PMIP4 SATIRE-M solar forcing data

The files contain Solar Spectral Irradiance (SSI) reconstruction based on **14C** or **10Be** and the SATIRE-M model, with and without an adaptation of the spectral irradiance to the CMIP6 *historical* forcing.

- 14C data for the last 9000 years (6754.5 BC to December 2015)
- 10Be data for the years 885 CE to December 2015

The **14C-based data set** scaled to the CMIP6 historical forcing is the **recommended forcing for the PMIP4-CMIP6 *tier-1* past1000 experiment**.

Data files

- file names = `SSI_<type>_cycle_yearly_cmip_v20160613_<scaling>.txt`
  - `type` = 14C or 10Be
  - `scaling` =
    - `fc`: adaptation of the spectral irradiance to the CMIP6 *historical* forcing
    - `nfc`: no re-scaling

Data format

The original data files are provided in simple text format, and we also provide the data in netCDF format. The text files' structure is as follows:

- 1st array: **wavelength array** in [nm], listing the center of each wavelength bin
  `[ 115.5, 116.5, 117.5, 118.5, 119.5, […] 100000.0078125 , 120000.0234375 , 140000.015625 , 160000.015625 ]`
- 2nd array: **wavelength bin** in [nm], listing the bin width of each wavelength bin
  `[ 1., 1., 1., 1. […] 40., 5010., 14990.00488281, 20000.00585938, 20000., 20000., 20000.00585938, 20000.00585938, 20000., 20000. ]`
- 3rd array: **time** in [year] (floating numbers)
  For 14C: `[-6754.5, -6753.5, -6752.5, -6751.5, […] 2015.98632812, 2015.98901367, 2015.99182129, 2015.99450684, 2015.99731445]`
- 4th array: **SSI reconstruction** in [W m-2 nm-1]. SSI is average SSI in corresponding bin.

We provide the following IDL and python code to read the `.txt` file and calculate TSI:

```
;=======================================================
;N=69235 for 14C reconstruction
;N=61595 for 10Be reconstruction
header=strarr(12)
satire_wl=dblarr(1070)
satire_dwl=dblarr(1070)
time=dblarr(N)
SSI=dblarr(1070,N)
```

```
openr,1,filename
 readf,1,header
 readf,1,satire_wl
 readf,1,satire_dwl
 readf,1,time
 readf,1,SSI
close,1

TSI=dblarr(N)
FOR i=0L,N-1 DO TSI[i]=TOTAL(satire_dwl*SSI[*,i])
;=======================================================
```

- The following python code shows how to deal with the original compressed text data. You can also check the full python script that was used to generate the netCDF files

```
# Get directly the data from the bz2 compressed file
file_in = bz2.BZ2File(input_full_path)

# Print the comments at the beginning of the file
print '\nData file header:'
for skip_header in range(nb_header_lines):
  hdr = file_in.readline().strip()
  print 'HEADER =>', hdr

# Get the wavelength data (on a single line) and store it in a numpy
# array
wl_str = file_in.readline()
wl = np.array(map(float, wl_str.strip().split()), dtype=np.float32)

# Get the wavelength bins data (on a single line) and store it in a
# numpy array
wl_bin_str = file_in.readline()
wl_bin = np.array(map(float, wl_bin_str.strip().split()),
dtype=np.float32)

# Get the years (on a single line) and store them in a numpy array
year_str = file_in.readline()
year = np.array(map(float, year_str.strip().split()), dtype=np.float32)

# The rest of the data is the ssi data, with one line for each time
# steps! Read it in an array
ssi = np.loadtxt(file_in, dtype=np.float32)

file_in.close()

print '\nSize of the SSI matrix =', ssi.shape

# Compute the TSI
tsi = np.dot(ssi, wl_bin)
```

References

- Baroni, M., and ASTER Team (2015), **A new 10Be record recovered from an Antarctic ice core: validity and limitations to record the solar activity**, Geophysical Research Abstracts 17, EGU2015-6357
- Vieira, L.E.A. et al. (2011), **Evolution of the solar irradiance during the Holocene**, Astron. Astroph., 531, A6, doi:10.1051/0004-6361/201015843
- Usoskin, I.G. et al. (2014), **Evidence for distinct modes of solar activity**, Astron. Astrophys., 562, L10, doi:10.1051/004-6361/201423391
- Usoskin, I.G. et al. (2016), **Solar activity during the Holocene: the Hallstatt cycle and its consequence for grand minima and maxima**, Astron. Astroph., 587, A150, doi:10.1051/0004-6361/201527295

Download

Once you have downloaded the compressed text data file, you can use the command `bzmore` to have a quick look at its content without having to uncompress it!

```
 > bzmore
SSI_14C_cycle_yearly_cmip_v20160613_fc.txt.bz
2
------>
SSI_14C_cycle_yearly_cmip_v20160613_fc.txt.bz
2 <------
;
;Solar Spectral Irradiance for last 9
millennia (added solar cycle), 6754.5 BC ~
 12.31.2015
;
;File structure
;1. wavelength: array[1070],nm
;2. wavelength bin: array[1070],nm
;3. year: array[69235], floating number
;   6754.5 BC~1849.5 AD, yearly cadence
;   1,1,1850 ~ 12,31,2015, daily cadence
;4. SSI(wavelength,date): array[1070,69235],
W m-2 nm-1
;
; Note: SSI adjusted to CMIP
     115.500     116.500     117.500
118.500     119.500     120.500     121
.500     122.500     123.500 [...]
```

You will find below a table with all the available data files, and their md5sum checksum (if you want to check that you download was OK, you can just type `md5sum file.nc` and compare the result to what is displayed in the table).

If you want to download a file, click on the PMIP4 SATIRE-M solar forcing data download link and then on the file you need. The files are currently protected by a password. Get in touch with Jean-Yves Peterschmitt if you need to access them.

md5sum output	**Data file**	**Size**
636519aa89b472a04748893d6f3ff1b3	**SSI_14C_cycle_yearly_cmip_v20160613_fc.txt.bz2** recommended forcing for the PMIP4-CMIP6 *tier-1* past1000 experiment	506 Mb
af4d1c36647f094b38fd6d9bc8e6617b	**SSI_14C_cycle_yearly_cmip_v20160613_fc.nc** recommended forcing for the PMIP4-CMIP6 *tier-1* past1000 experiment	283 Mb
86bae35d2cd4d7f2c3dde9ee567d5a87	SSI_14C_cycle_yearly_cmip_v20160613_nfc.txt.bz2	506 Mb
b5639df4fab6cac7d55972d7a066e2b9	SSI_14C_cycle_yearly_cmip_v20160613_nfc.nc	283 Mb
96cdeb6a561f0be6b83e1b45a809f8ad	SSI_10Be_cycle_yearly_cmip_v20160613_fc.txt.bz2	450 Mb
1f9075a93e58173281ee11731bdb97e5	SSI_10Be_cycle_yearly_cmip_v20160613_fc.nc	252 Mb
0516a6a073c25365674a004034392130	SSI_10Be_cycle_yearly_cmip_v20160613_nfc.txt.bz2	450 Mb
c2922684c81e839fb07de7017ed0d1f3	SSI_10Be_cycle_yearly_cmip_v20160613_nfc.nc	252 Mb

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