corrVandFlux

User Manual

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Document Change Log

Issue/ Rev.	Issue Date	Sections	Reason for Change
1	7 Oct 2020	All	Initial release
2	20 Sep 2023	All	Incorporates changes of software since issue 1
3	30 Sep 2023	All	Prefinal revisions
3.1	06 Nov 2023	5	Updated description of main control panel items
3.2	08 Jan 2024	5.1.13	Added output choice for photocurves

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1 Overview

The program corrVandFlux displays and analyzes data from the NASA Magnetospheric Multiscale (MMS) Mission related to spacecraft charging which have been preprocessed by the program mmsedpana in order to obtain spin averages of relevant quantities. In addition, MMS data may be correlated with solar activity data.

1.1 Instrument data

Inputs to the program include data from the instruments

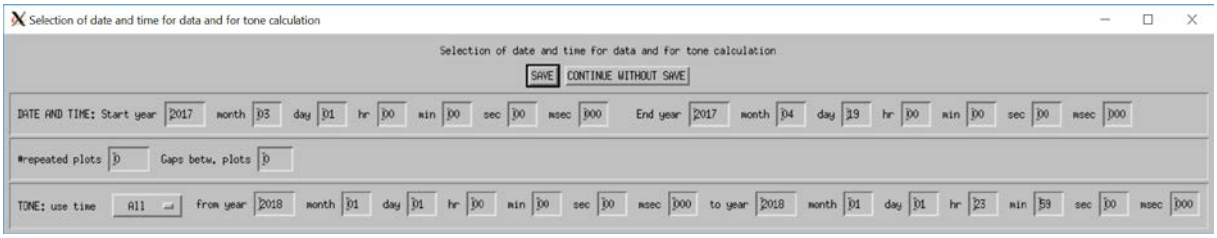
Acronym	Name	Ref.	Parameter
ASPOC	Active Spacecraft Potential Control	[1]	Ion beam current
EDI	Electron Drift Instrument	[2]	Gun beam current
EDP	Electric Field Double Probes, consisting of:	[3]	
SDP	Spin Plane Double Probes	[4]	Spacecraft potential, Electric field
ADP	Axial Double Probes	[5]	Spacecraft potential, Electric field
FPI	Fast Plasma Instrument, consisting of:	[7]	
DES	Dual Electron Sensors		Electron moments, energy distributions
DIS	Dual Ion Sensors		Ion moments, energy distributions

1.2 Input data base

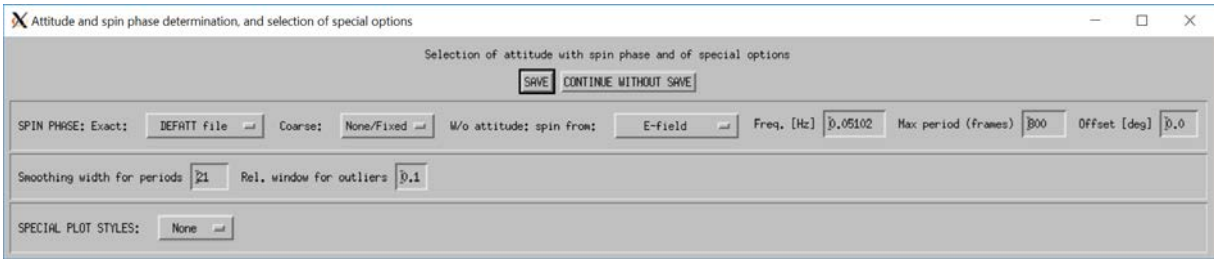
The program mmsedpana has been used to generate spin average data of spacecraft potential, electric field, ASPOC current, electron and ion density, temperature, and current. The files in the distribution cover the time range 2015-09-01 to 2023-05-31. Due to the long processing time, the data in Fast Survey mode have been analysed in batches of 2 months, and for electron and ion data separately. The combination of electron and ion data has been performed by the program mmsedpoutput_merge_vel_ei_leo. The concatenation of the 2-month files has been performed by the program mmsedpoutput_concatenate_leo. Data in Slow Survey mode received a similar treatment, but in 4-month junks. These steps have been performed in the Unix environment at IWF (leo1). The results were copied to a Windows environment. Finally, the Fast Survey and Slow Survey data were merged by the program by the program mmsedpoutput_merge_vel_fastslow. The nomenclature of these files is mms*_out_*eandivfands.dat. The first lines of one of these files are reproduced below.

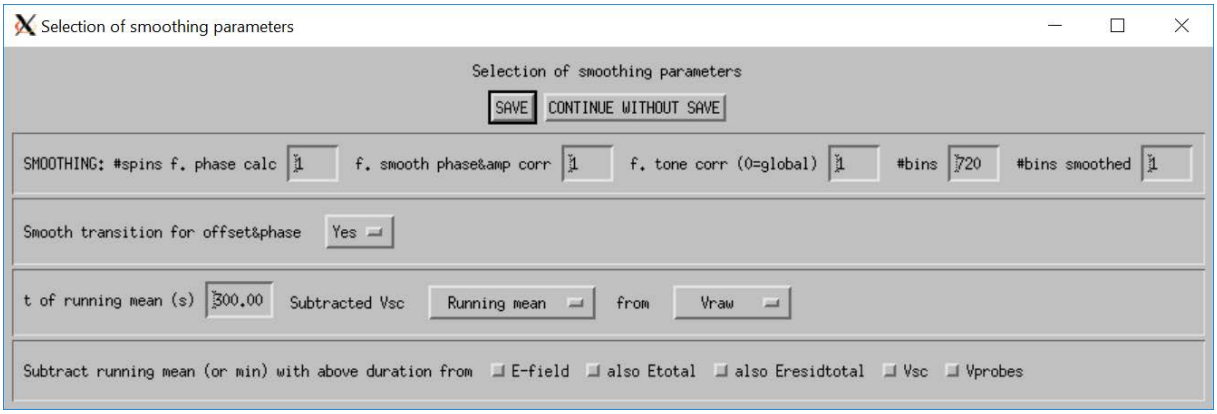
```
Time[UT]                Phase12 E12ampl E34ampl Etotamp   ExDSL   EyDSL     Vsc El.Dens El.Temp El.Curr ASP-EDI  veGSEx  veGSEy  veGSEz IonDens IonTemp IonCurr viGSEx viGSEy viGSEz
Time[UT]                 [deg]  [mV/m]  [mV/m]  [mV/m]  [mV/m]  [mV/m]     [V] [cm^-3]     [eV]     [uA]     [uA]  [km/s]  [km/s]  [km/s] [cm^-3]     [eV]     [uA]  [km/s]  [km/s]  [km/s]
2015-09-01T09:52:06.527  59.617  -0.018  -0.261   0.262  -0.018  -0.261   3.003   0.650  259.67   2.845  19.712   -7.05  -21.41   31.68   0.763 5855.32   1.241   -0.67    2.58    8.45
2015-09-01T09:52:25.887  59.174  -0.159  -0.092   0.184  -0.159  -0.092   3.010   0.609  272.42   2.728  19.710   -0.71   -3.00   31.20   0.766 5712.50   1.230    0.20    0.92    6.47
2015-09-01T09:52:45.246  69.954  -0.109   0.171   0.202  -0.109   0.171   3.023   0.495  329.90   2.435  19.711    5.66   12.28   32.16   0.757 5698.14   1.213    3.56    5.81    5.98
```

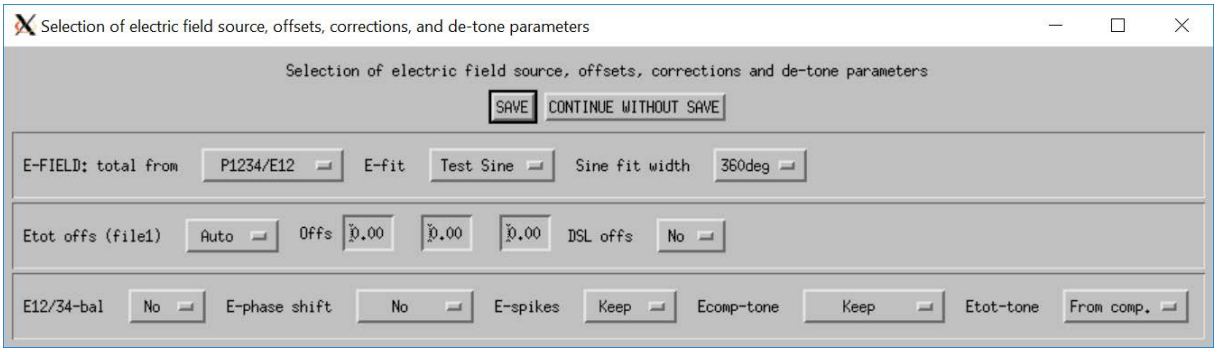
The settings of mmsedpana can be seen in the control panels listed below.

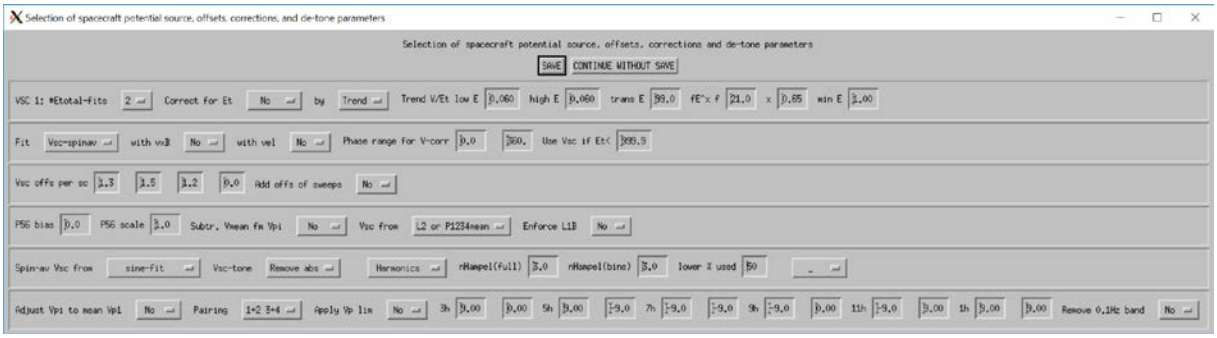

Selection of date and time for data and for tone calculation
Selection of date and time for data and for tone calculation
SAVE
CONTINUE WITHOUT SAVE
DATE AND TIME: Start year 2017 month 03 day 01 hr 00 min 00 sec 00 msec 000 End year 2017 month 04 day 19 hr 00 min 00 sec 00 msec 000
#repeated plots 0 Gaps betw. plots 0
TONE: use time All from year 2018 month 01 day 01 hr 00 min 00 sec 00 msec 000 to year 2018 month 01 day 01 hr 23 min 59 sec 00 msec 000

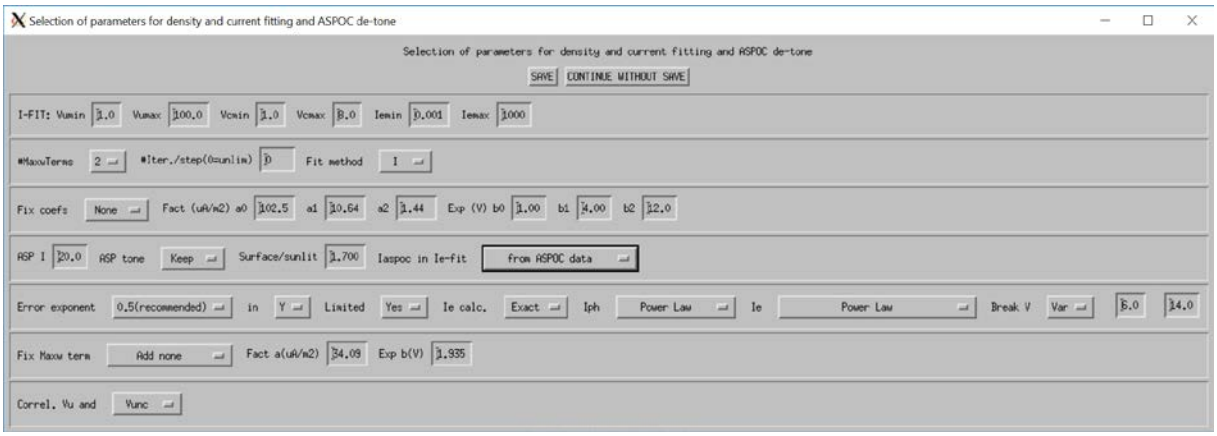

Selection of data sets and data filters
Selection of data sets and data Filters
SAVE
CONTINUE WITHOUT SAVE
Science data directory root: /mms/mms/spedas/mms/
Aux data directory root: /mms/mms/sdc/

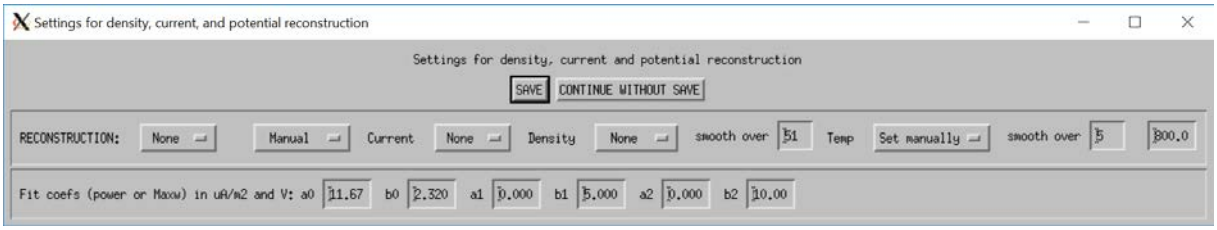

Attitude and spin phase determination, and selection of special options
Selection of attitude with spin phase and of special options
SAVE
CONTINUE WITHOUT SAVE
SPIN PHASE: Exact: DEFATT file Coarse: None/Fixed W/o attitude: spin from: E-field Freq. [Hz] 0.05102 Max period (frames) 800 Offset [deg] 0.0
Smoothing width for periods 21 Rel. window for outliers 0.1
SPECIAL PLOT STYLES: None

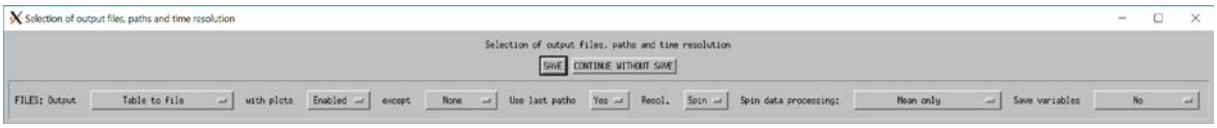

Selection of smoothing parameters
Selection of smoothing parameters
SAVE
CONTINUE WITHOUT SAVE
SMOOTHING: #spins f. phase calc 1 f. smooth phase&amp corr 1 f. tone corr (0=global) 1 #bins 720 #bins smoothed 1
Smooth transition for offset&phase Yes
t of running mean (s) 300.00 Subtracted Vsc Running mean from Vraw
Subtract running mean (or min) with above duration from E-field also Etotal also Eresidtotal Vsc Vprobes

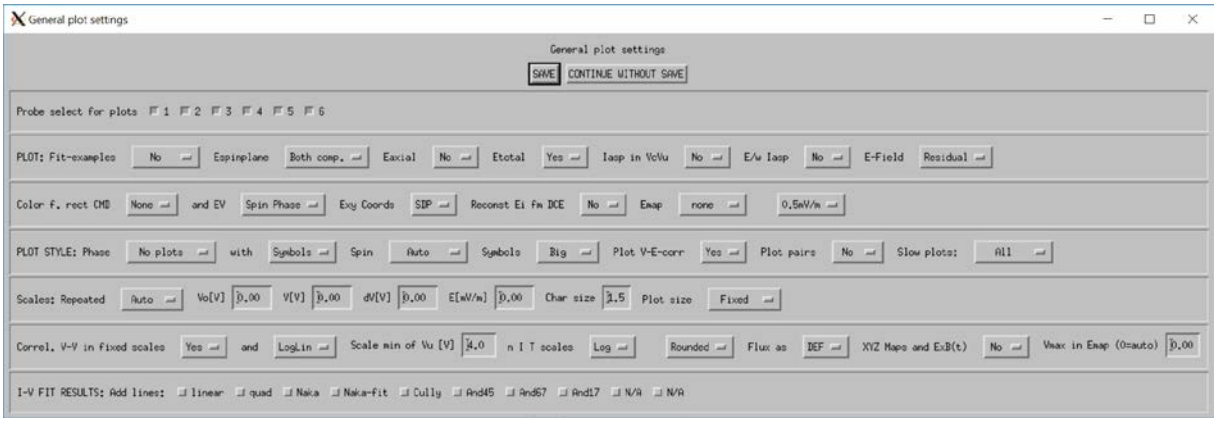

Selection of electric field source, offsets, corrections, and de-tone parameters
Selection of electric field source, offsets, corrections and de-tone parameters
SAVE
CONTINUE WITHOUT SAVE
E-FIELD: total from P1234/E12 E-fit Test Sine Sine fit width 360deg
Etot offs (file1) Auto Offs 0.00 0.00 0.00 DSL offs No
E12/34-bal No E-phase shift No E-spikes Keep Ecomp-tone Keep Etot-tone From comp.


Selection of spacecraft potential source, offsets, corrections, and de-tone parameters
Selection of spacecraft potential source, offsets, corrections and de-tone parameters
SAVE
CONTINUE WITHOUT SAVE
VSC 1: #Etotal-fits
Correct for Et
by
Trend
Fit
with vxB
with vel
Phase range for V-corr
Use Vsc if Et<
Vsc offs per sc
Add offs of sweeps
P56 bias
P56 scale
Subtr. Vmean fm Vpi
Vsc from
Enforce L1B
Spin-av Vsc from
sine-fit
Vsc-tone
Remove abs
Harmonics
Adjust Vpi to mean Vpl
Pairing
Apply Vp lim
Remove 0.1Hz band


Selection of parameters for density and current fitting and ASPOC de-tone
Selection of parameters for density and current fitting and ASPOC de-tone
SAVE
CONTINUE WITHOUT SAVE
I-FIT: Vumin
Vumax
Vcmin
Vcmax
Iemin
Iemax
#MaxwTerms
#Iter./step(0=unlim)
Fit method
Fix coefs
Fact (uA/m2) a0
a1
a2
Exp (V) b0
b1
b2
ASP I
ASP tone
Keep
Surface/sunlit
Iaspoc in Ie-fit
from ASPOC data
Error exponent
0.5(recommended)
in
Limited
Ie calc.
Exact
Iph
Power Law
Ie
Break V
Var
Fix Maxw term
Add none
Fact a(uA/m2)
Exp b(V)
Correl. Vu and
Vunc


Settings for density, current, and potential reconstruction
Settings for density, current and potential reconstruction
SAVE
CONTINUE WITHOUT SAVE
RECONSTRUCTION:
None
Manual
Current
None
Density
None
smooth over
Temp
Set manually
smooth over
Fit coefs (power or Maxw) in uA/m2 and V: a0
b0
a1
b1
a2
b2


Selection of output files, paths and time resolution
Selection of output files, paths and time resolution
SAVE
CONTINUE WITHOUT SAVE
FILES: Output
Table to file
with plots
Enabled
except
None
Use last paths
Yes
Resol.
Spin
Spin data processing:
Mean only
Save variables
No


General plot settings
General plot settings
SAVE
CONTINUE WITHOUT SAVE
Probe select for plots
1
2
3
4
5
6
PLOT: Fit-examples
No
Espinplane
Both comp.
Eaxial
Etotal
Yes
Iasp in VcVu
E/w Iasp
E-Field
Residual
Color f. rect CMD
None
and EV
Spin Phase
Exy Coords
SIP
Reconst Ei fm DCE
Emap
none
0.5mV/m
PLOT STYLE: Phase
No plots
with
Symbols
Spin
Auto
Symbols
Big
Plot V-E-corr
Plot pairs
Slow plots:
All
Scales: Repeated
Vo[V]
V[V]
dV[V]
E[mV/m]
Char size
Plot size
Fixed
Correl. V-V in fixed scales
and
LogLin
Scale min of Vu [V]
n I T scales
Log
Rounded
Flux as
DEF
XYZ Maps and ExB(t)
Vmax in Emap (0=auto)
I-V FIT RESULTS: Add lines:
linear
quad
Naka
Naka-fit
Cully
And45
And67
And17
N/A
N/A

1.3 Interaction between programs

Three programs working in the Windows environment analyse spin average data, define parameters for the reconstruction of plasma densities, and produce tables of the reconstructed values.

1.3.1 corrVandFlux

- Reads spin average data from a single spacecraft (mms*_out_edppeandiv.dat), orbit data, solar aspect angle data, and solar indices
- Calculates reconstruction parameters for a single magnetospheric region or for all regions together, and outputs files of these parameters. Available regions are: magnetosphere, magnetosheath, solar wind. Parameters are different for ASPOC OFF and ASPOC ON (nominal current). Therefore there are 6 parameter files in total.
- Produces plots with data from a single region or all regions together.
- Plots solar correlations.
- Calculates reconstructed densities.
- Uses a special temperature law for the combination of ASPOC ON, inside magnetosphere.
- Uses correction terms for the spacecraft potential in dependence of electric field, ion velocity, F10.7 cm flux, ion Mach number.
- Outputs parameter files to be used by corrVandFluxPredef.
- Outputs reconstructed density files for a single region and a single ASPOC state in a format compatible with outputs of multiple regions produced by corrVandFluxPredef.

1.3.2 corrVandFluxPredef

- This program serves to use the six parameter files produced by corrVandFlux to produce a single file with reconstructed densities covering all regions.
- Reads spin average data from a single spacecraft (mms*_out_edppeandiv.dat), orbit data, and solar indices
- No filtering of input data except for time
- Results near the region boundaries are interpolated in order to get smooth transitions
- Outputs reconstructed density files for all regions and ASPOC states together in a format compatible with outputs of single regions produced by corrVandFlux.

1.3.3 corrVandFluxRec

- Reads a reconstructed density file, orbit data, and solar data.
- Plots solar correlations.
- Plots correlations between measured and reconstructed data.

1.4 Processing options

Processing options include the following

- Plots or tables of data over time
- Plots of MMS data in the equatorial plane
- Correlation of MMS data with solar activity indices
- Correlation between spacecraft potential and plasma density
- Correlation between spacecraft potential and currents from plasma and ASPOC
- Correlation between spacecraft potential and electric field
- Correlation between electron and ion density
- Histograms of spacecraft potential and density
- Calculation of photocurve from dual spacecraft potential data in multiple function options
- Calculation of photocurve from spacecraft potential and plasma electron data in multiple function options
- Reconstruction of uncontrolled spacecraft potential based on the above fitting methods
- Reconstruction of plasma density based on the above fitting methods
- Reconstruction of plasma current based on the above fitting methods
- Plots of plasma current over spacecraft potential, plasma temperature, electron velocity, ion velocity, and ion Mach number
- Plots of particle density over spacecraft potential, electron velocity, and ion velocity
- Plots of reconstructed over measured particle density
- Plots of reconstructed over measured plasma current
- Plots of spacecraft potential over electron velocity, ion velocity, temperature, and ion Mach number
- Plots of electron velocity, ion velocity, and ion Mach number over temperature

1.5 Output

- Plots in PNG or Postscript format
- ASCII tables of input data together with reconstructed plasma data from the selected orbital regions.
- ASCII files of the parameters used for the reconstruction in the selected orbital region

2 System Requirements

Source codes are compatible with IDL 8.7 or higher.
The program works best in a Windows environment.

3 Installation

3.1 Contents of distribution

The distribution comes as a zip file corrVandFlux.zip containing three directories.

doc	documentation including this document and the EDP data products guide
data	files with spin average data, orbit data, solar aspect angle of the spacecraft, and solar activity
source	IDL source code

3.2 Directories

Input data (spin average MMS data, orbit data, solar aspect (tilt) angle of the spacecraft, and solar activity) should be located in the same directory.

If the option to generate an output file with reconstructed density data is selected, the user will be prompted for the output directory and file name.

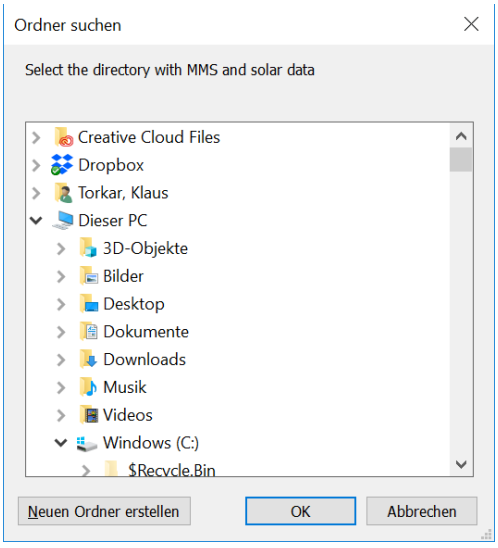
3.3 Step-by-step installation procedure

- Unpack the zip file
- Move the files in the directory "source" to the appropriate path of the IDL distribution for subsequent compilation and execution.
- Move the files in the directory "data" to the final location.

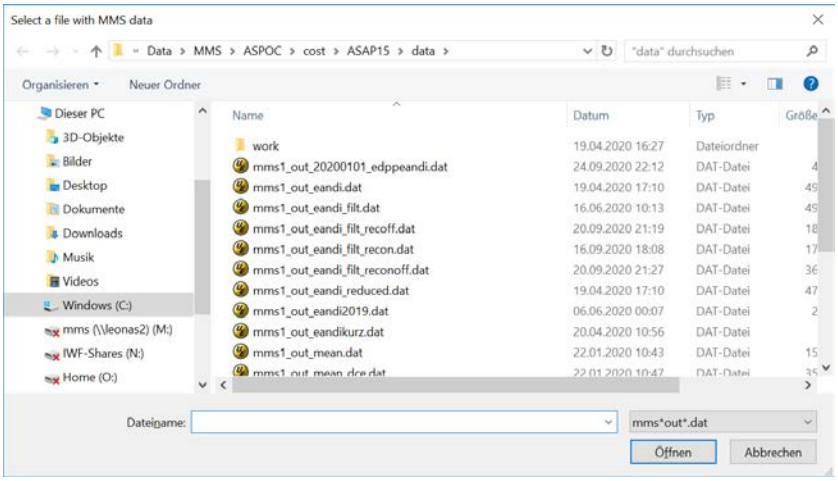
Compile the sources and execute them, or load the sources into the IDL development environment and execute them.

3.4 Program usage

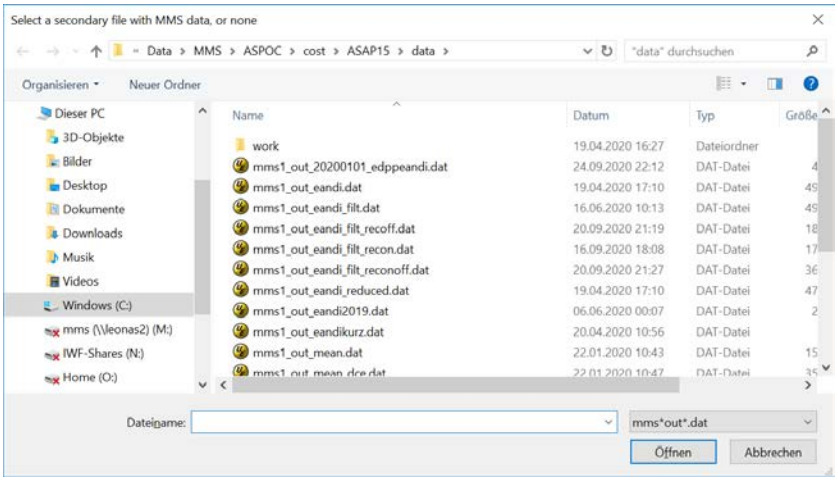
- At the beginning the following window entitled "Select the directory with MMS and solar data" will appear for the input of a directory which contains all input data:



- Thereafter the user shall select the primary MMS data file for analysis. The following window entitled "Select the file with MMS data" will appear. This file is mandatory. Three versions of spin average data files can be selected: Files with Fast Survey mode data only, files with Slow Survey mode data only, and files with merged Fast and Slow Survey mode data. The files follow the nomenclature mms*_out_<fastslow>edppeandiv<mergeID>.dat. "eandi" stands for the fact that the contain both electron and ion data. Examples:
mms1_out_fastedppeandiv.dat : MMS1 Fast Survey data
mms2_out_slowedppeaniv.dat: MMS2 Slow Survey data
mms3_out_edppeandivfands: MMS3 Fast and Slow Survey merged data

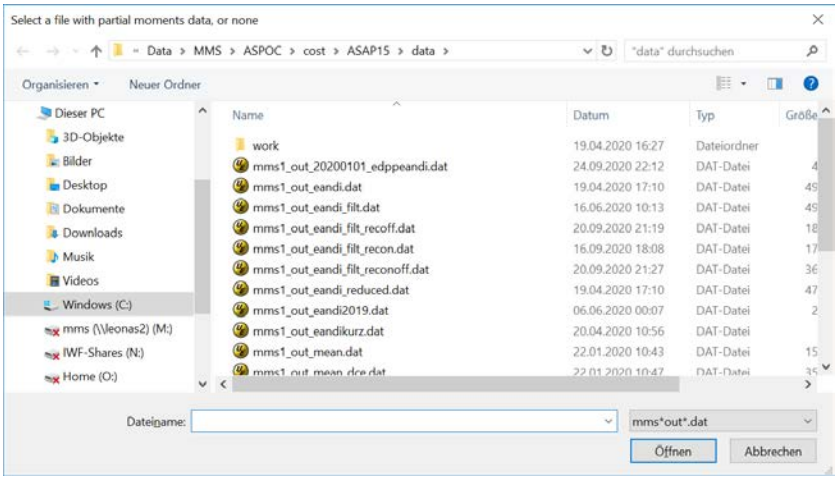


- Thereafter the following window entitled "Select a secondary file with MMS data or none" will appear:



Here the user may select a MMS data file of a different spacecraft in order to perform comparisons between controlled and uncontrolled potentials. If such a comparison is not requested, pressing "Cancel" ("Abbrechen") leads immediately to the next window.

- Thereafter the user may select a file with partial moments data for additional analyses in the following window entitled "Select a file with partial moments data or none". These files are optionally produced by mmsedpana when partial moments analysis is enabled.



If a partial moments file is selected, all analyses involving FPI plasma data will be based on partial moments with a selectable lower energy limit.

- Thereafter the main control panel shown below will appear. For further instructions refer to section 5.

4 Output Data

4.1 Plots

By default the program outputs plots to the display. By selecting "Plots to XXX files" in the drop list for output files the user may generate plot files containing the same graphics as on the display. By default, the program proposes a file name consisting of the name of the main input file appended by an underscore and a code given in section 4.1.1. The format of the plot files is PNG or Postscript. The user may change the file name.

4.1.1 Plot file types and file names

Code	Content
corr	spacecraft potential versus solar index
corri	plasma current versus solar index
corrn	spacecraft potential versus solar index, normalized
curr	plasma current over time
dens	particle density over time
djde	dj/dE vs E
dvde	d(Vsc)/d(E) over time
efld	total electric field over time
etvsca	spacecraft potential versus total electric field
evsc	total electric field versus spacecraft potential
f107	Penticton radio flux over time
fivsc	modified plasma current versus spacecraft potential
iasp	reconstructed ASPOC current versus spacecraft potential
imrec	reconstructed over measured plasma current, in single data point format
imrecb	reconstructed over measured plasma current, in histogram format
ioverm	plasma current over ion Mach number
iovert	plasma current over plasma temperature
ioverve	plasma current over electron velocity
ioververvi	plasma current over ion velocity
ivsc	plasma current versus spacecraft potential, in single data point format
ivscb	plasma current versus spacecraft potential, in histogram format
movert	ion Mach number over temperature
neni	electron versus ion density
nhist	histogram of plasma density
nmrec	reconstructed over measured particle density, in single data point format
nmrecb	reconstructed over measured particle density, in histogram format
novert	particle density over temperature
noverve	particle density over electron velocity
novervi	particle density over ion velocity
nvsc	particle density versus spacecraft potential, in single data point format
nvscb	particle density versus spacecraft potential, in histogram format
pnrvsc	partial particle density versus residual spacecraft potential
pnvsc	partial particle density versus spacecraft potential
pos	orbit map
regr	regression coefficient of potential with partial particle density
see	solar irradiance over time
seef	solar flux index, filtered
spect	particle spectrogram
spot	American sunspot number over time

Code	Content
sw	solar wind over time
tvsc	temperature versus spacecraft potential
veovert	electron velocity over temperature
vhist	histogram of spacecraft potential
viovert	ion velocity over temperature
vsc	spacecraft potential over time
vscoverm	spacecraft potential over ion Mach number
vscovert	spacecraft potential over temperature
vscoverve	spacecraft potential over electron velocity
vscovervi	spacecraft potential over ion velocity
vuvc	uncontrolled versus controlled spacecraft potential

4.2 Tables

By selecting "Plots to screen and data to file" or "Plots to screen and all data with filtered ASPOC to file" in the drop list for output files the user may generate an ASCII file containing time series of:
spacecraft potential (input)
total electric field (input)
electron density (input)
electron temperature (input)
electron current (input)
ASPOC current minus EDI current (input)
sum of electron and ASPOC current as result of the fitting
density reconstructed from spacecraft potential and measured temperature
density reconstructed from spacecraft potential and assumed temperature of 10 eV
density reconstructed from spacecraft potential and assumed temperature of 100 eV
density reconstructed from spacecraft potential and assumed temperature of 1000 eV
ion velocity (input)
ion Mach number (input)
region ID (0=any, 1=magnetosphere, 2=solar wind, 3=magnetosheath)
ID for parameter set used
ID for interpolation between regions (0=no, 1=yes)
ID showing that interpolated values are replaced by values derived from measured densities

In the distribution these output files have names in the nomenclature mms<N>_rec_*.dat. Depending on the selection of orbit regions, these files contain data from within these regions only. Such files can be used later to plot reconstructed parameters from the given orbit region by the program corrVandFluxRec. In addition, a parameter file (see 4.3) can be generated Some lines of one of these files are reproduced below.

```
Source: mms1_out_edppeandiv.
Data include velocities
Analysing electrons
Limits (from/to):
2015-11-01T00:00:00/2016-11-01T00:00:00
E-field: 0.00/10.00
S/C potential: 2.0/50.0
EI. Density: 0.080/1000.000
EI. Temp.: 5.0/10000.0
EI. Current: 0.100/1000.000
ASPOC current: -1.00/1.00
LyA: 0.0000/0.0098
```

```
Orbit radius: 10.00/30.00
Orbit phase (Sun=0): 0/360
|ne-ni|<999.0 OR ne/ni<2.00
In Magnetosphere
Transition width:    2.5
T-exponent:    -0.25
applies for T<    50.0
and exp:     0.00
for higher T up to:      0.0
E-field correction term for Vsc:     0.00
v(ion) correction term for Vsc:     0.00
Fudge factor for maxcurrent:     1.00
Fudge factor for Iplasma:     1.00
Use set low-E-Maxw for Maxw-fit: No
coefs:j0:    31.90
V0:    1.610
Fit I vs V: Power i~V^x
or n vs V: No
#Terms: 1
Limits: Yes
Method: Simple
Error exp: 0
in: Y
Break V: Variable
Vbreak1e:      6.0
Vbreak2e:     14.0
T for n-fit: Variable
at 2V:     20.0
at 7V:     40.0
at 10.5V:     70.0
at 20V:    300.0
fixed:    150.0
jph=30.762*V^(-1.708)
T=10.000 :
n=213.832*V^(-1.708)
T=100.000 :
n=67.620*V^(-1.708)
T=1000.000 :
n=21.383*V^(-1.708)
END OF PARAMETERS
Time[UT]                    Vsc Etotamp El.Dens El.Temp El.Curr ASP-EDI Ie+afit neTmeas neT0010 neT0100 neT1000    Vion MachIon      IDs
Time[UT]                    [V]  [mV/m] [cm^-3]    [eV]    [uA]    [uA]    [uA] [cm^-3] [cm^-3] [cm^-3] [cm^-3] [km/s]      [I] R P I F
2015-10-12T10:30:41.991  10.908   3.487  31.264   50.45  63.113   0.000  28.249  14.818  33.283  10.525   3.328  190.01    0.81 1 0 0 0
2015-10-12T10:31:01.335  11.197   3.849  31.357   49.32  62.662   0.000  28.330  15.030  33.378  10.555   3.338  188.12    0.82 1 0 0 0
2015-10-12T10:31:20.679   9.671   4.261  31.491   51.35  64.035   0.000  28.776  14.961  33.904  10.721   3.390  187.90    0.82 1 0 0 0
```

4.3 Parameter data files

Different orbital regions and ASPOC states require different sets of parameters for density reconstruction. Parameters for a single region and ASPOC state are calculated by corrVandFlux. These parameters are written into small data files, which are then used to produce a combined file of reconstructed data valid for all regions and ASPOC states. The header of the data file reproduced in the previous section represents an example for such a parameter data file. For the program corrVandFluxPredef to work properly, corrVandFlux must produce exactly 6 parameter files in the nomenclature:
mms*_para_<ASPOCstate>_<regionID>_<startdate>_<enddate>.txt
with
ASPOCstate = "on_" or "off"

regionID = "msphere", "solarwd", or "msheath"

An example of such a parameter file is reproduced below.

```
     1 ; spacecraft number
  2015 ; start year
    11 ; start month
     1 ; start daty
     0 ; start hour
  2021 ; end year
    11 ; end month
     1 ; end daty
     0 ; end hour
 19.00 ; ASPOC min current
 21.00 ; ASPOC max current
 10.00 ; min orbit radius
 30.00 ; max orbit radius
  0.00 ; min orbit phase
360.00 ; max orbit phase
     0 ; anyinoutbound
     1 ; region selector
  2.50 ; region transition width at Y=0
  7.00 ; region transition width at Y=20
 12.50 ; xgsedist (parabola of central magnetosheath)
 20.00 ; pygsedist (parabola of central magnetosheath for +Y)
 18.00 ; nygsedist (parabola of central magnetosheath for -Y)
     0 ; as j use th | th+ve | th+vi | SQRT(th^2+ve^2) | SQRT(th^2+vi^2)
     0 ; as v use Total | SpinPlane | Axial | X-GSE | Y-GSE | Z-GSE
  1.00 ; with v times
 0.000 ; E-field correction term for Vsc
0.0000 ; ion velocity correction term for Vsc
0.0000 ; Sun correction term for Vsc
0.0000 ; ion Mach number correction term for Vsc
     0 ; solar parameter ID
  5.90 ; sunlit area
 10.03 ; surface area
     2 ; powerrmsi
     1 ; ntermsrms
     2 ; vsccorrwith
 10.00 ; assumed temperature 1
100.00 ; assumed temperature 2
1000.00 ; assumed temperature 3
 -0.25 ; n&I-T-exponent
 50.00 ; applies for T<
  0.00 ; and exp:
  0.00 ; for higher T up to:
 50.00 ; enhance n&I at T<
  0.00 ; by
  0.00 ; Min T for I-calc
  0.00 ; lg(T)lo
  0.00 ; lg(T)hi
300.00 ; Tthresh
     0 ; Use set low E-Maxw ID
 31.90 ; coefs:jph0
 1.610 ; V0
     1 ; T for n-fit ID
 20.00 ; at 2V
 40.00 ; 7V
```

```
     70.00 ; 10.5V
    300.00 ; 20V
    150.00 ; fix:
         0 ; method ID
      1.00 ; fudge factor for maxcurrent
      1.00 ; fudge factor for Iplasma
           ; Currents
Power      ; law
    46.936 ; jph0
    -1.873 ; exponent of V
           ; Densities for fixed temperatures
     10.00 ; Temperature for the following parameters
Power      ; law
    55.300 ; n0
    -1.873 ; exponent of V
    100.00 ; Temperature for the following parameters
Power      ; law
    17.487 ; n0
    -1.873 ; exponent of V
   1000.00 ; Temperature for the following parameters
Power      ; law
     5.530 ; n0
    -1.873 ; exponent of V
```

5 Control Panel Items

The program checks for most possible inconsistencies between entries in the control panel. However, bad entries are not always checked and the program might crash in these cases, for example if letters are entered into a field that requires a number. Possible inputs in the main control panel are numerical values, selections in drop lists, and buttons.

5.1 Main Group

5.1.1 Line 1

Type: Button
Label: EXECUTE WITH CURRENT DATA
Description: Runs the program with the current selection of input files.

Type: Button
Label: LOAD NEW DATA
Description: Allows the user to select new input files, but by default from the same directory as at the start of the program. All other values in the control panel are kept.

Type: Button
Label: REFRESH PANEL
Description: Refreshes the main control panel. Thereby the energy ranges in the drop list for partial moments and the spacecraft names are updated.

Type: Button
Label: END PROGRAM
Description: This button ends the program execution.

Labels at the right of the buttons indicate the primary input file and the selected spacecraft.

5.1.2 Line 2

Type: Drop list
Label: Output
Variable: makeoutput
Description: Defines output options for tables and plots
Selection:

Plots to screen only
: Plots to screen only, no output in files

Plots to screen and data to file
: Plots to screen, output of tabulated data including reconstructed densities (see section 4.2). The output file contains the filtered time and orbit intervals only.

Plots to screen and all data with filtered ASPOC to file
: Plots to screen, output of tabulated data including reconstructed densities (see section 4.2). The output file contains all time stamps of the input file for which filtered ASPOC status is valid.

Plots to screen and PNG files
: Plots to screen, and output of plot files in PNG format

Plots to PNG files
: No plots to screen, output of plot files in PNG format

Plots to PS files
: No plots to screen, output of plot files in Postscript format.

Type: Drop list
Label: **Process**
Variable: withfpi
Description: Defines whether all input data input are processed or only those records which contain valid FPI data.
Selection:
all data All records in the input file are processed
density data
Input records without valid FPI data are ignored

Type: Drop list
Label: **Solar wind filter**
Variable: swid
Description: This entry uses a beta version of a filter for solar wind conditions. It uses the conditions in the data file "mms1_20150901_0000_0000_dis_8_24_6_all.dat" which contains a status variable with 4 possibilities: inside solar wind, outside solar wind, undetermined, no data available. By default the user should enter "Any". Note that this data file has not been updated and should not be used when analysing data after 30 August 2021.
Selection:
Definitely outside
Filter for times being definitely outside solar wind
Outside or no data
Filter for times without available data or being outside solar wind
Definitely inside
Filter for times being definitely inside solar wind
Inside or no data
Filter for times without available data or being inside solar wind
Any
Solar wind filter is not applied

Type: Drop list
Label: **Dump data**
Variable: dodump
Description: Allows to print test data in the IDL development environment.
Selection:
No No output of test data
Yes Output of test data

Type: Drop list
Label: **Hide fits**
Variable: suppress
Description: Allows to print test data in the IDL development environment.
Selection:
No Fitted lines are shown in all plots
Yes Only data points, but no fitted lines are shown in the plots

---

Type: Drop list
Label: **Plot style**
Variable: plotstyle
Description: Defines the style of plots.
Plot style, size, and character size are interconnected as follows:
Standard plot style, fixed plot size: By choosing a larger character size than 1.5, the text is larger but may spill outside the plot window.
Standard plot style, variable plot size: By choosing a larger character size than 1.5, the plot size is automatically increased if the character size exceeds 1.5.
Publication plot style: character size is set to 2.5 and the plot size is increased accordingly
Selection:
Std Plots are produced in their standard format for working purposes
Pub Plots are produced in a format suitable for publication

Type: Drop list
Label: **OR size**
Variable: dovariableplotsize
Description: Defines the size of plot windows, typically 800*600 pixels.
Selection:
Fixed Plots are produced in fixed size, without taking into account the size of the characters.
Variable Plots are produced in variable size depending on the size of the characters.

Type: Number
Label: **Char size**
Variable: cs
Description: Defines the size of the characters in the plots. The standard value is 1.5.

5.1.3 Line 3

This line the user shall input the time range of the analyses. Note that the time range of the input data provided in the distribution is from 2015-09-01 to 2023-05-31.

Type: Number
Label: **Start time: year**
Variable: yrmin
Description: Year of the start of the time interval.

Type: Number
Label: **month**
Variable: momin
Description: Month of the start of the time interval (1 ... 12).

Type: Number
Label: **day**
Variable: damin
Description: Day of the start of the time interval (1 ... 31).

Type: Number
Label: **hour**
Variable: hrmin
Description: Hour of the start of the time interval (0 ... 23).

Type: Number
Label: **minute**
Variable: mimin
Description: Minute of the start of the time interval (0 ... 59).

Type: Number
Label: **second**
Variable: semin
Description: Second of the start of the time interval (0 ... 59).

Type: Number
Label: **End time : year**
Variable: yrmax
Description: Year of the end of the time interval.

Type: Number
Label: **month**
Variable: momax
Description: Month of the end of the time interval (1 ... 12).

Type: Number
Label: **day**
Variable: damax
Description: Day of the end of the time interval (1 ... 31).

Type: Number
Label: **hour**
Variable: hrmax
Description: Hour of the end of the time interval (0 ... 23).

Type: Number
Label: **minute**
Variable: mimax
Description: Minute of the end of the time interval (0 ... 59).

Type: Number
Label: **second**
Variable: semax
Description: Second of the end of the time interval (0 ... 59).

5.1.4 Line 4

Type: Drop list
Label: Solar Data
Variable: sunselect
Description: Defines the solar activity parameter for correlations. Note that solar activity data are available in the period 2015-09-01 to 2023-06-30.
Selection:
- SEE — TIMED SEE L3A data of solar irradiance from https://cdaweb.gsfc.nasa.gov/cgi-bin/eval2.cgi?dataset=TIMED_L3A_SEE&index=sp_phys
- F10.7 — Penticton Solar Radio Flux at 10.7 cm from https://lasp.colorado.edu/lisird/data/penticton_radio_flux/
- Sunspots — American Relative Sunspot Number from https://lasp.colorado.edu/lisird/data/american_relative_sunspot_number_daily/

Type: Drop list
Label: Analyse
Variable: species
Description: Selects the particle species to be analysed.
Selection:
- Electrons — Electron moments measured by FPI/DES
- Ions — Ion moments measured by FPI/DIS

Type: Drop list
Label: above eV
Variable: fpimomsfrom
Description: Determines the energy level in FPI data for partial moments calculations. The selected energy is the lower boundary for the integration of flux over energy. This entry is only valid if partial moments data are selected. Note that the energy levels are default ones. The actual levels in the selected data may differ. This selection is only valid if a file with partial moments has been read, see section 3.4.
Selection:
- all — All energy levels are used
- energy value — Selected lowest bin of the energy

Type: Drop list
Label: Plot: Solar correl.
Variable: plotsun
Description: Allows to plot correlations between various quantities and the selected solar index.
Selection:
- No — No plot
- Yes — Plots correlations between various quantities and the selected solar index

---

Type: Drop list
Label: **Vsc vs E**
Variable: plotve
Description: Allows to plot the correlation between spacecraft potential and electric field.
Selection:
No No plot
Yes Plots the correlation between spacecraft potential and electric field

---

Type: Drop list
Label: **Time series**
Variable: plottime
Description: Allows to plot time series of various quantities.
Selection:
No No plot
Yes Plots time series of various quantities

Type: Drop list
Label: **Corr: E-I**
Variable: plotncorr
Description: Allows to plot the correlation between electron and ion density.
Selection:
No No plot
Yes Plots the correlation between electron and ion density

Type: Drop list
Label: **nTIv**
Variable: donovertplot
Description: Allows to plot the dependence of current and density on various parameters.
Selection:
No No such plots
Yes Plots current over temperature, current over electron velocity, current over ion velocity, current over ion Mach number, density over temperature, density over electron velocity, density over ion velocity, electron velocity over temperature, ion velocity over temperature.

Type: Drop list
Label: **Vsc-Tv**
Variable: dovscovervtplot
Description: Allows to plot the dependence of spacecraft potential on various parameters.
Selection:
No No such plots
Yes Plots spacecraft potential over electron velocity, ion velocity, temperature, and ion Mach number.

Type: Drop list
Label: **Detrend**
Variable: dodetrend
Description: If set, a trend of log(current) with potential is subtracted from the current, and the result is set to 1 at the mean potential.
Selection:
No No detrend
Yes A detrend as described above is done.

Type: Drop list
Label: **meas-rec-corr w/T**
Variable: domeasreccorr
Description: Defines whether the correlation between measured and reconstructed density for a given temperature is plotted
Selection:
No No such plots
Yes Measurement-Reconstruction correlation is plotted.

5.1.5 Line 5

In this line the limits of various solar activity parameters can be set, which are used for filtering the input data. In addition, the limits for the tilt angle of the spacecraft axis to the sun can be set.

Type: Number
Label: **Solar activity: Irradiance>**
Variable: seemin
Description: Sets the lower limit of SEE in [W/m^2/nm].

Type: Number
Label: **<**
Variable: seemax
Description: Sets the upper limit of SEE in [W/m^2/nm].

Type: Number
Label: **F10.7 cm Flux>**
Variable: f107min
Description: Sets the lower limit of F10.7 cm flux in [Jy].

Type: Number
Label: **<**
Variable: f107max
Description: Sets the upper limit of F10.7 cm flux in [Jy].

Type: Number
Label: **Sunspots>**
Variable: sunspotmin
Description: Sets the lower limit of the sunspot number.

Type: Number
Label: **<**
Variable: sunspotmax
Description: Sets the upper limit of the sunspot number.

Type: Number
Label: **Tilt(deg)>**
Variable: tiltmin
Description: Sets the lower limit of the tilt angle.

Type: Number
Label: **<**
Variable: tiltmax
Description: Sets the upper limit of the tilt angle.

5.1.6 Line 6

In this line several parameters related to orbit filtering and plotting are defined

Type: Number
Label: **Orbit: R>**
Variable: orbitrmin
Description: Sets the lower limit of the radial distance from the Earth in Earth radii, which is used for filtering the input data.

Type: Number
Label: **<**
Variable: orbitrmax
Description: Sets the upper limit of the radial distance from the Earth in Earth radii, which is used for filtering the input data.

Type: Number
Label: **Phase(Sun=0)>**
Variable: orbitphasemin
Description: Sets the lower limit of the angular location in the GSE XY plane in degrees. Zero points to the Sun, the angle is defined in anticlockwise direction. For example, to select data from within 10° form the Sun enter 350° in this field and 10° in the field to the right.

Type: Number
Label: **<**
Variable: orbitphasemax
Description: Sets the upper limit of the angular location in the GSE XY plane.

Type: Drop list
Label:
Variable: anyinoutbound
Description: Selects the inbound, outbound, or both legs of the orbit.
Selection:

In- & Outbound
: All parts of the orbit

Inbound only
: Select only the inbound part of the orbit

Outbound only
: Select only the outbound part of the orbit

Type: Drop list
Label: Orbit map
Variable: colorposfrom
Description: Selects the parameter for the colour scale in the orbit map.
Selection:

None
: No orbit map is plotted

E-field-total
: Parameter is the total electric field

SC-Potential
: Parameter is the spacecraft potential

Density
: Parameter is the density of the species selected above

Temperature
: Parameter is the temperature of the species selected above

Current
: Parameter is the current of the species selected above

ASPOC Current
: Parameter is the ASPOC current

Modified Current
: Parameter is the current of the species selected above in a modified calculation method

El. Velocity
: Parameter is the electron velocity

Ion Velocity
: Parameter is the ion velocity

Debye Length
: Parameter is the Debye length

Ion Mach Number
: Parameter is the ion Mach number

Rel Ve Error
: Parameter is the relative error of the electron velocity in the input data. Not available in the current version of the input files.

Rel Vi Error
: Parameter is the relative error of the ion velocity in the input data. Not available in the current version of the input files.

Type: Drop list
Label: **Scale**
Variable: posscaleislimits
Description: Selects the range of the colour scale in the orbit map.
Selection:
Data The range of the colour scale is defined by the input data, additionally limited to the range given in group 5.2.
Limits The range of the colour scale is defined by the limits specified in the control panel

---

Type: Drop list
Label: **Resol.**
Variable: posbini
Description: Selects the spatial resolution of the orbit map.
Selection:
0.1Re One pixel is 0.1 x 0.1 Earth radii
0.2Re One pixel is 0.2 x 0.2 Earth radii
0.5Re One pixel is 0.5 x 0.5 Earth radii
1Re One pixel is 1 x 1 Earth radii
2Re One pixel is 2 x 2 Earth radii
4Re One pixel is 4 x 4 Earth radii

Type: Number
Label: **Central Msheath@X&+Y&-YGSE**
Variable: xgsedist
Description: Sets the X(GSE) value of the nominal parabola defining the central magnetosheath position in the GSE XY plane, for Y(GSE)=0.

Type: Number
Label:
Variable: pygsedist
Description: Sets the positive Y(GSE) value of the nominal parabola defining the central magnetosheath position in the GSE XY plane, for X(GSE)=0.

Type: Number
Label:
Variable: nygsedist
Description: Sets the nagative Y(GSE) value of the nominal parabola defining the central magnetosheath position in the GSE XY plane, for X(GSE)=0.

Type: Drop list
Label: **Region**
Variable: regionselect
Description: Selects the region in space for which the input data are filtered.
Selection:

All	All regions are selected (no filtering)
Msph	Regions inside the magnetosphere are selected. For the definition of boundaries see label "Width@Y=0&Y=20".
Wind	Regions in solar wind are selected. For the definition of boundaries see label "Width@Y=0&Y=20".
Sheath	Regions inside the magnetosheath are selected. For the definition of boundaries see label "Width@Y=0&Y=20".

Type: Number
Label: **Width@Y=0&Y=20**
Variable: regiontrans0
Description: This is the width of the transition range (+/-) around the nominal central magnetosheath position at Y(GSE)=0.

Type: Number
Label:
Variable: regiontrans20
Description: This is the width of the transition range (+/-) around the nominal central magnetosheath position at Y(GSE)=20 Earth radii.

5.1.7 Line 7

Type: Drop list
Label: Color label is
Variable: colorfrom
Description: Selects the parameter for the colour scale in the correlation plots.
Selection:

- None — No colour scale is applied
- E-field-total — Parameter is the total electric field
- SC-Potential — Parameter is the spacecraft potential
- Density — Parameter is the density of the species selected above
- Temperature — Parameter is the temperature of the species selected above
- Current — Parameter is the current of the species selected above
- ASPOC Current — Parameter is the ASPOC current
- Modified Current — Parameter is the current of the species selected above in a modified calculation method
- Radius — Parameter is the Earth distance
- XY GSE Angle — Parameter is the angle in the GSE XY plane
- Rel. Time — Parameter is the time
- Solar Index — Parameter is the previously selected solar activity index
- El. Velocity — Parameter is the electron velocity
- Ion Velocity — Parameter is the ion velocity
- Debye Length — Parameter is the Debye length
- Ion Mach Number — Parameter is the ion Mach number
- Rel Ve Error — Parameter is the relative error of the electron velocity in the input data. Not available in the current version of the input files.
- Rel Vi Error — Parameter is the relative error of the ion velocity in the input data. Not available in the current version of the input files.

Type: Drop list
Label: Colour is occurrence
Variable: doocc
Description: Defines the colour of the individual bins in the alternative plots of density or current over spacecraft potential (extensions _ivscb and _nvscb).
Selection:

- No — The bins are coloured according to the selected colour label above.
- Yes — The bins are coloured according to the occurrence of the data.

Type: Drop list
Label: Label time plots
Variable: dotimecolor
Description: Selects the style of time series plots.
Selection:
No Time series plot style is full lines in a single colour.
Yes Time series are plotted with symbols in the colour according to the previously selected parameter.

Type: Number
Label: #labels in n-V-plots
Variable: ntimelabels
Description: Defines the maximum number of labels attached to data points in the density over potential plots. The maximum number is 100. Note that the parameter range within the labels is defined in the fields at the right.

Type: Number
Label: in V
Variable: labelvscmin
Description: Defines the minimum spacecraft potential in the density-potential plots which is labelled.

Type: Number
Label:
Variable: labelvscmax
Description: Defines the maximum spacecraft potential in the density-potential plots which is labelled.

Type: Number
Label: and n
Variable: labeldensmin
Description: Defines the minimum particle density in the density-potential plots which is labelled.

Type: Number
Label:
Variable: labeldensmax
Description: Defines the maximum particle density in the density-potential plots which is labelled.

Type: Drop list
Label: Scale ranges
Variable: dofixscales
Description: Selects the scale range style in all plots except the orbit plots.
Selection:
Data The scale range is defined by the input data
Limits The scale range is defined by the limits specified in the control panel

---

Type: Drop list
Label: 2nd param f. solar correl.
Variable: secondvar
Description: Defines whether an additional dimension shown as coloured symbols is applied in correlations with solar activity.
Selection:
- None — No second variable is used
- E-field-total — Second variable is the total electric field
- SC-Potential — Second variable is the spacecraft potential
- Density — Second variable is the density of the species selected above
- Temperature — Second variable is the temperature of the species selected above
- Current — Second variable is the current of the species selected above
- ASPOC Current — Second variable is the ASPOC current
- Modified Current — Second variable is the current of the species selected above in a modified calculation method
- Radius — Second variable is the Earth distance
- XY GSE Angle — Second variable is the angle in the GSE XY plane

5.1.8 Line 8

Type: Drop list
Label: Correlate Vsc with
Variable: vsccorrwith
Description: Defines whether an additional dimension shown as coloured symbols is applied in correlations with solar activity.
Selection:
- None — No correlation of any parameter is performed with spacecraft potential
- Density — Spacecraft potential is correlated with particle density
- Density and current — Spacecraft potential is correlated with particle density and current
- Density and current and modified current — Spacecraft potential is correlated with particle density, current, and a current calculated in a modified way
- Temperature — Spacecraft potential is correlated with temperature of selected species
- Electric field — Spacecraft potential is correlated with the total electric field
- Uncontr. Vsc at ASPOC ONOFF or from 2 SC — If data of only a single spacecraft are available, then a correlation between controlled and uncontrolled potentials around times when ASPOC turned on or off is performed. If data of two spacecraft are available, then the potential of the primary spacecraft is assumed to be the controlled one and the other potential the uncontrolled one, and a correlation between controlled and uncontrolled potential is performed.

Type: Drop list
Label: **As j Use**
Variable: tempwithvel
Description: Defines whether the current in the input file is replaced by a combination of thermal current and current from bulk flow.
Selection:

j(th)	No change from the input values. The current used in the calculations is the thermal current of the input file.
j(th)+j(ve)	The current used in the calculations is the sum of the thermal current of the input file and the electron current of derived from the bulk flow.
j(th)+j(vi)	The current used in the calculations is the sum of the thermal current of the input file and the ion current of derived from the bulk flow.
SQRT(j(th)^2+j(ve)^2)	The current used in the calculations is the geometric sum of the thermal current of the input file and the electron current of derived from the bulk flow.
SQRT(j(th)^2+j(vi)^2)	The current used in the calculations is the geometric sum of the thermal current of the input file and the ion current of derived from the bulk flow.

Type: Drop list
Label: **As v Use**
Variable: velocomp
Description: Defines which components of the bulk velocity are used for the calculations.
Selection:

Total	The total velocity is used.
SpinPlane	The total velocity components in the spin plane are used.
Axial	The total velocity component in axial direction is used.
X-GSE	The total velocity component in X(GSE) direction is used.
Y-GSE	The total velocity component in Y(GSE) direction is used.
Z-GSE	The total velocity component in Z(GSE) direction is used.

Type: Number
Label: **with v times**
Variable: tempwithvelfudge
Description: Sets an arbitrary factor by which the bulk velocity is multiplied to obtain the current.

Type: Number
Label: **ASPOC step analysis: time window(s)**
Variable: tawindow
Description: This entry specifies the time window used in the comparison between controlled and uncontrolled potentials around a turn-on or turn-off of ASPOC. The program will look for all pairs of data which are tawindow seconds apart. There will be several pairs for any single on/off. The program will determine the significant differences.

Type: Number
Label: **I-window**
Variable: iawindow
Description: This entry specifies the minimum change of ASPOC current (in µA) that characterizes a turn-on or turn-off.

Type: Number
Label: **Max gap**
Variable: maxgap
Description: This entry specifies the maximum allowed size of a data gap (i nunits of spin periods) around an apparent turn-on or turn-off of ASPOC to be considered in the analysis.

5.1.9 Line 9

Type: Number
Label: **n &I-T-exponent:**
Variable: novertexp2
Description: This is the exponent to temperature used to calculate plasma current under certain conditions, see below.

Type: Number
Label: **applies for T<**
Variable: noverttemp2
Description: This is temperature T2 (in eV) used to calculate plasma current under certain conditions, see above.

Type: Number
Label: **and exp:**
Variable: novertexp
Description: This is the exponent to temperature used to calculate plasma current under certain conditions, see above.

Type: Number
Label: **for higher T up to:**
Variable: noverttemp
Description: The particle current is calculated as being proportional to density times the square root of temperature for temperatures larger than set in this field.
If a value greater than 0 is specified, then the standard formula for calculating current (proportional to density times the square root of temperature) is not applied for a certain range of temperatures.
This field and the two fields at the right (labeled "T-exponent" and "for T<") work together. Temperatures are given in eV. Let us call this temperature T1 and the one at right T2.

Case T1>0 AND T1<T2:
Measured T<T2: Current is calculated by the fixed exponent and T1.
Measured T>T2: Current is taken from the input file where the standard formula has been used

Case T1>0 AND T1>T2:
Measured T<T2: Current is calculated by the fixed exponent and T1.
T1>Measured T>T2: Current calculated by the standard formula.
Measured T>T1: Current is taken from the input file where the standard formula has been used.

Case T1>0 AND T1=T2:
Measured T<T2: Current is calculated by the fixed exponent and T1.
Measured T>T2: Current is taken from the input file where the standard formula has been used.

Type: Number
Label: **Enhance n&I at T<**
Variable: plasmaenhanceT0
Description: Densities and currents below this temperature are modified by the factor plasmaenhanceT0^plasmaenhanceexp.

Type: Number
Label: **by**
Variable: plasmaenhanceexp
Description: Densities and currents below this temperature are modified by the factor plasmaenhanceT0^plasmaenhanceexp.

Type: Number
Label: **Min T for I-calc**
Variable: tempminforI
Description: This defines a minimum temperature used to calculate reconstructed densities.

Type: Drop list
Label: **FPI spectra**
Variable: dospectra
Description: Selects whether an energy-time spectrogram of electron or ion flux is plotted.
Selection:
No No plot
Yes Spectrogram is plotted

Type: Number
Label: **Max energy step**
Variable: maxestep
Description: Sets the maximum energy step of the FPI data which is plotted in the spectrogram. The input data contain 32 steps. This selection is relevant only if a partial moments file has been read.

Type: Drop list
Label: **Regres w/V**
Variable: dopartcorr
Description: Selects whether spacecraft potential shall also be correlated with partial particle density. This selection is relevant only if a partial moments file has been read.
Selection:
No No correlation
Yes Correlation is performed

5.1.10 Line 10

Type: Drop list
Label: **Manual correction of ivsc**
Variable: doivsccorr
Description: Selects the fitting function between current and spacecraft potential shall be corrected manually.
Selection:
No No manual correction
Yes Apply manual correction

Type: Number
Label: **# points**
Variable: ivsccorrn
Description: Specifies the number of valid data points in the polynomial for the manual correction of the current-spacecraft potential fit. Minimum number: 2, maximum number: 6

Type: Number
Label: **Vsc**
Variable: ivsccorrVsc
Description: Specifies up to 6 spacecraft potential values in the polynomial for the manual correction of the current-spacecraft potential fit.

Type: Number
Label: Factors
Variable: ivsccorrfac
Description: Specifies up to 6 correction factors in the polynomial for the manual correction of the current-spacecraft potential fit. Corrected current = Automatically fitted current / correction factor.

5.1.11 Line 11

Type: Drop list
Label: Histograms of
Variable: vschistsel2
Description: Defines the parameter used to plot histograms versus a second parameter.
Selection:

- None — No histogram of any parameter is plotted
- E-field-total — Histograms of total electric field versus a second parameter are plotted
- SC-Potential — Histograms of spacecraft potential versus a second parameter are plotted
- Density — Histograms of particle density versus a second parameter are plotted
- Temperature — Histograms of temperature versus a second parameter are plotted
- Current — Histograms of plasma current versus a second parameter are plotted
- ASPOC Current — Histograms of ASPOC current versus a second parameter are plotted
- Modified Current — Histograms of modified plasma current versus a second parameter are plotted
- Radius — Histograms of radial distance versus a second parameter are plotted
- XY GSE Angle — Histograms of the position angle in the GSE XY plane versus a second parameter are plotted
- Solar Index — Histograms of the solar index selected in line 4 versus a second parameter are plotted
- El. Velocity — Histograms of electron bulk velocity versus a second parameter are plotted
- Ion Velocity — Histograms of ion bulk velocity versus a second parameter are plotted
- Debye Length — Histograms of Debye length versus a second parameter are plotted
- Ion Mach Number — Histograms of ion Mach number versus a second parameter are plotted

Type: Drop list
Label: vs
Variable: vschistsel
Description: Defines the second parameter in the histograms.
Selection:
None No second parameter
E-field-total
Second parameter is total electric field
SC-Potential
Second parameter is spacecraft potential
Density Second parameter is particle density
Temperature
Second parameter is temperature
Current Second parameter is plasma current
ASPOC Current
Second parameter is ASPOC current
Modified Current
Second parameter is modified plasma current
Radius Second parameter is radial distance
XY GSE Angle
Second parameter is the position angle in the GSE XY plane
Solar Index
Second parameter is the solar index selected in line 4
El. Velocity
Second parameter is electron bulk velocity
Ion Velocity
Second parameter is ion bulk velocity
Debye Length
Second parameter is Debye length
Ion Mach Number
Second parameter is ion Mach number

Type: Number
Label: #bins
Variable: histnbins
Description: Specifies the number of bins in the histograms.

Type: Number
Label: #param steps
Variable: histnvstep
Description: Specifies the number of curves in the histograms.

Type: Number
Label: Scatterplots 1:x points
Variable: n100
Description: Scatterplots may become too crowded if all data of a long time period are plotted. In this field the user may specify that only a subset of points is plotted.

Type: Number
Label: **Symbol size**
Variable: symsi
Description: Specifies the symbol size in scatterplots.

Type: Number
Label: **#bins**
Variable: nscatbins
Description: Specifies the number of bins in alternative scatterplots, for example for density over spacecraft potential.

Type: Number
Label: **cutoff**
Variable: lowcutoff
Description: Specifies the minimum number of data points in each plotted bin in alternative scatterplots, for example for density over spacecraft potential. Bins with less data points are set emptynumber of bins in alternative scatterplots, for example for density over spacecraft potential.

Type: Number
Label: **#equal-weight bins**
Variable: nhistbins
Description: Specifies the number of bins of equal weight. This entry is valid only if in the drop list "Error exp" the value "hist" has been selected.

Type: Drop list
Label: **Omit data near NaN**
Variable: omitnearnan
Description: Selects whether data points in the time series which are adjacent to not available data (NaN) are omitted
Selection:
No No omission
Yes Data are omitted

5.1.12 Line 12

Type: Number
Label: **Corrections for Vsc: E-field[km]**
Variable: efldfac
Description: This value defines the trend correction factor of spacecraft potential for the electric field, Vsctrend[V] = E[mV/m]*factor.

Type: Number
Label: **vi[mV s/m]**
Variable: vifac
Description: This value defines the trend correction factor of spacecraft potential for ion bulk velocity in units of [mV s/m].

Type: Number
Label: **Sun**
Variable: sunfac
Description: This value defines the trend correction factor of spacecraft potential for the solar activity parameter selected in line 4.

Type: Number
Label: **Mach**
Variable: vmachfac
Description: This value defines the trend correction factor of spacecraft potential for the ion Mach number.

Type: Number
Label: **lg(T)lo**
Variable: tempfaclo
Description: This value defines the trend correction factor of spacecraft potential for the logarithm of temperature below the threshold temperature at the right.

Type: Number
Label: **lg(T)hi**
Variable: tempfachi
Description: This value defines the trend correction factor of spacecraft potential for the logarithm of temperature above the threshold temperature at the right.

Type: Number
Label: **Tthresh**
Variable: tempfacthresh
Description: This value defines the threshold temperature for the two correction factors defined at the left.

Type: Number
Label: **Fudge factor for maxcurrent**
Variable: maxcurrentfactor
Description: The program uses a constant ASPOC current for some calculations, which is derived from the mean value of this current in the data. This field contains a correction factor to this.

Type: Number
Label: **for Iplasma**
Variable: iefudgefactor
Description: This field contains a correction factor for the plasma current calculated from density and temperature.

5.1.13 Line 13

Type: Drop list
Label: Show VV power fit in IV-plot
Variable: doplotvvresult
Description: Defines the photocurve with power law parameters derived from the comparison of controlled and uncontrolled potential in a previous session shall be plotted in the present plot.
Selection:
- No — The previous photocurve is not plotted
- Power — The photocurve is shown as power law, as previously calculated
- Single Maxw — The previously calculated power law photocurve is approximated by a single Maxwellian function and plotted
- Sum of 2 Maxw — The previously calculated power law photocurve is approximated by a sum of 2 Maxwellian functions and plotted
- Sum of 3 Maxw — The previously calculated power law photocurve is approximated by a sum of 3 Maxwellian functions and plotted

---

Type: Number
Label: coefs jph
Variable: aph0
Description: Factor in the power law approximation of photoelectron current density.

Type: Number
Label: bph1
Variable: bph1
Description: Exponent in the power law approximation of photoelectron current density.

Type: Number
Label: Use Vsc dev. from smoothing x spins (0=no). x:
Variable: smoothvscdata
Description: If set greater than 0, this value sets the smoothing range of the spacecraft potential in the correlation with the electric field.

Type: Number
Label: Smooth dV/dE (0=no). x:
Variable: smoothdvdedata
Description: If set greater than 0, this value sets the smoothing range of dVsc/dE in the plot of this quantity over time.

Type: Number
Label: |dV/dE| scale<
Variable: dvdemax
Description: This entry sets the scale maximum of the quantity dVsc/dE in the plot of this quantity over time.

Type: Drop list
Label: **Divide dV/dE by V**
Variable: dorelativedvde
Description: Defines whether the dependence of spacecraft potential with the electric field is plotted in a normalized way, i.e. divided by the spacecraft potential.
Selection:
No Quantity dV/dE is plotted as is
Yes Quantity is divided by spacecraft potential

Type: Drop list
Label: **Output photocurve**
Variable: dophotocurve
Description: Defines whether the derived Current-Voltage curve (also named photocurve) is output as a plot and as text in the IDL status window.
Selection:
No No output
Yes Output of photocurve

5.1.14 Line 14

Type: Drop list
Label: **Fit I or n vs V on set polynomial not data**
Variable: fitpolynotdata
Description: Defines whether the fitting in the current or density over spacecraft potential data shall be performed on the data or on the polynomial defined by the coefficients at the right.
Selection:
No Fits are performed on data
Yes Fits are performed on the polynomial defined at the right

---

Type: Number
Label: **#coefs**
Variable: npolycoefs
Description: Defines the number of polynomial coefficients approximating the n-V or I-V curves. Only the given number of coefficients at the right are applied.

Type: Number
Label: **coefs:**
Variable: polycoef0
Description: Coefficient 0 of the polynomial approximating the measured data.

Type: Number
Label:
Variable: polycoef1
Description: Coefficient 1 of the polynomial approximating the measured data.

Type: Number
Label:
Variable: polycoef2
Description: Coefficient 2 of the polynomial approximating the measured data.

Type: Number
Label:
Variable: polycoef3
Description: Coefficient 3 of the polynomial approximating the measured data.

Type: Number
Label:
Variable: polycoef4
Description: Coefficient 4 of the polynomial approximating the measured data.

Type: Number
Label:
Variable: polycoef5
Description: Coefficient 5 of the polynomial approximating the measured data.

Type: Number
Label:
Variable: polycoef6
Description: Coefficient 6 of the polynomial approximating the measured data.

Type: Drop list
Label: Plot poly
Variable: doplotpoly
Description: Defines whether the polynomial fited to the data is plotted with the data.
Selection:
No Polynomial is not plotted together with the data
Yes Polynomial is plotted together with the data

Type: Drop list
Label: Use set low-E Maxw for Maxw-fit
Variable: addmaxw
Description: Defines whether the terms for the Maxwellian population at low energy given at the right shall be added when fitting the photocurve.
Selection:
No Pre-set low energy Maxwellian terms are not added
Yes Pre-set low energy Maxwellian terms are added

Type: Number
Label: coefs: j0
Variable: addj0
Description: Factor of the low energy Maxwellian term added to the fit.

Type: Number
Label: V0
Variable: addv0
Description: Characteristic energy of the low energy Maxwellian term added to the fit.

5.1.15 Line 15

Type: Drop list
Label: Fit I vs V
Variable: powerrmsi
Description: Defines the function used to fit the current over spacecraft potential data to obtain the photocurve.
Selection:

No — No fitting is performed

Maxwellians — A single Maxwellian distribution or a sum of 2 or 3 Maxwellian distributions is used for the fitting. The number of terms is given by the entry "#Terms" at the right.

Power i~V^x — A power law distribution i~V^x is used for the fitting.

Max w power init — A single Maxwellian distribution or a sum of 2 or 3 Maxwellian distributions is used for the fitting, using a power law fit for the start value of the nonlinear Maxwellian fit. The number of terms is given by the entry "#Terms" at the right.

Max fm power — A single Maxwellian distribution or a sum of 2 or 3 Maxwellian distributions is used for the fitting. The fit is not performed on the data, but rather on the approximation of the power law fit. The number of terms is given by the entry "#Terms" at the right.

3-range Max — Three Maxwellian terms separated in spacecraft potential are used for the fitting.

Power V~i^x — A power law distribution V~i^x is used for the fitting.

Polynomial in i — A polynomial in current i is with the number of terms given at the right used for the fitting.

Type: Drop list
Label: Maxw fit
Variable: dofullmaxw
Description: Defines the function used to fit the current over spacecraft potential data to obtain the photocurve.
Selection:

Regress — The Maxwellian fit is performed without any weighting or limits by a simple regression function.

Mpfit — The Maxwellian fit is performed by the IDL routing MPFIT including weights and limits.

Type: Number
Label: **#Terms**
Variable: ntermsrms
Description: Number of terms used in the fitting of Maxwellian functions.

Type: Drop list
Label: **Limits**
Variable: limitedrms
Description: Defines whether the non-linear fitting of the Maxwellian terms shall be performed with limits to the parameters.
Selection:

No	non-linear fitting of Maxwellian functions are performed without limits for parameters
Yes	non-linear fitting of Maxwellian functions are performed out limits for parameters

---

Type: Drop list
Label: **Method**
Variable: methodrms
Description: Defines the formula used to calculate plasma electron current. The "exact" option includes the correction terms for an attracting sphere
Selection:

Simple	Current ~ density * root(temperature)
Exact	Current ~ density * root(temperature) * (1 + potential/temperature_in_eV)

Type: Drop list
Label: **Error exp**
Variable: weightsrmse
Description: The convergence of the nonlinear fit to obtain the photo-emission spectrum is critical. This selection allows to define relative weights to the data points to improve the convergence.
Selection:

-3	Weight is uncontrolled potential (of the second spacecraft) to the power -3.
-2	Weight is uncontrolled potential (of the second spacecraft) to the power -2.
-1	Weight is uncontrolled potential (of the second spacecraft) to the power -1.
0	Weight is unity.
0.5	Weight is uncontrolled potential (of the second spacecraft) to the power -0.5.
1	Weight is uncontrolled potential (of the second spacecraft) to the power +1.
2	Weight is uncontrolled potential (of the second spacecraft) to the power +2.
hist	The total weight of all data points of the uncontrolled potential (of the second spacecraft) in each interval is equal. There are 30 intervals, logarithmically spaced in the range between 1 V and 60 V.

Type: Drop list
Label: in
Variable: weightsinye
Description: Defines whether the error is calculated in the Y axis (dependent variable) or X axis (indeendent variable).
Selection:
X Errors are calcualted for the independent variable, usually plotted in X
Y Errors are calcualted for the dependent variable, usually plotted in Y

Type: Drop list
Label: Break V
Variable: Vbreakvariab
Description: Defines whether the potentials separating the validity of three Maxwellian fittings are set manually by the values entered at the right, or are calculated automatically based on minimum total error.
Selection:
Fix Fixed limits given at the right are used
Var Variable limits are calculated

Type: Number
Label:
Variable: Vbreak1e
Description: Potential separating the fits at low and medium potential

---

Type: Number
Label:
Variable: Vbreak2e
Description: Potential separating the fits at medium and high potential

---

Type: Drop list
Label: T for n-fit
Variable: varassumedtemp
Description: Defines whether the temperature assumed for the conversion of density to current is assumed to be constant at the value given at the right under the label "fix", or a function of spacecraft potential given by a straight line between two points given at the right.
Selection:
Fix A fixed temperature is assumed
Var A variable temperature is assumed

Type: Number
Label: at 2 V
Variable: assumedt0
Description: Assumed variable temperature at 2 V spacecraft potential

---

Type: Number
Label: **7 V**
Variable: assumedt1
Description: Assumed variable temperature at 7 V spacecraft potential

---

Type: Number
Label: **10.5 V**
Variable: assumedt2
Description: Assumed variable temperature at 10.5 V spacecraft potential

---

Type: Number
Label: **20 V**
Variable: assumedt3
Description: Assumed variable temperature at 20 V spacecraft potential

---

Type: Number
Label: **fix:**
Variable: assumedtemp
Description: Assumed constants temperature

5.2 Group "SETTINGS FOR SPACECRAFT 1"

In this part of the screen the settings, mainly filters, applied to the primary spacecraft - or in general if no secondary spacecraft has been selected - are defined.

5.2.1 Line 1

Type: Number
Label: **Efield>**
Variable: efldmin
Description: Minimum total electric field used for filtering input data and for setting the scale range.

Type: Number
Label: **>**
Variable: efldmax
Description: Maximum total electric field used for filtering input data and for setting the scale range.

Type: Number
Label: **Vsc>**
Variable: vscmin
Description: Minimum spacecraft potential used for filtering input data and for setting the scale range.

Type: Number
Label: **>**
Variable: vscmax
Description: Maximum spacecraft potential used for filtering input data and for setting the scale range.

Type: Drop list
Label: **Vsc scale**
Variable: dologvsc
Description: Defines the scale for the spacecraft potential in the correlation plots.
Selection:
Linear Spacecraft potential is plotted in a linear scale.
Logarithmic
Spacecraft potential is plotted in a logarithmic scale.

Type: Number
Label: **Iaspoc>**
Variable: aspmin
Description: Minimum ASPOC current used for filtering input data. Note that the data files in the distribution contain the difference between the ASPOC current and the EDI current. Therefore, in oder to include all data with ASPOC OFF, the minimum current should be set to -1 and the maximum current to +1.

Type: Number
Label: **<**
Variable: aspmax
Description: Maximum ASPOC current used for filtering input data. Note that the data files in the distribution contain the difference between the ASPOC current and the EDI current. The nominal ASPOC current is 20µA per spacecraft. Therefore, in oder to include all data with ASPOC ON excluding the current sweeps, the minimum current should be set to 19 and the maximum current to +21.

Type: Number
Label: **Density: |ne-ni|<**
Variable: densdiffmax
Description: Sets the maximum permitted difference between measured electron and ion density.

Type: Number
Label: **AND |ne-ni|<**
Variable: densfactmax
Description: Sets the maximum permitted factor between measured electron and ion density.

Type: Number
Label: **Te for fit>**
Variable: etempminforfit
Description: Sets the minimum temperature used for fitting current or density.

Type: Number
Label: **IonMach>**
Variable: machmin
Description: Sets the minimum ion Mach number used for filtering input data.

Type: Number
Label: **>**
Variable: machmax
Description: Sets the maximum ion Mach number used for filtering input data.

Type: Number
Label: **Min v-comp**
Variable: velocompmin
Description: sets the minimum value of individual bulk velocity components used for filtering input data..

5.2.2 Line 2

Type: Number
Label: **Electrons: Ne>**
Variable: edensmin
Description: Minimum electron density used for filtering input data and for setting the scale range.

Type: Number
Label: **>**
Variable: edensmax
Description: Maximum electron density used for filtering input data and for setting the scale range.

Type: Number
Label: **Te>**
Variable: etempmin
Description: Minimum electron temperature used for filtering input data and for setting the scale range.

Type: Number
Label: **>**
Variable: etempmax
Description: Maximum electron temperature used for filtering input data and for setting the scale range.

Type: Number
Label: **Ie>**
Variable: ecurrmin
Description: Minimum electron current used for filtering input data and for setting the scale range.

Type: Number
Label: **>**
Variable: ecurrmax
Description: Maximum electron current used for filtering input data and for setting the scale range.

Type: Number
Label: **ve>**
Variable: evelomin
Description: Minimum electron velocity used for filtering input data.

Type: Number
Label: **>**
Variable: evelomax
Description: Maximum electron velocity used for filtering input data.

Type: Number
Label: **Ions: Ni>**
Variable: idensmin
Description: Minimum ion density used for filtering input data and for setting the scale range.

Type: Number
Label: **>**
Variable: idensmax
Description: Maximum ion density used for filtering input data and for setting the scale range.

Type: Number
Label: **Ti>**
Variable: itempmin
Description: Minimum ion temperature used for filtering input data and for setting the scale range.

Type: Number
Label: **>**
Variable: itempmax
Description: Maximum ion temperature used for filtering input data and for setting the scale range.

Type: Number
Label: **Ii>**
Variable: icurrmin
Description: Minimum ion current used for filtering input data and for setting the scale range.

Type: Number
Label: **>**
Variable: icurrmax
Description: Maximum ion current used for filtering input data and for setting the scale range.

Type: Number
Label: **vi>**
Variable: ivelomin
Description: Minimum ion velocity used for filtering input data and for setting the scale range.

Type: Number
Label: **<**
Variable: ivelomax
Description: Maximum ion velocity used for filtering input data and for setting the scale range.

5.3 Group "SETTINGS FOR SPACECRAFT 2 OR FOR UNCONTROLLED DATA IF APPLICABLE"

In this part of the screen the settings applied to the secondary spacecraft - if present - are defined.

5.3.1 Line 1

Type: Drop list
Label: **Plot Vsc2(unc) over Vsc1(cont) OR Vsc1 at ASPOC changes**
Variable: dovvcorr
Description: Defines whether a correlation between controlled and uncontrolled spacecraft potential shall be performed.
Selection:
No No correlation
Yes Correlation is performed

Type: Number
Label: **Iaspoc2>**
Variable: asp2min
Description: Minimum ASPOC current in the uncontrolled case for either the primary or secondary spacecraft used for filtering input data. Note that the data files in the distribution contain the difference between the ASPOC current and the EDI current. Therefore, in oder to include all data with ASPOC OFF, the minimum current should be set to -1 and the maximum current to +1.

Type: Number
Label: **<**
Variable: asp2max
Description: Maximum ASPOC current in the uncontrolled case for either the primary or secondary spacecraft used for filtering input data. Note that the data files in the distribution contain the difference between the ASPOC current and the EDI current. Therefore, in oder to include all data with ASPOC OFF, the minimum current should be set to -1 and the maximum current to +1.

Type: Number
Label: **(Vsc2 only) Vsc2>**
Variable: vsc2min
Description: Minimum spacecraft potential current in the uncontrolled case for either the primary or secondary spacecraft used for filtering input data and for setting the scale range.

Type: Number
Label: **>**
Variable: vsc2max
Description: Maximum spacecraft potential current in the uncontrolled case for either the primary or secondary spacecraft used for filtering input data and for setting the scale range.

Type: Drop list
Label: **Vsc2 scale**
Variable: dologvsc2
Description: Defines the scale for the uncontrolled spacecraft potential in the correlation plots.
Selection:
Linear Uncontrolled spacecraft potential is plotted in a linear scale.
Logarithmic
Uncontrolled spacecraft potential is plotted in a logarithmic scale.

Type: Number
Label: **Vsc2 correction**
Variable: vsc2correct
Description: Arbitrary offset added to the potential of the secondary spacecraft.

5.3.2 Line 2

Type: Drop list
Label: **Fit**
Variable: dompfitv
Description: Defines the function used to derive the photocurve form controlled and uncontrolled potential.
Selection:
- None — No fitting is performed
- 2-range Maxw — Two Maxwellian terms separated in spacecraft potential are used for the fitting.
- Power — A power law distribution is used for the fitting.

Type: Drop list
Label: **Maxw break V**
Variable: Vbreakvariabv
Description: Defines whether the potential separating the validity of two Maxwellian fittings is set manually by the value entered at the right, or is calculated automatically based on minimum total error.
Selection:
- Fix — The fixed limit given at the right is used
- Var — A variable limit is calculated

Type: Number
Label:
Variable: Vbreak1v
Description: Potential separating the fits at low and high potential

---

Type: Drop list
Label: **Error exp**
Variable: weightsrmsv
Description: The convergence of the nonlinear fit to obtain the photo-emission spectrum is critical. This selection allows to define relative weights to the data points to improve the convergence.
Selection:
- -3 — Weight is uncontrolled potential (of the second spacecraft) to the power -3.
- -2 — Weight is uncontrolled potential (of the second spacecraft) to the power -2.
- -1 — Weight is uncontrolled potential (of the second spacecraft) to the power -1.
- 0 — Weight is unity.
- 0.5 — Weight is uncontrolled potential (of the second spacecraft) to the power -0.5.
- 1 — Weight is uncontrolled potential (of the second spacecraft) to the power +1.
- 2 — Weight is uncontrolled potential (of the second spacecraft) to the power +2.
- hist — The total weight of all data points of the uncontrolled potential (of the second spacecraft) in each interval is equal. There are 30 intervals, logarithmically spaced in the range between 1 V and 60 V.

Type: Drop list
Label: in
Variable: weightsinyv
Description: Defines whether the error is calculated in the Y axis (dependent variable) or X axis (indeendent variable).
Selection:
X Errors are calcualted for the independent variable, usually plotted in X
Y Errors are calcualted for the dependent variable, usually plotted in Y

Type: Number
Label: Start coefs
Variable: startcoefs0
Description: Start value in the fit for the factor of the power law or of the first Maxwellian term, in $\mu A/m^{-2}$

Type: Number
Label:
Variable: startcoefs1
Description: Negative exponent of the power law or characteristic potential of the first Maxwellian term in V

Type: Number
Label:
Variable: startcoefs2
Description: Characteristic potential of the second Maxwellian term in V. This entry is not applicable for the power law fit.

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7 Annex: List of Routines

7.1 Main program

CORRVANDFLUX

7.2 Routines inside corrVandFlux.pro

EP_TICKSD
GAPOPLOT
GETIASPOC1D
GETLNIASPOC3PARTS
GETMAXW
GETVC2PARTS
GETVC3PARTS
GETVCPOWER
NOTICK
PRINTF111
POWERTOMAXW
TIMEAXISD
TWOSLOPES
YGAPOPLOT

7.3 Third party routines

MPFITFUN