Parker Solar Probe SWEAP SPAN-Electron

Data Release Notes

Versions:

November 19, 2019
Initial Data Release

April 3, 2020
Updated for SPAN Pitch Angle Distributions Data Release

Contacts

For science questions related to the SPAN-Electron measurements, contact the Instrument Lead, Phyllis Whittlesey (phyllisw@berkeley.edu), or Davin Larson (davin@berkeley.edu).

Overview of Measurements

The SWEAP team is pleased to release the Level 3 data from Encounter 1 and Encounter 2, adding to the Level 2 data released previously from Encounters 1 - 3. The Level 3 files contain data from the time range October 31, 2018 - June 18, 2019. The Level 2 files contain data from the time range October 31, 2018 - October 13, 2019.

The prime mission of Parker Solar Probe is to take data when within 0.25AU of the Sun. However, there have been some extended campaign measurements outside of this distance. Data are available for those days that are within 0.25AU as well as those days when the instruments were operational outside of 0.25AU.

Each SWEAP data file includes a set of a particular type of measurements over a single observing day. Measurements are provided in Common Data Format (CDF), a self-documenting data framework for which convenient open source tools exist across most scientific computing platforms. Users are strongly encouraged to consult the global metadata in each file, and the metadata that are linked to each variable. The metadata includes comprehensive listings of relevant information, including units, coordinate systems, qualitative descriptions, measurement uncertainties, methodologies, links to further documentation, and so forth.

SPAN-E Level 2 Version 01 Release Notes

The SPAN-Ae and SPAN-B instruments together have fields of view covering >90% of the sky; major obstructions to the FOV include the spacecraft heat shield and other intrusions by spacecraft components. Each individual SPAN-E has FOV of +/- 60° in theta and 240° in phi. The rotation matrices to convert into the spacecraft frame can be found in the individual CDF files, or in the instrument paper.

This data set covers all periods for which the instrument was turned on and taking data in the solar wind. This includes maneuvers affecting the spacecraft attitude and orientation. Measurements taken by SPAN-B when the spacecraft is pointed away from the sun are taken in sunlight, which is typically during communications slews and other spacecraft operations. Special care should be taken for these intervals with regards to photoelectrons and pitch angle distributions, since within 0.75 AU SPAN-B tends to overheat and power off.

General Remarks for v01

Users interested in field-aligned electrons should take care regarding potential blockages from the heat shield when B is near radial, especially in SPAN-Ae. Artificial reductions in strahl width can result.

Due to the relatively high electron temperature in the inner heliosphere, many secondary electrons are generated from spacecraft and instrument surfaces. As a result, electron measurements in this release below 30eV are not advised for scientific analysis.

The fields of view in SPAN-Ae and SPAN-B have many intrusions by the spacecraft, and erroneous pixels discovered in analysis, in particular near the edges of the FOV, should be viewed with skepticism. Details on FOV intrusion are found in the instrument paper, https://doi.org/10.3847/1538-4365/ab7370, or by contacting the SPAN-E instrument scientist.

The instruments' mechanical attenuators are engaged during the eight days around perihelia 1 and 2, which results in a factor of ~10 reduction of the total electron flux into the instrument. During these eight days, halo electron measurements are artificially enhanced in the L2 products as a result of the reduced instrument geometric factor and subsequent ground corrections.

A general note for Encounter 1 and 2 data: a miscalculation in the deflection tables loaded to both SPAN-Ae and SPAN-B resulted in over-deflection of the outermost theta angles during Encounters 1 and 2. As such, the outermost theta pixels should be ignored. This error was corrected by a table upload prior to Encounter 3.

Lastly, when viewing time gaps in the SPAN-E measurements, be advised that the first data point produced by the instrument after a power-on is the maximum value permitted by internal instrument counters. Therefore, the first data point after powerup is erroneous and should be discarded, as indicated by quality flags.

SPAN-E Level 2 3D Spectra Data *(“psp_swp_spa_sf0_L2_16Ax8Dx32E_YYYYMMDD_v01.cdf”)*

The SF0 products are the “full 3D” spectra from each individual SPAN-E instrument (SPAN-Ae and SPAN-B). Units are in differential energy flux, degrees, and eV. One spectrum comprises decreasing steps in Energy specified by the number in the filename, alternating sweeps in theta/Deflection, also specified by the number in the filename, and a number of phi/Anode directions, also specified by the number in the filename. The sample filename above includes 16 Anodes, 8 Deflections, and 32 Energies.

This data set covers all periods for which the instrument was turned on and taking data in the solar wind in “Full Sweep”, normal cadence survey mode. This includes maneuvers affecting the spacecraft attitude and orientation. Measurements taken by SPAN-B during cruise phase periods when the spacecraft is pointed away from the sun are taken in sunlight.

SPAN-E Level 2 Energy Spectra Data *(“psp_swp_spa_sf1_L2_32E_YYYYMMDD_v01.cdf”)*

The “sf1” product is an energy spectrum produced on the spacecraft by summing over the theta and phi directions. The units are differential energy flux and eV.

The larger theta angles (deflection angles) are artificially enhanced in the “sf1” energy spectra data products due to the method of spectra production on the SPAN-E instrument (straight summing). Thus, SF1 energy spectra are not recommended for rigid statistical analysis.

SPAN-E Level 3 Version 01 Release Notes

SPAN-E Level 3 Pitch Angle Distribution Data: PADs *(“psp_swp_sp?_sf0_L3_pad_YYYYMMDD_v01”)*

The SPAN-E pitch angle distributions (PADs) are distributions of the measured electrons plotted relative to the simultaneous magnetic field direction. Angles of 0° are co-aligned with the magnetic field vector, and angles of 180° are anti-parallel with the magnetic field vector. The data are resampled into 12 bins of 15 degree widths spanning 0° to 180°. CDF files with the

“spa” keyword in the filename are generated from SPAN-Ae; those with “spb”, from SPAN-B. The combined SPAN-Ae / SPAN-B files are identified with the “spe” label. Units are in differential energy flux, degrees from the magnetic field vector direction, and eV.

Caution should be exercised when looking for interesting “features” in the combined “spe” PADs: these files are the product of two different instruments combining their fields of view. When in doubt, compare combined “spe” PADs to individual “spa” and “spb” files to see if the “feature” seen in the “spe” PAD is a true measurement, or an artifact from sensor fusion.

Timeline Remarks By Encounter:

SPAN-E Encounter 1 Remarks

SPAN-E operated nominally for the majority of the first encounter. Exceptions to this include: a few instances of corrupted, higher-energy sweep tables, and an instrument commanding error for the two hours surrounding perihelion 1. These and other instrument diagnostic tests are indicated with the QUALITY_FLAG variable in the CDFs.

The mechanical attenuator was engaged for the 8 days around perihelion 1: as a result the MCP noise due to thermal effects and cosmic rays are artificially enhanced and are particularly obvious at higher energies. Likewise, secondary electron production is enhanced at lower energies, and are distinguished by the presence of a distinct peak at roughly 20eV in the distribution below the core electron energy. Exercise caution in this data release if looking for halo electrons when the mechanical attenuator is engaged.

SPAN-E Cruise Phase Remarks

The cruise mode rates of SPAN-E are greatly reduced compared to the encounter mode rates. When the PSP spacecraft is in a communications slew, the SPAN-B instrument occasionally reaches its maximum allowable operating temperature and is powered off by the instrument data processing unit.

Timing for the SF1 products in cruise phase is not corrected in v01, and thus it is not advised to use the data at this time for scientific analysis. The typical return of SF0 products is 1 spectrum out of every 32 survey spectra is returned every ~15 minutes. One out of every four 27 second SF1 spectra is produced every 111 seconds.

SPAN-E Encounter 2 Remarks

SPAN-E operated nominally for the majority of the second encounter. Exceptions include instrument diagnostic and health checks, and a few instances of corrupted high-energy sweep tables. These tests and corrupted table loads are indicated with the QUALITY_FLAG parameter.

The mechanical attenuator was engaged for the 8 days around perihelion 2: as a result the MCP noise due to thermal effects and cosmic rays are artificially enhanced and are particularly obvious at higher energies. Likewise, secondary electron production is enhanced at lower energies, and are distinguished by the presence of a distinct peak at roughly 20eV in the distribution below the core electron energy. Exercise caution in this data release if looking for halo electrons when the mechanical attenuator is engaged.

SPAN-E Encounter 3 Remarks

SPAN-E operated nominally for the third encounter period. Exceptions include instrument diagnostics and health checks, with interspersed periods of a corrupted high-energy sweep table and a few tests of the SPAN-E instrument spoiler (see Whittlesey et al, 2020). These intervals again are indicated with the QUALITY_FLAG parameter.

The mechanical attenuator was engaged for 9 days around perihelion 3: the same caveats about MCP noise and cosmic rays, as well as secondary electron production off of the mechanical attenuator apply here as they did in encounter 2.

Remarks on the Electron Solar Probe ANalyzer (SPAN-E) v01 data products

The data quality flags for the SPAN data can be found in the CDF files in the variable named QUALITY_FLAG, which is a byte-type variable with each bit indicating:
Bit 1: Counter Overflow
Bit 2: Snapshot On
Bit 3: Alternate Energy Table
Bit 4: Spoiler Test
Bit 5: Mechanical Attenuator Engaged
Bits 6-8: Reserved
Apart from Bit 5 (instrument mechanical attenuator engaged), when any of the other bits are set, the data quality may be reduced.

SPAN-Electron Data Files

The following files are available with electron measurements

psp_swp_spa_sf0_L2_16Ax8Dx32E_YYYYMMDD_v01.cdf (SPA 3D spectra)
psp_swp_spb_sf0_L2_16Ax8Dx32E_YYYYMMDD_v01.cdf (SPB 3D spectra)
psp_swp_spa_sf1_L2_32E_YYYYMMDD_v01.cdf (SPA Summed energy spectra)
psp_swp_spb_sf1_L2_32E_YYYYMMDD_v01.cdf (SPB Summed energy spectra)
psp_swp_spe_sf0_L3_pad_YYYYMMDD_v01.cdf (Combined SPA/SPB PADs)
psp_swp_spa_sf0_L3_pad_YYYYMMDD_v01.cdf (SPA PADs)
psp_swp_spb_sf0_L3_pad_YYYYMMDD_v01.cdf (SPB PADs)

SWEAP Science Working Group

For a further discussion of the scientific uses of the data please join the Parker Solar Probe Working Groups. Call in information and times will be posted on the SWEAP and FIELDS website prior to the meeting. Announcements will also be made in SPA and Solar newsletters.

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