WGGS

An Interactive Solar WIND/SWE Data Analysis Tool
(Completed new-mode modifications: 03/12/2004)

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Chapter 1. Introduction

1a. Overview.

WGGS is an interactive software tool designed to facilitate the analysis of solar wind data from a variety of experiments. The tool utilizes widget interfaces and was originally intended for the analysis of experimental data from the ISTP Global Geospace (GGS) mission spacecraft, WIND and POLAR. Hence, the acronym WGGS. The tool provides access and display capability for multiple and diverse data sets on a common time scale and is not limited to any particular spacecraft or experiment. The tool is written in the IDL language and consists of analysis procedures interactively executed through the widget interfaces. It has the flexibility to simultaneously display and analyze data sets with different time scales. The time scales may range from multiday survey plots down to the highest time resolution detailed data. For example, 3sec electron velocity distribution function data can be viewed and analyzed in conjunction with 24 hour plots of electron plasma parameters such as density and temperature. The tool can be readily adapted to include new and specialized analysis modules as well as new data sets. All WIND/SWE data processing is also performed within the tool environment as outlined in Chapter 4.

Use of the interactive part of the tool begins with the main widget interface which accesses data and then displays the data versus time in panels stacked one upon the other. The data displayed in these plots are referred to as survey data and this widget interface is referred to as the *Survey Data Display*, which provides entry to the other tool functions, including the level zero data interfaces, which are additional, specialized widget interfaces to access and display the high time resolution data which may complement the survey data being displayed.

1b. How to use this document.

This document is intended to be read as the tool is being used. Chapters 2 and 3 are in tutorial form with specific instructions for commands to enter and buttons to push in the widget interfaces. This hands-on approach should facilitate learning the tool much faster than simply referring the reader to figures of widget buttons on paper. It is important therefore to follow the tool-use instructions exactly in the tutorial that follows. The widget interfaces covered by the tutorial have **HELP** buttons which bring up on-line documentation which also appears in Appendices 2 and 3. More detailed information about the tool functions are found in Appendices 4 - 7. Appendix 1 contains essential information on starting the tool and tailoring the startup file to the user's machine.

This document is also intended to be an overview of the SWE data processing methods and procedures associated with the conversion of SWE level zero data to the final data products accessed by the WGGS tool. The very important Chapter 4 provides an overview of the data processing system as well as instructions on maintaining the input level zero data and the final survey data files. Appendix 9 contains bar charts of the completed processed data coverage for the period 1995 – 2002.

Chapter 2. How to use the Survey Data Display: Tutorial.

In order to provide hands-on experience to a new user, the reader should now run the following tutorial session.

First, install the latest version of the WGGS tool, wggs00/ (where 00 designates version number), and the companion directory, wggs_tutor/, on the user machine directory from which you wish to run the tool. The directories wggs00/ and wggs_tutor/ can be found as tar files on the ftp site of machine leprjf:ftp/pub/exports/. Secondly, in file wggs_tutor/startup.pro, edit two lines at the beginning of the file, entering the name of the current version name of the tool, and the full path to the tool location. The lines to be edited for the user's particular machine in file wggs_tutor/startup.pro are

wggs_version = 'wggs10'   ; name of current version of the WGGS tool
wggs_dir = '/export/home/rjf/'   ; path name of directory of wggs_version

Then follow these instructions:

1.   cd to the directory in which wggs00/ and wggs_tutor/ are located and initiate an IDL session as follows:

         % *idl wggs_tutor/startup*

2.   The WGGS tool is started by typing at the IDL prompt:

         IDL> *wanal*

         which brings up the main *Survey Data Display*.
         IMPORTANT: Position the *Survey Data Display* in the upper part of the screen and the command window used to start the tool at the bottom of the screen so that part of the command window can be seen at all times.

The set of instructions which follow are user actions on widgets in the *Survey Data Display:*

3.   Type 19990510 in **yyyymmdd** field. (Data for this date are included in wggs_tutor/).
4.   Click **swe_moments** and **swe_fpitch** in data types box.
5.   Click **READ**
6.   In pop-up widget, *click N density, T temperature, U flow speed, A anisotropy, Q heat flux, th_q, ph_q, B magnetic field, th_b, ph_b, cos(Q.B), Spin avg f(en,t), 94.3*
7.   Click **Save 0**
8.   Click **Plot 0**   (Selected plot variables are plotted in stacked panels.)
9.   Click left mouse button at any time on any plot panel.
10.   Click middle mouse button at any *later* time.
11.   In pop-up widget, click **Plot**. (The selected time interval is plotted.)

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12.   Click 5 in **Smooth** droplist widget. (Median smoothing.)
13.   Click 0 in **Smooth** droplist widget.
14.   Click **Minmax** in **Y-axis** droplist widget. (Y scale range changes to minmax.)
15.   Click **Preset** in **Y-axis** droplist widget.
16.   Click **On** in **Time mark** droplist widget.
17.   Click left mouse button on plot panel. (Vertical line is plotted at selected time.)
18.   Click **Off** in **Time mark** droplist widget.
19.   Click left mouse button on plot panel. (No new vertical time mark line is plotted.)
20.   Click **Remove** button. (Vertical time mark lines disappear.)
21.   Click **Previous** in Time interval button set. (Previous time interval plotted.)
22.   Click **Current** in Time interval button set. (Last time interval selected by mouse.)
23.   Click **Original** in Time interval button set. (Original time interval is plotted.)
24.   Click **Current** in Time interval button set. (Original has become current interval.)
25.   Click 3 in **Nr days** droplist widget.
26.   Click **swe_moments, swe_fpitch, and swe_strahl** in data types box.
27.   Click **READ**. (Reading **swe_strahl** data will take a little longer than other types.)
28.   In pop-up widget, click *strahl energy spectrum, strl_max_cts, strl_widthmx, 251, N density, B magnetic field, th_b, ph_b.*
29.   Click **Save 1**.
30.   Click **Plot 1** (Selected plot variables are plotted in stacked panels.)
31.   Click 3 in **Smooth** droplist widget. (Removing noise pixcel changes color scale.)
32.   Click **Quit** (Survey Data Display interface disappears and IDL prompt appears..)
33.   Type *wanal* at the IDL prompt (Survey Data Display interface reappears.)
34.   Click **Current** (Last plot reappears.)

A more detailed description of the *Survey Data Display* can be accessed by clicking on the **HELP** button. The on-line HELP documentation can also be found in Appendix 2.

Chapter 3. How to use the SWE Level Zero Data Interface: Tutorial.

3a. VEIS distribution function plots.

The tutorial continues in this section with access of the *SWE LZ Data Display* interface from the *Survey Data Display* in which survey data is plotted. SWE data is used in this tutorial, but any type of survey data that overlaps the time for which level zero data is desired may be used. The starting point for this part of the tutorial is step 34 of the previous section.

35.   Click on the **SWE level zero** button of the *Survey Data Display* interface. (The *SWE LZ Data Display* interface appears with the *strahl energy spectrum* color image from the *Survey Data Display* plotted in the top panel.)
36.   Click **Parent** to return to *Survey Data Display*.
37.   Click **SWE levelzero** on *Survey Data Display* to return to *SWE LZ Data Display*.
38.   Click on **Strahl** from the droplist (first widget, second row). (The strahl line plot replaces the strahl image in the top panel.)

39.   Click on 19950511 in the date droplist (fourth widget, first row.)
40.   Click **Open LZ**. (See Chapter 4a for details on the result of this action.)

Steps 41 – 46 are the various ways to select a time for a distribution function plot:
41.   Click left mouse button on top panel at any time of date, 19950511.
      (Default plot, f contours and f cuts, appears in one lower plot windows.)
42.   Click + and/or – buttons of the **Spin** group (second row).
      (Distributions appear sequentialy in lower three plot windows with each click.)
43.   Click **auto** in **Spin** group. (Three consecutive plots appear.)
44.   Click + and/or – buttons of the **Mfrm** group. (Increments major frame.)
45.   Type 300 in **Mfrm**, hit return, then click in any of three windows. (Selecting mjf.)
46.   Type 024850 in **hhmmss** field, hit return, then click in window. (Selecting time.)

47.   Select each plot type in the droplist (third widget from the right, second row),
      clicking in a plot window after each selection to see the plot.
48.   Select default plot type **f fcuts** and click in a plot window.
49.   Click 10 in **vstps** droplist (second widget from right, second row) and click in a
      plot window.
50.   Click 16 in **vstps** droplist (second widget from right, second row) and click in a
      plot window.
51.   Click 3 in **pbin** droplist (last widget on right, second row) and click in plot
      window.
52.   Click 15 in **pbin** droplist and click in plot window.
53.   Click 9 (default) in **pbin** droplist and click in plot window

When a VEIS distribution function is plotted, then the VEIS raw counts spectrum and
the STRAHL sensor data for the selected major frame and spin may also be displayed.
Clicking on the **Veis data** brings up another widget interface, *SWE Veis Counts Data*, in
which the VEIS raw counts are plotted vs electron speed. The *SWE Veis Counts Data*
interface also provides various diagnostic and calibration functions on the data and which
are explained Chapter 3b. Clicking on the **Strahl data** button brings up yet another
widget interface, *SWE Strahl Counts Data*, which is described in Chapter 3c. The use and
function of all the widget buttons in the *SWE LZ Data Display* are explained by clicking
on the *HELP* button and also in described in Appendix 3.

3b. VEIS raw data counts spectra.

The tutorial continues with the *SWE Veis Counts Data* interface. The starting point is step
53 of the last section in the *SWE LZ Data Display.*

54.   Click left mouse button on top panel at any time of date, 19950511 in the *SWE LZ
      Data Display*.
55.   Click on the **Veis data** button which brings up the *SWE Veis Counts Data*
      interface. (Default plot of raw electron counts vs electron velocity step is
      displayed. Sun glint points are highlighted but are eliminated in final distribution
      function plots and in creation of daily moments and pitch angle files.)

56.   Click (in turn) on buttons **Cts_sector, Cts_phi,** and **Cts_pitch**. (Raw data counts are plotted vs sector, sun phase angle, and pitch angle, respectively, at a single velocity step.)
57.   Click on **Vstep** + or – to increment velocity step for any of the plots selected in previous step.
58.   Click on **Spin** + or – to increment spin (seven spins per major frame).
59.   Click on **Mfrm** + or – to increment major frame (major frame = record).
60.   Click on **Sect** + or – .(No effect for plots of counts vs sector, sun phase angle, or pitch angle.)
61.   Click **Det angles.** (Plots VEIS look angles phi (azimuth) and theta (elevation), and velocity sweep steps during one 3s spacecraft rotation.)
62.   Click (in turn) **Cts_phi all steps** and **Cts_sun all steps.** (Plots raw counts for all velocity steps vs azimuthal look angle, phi, and vs sun phase angle, respectively.)
63.   Click **Cts_step (def).** (Plots raw counts.)
64.   Click **Cts_step /correctd**. (Plots counts corrected for relative gain factors, removal of sun glint samples, and background adjustments.)
65.   Click **f_step.** (Plots phase density converted from corrected counts.)
66.   Click **f w/ patch, scpot**. (Plots distribution function with Adolfo Vinas fitted 3D gaussian patch over thermal core using coefficients from moments file which also corrects for spacraft potential.)
67.   Click **f w/ new patch**. (Same as previous step except fitted patch coefficients are computed on-line.)
68.   Click **Cts_step (def)**. (returns to default plot.)
69.   Click **Sect** + six times and observe the spin count advance.
70.   Click **Spin** + seven times and observe the major frame count advance.
71.   Click **Mfrm** + and observe the major frame count advance
72.   Click on **Parent** to bring forward the *SWE LZ Data Display*.
73.   Click on **Veis data** which brings back the *SWE Veis Counts Data* interface.
74.   Click on **Parent** to return to the *SWE LZ Data Display*.

3c. Strahl electron distribution data display.

The tutorial continues with the *SWE Strahl Counts Data* interface. The starting point is step 74 of the last section in the *SWE LZ Data Display.*

75.   Enter 112 in the **Mfrm** widget field in the *SWE LZ Data Display* and hit Return (keyboard).
76.   Click in one of the three lower plot windows.
77.   Increment **Spin** + or – to 1.
78.   Click **Strahl data.** (SWE *Strahl Counts Data* interface appears with STRAHL image at 154 eV.)
79.   Click (in turn) **Counts vs phi, f vs phi,** and **Count vs pa, f vs pa** ,where pa = pitch angle. (These plots are for strahl detectors 0 2 4 6 8 10.)
80.   Click the **1 3 5 7 9 11** button and repeat the previous step.
81.   Click **f vs pa (all detectors)**.

82. Click **Counts vs phi index**.
83. Click **Compare strahl & veis**.
84. Click **Increment spin** + or – and watch **Spin** field change and plot at next energy appear.
85. Click **f(phi, theta) (def)** .
86. Click **Search for current strahl step** + or **-** . (The next occurrence of major frame and spin with the same energy step as the current one is plotted.)
87. Enter 209 in the **Increment recn** field and hit Return. (Strahl image should appear with Sun showing as intense image at 180 degrees.)
88. Toggle **Sun mask** button and watch strahl appear when Sun mask is **On**.
89. Click on **Parent** return to *SWE LZ Data Display*.
90. Click **Strahl data** in *SWE LZ Data Display* to bring back SWE *Strahl Counts Data* interface.

This ends the tutorial.

Chapter 4. SWE Electron Data Processing in the WGGS Environment.

4a. Converting level zero data to distribution functions.

This section outlines the data processing steps performed by the WGGS tool in converting the raw level zero data into VEIS and STRAHL distribution function plots. When a level zero file is opened by clicking on the **Open LZ** button in te *SWE LZ Data Display*, procedure lzinput.pro is called which reads or makes available the following:

1. lzinput.pro
   a.) telemetry index map which unpacks the science and housekeeping data blocks from the level zero data file;
   b.) spin phase look angles of each detector, energy step, and sector and the corresponding unit vectors;
   c.) relative gains for the set of six detectors for the current date;
   d.) definition of swest.patch_include(n_vdets,n_sectors,n_vesteps), which determines which detector, sector, and energy steps are to be omitted (in cases of very low or unreliable detector response) from the calculation of the A. Vinas' gaussian patch over the core of the distribution function (see documentation in lzinput.pro);
   e.) magnetic field data for the entire day from the MFI experiment (first preference is 3s data, which if not available, then key parameter data used);
   f.) WIND orbit and attitude data for the entire day;
   g.) SWE ion key parameter data for the entire day;
   h.) level zero file header for the current day;
   i.) which science mode (determined by reading the first level zero record);
   j.) background counts data file (only for dates prior to 26 October, 1997);
   k.) sun glint map appropriate for the current date.

Each time a VEIS or STRAHL data plot is made, raw data corresponding to the selected input time is unpacked from the levelzero file record and converted to the appropriate plot variables. Selecting a time by any of the various methods described in the previous section (e.g., clicking on a plot window, etc) initiates execution of the following sequence of procedures:

2. proc_fw.pro :
    a.) The selected levelzero file major frame and spin number are determined from the selected input time (there are seven spin blocks of data per major frame; the terms major frame and level zero record are used interchangeably).
    b.) The procedure proc_rec.pro unpacks the selected major frame of data from the level zero file and stores the VEIS and STRAHL data in the structure, *vsmjf*, as described below in Cahapter 4b.
    c.) The magnetic field data is obtained for the selected time.
    d.) The VEIS distribution function array, *fblk(ndets, nvsteps, nsectors)*, for the selected time is formed, where *ndets* = number of detectors, *nvsteps* = number of velocity steps, *nsectors* = number of sectors. The gaussian patch over the thermal core of the electron distribution function is determined (using a method by Adolfo Vinas).
    e.) The procedure fparr.pro prepares the data for display, such as contouring.
    f.) The procedure do_lzplot.pro calls the actual plot procedures.

3. proc_rec.pro
    a.) The selected major frame (containing seven spins) is read. Since only one spin per major frame is time-tagged, the next major frame is also read for the purpose of computing spin period using the number of spacecraft rotations between time tags.
    b.) The science mode of the instrument is determined for the selected record.
    c.) The unpacking of the selected major frame of level zero data is done by procedure mode1.pro for science mode = 1 and science mode = 4, and by procedure mode6.pro for science mode = 6 in which the data structure, *vsmjf*, is formed. Data structure *vsmjf* contains the selected major frame (seven spins) of unpacked levelzero data in both raw counts and phase density form, as well as necessary conversion and calibration data, and is described in Chapter 4b.

4b. Description of the Level Zero Data Structure, *vsmjf*.

The structure *vsmjf* is defined in the procedure wggs00/swelz/mode1.pro or wggs00/swelz/mode6.pro, depending on science mode, and contains all the raw data counts, the converted phase densities, and the instrument conversion factors for a single major frame of data, which is seven spacecraft rotations. Also included are the sweep energy steps and phase angles for all data samples. The structure *vsmjf* is shared with other program elements through the *common* statement (given below) and the

help,vsmjf,/str describes the tags to *vsmjf*. Detailed information can be found in the documentation included in the programs, `mode1.pro` or `mode6.pro`.

IDL> common lzstuff,lzfile,lundat,recn,fh,lz,ihk,sp,vsmjf,veis_hvtbl
IDL> help,vsmjf
VSMJF (LZSTUFF) STRUCT   = -> <Anonymous> Array[1]
IDL> help,vsmjf,/str
** Structure <801850>, 68 tags, length=322936, refs=1:
  DESCR   STRING   'veis-strahl data samples'
  TJD   LONG   1308
  SEC   DOUBLE   79860.701
  HOUR   LONG   22
  MIN   LONG   11
  ISEC   LONG   0
  MS   INT   701
  MJFCNT   LONG   216
  SCIMODE   INT   6
  SPINP   DOUBLE   3.0630667
  N_VDETS   LONG   6
  N_VESTEPS   LONG   16
  N_SECTORS   LONG   6
  N_SPINS   LONG   7
  N_STRDETS   LONG   12
  N_STRPHIS   LONG   28
  DELTASP   DOUBLE   0.0097656250
  DEADTIM_ELE DOUBLE   0.0000000
  DEADTIM_ION DOUBLE   0.0000000
  DELT_ELE   DOUBLE   0.025912760
  DELT_ION   DOUBLE   0.025912760
  GEOMF   FLOAT   Array[6]
  LZRECN   LONG   870
  VEIS   INT   Array[6, 16, 6, 7]
  VEIS_B   FLOAT   Array[6, 16, 6, 7]
  CVEIS   FLOAT   Array[6, 16, 6, 7]
  CVEIS_B   FLOAT   Array[6, 16, 6, 7]
  FVEIS   FLOAT   Array[6, 16, 6, 7]
  FVEIS_B   FLOAT   Array[6, 16, 6, 7]
  VEISTEP   BYTE   Array[16, 7]
  ELEION_SWEEP INT   Array[7]
  ELEION   INT   Array[7]
  ALTSPIN_ENABLED INT   Array[7]
  PRIMALT_TBL INT   Array[7]
  SECVEIS   DOUBLE Array[16, 6, 7]
  PHIVEIS   DOUBLE Array[6, 16, 6, 7]
  THEVEIS   DOUBLE Array[6]
  VUNIT   DOUBLE Array[6, 16, 6, 3, 7]
  STRL   BYTE   Array[12, 28, 7]
  FSTRL   FLOAT   Array[12, 28, 7]
  STRLSTEP   BYTE   Array[7]
  NUMSTRLSTPS INT   32
  IBCI_STRL   INT   Array[28, 7]
  SECSTRL   DOUBLE Array[28, 7]
  PHISTRL   DOUBLE Array[28, 7]
  THESTRL   DOUBLE Array[12]
  VUNITSTRL   DOUBLE Array[12, 28, 3, 7]

```
BXYZ_STATUS    BYTE      Array[7]
BXYZ_IND       BYTE      Array[7]
BXYZ_RANGE     INT       Array[7]
BXYZ_PHASE     INT       Array[7]
BXYZ_BX        INT       Array[7]
BXYZ_BY        INT       Array[7]
BXYZ_BZ        INT       Array[7]
SUNSEC_VSBL    DOUBLE    Array[7]
SUNTIM_VSBL    DOUBLE    Array[7]
PB5TIM_VSBL    LONG      Array[3, 7]
VQLTY          LONG      Array[7]
SQLTY          LONG      Array[7]
XVEIS          INT       Array[6, 16, 6, 7]
RELGAIN        FLOAT     Array[6]
BDATE          STRING    '00000000'
BCTS           FLOAT     Array[6, 16, 6, 7]
RELGAIN_BACKG  FLOAT     Array[6]
CTS_FACTOR     FLOAT     Array[6, 16, 7]
STRL_CTS_FACTOR FLOAT    Array[12, 7]
BACKGROUND_TEST INT          0
SET_DET2_EQ_DET3 INT    =     0
```

4c. Creation and storage of daily survey files of electron moments, strahl detector data, and electron pitch angle distributions.

The end product of SWE data processing consists of 1) daily survey files, such as moments, VEIS pitch angle distributions, and STRAHL data versus time, which are displayed by the WGGS tool as described in Chapter 2, and 2) detailed distribution function data collected over a single 3s spacecraft rotation which are processed and displayed directly from the raw level zero data as described in Chapter 3. While distribution function data are processed and displayed interactively using the WGGS tool, the survey data files are created in a batch mode in the WGGS tool environment. Both interactively plotted distributuions and daily survey plots both use the same analyses and tool procedures described in Chapter 4a to form the data structure, *vsmjf,* described in Chapter 4b, on which both data products are based.

These are the steps to follow in creating the daily survey files from level zero data files:

1) Start an IDL session using wggs_startup.pro as described in Appendix 1.

> % *idl wggs_startup*

2) Run the procedure

> IDL> .r *lzdates_to_process*

and follow the prompts. The program lzdates_to_process.pro does the following:

a) reads the dates of the levelzero files in the *swe_levelzero* data path that you specify in the pop-up widget that appears;
b) creates a file of those dates to be processed (**for "mode7" it's the** lzpitch_dates **file mentioned in the "new operational-mode note" below**);
c) prompts you to choose which type of processing and then prompts you with the name of the processing program to run, i.e., **(see below)**

moments :	*mom*	.r	lzmom
pitch angle distribution at each energy:	*pitch*	.r	lzpitch
strahl:	*strahl*	.r	lzstrahl
60 degree pitch angle average:	*pitchavg*	.r	lzpitchavg

New operational-mode (mode7) note: All "old-mode" (before mode7) data products have been **finalized** as of the printing of this WGGS documentation-version. When processing "new-mode" (mode7) data products, select the 'pitch' processing-type when running the *lzdates_to_process* procedure (or, for small processing runs, directly create/modify the lzpitch_dates file in your WGGS-registered [via startup file] sav_dir directory by listing the *yyyymmdd* values of the dates-to-process—one per line, **no extraneous characters** [headers, spaces, extra newlines, etc].) This is due to the unification of all new-mode data-product processing into a *single* processing routine (based upon the original old-mode lzpitch.pro code) called lzswenewmode.pro. After selecting the dates-to-process, simply execute:

'.r lzswenewmode' from the IDL command-line (follow prompts).

The result is a *.mom, *.pit, and *.str data-product file for each selected date.

The processing program names, the corresponding data type names, output file name extensions, and the output file data paths are as follows:

Processing program	Data type	Extension	leprjf.gsfc.nasa.gov:data path
lzmom.pro	swe_moments	.mom	/data7/swe/moments/
lzpitch.pro	swe_fpitch	.pit	/data9/swe/ptch/
lzstrahl.pro	swe_strahl	.strahl	/data8/swe/strl/
lzpitchavg.pro	swe_fparaperp	.pitavg	/data5/swe/ptchav/

New-mode (mode7) processing: (see note above)

lzswenewmode.pro	**all new-mode**	**all ext.**	**/data3/swe/**<data-type>

The files created by these processing programs are all saved in the subdirectory mpnew whose full path is specified in the user's startup file wggs_startup.pro. This is a temporary staging location. After processing, the files must be moved to the locations on the data server machine given by the data path names in the table above.

Each processing program listed above contains documentation and is located in subdirectory wggs00/swelz , where wggs00 is the top directory of the WGGS tool.

Data calibration files used by these programs in processing the raw counts, such as relative detector gains and sun glint maps, are included within the WGGS tool.

Other ancillary data required by one or more of these processing programs are:

Ancillary data type	Description
swe_ionkp	SWE ion key parameter density and bulk flow speed
mfi_mag3s	MFI 3s magnetic field data
mfi_magkp	MFI key parameter data (used only if 3s data unavailable)
wind_orbit	WIND spacecraft orbit and attitude data

The data paths for these ancillary data are given in the startup file wggs_startup.pro. The WGGS tool accesses the MFI data files by mounting a disk exported by MFI Co-Investigator Adam Szabo. The SWE key parameter data files, the WIND orbit and attitude files, and the SWE levelzero data files are sent electronically to the server machine leprjf.gsfc.nasa.gov each day. Periodically (approximately once each week) these files must be moved from the anonymous ftp site to their permanent location on leprjf.gsfc.nasa.gov. This is done automatically by running the following program on machine leprjf.gsfc.nasa.gov and following the program prompts:

> leprjf.gsfc.nasa.gov% *idl wggs_startup*
> IDL>   .r *move_wind_files*

The SWE levelzero files received electronically may be removed from leprjf.gsfc.nasa.gov *only after* the CD-ROMs containing the SWE LZ data have been received and checked.

4d. Maintaining the SWE data files and processing system.

There are three critical functions that must be performed periodically.

1. A copy of the current version of the WGGS tool should be kept on the server machine leprjf.gsfc.nasa.gov as well as any other machine on which the tool is to be used. Current backups of the tool should be kept.

2. The ancillary files discussed in the previous section and the SWE levelzero files, all of which are currently sent to the anonymous ftp site on machine leprjf.gsfc.nasa.gov each day should be moved to their permanent disk location on leprjf.gsfc.nasa.gov by running the program move_wind_files.pro as discussed in the previous section.

3. Backups should be maintained of the following file systems containing SWE data and necessary ancillary data on leprjf.gsfc.nasa.gov using the DLT IV ½ inch cartridge tapes: (See next page for complete new-mode listing.)

leprjf.gsfc.nasa.gov file system	Program leprjf.gsfc.nasa.gov:/opt/local/Backup/
/data7	data7_moments_dump0
/data8	data8_strahl_dunp0
/data9	data9_pitch_dump0
/data5	**data5_swe_ancil_dump0**
/data2	**data26_dump0 (level zero data)**
/data3	**data13_dump0 (new-mode data)**

4e. Timeline of SWE instrument mode and bias level changes and other events affecting SWE electron data processing.

Date	Mode	Significant changes	
19941130 – 19950801	1		
		19950510	VEIS bias increase.
19950802 – 19950807	2		
19950808 - 19950916	1		
19950917 – 19950918	2		
19950919 – 19951127	1		
		19951121	VEIS bias increase.
19951128 – 19960125	2		
19960126 – 19960321	1		
19960322 – 19960513	2		
		19950513	VEIS bias increase.
19960514 – 19960813	1		
		19960813	VEIS bias increase.
19960814 – 19961108	2		
19961109 – 19961113	1		
19961114 – 19970114	2		
19970115 – 19971014	1		
19971015 – 19990125	4		
		19971028	VEIS detector response degrades more rapidly.
		19980514	VEIS bias increase.
		19980728	VEIS bias increase.
		19980811	VEIS bias increase.
		19981026	Lowest energy steps of detectors 0, 2 unusable; cause unknown.
		19981124	VEIS bias increase.
19990126 – 20020715		19990326	VEIS bias increase.
		19990405	VEIS bias increase.

20001023   VEIS bias increase.
20001023   STRAHL bias increase.
20011029   VEIS bias increase to
                  highest possible level.

20011119   VEIS bias supply fails.

20020815   VEIS turned off; new STRAHL operational-mode implemented. This marks the beginning of "new-mode" (mode7) mission operation.

Chapter 5. ISEE-1 Data Access and Display with the WGGS Tool.

<No documentation yet for this partially-developed tool functionality.>

Chapter 6. SWE/Strahl New Science-mode ("mode7") in the Absence of VEIS Data.

6a. Basics of new-mode operation.

Background Facts:
1) WIND is a spinning spacecraft with a spin-period of about 3 seconds. The spin-axis is oriented in the –Z GSE direction (s/c spin-phase given in the –ϕ GSE direction). Each successive spin is assigned a successive spincount value (0-255, "rolling over" periodically) and one spin per major-frame (LZ record) recieves a time-tag reference.
2) A sun-pulse is generated by the spacecraft's on-board processor when the s/c +X-axis points at the Sun (+X GSE direction)—the absolute s/c spin-phase (= 0°) reference.
3) A pseudo sun-pulse is then generated by the SWE DPU at a programmable angle with respect to this reference. All SWE/Strahl processing is referenced to **this** angle.
4) Each full s/c spin is divided into 4096 "clicks" of the s/c spin-phase clock. A Basic Counting Index (BCI) is defined to be 42 clicks in this mode, providing the general construct for referring collected data back to a time-and-s/c-spin-phase-angle.

    The "mode7" SWE/Strahl operation is ONLY different than mode6 in the handling of Strahl and VEIS data. It does NOT constitute a new science-mode in the sense of CDHF processing of KP data or in its effect on any other instrument. In fact, the only indicator of this mode's activity is a single (unused until now) byte in one of the housekeeping blocks (described in detail below). Otherwise, the new mode represents only a rearrangement within telemetry already allocated to SWE/Strahl and SWE/VEIS.
    Acculmulation of mode7 data takes place over three (ALWAYS consecutive) spins, and a total energy-spectrum consisting of 15 energy-steps is generated during these three spins. There are usually gaps of one or more spins between spectra, but the spincount values at the beginning of each spectrum (the "spincount-begin" values) are given in the header of each spectrum in the LZ record (described in detail below). Azimuth-angle coverage is provided by the spinning of the s/c; each spin divided into 8 sectors, each energy being visited exactly once in each sector. Elevation-angle coverage is provided by the fixed angular spread of the 12 (pairwise-binned into 6) strahl detectors (all having the same azimuth orientation at any given time—elevation angles given in detail below).
    In the first spin of a spectrum (spincount = <spincount-begin>+0) energy steps 0-4 are repeatedly visited in each of the 8 sectors. The first BCI (BCI = 0) of sector 0 of any spin comes exactly one BCI after the SWE DPU's delayed pseudo sun-pulse. Including this BCI, sector 0 subtends 12 BCIs (as do all sectors, but with different BCI values):

<div align="center">Sector 0</div>

BCI	0	1	2	3	4	5	6	7	8	9	10	11
step	S	0	S	1	S	2	S	3	S	4	S	S

Where the 'S' symbol in the 'step' row represents the settling of HV power supplies, and 0-4 on this row represent acculmulation of counts at the 5 energy steps visited in this sector. The same pattern is exactly repeated in sectors 1-7 of this spin. In the 8 sectors of spin spincount = <spincount-begin>+1 the same pattern is seen, except that steps 5-9 replace 0-4 respectively; steps 10-14 replace 0-4 in the 8 sectors of spincount = <spincount-begin>+2. This completes the acculmulation of a full energy-spectrum.

6b. Detailed specifications.

Azimuth angles:
The interpretation of strahl data requires detailed angular information. Each energy-step of each sector has a different angular position at which counts are acculmulated. Basic angular information is provided as a s/c spin-phase angle, instrument position given in payload coordinates. As mentioned above, the s/c spin-axis is aligned with the –Z GSE axis, so that spin-phase/payload angles are defined opposite to GSE conventions (but +X-axis is in the same direction either way). Hence a 180-degree rotation about the x-axis transforms "payload" spin-phase angles into GSE azimuth angles.

The following table provides **degree** measurements at the **beginning** of each BCI in a full spin (assumed to be spincount = <spincount-begin>+0—make energy-step replacements described above for the two subsequent spins), with columns to be interpreted as follows ('*' indicates counts acculmulated this BCI):

BCI: Basic Counting Index (42 clicks) begun at these angles.
SECTOR: Integer value (0-7) giving sector number for this BCI.
STEP: Integer value (0-4) giving HV step for this BCI (first spin only).
STRAHL: S/c spin-phase *look-angle* of strahl detector (payload coords.).
FLIPPED: Strahl detector *look-angle* in GSE coords. (after rotation).
VELOCITY: Strahl *particle-velocity* angles in GSE (after 180° phase-shift).

BCI	SECTOR	STEP	STRAHL	FLIPPED	VELOCITY
0	0	0	200.7	159.3	339.3
1	0	0	204.4*	155.6*	335.6*
2	0	1	208.1	151.9	331.9
3	0	1	211.8*	148.2*	328.2*
4	0	2	215.5	144.5	324.5
5	0	2	219.2*	140.8*	320.8*
6	0	3	222.9	137.1	317.1
7	0	3	226.6*	133.4*	313.4*
8	0	4	230.3	129.7	309.7
9	0	4	234.0*	126.0*	306.0*
10	0	5	237.6	122.4	302.4
11	0	5	241.3	118.7	298.7
12	1	0	245.0	115.0	295.0
13	1	0	248.7*	111.3*	291.3*
14	1	1	252.4	107.6	287.6
15	1	1	256.1*	103.9*	283.9*
16	1	2	259.8	100.2	280.2
17	1	2	263.5*	96.5*	276.5*
18	1	3	267.2	92.8	272.8
19	1	3	270.9*	89.1*	269.1*
20	1	4	274.6	85.4	265.4
21	1	4	278.2*	81.8*	261.8*
22	1	5	281.9	78.1	258.1
23	1	5	285.6	74.4	254.4
24	2	0	289.3	70.7	250.7
25	2	0	293.0*	67.0*	247.0*
26	2	1	296.7	63.3	243.3
27	2	1	300.4*	59.6*	239.6*
28	2	2	304.1	55.9	235.9
29	2	2	307.8*	52.2*	232.2*
30	2	3	311.5	48.5	228.5
31	2	3	315.2*	44.8*	224.8*
32	2	4	318.9	41.1	221.1
33	2	4	322.5*	37.5*	217.5*
34	2	5	326.2	33.8	213.8
35	2	5	329.9	30.1	210.1
36	3	0	333.6	26.4	206.4
37	3	0	337.3*	22.7*	202.7*
38	3	1	341.0	19.0	199.0
39	3	1	344.7*	15.3*	195.3*
40	3	2	348.4	11.6	191.6
41	3	2	352.1*	7.9*	187.9*
42	3	3	355.8	4.2	184.2
43	3	3	359.5*	0.5*	180.5*
44	3	4	3.2	356.8	176.8
45	3	4	6.8*	353.2*	173.2*
46	3	5	10.5	349.5	169.5
47	3	5	14.2	345.8	165.8
48	4	0	17.9	342.1	162.1
49	4	0	21.6*	338.4*	158.4*
50	4	1	25.3	334.7	154.7
51	4	1	29.0*	331.0*	151.0*
52	4	2	32.7	327.3	147.3
53	4	2	36.4*	323.6*	143.6*
54	4	3	40.1	319.9	139.9
55	4	3	43.8*	316.2*	136.2*
56	4	4	47.4	312.6	132.6
57	4	4	51.1*	308.9*	128.9*
58	4	5	54.8	305.2	125.2
59	4	5	58.5	301.5	121.5
60	5	0	62.2	297.8	117.8
61	5	0	65.9*	294.1*	114.1*
62	5	1	69.6	290.4	110.4
63	5	1	73.3*	286.7*	106.7*
64	5	2	77.0	283.0	103.0
65	5	2	80.7*	279.3*	99.3*
66	5	3	84.4	275.6	95.6
67	5	3	88.1*	271.9*	91.9*
68	5	4	91.7	268.3	88.3
69	5	4	95.4*	264.6*	84.6*
70	5	5	99.1	260.9	80.9
71	5	5	102.8	257.2	77.2
72	6	0	106.5	253.5	73.5
73	6	0	110.2*	249.8*	69.8*
74	6	1	113.9	246.1	66.1
75	6	1	117.6*	242.4*	62.4*
76	6	2	121.3	238.7	58.7
77	6	2	125.0*	235.0*	55.0*
78	6	3	128.7	231.3	51.3
79	6	3	132.4*	227.6*	47.6*
80	6	4	136.0	224.0	44.0
81	6	4	139.7*	220.3*	40.3*
82	6	5	143.4	216.6	36.6
83	6	5	147.1	212.9	32.9
84	7	0	150.8	209.2	29.2
85	7	0	154.5*	205.5*	25.5*
86	7	1	158.2	201.8	21.8
87	7	1	161.9*	198.1*	18.1*
88	7	2	165.6	194.4	14.4
89	7	2	169.3*	190.7*	10.7*
90	7	3	173.0	187.0	7.0
91	7	3	176.6*	183.4*	3.4*
92	7	4	180.3	179.7	359.7
93	7	4	184.0*	176.0*	356.0*
94	7	5	187.7	172.3	352.3
95	7	5	191.4	168.6	348.6
96	8	0	195.1	164.9	344.9
97	8	0	198.8	161.2	341.2

Elevation angles:

    This list of GSE *particle-velocity direction* elevation angles (given in degrees above the eccliptic plane), for particles entering the 6 "pseudo detectors" that result from pairwise-binning the counts from the 12 actual detectors, is derived by pairwise-averaging the (known and fixed) values for the 12—resulting in 6 "center-angles":

```
    -26.55      -17.10        -7.34         7.63        17.10        26.53
```
<div align="center">(Note: not in detector-order.)</div>

Reading new-mode strahl LZ data records:

    The file, swemode7.prt, from the 'swedatlib' directory contains a "map" of offsets into an LZ record array, allowing the count value for any detector, sector, energy-step and spectrum of the new mode strahl data to be correctly located in its LZ major-frame and stored for processing. The procedure, mode7map.pro, in the same directory reads this file and stores information about where in each major-frame to locate all housekeeping, Faraday cup and strahl data. The housekeeping (except for a previously-unused field, now storing a 'mode7 indicator') and Faraday cup data are unaffected, only the information read from the new-mode telemetry map is different from previous modes. The 'mode7 indicator' is a byte which takes on the value '0' (always has in the past) when a major-frame is not in "mode7", and takes on the value '7' when in that mode.

Spincounts, time-tags and null spectra:

    As described above, each s/c spin has an associated spincount value, and each major-frame has one time-tagged spin. In general, the time-tags for each spectrum are defined by incrementing (or decrementing) the tagged time by the appropriate number of (calculated) spin-periods needed to account for the difference between the current spectrum's spincount-begin value and the time-tagged spincount value. There are two types of exceptions, which are accounted for in the code:
1) There was a rollover (from 255 to 0) in the spincount values.
2) The spincount-begin value (and all of the rest of the values in the current spectrum—including the second byte from the same spectrum-header) is 255. This indicates a "null spectrum" where no counts were acculmulated (due to *in-situ* time limits).

Compressed counts to phase densities:

    To convert the log-compressed strahl level-zero counts into phase densities the definitions of the 'efficiency' and 'geometry' vectors from cts_f_strl.pro were revised to account for the pairwise binning of the detector counts:

```
efficiency = [0.75926, 0.75926, 0.75926, 0.82945, 0.82945, 0.82945]
geometry  = [(4.4349 + 5.4222), (6.1882 + 6.1182), (6.4422 + 6.5440),$
             (6.5149 + 6.2687), (5.9394 + 6.2334), (5.5779 + 4.5819)]
```

The change consisted of: taking efficiency values associated with the first-6 and last-6 detectors and associating them with the first-3 and last-3 of the 6 respective pseudo detectors; pairwise-summing (as above) the 12 geometric factors. Finally—in the conversion itself, again due to the pairwise binning, 1 is subtracted from the log-compressed LZ record values, then these values are uncompressed and converted to phase densities in the same way as with previous modes (but using the above values).

6c. WGGS software modifications.

Modifications to routines/sub-applications of the WGGS tool (located at <tool>):

<tool>/swelz/lzinput.pro   Calling mode7map, calling proc_rec to find mode7 science record.
<tool>/swelz/proc_rec.pro   Determining if in new science mode, calling mode7 to read a record.
<tool>/swelz/swedatlib/mode7map.pro   Reading telemetry map for new-mode records.
<tool>/swelz/mode7.pro   Reading a new-mode LZ record, unpacking/storing new-mode data.
<tool>/swelz/cts_f_strl.pro   Converting new-mode, pairwise-binned counts into phase densities.
<tool>/widgets/swe_levelzero.pro   Recognizing new-mode data, providing new-mode interface.
<tool>/swelz/strl_newmode.pro   Sel. new-mode rec. prelim. proc., calling strl_phth_newmode.
<tool>/swelz/lztimrec.pro   Makes time-to-record/spectrum (instead of record/spin) conversion.
<tool>/swelz/strl_phth_newmode.pro   Display current spectrum of new-mode strahl data.

6d. Use and function of SWE levelzero display with new mode.

See Appendix 3 for a detailed description of the use and function of the level-zero data interface widgets. This section provides a brief description of the differences in using the interface with new-mode data. There are several features which are "turned off" in the new-mode format, most of the remaining features behave as described in the appendix.

There are a few exceptions:
1) The 'Spin' button/field widget becomes the 'Spectrum' widget, but otherwise behaves the same. Allows the user to increment display by one spectrum.
2) The 'Plot-type' droplist has been replaced by a 'style' droplist:
     '**style 1**': The energies which make up a strahl spectrum are displayed in an "alternating" order which proceeds (in order of increasing energy) along each row before proceeding to the next. This display-style is useful because it displays the full strahl energy range in each column.
     '**style 2**': The energies are displayed in a "monotonic" order which proceeds (in order of increasing energy) down the left, then right, columns. Energy-dispersion effects are more easily seen in this style.

The new-mode strahl data display itself is to be interpreted in the following way. The azimuth and elevation *particle-velocity direction* angles described above provide the absissa and ordinate, resp., for each plot-panel (displaying phase-densities for counts of particles at the labelled energies). Each panel is overplotted with contours at the ¼-max and ½-max phase-density levels. The '+' and '-' symbols annotated on each plot-panel indicate the magnetic-field and anti-magnetic-field directions, resp. The vertical dotted black lines in each sector (denoted by blocks of constant phase-density color) of each plot-panel, indicate the angles at which count-acculmulation actually began for that particle-energy, in that sector. Finally, as a reference, the vertical solid white lines in each plot-panel mark the 0° and 180° (resp.) *particle-velocity direction* angles.

Appendix 1. How to start the WGGS tool and description of the startup procedure.

Installation of the WGGS tool.
The WGGS tool is packaged in the directory wggs00/ and its subdirectories. The latest
version, where 00 designates version number, can be found as a tar file in the anonymous
ftp site of the server machine leprjf:ftp/ftp/pub/exports/wggs00.tar. To install the tool,
first copy wggs00.tar to the user machine and untar:

> % *tar xvf wggs00.tar*

which creates the tool directory wggs00/ and its subdirectories.

Secondly copy the IDL startup procedure, wggs_startup.pro from the same leprjf ftp site
to the user machine at the same directory level as wggs00/. The startup procedure
includes the path to the most recent version of the WGGS tool software as well as other
data paths and the setting of environment variables. The startup procedure
wggs_startup.pro contains documentation with instructions on how to tailor it to the
user's computer environment. The listing of the startup procedure is included in this
appendix.

Thirdly, if this is a new installation, make sure that there is not a directory on the user
machine named idlsav in the data path sav_dir , which can be found in a line near the
beginning of wggs_startup.pro. A new idlsav directory will be created the first time the
tool is used if a directory of that name does not already exist.

Running the WGGS tool.
The WGGS tool is now ready to run. The normal use of the WGGS tool begins with the
start of an IDL session as follows:

> % *idl wggs_startup*

where wggs_startup is the name of the startup procedure, wggs_startup.pro. The WGGS
tool is started by typing at the IDL prompt:

> IDL> *wanal*

which brings up the main *Survey Data Display*.

Editing the startup procedure.
The listing of the startup procedure with line numbers follows on the next pages. The
documentation included in the listing should guide the user as to what needs to be
changed or updated. The lines 1 – 44 contain *required* user settings, lines 8, 10, and 12
being the most important. The lines 45 – 148 contain *optional user settings,* the most
important being the data paths to the SWE level zero data and the survey data. These data
paths may be direct paths to specific data directories or to mount points on the user's
machine.

Appendix 2. Use and Function of the Survey Data Display Widgets.

The following is the documentation to explain the use and function of all the widgets in the *Survey Data Display* which is available by clicking on the **HELP** button. The buttons, fields, droplists, and labels appear here in bold type, e..g., the **HELP** button, and to the right is a brief description of the action caused by the respective widget event, such as clicking on a button.

BUTTON/FIELD/DROPLIST   ACTION

SWE level zero   Starts/brings forward *SWE LZ Data Display*.
                             Use this button rather than mouse button on window
                             to bring forward *SWE LZ Data Display*!

ISEEf   Starts/brings forward ISEE f *DATA INTERFACE*.
                             (ISEE moments MUST have already been read.)

Path   Displays the input (source) data paths for all of the various
                             data types and permits changes to be made.

HELP   On-line documentation.

Quit   Normal exit.

Date/File   Toggle to File to select from a list of files.
                             Toggle to Date to automatically search files.

yyyymmd   Enter date (yymmd) for file search by date; the date
                             will also appear when file is manually selected.

Nr days   Select number of days for multiple day plot.

swe_strahlen   Use the droplists which display the two energies to be
                             displayed when data type **swe_strahlen** is selected.

Button group **SELECT input data types, then READ** :
One or more data types (swe_moments etc) may be selected. The last selected data types are retained.
NOTE: When swe_moments are selected, swe_ionkp is automatically selected and overplotted on the electron plots.

READ   Click to read the data types last selected above.
                             The data interval read is the number of days selected
                             above beginning with the selected date in yyyymmdd.
                             After the data is read,a list of available data
                             variables appears from which to make plot selections.

(See **Select plot variables** button below.)

READ/PLOT sequence	A widget appears which permits data to be read and plotted on sequential days with a single button click. The data type will be the current data type selection, and the plot variables will be those stored in the selected plot variable buffer. (see **Select plot variables** button below)
Data version	Displays data versions of data types for which multiple version exist. The default in all cases is **Latest**, but other versions may be selected.
Select plot variables	Widget *AVAILABLE DATA* appears. Select one or more data variables to plot. Button **Do plot** plots the data.

Short cuts: After making a plot variable selection, it may be saved by clicking on one of **Save X** buttons, where X=0,1,2,3. The saved selection is then plotted by the corresponding **Plot X** button. The **Save X** buffers are not reset with a new IDL session, but rather are kept.

Default time interval plotted: entire file.

Special cases: For certain data types, additional plot parameter choices can be made, For example, when plotting strahl peak flux,the available energies also appear in the *AVAILABLE DATA* widget.

Change plot parameters   Widget *CHANGE PRESET PLOT PARAMETERS* appears. Plot parameters such as y-axis range, i.e., Y min and Y max, yaxis labels, tick marks, etc can be altered from their default preset values for each panel individually. Changes made here are retained during the current IDL session. The "**Y-axis**" button described below toggles the Y-axis range between the preset and min-max of the plotted variables for all panels.

The vertical size of each panel relative to the other panels is displayed and can be changed. For example, a given panel can be made twice as large as the rest.

To select time intervals to plot:
The default time interval plotted is the entire file. To "zoom", i.e., to select a time
subinterval to plot, click the left and middle mouse buttons at the begin and end times,
respectively, of the desired interval. When the middle mouse button is clicked, a new
widget pops up entitled, *SELECTED TIME INTERVAL*. These are the relevant buttons in
the pop-up widget: Click on **Plot** to plot the new time interval. The new time interval
becomes the current time interval and is retained until a different time interval is selected.
Click on **Store interval and plot** to store any selected time interval to be kept for later
recall even as the current interval changes.

Button group **Time interval**
The currently selected variables can be plotted for various time intervals:

Current   The current time interval.

                   The current time selection may be replotted at any time.
                   In particular, if program wanal is restarted in a given IDL
                   session, data does not have to be reread, but rather the
                   plot can be restored by clicking the **Current** button.
                   NOTE: Going back and forth between windows may sometimes cause plot
                   controls to become "unset" and the tool may appear
                   unresponsive. Try clicking on **Current** or **Original** to reset.

Previous   The time interval selected prior to the last (current)
                   selection is plotted.The current time selection still in memory.

Original   The input time selection is plotted and becomes
                   the new current selection.

Stored   The time interval saved in memory for later recall.

Array reduction   To keep plot array sizes manageable, IDL library procedure
                           congrid.pro reduces the array size using an interpolative method.
                           Use of **congrid** is the default. The droplist povides
                           the option to turn off array reduction. When using the
                           IDLsave button (described below) to create a file of
                           the plotted data, array reduction should be set to
                           off to retain the full time resolution in the
                           created data file.

Smooth   Median smoothing, 3, 5 or 10 points (0 is no smoothing).

Y-axis   Choices for the y axis scale are **Preset** (default) and **Minmax.**
                  The Preset values can be changed using button
                  Change plot parameters. The original default preset values
                  can be reset by using button **Select plot variables** and

redoing the plot variable selection or using button
Change plot parameters and clicking on **Restore**.
These actions do not change the time interval.

Time axis   The **Selected time interval** widget appears.

Hardcopy droplist:

Hrdcpy bw   Makes black and white hardcopy of current plot.

Hrdcpy clr   Makes color hardcopy.

Printer/file   Pop-up widget displays and allows changes in names of
printer and printfile.

Color scale droplist:

Color tbl   IDL procedure xloadct.pro is used to display and/or modify
the color table (stretching etc).

Restore clrs   Current color table is restored and the top color
(plot axes, etc) is set to white.

Application droplist:

WIND orbit   Plots the orbit for the current day.

Local Appl   Local user applications. Executes procedure
local_appl.pro if it exists in directory specified by
LOCALUSER environment variable in startup file.

IDLsave   An IDL save file is made of the plotted data which may be
retrieved by IDL restore (line plots only). It is adviseable
to turn the array reduction FROM congrid TO off in order to
retain full time resolution.
The saved data files may be accessed as follows:
        ".run idlsav_plot" to plot the data,
        ".run idlsave_to_ascii" to create an ascii file,
        ".run idlsave_to_ascii_cols" to create an ascii file
in column format.

Appendix 3. Use and Function of the SWE Levelzero Data Interface Widgets.

The following is the documentation to explain the use and function of all the widgets in the *SWE LZ Data Display* which is available by clicking on the **HELP** button. The buttons, fields, droplists, and labels appear here in bold type, e..g., the **HELP** button, and to the right is a brief description of the action caused by the respective widget event, such as clicking on a button.

The top plot window contains one of survey plots from the parent widget.
Which of the survey plot variables that is plotted here can be selected using the first droplist in the second row of buttons above the plot panel.

The three lower windows are available for distribution function plots at selected times.

The top row of buttons:

BUTTON/FIELD/DROPLIST   ACTION

Parent   Returns to main or "parent" widget *Survey Data Display*. From *Survey Data Display*, click **SWE level zero**
                to get back to this "child" widget.
                NOTE: Use parent and child buttons to go back and forth
                between widget displays. Avoid using the windows mouse functions to
                bring windows forward.

HELP   On-line documentation.

Quit   Normal termination.

Dates   Droplist containing all dates for survey data read in. Any date
                from this list may be selected and will be read when "Open LZ"
                is clicked.

Open LZ   Opens SWE lz file, reads anciliary files,
                orbit-attitude, 3sec magnetic field, sun glint mask,
                VEIS background counts. Distribution function data can now
                be plotted directly using data from the opened levelzero file,
                as discussed below under "Ways to select time".

Veis data   Brings up the SWE VEIS Counts Data display widget
                which has its own HELP button.

Strahl data Brings up the SWE Strahl Counts Data display widget
                which has its own HELP button.

Color adjustment droplist:

Xloadct A widget pops up which allows adjustment of color
scale (stretching etc) or changing color table.

Restore colors Current color table restored which also sets the
top color (plot axes, etc) to white.

Hardcopy droplist:

Hrdcpy bw Makes black and white hardcopy of current plot.

Hrdcpy clr Makes color hardcopy.

Applications droplist:

Orbit Window appears with orbit plot.

Display options Pop-up window appears providing various information about
and control of display options. A HELP button is included.

Scan LZ file A new widget appears containing various instrument and
data information from the telemetry record.

Save f Makes an ASCII file of perpendicular and parallel cuts and
reduced F vs parallel velocity, as well as the measured f
closest to parallel, anti-parallel, and perpendicular.

The second row of buttons:
BUTTON/FIELD/DROPLIST   *ACTION*
Droplist of survey plot variables. Choose one to plot in upper panel.

mode The SWE/VEIS instrument mode is displayed: 1, 2, 4, or 6.

-------------------- *Ways to select time*: ---------------------------------------
There are several ways to select times for plotting distribution function data:
1. Click at desired time in the top panel (with left mouse button) and plot
will appear in one of three bottom panels. Successive clicks on top panel will
cause plots to cycle through the three bottom plot panels.
(A vertical line at the selected time will appear in the upper panel).

2. Click on any of three bottom panels and the plot at currently selected time
will appear.

3. Click on Spin "+" or "-" button or click on Mfrm (major frame=7 spins)
 "+" or "-" button to increment the time index; the plot at the newly

selected time will appear. Successive clicks on "+" or "-" will cause plots to cycle through the three plot panels. The spin (mfrm) number will appear in the field to the right.

4. Click on the "auto" button to cause three successive plots to appear, one in each window.

5. Enter time explicity into "hhmmss" field.

Plot type droplist:

fcntrs   Contours of f on perpendicular-parallel velocity grid with magnetic field direction along +vparallel.

f(en,pa)   Color-coded pitch angle distribution on energy-pitch angle grid.

fcuts   Parallel (solid line) and perpendicular (dashed line) cuts of f and measure data sampled closest to magnetic field (+/-) direction (triangles). Dotted line is one-count level.

redF   Reduced distribution.

f fcuts   Contours and cuts of f (default).

f F   Contours of f and reduced f.

fsurface   Perspective 3-D contour map of f.

triangles   The triangulation mesh computed by triangulate.pro to help show the validity of the platewise interpolation used to do contouring.

fpolar   Contours of f on perpendicular-parallel velocity grid with magnetic field direction along +vparallel.

vstps   Truncate the upper range of energy steps included in plots of f by selecting a number less than 16.

pbin   Select the value of the pitch angle bin used for the data in making the polar plots of f, i.e., contours, etc.

Appendix 4. How the Survey Data Display Works.

This section is an introduction to the inner workings of the tool. A working knowledge of the IDL language would be helpful though not essential in reading it. The reader whose only interest is in using the tool may skip this section. It is intended for those readers who may be involved in setting up the tool or wish to adapt it, i.e., to access and plot a new data type or to add a new application for an existing data type.

The following are the names of the experiment data types currently accessed by the *Survey Data Display*:

IDL> print, d.datype

swe_moments	SWE VEIS electron moments
swe_fpitch	SWE VEIS electron pitch angle distributions
mfi_mag3s	MFI 3s magnetic field data
swe_ionkp	SWE Faraday cup solar wind ion data
mfi_magkp	MFI key parameter magnetic field data
swe_strahl	SWE strahl sensor data
isee_moments	ISEE-1 VES electron moments and distributions
wav_tnr	WAV 1m TNR data
swe_redfcuts	SWE reduced velocity distributions
wav_hrtnr	WAV high resolution TNR data
swe_strahlen	SWE strahl data at selected energies
wind_orbit	WIND orbit data
swe_fparaperp	SWE 60° pitch angle averages
wav_nekp	WAV key parameter electron density
wav_nehr	WAV high resolution electron density

Data structure d.

The heart of the *Survey Data Display* functionality is the data structure *d.* It contains all that is necessary to read the selected input data, such as data paths, the input data itself, and all the parameters necessary for constructing and controlling the data display. The structure *d* is created automatically and is accessed by all parts of the program through the common block, *common shared,d*. The structure *d* with the tag names *NDVAR, DATYPE*, etc is described below using the IDL language command, *HELP,/STRUCTURE* . Explanatory notes are included to the right of only those tag names that are relevant to this introduction. Tag names of structure *d* which relate to the internal operation of the widget interface are not discussed.

IDL> help,d
D (SHARED)   STRUCT   = -> <Anonymous> Array[1]
IDL> help,d,/str

NDVAR	LONG	15	Number of input data types
DATYPE	STRING	Array[15]	Names of input data types
DIR	STRING	Array[15]	Data path for each data type

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```
PATHENV        STRING   Array[15]              Data path environment variables
FLTR           STRING   Array[15]              Data filename extensions
FLNM           STRING   Array[15]              Data filename for each data type
DATYPE_INPUT   INT      Array[15]
WILABL         STRING   Array[15]
PNLIST         STRUCT   -> <Anonymous> Array[1]
NDX            LONG     Array[2, 15]     Begin and end indices of current time interval.
NDX_ORIG       LONG     Array[2, 15]
NDX_LAST       LONG     Array[2, 15]
NDX_BUFF       LONG     Array[2, 15]
NDX_BUFF2      LONG     Array[2, 15]
NDX_STORED     LONG     Array[2, 15]
PNL            STRUCT   -> <Anonymous> Array[174]              See below.
PNLSEL         INT      Array[174]
PNLSEL_LAST    INT      Array[174]
WDATYPE        LONG     Array[174, 15]
TIMSEL         STRING   'lz'
XSCROLL        INT      Array[15]
YSCROLL        INT      Array[15]
BTTN           INT      Array[15]
WITYPE         INT      Array[15]
REFSEC         DOUBLE   0.0000000        The reference time used for all plots.
MAXNUMBERDAYS  INT      4
DATYPE_MULTIDAY STRING  Array[8]
```

If for example, the data types, *swe_moments*, *swe_fpitch,* and *swe_strahl* were selected as input data, then the following tags referencing the input data would be concatenated to the structure *d*:

```
SWE_MDAT       STRUCT   -> <Anonymous> Array[12754]
SWE_PDAT       STRUCT   -> <Anonymous> Array[12749]
SWE_STRAHLDAT  STRUCT   -> <Anonymous> Array[12749]
```

Each of the 15 data types in the list, *d.datype*, has a corresponding list of variables available for plotting, and the variable lists for all data types are concatenated into a single list totaling 174 elements, each element being a plot variable name string. For each of the 174 plot variables, there is a set of plot control parameters, most of which correspond to standard keywords used in the IDL plot routines. The plot variable names, the corresponding data types, and plot control parameters are the tags of the structure, *d.pnl*, described below:

```
IDL> help,d.pnl
<Expression>   STRUCT   = -> <Anonymous> Array[174]
IDL> help,d.pnl,/str
DTP            STRING   "                Data type of the plot variable, *varname*.
VARNAME        STRING   "                Plot variable name.
```

In this document, the term *data type* will always refer to the data type name as given by *d.pnl.dtp* (or *d.datype*), and the term *plot variable* will always refer to the quantity to be plotted as given by *d.pnl.varname*. For example, a partial list of plot variables for the data type *swe_moments* is 'N density', 'T temperature', 'U flow speed', etc.

The remaining tags to *d.pnl* are plot control parameters:

```
YPNLP          FLOAT        0.00000
ZTITLE         STRING    "
LABL           STRING    "
RANGE          FLOAT     Array[2]
TICKS          INT          2
MINOR          INT          5
TICKV          FLOAT     Array[30]
TICKNAME       STRING    Array[30]
SUBTITLE       STRING    "
TMLABL         STRING    "
TMRANGE        DOUBLE    Array[2]
TMTICKS        INT          2
TMINOR         INT          5
FILL           FLOAT     -1.00000e+31
TMTICKV        DOUBLE    Array[30]
TMTICKNAME     STRING    Array[30]
PLOTIO         INT          0
PSYM           INT          0
SYMSIZE        FLOAT        1.00000
OPLOT          INT          0
OPLOTVAR       STRING    "
OLINESTYLE     INT          0
OCOLOR         INT          225
PLTYPE         STRING    "
ENINDX         INT          0
INDX           INT          0
XORY           INT          0
EV_VAL         INT          0
STEP           FLOAT        0.00000
LZRANGE        FLOAT     Array[2, 2]
CHARTHICK      FLOAT        1.00000
CHARSIZE       FLOAT        1.15000
HORIZLIN       FLOAT     -1.00000e+31
```

Having outlined the essential parts of the structure, *d*, its use in the program will be discussed. The following table illustrates a typical selection of data variables to be plotted as a panel stack, beginning with the top panel:

Table 1.

Panel i	Data Type d.datype(ityp(i))	Type index ityp(i)	Data Variable d.pnl(ivar(i)).varname	Variable Index ivar(i)
0	swe_moments	0	heat flux	6
1	swe_fpitch	1	spin avg f(en,t)	45
2	swe_fpitch	1	94.3	55
3	swe_strahl	5	strahl energy spectrum	93

The data types and data variables are selected by the user from the widget interface using the names given in the second and fourth columns,respectively, of Table 1. The other columns in Table 1, i.e., the first, third, and fifth columns, are indices determined by the

program corresponding to the user selection and are used in structure *d* to reference the data, transparent to the user. The data type indices (third column) are

ityp = where(d.datype_input ne –1) = 0, 1, 5.

The *swe_strahl* data structure corrsponding to ityp(3)=5, for example, is referenced as

d.swe_strahldat(d.ndx(5,0): d.ndx(5,1)).*tag* ,

where d.ndx(5,0): d.ndx(5,1) is the range of indices of the *swe_strahl* data for the selected time interval, and the tag represents an input data variable, such as time or flux. The plot variable indices (fifth column) are

ivar = d.pnlsel(where(d.pnlsel ne –1)) = 6, 45, 55, 93.

The parameters for controlling the *strahl energy spectrum* plot corresponding to ivar(3)=93 are referenced as d.pnl(93).*tag* (unless overridden in the plot procedure itself), where the tag represents a parameter such as the y-axis range.

Survey data directory structure.

All of the procedures pertaining to a specific data type are located in a single subdirectory whose name is the same as the data type. The directory structure for the currently available data types is

wggs00 /survey/:

swe_moments /	swe_fpitch/	mfi_mag3s/
swe_ionkp/	mfi_magkp/	swe_strahl/
isee_moments/	wav_tnr/	swe_redfcuts/
wav_hrtnr/	swe_strahlen/	wind_orbit/
swe_fparaperp/	wav_nekp/	wav_nehr/

where wggs00/ is the top directory of the entire tool. Each data type subdirectory has a requisite set of procedures given by the following, where *exp_dtyp* represents one of the above data type names:

wggs00/survey/ *exp_dtyp*/:

*exp_dtyp*_list.pro	List of plot variables included in d.pnl.varname.
*exp_dtyp*_read.pro	Reads the input data.
*exp_dtyp*_timerange.pro	Returns begin and end times of the data.
*exp_dtyp*_datatime.pro	Returns data time relative to reference time.
*exp_dtyp*_struct.pro	Returns plot parameters for each plot variable listed in *exp_dtyp*_list.pro.
*exp_dtyp*_plt.pro	Plots the data corresponding to the plot variable selected in the panel whose position in the stacked plot panels is determined by the order of selection.
*exp_dtyp*var.pro	Called by *exp_dtyp*_plt.pro, returns the actual data for each plot variable selected for the current time interval.

The above procedures must be tailored to to each specific *exp_dtyp.* These are the

minimun requisite procedures but subdirectory wggs00/survey / *exp_dtyp* / may include other procedures or functions to be called by any of the above to meet a specific requirement. For example, the data type *swe_strahl* requires procedures for making both line plots and images, and therefore, swe_strahl_plt.pro calls another procedure swe_strahl_spectrum_img.pro, which is also located in subdirectory, wggs00/survey / swe_strahl. The requirements for each of the requisite set of procedures under each wggs00/survey/*exp_dtyp*/ is given in Appendix 5, which discusses in detail how to expand WGGS to include new data sets.

Survey data flow.

The following is the sequence of called procedures and widget actions necessary to select, read, and display a set of plot variables, represented by *var,* from a selected set of data types, represented by *exp_dtyp*. In the following, *Widget* and *Keyboard* refer to user actions via the widget interface and keyboard, respectively, and the fully qualified procedure name, *path/procedure.pro*, refers to the automatic execution of the named procedure by the program.

Action / called procedure	Result
1) Keyboard: wanal	Starts the tool.
wggs00/init/define_widgets.pro	Defines all widget interfaces.
wggs00/init/panelist.pro	Creates/initializes structure, *d*.
2) Widget: Enter begin date, nr. days	
3) Widget: Select data types, *exp_dtyp*	Stores data type selections, *exp_dtyp*.
4) Widget: Read	Initiates data read-in.
wggs00/init/panelist.pro	Structure *d* is re-initialized.
wggs00/survey/input.pro	Data type selections *exp_dtyp* are put into *d.datype_input*.
	Current data paths are searched for the selected data type files according to date.
*exp_dtyp*_read.pro	Data for data type *exp_dtyp* are read in and concatenated onto structure, *d*.
	Common reference time is established.
	Orbit and attitude data are read.
5) Widget: Select plot variables	
wggs00/widgets/select_pltvar.pro	Plot variables, *var*, are selected.
6) Widget: Do plot	Initiates the plot.
wggs00/survey/mstruct.pro	Plot parameters common to all panels stored in appropriate tags of *d.pnl*.

wggs00/survey/*exp_dtyp*/ *exp_dtyp*_timerange.pro	Set time axis scale.
wggs00/survey/*exp_dtyp*/ *exp_dtyp*_struct.pro	Set y-axis and other plot parameters for each plot variable of set, *var* and stored in d.pnl.
wggs00/survey/plt.pro	Set the plot window coordinates for each panel.
wggs00/survey/*exp_dtyp*/ *exp_dtyp*_plt	Plot data corresponding to each variable of set, *var*, in panel according to order of selection.

Appendix 5. Expanding WGGS to Include New Survey Data Sets.

The WGGS tool can be readily adapted to include new survey data sets. These are the steps to follow:

1. Select a descriptive name for the data type of the form *exp_dtyp,* where *exp* represents a satellite or project and *dtyp* represents a specific experiment or source of the data.

2. Select names for the variables to be plotted represented here as the set var={var1, var2,…..}. <u>Note</u>: The names of these variables *must* be unique among *all* datatype-variable-names. This is because sometimes (internal to WGGS) these names are used as the only identifier of a time-series, and non-uniqueness could cause problems.

3. A subdirectory named *exp_dtyp* must be created under the directory wggs00/survey. A template subdirectory with the requisite files exists which should be copied and given the name selected in step 1. The subdirectory and its files with a brief description is as follows:

wggs00/survey/ *exp_dtyp*/:

*exp_dtyp*_list.pro	List of plot variables *var*.
*exp_dtyp*_read.pro	Reads the input data.
*exp_dtyp*_timerange.pro	Returns begin and end times of the data.
*exp_dtyp*_datatime.pro	Returns data time relative to reference time.
*exp_dtyp*_struct.pro	Returns plot parameters for each plot variable listed in *exp_dtyp*_list.pro.
*exp_dtyp*_plt.pro	Plots the data corresponding to the selected plot variable.
*exp_dtyp*var.pro	Called by *exp_dtyp*_plt.pro, returns the actual data for each plot variable selected for the current time interval.

4. After naming the above directory with the name selected for new data type, each of the files may be readily modified by searching for the dummy data type name *exp_dtyp* wherever it occurs and substituting the selected data type name. Procedures

*exp_dtyp_*list.pro, *exp_dtyp_*struct.pro, and *exp_dtyp*var.pro will also require searching for the dummy variable names *var1,var2,...* and substituting the actual plot variable names. The procedure *exp_dtyp_*struct.pro contains plot axis and other plot appearance parameters and must be modified to meet the user's requirements. The procedure *exp_dtyp_*read.pro must also be specially modified to read the new data . The template *exp_dtyp_*read.pro contains all that is required and must be included, such as specific time formats, data index definition, and concatenation of structure *d.*

5. The directory wggs00/survey/ *exp_dtyp*/ also contains two additional procedures which are not part of the actual directory for the new data type, but are included as templates for the two remaining procedures to be modified. They are panelist_illustrative_version.pro and startup_file_ illustrative_version.pro. Follow the instructions in the documentation at the beginning of each file on how to modify. Then replace (or modify) the old wggs00/init/panelist.pro and your old startup file (located in the directory in which the IDL session is started) with the new versions.

6. Finally, be aware that—in some cases—there may be a need to (possibly with help from a SWE Data System developer) modify the following fileswhen adding new (or modifying old) data types: wggs00/survey/input.pro, wggs00/survey/get_flnm.pro and wggs00/survey/mstruct.pro. This requires advanced understanding of IDL.

7. This completes the installation of the new survey data type. All of the functionality of the tool is now available to the new data type.

Appendix 6. Relative gain balancing of VEIS detectors.

The six VEIS channeltrons have aged over time since the WIND launch with variable rates of degradation of detector response. The channeltron bias levels were raised periodically to counteract this natural aging process. In order to accurately compute the odd electron velocity moments such as the bulk flow velocity and heat flux vectors, it is necessary that the response of the six channeltrons be balanced relative to each other. To account for channeltron aging and changes in bias levels, the detectors were balanced on a regular basis, approximately once each five to ten days, and a set of six gain factors were determined. The set of six factors were normalized to one of the detectors, which appeared to be most constant over time. These periodically determined gain factors were used to compute by interpolation a table of gain factors, one set of six for each day, during the useful lifetime of the VEIS spectrometer, 1994 – 2002. This relative gain table is included within the tool and its application to the data is transparent to the user. The following is intended to document the gain balancing procedure and to serve as a guide should it be necessary to repeat the process.

The procedure for balancing the gains of the six VEIS detectors is outlined in the following steps. Graphical user interface names are given in italics, e.g., *Survey Data Display*, and widget buttons, fields, and droplists are in bold type, e..g., the widget button, **SWE level zero**.

1. Select a time period over which gain balancing is to be done, from 1-30 days, and plot the WIND plasma and magnetic field key parameters, Ni, Ui, B, θ_b, and φ_b in the *Survey Data Display* plot window.
2. Select a day containing an approximately one hour interval in which Ni > 5 and φ_b is approximately 90° or 270°, if possible.
3. Click on the widget button **SWE level zero** in the *Survey Data Display* which causes the *SWE LZ Data Display* interface to appear.
4. In the *SWE LZ Data Display*, select the chosen date from the droplist and click on **Open LZ**.
5. With the left mouse button, select a time causing a plot of f(v$_\parallel$, v$_\perp$) to appear.
6. Click **VEIS data** in the *SWE LZ Data Display* and the *SWE Veis Counts Data* interface will appear with the default plot, counts vs speed for each detector in sector 0. This is a display of raw counts for opposing pairs of detectors 0-5, 1-4, and 2-3. Sectors 0 through 5 can be displayed by incrementing **Sect** for the given spin and major frame. This plot is also created when **Cts_step** is clicked.
7. Click **Relative gain determination; Background** in *SWE Veis Counts Data* and the *Do counts average* widget interface will appear.
8. In the the *Do counts average* interface, select a detector, 0 through 5, to which the computed gains of each detector is to be normalized by using the droplist labeled **Normal detector.** Select the detector which has been most stable over time with high counts.
9. Select the energy for which the pitch angle distributions for each detector are to be computed in the gain balancing procedure by using the droplist labeled **Energy step (ev)**. Energy 29 eV is suggested.
10. Select which of the six detectors 0, 1, 2, 3, 4, and 5 are to be used in the gain balancing. If all six detectors were to have aproximately equal responses, than all six would be used. If one or two detectors were to have a severely diminished response compared to the rest, say down by a factor 10 or more, then those detectors should not be included in the gains determination. For example, if detectors 0 and 2 are not to be included, then select the set of detectors **1345** from the droplist labeled **Pitch fit: Det's**. Gains will be computed using detectors 1, 3, 4, and 5 and normalized to the detector selected in step 8. Detectors 0 and 2 will be assigned a gain of 0 in the gains table for the purpose of identification, but the gain factors actually used for detectors 0 and 2 will be unity.
11. Click on **Accumulate slctd spins (YES glint rmvd)** which will sum the raw counts for each detector (included in step10) over 30 major frames or 210 spins beginning at the current record and spin.
12. Click on **Pitch fit each detector, get rel gains.** A new set of six plots, one for each detector, will appear in the plot window. Each plot contains the sum of counts vs pitch angle and the parabolic fit for the given detector as well as the parabolic fit to the total counts of all detectors (only for detectors included in step 10) vs pitch angle. The ratio of the pitch angle fit using all (included) detectors to the pitch angle fit of each detector individually is defined as the gain of the given detector. The gains are then normalized to the gain of the detector selected in step 8 and is printed in the command window. These are the factors by which the raw counts are multiplied to correct for imbalance in the detector set, which is primarily due to differing rates of

aging of the channeltrons and changes in voltage bias levels of channeltrons that have been made at various times during the WIND mission to compensate for diminishing response.

13. If satisfied with the computed gains, then click on **Save relative gains** which appends the relative gains and date to the file wggs00/swelz/swecal/gains/gainsrev/add_to_lib.ascii.

14. Repeat steps 2 through 13 for other dates in the survey plot (step 1). Choosing dates 3 to 6 days apart is suggested.

15. The next step is to use the gains for selected dates saved in step 13 to compute gains for each day in the selected time period using a fitting procedure within wggs00/swelz/swecal/gains/gainsrev/getrelgains_tblgen_after_19971027.pro. Add the time period over which the fit is to be made by editing getrelgains_tblgen_after_19971027.pro (array date_range =), then run the procedure. A plot of the calculated input gains and the fitted gains will appear and a file of the fitted gains for each day will be created, both in ascii form and and as an IDL restore file. Add the time period (from the addition to the array date_range above) and the name of the IDL restore file to the appropriate else-if statement in wggs00/swelz/swecal/gains/gainsrev/getrelgains_tbl_flnm.pro. The ascii file provides a visual check of the daily gains table just created and the restore filename is returned by getrelgains_tbl_flnm.pro when referenced by date by wggs00/swelz/lzinput.pro. The restore file with the appropriate gains is read by lzinput.pro each time a level zero file for a new date is opened.

16. The final step is to check the daily gains just determined. Display again the survey data for the original time interval in the *Survey Data Display* plot window and click on **SWE level zero.** On the *SWE LZ Data Display*, click on **Open LZ** for any of the dates plotted. Select a time causing a distribution function to be plotted and then click on **Veis data** to bring up the *SWE Veis Counts Data*. Click on **f w/ new patch** which will display a fitted gaussian patch over the thermal core portion of the measured distribution function. The new gains are used in the patch and are displayed in the widget field labeled **Relative gain adjustment, Old**. The density, temperature, and flow velocity magnitude, elevation, and azimuthal angles of the fitted gaussian are displayed in the plot window. (The patch is Adolfo Vinas' standard 3D patch used in moments calulations and which uses data from all detectors and all sectors in a 3D gaussian fit. Certain detectors and sectors are not used in the fit depending on data quality and whether a particular detector or sector was included in the gain computation. Which detectors and sectors are used to compute patch is prescribed by the array of indices, swest.patch_include.) The criterion used for gains which balance the detectors reasonably well is that the flow velocity elevation angle should be between -30° and +30° of the ecliptic plane.

Appendix 7. Treatment of sun glint effects.

Soon after the WIND launch and onset of the operation of the SWE VEIS instrument, it became apparent that the measured electron spectra contained high count rates when certain detectors were either facing the Sun, or were facing a particular fixed direction relative to the Sun, and which were repeated with each spacecraft rotation. It was

concluded that the extraneously high counts were due to sunlight penetrating certain detectors viewing the Sun directly, and in the case of one particular detector, from sunlight penetrating via a glancing reflection into the detector. This so-called "sun glint" had the effect on the VEIS distributions of appearing to show a constant high flux of electrons from the direction of the Sun. The solar wind electron heat flux, for example, would always appear to come from the Sun instead of being magnetic field aligned. The solution to the problem was to identify and remove the effects of the sun glint.

Three methods were utilized. One was to put the VEIS instrument into a mode in which it would only measure the background spectra and not the ambient electrons. The measurements at *detector, energy sweep step,* and *sector* samples that were contaminated by sun glint stood out prominently against the normal background. This formed an initial identification of *sun-glint detector, energy sweep step,* and *sector* samples to be used in subtracting background from the measured electron spectra.

A second method of identification was to accumulate the differences in measured electron counts from opposing detectors for an extended period, usually one day, and plot the differences against sun phase angle of the measured sample. If there were no favored direction, it was assumed that the counts differences would average out to zero for the extended period. If the Sun were a favored direction then the differences would peak for measurements looking toward the Sun. The set of *sun-glint detector, energy sweep step,* and *sector* samples determined by this method were consistent with the set obtained by the first method.

A third method was used which was to visually inspect the spectral plots. Most of the *sun-glint detector, energy sweep step,* and *sector* samples from the first two methods were clearly identifiable, but not in every case.

A sun glint map using the above methods was determined for a particular period, say one week to one month, applied to the data and electron moments were computed. The operational criteria for success in eliminating or minimizing the sun-glint effects was that the solar wind bulk flow velocity vector should lie within +/- 20 degrees of the ecliptic and that the solar wind heat flux vector should track with the magnetic field direction when there is a significant heat flux magnitude. It was found that the sun glint map could be effectively fine-tuned by adding to or subtracting from the sun glint map by inspection of the spectral plots (method three above) and recomputing the moments velocity vector with the modified sun glint map. This method was applied during the early years of the WIND mission and a sun glint map was found to apply to nearly the whole mission. This indicates that the sun glint effects on the instrument were essentially constant over time and is consistent with the fact that the WIND attitude changed very little.

The application of the daily sun glint map is applied to the data transparent to the user. The *sun-glint detector, energy sweep step,* and *sector* samples are readily identified as highlighted points in the VEIS spectra vs electron speed which is the default plot in the *SWE Veis Counts Data* interface. Typically there are approximately 30 – 40 *sun-glint*

detector, energy sweep step, and *sector* samples which are eliminated entirely, which is only about 5% - 7% of all the data samples collected in one spacecraft rotation.

Appendix 8. Using strahl sensor observations of the Sun to recover WIND spin phase.

To date (December, 2001), there have been three high-flux solar proton events which disabled the Sun sensors on the Wind spacecraft. Normally the spacecraft X-axis is time-tagged by the spacecraft Sun sensor when the X-axis points to the Sun. When the Sun sensor becomes disabled , the spacecraft automatically generates a pseudo-sun pulse each 2.4 sec instead of the nominal 3s true spin period. However, the spin phase of the spacecraft X-axis is unknown at any of these 2.4s time tags. On-board processing keyed to the Sun pulse will therefore be out of phase, such as the spin phase sampled by the strahl sensor, which tracks with the on-board determined magnetic field. However, during each period of loss of the Sun pulse to date, the strahl sensor field of view frequently captured the Sun, providing the necessary spin phase information to compute spin period accurately. The procedure used for determining the true spin period during a no-sun pulse event is documented in procedure wggs00/swelz/nosunpuls_readlz.pro.

Appendix 9. Processed SWE Data File Coverage of Years 1995 – 2002.

The graphs on the following pages show the processed SWE electron data coverage during the years 1995 through 2002. There are three primary survey data types, swe_moments, swe_fpitch, and swe_strahl, for which daily files exist. Days for which daily survey files exist are represented in black, missing data in white. Missing data may be due to several factors such as, the instrument not being in a science mode, poor data quality, or, in the case of swe_moments, WIND not being in the solar wind. The storage location of these survey data files given in Chapter 4c and repeated below can be accessed publicly via anonymous ftp to leprjf:

swe_moments   leprjf:/data7/swe/moments   leprjf:ftp/pub/swe1/swe/moments
swe_fpitch   leprjf:/data9/swe/ptch   leprjf:ftp/pub/swe3/swe/ptch
swe_strahl   leprjf:/data8/swe/strl   leprjf:ftp/pub/swe2/swe/strl

There are three primary data coverage summaries for swe_moments and are differentiated by the file name extension:

1)   The first swe_moments data coverage bar chart includes only files with extension _sv13.mom, which designate IDL restore files and version 13. These are considered to be the prime moments data set because the instrument was in mode 1, mode 4, or mode 6, and all data variables are considered reliable. This is the data set that has been archived in the NSSDC.

2)   The second swe_moments data coverage bar chart adds instrument mode2, version 5 moments files with extension _v05.mom to the first summary of _sv13.mom files. Not all moments variables of the mode 2, version 5 moments files are reliable due to sun glint contamination. The electron temperature and anisotropy should be reliable, but the heat flux is not reliable and should be used with caution. The VEIS instrument was in mode 2 for parts of 1995 and 1996.

3)   The third swe_moments data coverage bar chart includes all the IDL binary version 13 files with extension _v13.mom that were processed. The IDL restore files with extension _sv13.mom are a subset of the _v13.mom files. Most of the _v13.mom files were converted to IDL restore files after visual inspection, but a few files were not converted because of questionable quality.