

corrVandFluxRec

User Manual

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1	7 Oct 2020	All	Initial release
2	20 Sep 2023	All	Incorporates changes of software since issue 1
3	30 Sep 2023	All	Final revisions

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1 Overview

The program corrVandFluxRec displays and analyzes data from the NASA Magnetospheric Multiscale (MMS) Mission which have been preprocessed by the program corrVandFlux in order to obtain reconstructed electron density data from the spacecraft potential.

The program is a modified version of the program corrVandFlux. The key addition is the plotting and processing of reconstructed densities.

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 corrVandFlux has been used to generate spin average data of spacecraft potential, electric field, ASPOC current, electron density, temperature, and current, and most importantly reconstructed electron densities. The files in the distribution cover the time range 2015-09-01 to 2023-06-30. The columns of these files contain:

- spacecraft potential (generated by mmsedpana)
- total electric field (generated by mmsedpana)
- electron density (generated by mmsedpana)
- electron temperature (generated by mmsedpana)
- electron current (generated by mmsedpana)
- ASPOC current minus EDI current (generated by mmsedpana)
- sum of electron and ASPOC current as result of the fitting (generated by corrVandFlux)
- density reconstructed from spacecraft potential and measured temperature (generated by corrVandFlux)
- density reconstructed from spacecraft potential and assumed temperature of 10 eV (generated by corrVandFlux)
- density reconstructed from spacecraft potential and assumed temperature of 100 eV (generated by corrVandFlux)
- density reconstructed from spacecraft potential and assumed temperature of 1000 eV (generated by corrVandFlux)

- ion velocity (generated by mmsedpana)
- ion Mach number (generated by mmsedpana)
- 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 files have names in the nomenclature mms<N>_rec_*.dat.

Some lines of one of these files are reproduced below.

```
Source: mmsl_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  
El. Density: 0.080/1000.000  
El. Temp.: 5.0/10000.0  
El. 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;0: 31.90  
V0: 1.610  
Fit I vs V: Power  $i \sim V^x$   
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	le+afit	neTmeas	neT0010	neT0100	neT1000	Vion	Machlon	modVsc	IDs
Time[UT]	[V]	[mV/m]	[cm^-3]	[eV]	[uA]	[uA]	[uA]	[cm^-3]	[cm^-3]	[cm^-3]	[cm^-3]	[km/s]	[I]	[V]	R P I F
2015-09-01T09:52:25.887	3.010	0.184	0.609	272.42	2.699	19.710	32.346	2.852	14.888	4.708	1.489	6.54	0.01	3.010	1 4 0 0
2015-09-01T09:52:45.246	3.023	0.202	0.495	329.90	2.413	19.711	32.183	2.558	14.694	4.647	1.469	9.07	0.01	3.023	1 4 0 0
2015-09-01T09:53:04.590	3.027	0.253	0.354	451.44	2.019	19.705	32.211	2.193	14.734	4.659	1.473	12.61	0.01	3.027	1 4 0 0

1.3 Processing options

Processing options include the following

- Plots or tables of data over time, including reconstructed densities
- Plots of MMS data in the equatorial plane
- Correlation of MMS data with solar activity indices
- Correlation between spacecraft potential and plasma density, including reconstructed density

1.4 Output

- Plots in PNG or Postscript format

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 corrVandFluxRec.zip containing three directories.

doc	documentation including this document and the EDP data products guide
data	files with spin average data 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 data) should be located in the same directory.

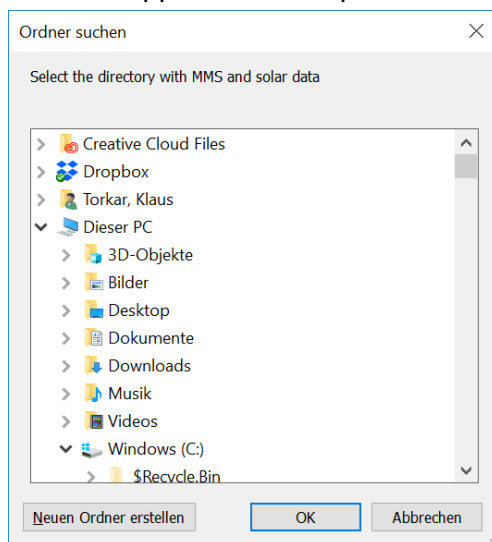
3.3 Step-by-step installation procedure

- 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.

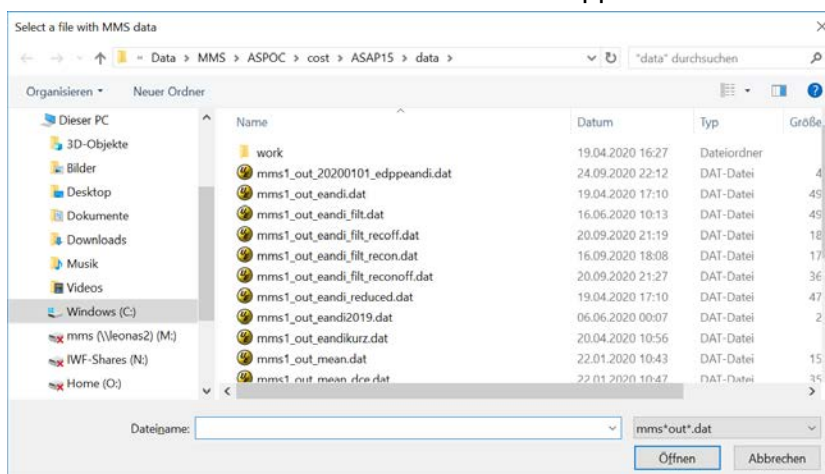
Compile the sources and execute them, or load the sources into the IDL development environment and execute them.

3.4 Program usage

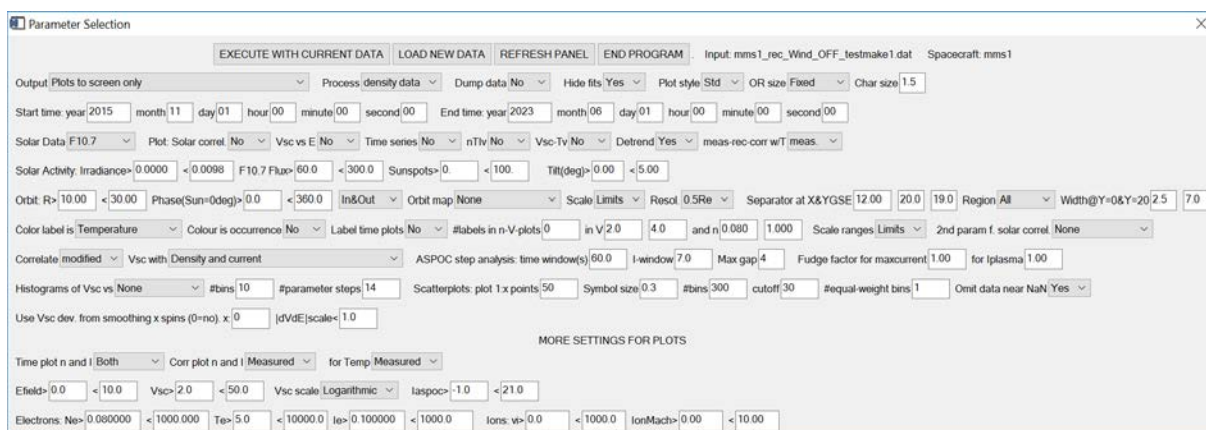
- At the beginning the following window entitled "Select the directory with MMS and solar data" will appear for the input of a directory which contains all input data:



- Thereafter the user shall select the MMS data file for analysis. The following window entitled "Select the file with MMS data" will appear



- Thereafter the main control panel shown below will appear. For further instructions refer to the user manual for corrVandFlux.



3.5 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.

3.5.1 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.

3.5.2 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.

3.5.3 corrVandFluxRec

- Reads a reconstructed density file, orbit data, and solar data (mms*_rec_*.dat).
- Plots solar correlations.
- Plots correlations between measured and reconstructed data.

4 Control Panel Items

The control panel is largely identical to the one of the program corrVandFlux, but a few items have been removed or added, respectively.

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.

4.1 Main Group

4.1.1 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.

4.1.2 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 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: **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.

4.1.3 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 2023-06-30.

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).

4.1.4 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: **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: plotime
Description: Allows to plot time series of various quantities.
Selection:
No No plot
Yes Plots time series of various quantities

Type: Drop list
Label: **nTlv**
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: dovscdiscovervplot
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 $\log(\text{current})$ 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.

4.1.5 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 $[\text{W}/\text{m}^2/\text{nm}]$.

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

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

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.

4.1.6 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=0deg)>**
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° from 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: posscalelimits
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
 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: **Separator at X&+Y&-YGSE**
Variable: xgsedist
Description: Sets the X(GSE) value of the nominal parabola defining the magnetopause 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 magnetopause in the GSE XY plane, for X(GSE)=0.

Type: Number
Label:
Variable: nygsedist
Description: Sets the negative Y(GSE) value of the nominal parabola defining the magnetopause 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 magnetopause at Y(GSE)=0.

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

4.1.7 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

EI. 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

4.1.8 Line 8

Type: Drop list
Label: **Correlate**
Variable: usemodifiedvsc
Description: Defines whether the measured spacecraft potential or a modified potential is used as an additional dimension shown as coloured symbols in correlation plots. The modifications include the correction terms for electric field, solar activity, plasma bulk velocity, ion Mach number, and electron temperature, as defined in the program corrVandFlux when the files with reconstructed data are produced.

Selection:
original Measured spacecraft potential (from column "Vsc" in the data) is used
modified Modified spacecraft potential (from column "modVsc" in the data) is used

Type: Drop list
Label: **Vsc with**
Variable: vscorrwith
Description: Defines whether an additional dimension shown as coloured symbols is applied in correlation plots.

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: 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 units of spin periods) around an apparent turn-on or turn-off of ASPOC to be considered in the analysis.

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.

4.1.9 Line 9

Type: Drop list
Label: **Histograms of Vsc vs**
Variable: vschistsel
Description: Defines the parameter used to plot histograms versus spacecraft potential.
Selection:

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

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

Type: Number
Label: **#parameter 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

4.1.10 Line 11

Type: Number
Label: **Use Vsc dev. from smoothing x spins (0=no). x:**
Variable: smoothvsdata
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: **|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.

4.2 Group "MORE SETTINGS FOR PLOTS"

In this part of the screen the settings, mainly filters, are applied.

4.2.1 Line 1

Type: Drop list
Label: **Time plot n and I**
Variable: timeplotmeasrec
Description: Defines whether time plots contain measured and/or reconstructed data.
Selection:
Measured Measured data are plotted.
Reconstr. Reconstructed data are plotted.
Both Both the measured and reconstructed data are plotted.

Type: Drop list
Label: **Corr plot n and I**
Variable: corrplotmeasrec
Description: Defines whether correlation plots for density and current contain measured or reconstructed data.
Selection:
Measured Measured data are plotted.
Reconstr. Reconstructed data are plotted.

Type: Drop list
Label: **for Temp**
Variable: plotnt
Description: Defines which temperature is used for plotting the reconstructed densities.
Selection:
Measured Measured temperatures, as given in the input file, are used.
10 eV A temperature of 10 eV, as given in the input file, is used.
100 eV A temperature of 100 eV, as given in the input file, is used.
1000 eV A temperature of 1000 eV, as given in the input file, is used.

4.2.2 Line 2

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: **laspoc>**
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 order 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 20 μ A per spacecraft. Therefore, in order 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.

4.2.3 Line 3

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: **le>**
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: **ions: 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.

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.

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6 Annex: List of Routines

6.1 Main program

CORRVANDFLUXREC

6.2 Routines inside corrVandFluxRec.pro

EP_TICKSD
GAPOPLOT
PRINTF111
TIMEAXISD
YGAPLOT

6.3 Third party routines

none