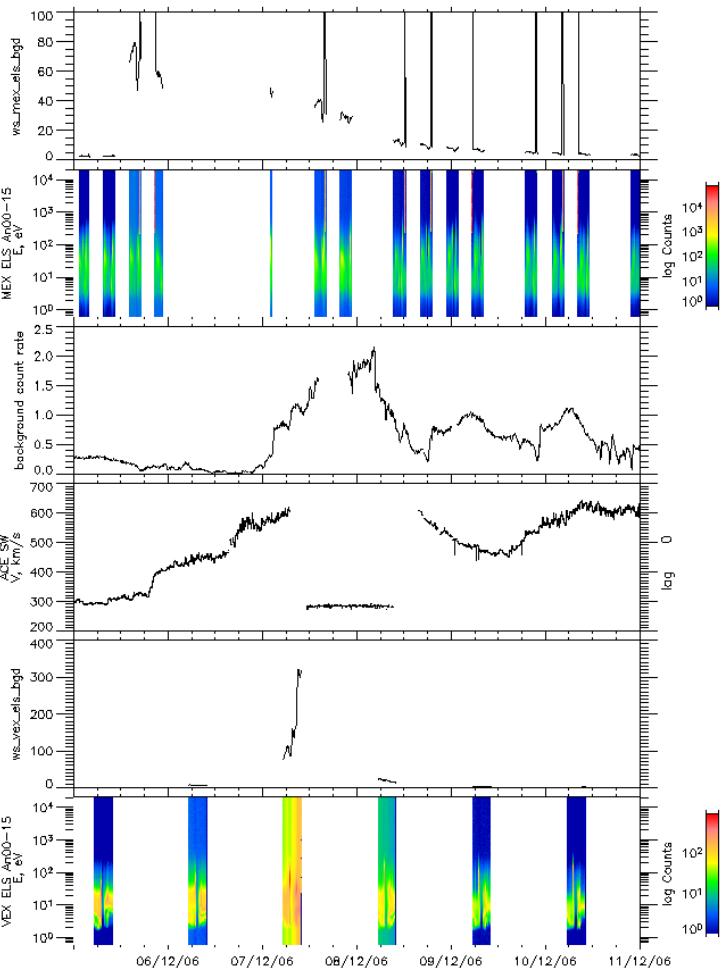


Illustration 3: ICMEs

Low Mach number solar wind

18 BS crossings reported
Atypical
Compressed effective obstacle

Venus

Event from Zhang et al., 2008

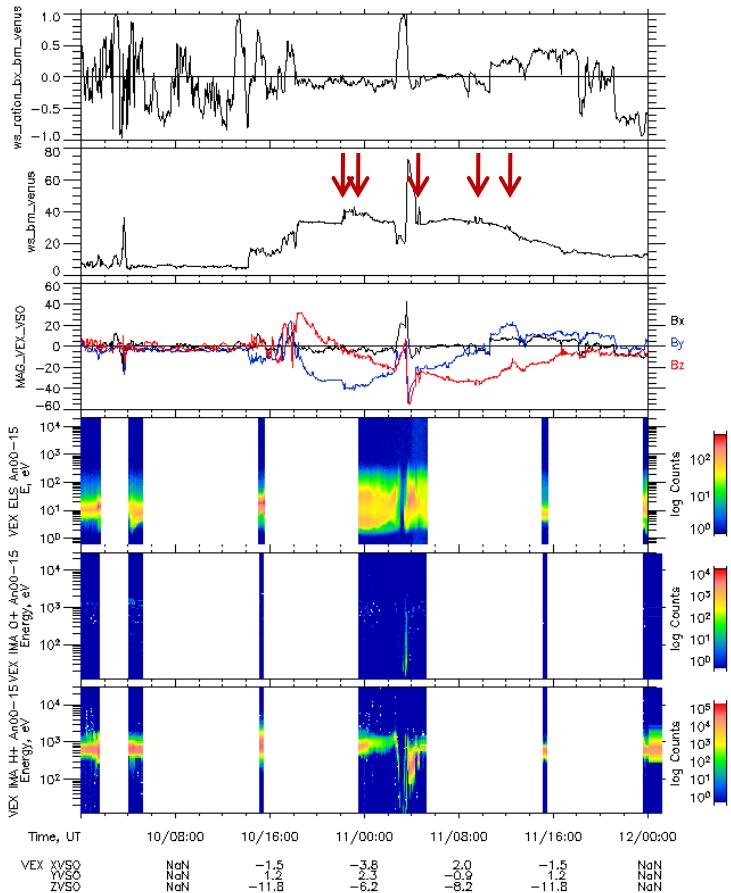
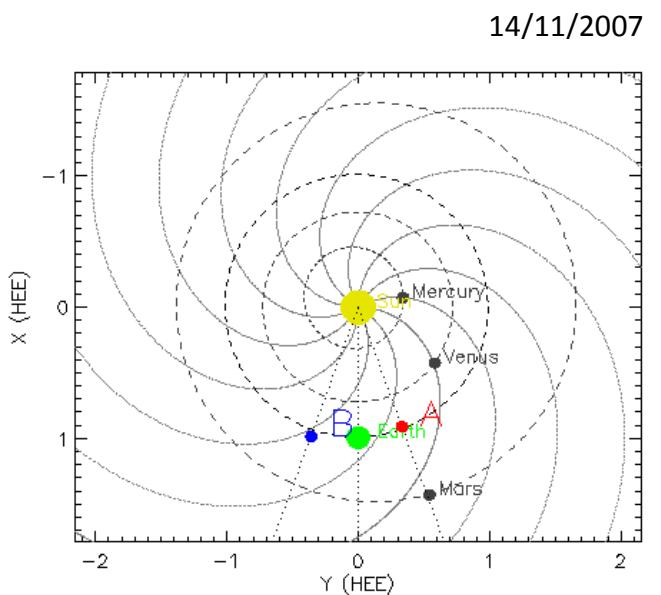


Illustration 3: ICMEs



Earth

Venus, Stereo A, Mars
Radial alignment

<http://stereo-ssc.nascom.nasa.gov/>
http://aten.igpp.ucla.edu/cgi-bin/stereo_PLASTIC_MAG_LEVEL2

- STEREO MAG and PLASTIC data (1 min)
- Level 3: Event lists (ICMEs)

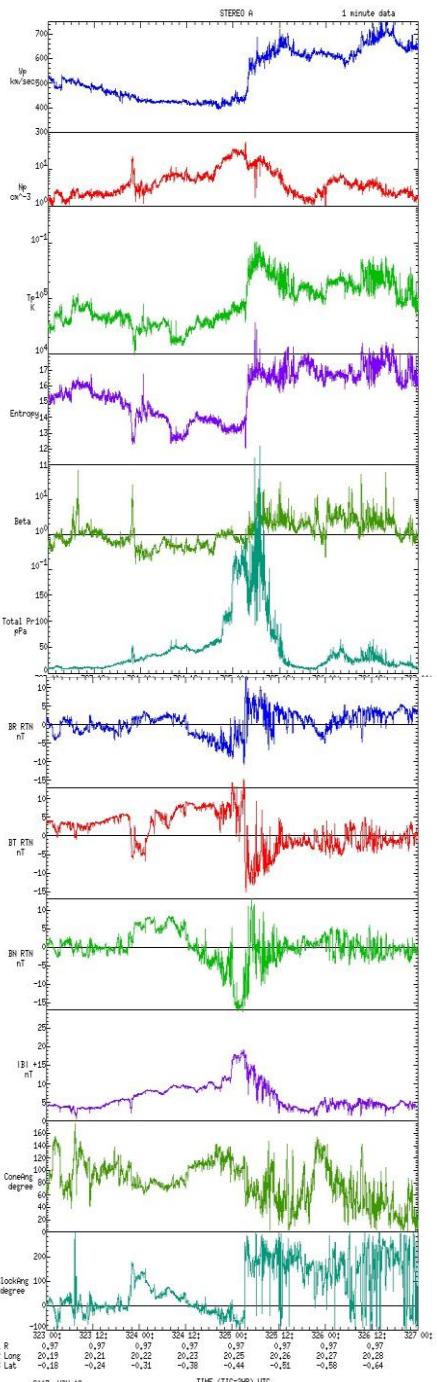


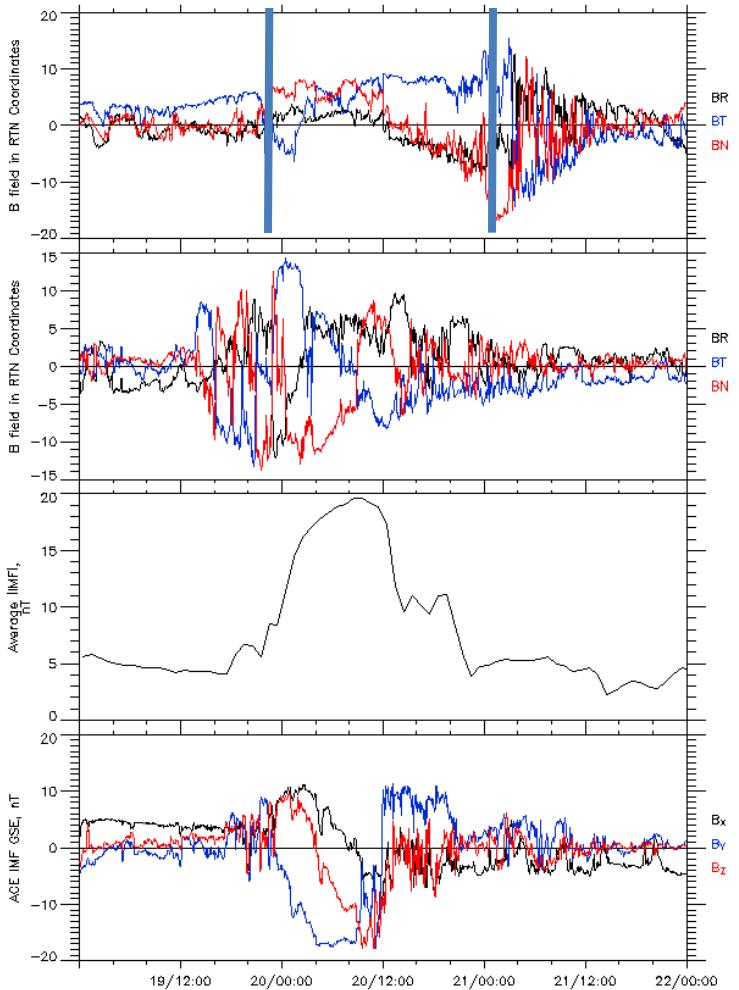
Illustration 3: ICMEs

Stereo A
Stereo B
ACE

Earth
MAG data

field rotation,
heliospheric current sheet crossing

2007 11/19 22:00
2007 11/21 03:17



AMDA Functionality: Solar Wind Virtual Monitor

Welcome to AMDA - Mozilla Firefox

Fichier Édition Affichage Historique Marque-pages Outils ?

<http://manunja.cesr.fr/~budnik/AMDAWEB/DDHTML/HTML/loginreq.php>

Les plus visités Débuter avec Firefox À la une

Help Feedback Logout

My Parameters My Time Tables Plot Data Download Data Search in Data External Data

CASSINI VEX MEX ephemeris IMA ELS elsspec spectra THEMIS-A THEMIS-B THEMIS-C THEMIS-D THEMIS-E CLUSTER1 CLUSTER2 CLUSTER3 CLUSTER4 CLUSTER-SP DoubleStar1 ACE INTERBALL-Tail WIND IMP-8 GEOTAIL POLAR Indices OMNI VEXGRAZ CDAWEB My Parameters

1 imf(0:2) 0 0.3 0.9 0.5 0 0 0 0 0
 2 omni_imf_mag 0 0.5 0.9 0.7 0 0 0 0 0
 3 omni_imf_mag_vec 0 0.7 0.9 0.9 0 0 0 0 0

Start Time Year / Mon / Day Hour : Min : Sec 2007 / 11 / 21 00 : 00 : 00

Time Interval Day / Hour : Min : Sec 003 / 00 : 00 : 00

Reset Plot PNG Plot PostScript Save Request To request
 Plot PNG for My Times SearchTable Plot PNG for Standard Times
 Load My Request Load Standard Request
 Delete My Request

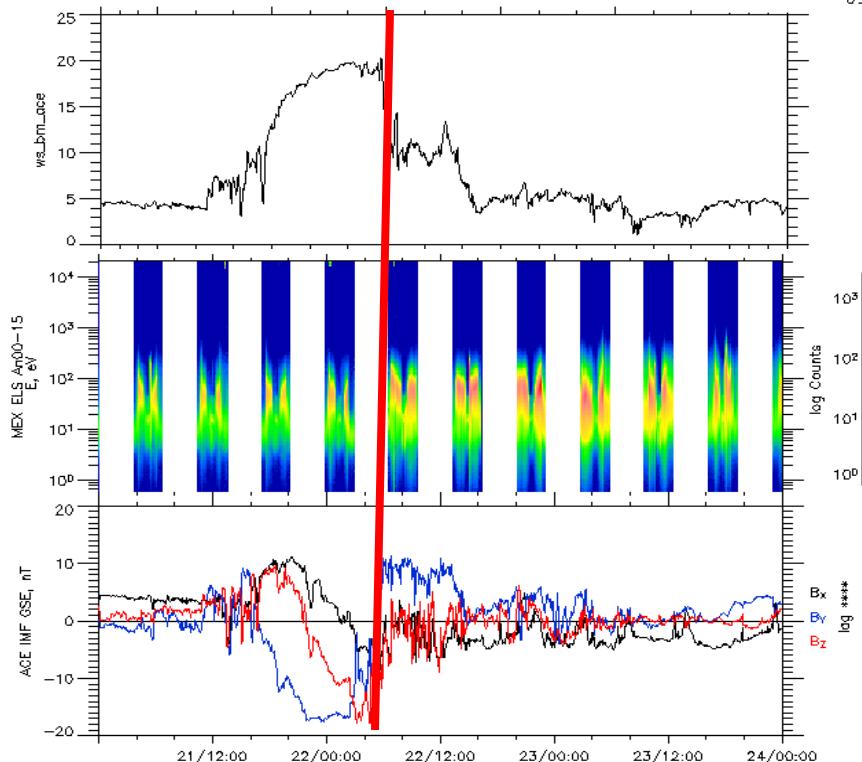
Time Shifting of Solar Wind Monitor Data (for AMDA Internal Data Base only)
 SWMonitor Time Delay (secs)
 ACE 150000 Save and Apply For Plot
 Target Year / Mon / Day Hour : Min
 Themis-A 2007 / 11 / 21 00 : 00 Calculate Delay

Add to Request Reset Terminé

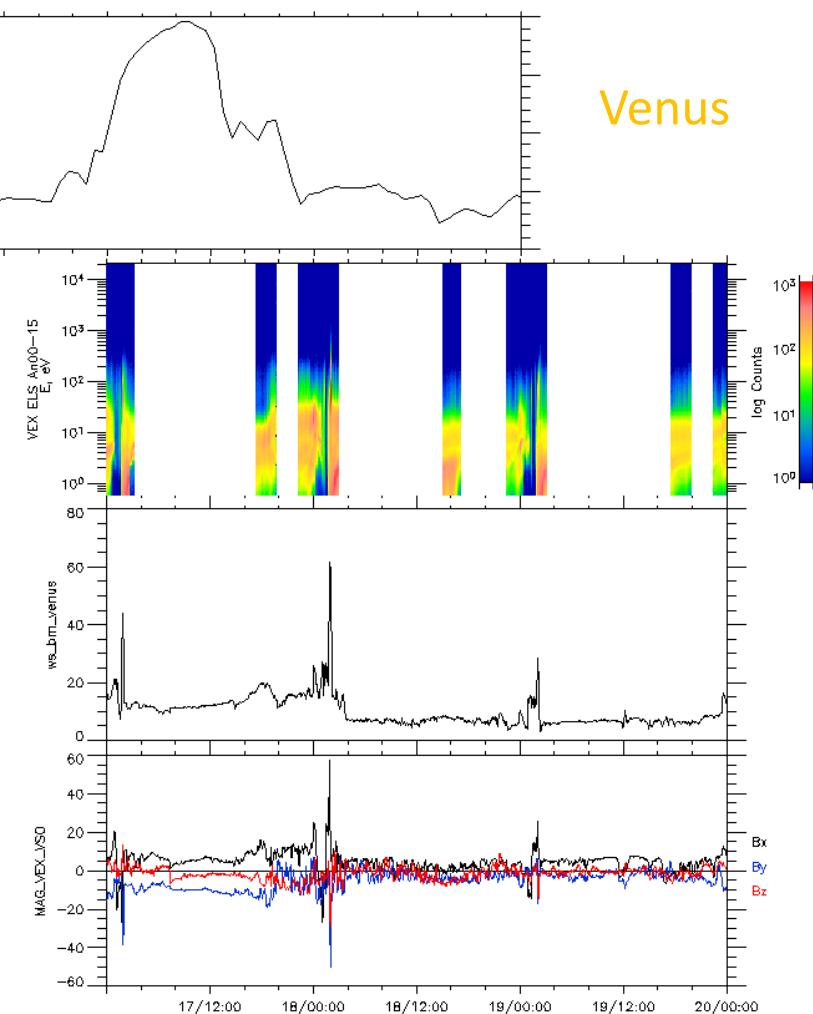
démarrer Microsoft PowerPoint ... Welcome to AMDA - ... 20:04

Illustration 3: ICMEs

Mars



Venus



CONCLUSIONS

- CDPP/AMDA (Automated Multi-Dataset Analysis) is **public**
<http://cdpp-amda.cesr.fr>
- Still a **prototype** but you are invited to use it (it will be open **at the end of this year**)
amda@cesr.fr

PERSPECTIVES

- Including other Martian datasets (locally or remotely) if possible
- Future connections with IVOA tools like Aladin under study (giant planet auroral emissions, HST observations)



EuroPlaNet IDIS
Plasma Node
activities

Online demonstration during the poster session