Solar Wind

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F10.7 cm flux

The F10.7 index is a measure of the solar radio flux per unit frequency at a wavelength of 10.7 cm. It serves as an index for solar input conditions required by the LFM and TIEGCM. Obtain this scalar value from the NASA F10.7 Flux archives. Write the number down before you run Make It So. Note that numbers reported in the chart have been multipled by 10 and need to be divided by 10 when input into the LFM via Make It So.

LFM Solar Wind File

A solar wind input file named "SW-SM-DAT" is required in order to run the LFM. This solar wind input file contains basic solar output parameters in SM coordinates at a uniform time cadence necessary to drive the LFM magnetosphere code.

Data Format

The Solar Wind file "SW-SM-DAT" has a simple ASCII text format, which is essentially a whitespace-delimited table.

Here are the first couple of lines from an example SW-SM-DAT:

```
1995 80 0 1
  540 11
   DATA:
     1.00   5.0  -400.0   0.0   0.0   40.00   0.0000   0.0000  -5.0000   5.0000   0.0000
     2.00   5.0  -400.0   0.0   0.0   40.00   0.0000   0.0000  -5.0000   5.0000   0.0000
     3.00   5.0  -400.0   0.0   0.0   40.00   0.0000   0.0000  -5.0000   5.0000   0.0000
```

The first three lines are necessary for the file format:

1. "1995 80 0 1" describes the year, day of year, hour and minute that corresponds to the beginning of the solar wind file
2. "540 11" describes the number of data rows (540) and columns (11) in the file
3. " DATA:" is a line required by the LFM SW-SM-DAT parser

The table below labels the columns of the `SW-SM-DAT` file. Each row is the solar wind state at a different point in time.

Variable	UT (i)	Njp	Vjx	Vjy	Vjz	Cs (i)	BjX	BjY	BjZ	BjT	Zangle
Column:	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
Units:	minutes	#/cc	km/s	km/s	km/s	km/s	nT	nT	nT	nT	degrees
Line #4:	1.00	5.0	-400.0	0.0	0.0	40.00	0.0000	0.0000	-5.0000	5.0000	0.0000
Line #5:	2.00	5.0	-400.0	0.0	0.0	40.00	0.0000	0.0000	-5.0000	5.0000	0.0000
Line #6:	3.00	5.0	-400.0	0.0	0.0	40.00	0.0000	0.0000	-5.0000	5.0000	0.0000
Line #n:	...	...	...	...	...	...	...	...	...	...	...

Internally, the LFM interpolates solar wind data based on the time in column 1 & start time at the file header.

Obtaining Solar Wind Input

Idealized

Any file named "SW-SM-DAT" conforming to the correct format can be used to drive the LFM. The LFM ships with idealized solar wind input. For example, see

```
test/LFM-MIX/utio/SW-SM-DAT
```

Observations

The LFM can be driven by data obtained from satellite data via NASA Coordinated Data Analysis Web (CDAWeb). We have used both the ACE and/or OMNI satellites with the LFM.

CDAWeb data must be processed before running with the LFM. We have a set of scripts (see below) to process the data. Our post-processing does two things with CDAweb data:

1. Convert from GSE & GSM coordinates to SM
2. Convert CDAweb format into 11 column whitespace-delimited SW-SM-DAT

ACE

3. Goto CDAWeb. Select the "ACE" source. Under instruments, select both "Magnetic Fields (space)", and "Plasma and Solar Wind". Click "Submit" at the bottom.
4. The LFM requires 5-minute or better temporal resolution. Select *only* AC_H0_MFI and AC_H0_SWE from the list:
    - AC_H0_MFI: H0 - ACE Magnetic Field 16-Second Level 2 Data - N. Ness (Bartol Research Institute)
      AC_K0_MFI: ACE Magnetic Field 5-Minute Key Parameters (PRELIM) - N. Ness (Bartol Research Institute)
      AC_H1_MFI: H1 - ACE Magnetic Field 4-Minute Level 2 Data - N. Ness (Bartol Research Institute)
      AC_K1_MFI: ACE Magnetic Field 16-Second Key Parameters (PRELIM) - N. Ness (Bartol Research Institute)
      AC_H2_MFI: H2 - ACE Magnetic Field 1-Hour Level 2 Data - N. Ness (Bartol Research Institute)
      AC_K2_MFI: K2 - ACE Magnetic Field 1-Hour Key Parameters (PRELIM) - N. Ness (Bartol Research Institute)
    - AC_H0_SWE: ACE/SWEPAM Solar Wind Experiment 64-Second Level 2 Data - D. J. McComas (SWRI)
      AC_K0_SWE: K0 - ACE Solar Wind Experiment 5-Minute Key Parameters (PRELIM) - D. J. McComas (Southwest Research Institute)
      AC_H2_SWE: ACE/SWEPAM Solar Wind Experiment 1-Hour Level 2 Data - D. J. McComas (SWRI)
      AC_K1_SWE: K1 - ACE Solar Wind Experiment 1-Hour Key Parameters (PRELIM) - D. J. McComas (Southwest Research Institute)
      AC_H2_SWI: ACE/SWICS Solar Wind Ion Composition Spectrometer 1-Hour Level 2 Data - G. Gloeckler (University of Maryland)
      OMNI_HRO_1MIN: OMNI Combined, Definitive, 1AU 1minute IMF and Plasma data - J.H. King, N. Papatashvilli (Perot Sys, NASA GSFC)
      OMNI_HRO_5MIN: OMNI Combined, Definitive, 1AU 5minute IMF and Plasma data - J.H. King, N. Papatashvilli (Perot Sys, NASA GSFC)
      OMNI2_H0_MRG1HR: OMNI Combined, Definitive, 1AU Hourly IMF, Plasma, Indices and Energetic Proton Fluxes - J.H. King, N. Papatashvilli (Perot Sys, NASA GSFC)
      AC_K0_GIFWALK: Links to ACE KP pre-generated survey and other plots - Polar-Wind-Geotail Ground System (NASA GSFC)
      Click "Submit"
5. Choose your favorite time range to select data from. Note that all time is in UTC.
6. Under **AC_H0_MFI**, select *only* the following starred item:

```
B-field magnitude
* Magnetic Field Vector in GSE Cartesian coordinates (16 sec)
Magnetic field vector in GSM coordinates (16 sec)
RMS of Magnetic Field (16 sec period)
ACE s/c position, 3 comp. in GSE coord.
ACE s/c position, 3 comp. in GSM coord.
```

7. Under **AC_H0_SWE**, select *only* the following starred items:

```
* Solar Wind Proton Number Density, scalar
Solar Wind Bulk Speed
* radial component of the proton temperature
alpha to proton density ratio
* Solar Wind Velocity in GSE coord., 3 components
Solar Wind Velocity in RTN coord., 3 components
Solar Wind Velocity in GSM coord., 3 comp.
* ACE s/c position, 3 comp. in GSE coord.
ACE s/c position, 3 comp. in GSM coord.
```

   Once you have selected a time range and the appropriate variables, select the "List Data (ASCII): select one or more variables from list below and press submit. (Works best for <31 days)" radio button and submit .
   If you get an error such as, "Unable to create output file due to a system error.", go stretch your legs, grab a cup of coffee and try again in a few minutes.
8. Download *both* the **AC_H0_MAG** and the **AC_H0_SWE** "listing"

OMNI

1. Goto CDAWeb. Select the "OMNI (Combined 1AU IP Data)" source. Under instruments, select both "Magnetic Fields (space)", and "Plasma and Solar Wind". Click "Submit" at the bottom.
2. The LFM requires 5-minute or better temporal resolution. Let's *only* take the 1-minute data. That is, un-check the 5minute and Hourly data .
    - OMNI_HRO_1MIN: OMNI Combined, Definitive, 1AU 1minute IMF and Plasma data - J.H. King, N. Papatashvilli (Perot Sys, NASA GSFC)
      OMNI_HRO_5MIN: OMNI Combined, Definitive, 1AU 5minute IMF and Plasma data - J.H. King, N. Papatashvilli (Perot Sys, NASA GSFC)
      OMNI2_H0_MRG1HR: OMNI Combined, Definitive, 1AU Hourly IMF, Plasma, Indices and Energetic Proton Fluxes - J.H. King, N. Papatashvilli (Perot Sys, NASA GSFC)
      Click "submit"
3. Choose your favorite time range to select data from. Note that all time is in UTC.
   Select the following variables to download:
    - 1AU IP Bx (nT), GSE
    - 1AU IP By (nT), GSE
    - 1AU IP Bz (nT), GSE
    - Vx Velocity (km/s), GSE
    - Vy Velocity (km/s), GSE
    - Vz Velocity (km/s), GSE
    - Proton density (n/cc)
    - Temperature (K)
      Once you have selected a time range and the appropriate variables, select the "List Data (ASCII): select one or more variables from list below and press submit. (Works best for <31 days)" radio button and submit .
      If you get an error such as, "Unable to create output file due to a system error.", go stretch your legs, grab a cup of coffee and try again in a few minutes.
4. Download "listing"

Modeled

Our tools for processing solar wind input can parse a variety of solar wind formats. We currently support two formats solar wind models :

- WSA-Enlil data from CCMC
- Enlil data directly from Enlil model

It is quite easy to add additional formats. Let us know what else you would like to see!

Processing Raw Solar Wind Input

See the "solarWind.py" script included with the Python tools for LTR for more information on solar wind processing.

> **Note**
>
> The latest release (LTR-2.1.0 as of December 2010) does not ship with pyLTR. The pyLTR page has download instructions.

Notes/warnings

- The LFM requires a period of spin-up time for the magnetosphere to stabilize. Make sure to read the documentation on LFM startup time.
- Observed data can have large data gaps. If you have problems processing solar wind data or the LFM crashes, check to make sure you do not have large gaps in your data!
- Once the end-of-file is reached, the LFM will be driven with constant solar wind forcing (using the last data point). Make sure your SW-SM-DAT file is long enough for the time interval you're interested in.