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**Description of GPS Particle Data Summary Plots Produced by NCEI**

Please refer to the LANL README file for details on the data files:

http://www.ngdc.noaa.gov/stp/space-weather/satellite-data/satellite-systems/gps/readme.pdf

The following notes are not intended to supersede the README file, but rather to document the summary plots created by NCEI.

One summary plot corresponds to one satellite-week data file. The data files are ASCII flat files with a JSON-formatted header. Using Python, the data array is read using the NumPy function 'loadtxt' with the keyword 'comments='#''. The variable names from the JSON header are assigned to the correct parts of the array using the START_COLUMN and DIMENSION values from the header.

Each plot comprises 5 panels.

The top panel shows the differential directional electron fluxes ('electron_diff_flux') at the discrete energies listed above, in units of $cm^{-2}$ $s^{-1}$ $sr^{-1}$ $MeV^{-1}$. The electron fluxes are evaluated at 15 discrete energies using the relativistic Maxwellian fits described in the README file and by Morley et al. (2016). These energies (for both BDD-IIR and CXD) are 0.12, 0.21, 0.30, 0.425, 0.6, 0.8, 1.0, 1.6, 2.0, 3.0, 4.0, 5.0, 6.0, 8.0, and 10.0 MeV. They are contained in the variable 'electron_diff_flux_energy'.

The second panel shows the proton channel rates ('rate_proton_measured') in broad energy ranges, in units of $s^{-1}$. Proton fluxes are not yet included in the data files. However, LANL does plan to release them in the future (J. Sullivan, private communication, 2016). For now, the summary plots display the proton rates and are labelled with BDD-IIR threshold (penetration) energies from Cayton et al. (1998) and CXD proton channel energies from Cayton (2004).

The measurements have broad fields of view and are not pitch-angle resolved (Cayton et al., 1998; Cayton, 2004). See Morley et al. (2016) for a discussion of the range of equatorial pitch angles to which the CXD observations correspond.

The bottom three panels provide the location of the observations in magnetic coordinates: McIlwain L-shell ($R_e$), magnetic latitude (degrees), and magnetic local time (hours). The magnetic latitude is estimated as a function of two quantities read from the files: atan(b_coord_height/b_coord_radius). The other two quantities are read from the files. From the CXD files, the L-shell variable is 'L_LGM_T89CDIP', which is McIlwain L calculated using a centered dipole internal field and a Tsyganenko 1989 (T89) external field. From the BDD-IIR files, the variable is 'L_shell' and the exact nature of the calculation is not given. For both BDD-IIR and CXD, the variable for MLT is 'local_time'.

The fill value of -1 is used to create masked arrays prior to plotting.

Please direct questions about the summary plots or this note to Juan Rodriguez (juan.rodriguez@noaa.gov).

**References:**

Cayton, T.E. (2004), Monte Carlo simulation of the particle channels of the Combined X-ray Sensor and Dosimeter (CXD) for GPS Block IIR and Block IIF, *LA-UR-04-7092*, Los Alamos National Laboratory.

Cayton, T.E., D.M. Drake, K.M. Spencer, M. Herrin, T.J. Wehner and R.C. Reedy (1998), Description of the BDD-IIR: Electron and proton sensors on the GPS, *LA-UR-98-1162*, Los Alamos National Laboratory.

Morley, S. K., J. P. Sullivan, M. G. Henderson, J. B. Blake, and D. N. Baker (2016), The Global Positioning System constellation as a space weather monitor: Comparison of electron measurements with Van Allen Probes data, *Space Weather, 14*, doi:10.1002/2015SW001339.