



cnes

CENTRE NATIONAL D'ÉTUDES SPATIALES



cnrs

dépasser les frontières



l'Observatoire
de Paris



**UNIVERSITÉ
TOULOUSE III
PAUL SABATIER**



Université
de Toulouse



GSO

DATA CENTRE

OBSERVATOIRE VIRTUEL GRAND SUD OUEST



CDPP

<http://www.cdpp.eu/>



CDPP : services du CDPP, certification et données théoriques

N. André, V. Génot, C. Jacquy, M. Bouchemit, E. Budnik, Q. Brzustowski, A. Schulz, B. Renard, M. Gangloff, F. Pitout, A. Rouillard, I. Plotnikov, N. Dufourg, D. Boucon, J. Durand, D. Heulet, M. Gangloff, B. Cecconi

ASOV meeting, 23 Mars 2021



CDPP

Plasma Physics Data Centre

- Established in 1998 from a CNES/CNRS collaboration for natural plasma [data distribution and archiving](#) : from the ionosphere to the heliosphere; about 3-5 FTE, engineers and scientists, main base in Toulouse, south of France
- Since 2006, CDPP is strongly involved in the development of data [analysis and visualization tools](#) including simulations
- CDPP expertise in data handling resulted in the participation to several [EU and ESA projects](#) aiming at enlarging data distribution via standards (Virtual Observatory concept) including simulations
- [Mission support activities](#) : quicklook visualization tool for the Rosetta Plasma Consortium team, role in discussion for Solar Orbiter, Bepi-Colombo and JUICE.
- These activities help [promoting science](#) (papers) and [education](#) (hands-on, tutorials)



CDPP News

CDPP and ESA/SSA

Integrating the ESA space weather portal

[Read more ...](#)

A new web site !

Have a new look on CDPP

[Read more ...](#)

CDPP is involved in ESA/Athena

When plasma physics helps X-ray astronomy

[Read more ...](#)

[All the news](#)

The CDPP is the French national data centre for natural plasmas of the solar system.

Created In 1998 jointly by **CNES** and **INSU**, the CDPP assures the long term preservation of data obtained primarily from Instruments built using French resources, and renders them readily accessible and exploitable by the international community. The CDPP also provides services to enable on-line data analysis (**AMDA**), 3D data visualization in context (**3DView**), **propagation tool** and **space weather tool** which bridges solar perturbations to in-situ measurements. The CDPP is involved in the development of interoperability, participates in several Virtual Observatory projects, and supports data distribution for scientific missions (Solar Orbiter, JUICE).

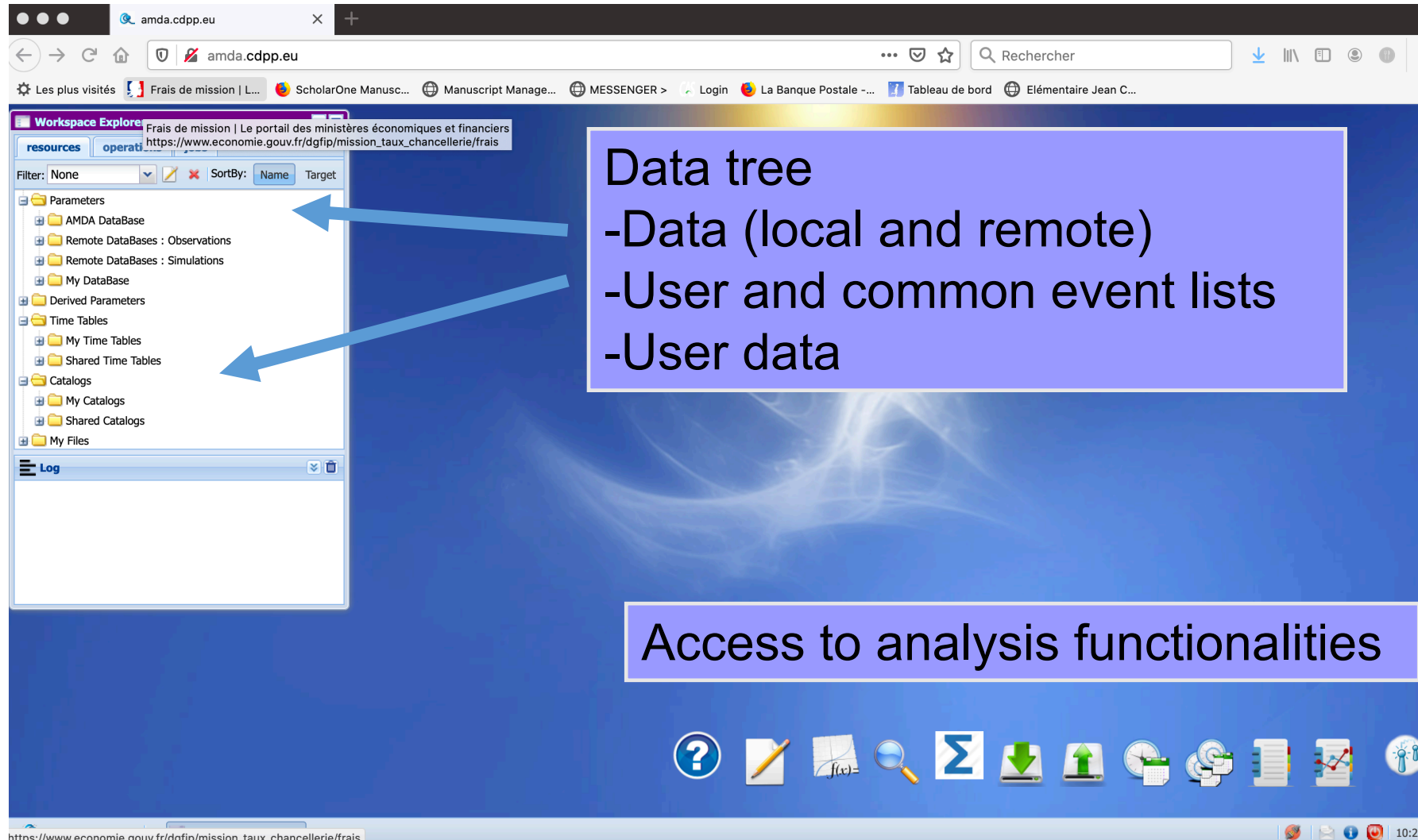
Direct access to our tools !



<http://amda.cdpp.eu/>



- **A data analysis tool in your browser**
 - *physical parameters not files !*
- **Data are**
 - replicated from ESA/Cluster Science Archive, NASA/PDS
 - or accessed remotely : CDAWeb, simulation and model databases, ...
 - public or restricted to communities
 - can be exported in companion tools (SAMP)
 - or uploaded by the user
 - can be accessed via web-services (SOAP/REST)
 - Are internally kept in netCDF
- **Sessions are saved (*so it's better to register !*)**
 - register at amda@irap.omp.eu
- **Public access w/o registration also available**

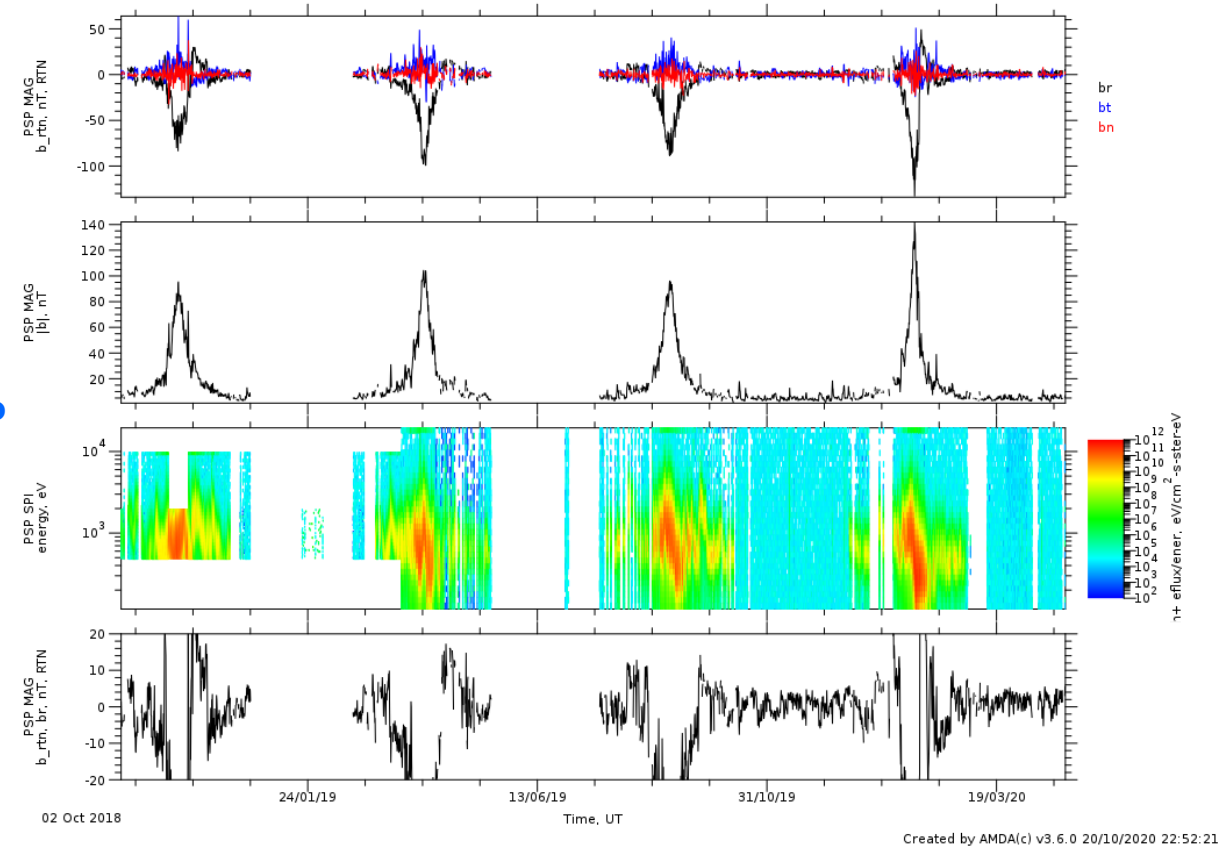
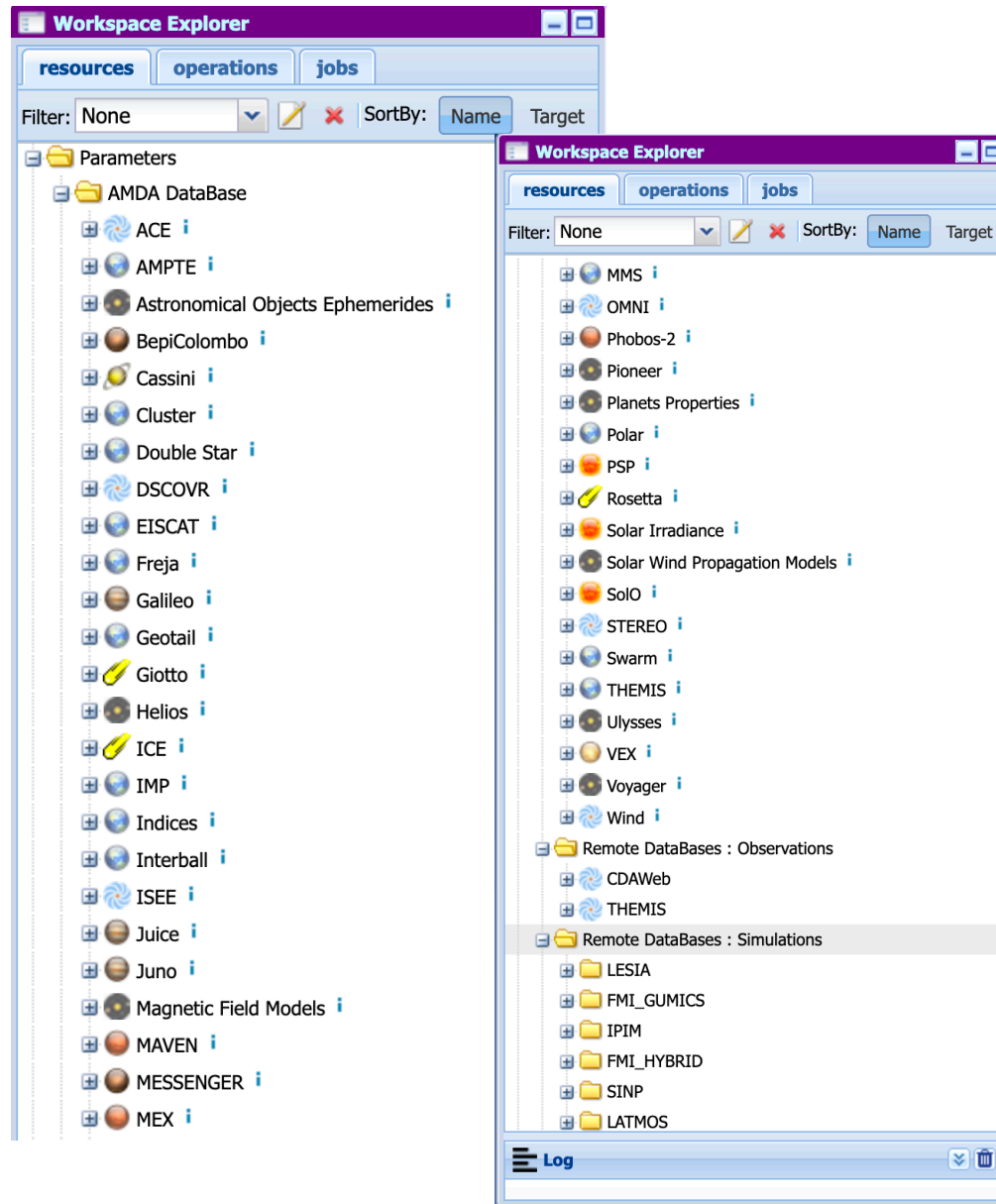


Data tree

- Data (local and remote)
- User and common event lists
- User data

Access to analysis functionalities

Datasets available in the online tool CDPP/AMDA

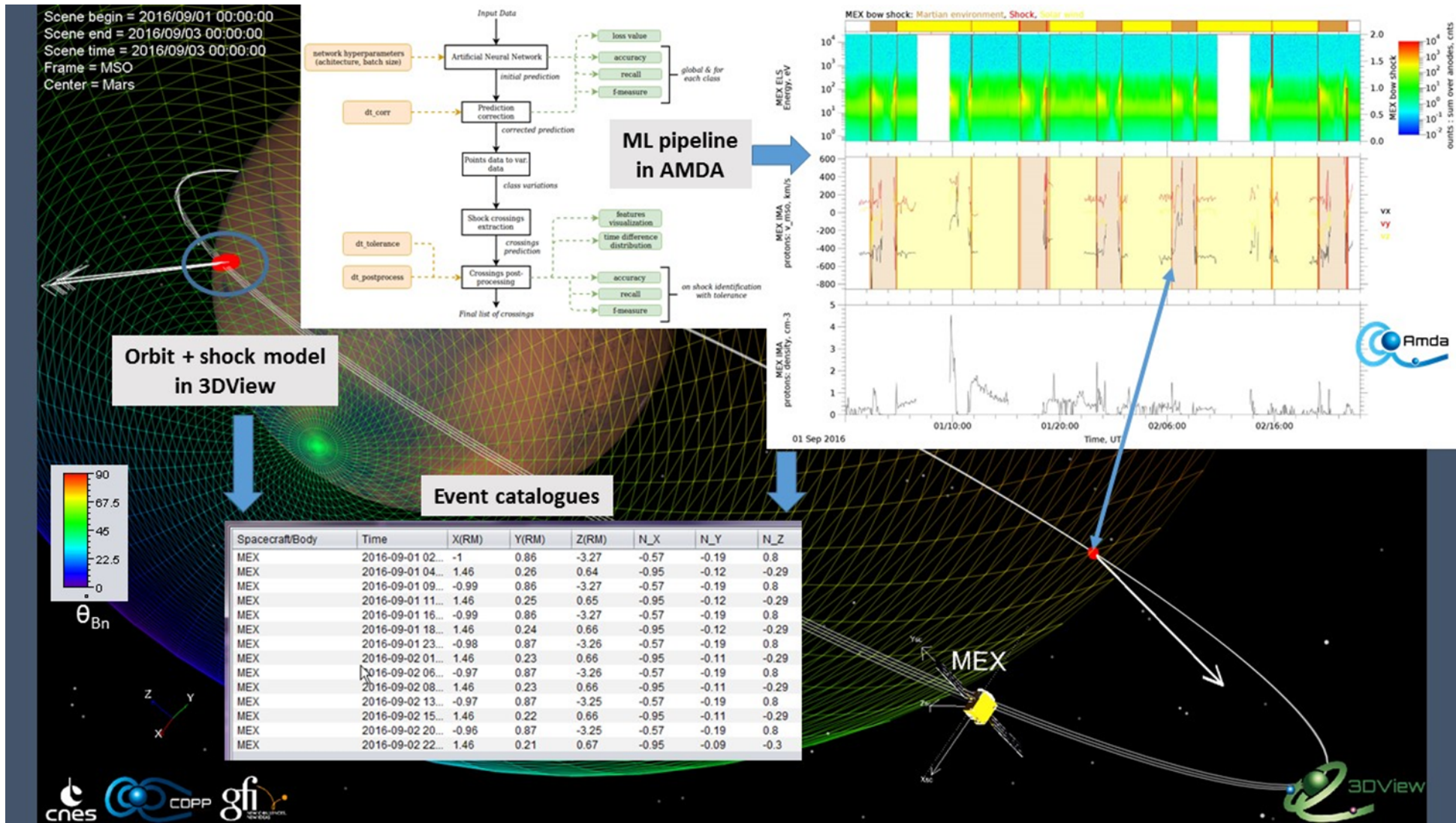


- Plot
- Data mining and combination
- Cataloguing (event lists)
- Upload / download (CDF, netCDF, VOTable, ASCII)
- Statistics (long term analysis)

Recent activities in AMDA

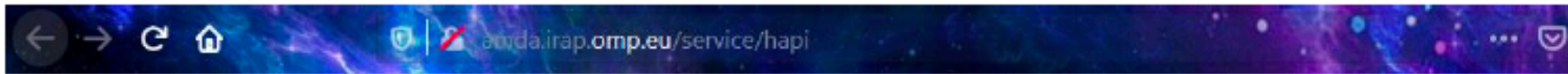
Machine learning: enhancing data visu & analysis

Python: amdapy / Jupyter notebook



AMDA and HAPI

<http://amda.irap.omp.eu/service/hapi>

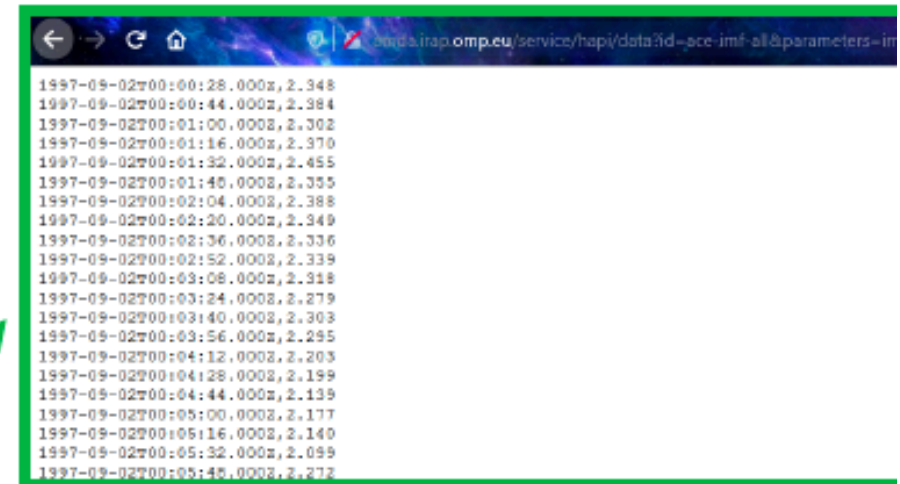


HAPI Server for amda datasets

This server supports the [HAPI 2.0 API](#) specification for delivery of time series data.

The server responds to GET requests to the following [HAPI endpoints](#):

- [capabilities](#) - list the API version and output options
- [catalog](#) - list the datasets that are available (499 total) **Now 649**
- [info](#) - list information about parameters in a dataset, e.g.,
 - </hapi/info?id=ace-imf-all>
 - </hapi/info?id=ace-mag-real>
 - </hapi/info?id=ace-swe-all>
 - </hapi/info?id=ace-swepam-real>
 - </hapi/info?id=ace-swp-all>
- [data](#) - stream data for parameters in a dataset. Examples for first dataset:
 - /hapi/data?id=ace-imf-all¶meters=imf_mag&time.min=1997-09-02T00:00:12Z&time.max=1997-09-03T00:00:12.000Z
 - </hapi/data?id=ace-imf-all¶meters=imf&time.min=1997-09-02T00:00:12Z&time.max=1997-09-03T00:00:12.000Z>
 - /hapi/data?id=ace-imf-all¶meters=imf_gsm&time.min=1997-09-02T00:00:12Z&time.max=1997-09-03T00:00:12.000Z



```
1997-09-02T00:00:28.000z, 2.348
1997-09-02T00:00:44.000z, 2.384
1997-09-02T00:01:00.000z, 2.302
1997-09-02T00:01:16.000z, 2.370
1997-09-02T00:01:32.000z, 2.455
1997-09-02T00:01:48.000z, 2.355
1997-09-02T00:02:04.000z, 2.388
1997-09-02T00:02:20.000z, 2.349
1997-09-02T00:02:36.000z, 2.336
1997-09-02T00:02:52.000z, 2.339
1997-09-02T00:03:08.000z, 2.318
1997-09-02T00:03:24.000z, 2.279
1997-09-02T00:03:40.000z, 2.303
1997-09-02T00:03:56.000z, 2.295
1997-09-02T00:04:12.000z, 2.203
1997-09-02T00:04:28.000z, 2.199
1997-09-02T00:04:44.000z, 2.139
1997-09-02T00:05:00.000z, 2.177
1997-09-02T00:05:16.000z, 2.140
1997-09-02T00:05:32.000z, 2.099
1997-09-02T00:05:48.000z, 2.272
```

Contact: amda@irap.omp.eu

[Run Validation Tests](#)



- <http://3dview.cdpp.eu/>
- In development for about 10 years (JAVA application, GPLv3)
 - Took a lot of inspiration from NASA/VISBARD
- Contractant: GFI, with CNES and EU project supports (IMPEX, Europlanet, ...)
- From an orbit viewer (NAIF/SPICE kernel) to a space physics data rendering system
- It now includes **access to several databases** (CDAWeb, ESA/CSA, Madrigal,...), and offers 3D representations for **data** and **model, statistics** capabilities, movies ...
- See *Génot et al., 2017, PSS* for a full functionality description

Missions

- [Show All Missions](#)

Science Programme

- [Cosmic Vision
2015-2025](#)
- [Future Missions
Department](#)
- [Collaborative Missions](#)
- [Director's Desk](#)

Community Areas

- [Astrophysics](#)
- [Fundamental Physics](#)
- [Solar System](#)

Resources

- [News Archive](#)
- [Multimedia gallery](#)
- [Publication Archive](#)
- [Status Reports Archive](#)
- [Calendar of Events](#)

EXPLORING PLANETARY PLASMA ENVIRONMENTS FROM YOUR LAPTOP

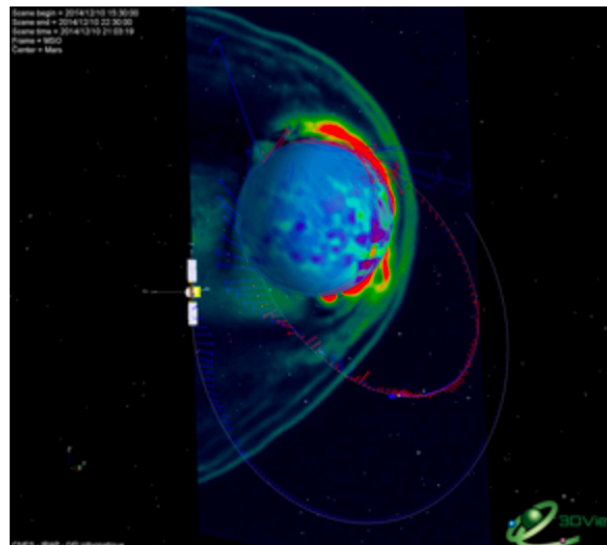
14 June 2018

A new database of plasma simulations, combined with observational data and powerful visualisation tools, is providing planetary scientists with an unprecedented way to explore some of the Solar System's most interesting plasma environments.

This digital space exploration story starts with the Integrated Medium for Planetary Exploration ([IMPEX](#)), a collaborative project to create a common data hub for space missions.

While planetary missions are crucial to understand how the solar wind interacts with the magnetospheres of planets and moons in our Solar System, numerical models are, in turn, essential to fully comprehend the measurements and improve our knowledge of planetary plasma environments.

The IMPEX project brought together experts from Austria, France, Finland and Russia to find a common language to combine data from various simulation models and to compare these numerical results with observational data collected by space missions across the Solar System.



Visualisation of Mars' plasma environment.
Credit: CNES/IRAP/GFI informatique; LatHyS;
3DView





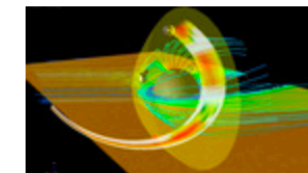
20-Oct-2020 21:02 UT





Shortcut URL

<https://sci.esa.int/s/ApEdDGw>

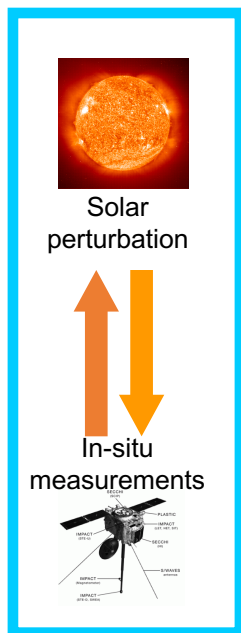


Images And Videos



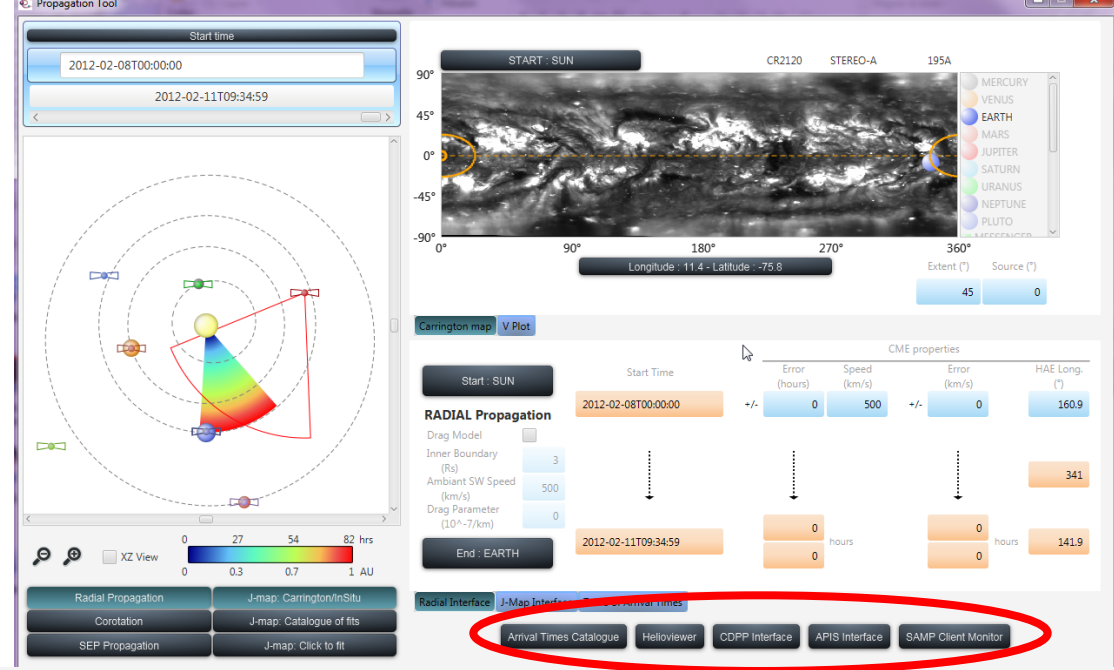
-  [Animated simulation of Mercury's plasma environment](#)
-  [Animated simulation of Mars' plasma environment](#)
-  [Visualisation of Mars' plasma environment](#)
-  [Visualisation of the ionised environment of Ganymede](#)

The Propagation Tool



- <http://propagationtool.cdpp.eu/>
- Computes timing for radial propagation of CME (inc. Drag model), co-rotation (CIR), and SEP propagation
 - *linking in-situ and remote observations*
- First version : 2013 (JAVA application, GPLv3)
- Contractant: GFI, with CNES and EU project supports (Europlanet)
- Designed by A. Rouillard, B. Lavraud and the STORMS team at IRAP based on a FP7 HELIO initial concept
- Used to distribute STEREO catalogues obtained during the FP7 HELCATS projects <http://www.helcats-fp7.eu/>
- Gives access to J-Maps (real and simulated), Carrington maps, catalogues, ...
- Connects to external tools and databases for further analysis

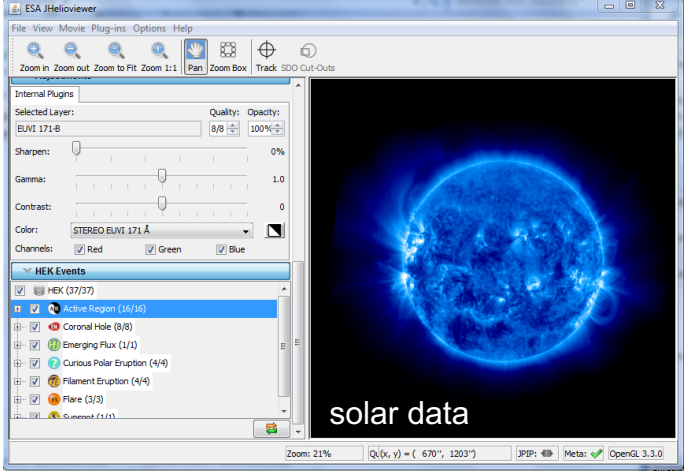
HELCATS catalogues propagated at a given source



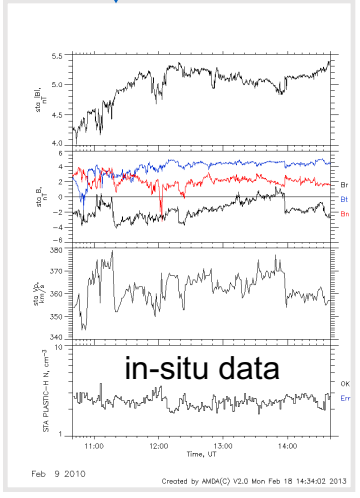
Data export to companion tools



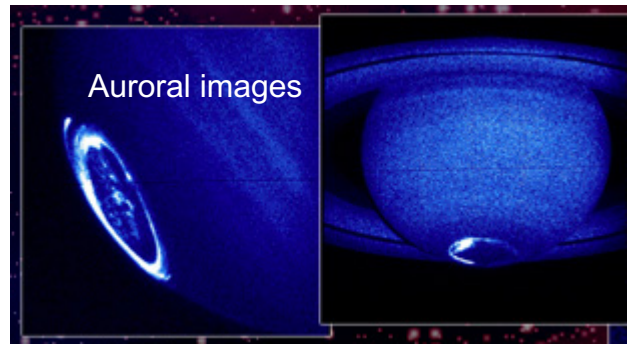
MEDOC database / JHelioviewer



AMDA plot



APIS



Transplanet: <http://transplanet.irap.omp.eu>

v2.4.0

Request Run | View Results | Published Runs | Acknowledgements | Publications | Links | License | Job

REQUEST A NEW RUN

Venus

Earth

Mars

Jupiter

USER

Email (where we'll send the link for downloading the result)

Description (optional, but recommended)

SPECIES

<input checked="" type="checkbox"/> H	<input checked="" type="checkbox"/> N	<input checked="" type="checkbox"/> H ⁺	<input checked="" type="checkbox"/> N ⁺
<input checked="" type="checkbox"/> O	<input checked="" type="checkbox"/> N ₂	<input checked="" type="checkbox"/> O ⁺	<input checked="" type="checkbox"/> N ₂ ⁺
<input checked="" type="checkbox"/> O ₂		<input checked="" type="checkbox"/> NO ⁺	<input checked="" type="checkbox"/> O ₂ ⁺

TIMESPAN

Simulation start date (YYYY / MM / DD):

Simulation start time (HH:MM:SS):

Simulation duration (HH:MM:SS):

Output time interval (s):

KINETICS

Compute Photoionization Compute electron precipitation

MAGNETIC FIELD

Magnetic field model

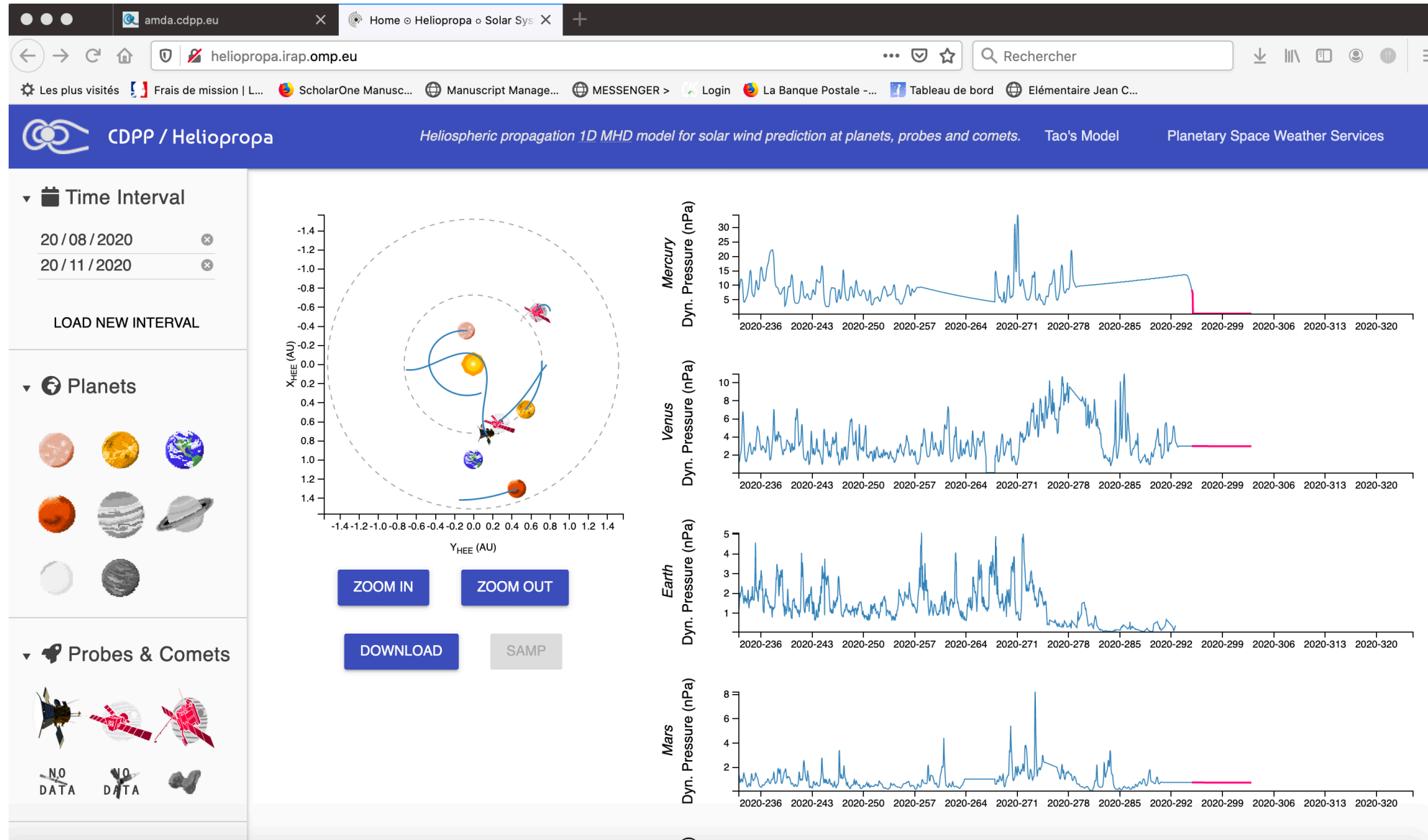
v2.4.0

Request Run | View Results | Published Runs | Acknowledgements | Publications | Links | License | Job

RUNS (202)

Initiated	User	Id	Description	Kti	Kpi	Mag
1 month ago	Julian Eisenbeis	julian.eisenbeis_20200908072655_5f57323fd426a1		1h	60s ✓	1 IGRF
1 month ago	Julian Eisenbeis	julian.eisenbeis_20200908072552_5f573200e43471		12h	60s ✓	1 IGRF
3 months ago	Jean-michel Glorian	jean-michel.glorian_20200625152612_5ef4c2142d9f21		1h	60s ✓	1 IGRF
5 months ago	Elowitzm	elowitzm_20200520180144_5ec570886af461	Initial Test Run	1h	60s ✓	1 IGRF
7 months ago	Sandrast	sandrast_20200310093646_5e475faec28f01		1h	60s ✓	1 IGRF
7 months ago	Nicolas Andre	nicolas.andre_20200228142400_5e592280ed20c1	mars is fun	1h	60s ✓	1 No B field
8 months ago	Sarakocevska4	sarakocevska4_20200128150831_5e304e6f7af311	A concise description of this run	1h	60s ✓	1 No B field
1 year ago	Aurelie Marchaudon	aurelie.marchaudon_20190906072941_5d720ae50f1a81	MH_eclipse2017	72h	60s ✓	1 IGRF
1 year ago	Mindurain	mindurain_20190905091008_5d7040f023c5a1	922da78 version test	6h	60s ✓	1 No B field
1 year ago	Mindurain	mindurain_20190905090929_5d7040c99858c1	922da78 version test	6h	60s ✓	1 No B field
1 year ago	Mindurain	mindurain_20190905090143_5d70cc4784ce71	922da78 version test	6h	60s ✓	1 IGRF

Heliopropa: <http://heliopropa.irap.omp.eu>









ESA/Space Situational Awareness

The screenshot shows a web browser window with the URL <https://swe.ssa.esa.int/heliospheric-weather>. The page header includes the ESA logo and the text "Welcome to the SSA Space Weather Service Network". The main content area is titled "Heliospheric Weather Expert Service Centre (H-ESC)" and features a navigation menu with tabs for "ESC Objectives", "Contributions", "Product demonstration", and "Contributors". The "Contributors" tab is active, showing a list of expert groups and consultants. A red circle highlights the "ESC Heliospheric Weather" link in the left sidebar and the "Centre de Données de la Physique des Plasmas (CDPP)" entry in the main content area.





ESC Heliospheric Weather

ESC Coordinator
Chris Perry (STFC)

Expert Groups providing products

-  Centre de Données de la Physique des Plasmas (CDPP)
France
-  RAL Space
Science and Technology Facilities Council (STFC)
United Kingdom
-  UK Met Office (UKMO)
United Kingdom
-  DH Consultancy (DHC)
Belgium
-  Solar Influences Data analysis Center (SIDC)
-  Royal Observatory of Belgium (ROB)
Belgium

Expert Consultants

-  Centre for mathematical Plasma-Astrophysics (CmPA)
Katholieke Universiteit Leuven (KUL)
Belgium
-  Technical University of Denmark (DTU)
Denmark
-  UNIGRAZ Institute of Physics (UNIGRAZ)
University of Graz (UNIGRAZ)
Austria
-  Institute for Astrophysics (UGOE)
University of Göttingen (GAU)
Germany

A community infrastructure

CDPP tools

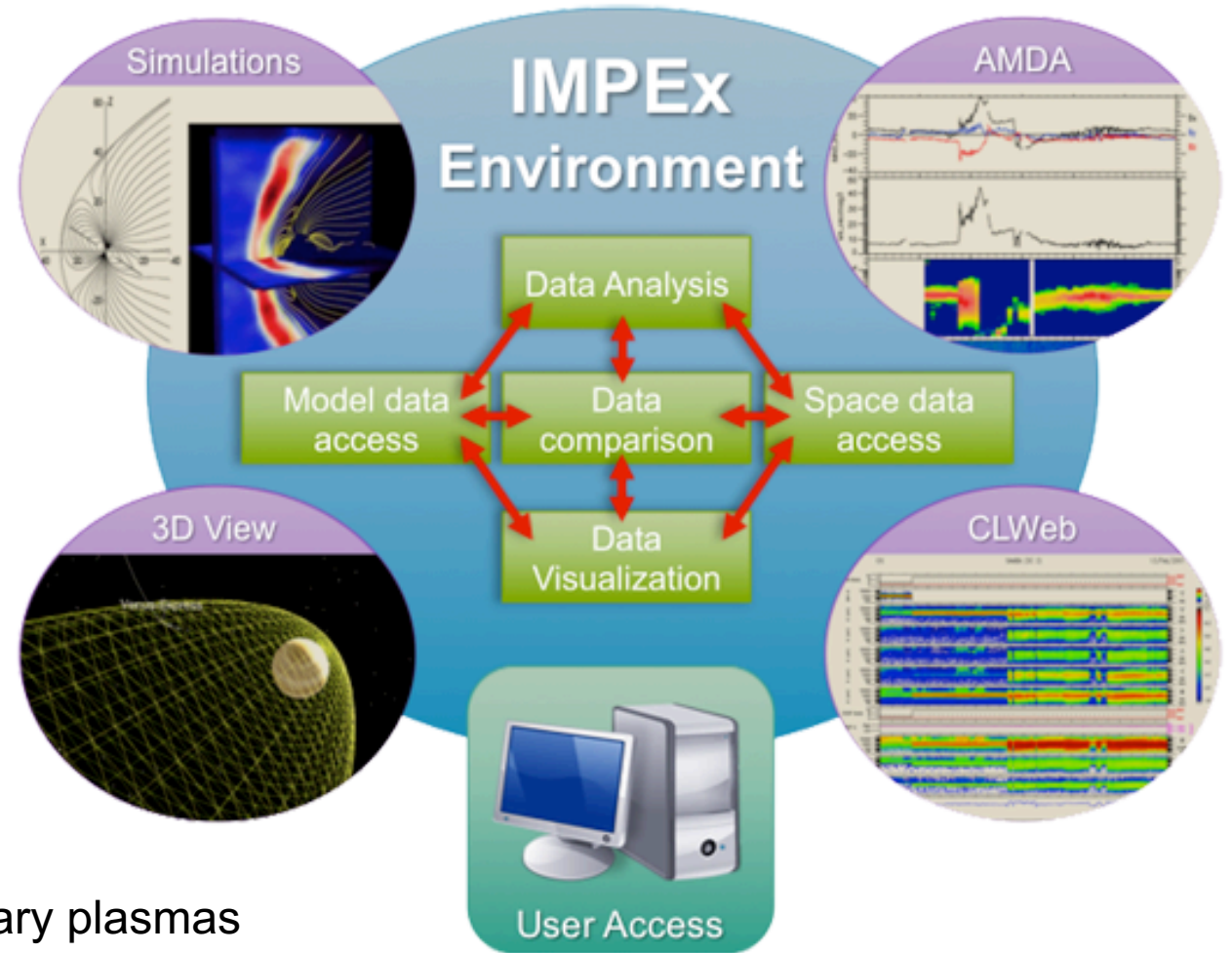
- Are used by a wide community of scientists
 - Eg, about 400 AMDA sessions / month
 - Including students (courses, projects, thematic schools)
- Are regularly reviewed by a user committee
- Help/facilitate scientific publication
 - About 10-15 papers / year



- 4 year FP7 project (2011-2015)
- 4 partners project :
 - LATMOS, CDPP (France)
 - FMI (Finland)
 - SINP (Russia)
 - IWF (Austria, *coordinator*)

Key features

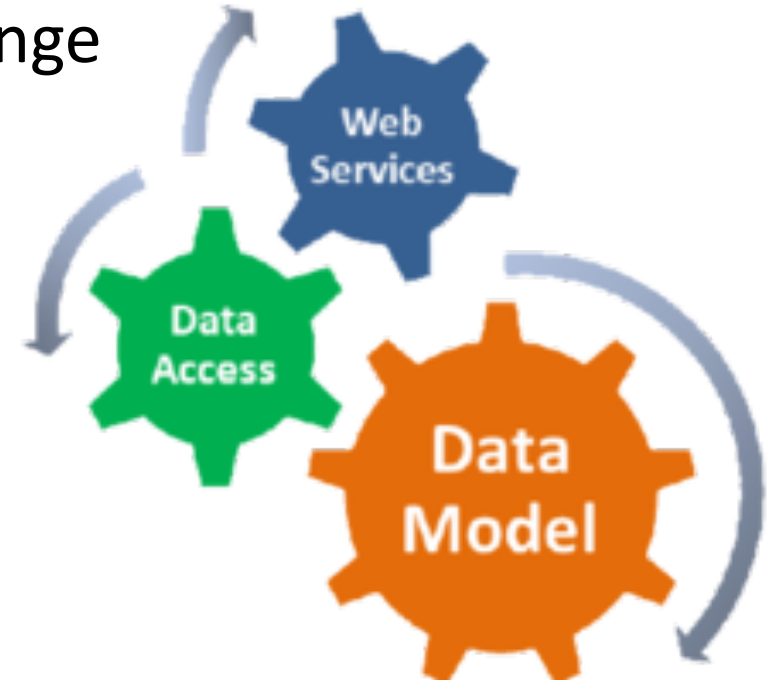
- No centralization
- Comparison Observations / Simulations for planetary plasmas
 - Fly virtual S/C in 3D simulation results
- Visualisation 2D/3D
 - Data along S/C trajectories, 3D model cuts, boundaries
- Event lists
- Method to find most relevant runs for given observations



IMPEX : how to share information ?

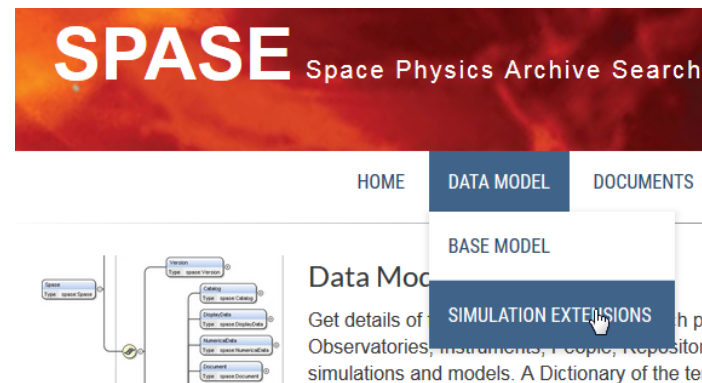
The use of a unified protocol

- A standard/unique dictionary for describing observations and simulations
 - Use of an extended version of SPASE
- Standard methods for machine to machine exchange
 - REST/SOAP web services definition
 - Implemented in all tools and databases
- Standard formats
 - netCDF, VOTable



Status of the IMPEx data model

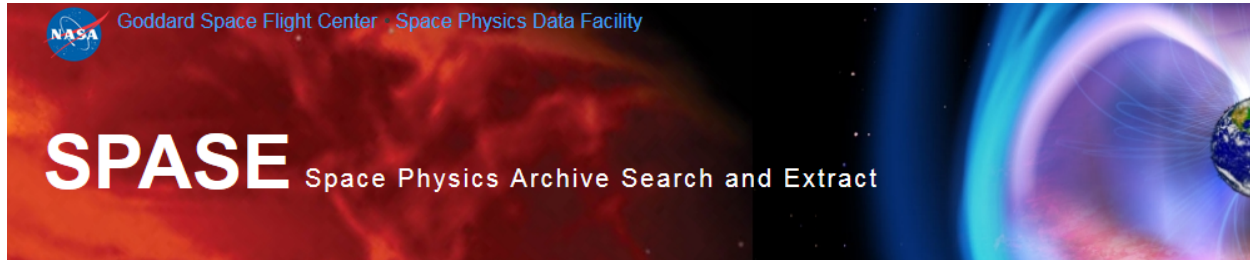
- Has been developed during 2011-2014
- Has been endorsed by the SPASE consortium as a « simulation extension»



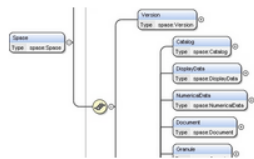
- Has been used for the Transplanet on-demand platform (Europlanet/PSWS)
- Has been re-used by CCMC for their large number of codes
- Is used (and extended) in France for a project concerning magnetosphere/exosphere code coupling (ANR TEMPETE)

Extension of the SPASE data model

<http://www.spase-group.org/>



HOME DATA MODEL DOCUMENTS TOOLS SCHOOL SERVICES NEWS ABOUT



Data Model

Get details of the SPASE Data Model, which provides terms and syntax for uniform descriptions of Heliophysics resources, including Observatories, Instruments, People, Repositories, and (most centrally) Numerical Data products. An extended set of terms deals with simulations and models. A Dictionary of the terms is provided, along with the XML schema documents used to validate SPASE descriptions.



Documents

Specifications for event lists (and catalogues) and endorsed conventions for text markup, resource ID formation, and help with dealing with plain text data within SPASE descriptions.

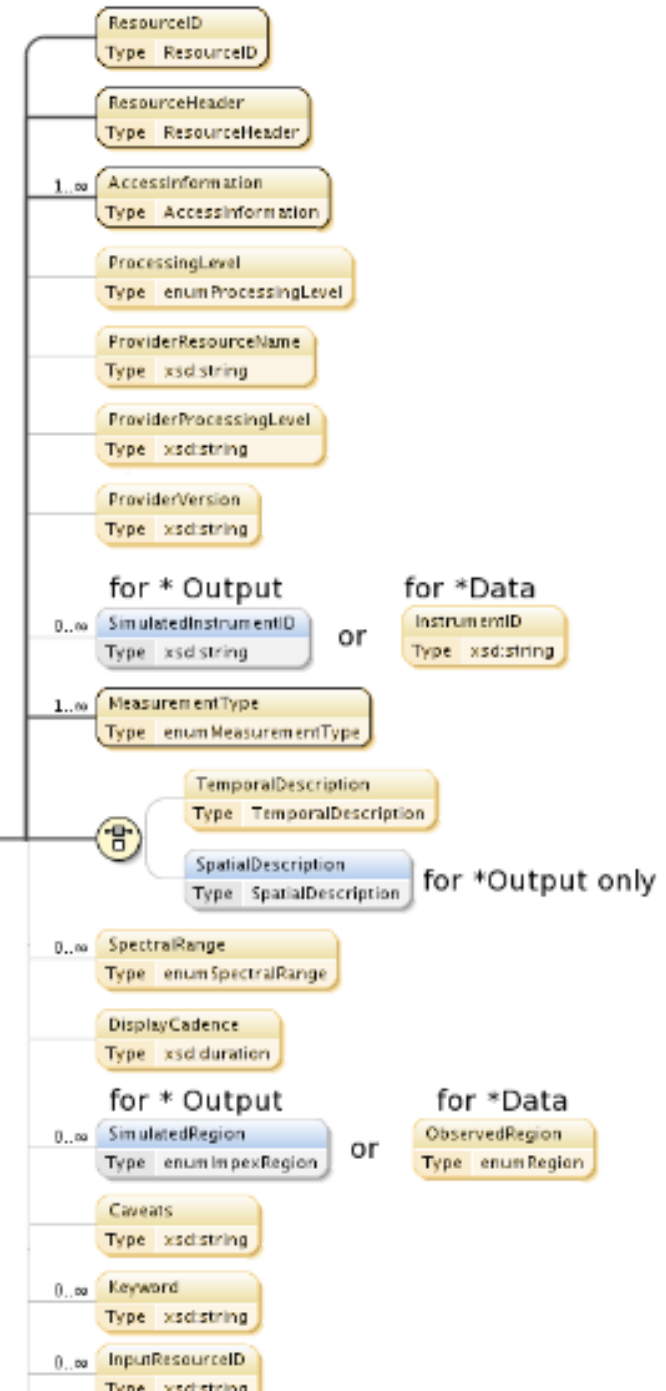
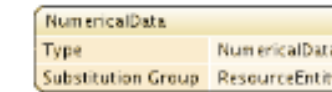


Tools

Reference implementations and tools for working with SPASE metadata and the SPASE framework. You can validate SPASE product descriptions, make and edit new SPASE IDs and files, and explore the SPASE registry.

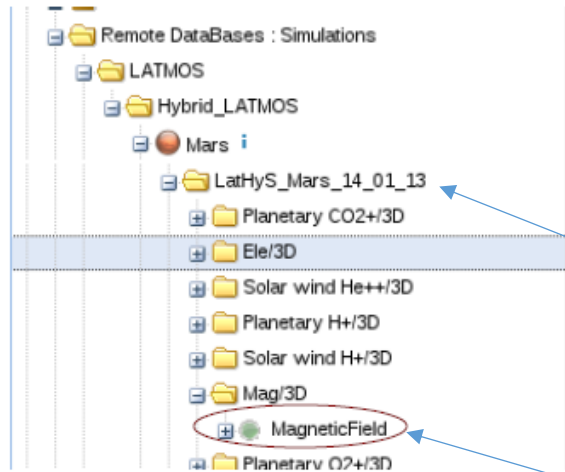
Fast, Free, Powerful

Observations Simulations

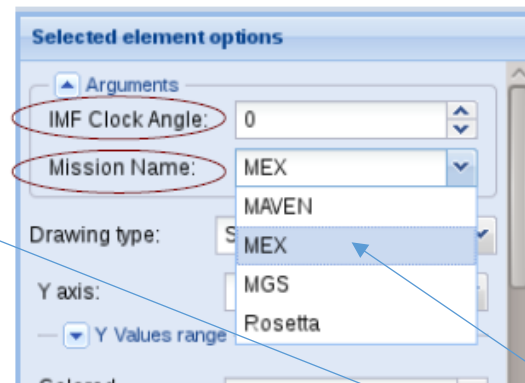


AMDA : Getting Parameters : `getDataPointValue()` IMPEX WebService

Select Parameters



Select Arguments (&Time)



AMDA => IMPEX

`getDataPointValue(RunID,
ParameterID,
XYZ_URL,
extraParams)`

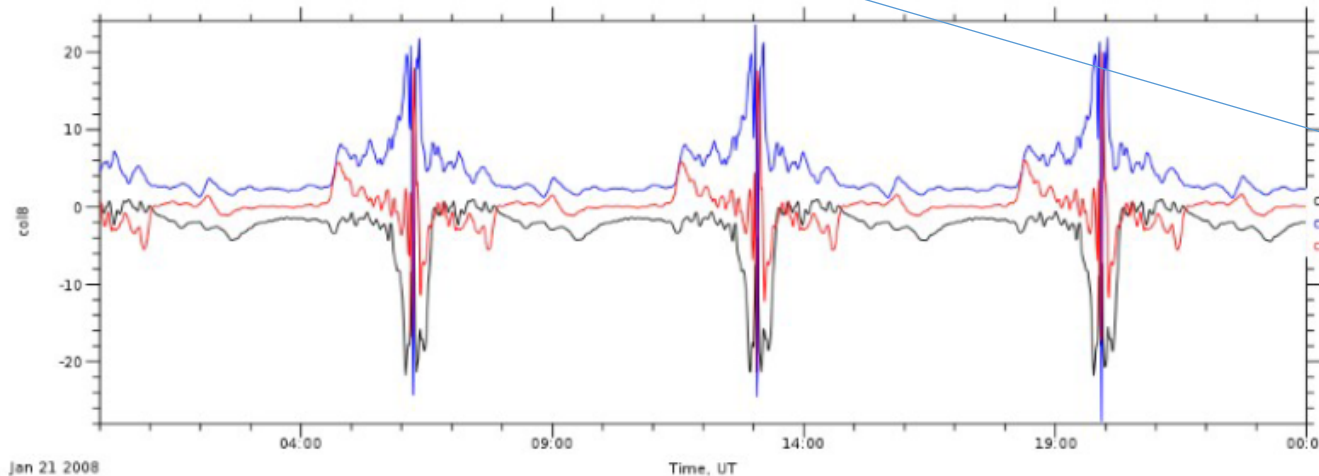
AMDA XYZ_URL:

XYZ file is run-time generated
from *mission /time* info

AMDA <= IMPEX

`get File (URL)`

Result



Paramètre de la simulation
3D interpolé le long de la
trajectoire du satellite
sélectionné

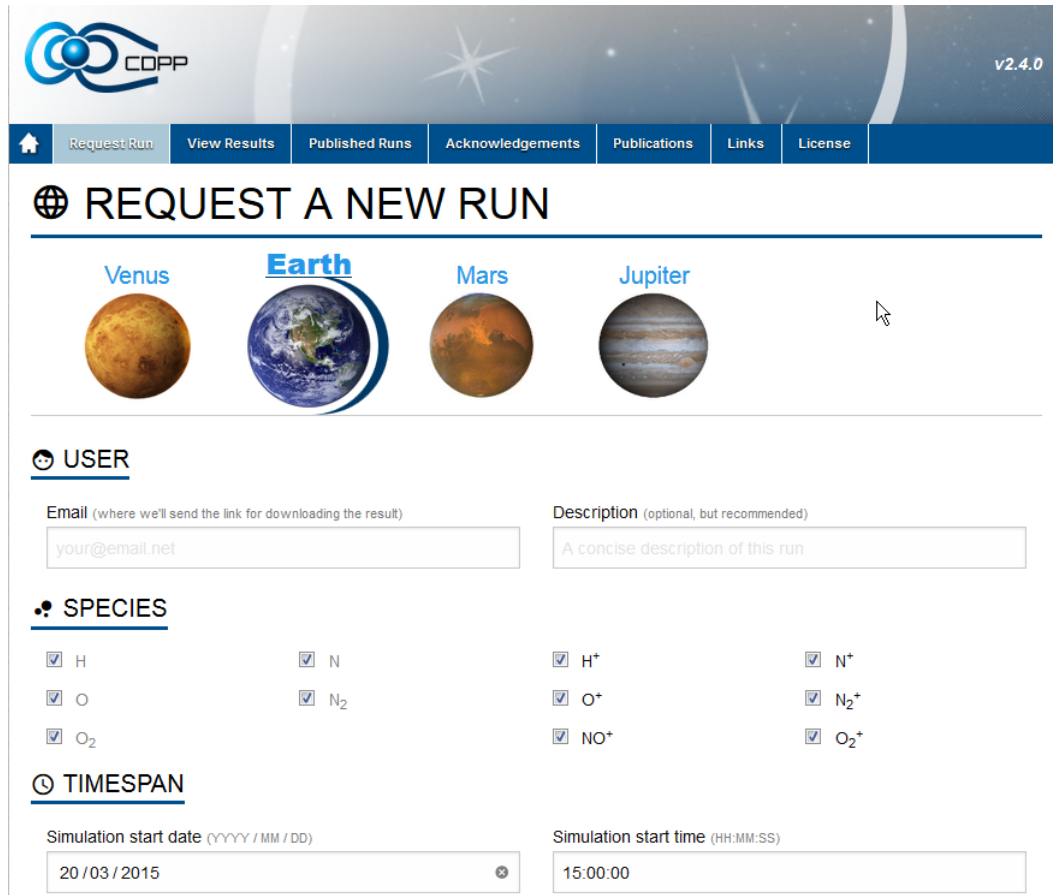
Perspectives

- Suite à la demande de collègues : réflexion sur un archivage de simulations au CDPP
 - Stockage des résultats sur baies (volume d'une simu ~ 200 Go)
 - Environnement d'analyse (méthodes d'interpolation et coupes) dispo au LATMOS à dupliquer au CDPP

Transplanet

Financement Europlanet

- <http://transplanet.cdpp.eu>
- Interface web → Request Run



The screenshot shows the 'REQUEST A NEW RUN' page of the Transplanet web interface. At the top, there is a navigation bar with the CDPP logo and version number v2.4.0. The main navigation menu includes 'Request Run', 'View Results', 'Published Runs', 'Acknowledgements', 'Publications', 'Links', and 'License'. The 'Request Run' section is active, displaying a header 'REQUEST A NEW RUN' and four planet selection buttons: Venus, Earth (selected), Mars, and Jupiter. Below this is a 'USER' section with an 'Email' field (containing 'your@email.net') and a 'Description' field (containing 'A concise description of this run'). The 'SPECIES' section features a grid of checkboxes for various chemical species: H, N, H⁺, N⁺, O, N₂, O⁺, N₂⁺, O₂, NO⁺, and O₂⁺. The 'TIMESPAN' section includes a 'Simulation start date' field (containing '20/03/2015') and a 'Simulation start time' field (containing '15:00:00').

- Lancement de la simulation sur le serveur de calcul
- Estimation de la durée du calcul
- Mail : YOUR REQUEST HAS BEEN SUBMITTED
Expected result in XX minutes
- Tâche sync entre le serveur web et le serveur de calcul toutes les 5'
→ retourne l'état des runs
- Mail : Your run id_XX is finished
You can download the results here : lien

➔ RUNS (204)

Initiated	User	Id	Description		Kti	Kpi	Mag
26 days ago	Nicolas Bergeot	nicolas.bergeot_20210203193312_601afa78b43991	test	1h	60s	✓	1 IGRF
1 month ago	Nicolas Andre	nicolas.andre_20210103211018_5ff232ba9ae471	test	1h	60s	✓	1 No B field

Download Zip File

View Results | Request Run | Acknowledgements | Publications | Links | License

Run 20161222103323_585babf39b14c

Mars case lat=0

[Download output](#) [Make another run like this](#)

General run configuration

Planet	Mars
Start Date and Time	2015-03-20 15:00:00
Duration	7200s by steps of 0.5s
Species	H ⁺ , N ₂ ⁺ , NO ⁺ , O ⁺ , O ₂ ⁺ , CO ₂ ⁺

Simulation configuration

Kinetics	Every 60s, with photoionization
Magnetic model	No B field
Atmospheric profile	MCD

Locations

GEO	180 / 0	Download CDF	Send via SAMP
-----	---------	------------------------------	-------------------------------

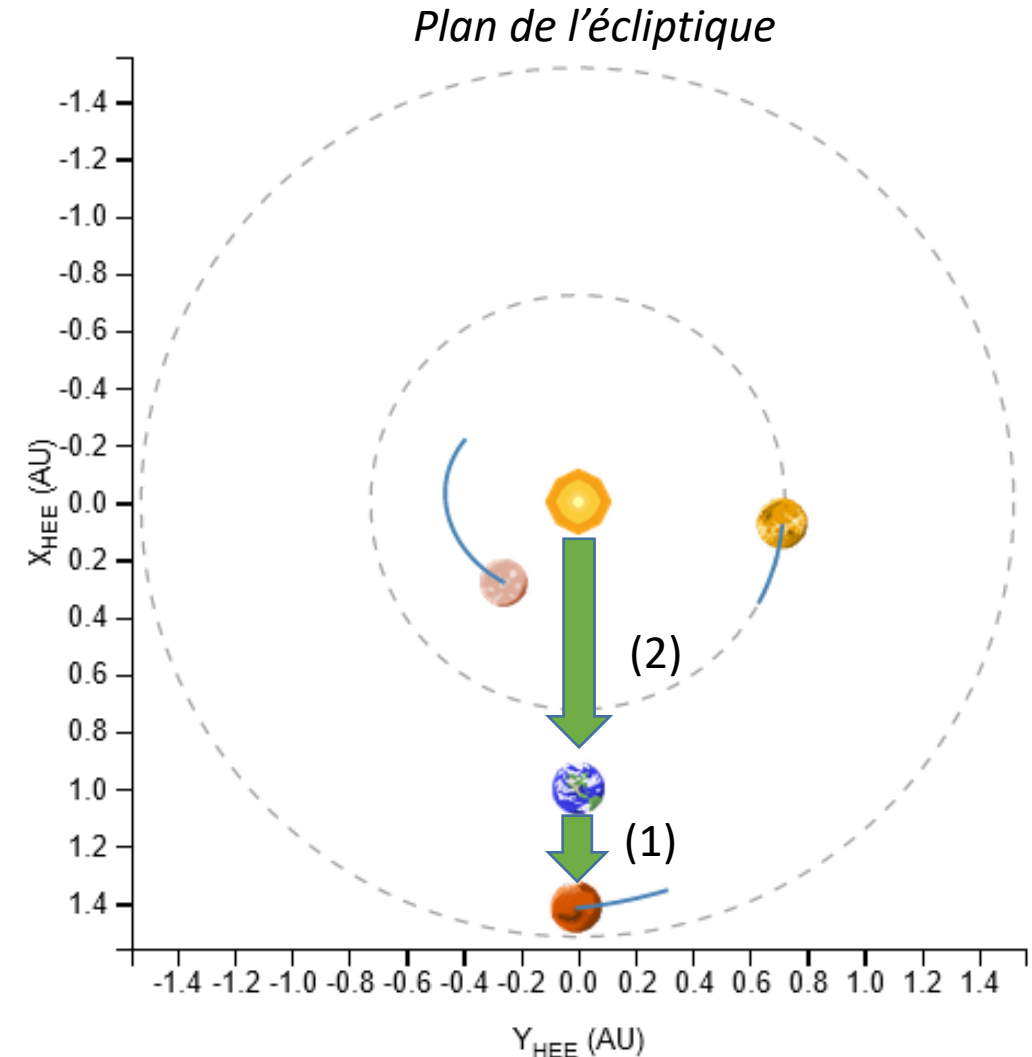
Download CDF

Send via SAMP

- 204 simulations , taille sur disque 31 Go
- 1 répertoire par simu avec un zip des fichiers en cdf (800 Ko – 700 Mo)
- Clé DSA pour communication entre serveur web et serveur calcul
- Framework Php Silex avec composants Symfony et Twig
- Utilisation du modèle SPASE
- Un fichier tree en xml contient les métadonnées de tous les runs

1D-MHD

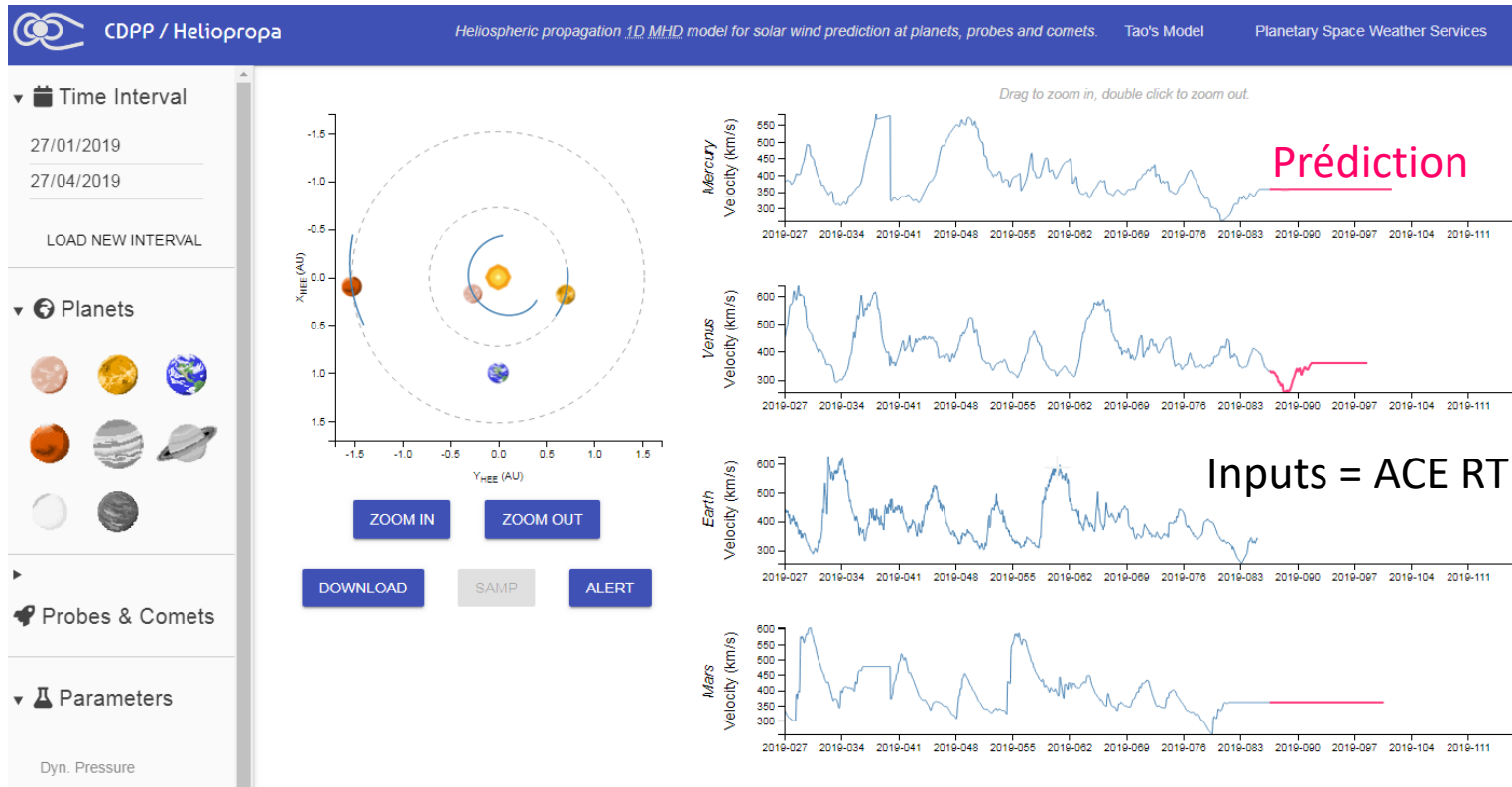
- Un modèle « simple et léger » permettant de simuler la propagation du vent solaire (N, V, T, B) entre 2 points de l'héliosphère
- 1. de la Terre aux planètes et sondes : données dans AMDA et HelioPropa
- 2. du Soleil ($21.5R_{\text{sun}}$) à la Terre : projet H2020 SafeSpace (*ensemble forecasting* pour trouver la meilleure prédiction)
- Nouveaux inputs tous les jours → nouvelle simu tous les jours



Heliopropa

Financement Europlanet

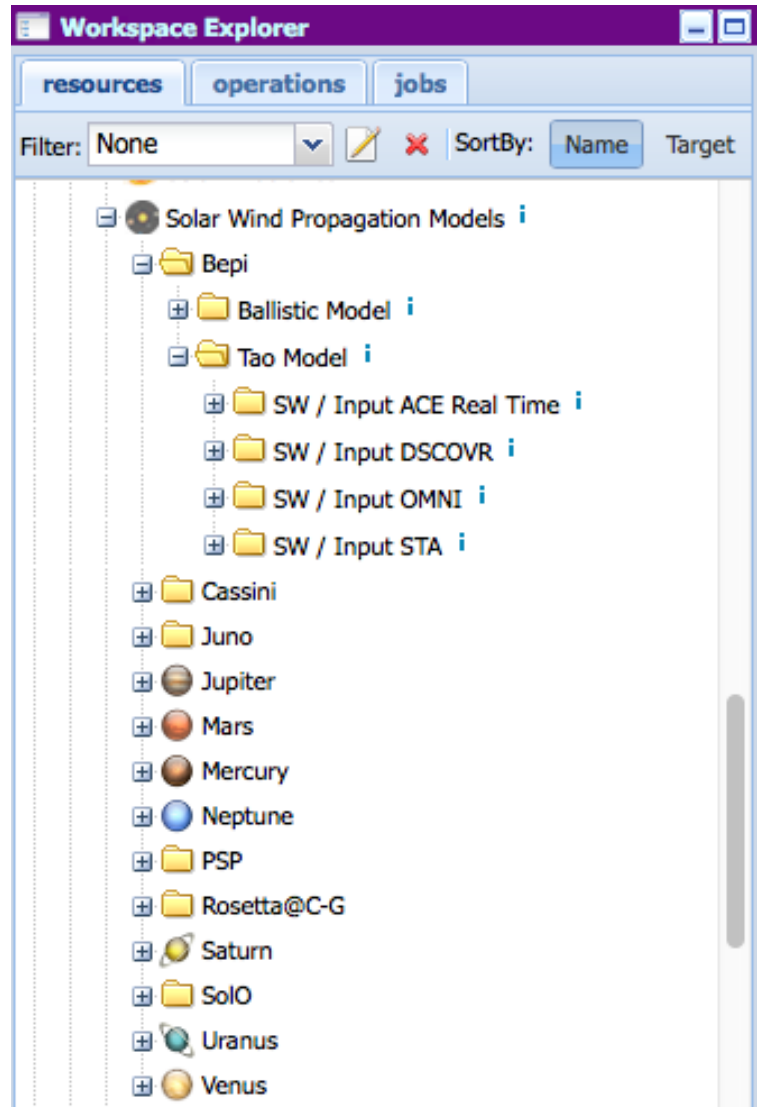
- Paramètres du vent solaire propagés à différentes planètes et sondes (code 1D MHD *Tao et al, 2005*)
- Interface web : appel à AMDA → visualisation
- Utilisation de données « real time » (ACE, DSCOVR) pour une prédiction à qq jours (Mars, Jupiter, Saturne)



Retours :

- Suivi de perturbations dans l'héliosphère
- Prédiction des conditions aux planètes
- Intégré au portail ESA/SSA
- Ajout de nouvelles sondes (PSP, SO, BepiColombo)

Données TAO dans AMDA



- Tâche cron toutes les nuits pour lancer le modèle de TAO (propagation des paramètres du vent solaire à différentes planètes et sondes)
 - Exécution script python sur machine distante
 - Vérification toutes les 10' de l'état du process
 - Transfert des données dans la base AMDA
- Mise à jour de l'arbre AMDA par script

Données TAO dans Héliopropa

- Tâche cron toutes les nuits récupère les données de TAO à partir d'AMDA par webservice
- Fichiers netcdf transformés en csv
- Stockage de ces fichiers dans le cache

- Les données peuvent être téléchargées ou envoyées par SAMP vers une autre application

- Serveur web Flask et d3.js pour les tracés