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## **RAPPORT TECHNIQUE**

# **SPIS - Virtual Observatory Plugin Installation and User Manual**

Auteurs : S. Hess ; L. Leclercq

DÉPARTEMENT PHYSIQUE INSTRUMENTATION  
ENVIRONNEMENT ESPACE

RT 1/29787 DPHY - Janvier 2022

# DÉPARTEMENT PHYSIQUE INSTRUMENTATION ENVIRONNEMENT ESPACE

Rapport Technique N° RT 1/29787 DPHY

Janvier 2022

## **SPIS - Virtual Observatory Plugin Installation and User Manual**

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## 1. OBJECT

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This document aims at providing a description of the SPIS virtual observatory plugin developed in the frame of the Europlanet 2024 Research Infrastructure Project. This plugin provides SPIS with an access to the major databases and data services in space physics. It allows the user to import environments from these databases directly in SPIS and to export back SPIS results in a format consistent with the international virtual observatory standards for space physics.



This project has received funding from the European Union's Horizon 2020 Research and Innovation Program under Grant Agreement No 871149.

## 2. REFERENCE DOCUMENTS

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- RD1      SPIS v6.1 User Manual
  
- RD2      D Aaron Roberts et al, *The SPASE Data Model: a Metadata Standard for Registering, Finding, Accessing, and Using Heliophysics Data Obtained From Observations and Modeling*, Space Weather, Volume16, Issue 12, Pages 1899-1911, December 2018

## 3. DEFINITIONS AND ACRONYMS

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- AMDA      “Automated Multi-Dataset Analysis”. Both a database of space physics datasets and a tool to explore and exploit it. AMDA is a product of the CDPP.
  
- CDAS      “Coordinated Data Analysis System”. Web services providing access to the CDAWeb database. CDAS is a product of the NASA.
  
- CDAWeb    “Coordinated Data Analysis Web”. Database of space physics dataset from the NASA Goddard Space Flight Center space physics data facility.
  
- CDPP      “Centre de Données de la Physique des Plasmas”. Database of space physics dataset from the CNES.
  
- CeCILL    “CEA CNRS INRIA Logiciel Libre ». Open source license fully compatible with and recognized under French law. CeCILL licenses are compatible with GPL licenses.
  
- CNES      “Centre National d’Etudes Spatiales”. French Space Agency.
  
- ESA        “European Space Agency”.
  
- EU         “European Union”.
  
- GPL        “General Public License”. Open source license published by the Free Software Foundation.
  
- IMPEX    “Integrated Medium for Planetary Exploration”. Project from the EU seventh framework program that developed a standard for space physics simulation databases.
  
- ONERA     “Office National d’Etudes et de Recherches Aéropatiales”. French agency for aerospace studies and research.
  
- SPASE     “Space Physics Archive Search and Extract” is a format of metadata dedicated to the space physics.



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SPIS “Spacecraft-Plasma Interaction Software”. Open source spacecraft charging simulation software. Available at <http://spis.org>. SPIS is a product of ONERA and Artemum with additional function from ESA and CNES and support and contribution from several members of the European space industry and scientific community.

## 4. INSTALLATION

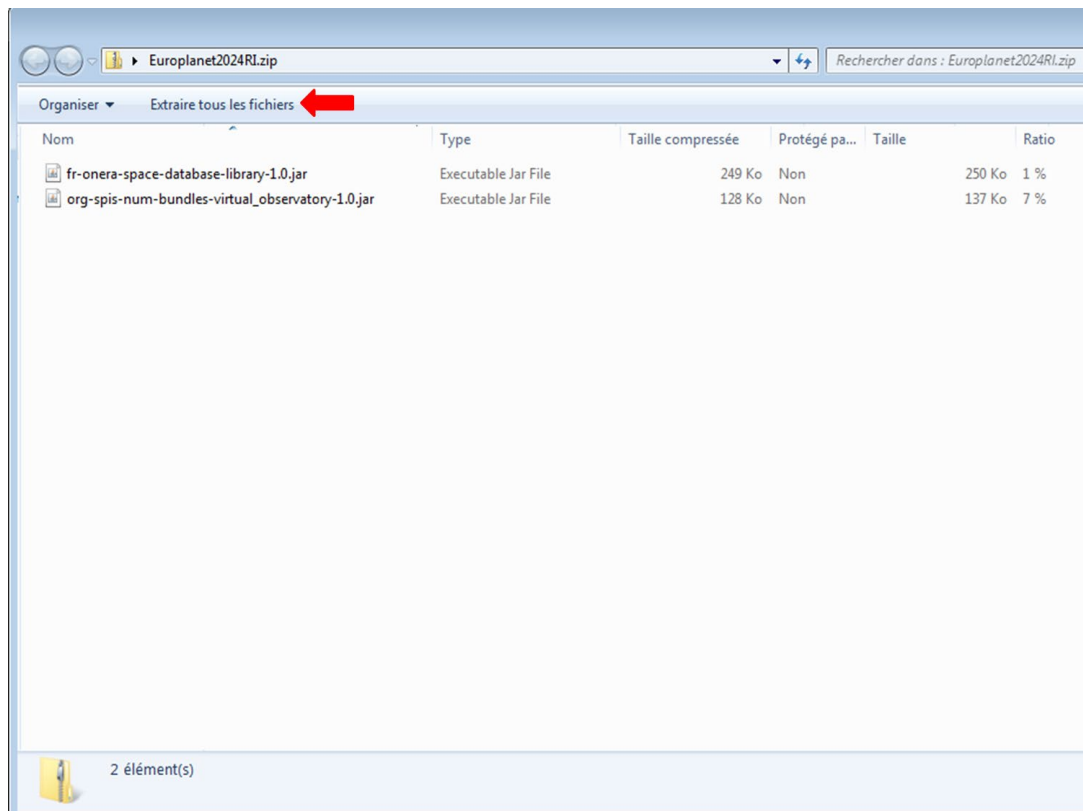
### 4.1. REQUIREMENTS

- The computer must support Java 8 and must have VTK support installed (see <http://spis.org> for details about SPIS installation).
- SPIS version 6.1 must be installed. SPIS can be downloaded from <http://spis.org>.
- The virtual observatory plugin archive (Europlanet2024RI.zip) must be downloaded from [https://w3.onera.fr/spacecraft\\_charging/fr/home#page-plugins](https://w3.onera.fr/spacecraft_charging/fr/home#page-plugins).

### 4.2. PLUGIN INSTALLATION

Open the Europlanet2024RI.zip archive. It should contain two .jar files:

- the ONERA space database library: fr-onera-space-database-library-1.0.jar
- the virtual observatory plugin: org-spis-bundles-virtual\_observatory-1.0.jar



**Figure 1 :** Content of the Europlanet2024RI.zip archive. Click on “Extract files” to extract the plugin in the SPIS library folder.



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With your file explorer, open the SPIS folder (where the SPIS executable is located). A folder named “lib” should be visible (**Figure 2**).

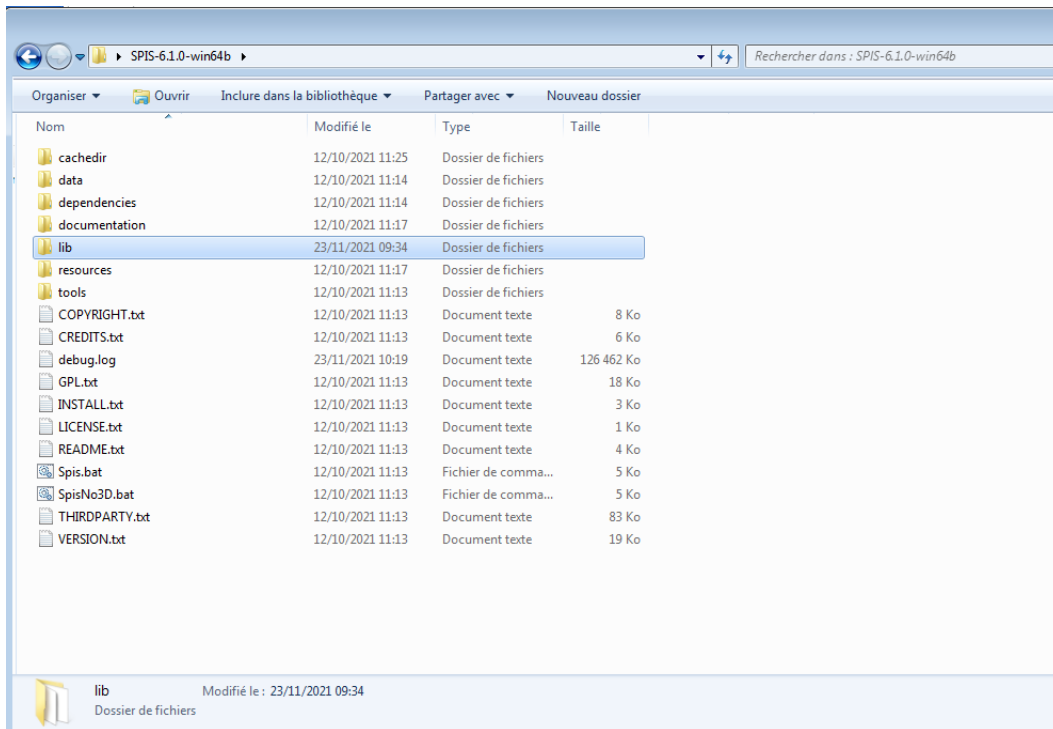


Figure 2 : SPIS folder. The virtual observatory plugin must be extracted in the « lib » folder.

Extract the Europlanet2024RI.zip archive in the “lib” folder (**Figure 1**). The two above-mentioned .jar files should be added to the existing files. The plugin is now installed!

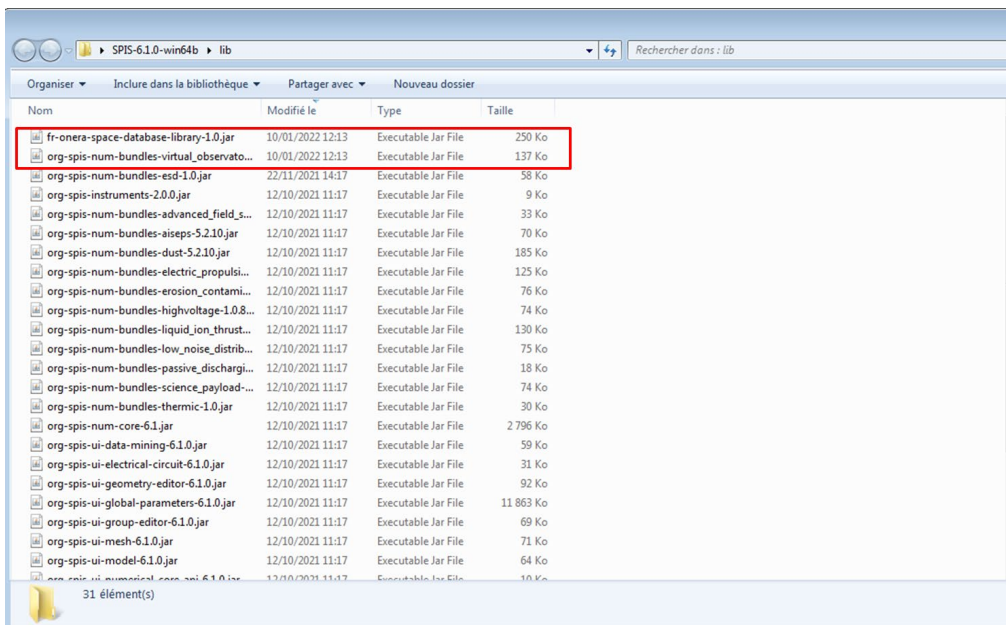


Figure 3 : Content of SPIS v6.1.0 « lib » folder once the plugin is installed.

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To check the installation, start SPIS and open the console (select “Log Console” in the “Tools” menu).

The plugins that are loaded by SPIS are listed between the “Starting SPIS NUM bundle(s)” line and the “SPIS NUM started” line. The virtual observatory plugin should appear.

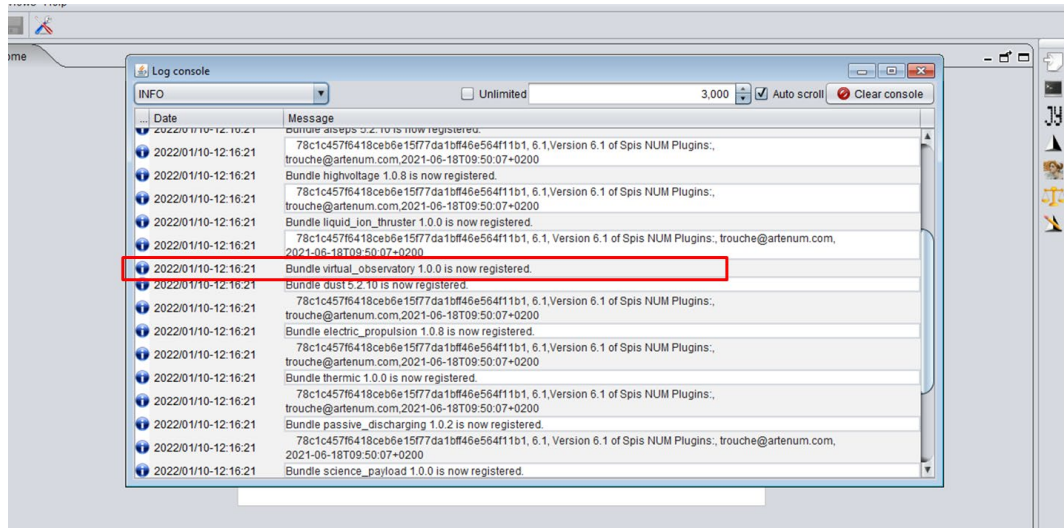
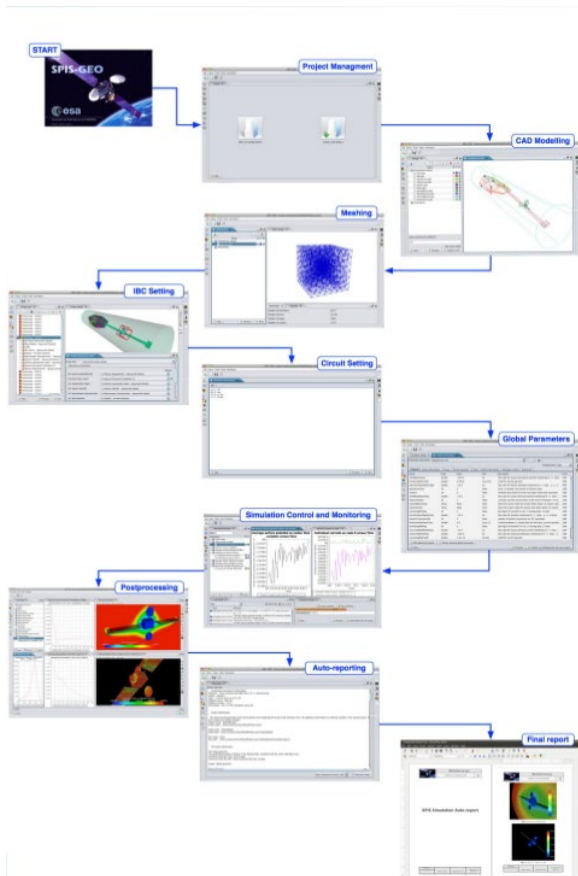


Figure 4 : Log console at SPIS start, showing the list of installed plugins among which the virtual observatory plugin.

## 5. SIMULATION SETUP



Since its fifth version, SPIS enjoys a wizard-like approach for the simulation definition. The user must sequentially define:

- the geometry
- the mesh
- the local (related to geometry) parameters
- the electric circuit
- the global (simulation level) parameters.

The environment is defined at this later stage. Thus, the virtual observatory panel brought to the user by the virtual observatory plugin is accessible at the global parameter stage.

Two subsequent stages are the simulation stage and the datamining stage.

Providing a detailed explanation on how to set up a SPIS simulation is out of the scope of the present document, thus the reader can refer to the “SPIS-v6 numerical core user manual and detailed design» document of the help package provided with any SPIS distribution.

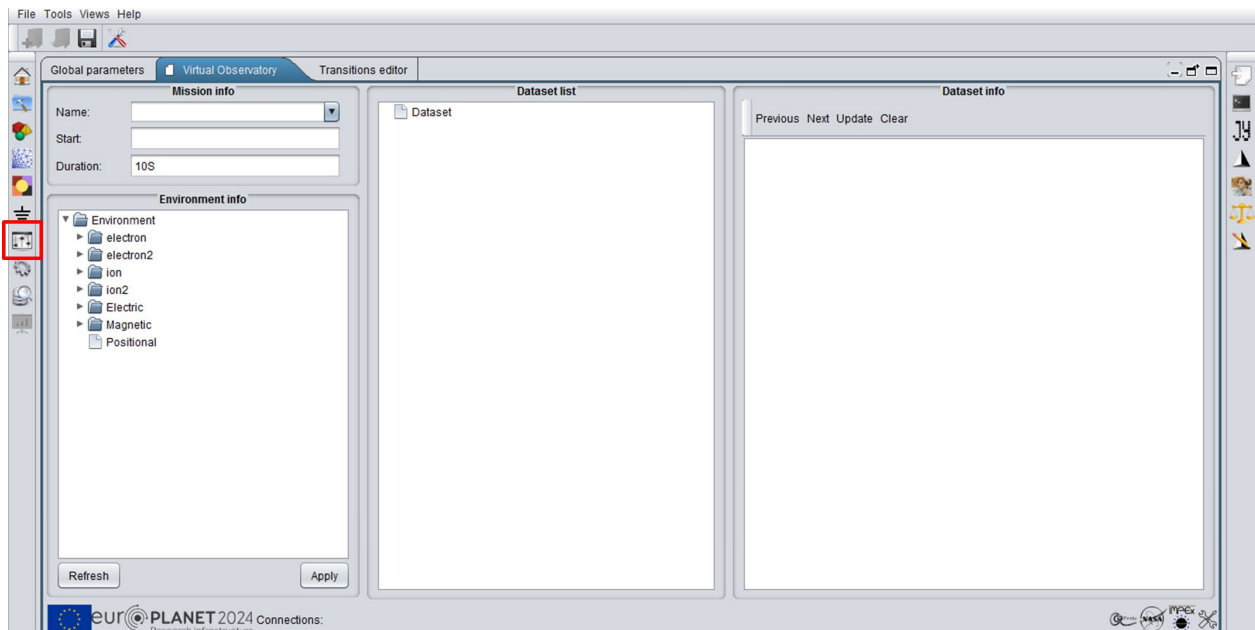


## 6. VIRTUAL OBSERVATORY PANEL

### 6.1. LAYOUT

The virtual observatory panel is part of the Global Parameter Editor in which the environment characteristics are defined. To access the Global Parameter Editor, click on the icon on the left sidebar or complete the preceding stages of the simulation definition.

The virtual observatory panel can be accessed by selecting the Virtual Observatory tab.



**Figure 5 :** General layout of the virtual observatory panel. To access it, click on the “Global Parameters” icon on the left sidebar and select the “Virtual Observatory” tab.


The virtual observatory panel is composed of four sub-panels:

- **Mission Info:** in this panel, the information about the mission can be defined. In particular, the start time and the duration are mandatory to import data from the remote databases. Both the start time and the duration must be defined following the ISO 8601 standard. The mission name can be selected in a combo-box built from the missions available in the databases. It is used as a filter, but can also be used by simulation database to provide interpolated data along the mission trajectory.
- **Environment Info:** in this panel, the information about the environment defined in SPIS is summarized. The information displayed by default (or by clicking on “Refresh”) is that defined in the Global Parameter tab. It is automatically completed if a dataset is selected but **the user must click on “Apply” for the import to be effective.**
- **Dataset List:** this panel lists all the databases and their content. The data are organized in a tree by database, mission and instrument. Click on the arrow to expand the folders and access the data. Information can be obtained on all elements by clicking on it, in which case the information appears in the Dataset info panel.

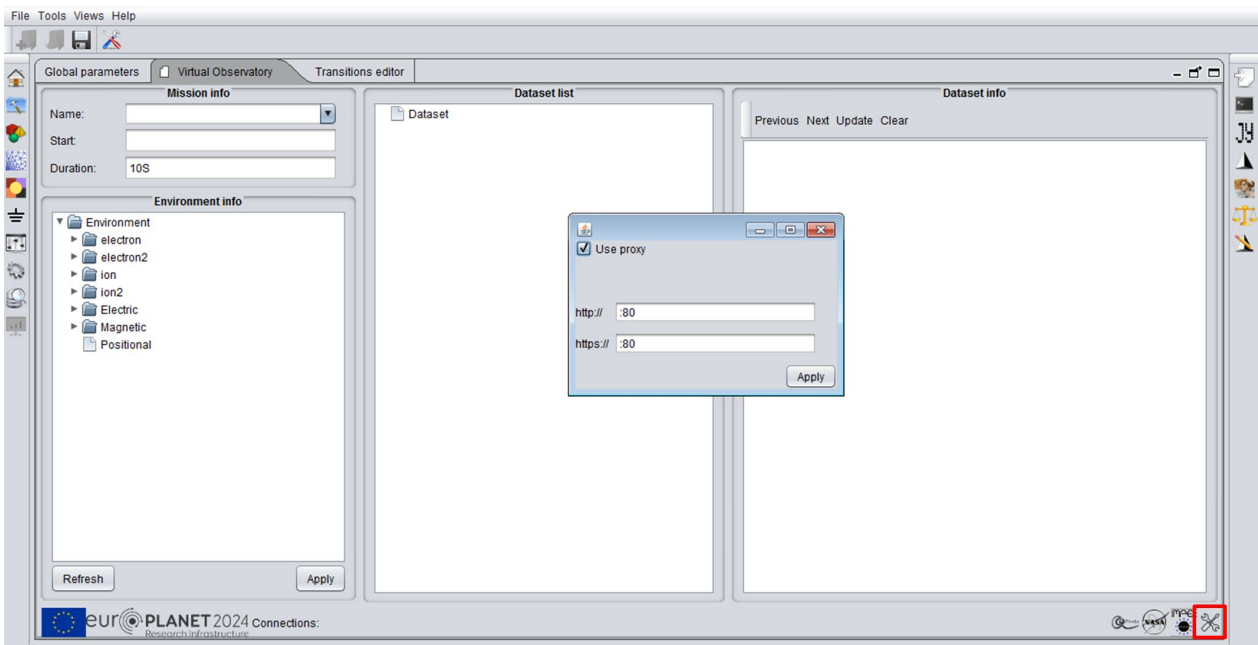
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- **Dataset Info:** this panel provides information on an element selected in the Dataset List. The information displayed is automatically generated from the SPASE descriptor of the selected resource. The information is hyper-textual: it is possible to navigate between resources by clicking on the links appearing in blue. It is possible to come back to a previously displayed resource information using the “Previous” and “Next” buttons. The information panel also allows selecting particular parameters to import in a dataset.

## 6.2. PROXY SETUP

The access to remote databases requires a functional internet connection, which may require the definition of a proxy. To define the proxy, click on the setting icon  at the bottom right corner of the virtual observatory panel. A popup appears allowing to define the proxy configuration (**Figure 6**).




It is possible to define different proxy for the HTTP and HTTPS connections. To use the proxy, select the “Use proxy” check box and click on apply.



*Figure 6 : The proxy can be defined by clicking on the settings icon and filling the proxy information.*

## 6.3. CONNECTION TO A DATABASE

A connection can be established with a database by clicking on the corresponding icon in the database bar at the bottom of the virtual observatory panel. The configured databases connections are:

-  AMDA: database from the CDPP/CNES. This database contains in particular data from French and European missions and instruments.
-  CDAWeb: database from the NASA Goddard Space Flight Center. This database contains in particular data from US missions and instruments.
-  IMPEX: framework linking toward several databases across Europe providing simulations of planetary environments.



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When the databases are disconnected, the database icon is greyed while it is colored when the database is connected.

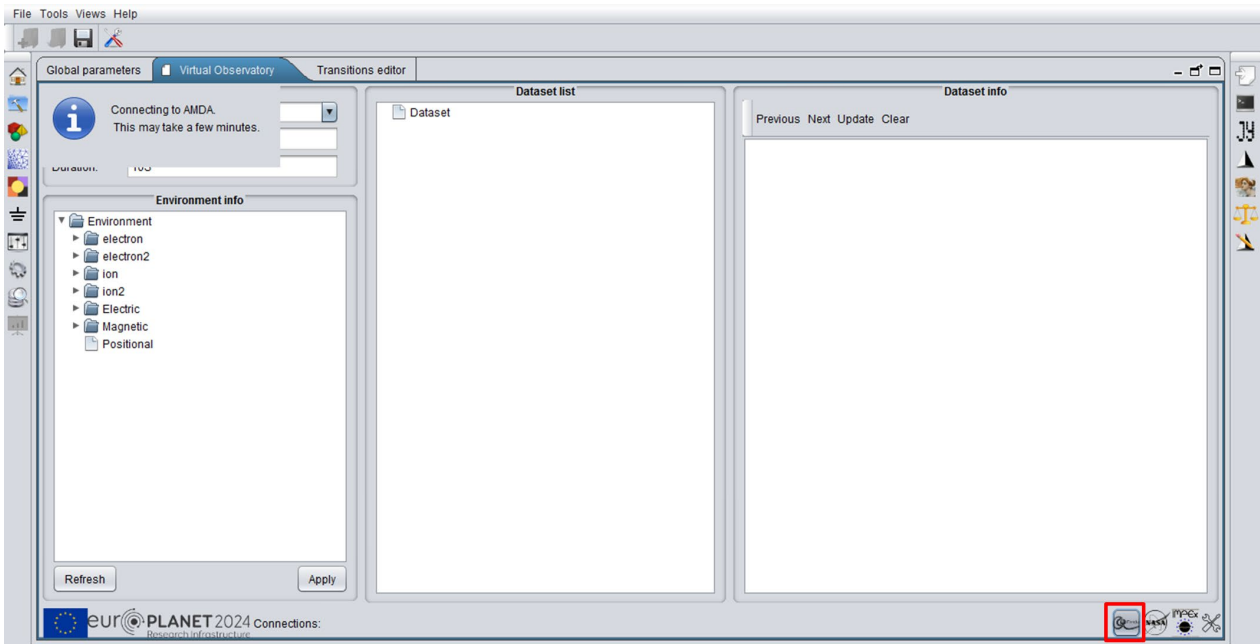


Figure 7 : The connection to a database is required by clicking on the corresponding icon. An insert on the upper left side of the panel acknowledges the request.

When SPIS connects to a database, it requires from it the list of datasets. This may take some time, thus an insert appears at the top left corner of the panel to inform the user. Note that for some databases, SPIS does not download at once all the resources, but rather download them on the fly.

When the database is connected, the corresponding tree appears in the Dataset List panel (Figure 8).

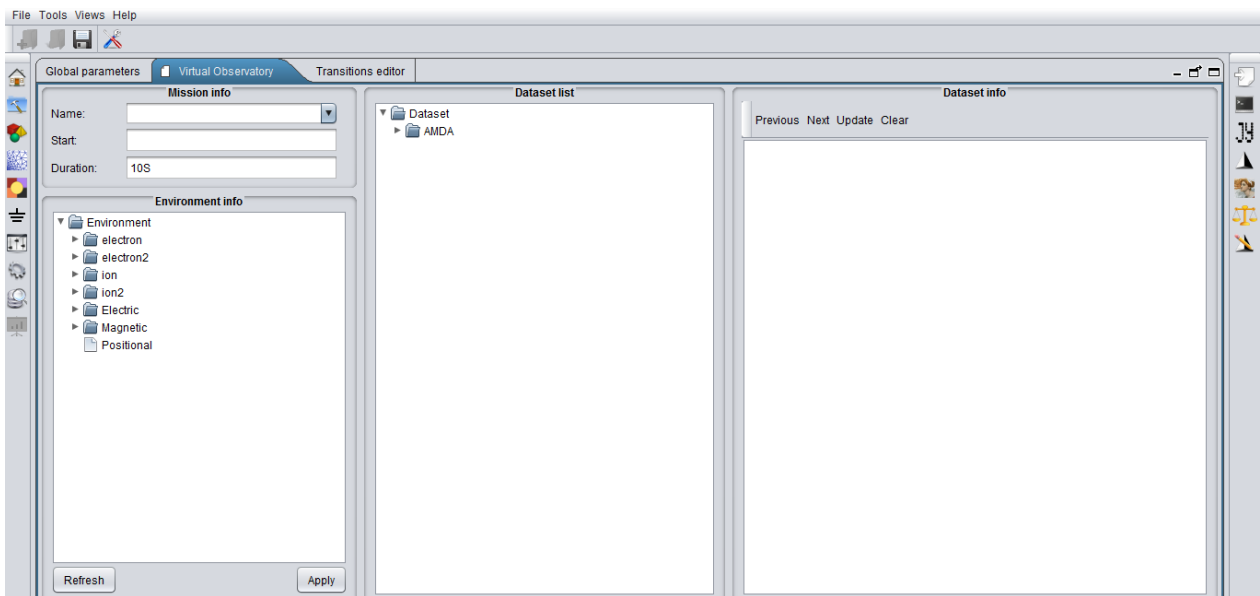


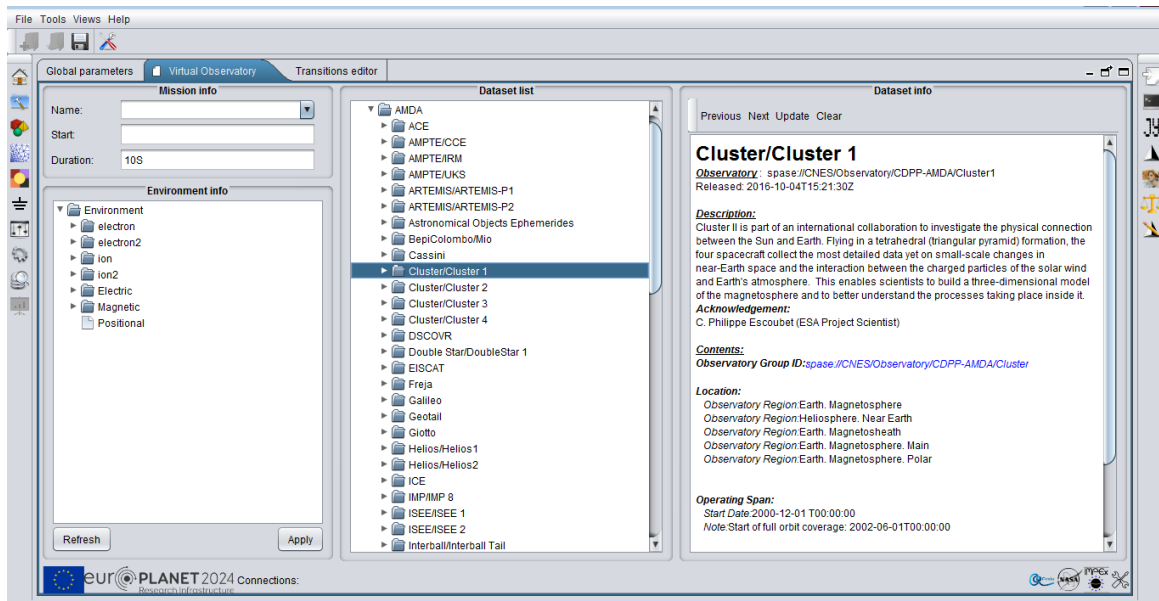
Figure 8 : Once connected, the database tree appears in the dataset list.

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## 6.4. EXPLORE THE DATABASE

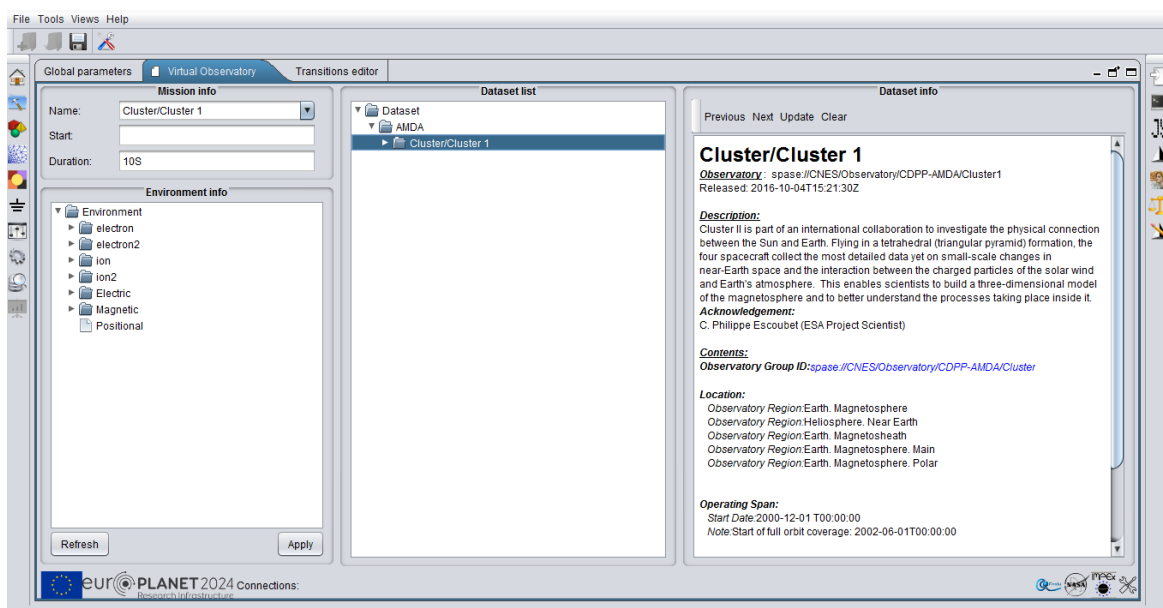
Once the databases are connected, it is possible to explore them by exploring the dataset tree in the Dataset List panel. To expand a node, click on the arrow in front of it.

For each node, there are metadata provided by the database under the SPASE format. When clicking on a node, this information is parsed by SPIS and displayed under a human readable format in the dataset info panel.



**Figure 9 :** View of the dataset list showing the missions for which the AMDA database provides data. When clicking on a mission, the corresponding information appears in the dataset info panel on the right.

It is possible to filter the missions by specifying the mission name in the mission info panel at the top left corner of the virtual observatory panel (**Figure 10**).



**Figure 10 :** It is possible to filter the missions by specifying the mission name in the mission info panel



The datasets are ordered by databases, mission (or planet for simulations) and instruments (Figure 11). The lowest level corresponds to the datasets themselves, for which the dataset info panel provides the content.

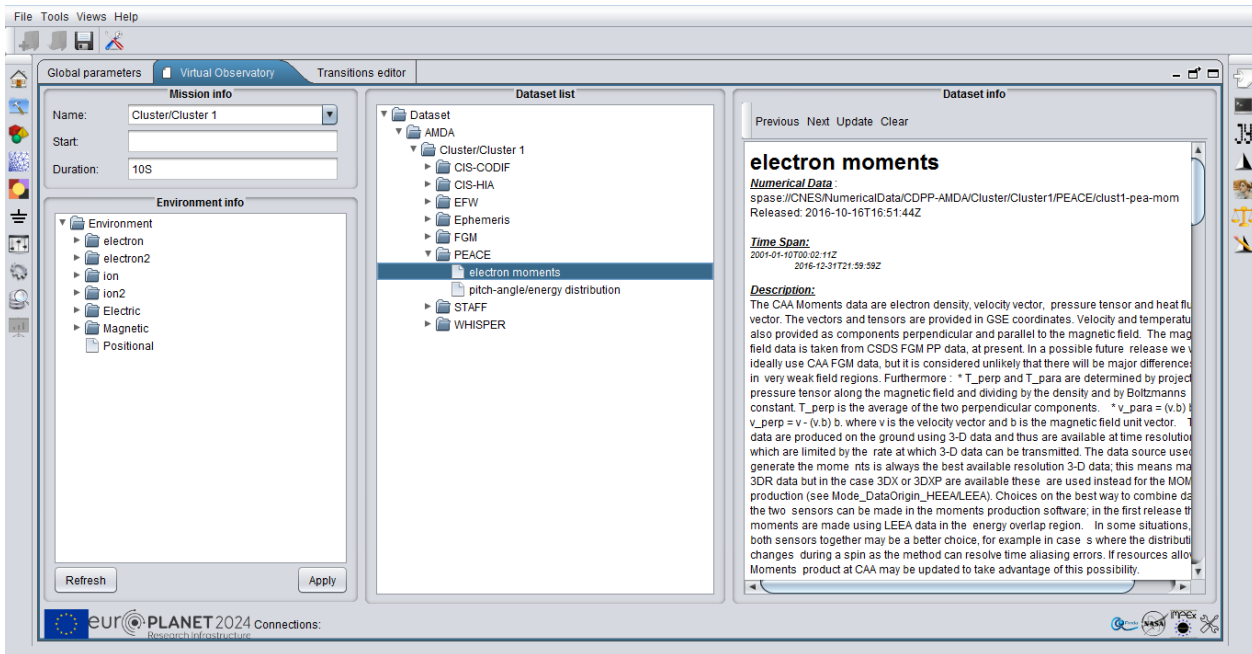


Figure 11 : The datasets are ordered by databases, mission (or planet for simulations) and instruments

The information is hyper-textual: it is possible to navigate between resources by clicking on the links appearing in blue. It is possible to come back to previously displayed resource information using the “Previous” and “Next” buttons (Figure 12).

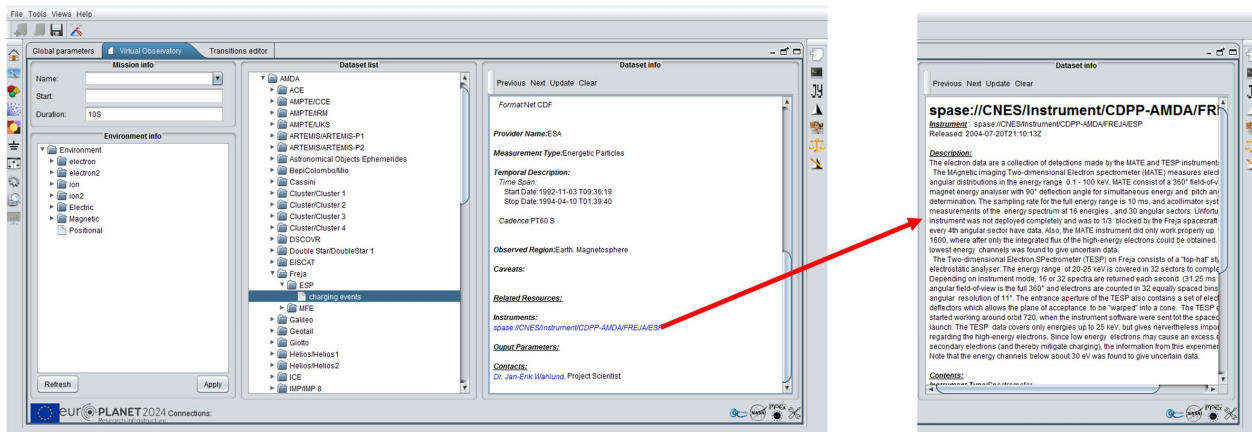


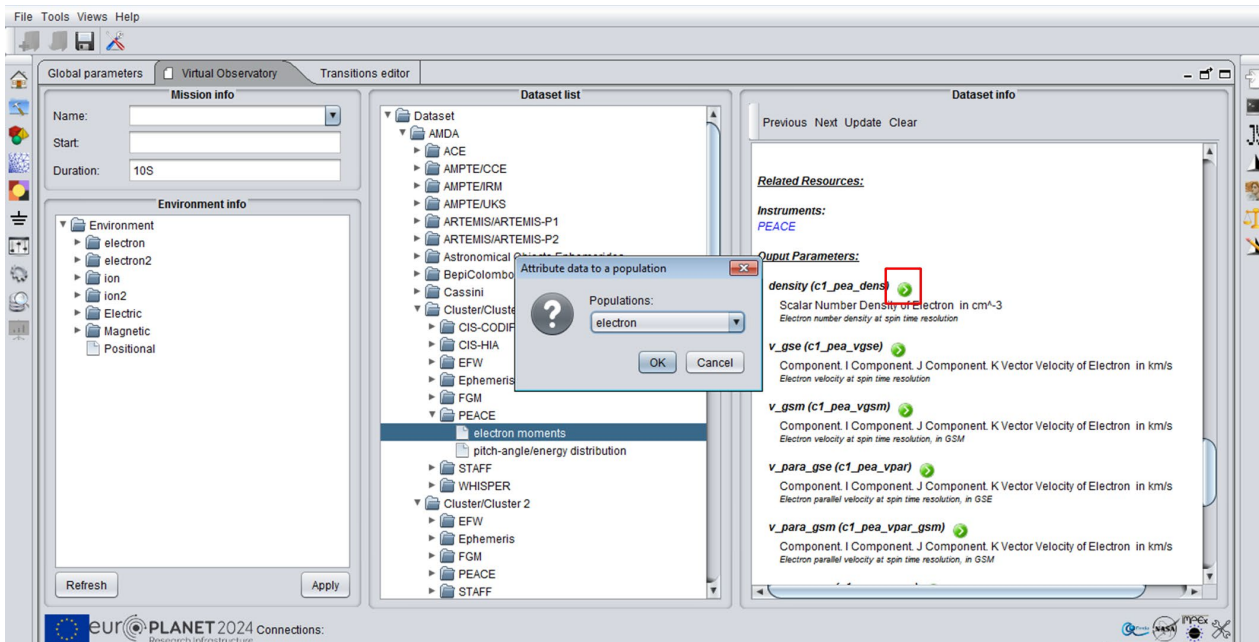
Figure 12 : The dataset info panel provides hypertext information. It is possible to navigate from resource to resource following the links.



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## 6.5. SELECT DATA

When a dataset is selected, its contents appears in the dataset info panel under the “Output Parameters” section.



*Figure 13 : A data can be imported by clicking on the corresponding import (green) icon.*

For each parameter SPIS displays (**Figure 13**):

- In bold, the name and between parenthesis the parameter Id.
- In regular font, the parameter physical quantity and unit. The parameter quantity is based on SPASE keywords, which may render the description awkward but can be interpreted by SPIS.
- An action icon, if SPIS recognizes the parameter as useable, based on the SPASE description. SPIS recognizes usable the particle density, temperature and vector velocity, as well as the vector electric and magnetic fields and the spacecraft position.
- In small font, a natural language description, if any is provided.



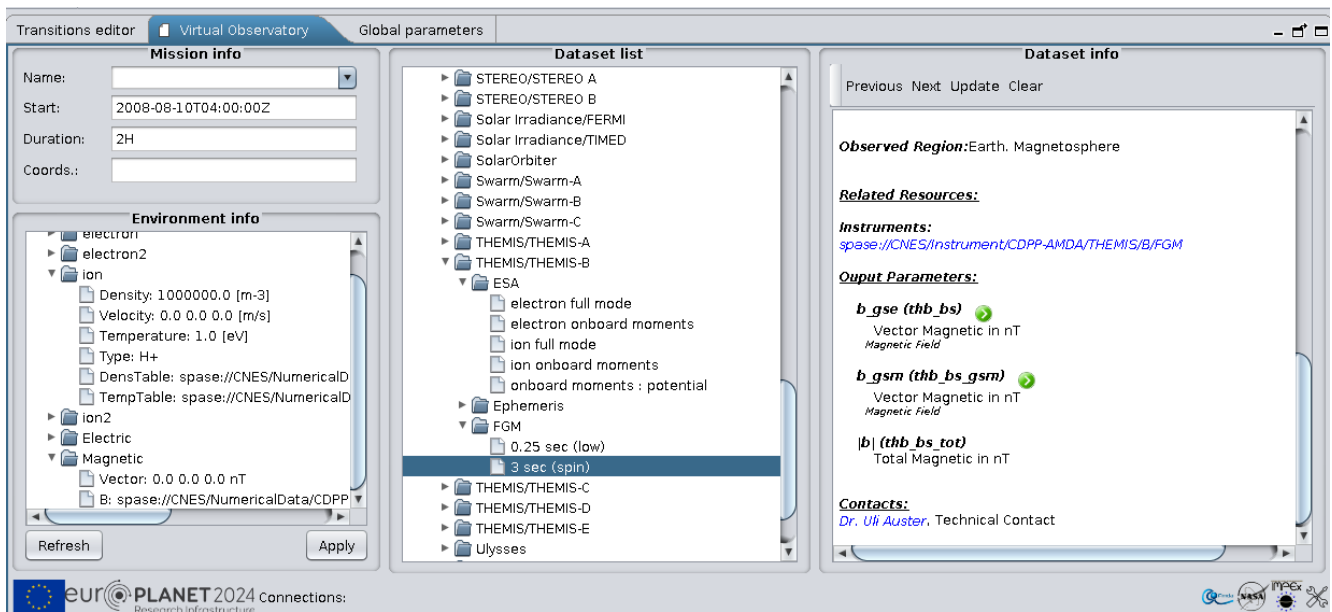


Figure 14 : Only parameters that can be used automatically by SPIS can be imported. In this case only the vector magnetic field can be imported, not the magnetic field amplitude.

To select a data to use, click on the green icon in the parameter description (Figure 13). If the green icon is absent, it means that SPIS does not know how to use this parameter so it cannot be imported. Please note that the automatic recognition of parameters is based on the parameter description provided by the database owner (or the resource publisher). If this description is not complete or does not follow the SPASE recommendation, a parameter may not be useable (Figure 14).

If the parameter to import relates to particles (density, temperature, velocity), a popup frame will appear asking to which population the data should be attributed (Figure 13). Electron populations are usually automatically recognized, but the SPASE recommendation does not include the mandatory specification of ion species. Thus, be careful to check the type of particle in each ion or neutral populations before starting the simulation.

Once a parameter is successfully selected, its SPASE ID appears in the Environment Info panel under the corresponding section (Figure 15).

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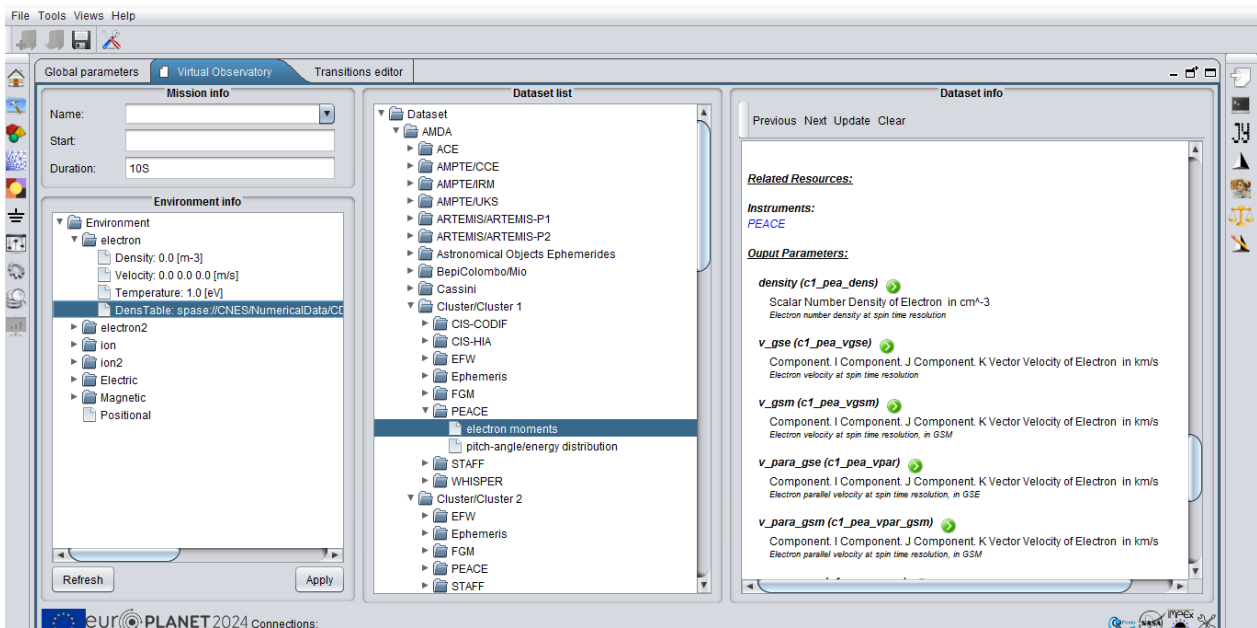


Figure 15 : Once a parameter is selected, it appears with its SPASE ID in the Environment info panel.

## 6.6. IMPORT DATA

Once all sets of data to use in the simulation are defined and appear under their SPASE ID in the Environment Info panel, it is possible to proceed to the data import (Figure 16).

Before requesting the import, it is important to define the start time and the duration in ISO 8601 format. Be careful: the duration indicated in the Virtual Observatory is that corresponding to the duration of the dataset imported from the databases, which may differ from the simulation duration. In case of doubt, it is recommended to set here a longer duration than the simulation duration.

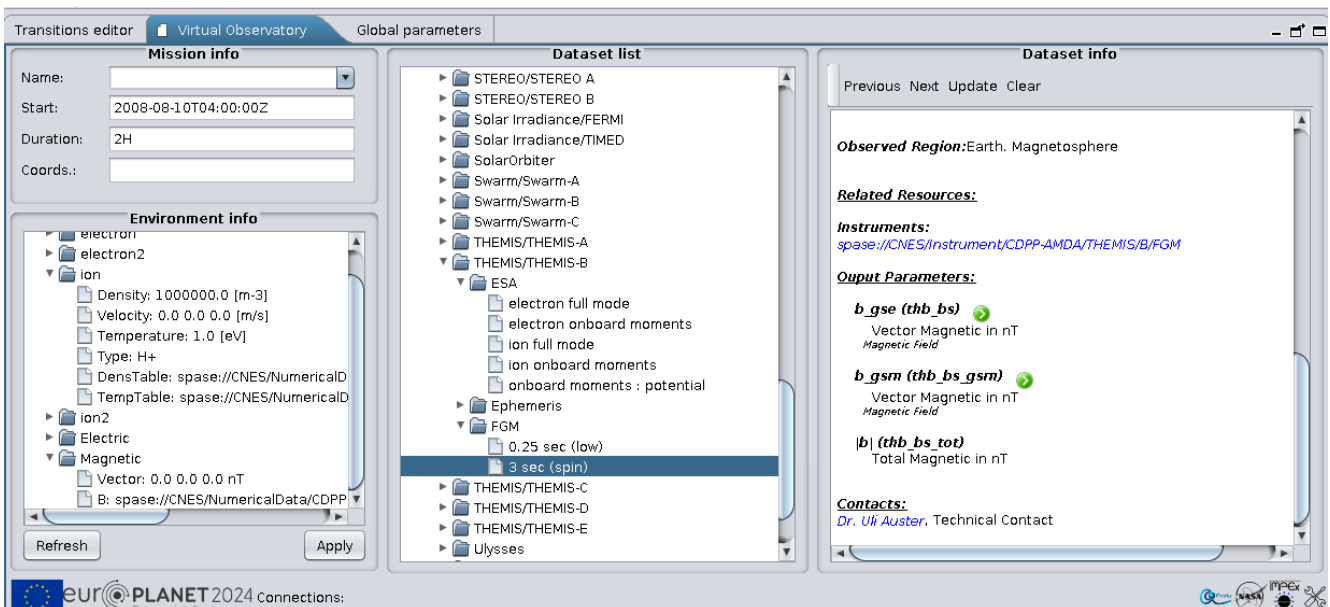


Figure 16 : Environment ready to be imported. The selected datasets appear under their SPASE id in the Environment Info panel and the Start time and the duration are defined. Import is triggered by the Apply button.

To trigger the data import, press the Apply button in the Environment Info panel.

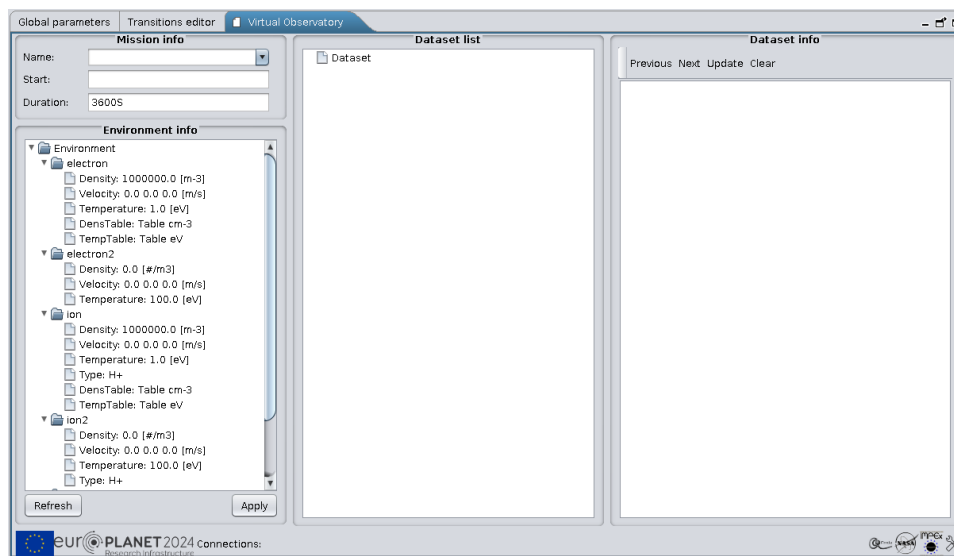


Figure 17 : Imported datasets appear as « Table » in the Environment Info panel.

Once the environment is imported, the selected datasets no longer apply under their SPASE ID in the Environment Info panel, but rather as a Table (Figure 17). The imported data are now stored as Global Parameters in the Global Parameter Editor table (Figure 18). The SPASE ID corresponding to the dataset imported should appear in the parameter description.

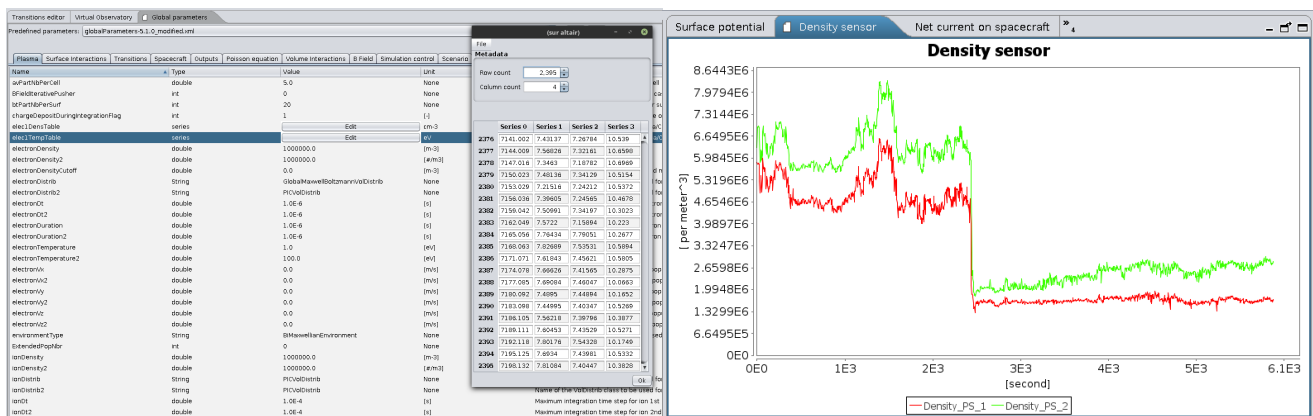


Figure 18 : View of the Global Parameter Editor, showing imported data. The right panel shows the results of the simulation showing the corresponding electron and ion densities.

When a dataset is imported, the simulation parameters are usually updated to specify that the environment evolves in time (the “environmentType” global parameter should be TimeDependentEnvironment) and Start time of the simulation (StartDate should correspond to the IOS 8601 date specified by the user). Please check these parameters before launching a simulation (Figure 19).

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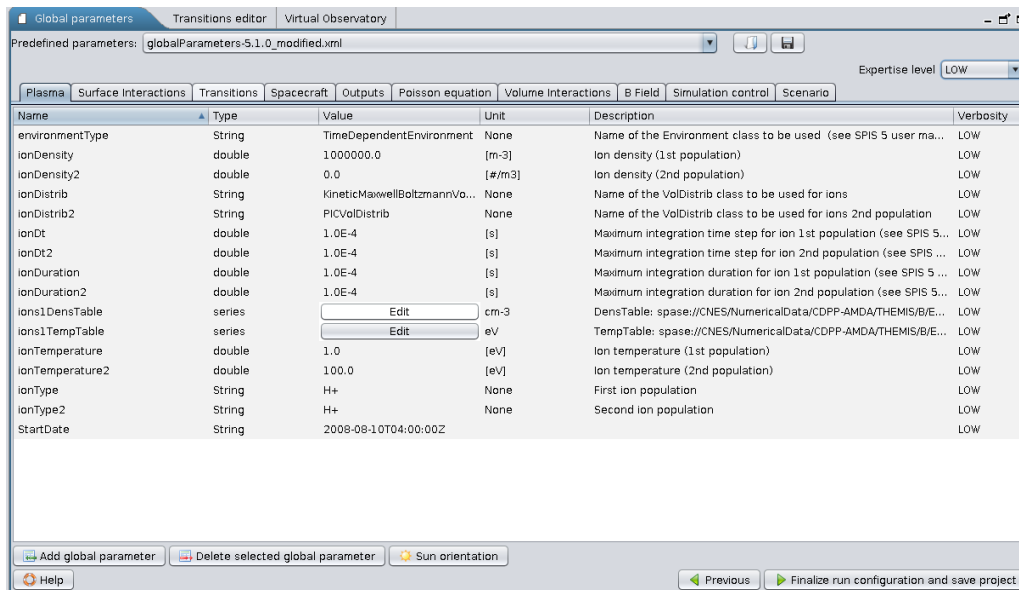


Figure 19 : When importing data, the environment type and start date should be automatically set.

## 7. DATA EXPORT

### 7.1. EXPORT INSTRUMENT RESULT AS VOTABLE

It is possible to export the result of a SPIS instrument, which can either simulate the functioning of a real scientific instrument or be a numerical diagnostic, under a VOTable format compatible with the virtual observatory standards.

To do so, the virtual observatory plugin must be installed. At any time of the simulation after the first measurement of the instrument, it is possible to save the results by selecting the instrument in the “Instruments” panel of the Simulation view and select “VOTable” as the file type instead of the default CSV type for SPIS (Figure 20).

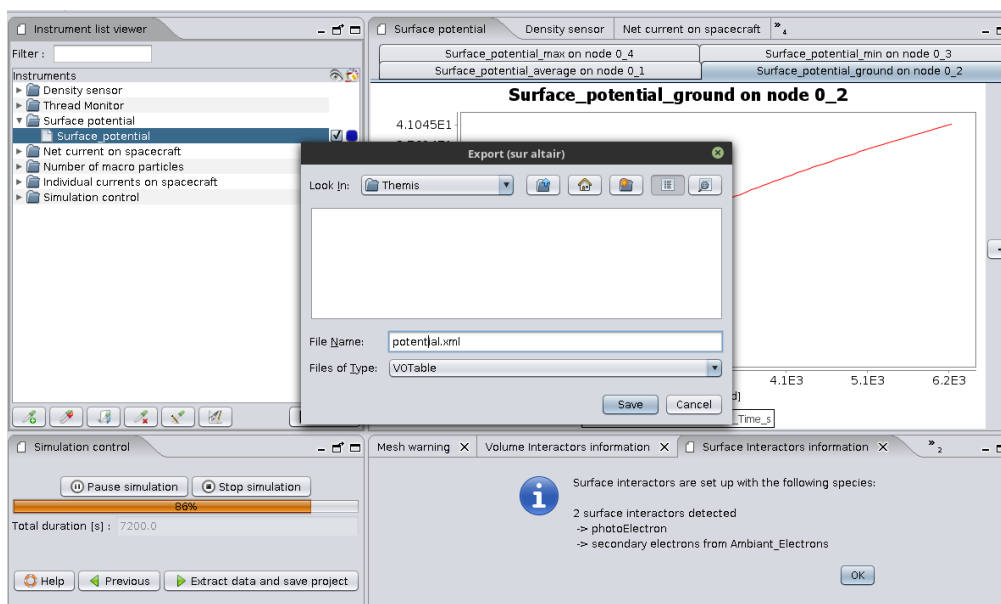


Figure 20 : During the simulation, it is possible to export a live monitored result by selecting the instrument, clicking on the Export button and choosing the “VOTable” format as the file type.

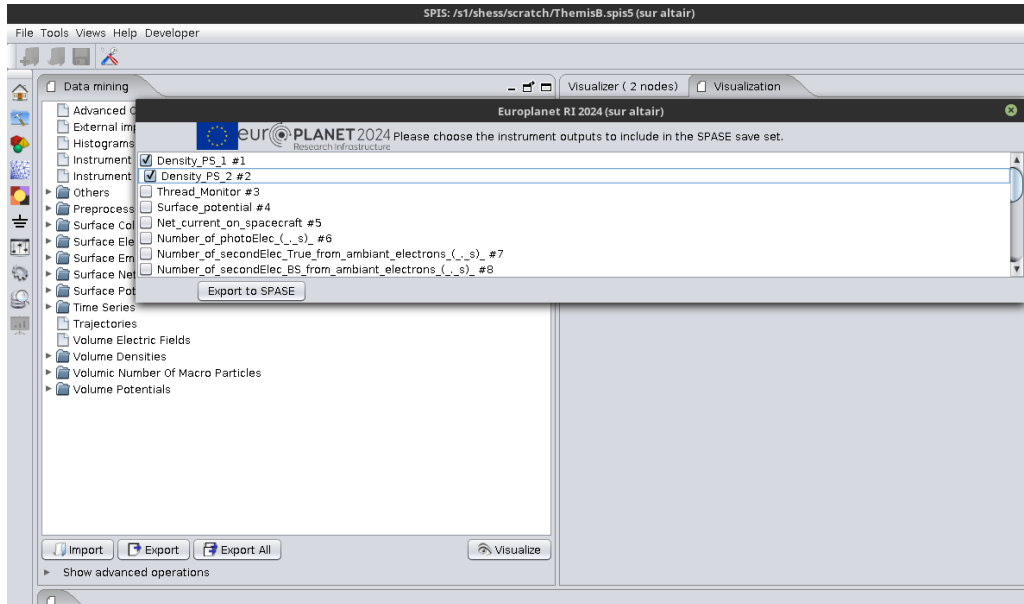


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## 7.2. FINAL SIMULATION EXPORT

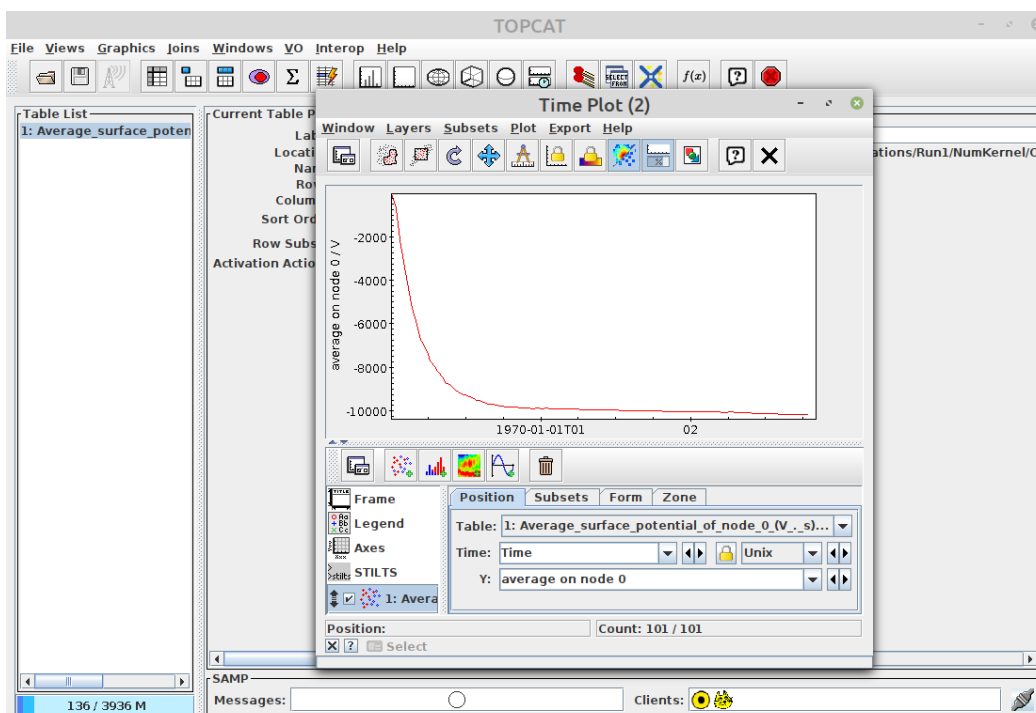
When a simulation is found to be relevant for the virtual observatory plugin (i.e. StartDate and TimeDependentEnvironment defined), a popup appears after the finalization of the simulation which proposes to select the results that should be exported as VOTables (**Figure 21**).



*Figure 21 : At the end of a virtual observatory simulation, SPIS proposes to save the datasets in the VOTable format.*

The VOTables are a virtual observatory standard that can be used by most of the virtual observatory tools (**Figure 22**), including the AMDA data analysis tool.

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*Figure 22 : Example of plasma potential evolution exported as a VOTable and visualized in the TOPCAT tool.*

