EUV Plasmapause Data: Directory Structure

In each event directory, you will find a "movies" directory and a "ppa" directory.

The "movie" directory contains one or more movies of EUV plasmasphere data. Check individual directory contents to see which of the list below is applicable. Depending on the analysis I happened to perform, the contents may vary by event.

The "ppa" directory contains the actual plasmapause data, as described below.

MOVIE DIRECTORIES INFORMATION

In each event folder there is a "movie" directory. The movie directory may contain as many as 4 sub-folders: "mapped movies", "raw movies", and "indices".

EUV_raw_movies: These are the movies of "raw" images downloaded from the EUV instrument, with minimal processing. (These movies are obtainable via anonymous FTP from http://euv.lpl.arizona.edu/euv/.)

EUV_mapped_movies:
These movies contain "mapped images." A mapped image is created by taking the pixels of the raw EUV image, and assigning L and phi values to the vertices of each pixel. The L-value is assigned using the "minimum L" routine of *Roelof and Skinner [2000]* (see reference below). Thus, the pixels of the raw EUV image are mapped to the magnetic equator (in SM coordinates), presumably removing much or most of the perspective effects from the raw images.

EUV_ppa_movies:
These movies show the extracted plasmapause data contained in the ***".ppa" files*** (see next section). The view is of the equatorial plane (SM coordinates) with the Sun to the right. The dots are the manually extracted points (SEE NEXT SECTION). The line is the Fourier expansion of those points (SEE NEXT SECTION for limitations of this Fourier expansion!).

EUV_PTP_movies:
These movies show overlays of EUV plasmapause data and one or more plasmapause test particle (PTP) model simulations.

indices: This directory simply contains a .GIF or .JPEG picture file of Dst, Kp, or other geomagnetic index, obtained for the event by WDC Kyoto.

PPA FILES INFORMATION: Information about EUV plasmapause files

The following is a very brief description of the primary plasmapause location files, the "ppa" files.

They contain multiple points that represent the plasmapause as manually extracted from global snapshots of the plasmasphere obtained by IMAGE EUV.

Not Always Just "Plasmapause" Data.
It's worth noting that these points are not always purely "plasmapause" data. In most cases, the points do indicate a best guess for the outer edge of the plasmasphere. But there are two exceptions.

(1) No Steep Outer Gradient. If there is no clear outer boundary (e.g., the plasmasphere density has a gradual roll-off rather than a single steep well-defined density gradient), an attempt was made to represent the plasmasphere shape by clicking. ***It is often the case that the plasmapause is not represented by a steep, well-defined density gradient.*** In cases where there was no sharp density gradient, the click points do not define a single curve, but rather make up a scattered "band" (intended to represent the thickness of the poorly-defined outer edge), or in some cases, the click points indicate some degree of structure to the outer boundary.

(2) Multiple Edges or Interior Structure. In cases where there are multiple sharp edges, or some kind of

interior structure, the click points do not define a single curve.

Noise, Sunlight Contamination, Instrumental Effects.

I did my best to avoid misinterpreting the images, but in some cases, very high background noise (believed to be caused by direct penetration into the instrument by energetic particles), sunlight contamination, etc., may have contributed to some extra uncertainty in the plasmapause location found in the .ppa file. It is probably a good idea for you to take a look at the corresponding EUV mapped movie before using the extracted plasmapause for a given event.

File Naming Convention

Each file is named according to the convention YYYYDDDHHMM.ppa, where

YYYY = 4-digit year
DDD = 3-digit day of year (e.g., day 1=Jan 1)
HH = 2-digit UT hour
MM = 2-digit UT minute
".ppa" = 3-letter extension ("ppa" = shorthand for plasmapause).

File Contents

In each file, you will find all the plasmapause location points corresponding to a single EUV image. That is, all the points in a given file are simultaneous global "measurements" of the plasmapause.

The .ppa file consists of ASCII text, 2 columns consisting of:

L = L-shell location (defined as the radial distance in the magnetic equator in Earth radii RE).
phi = angular location in radians, defined so that phi=0 at 1200 MLT (noon), phi=pi at 2400 MLT, etc.

At the end of the .ppa file, you will find a Fourier expansion of the (L,phi) points. This Fourier expansion is useful in cases where one wishes to determine electric fields from the plasmapause motion (as described in Goldstein et al., [2004]; see reference below.). It is not advised that you use this Fourier expansion without ***first consulting with Jerry Goldstein (jgoldstein@swri.edu)***. The reason for this warning is that the Fourier expansion is only a good representation of the plasmapause under certain restrictive circumstances. Probably the most important requirement for a "good" Fourier expansion is that the plasmapause (L vs phi) curve must be single-valued. If there is a drainage plume, for example, it is most likely that the plasmapause curve is *NOT* single-valued. A secondary consideration is that the Fourier expansion is only really good inside a range of MLT (i.e., phi) values for which there were actually extracted points. For example, if there are only plasmapause points extracted on the nightside, one should not expect, in general, the Fourier expansion to be accurate on the dayside. *Improper use of the Fourier expansion can provide a very innaccurate plasmapause!*

Notes on Manually-Extracted Plasmapause Location: "Click Points"

THESE DATA ARE UNSORTED!!!!

The click points are not single-valued and are not monotonic, in either MLT or L-shell. When using a given .ppa data file, you may want to sort the data points by MLT before you plot them or use them. Also, when you plot the plasmapause data, *it is strongly advised that you use discrete symbols (filled circles or dots) to plot the points rather than connecting the points with lines.*

SUBJECTIVE ERROR

Something to keep in mind is that the (L,phi) points have been manually extracted. There is inescapably some subjectivity to the extraction, although comparison with in situ data has shown that the manually extracted plasmapause is reasonably accurate (within a few tenths of an RE) under most circumstances.

Many extractions show not a single well-defined plasmapause, but rather a "band" of scattered or staggered points. In these cases, the error can be crudely estimated as the radial thickness of the band, or as the scatter in plasmapause location within some given range of MLT, say 0.5 hours to 1 hour of MLT. If a well-defined plasmapause does exist, it probably has 0.3-0.7 RE uncertainty, due to the high background noise in

this 2003 Halloween event.

Why are we still using manual extractions?

A common question raised is, "Why hasn't anyone devised a routine for automated plasmapause extraction? Wouldn't an automated routine be better? One argument is that the automated extraction might be described as "not subjective" (since a computer isn't usually thought of as subjective). Another is that the automated routine would be quicker, not so labor intensive. The answer to this question is that the human eye does as well, or better, at recognizing the plasmapause location, when compared to any automated routine developed at the present time. It's a challenging problem to design an automated routine that can ignore shadows, noise, sunlight contamination, etc. So for now, the best we have is manual extraction, and we do our very best to minimize the subjectivity.

IMPORTANT NOTE ON USING PLASMAPAUSE DATA

In cases where a well-defined plasmapause edge existed, single plasmapause location points can be trusted. However, in cases where the click points were intended to represent a gradual density gradient, or interior features, care must be exercised in interpreting single points. In fact, the best way to use the EUV extracted "plasmapause" data is to plot the data and do a global "by eye" assessment of the overal plasmapause shape and size.

If you have any **questions** about how to use EUV plasmapause data, *please contact* ***Jerry Goldstein (jgoldstein@swri.edu).***

Linux Compatibility

For users of Linux or UNIX, some may have problems with the .ppa files that were created using IDL 5.3 for Mac OS 9.1. Specifically, the Mac OS 9.1 IDL "carriage return" may not contain the "line feed" command that Linux expects. If this problem interferes with your use of the data, please contact ***Jerry Goldstein (jgoldstein@swri.edu).***

References

Goldstein, J., R. A. Wolf, B. R. Sandel, and P. H. Reiff, Electric fields deduced from plasmapause motion in IMAGE EUV images, *Geophys. Res. Lett., 31*(1), L01801, doi:10.1029/2003GL018797,386, 2004.

Roelof, E. C., and A. J. Skinner, Extraction of ion distributions from magnetospheric ENA and EUV images, *Space Sci. Rev., 91*, 437, 2000.