README: Van Allen Probes RPS Response Function Files

This README document describes the NASA Van Allen Probes Relativistic Proton Spectrometer (RPS) sensor response function files. These files provide the sensor's response to protons and electrons as a function of energy and angle of incidence. For further information contact the instrument PI Joe Mazur joseph.e.mazur@aero.org or the science operations lead, Paul O'Brien, paul.obrien@aero.org.

Four response files are provided:

- rbsp_rps_MIN2SSD_log_polygons.cdf – Energy-angle response in PRBEM format (NASA CDF)
- rbsp_rps_MIN2SSD_log_polygons.hdf5 – Energy-angle response in PRBEM format (HDF5)
- rbsp_rps_MIN2SSD_log_polygons_iso.csv – Energy response to isotropic proton flux (CSV)
- rbsp_rps_MIN2SSD_log_polygons_elec_iso.csv – Energy response to isotropic electron flux (CSV)

The filenames reflect that the MIN2SSD method was used for assigning energies to the incident particles and the "logarithmic polygons" were used to remove background. These techniques are described in Aerospace Technical Reports ATR-2021-02018.

Energy-angle (PRBEM) response files

The Energy-angle response files are provided using the Panel on Radiation Belt Environment Models (PRBEM) response file format (v1.1.1) which can be found here: prbem.github.io/docs/. In these files, the proton and electron response of the RPS sensor is given for each of the 20 RPS channels described in ATR-2021-02018, , ATR-2021-2025, and ATR-2021-2026. The sensor is represented as a cylindrically symmetric telescope with normally incident particles having an incident angle THETA (θ) of 0. For proton response, supplemental E0 (E_0), G, and DE (δE) values are provided from the bowtie analysis in ATR-2021-02018 are also provided. E0 is the bowtie channel energy and DE is the bowtie channel bandwidth, where each channel is approximated as an idealized differential channel. The PRBEM response files are provided both in NASA CDF (.cdf) and HDF5 (.h5) format.

The HDF5 format PRBEM response files (.h5 extension) were produced from Matlab and have some subtleties in their structure. The following information may be helpful:

- HDF5 written from Matlab does not store strings. So, strings are stored in UTF-8 encoding as uint8 data. String variables have an attribute isString.
- Boolean variables are stored as uint8 and have an attribute isBoolean.
- Matlab stores arrays of strings as "cell arrays." These are captured in HDF5 as groups with an isArray attribute. Members of the group have variable names 000, 001, 002, … Enough digits are used to accommodate all members of the group with zero-padded variable names of the same length. When reading the group, the members should be sorted (by increasing variable name number) to restore the original order in the array.
- Most of the data are stored in groups and sub-groups, with isStruct attribute set.
- Matlab treats all variables as double precision and matrix by default. Thus, even scalars will have size 1x1, and many integers will be stored as double precision.

Isotropic response files

Isotropic response files are provided for both protons and electrons by numerically integrating the energy-angle response over the angular dependence. Each of these files has a single column providing the energy value in MeV and the one column per sensor channel. Note that the response units cm^2sr are given only in the header for the final channel (P20). The numerical values in the sensor channel columns are the response of the specified channel at the associated energy. Figure 1 plots the channel response for isotropic protons, and Figure 2 plots the channel response for isotropic electrons.

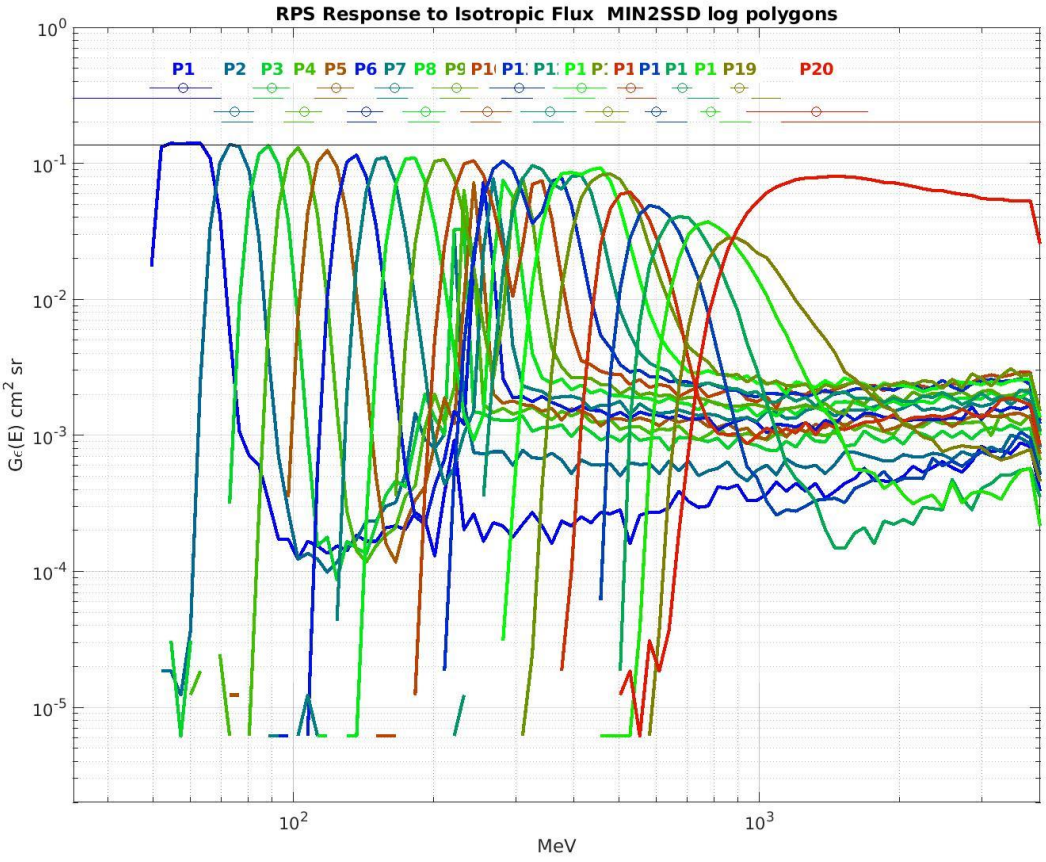

Figure 1. RPS isotropic proton response. Solid curves indicated the computed isotropic response of each channel. Circles indicate E0 (E_0) the bowtie channel energy, short horizontal lines through the circles indicate the bandwidth DE (δE). Longer horizontal lines below the circles indicate the MIN2SSD computed energies accepted into each energy channel. A vertical line is plotted at the nominal geometric factor 0.136 cm^2sr.

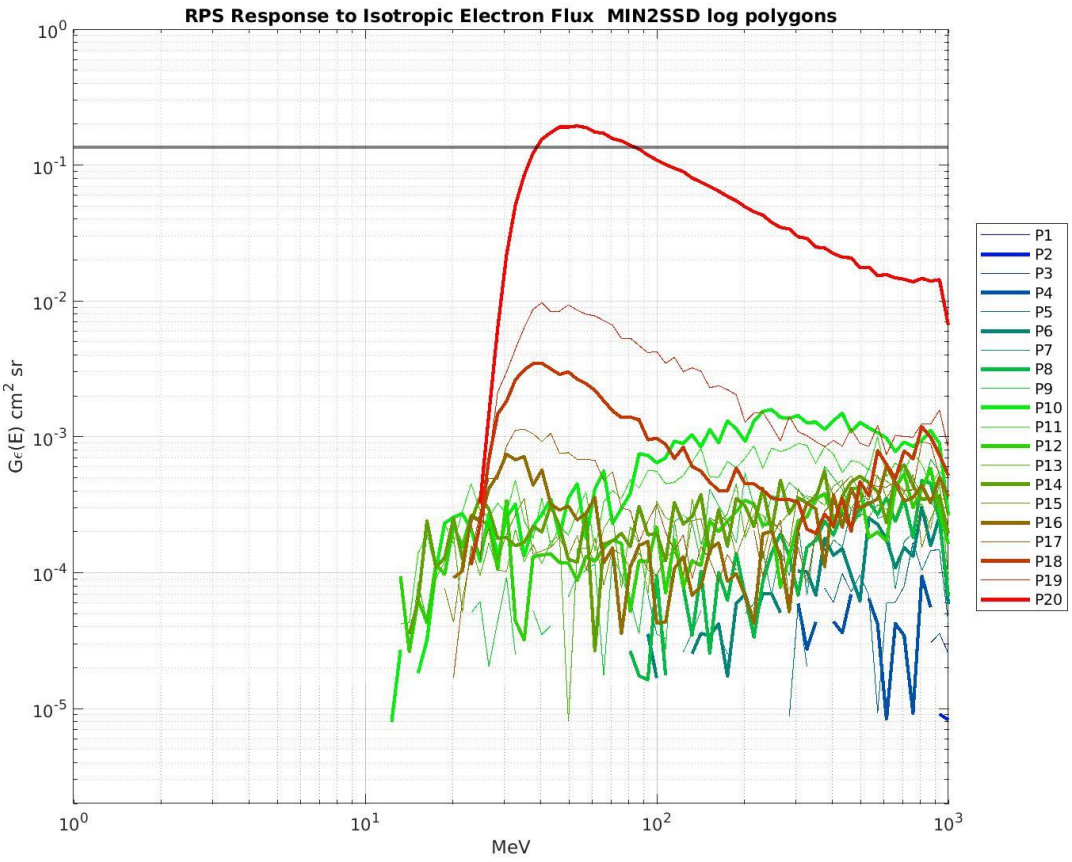

Figure 2. RPS isotropic electron response.

References

ATR-2021-02018, T.P. O'Brien, M.D. Looper, J.E. Mazur, and E.L. Mazur, Relativistic Proton Spectrometer Flux Determination and Data Products, The Aerospace Corporation, 2021.

ATR-2021-02025, M.D. Looper, T.P. O'Brien, and J.E. Mazur, Relativistic Proton Spectrometer Detector Calibration, The Aerospace Corporation, 2021.

ATR-2021-02026, M.D. Looper, T.P. O'Brien, and J.E. Mazur, Relativistic Proton Spectrometer Electron Response, The Aerospace Corporation, 2021.

These reports may be obtained from library.mailbox@aero.org