Simulation database of planetary environments and interoperability with VO visualization tools”

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LATMOS, ONERA, IRAP / CDPP

Simulation data sharing and analysis : Towards a Findable Accessible Interoperable Reusable approach

Goals :

- **Findable** : Describe and archive 3D simulation of planetary environments
- **Accessible** : Make available/access simulation results.
- **Interoperable** : Connect the visualization tools and the simulation database.
- **Reusable** :Use of a simulation set for different studies and by different teams.

Context and models:
Modelisation and simulation of planetary neutral and ionized environments

Magnetosphere – LatHyS Modolo et al, 2016
Exosphere – EGM Leblanc et al, 2017

Projects :

ANR HELIOSARES (2009-2014)
FP7 IMPEx (2011-2015)
ANR MARMITE (2014-2019)
ANR TEMPETE (2018-2022)
IPI SU METEO (2022-2024)
SIMPA LATMOS (2022-2023)

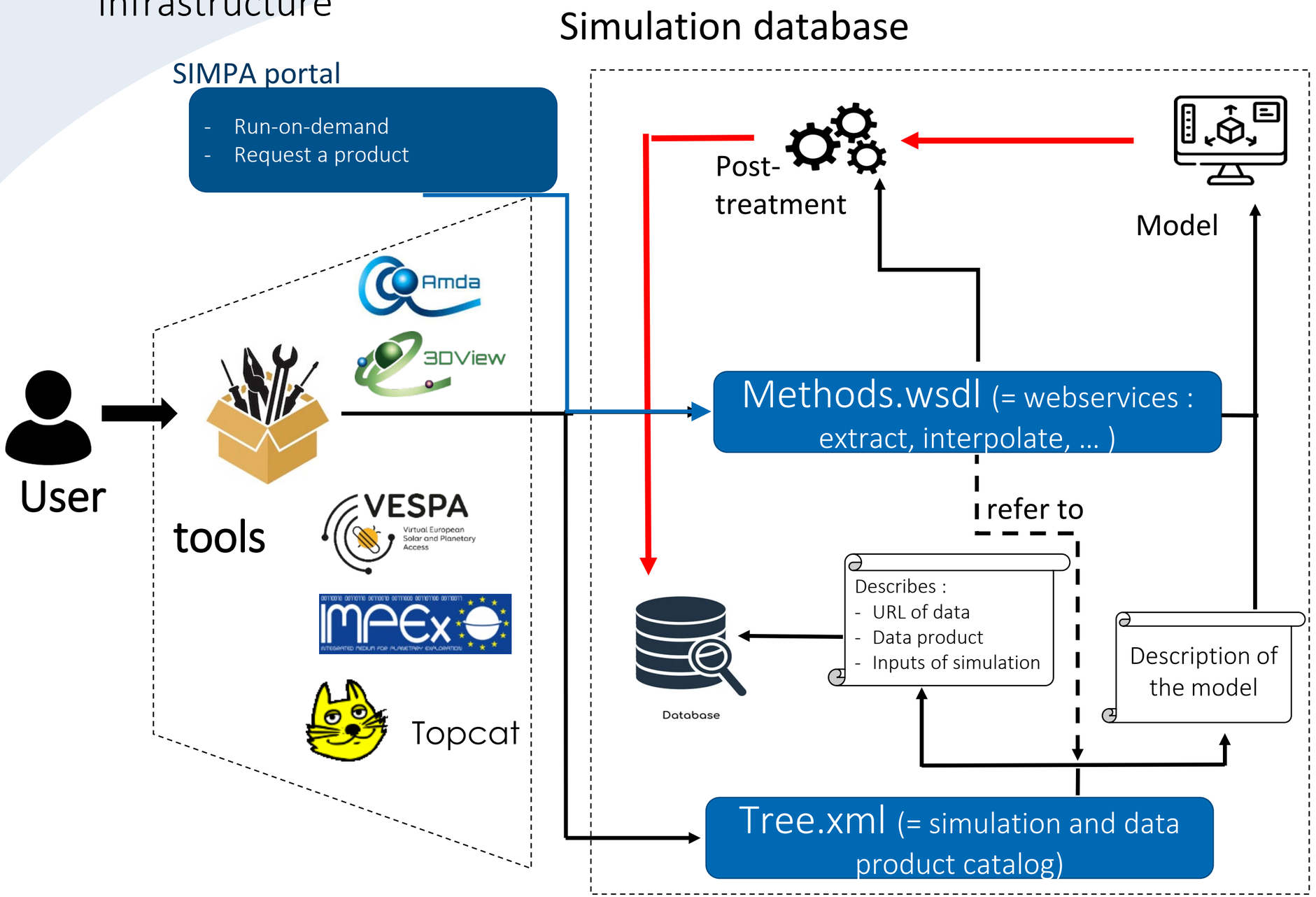
Metadata and data model

Space Physics Archive Search and Extract (SPASE) data model consists of an exclusive set of resource types which can be used to describe data along with its scientific context, source, provenance, content and location.

Use of SPASE data model along with the simulation extensions proposed by IMPEx, and now fully included in the current SPASE data model, are a COSPAR recommendation (COSPAR panel, 2021).

Major metadata for simulations : SimulationModel, SimulationRun, NumericalOutput, Granule,…

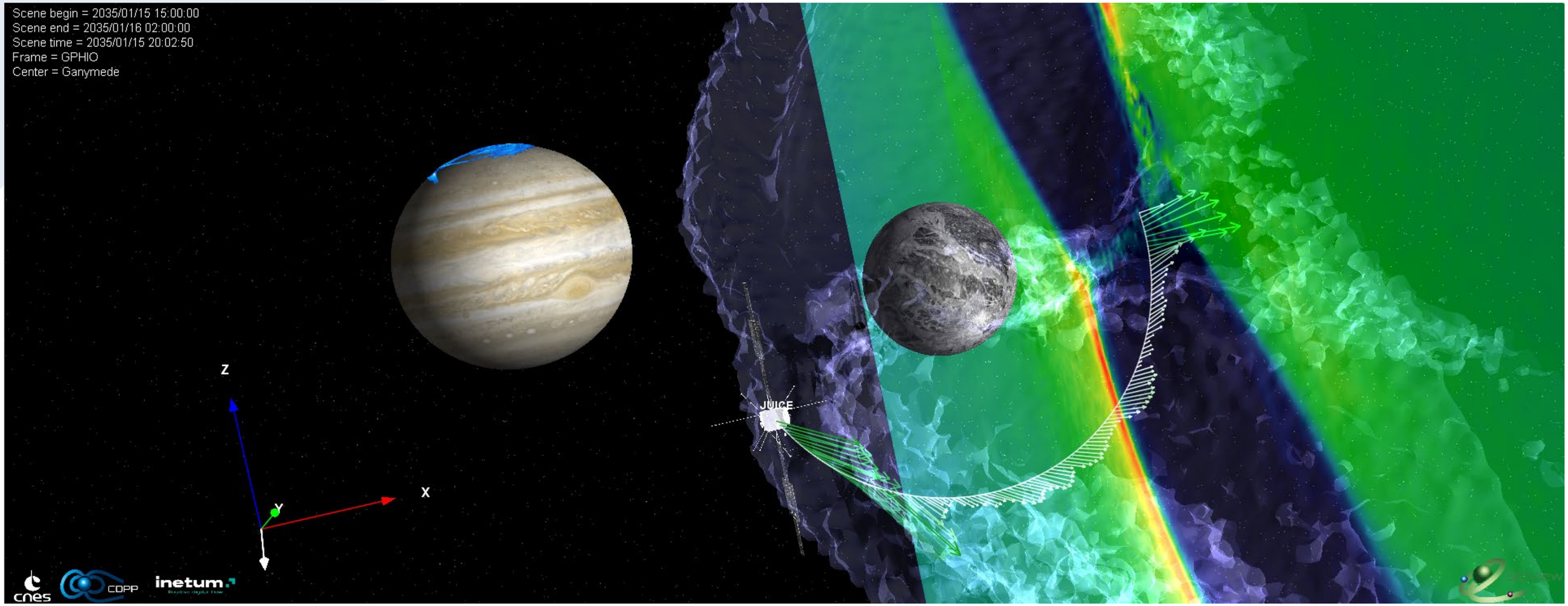
Infrastructure



Catalog of simulation results, their descriptions with metadata, the different set of data products with the URL to the (pre-computed and archived) data
« tree.xml »
Ex :
http://impex.latmos.ipsl.fr/tree.xml

Webservices : additional service to fetch, extract, interpolate data along S/C trajecory, construct high level data (field/flow lines,…)
« **webservices.wsdl** »
Ex :
http://impex.latmos.ipsl.fr/Methods_LATMOS.wsdl

GetFileURL
GetDataPointValue
GetFieldLines
GetdataPointSpectra
GetColumnDensity,….



Jupiter- Ganymede interaction, with its Alfvén wings (isosurface shaded blue), Bulk speed along S/C trajectory (colored vectors) and 2D velocity map in the wake of the moon

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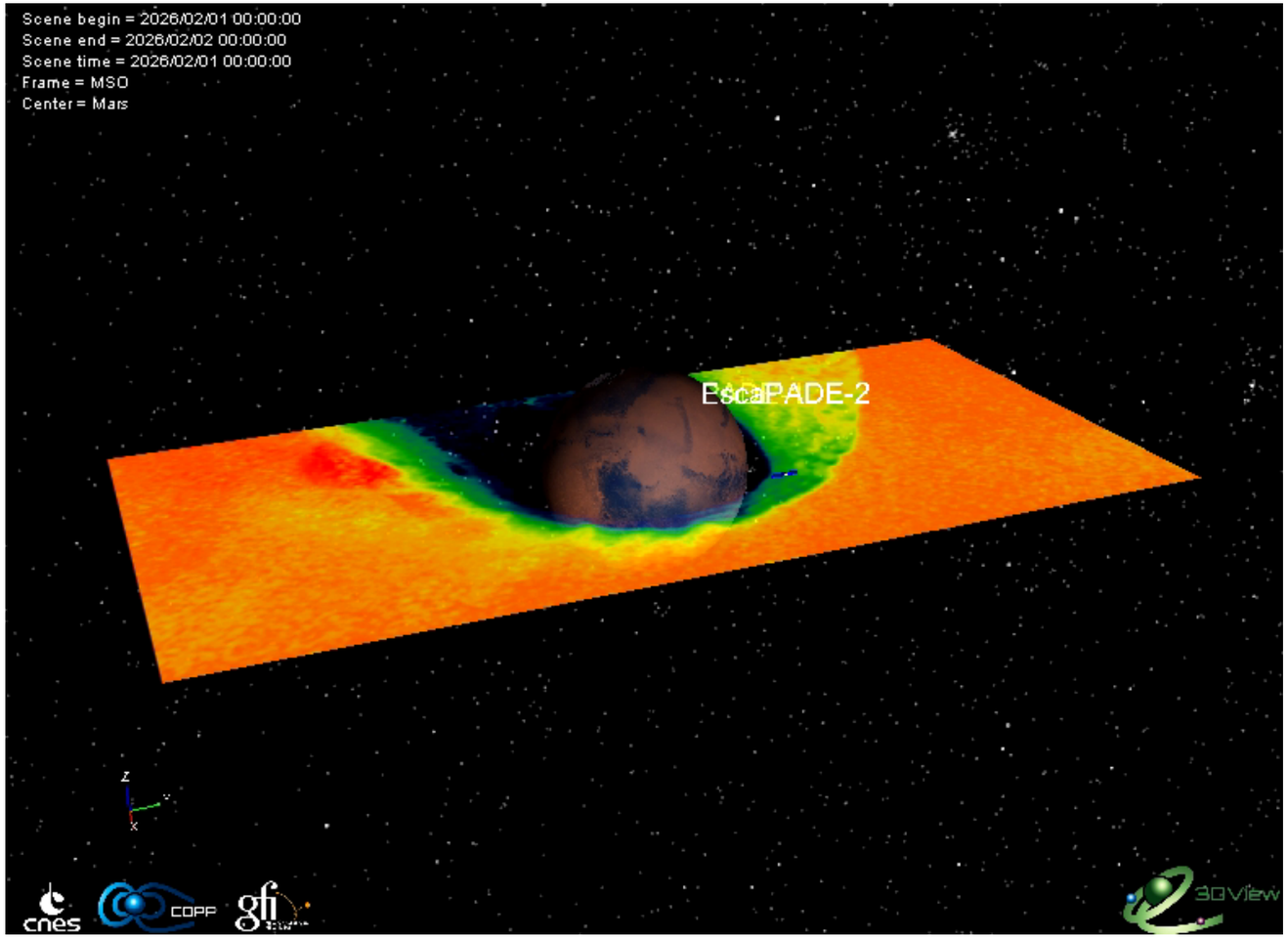
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PADE-2
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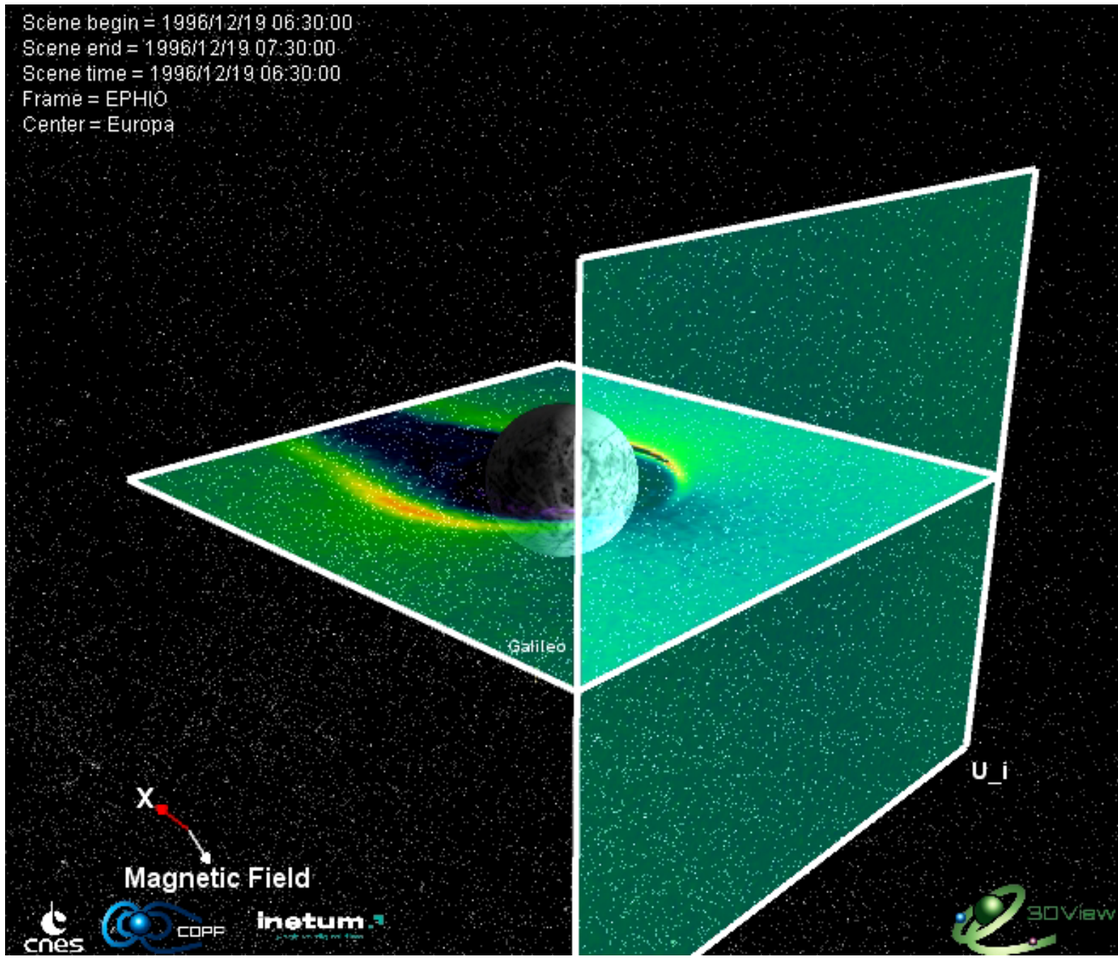
COPP
gfi
3DView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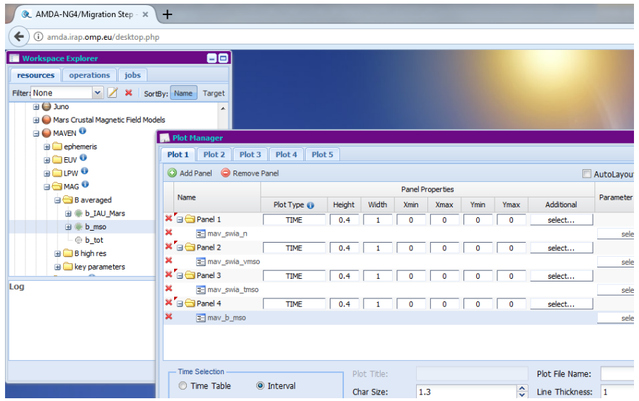
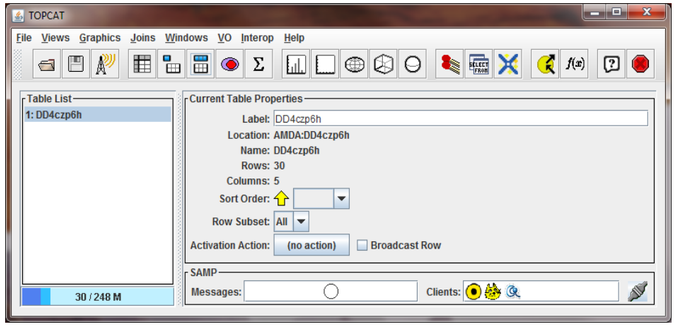
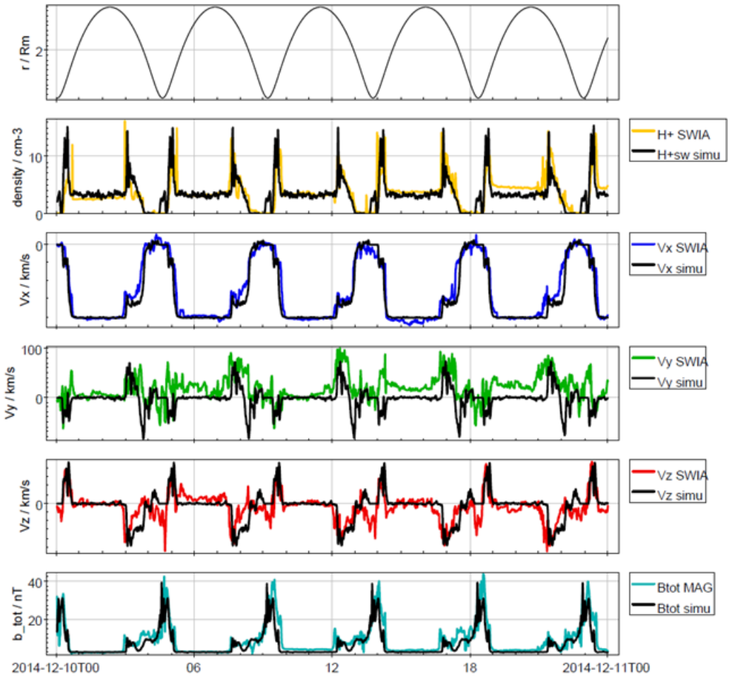
U_i
X
Magnetic Field
cnes
COPP
inetum
3DView

Example of a scientific use case : Comparison of simulation results and MAVEN and MEX observations (Modolo et al, 2018)

- Determination of the solar wind conditions using **AMDA** and **TOPCAT** and the SAMP application (Génot et al, 2014)

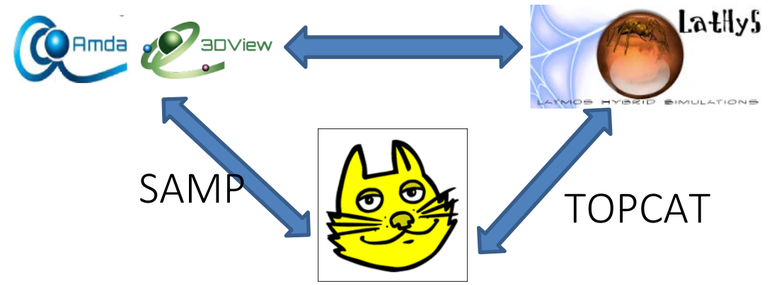






5 orbits comparison of MAVEN observations in black (n, Vx,Vy,Vz, |B|) and simulation (colors) using TOPCAT (also possible with AMDA)

- Finding the most relevant simulation the in the LatHyS database
- Using the LatHyS webservices through the AMDA interface
- Visualisation on AMDA and/or TOPCAT



Visualization of simulation results and observations in a 3D interactive scene

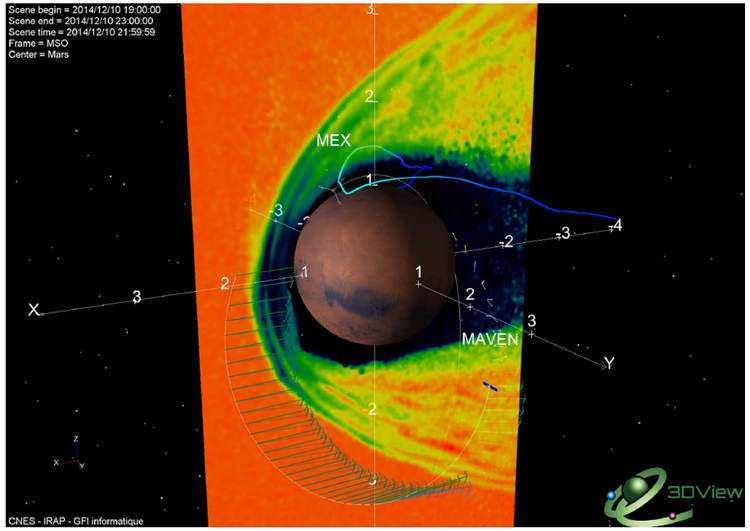


Illustration of the catalog : http://impex.latmos.ipsl.fr/LatHyS.htm