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SPARTA: a PDS3 to CDF ISTP compliant data converter, application to Rosetta RPC datasets

A. Masson (1), F. Vallejo (1), B. Martinez (1), D. Fraga (1), M.G.G.T. Taylor (2), L. O'Rourke (1)
(1) ESAC/ESA, SCI-O, Madrid, Spain, (2) ESTEC/ESA, SCI-S, Noordwijk, The Netherlands (Arnaud.Masson@esa.int)

Abstract

The SPace dAta foRmat TrAnslator (SPARTA) software enables to convert the best calibrated PDS3 datasets of the Rosetta Plasma Consortium (RPC) into daily CDF ISTP compliant files. These files are now available for download on the European Space Agency (ESA) Planetary Science Archive (PSA). The mapping of the data and the metadata will be first explained. Practical examples will then be presented. Finally, possible plans of future development will be discussed.

1. The Rosetta Plasma Consortium

RPC, the Rosetta Plasma Consortium, is a set of five instruments onboard the Rosetta orbiter to explore the plasma environment around comet 67P. RPC consists of five sensors: the Ion Composition Analyser (ICA), the Ion and Electron Sensor (IES), two Langmuir Probes (LAP), a Fluxgate Magnetometer (MAG) and a Mutual Impedance Probe (MIP). The PSA hosts all the datasets successfully collected by these sensors: from raw data to calibrated to advanced derived products.

2. A push from the space plasma physics community

All the RPC consortium datasets are stored in PDS3 format. This format has clear advantages such as its flexibility and the possibility to store the data in ASCII format. However, it is far from being the standard data format for space plasma physicists. The heliophysics scientific community is indeed much more used to manipulate such in-situ measurements in Common Data Format (CDF). Contrary to PDS3, a CDF file can contain both data and metadata in a single file. Data are stored as variables, with metadata stored as attributes. CDF enables to store of scalar and multidimensional data, particularly useful when storing 3D distribution functions collected by electrostatic analyzer such as IES. Various reading routines, visualization software and applications are supported on all major platforms. For decades, ISTP/IACG organizations have defined usage guidelines (or best practices) to enhance data sharing. By being ISTP compliant, a CDF dataset is correctly and independently usable by the science community and guaranteed to be read successfully by NASA supported software. However, there was so far no data format converter to generate CDF ISTP compliant file(s) from a PDS3 dataset.

3. SPARTA in a nutshell

SPARTA is mapping the metadata and data contained in a PDS3 dataset into daily CDF/ISTP files. A PDS3 dataset usually covers several months of data.
The metadata of a CDF ISTP file must be composed of compulsory but limited number of global attributes such Project, Discipline or PI_name. Those are put on top of the global attributes' list. Then, the PDS3 keywords are mapped. "Pds_" is added at the beginning of each PDS3 mapped keyword to make the distinction. A folder named CATALOG is usually contained in a PDS3 dataset and composed of a few files, describing the mission, experiment etc... Each of these files contains essential information to interpret the data. Hence, the content of each of these files has been mapped to a global variable in the CDF file. Extra information specific to each experiment is finally added to the TEXT global variable, where the reference paper is mentioned.
The mapping of the data content can be either straightforward as in the case of a fluxgate magnetometer to more complicated when dealing with 3D distribution function. However, even in the case of DC magnetic field, the data stored in the original PDS3 TAB files per component are converted as a vector in one variable instead. The mapping of 3D distribution functions is evoked in the following section. A technical note for each experiment can be downloaded when downloading CDF files from PSA.

4. Easy display of 3D distribution functions

The detailed mapping of 3D distribution functions from PDS3 RPC-IES to CDF is beyond the scope of this abstract. In a nutshell, the maximum size of the 3D data cube of differential energy fluxes is 16x16x128 (azimuths x elevation angles x energies). The number of time steps depend on the cycle duration and how long the instrument has been operated during the day. Hence, the data are mapped as follows. The differential energy fluxes is always contained in a variable of 4 dimensions 16 azimuth x 16 elevation x 128 energies x Number of time steps.
Clearly, SPARTA does not optimize the size of these data cubes. However, this approach has one main advantage. One CDF file per day can be generated even if RPCIES is changing mode during the course of a day, which happens. Otherwise, several files shall be generated for such a day, as much as the number of modes used. In a CDF file, a variable has indeed and logically a fixed size. A typical file size of a converted daily CDF is of the order of 100 MB. Despite this size, a CDF file is loaded in a few seconds by Matlab with spdfcdfread.m NASA routine. Please find below an example of omnidirectional electron differential energy flux derived from the 3D distribution function measured by RPC-IES onboard Rosetta on 09-09-2016 where a mode change is clearly visible around 10 am.

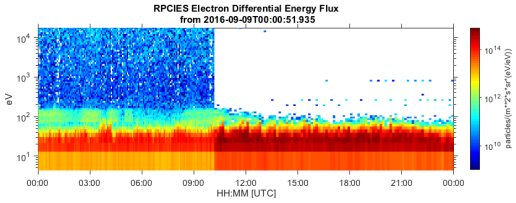

Figure 1: Omnidirectional electron differential energy flux measured by RPC-IES on 2016-09-09, please note the mode change around 10 am.

5. Summary and Conclusions

The SPace dAta foRmat TrAnslator software developed at ESA is the first software able to convert PDS3 datasets in CDF ISTP compliant files. It has been applied to the best calibrated of the Rosetta Plasma Consortium.

SPARTA has been written in view of being made open source to be used by the community at large for converting other PDS3 datasets to CDF/ISTP, especially those related to in-situ space plasma physics instruments.

Acknowledgements

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