

## TABLE OF CONTENTS

- 1. [SOLAR IRRADIANCE FCDR/bin\\_average.pro](#)
- 2. [SOLAR IRRADIANCE FCDR/bin\\_ssi.pro](#)
- 3. [SOLAR IRRADIANCE FCDR/compute\\_ssi.pro](#)
- 4. [SOLAR IRRADIANCE FCDR/compute\\_sunspot\\_blocking.pro](#)
- 5. [SOLAR IRRADIANCE FCDR/compute\\_tsi.pro](#)
- 6. [SOLAR IRRADIANCE FCDR/create\\_filename.pro](#)
- 7. [SOLAR IRRADIANCE FCDR/create\\_manifest.pro](#)
- 8. [SOLAR IRRADIANCE FCDR/get\\_daily\\_time\\_bounds.pro](#)
- 9. [SOLAR IRRADIANCE FCDR/get\\_mg\\_index.pro](#)
- 10. [SOLAR IRRADIANCE FCDR/get\\_model\\_params.pro](#)
- 11. [SOLAR IRRADIANCE FCDR/get\\_monthly\\_time\\_bounds.pro](#)
- 12. [SOLAR IRRADIANCE FCDR/get\\_solar\\_latitude.pro](#)
- 13. [SOLAR IRRADIANCE FCDR/get\\_spectral\\_bins.pro](#)
- 14. [SOLAR IRRADIANCE FCDR/get\\_sunspot\\_blocking.pro](#)
- 15. [SOLAR IRRADIANCE FCDR/get\\_yearly\\_time\\_bounds.pro](#)
- 16. [SOLAR IRRADIANCE FCDR/group\\_by\\_day.pro](#)
- 17. [SOLAR IRRADIANCE FCDR/group\\_by\\_function.pro](#)
- 18. [SOLAR IRRADIANCE FCDR/group\\_by\\_tag.pro](#)
- 19. [SOLAR IRRADIANCE FCDR/iso\\_date2mjd.pro](#)
- 20. [SOLAR IRRADIANCE FCDR/jd2iso\\_date.pro](#)
- 21. [SOLAR IRRADIANCE FCDR/jd2mdd.pro](#)
- 22. [SOLAR IRRADIANCE FCDR/mjd2iso\\_date.pro](#)
- 23. [SOLAR IRRADIANCE FCDR/mjd2iso\\_yyyy.pro](#)
- 24. [SOLAR IRRADIANCE FCDR/mjd2iso\\_yyyymm.pro](#)
- 25. [SOLAR IRRADIANCE FCDR/nrl2\\_to\\_irradiance.pro](#)
- 26. [SOLAR IRRADIANCE FCDR/process\\_irradiance.pro](#)
- 27. [SOLAR IRRADIANCE FCDR/process\\_sunspot\\_blocking.pro](#)
- 28. [SOLAR IRRADIANCE FCDR/read\\_latis\\_data.pro](#)
- 29. [SOLAR IRRADIANCE FCDR/remove\\_duplicate\\_records.pro](#)
- 30. [SOLAR IRRADIANCE FCDR/remove\\_hyphens.pro](#)
- 31. [SOLAR IRRADIANCE FCDR/unix2mjd.pro](#)
- 32. [SOLAR IRRADIANCE FCDR/write\\_irradiance\\_data.pro](#)
- 33. [SOLAR IRRADIANCE FCDR/write\\_monthly\\_average\\_ssi\\_to\\_netcdf2.pro](#)
- 34. [SOLAR IRRADIANCE FCDR/write\\_monthly\\_average\\_tsi\\_to\\_netcdf2.pro](#)
- 35. [SOLAR IRRADIANCE FCDR/write\\_ssi\\_model\\_to\\_netcdf2.pro](#)
- 36. [SOLAR IRRADIANCE FCDR/write\\_sunspot\\_blocking.pro](#)
- 37. [SOLAR IRRADIANCE FCDR/write\\_to\\_manifest.pro](#)
- 38. [SOLAR IRRADIANCE FCDR/write\\_tsi\\_model\\_to\\_netcdf2.pro](#)
- 39. [SOLAR IRRADIANCE FCDR/write\\_yearly\\_average\\_ssi\\_to\\_netcdf2.pro](#)
- 40. [SOLAR IRRADIANCE FCDR/write\\_yearly\\_average\\_tsi\\_to\\_netcdf2.pro](#)
- 41. [SOLAR IRRADIANCE FCDR/yymmdd2mjd.pro](#)
- 42. [TSI FCDR/get\\_sunspot\\_data.pro](#)
- 43. [TSI FCDR/replace\\_nan\\_with\\_value.pro](#)

# 1. SOLAR\_IRRADIANCE\_FCDR/bin\_average.pro [ Programs ]

[ [Top](#) ] [ Programs ]

## NAME

`bin_average`

## PURPOSE

The **bin\_average.pro** is a function that performs time averaging of data records.

## DESCRIPTION

The **bin\_average.pro** is a function that performs time averaging of data records. The data records are assumed to be a list of structures where the first element is time in Modified Julian Date (MJD) and the second element is the value to be averaged. All other structure elements are ignored.

```
'bin'
```

## INPUTS

`records` - The data records (a list of structures) containing the Modified Julian Date and the value to be averaged  
`bin` - Designates the time averaging. It is either 'year' or 'month' or 'day'. The default is 'day'.

## OUTPUTS

`averaged` - An IDL hash mapping of the iso time to the average of the values in the records for that time bin.

## AUTHOR

Odele Coddington, Laboratory for Atmospheric and Space Physics, Boulder, CO  
 Doug Lindholm, Laboratory for Atmospheric and Space Physics, Boulder, CO  
 Judith Lean, Space Science Division, Naval Research Laboratory, Washington, DC

## COPYRIGHT

THIS SOFTWARE AND ITS DOCUMENTATION ARE CONSIDERED TO BE IN THE PUBLIC DOMAIN AND THUS ARE AVAILABLE FOR UNRESTRICTED PUBLIC USE. THEY ARE FURNISHED "AS IS." THE AUTHORS, THE UNITED STATES GOVERNMENT, ITS INSTRUMENTALITIES, OFFICERS, EMPLOYEES, AND AGENTS MAKE NO WARRANTY, EXPRESS OR IMPLIED, AS TO THE USEFULNESS OF THE SOFTWARE AND DOCUMENTATION FOR ANY PURPOSE. THEY ASSUME NO RESPONSIBILITY (1) FOR THE USE OF THE SOFTWARE AND DOCUMENTATION; OR (2) TO PROVIDE TECHNICAL SUPPORT TO USERS.

## REVISION HISTORY

06/04/2015 Initial Version prepared for NCDC

## USAGE

```
result=bin_average(records, bin)
```

## 2. SOLAR\_IRRADIANCE\_FCDR/bin\_ssi.pro [ Programs ]

[ [Top](#) ] [ Programs ]

### NAME

**bin\_ssi.pro**

### PURPOSE

The **bin\_ssi.pro** function is called from the routine, [process\\_irradiance.pro](#). It bins the Solar Spectral Irradiance into a variable-sized wavelength grid as defined in [get\\_spectral\\_bins.pro](#).

The wavelength grid is as follows:

```
1 nm from 115 to 750
5 nm from 750 to 5000
10 nm from 5000 to 10000
50 nm from 10000 to 100000
```

### DESCRIPTION

The **bin\_ssi.pro** function uses wavelength grid information (number of bands, bandcenters, and bandwidths), and bins the Solar Spectral Irradiance onto the wavelength grid, defined by bandcenter and bandwidth.

### INPUTS

```
model_params - a structure containing wavelength values of modeled SSI on
               lambda - wavelength (nm; in 1-nm bins)
spectral_bins - a structure containing the desired wavelength grid information of the
output SSI:
  nband - number of spectral bands, for a variable wavelength grid, that the NRL2
model bins 1 nm solar spectral irradiance onto.
  bandcenter - the bandcenters (nm) of the variable wavelength grid.
  bandwidth - the bandwidths (delta wavelength, nm) of the variable wavelength grid.
ssi - a structure containing the modeled SSI:
  nrl2 - the NRL2 modeled Solar Spectral Irradiance at 1 nm spectral resolution
  nrl2unc - the uncertainty of the modeled Solar Spectral Irradiance
```

### OUTPUTS

```
ssi_bin - a structure containing the following variables:
  nrl2bin - the binned NRL2 modeled Solar Spectral Irradiance, on a variable wavelength
grid
  nrl2binunc - the uncertainty of the modeled Solar Spectral Irradiance, binned for the
variable wavelength grid
  nrl2binsum - the sum of the binned irradiance (equal to nrl2bin * bandwidth).
```

### AUTHOR

Odele Coddington, Laboratory for Atmospheric and Space Physics, Boulder, CO  
 Doug Lindholm, Laboratory for Atmospheric and Space Physics, Boulder, CO  
 Judith Lean, Space Science Division, Naval Research Laboratory, Washington, DC

### COPYRIGHT

THIS SOFTWARE AND ITS DOCUMENTATION ARE CONSIDERED TO BE IN THE PUBLIC DOMAIN AND THUS ARE AVAILABLE FOR UNRESTRICTED PUBLIC USE. THEY ARE FURNISHED "AS IS." THE AUTHORS, THE UNITED STATES GOVERNMENT, ITS INSTRUMENTALITIES, OFFICERS, EMPLOYEES, AND AGENTS MAKE NO WARRANTY, EXPRESS OR IMPLIED, AS TO THE USEFULNESS OF THE SOFTWARE AND DOCUMENTATION FOR ANY PURPOSE. THEY ASSUME NO RESPONSIBILITY (1) FOR THE USE OF THE SOFTWARE AND DOCUMENTATION; OR (2) TO PROVIDE TECHNICAL SUPPORT TO USERS.

## REVISION HISTORY

06/04/2015 Initial Version prepared for NCDC

## USAGE

```
result=bin_ssi(model_params, spectral_bins, ssi)
```

## 3. SOLAR\_IRRADIANCE\_FCDR/compute\_ssi.pro [ Programs ]

[ [Top](#) ] [ Programs ]

## NAME

**compute\_ssi.pro**

## PURPOSE

The **compute\_ssi.pro** procedure is a function called by the routine, `process_irradiance.pro`, to compute Solar Spectral Irradiance using multiple regression coefficients specific to the NRLSSI2 model and given values for the sunspot darkening function and the facular brightening function.

## DESCRIPTION

The **compute\_ssi.pro** function calculates the Solar Spectral Irradiance (SSI) for a specific day, given values for the sunspot darkening and the facular brightening function using a 2-component multiple regression formula.

Variable Definitions:

$I(k,t)$  is the spectral ( $k$ ) and time-dependency ( $t$ ) of SSI.

$\Delta I_F(k,t)$  is similarly described, but for SSI, and is also spectrally dependent

$\Delta I_S(t)$  is similarly described, but for SSI, and is also spectrally dependent

$I_Q$  is the SSI of the adopted Quiet Sun reference spectrum.

2-Component Regression formulas:

$$I(k,t) = I_Q + \Delta I_F(t) + \Delta I_S(t)$$

Quantifying time and spectrally-dependent SSI ( $I$ ) Irradiance variation from Faculae ( $F$ ) and Sunspot ( $S$ ):

$$\Delta I_F(k,t) = c_F(k) + d_F(k) * [F(t) - F_Q] + e_F * [F(t) - F_Q]$$

$$\Delta I_S(k,t) = c_S(k) + d_S(k) * [S(t) - S_Q] + e_S * [S(t) - S_Q]$$

Coefficients for faculae and sunspots:

The  $c(k)$ , and  $d(k)$  coefficients for faculae and sunspots are specified (determined using multiple linear regression)

and supplied with the algorithm. These coefficients best reproduce the detrended SSI irradiance variability (removal of 81-day running mean) measured by SORCE SIM.

Note, the  $c_F$  and  $c_S$  coefficient is nominally zero so that when  $F=F_Q$  and  $S=S_Q$ , then  $I=I_Q$ .

The additional wavelength-dependent terms in the spectral irradiance facular and sunspot components evaluated with the

e coefficients provide small adjustments to ensure that 1) the numerical integral over wavelength of the solar spectral irradiance is equal to the total solar irradiance, 2) the numerical integral over wavelength of the time-dependent SSI irradiance variations from faculae and sunspots is equal to the time-dependent TSI irradiance variations from the faculae and sunspots.

Additional explanation of coefficients used to model solar spectral irradiance:

A relationship of solar spectral irradiance variability to sunspot darkening and facular brightening determined using observations of

solar rotational modulation: instrumental trends are smaller over the (much) shorter rotational times scales than during the solar cycle.

For each 1 nm bin, the observed spectral irradiance and the facular brightening and sunspot darkening indices are detrended by

subtracting 81-day running means. Multiple linear regression is then used to determine the relationships of the detrended time series:

$$I_{\text{detrend\_mod}}(k,t) = I_{\text{mod}}(k,t) - I_{\text{smooth}}(k,t) \\ = c(k) + d_F \text{detrend}(k) * [F(t) - F_{\text{smooth}}(t)] + d_S \text{detrend}(k) * [S(t) - S_{\text{smooth}}(t)]$$

Variable Definitions:

$I_{\text{mod}}(k,t)$  = the spectral (k) and time (t) dependencies of the modeled spectral irradiance,  $I_{\text{mod}}$ .

$I_{\text{smooth}}(k,t)$  = the spectral and time dependencies of the smoothed (i.e. after subtracting 81-day running mean) from observed spectral irradiance.

$F_{\text{smooth}}(t)$  = the time dependency of the smoothed (i.e. after subtracting 81-day running mean) from observed facular brightening index,  $F(t)$ .

$S_{\text{smooth}}(t)$  = as above, but for the observed sunspot darkening index,  $S(t)$ .

The range of facular variability in the detrended time series is smaller than during the solar cycle which causes the coefficients

of models developed from detrended time series to differ from those developed from non-detrended observations. To address this, total

solar irradiance observations are used to numerically determine ratios of coefficients obtained from multiple regression using direct observations,

with those obtained from multiple regression of detrended observations. Using a second model of TIM observations (using detrended observations)

was determined and the ratios of the coefficients for the two approaches were used to adjust the coefficients for spectral irradiance variations.

For wavelengths > 295 nm, where both sunspots and faculae modulate spectral and total irradiance,

the d coefficients,  $d_F$  and  $d_S$  are estimated as:

$$d_F(k) = d_F \text{detrend}(k) * [b_F / b_F \text{detrend}]$$

$$d_S(k) = d_S \text{detrend}(k) * [b_S / b_S \text{detrend}]$$

For wavelengths < 295 nm, where faculae dominate irradiance variability ( $d_S(k) \sim 0$ ), the adjustments for

the coefficients are estimated using the Ca K time series, a facular index independent of Mg II index, and a proxy for UV

spectral irradiance variability.

Reference(s):

Reference describing the solar irradiance variability due to linear combinations of sunspot darkening

and facular brightening:

Frühlich, C., and J. Lean, The Sun's total irradiance: Cycles, trends

and climate change uncertainties since 1976, Geophys. Res. Lett., 25, 4377-4380, 1998.

References describing the original NRLTSI and NRLSSI models are:

Lean, J., Evolution of the Sun's Spectral Irradiance Since the Maunder Minimum, Geophys. Res. Lett., 27, 2425-2428, 2000.

Lean, J., G. Rottman, J. Harder, and G. Kopp, SORCE Contributions to New Understanding of Global Change and Solar Variability,

Solar. Phys., 230, 27-53, 2005.

Lean, J. L., and T.N. Woods, Solar Total and Spectral Irradiance Measurements and Models: A Users Guide,

in Evolving Solar Physics and the Climates of Earth and Space, Karel Schrijver and

George Siscoe (Eds), Cambridge Univ. Press, 2010.

Reference describing the extension of the model to include the extreme ultraviolet spectrum and the empirical capability to specify

entire solar spectral irradiance and its variability from 1 to 100,000 nm:

Lean, J. L., T. N. Woods, F. G. Eparvier, R. R. Meier, D. J. Strickland, J. T. Correia, and J. S. Evans,

Solar Extreme Ultraviolet Irradiance: Present, Past, and Future, J. Geophys. Res., 116, A001102,

doi:10.1029/2010JA015901, 2011.

## INPUTS

```

sb      - sunspot darkening indice
mg      - facular brightening indice
model_params - a structure containing NRL2 coefficients necessary to construct modeled
TSI:
    lambda - wavelength (nm; in 1-nm bins)
    iquiet - the adopted solar spectral irradiance of the Quiet Sun
    ccoef  - the sum of the 'c' multiple regression coefficient for spectral facular
brightening (equal to c_F(k), in above description)
            and the 'c' multiple regression coefficient for spectral sunspot darkening
(equal to c_S(k), in above description)
    dfaccoef - the 'd' multiple regression coefficient for spectral facular brightening
(equal to d_F(k), in above description);
            obtained from regression against detrended spectral irradiance observations
multiplied with the ratio of the 'b' coefficients
            obtained from regression against total solar irradiance observations to
that obtained from regression against detrended total
            solar irradiance observations.
    dspotcoef - the 'd' multiple regression coefficient for spectral sunspot darkening
(equal to d_S(k), in above description);
            obtained from regression against detrended spectral irradiance observations
multiplied with the ratio of the 'b' coefficients
            obtained from regression against total solar irradiance observations to
that obtained from regression against detrended total
            solar irradiance observations.
    bfaccoef - the 'b' multiple regression coefficient for bolometric facular brightening
(equal to b_F, in above description)
    bspotcoef - the 'b' multiple regression coefficient for bolometric sunspot darkening
(equal to b_S, in above description)
    mgquiet - the value of the facular brightening corresponding to quiet Sun (equal to
F_Q, in above description)
    efaccoef - the small, but nonzero, correction factor needed so the numerical integral
over wavelength of the time-dependent
            SSI irradiance variations from faculae is equal to the time-dependent TSI
irradiance variations from the faculae.
    espotcoef - the small, but nonzero, correction factor needed so the numerical integral
over wavelength of the time-dependent
            SSI irradiance variations from sunspots is equal to the time-dependent TSI
irradiance variations from sunspots.
    tsisigma - the 1-sigma uncertainty estimates for the coefficients returned in the
multiple linear
            regression of TSI. A 3-element array where first element contains the
uncertainty in acoef (equal
            to a_F_unc in above description), the second element contains the
uncertainty in bfaccoef (equal to
            b_F_unc in above description), and the third element contains the
uncertainty in bspotcoef (equal to
            b_S_unc in above description).
    mgu      - the relative uncertainty in change in facular brightening from its minimum
value, mgquiet. Specified as 0.2 (20 %)
    sbu      - the relative uncertainty in change in sunspot darkening from its minimum
value, '0'. Specified as 0.2 (20%)
    faccfunc - the relative uncertainty estimate for the coefficients of spectral facular
brightening obtained from multiple linear
            regression of the detrended spectral observations, and detrended indices.
Corrected by a scaling factor
            derived from the ratio of linear regression coefficients from TSI
observations and detrended TSI observations.
            Also accounts for autocorrelation.
    spotcfunc - the relative uncertainty estimate for the coefficients of spectral sunspot
darkening obtained from multiple linear
            regression of the detrended spectral observations, and detrended indices.
Corrected by a scaling factor
            derived from the ratio of linear regression coefficients from TSI
observations and detrended TSI observations.
            Also accounts for autocorrelation.
    qsigmafacs - the absolute uncertainty in the 'coeff0fac' factor
    coeff0fac - the regression coefficient that linearly relates the facular brightening
index to the residual energy in the facular
            brightening index; only the 2nd element in the array (i.e. the "slope"
coefficient) is used in the uncertainty propagation
    qsigmaspot - the absolute uncertainty in the small, but nonzero 'coeff0spot' factor
    coeff0spot - the regression coefficient that linearly relates the sunspot darkening
index to the residual energy in the sunspot darkening
            index; only the 2nd element in the array (i.e. the "slope" coefficient) is
used in the uncertainty propagation
    ccofunc   - the absolute uncertainty in 'ccoef'

```

## OUTPUTS

```
ssi - a structure containing the following variables:
nrl2 - modeled solar spectral irradiance
dfactot - spectrally integrated value of the facular brightening
dspottot - spectrally integrated value of the sunspot darkening
nrl2tot - spectrally integrated value of the SSI, nrl2
nrl2unc - spectrally dependent uncertainty in the modeled solar spectral irradiance
```

## AUTHOR

Odele Coddington, Laboratory for Atmospheric and Space Physics, Boulder, CO  
Doug Lindholm, Laboratory for Atmospheric and Space Physics, Boulder, CO  
Judith Lean, Space Science Division, Naval Research Laboratory, Washington, DC

## COPYRIGHT

THIS SOFTWARE AND ITS DOCUMENTATION ARE CONSIDERED TO BE IN THE PUBLIC DOMAIN AND THUS ARE AVAILABLE FOR UNRESTRICTED PUBLIC USE. THEY ARE FURNISHED "AS IS." THE AUTHORS, THE UNITED STATES GOVERNMENT, ITS INSTRUMENTALITIES, OFFICERS, EMPLOYEES, AND AGENTS MAKE NO WARRANTY, EXPRESS OR IMPLIED, AS TO THE USEFULNESS OF THE SOFTWARE AND DOCUMENTATION FOR ANY PURPOSE. THEY ASSUME NO RESPONSIBILITY (1) FOR THE USE OF THE SOFTWARE AND DOCUMENTATION; OR (2) TO PROVIDE TECHNICAL SUPPORT TO USERS.

## REVISION HISTORY

06/04/2015 Initial Version prepared for NCDC

## USAGE

```
result=compute_ssi(sb, mg, model_params)
```

## 4. SOLAR\_IRRADIANCE\_FCDR/compute\_sunspot\_blocking.pro [ Programs ]

[ [Top](#) ] [ Programs ]

## NAME

**compute\_sunspot\_blocking.pro**

## PURPOSE

The **compute\_sunspot\_blocking.pro** procedure computes the sunspot blocking function using a formula that weights the heliographic area of the sunspot group corrected by the solar latitude (corrected for ecliptic plane variation) and longitude.

## DESCRIPTION

The **compute\_sunspot\_blocking.pro** procedure computes the sunspot blocking function using a formula that weights the heliographic area of the sunspot group corrected by the solar latitude (corrected for ecliptic plane variation) and longitude. The calculation effectively sums the projected area of sunspot regions on the solar hemisphere and multiplies this by the contrast of sunspots relative to the background (reference) Sun, taking into account variations with limb position on the solar disk.



[Lean, J.L., Cook, J., Marquette, W., and Johannesson, A.: 1998, Astrophys. J., 492, 390-401].

It does not include empirical corrections for the additional darkness of larger sunspot than smaller sunspots

[Brandt, P, N., Stix, M., and Wdinhart, H.: 1994, Solar Phys. 152 (119)].

Formula (from Lean et al., 1998):

sunspot darkening =  $\mu * (3*\mu + 2)/2.0 * \text{area}$  , where  $\mu = \cos(\text{latitude}) \tilde{-} \cos(\text{longitude})$  is the

cosine weighted area projection of sunspot area, and area = heliographic area of the sunspot group

For reference: sunspot darkening (with empirical corrections for the additional darkness of larger sunspot than smaller sunspot =

$\mu * (3*\mu + 2)/2.0 * \text{area} * (0.2231 + 0.0244 * \log_{10}(\text{area}))$

## INPUTS

area - heliographic area of the sunspot group  
lat - heliographic latitude of sunspot group, adjusted for the Bo angle of the Sun's axis to the ecliptic plane  
lon - heliographic longitude of sunspot group

## OUTPUTS

ssb - the sunspot darkening

## AUTHOR

Odele Coddington, Laboratory for Atmospheric and Space Physics, Boulder, CO

Doug Lindholm, Laboratory for Atmospheric and Space Physics, Boulder, CO

Judith Lean, Space Science Division, Naval Research Laboratory, Washington, DC

## COPYRIGHT

THIS SOFTWARE AND ITS DOCUMENTATION ARE CONSIDERED TO BE IN THE PUBLIC DOMAIN AND THUS ARE AVAILABLE FOR UNRESTRICTED PUBLIC USE. THEY ARE FURNISHED "AS IS." THE AUTHORS, THE UNITED STATES GOVERNMENT, ITS INSTRUMENTALITIES, OFFICERS, EMPLOYEES, AND AGENTS MAKE NO WARRANTY, EXPRESS OR IMPLIED, AS TO THE USEFULNESS OF THE SOFTWARE AND DOCUMENTATION FOR ANY PURPOSE. THEY ASSUME NO RESPONSIBILITY (1) FOR THE USE OF THE SOFTWARE AND DOCUMENTATION; OR (2) TO PROVIDE TECHNICAL SUPPORT TO USERS.

## REVISION HISTORY

06/04/2015 Initial Version prepared for NCDC

## USAGE

result=compute\_sunspot\_blocking(area,lat,lon)

## 5. SOLAR\_IRRADIANCE\_FCDR/compute\_tsi.pro [ Programs ]

[ [Top](#) ] [ Programs ]

### NAME

compute\_tsi.pro



## PURPOSE

The **compute\_tsi.pro** procedure is a function called by the routine, **process\_irradiance.pro**, to compute Total Solar Irradiance using multiple regression coefficients specific to the NRLTSI2 model and given values for the sunspot darkening function and the facular brightening function.

## DESCRIPTION

The **compute\_tsi.pro** function calculates the Total Solar Irradiance (TSI) for a specific day, given values for the sunspot darkening and the facular brightening function using a 2-component multiple regression formula.

Variable Definitions:

T(t) is the time-dependency (t) of TSI,  
 delta\_T\_F(t) is the time dependency of the delta change to TSI from the facular brightening index, F(t)  
 delta\_T\_S(t) is the time dependency of the delta change to TSI from the sunspot darkening index, S(t)  
 T\_Q is the TSI of the adopted Quiet Sun reference value.

2-Component Regression formulas:

$T(t) = T_Q + \text{delta\_T\_F}(t) + \text{delta\_T\_S}(t)$

Quantifying time-dependent TSI (T) Irradiance Variations from Faculae (F) and Sunspots (S):

$\text{delta\_T\_F}(t) = a_F + b_F * [F(t) - F_Q]$

$\text{delta\_T\_S}(t) = a_S + b_S * [S(t) - S_Q]$  and  $a_S = 0$

F\_Q and S\_Q (=0) are the values of the facular brightening and sunspot darkening indices corresponding to T\_Q  
 (i.e. for the quiet Sun, T\_Q).

Quantifying time-dependent Uncertainties in TSI Irradiance Variation from faculae and sunspots:

$T_{\text{unc}}(t) = T_Q_{\text{unc}} + \text{delta\_T\_F\_unc}(t) + \text{delta\_T\_S\_unc}(t)$  where,

$\text{delta\_T\_F\_unc}(t) = a_{F\_unc} + (\text{the uncertainty in } b_F * [F(t) - F_Q])$

$\text{delta\_T\_S\_unc}(t) = (\text{the uncertainty in } b_S * [S(t) - S_Q])$

The uncertainty in  $b_F * [F(t) - F_Q]$ :

$[(\text{uncertainty in } b_F * [F(t) - F_Q]) / (b_F * [F(t) - F_Q])]^2 = (b_{F\_unc} / b_F)^2 + ((\text{uncertainty in } [F(t) - F_Q]) / [F(t) - F_Q])^2,$

therefore,  $\text{delta\_T\_F\_unc}(t) = a_{F\_unc} + \text{the square root of the above result multiplied by } [b_F * [F(t) - F_Q]]$

The uncertainty in  $b_S * [S(t) - S_Q]$ :

$[(\text{uncertainty in } b_S * [S(t) - S_Q]) / (b_S * [S(t) - S_Q])]^2 = (b_{S\_unc} / b_S)^2 + ((\text{uncertainty in } [S(t) - S_Q]) / [S(t) - S_Q])^2,$

therefore,  $\text{delta\_T\_S\_unc}(t) = \text{the square root of the above result multiplied by } [b_S * [S(t) - S_Q]]$

Coefficients for faculae and sunspots:

The a and b coefficients for faculae and sunspots are specified and supplied with the algorithm, as are their

1-sigma estimates (determined from the multiple linear regression analysis) . These coefficients best reproduce

the TSI irradiance variability measured directly by SORCE TIM from 2003 to 2014.

Note, the a coefficient is nominally zero so that when  $F=F_Q$  and  $S=S_Q$ , then  $T=T_Q$ .

Reference(s):

Reference describing the solar irradiance variability due to linear combinations of sunspot darkening

and facular brightening:

Frühlich, C., and J. Lean, The Sun's total irradiance: Cycles, trends

and climate change uncertainties since 1976, Geophys. Res. Lett., 25, 4377-4380, 1998.

References describing the original NRLTSI and NRLSSI models are:

Lean, J., Evolution of the Sun's Spectral Irradiance Since the Maunder Minimum, Geophys. Res. Lett., 27, 2425-2428, 2000.

Lean, J., G. Rottman, J. Harder, and G. Kopp, SORCE Contributions to New Understanding of Global Change and Solar Variability, Solar. Phys., 230, 27-53, 2005.

Lean, J. L., and T.N. Woods, Solar Total and Spectral Irradiance Measurements and Models: A Users Guide,

in Evolving Solar Physics and the Climates of Earth and Space, Karel Schrijver and George Siscoe (Eds), Cambridge Univ. Press, 2010.

Reference describing the extension of the model to include the extreme ultraviolet spectrum and the empirical capability to specify

entire solar spectral irradiance and its variability from 1 to 100,000 nm:  
 Lean, J. L., T. N. Woods, F. G. Eparvier, R. R. Meier, D. J. Strickland, J. T. Correia, and J. S. Evans,  
 Solar Extreme Ultraviolet Irradiance: Present, Past, and Future, J. Geophys. Res., 116, A001102,  
 doi:10.1029/2010JA015901, 2011.

## INPUTS

sb - sunspot darkening indice  
 mg - facular brightening indice  
 model\_params - a structure containing model coefficients necessary to construct modeled TSI:  
 tquiet - the adopted total solar irradiance of the Quiet Sun  
 acoef - the 'a' multiple regression coefficient for facular brightening (equal to a\_F, in above description)  
 bfaccoef - the 'b' multiple regression coefficient for facular brightening (equal to b\_F, in above description)  
 bspotcoef - the 'b' multiple regression coefficient for sunspot darkening (equal to b\_S, in above description)  
 mgquiet - the value of the facular brightening corresponding to quiet Sun (equal to F\_Q, in above description)  
 tsisigma - the 1-sigma absolute uncertainty estimates for the coefficients returned in the multiple linear regression, so also accounts for autocorrelation in the time series.  
 A 3-element array where first element contains the uncertainty in acoef (equal to a\_F\_unc in above description), the second element contains the uncertainty in bfaccoef (equal to b\_F\_unc in above description), and the third element contains the uncertainty in bspotcoef (equal to b\_S\_unc in above description).  
 mgu - the relative uncertainty in change in facular brightening from its minimum value, mgquiet. Specified as 0.2 (20 %)  
 sbu - the relative uncertainty in change in sunspot darkening from its minimum value, '0'. Specified as 0.2 (20%)

## OUTPUTS

tsi - a structure containing the following variables:  
 totirrad - modeled total solar irradiance  
 totfac - bolometric (spectrally integrated) contribution from facular brightening  
 totspot - bolometric (spectrally integrated) contribution from sunspot darkening  
 totirradunc - uncertainty in the modeled total solar irradiance. Does not include the contribution from uncertainty in the absolute scale of the measured irradiance (+/- 0.5 Wm-2 or approx. 0.03%)  
 totfacunc - uncertainty in the modeled total solar irradiance attributed to facular brightening contribution  
 totspotunc - uncertainty in the modeled total solar irradiance attributed to the sunspot darkening contribution

## AUTHOR

Odele Coddington, Laboratory for Atmospheric and Space Physics, Boulder, CO  
 Doug Lindholm, Laboratory for Atmospheric and Space Physics, Boulder, CO  
 Judith Lean, Space Science Division, Naval Research Laboratory, Washington, DC

## COPYRIGHT

THIS SOFTWARE AND ITS DOCUMENTATION ARE CONSIDERED TO BE IN THE PUBLIC DOMAIN AND THUS ARE AVAILABLE FOR UNRESTRICTED PUBLIC USE. THEY ARE FURNISHED "AS IS." THE AUTHORS, THE UNITED STATES GOVERNMENT, ITS INSTRUMENTALITIES, OFFICERS, EMPLOYEES, AND AGENTS MAKE NO WARRANTY, EXPRESS OR IMPLIED, AS TO THE USEFULNESS OF THE SOFTWARE AND DOCUMENTATION FOR ANY PURPOSE. THEY ASSUME NO RESPONSIBILITY (1) FOR THE USE OF THE SOFTWARE AND DOCUMENTATION; OR (2) TO PROVIDE TECHNICAL SUPPORT TO USERS.

## REVISION HISTORY

06/04/2015 Initial Version prepared for NCDC

## USAGE

```
result=compute_tsi(sb, mg, model_params)
```

## 6. SOLAR\_IRRADIANCE\_FCDR/create\_filename.pro [ Programs ]

[ [Top](#) ] [ Programs ]

### NAME

```
create_filename
```

### PURPOSE

The **create\_filename.pro** function dynamically constructs a data product file name.

### DESCRIPTION

The **create\_filename.pro** function dynamically constructs a data product file name.

### INPUTS

ymd1	- starting time range for the time range of the form 'yyyy-mm-dd'
ymd2	- ending time range for the time range of the form 'yyyy-mm-dd'
version	- version and revision number of the NRLTSI2 and NRLSSI2 models (e.g.,
v02r00)	
time_bin	- A value of 'year', 'month', or 'day' that defines the time-averaging
performed for the	given data records.
	'day' is the default.
tsi	- Keyword parameter designating file name is to be constructed for TSI
data.	
ssi	- Keyword parameter designating file name is to be constructed for SSI
data.	

### OUTPUTS

filename	- The data product file name
----------	------------------------------

### AUTHOR

Odele Coddington, Laboratory for Atmospheric and Space Physics, Boulder, CO  
 Doug Lindholm, Laboratory for Atmospheric and Space Physics, Boulder, CO  
 Judith Lean, Space Science Division, Naval Research Laboratory, Washington, DC

### COPYRIGHT

THIS SOFTWARE AND ITS DOCUMENTATION ARE CONSIDERED TO BE IN THE PUBLIC DOMAIN AND THUS ARE AVAILABLE FOR UNRESTRICTED PUBLIC USE. THEY ARE FURNISHED "AS IS." THE AUTHORS, THE UNITED STATES GOVERNMENT, ITS INSTRUMENTALITIES, OFFICERS, EMPLOYEES, AND AGENTS MAKE NO WARRANTY, EXPRESS OR IMPLIED, AS TO THE USEFULNESS OF THE SOFTWARE AND DOCUMENTATION FOR ANY PURPOSE. THEY ASSUME NO RESPONSIBILITY (1) FOR THE USE OF THE SOFTWARE AND DOCUMENTATION; OR (2) TO PROVIDE TECHNICAL SUPPORT TO USERS.

## REVISION HISTORY

06/04/2015 Initial Version prepared for NCDC

## USAGE

```
result=create_filename(ymd1, ymd2, version, time_bin, tsi=tsi, ssi=ssi)
```

## 7. SOLAR\_IRRADIANCE\_FCDR/create\_manifest.pro [ Programs ]

[ [Top](#) ] [ Programs ]

### NAME

create\_manifest

### PURPOSE

The **create\_manifest.pro** function determines file sizes (in bytes) and the MD5 checksum value of a file and passes the values to [write\\_to\\_manifest.pro](#)

### DESCRIPTION

The **create\_manifest.pro** function determines file sizes (in bytes) and the MD5 checksum value of a file and passes the values to [write\\_to\\_manifest.pro](#)

### INPUTS

```
output_dir - Path of directory to the input files
tsifile    - TSI file containing data for file size and MD5 checksum
ssifile    - SSI file containing data for file size and MD5 checksum
```

### OUTPUTS

```
struct      - A structure containing:
  tsibytes   - File size (in bytes) of tsifile
  ssibytes   - File size (in bytes) of ssifile
  tschecksum - MD5 checksum of tsifile
  sschecksum - MD5 checksum of ssifile
```

### AUTHOR

Odele Coddington, Laboratory for Atmospheric and Space Physics, Boulder, CO  
Doug Lindholm, Laboratory for Atmospheric and Space Physics, Boulder, CO  
Judith Lean, Space Science Division, Naval Research Laboratory, Washington, DC

### COPYRIGHT

THIS SOFTWARE AND ITS DOCUMENTATION ARE CONSIDERED TO BE IN THE PUBLIC DOMAIN AND THUS ARE AVAILABLE FOR UNRESTRICTED PUBLIC USE. THEY ARE FURNISHED "AS IS." THE AUTHORS, THE UNITED STATES GOVERNMENT, ITS INSTRUMENTALITIES, OFFICERS, EMPLOYEES, AND AGENTS MAKE NO WARRANTY,

EXPRESS OR IMPLIED, AS TO THE USEFULNESS OF THE SOFTWARE AND DOCUMENTATION FOR ANY PURPOSE. THEY ASSUME NO RESPONSIBILITY (1) FOR THE USE OF THE SOFTWARE AND DOCUMENTATION; OR (2) TO PROVIDE TECHNICAL SUPPORT TO USERS.

## REVISION HISTORY

06/04/2015 Initial Version prepared for NCDC

## USAGE

```
result=create_manifest(output_dir=output_dir,tsifile,ssifile)
```

## 8. SOLAR\_IRRADIANCE\_FCDR/get\_daily\_time\_bounds.pro [ Programs ]

[ [Top](#) ] [ Programs ]

### NAME

get\_daily\_time\_bounds

### PURPOSE

Defines the bounds for each time bin in the daily irradiance data

### DESCRIPTION

Defines the bounds for each time bin in the daily irradiance data

### INPUTS

mjd - array of Modified Julian Date for the data time bins

### OUTPUTS

bounds - The bounds (in modified Julian data) for the start of each day (inclusive), and end of each day (exclusive).

### AUTHOR

Odele Coddington, Laboratory for Atmospheric and Space Physics, Boulder, CO  
Doug Lindholm, Laboratory for Atmospheric and Space Physics, Boulder, CO  
Judith Lean, Space Science Division, Naval Research Laboratory, Washington, DC

### COPYRIGHT

THIS SOFTWARE AND ITS DOCUMENTATION ARE CONSIDERED TO BE IN THE PUBLIC DOMAIN AND THUS ARE AVAILABLE FOR UNRESTRICTED PUBLIC USE. THEY ARE FURNISHED "AS IS." THE AUTHORS, THE UNITED STATES GOVERNMENT, ITS INSTRUMENTALITIES, OFFICERS, EMPLOYEES, AND AGENTS MAKE NO WARRANTY, EXPRESS OR IMPLIED, AS TO THE USEFULNESS OF THE SOFTWARE AND DOCUMENTATION FOR ANY PURPOSE. THEY ASSUME NO RESPONSIBILITY (1) FOR

THE USE OF THE SOFTWARE AND DOCUMENTATION; OR (2) TO PROVIDE TECHNICAL SUPPORT TO USERS.

## REVISION HISTORY

06/04/2015 Initial Version prepared for NCDC

## USAGE

```
result=get_daily_time_bounds(mjd)
```

## 9. SOLAR\_IRRADIANCE\_FCDR/get\_mg\_index.pro [ Programs ]

[ [Top](#) ] [ Programs ]

### NAME

```
get_mg_index
```

### PURPOSE

The **get\_mg\_index.pro** is a function that parses a time-series of the facular brightening index for the desired starting and ending date.

### DESCRIPTION

The **get\_mg\_index.pro** is a function that parses a time-series of the facular brightening index (actually, a proxy of the facular brightening index - Mg II) for the desired starting and ending date, and passes the results to the routine, [process\\_irradiance.pro](#).

Final data is parsed from LASP's time-series server, LaTiS, via an IDL net URL.

### INPUTS

```
ymd1      - starting time range respective to midnight GMT of the given day, in 'yyyy-  
mm-dd' format.  
ymd2      - ending time range respective to midnight GMT of the given day (i.e. in NOT  
inclusive), in 'yyyy-mm-dd' format.  
final     - delegate to the LaTiS server for final released data.
```

### OUTPUTS

```
data      - an IDL list containing the modified Julian date index and the Mg II index
```

### AUTHOR

Odele Coddington, Laboratory for Atmospheric and Space Physics, Boulder, CO  
Doug Lindholm, Laboratory for Atmospheric and Space Physics, Boulder, CO  
Judith Lean, Space Science Division, Naval Research Laboratory, Washington, DC

### COPYRIGHT

THIS SOFTWARE AND ITS DOCUMENTATION ARE CONSIDERED TO BE IN THE PUBLIC DOMAIN AND THUS ARE AVAILABLE FOR UNRESTRICTED PUBLIC USE. THEY ARE FURNISHED "AS IS." THE AUTHORS, THE UNITED STATES GOVERNMENT, ITS

INSTRUMENTALITIES, OFFICERS, EMPLOYEES, AND AGENTS MAKE NO WARRANTY, EXPRESS OR IMPLIED, AS TO THE USEFULNESS OF THE SOFTWARE AND DOCUMENTATION FOR ANY PURPOSE. THEY ASSUME NO RESPONSIBILITY (1) FOR THE USE OF THE SOFTWARE AND DOCUMENTATION; OR (2) TO PROVIDE TECHNICAL SUPPORT TO USERS.

## REVISION HISTORY

06/04/2015 Initial Version prepared for NCDC

## USAGE

```
result=get_mg_index(ymdl,ymd2,final=final)
```

## 10. SOLAR\_IRRADIANCE\_FCDR/get\_model\_params.pro [ Programs ]

[ [Top](#) ] [ Programs ]

### NAME

get\_model\_params

### PURPOSE

The **get\_model\_params.pro** function is called from [process\\_irradiance.pro](#). It extracts coefficients for faculae and sunspots that are pre-specified (determined using multiple linear regression) for the algorithm. The coefficients for reproducing TSI are spectrally integrated, while those for reproducing SSI are wavelength dependent. The purpose of the coefficients is to convert the facular brightening and sunspot darkening indices to their equivalent irradiance change, in energy units, depending on the wavelength-dependent strengths of the facular and sunspot influences at that time.

### DESCRIPTION

The **get\_model\_params.pro** function restores pre-specified coefficients from an IDL save file and passes them in a structure, 'params', to the main routine.

### INPUTS

file - an IDL save file containing the NRLTSI2 and NRLSSI2 model coefficients used to adjust the baseline, quiet Sun irradiance, either increasing or decreasing it depending on the wavelength-dependent strengths of the facular, F, and sunspot, S, influences at that time.

### OUTPUTS

params - a structure containing the following variables:

- simver = The data version of SORCE SIM used to derive model coefficients
- tquiet = specified, invariant, quiet Sun reference value for total solar irradiance
- iquiet = specified, invariant, quiet Sun reference value for solar spectral irradiance. Function of wavelength, k.
- lambda = wavelength (k); consists of 1 nm bins centered at the bin midpoint from 115.5 nm to 99999.5 nm



```

    acoef      = the 'a' multiple regression coefficient for facular brightening
    bfaccoef   = coefficient used to determine spectrally integrated facular brightening
adjustment to baseline, quiet Sun, tquiet.
    bspotcoef  = coefficient used to determine spectrally integrated sunspot darkening
adjustment to baseline, quiet Sun, tquiet.
    ccoef      = coefficient for wavelength-dependent facular brightening
    dfaccoef   = coefficient used to determine wavelength-dependent (k) facular brightening
adjustment to baseline, quiet Sun, iquiet.
    efaccoef   = small, but nonzero, adjustment factor that accounts for the imperfect nature
of the facular brightening index. Used to ensure
    the integral of the time and spectrally-dependent spectral irradiance
variations from faculae equal the time-dependent total
    irradiance variations from faculae.
    dspotcoef  = coefficient used to determine wavelength-dependent (k) sunspot darkening
adjustment to baseline, quiet Sun, iquiet.
    espotcoef  = small, but nonzero, adjustment factor that accounts for the imperfect nature
of the sunspot darkening index. Used to ensure
    the integral of the time and spectrally-dependent spectral irradiance
variations from sunspots equal the time-dependent total
    irradiance variations from sunspots.
    mgquiet    = specified, invariant, reference value for the Mg II index for the quiet sun.
Nonzero value. By contrast, the reference value
    for sunspot darkening at quiet sun conditions is zero.
    ccoefunc   = the absolute uncertainty in 'ccoeff'
    mgu        = the relative uncertainty in change in facular brightening from its minimum
value, mgquiet.
    sbu        = the relative uncertainty in change in sunspot darkening from its minimum
value, '0'.
    tsisigma   = the 1-sigma absolute uncertainty estimates for the coefficients returned in
the multiple linear
    regression, so also accounts for autocorrelation in the time series.
    faccfunc   = the relative uncertainty estimate for the coefficients of spectral facular
brightening obtained from multiple linear
    regression of the detrended spectral observations, and detrended indices.
    spotcfunc  = the relative uncertainty estimate for the coefficients of spectral sunspot
darkening obtained from multiple linear
    regression of the detrended spectral observations, and detrended indices.
    coeff0spot = the regression coefficient that linearly relates the sunspot darkening
index to the residual energy in the sunspot darkening
    index
    qsigmaspot = the absolute uncertainty in the small, but nonzero 'coeff0spot' factor
    coeff0fac  = the regression coefficient that linearly relates the facular brightening
index to the residual energy in the facular
    brightening index
    qsigmafac  = the absolute uncertainty in the 'coeff0fac' factor
    selmg      = internal QA flag (not used to compute model irradiances)
    selfrac    = internal QA flag (not used to compute model irradiances)
    seltim     = internal QA flag (not used to compute model irradiances)

```

## AUTHOR

Odele Coddington, Laboratory for Atmospheric and Space Physics, Boulder, CO  
 Doug Lindholm, Laboratory for Atmospheric and Space Physics, Boulder, CO  
 Judith Lean, Space Science Division, Naval Research Laboratory, Washington, DC

## COPYRIGHT

THIS SOFTWARE AND ITS DOCUMENTATION ARE CONSIDERED TO BE IN THE PUBLIC DOMAIN AND THUS ARE AVAILABLE FOR UNRESTRICTED PUBLIC USE. THEY ARE FURNISHED "AS IS." THE AUTHORS, THE UNITED STATES GOVERNMENT, ITS INSTRUMENTALITIES, OFFICERS, EMPLOYEES, AND AGENTS MAKE NO WARRANTY, EXPRESS OR IMPLIED, AS TO THE USEFULNESS OF THE SOFTWARE AND DOCUMENTATION FOR ANY PURPOSE. THEY ASSUME NO RESPONSIBILITY (1) FOR THE USE OF THE SOFTWARE AND DOCUMENTATION; OR (2) TO PROVIDE TECHNICAL SUPPORT TO USERS.

## REVISION HISTORY

06/04/2015 Initial Version prepared for NCDC

## USAGE

```
result=get_model_params(file=file)
```

## 11. SOLAR\_IRRADIANCE\_FCDDR/get\_monthly\_time\_bounds.pro [ Programs ]

[ [Top](#) ] [ Programs ]

### NAME

```
get_monthly_time_bounds
```

### PURPOSE

```
Defines the bounds for each time bin in the monthly-averaged irradiance data
```

### DESCRIPTION

```
Defines the bounds for each time bin in the monthly-averaged irradiance data
```

### INPUTS

```
mjd - array of Modified Julian Date for the data time bins at the middle of the month  
(15th)
```

### OUTPUTS

```
bounds - The bounds (in modified Julian data) for the 1st of each month (inclusive),  
         and end of each month (exclusive).
```

### AUTHOR

```
Odele Coddington, Laboratory for Atmospheric and Space Physics, Boulder, CO  
Doug Lindholm, Laboratory for Atmospheric and Space Physics, Boulder, CO  
Judith Lean, Space Science Division, Naval Research Laboratory, Washington, DC
```

### COPYRIGHT

```
THIS SOFTWARE AND ITS DOCUMENTATION ARE CONSIDERED TO BE IN THE PUBLIC  
DOMAIN AND THUS ARE AVAILABLE FOR UNRESTRICTED PUBLIC USE. THEY ARE  
FURNISHED "AS IS." THE AUTHORS, THE UNITED STATES GOVERNMENT, ITS  
INSTRUMENTALITIES, OFFICERS, EMPLOYEES, AND AGENTS MAKE NO WARRANTY,  
EXPRESS OR IMPLIED, AS TO THE USEFULNESS OF THE SOFTWARE AND  
DOCUMENTATION FOR ANY PURPOSE. THEY ASSUME NO RESPONSIBILITY (1) FOR  
THE USE OF THE SOFTWARE AND DOCUMENTATION; OR (2) TO PROVIDE TECHNICAL  
SUPPORT TO USERS.
```

### REVISION HISTORY

```
06/04/2015 Initial Version prepared for NCDC
```

### USAGE

```
result=get_monthly_time_bounds(mjd)
```

## 12. SOLAR\_IRRADIANCE\_FCDR/get\_solar\_latitude.pro [ Programs ]

[ [Top](#) ] [ Programs ]

### NAME

`get_solar_latitude.pro`

### PURPOSE

Obtains solar latitude from a generic file (betasun2.dat)

### DESCRIPTION

Obtains the ecliptic plane correction, B0, for the given day. The B0 factor is used to correct the heliocentric latitude of the sunspot grouping, 'lat' for an approximate +/- 7 degree annual change in the ecliptic plane (the angle between the perpendicular of the line from the earth center to the center of the Sun) and the angle of rotation of the Sun. The B0 correction is an area projection (cosine weighting).  
The corrected solar latitude = latitude - B0

### INPUTS

jd - Julian Date

### OUTPUTS

lat - the ecliptic plane correction

### AUTHOR

Odele Coddington, Laboratory for Atmospheric and Space Physics, Boulder, CO  
Doug Lindholm, Laboratory for Atmospheric and Space Physics, Boulder, CO  
Judith Lean, Space Science Division, Naval Research Laboratory, Washington, DC

### COPYRIGHT

THIS SOFTWARE AND ITS DOCUMENTATION ARE CONSIDERED TO BE IN THE PUBLIC DOMAIN AND THUS ARE AVAILABLE FOR UNRESTRICTED PUBLIC USE. THEY ARE FURNISHED "AS IS." THE AUTHORS, THE UNITED STATES GOVERNMENT, ITS INSTRUMENTALITIES, OFFICERS, EMPLOYEES, AND AGENTS MAKE NO WARRANTY, EXPRESS OR IMPLIED, AS TO THE USEFULNESS OF THE SOFTWARE AND DOCUMENTATION FOR ANY PURPOSE. THEY ASSUME NO RESPONSIBILITY (1) FOR THE USE OF THE SOFTWARE AND DOCUMENTATION; OR (2) TO PROVIDE TECHNICAL SUPPORT TO USERS.

### REVISION HISTORY

06/04/2015 Initial Version prepared for NCDC

### USAGE

```
result=get_solar_latitude(jd)
```

## 13. SOLAR\_IRRADIANCE\_FCDR/get\_spectral\_bins.pro [ Programs ]

[ [Top](#) ] [ Programs ]

### NAME

**get\_spectral\_bins.pro**

### PURPOSE

The **get\_spectral\_bins.pro** function is called from the routine, [process\\_irradiance.pro](#). It sets up wavelength bands for the output solar spectral irradiance. The wavelength grid is as follows:

```
1 nm from 115 to 750
5 nm from 750 to 5000
10 nm from 5000 to 10000
50 nm from 10000 to 100000
```

The routine defines the bandcenters and bandwidths for the wavelength grid, and passes the variables back to the driver routine in a structure, 'bins'.

### DESCRIPTION

The **get\_spectral\_bins.pro** function passes wavelength grid information (number of bands, bandcenters, and bandwidths) to the driver routine for later use in binning spectral irradiance data.

### INPUTS

### OUTPUTS

bins - a structure containing the following variables:

```
nband      = number of spectral bands, for a variable wavelength grid, that the NRLSSI2
model bins 1 nm solar spectral irradiance onto.
bandcenter = the bandcenters (nm) of the variable wavelength grid.
bandwidth  = the bandwidths (delta wavelength, nm) of the variable wavelength grid,
centered on bandcenter.
```

### AUTHOR

Odele Coddington, Laboratory for Atmospheric and Space Physics, Boulder, CO  
 Doug Lindholm, Laboratory for Atmospheric and Space Physics, Boulder, CO  
 Judith Lean, Space Science Division, Naval Research Laboratory, Washington, DC

### COPYRIGHT

THIS SOFTWARE AND ITS DOCUMENTATION ARE CONSIDERED TO BE IN THE PUBLIC DOMAIN AND THUS ARE AVAILABLE FOR UNRESTRICTED PUBLIC USE. THEY ARE FURNISHED "AS IS." THE AUTHORS, THE UNITED STATES GOVERNMENT, ITS INSTRUMENTALITIES, OFFICERS, EMPLOYEES, AND AGENTS MAKE NO WARRANTY, EXPRESS OR IMPLIED, AS TO THE USEFULNESS OF THE SOFTWARE AND DOCUMENTATION FOR ANY PURPOSE. THEY ASSUME NO RESPONSIBILITY (1) FOR THE USE OF THE SOFTWARE AND DOCUMENTATION; OR (2) TO PROVIDE TECHNICAL SUPPORT TO USERS.

### REVISION HISTORY

## USAGE

```
result=get_spectral_bins()
```

# 14. SOLAR\_IRRADIANCE\_FCDR/get\_sunspot\_blocking.pro [ Programs ]

[ [Top](#) ] [ Programs ]

## NAME

**get\_sunspot\_blocking.pro**

## PURPOSE

The **get\_sunspot\_blocking.pro** is a utility function that iteratively invokes the function `process_sunspot_blocking` for a time period defined by a starting and ending date.

## DESCRIPTION

The `get_sunspot_blocking` function is a utility function that iteratively invokes a second function, `process_sunspot_blocking`, which computes the sunspot darkening index for a time period defined by a starting and ending date. Keyword parameters define whether the sunspot darkening index is obtained from files identified as "final", or preliminary data ("dev")

## INPUTS

<code>ymd1</code>	- starting time range respective to midnight GMT of the given day, in 'yyyy-mm-dd' format
<code>ymd2</code>	- ending time range respective to midnight GMT of the given day (i.e. in NOT inclusive), in 'yyyy-mm-dd' format.
<code>final</code>	- delegate to the LaTiS server for final released data.
<code>dev</code>	- delegate to processing routine for preliminary data.

## OUTPUTS

<code>data</code>	- an IDL list containing modified Julian date and sunspot darkening index
-------------------	---

## AUTHOR

Odele Coddington, Laboratory for Atmospheric and Space Physics, Boulder, CO  
 Doug Lindholm, Laboratory for Atmospheric and Space Physics, Boulder, CO  
 Judith Lean, Space Science Division, Naval Research Laboratory, Washington, DC

## COPYRIGHT

THIS SOFTWARE AND ITS DOCUMENTATION ARE CONSIDERED TO BE IN THE PUBLIC DOMAIN AND THUS ARE AVAILABLE FOR UNRESTRICTED PUBLIC USE. THEY ARE FURNISHED "AS IS." THE AUTHORS, THE UNITED STATES GOVERNMENT, ITS

INSTRUMENTALITIES, OFFICERS, EMPLOYEES, AND AGENTS MAKE NO WARRANTY, EXPRESS OR IMPLIED, AS TO THE USEFULNESS OF THE SOFTWARE AND DOCUMENTATION FOR ANY PURPOSE. THEY ASSUME NO RESPONSIBILITY (1) FOR THE USE OF THE SOFTWARE AND DOCUMENTATION; OR (2) TO PROVIDE TECHNICAL SUPPORT TO USERS.

## REVISION HISTORY

06/04/2015 Initial Version prepared for NCDC

## USAGE

```
result=get_sunspot_blocking(ymd1,ymd2,final=final,dev=dev)
```

## 15. SOLAR\_IRRADIANCE\_FCDR/get\_yearly\_time\_bounds.pro [ Programs ]

[ [Top](#) ] [ Programs ]

## NAME

get\_yearly\_time\_bounds

## PURPOSE

Defines the bounds for each time bin in the yearly-averaged irradiance data

## DESCRIPTION

Defines the bounds for each time bin in the yearly-averaged irradiance data

## INPUTS

mjd - array of Modified Julian Date for the data time bins at the middle of the year (July 1)

## OUTPUTS

bounds - The bounds (in modified Julian data) for the 1st of each year (inclusive), and end of each year (exclusive).

## AUTHOR

Odele Coddington, Laboratory for Atmospheric and Space Physics, Boulder, CO  
Doug Lindholm, Laboratory for Atmospheric and Space Physics, Boulder, CO  
Judith Lean, Space Science Division, Naval Research Laboratory, Washington, DC

## COPYRIGHT

THIS SOFTWARE AND ITS DOCUMENTATION ARE CONSIDERED TO BE IN THE PUBLIC DOMAIN AND THUS ARE AVAILABLE FOR UNRESTRICTED PUBLIC USE. THEY ARE FURNISHED "AS IS." THE AUTHORS, THE UNITED STATES GOVERNMENT, ITS INSTRUMENTALITIES, OFFICERS, EMPLOYEES, AND AGENTS MAKE NO WARRANTY,

EXPRESS OR IMPLIED, AS TO THE USEFULNESS OF THE SOFTWARE AND DOCUMENTATION FOR ANY PURPOSE. THEY ASSUME NO RESPONSIBILITY (1) FOR THE USE OF THE SOFTWARE AND DOCUMENTATION; OR (2) TO PROVIDE TECHNICAL SUPPORT TO USERS.

## REVISION HISTORY

06/04/2015 Initial Version prepared for NCDC

## USAGE

```
result=get_yearly_time_bounds(mjd)
```

## 16. SOLAR\_IRRADIANCE\_FCDR/group\_by\_day.pro [ Programs ]

[ [Top](#) ] [ Programs ]

### NAME

**group\_by\_day.pro**

### PURPOSE

Bins USAF white light sunspot data by day.

### DESCRIPTION

This routine is called from [process\\_sunspot\\_blocking.pro](#). Using a structure containing USAF white light sunspot region data (from [get\\_sunspot\\_data.pro](#)), it returns a Hash where the key is the modified julian day number and the value is a list of sunspot records for that modified julian day number

### INPUTS

```
structures - A structure containing (for each record in the USAF data):
  mjd - Modified Julian Date
  lat - latitude of sunspot group
  lon - longitude of sunspot group
  group - sunspot group number
  area - recorded sunspot area
  station - station name
```

### OUTPUTS

result - an IDL Hash (compound data type of key-value pair) where the key is the Julian Day Number and the value is a List of records for that day.

### AUTHOR

Odele Coddington, Laboratory for Atmospheric and Space Physics, Boulder, CO  
Doug Lindholm, Laboratory for Atmospheric and Space Physics, Boulder, CO  
Judith Lean, Space Science Division, Naval Research Laboratory, Washington, DC



## COPYRIGHT

THIS SOFTWARE AND ITS DOCUMENTATION ARE CONSIDERED TO BE IN THE PUBLIC DOMAIN AND THUS ARE AVAILABLE FOR UNRESTRICTED PUBLIC USE. THEY ARE FURNISHED "AS IS." THE AUTHORS, THE UNITED STATES GOVERNMENT, ITS INSTRUMENTALITIES, OFFICERS, EMPLOYEES, AND AGENTS MAKE NO WARRANTY, EXPRESS OR IMPLIED, AS TO THE USEFULNESS OF THE SOFTWARE AND DOCUMENTATION FOR ANY PURPOSE. THEY ASSUME NO RESPONSIBILITY (1) FOR THE USE OF THE SOFTWARE AND DOCUMENTATION; OR (2) TO PROVIDE TECHNICAL SUPPORT TO USERS.

## REVISION HISTORY

06/04/2015 Initial Version prepared for NCDC

## USAGE

```
result=group_by_day(structures)
```

## 17. SOLAR\_IRRADIANCE\_FCDR/group\_by\_function.pro [ Programs ]

[ [Top](#) ] [ Programs ]

### NAME

group\_by\_function

### PURPOSE

When given the name of a function that takes a structure as an argument, uses its return value as the key.

### DESCRIPTION

When given the name of a function that takes a structure as an argument, uses its return value as the key.

### INPUTS

structures - A structure or list of structures  
hash\_function - Name of the hash function

### OUTPUTS

result - an IDL Hash containing the key components of the structure

### AUTHOR

Odele Coddington, Laboratory for Atmospheric and Space Physics, Boulder, CO  
Doug Lindholm, Laboratory for Atmospheric and Space Physics, Boulder, CO  
Judith Lean, Space Science Division, Naval Research Laboratory, Washington, DC

## COPYRIGHT

THIS SOFTWARE AND ITS DOCUMENTATION ARE CONSIDERED TO BE IN THE PUBLIC DOMAIN AND THUS ARE AVAILABLE FOR UNRESTRICTED PUBLIC USE. THEY ARE FURNISHED "AS IS." THE AUTHORS, THE UNITED STATES GOVERNMENT, ITS INSTRUMENTALITIES, OFFICERS, EMPLOYEES, AND AGENTS MAKE NO WARRANTY, EXPRESS OR IMPLIED, AS TO THE USEFULNESS OF THE SOFTWARE AND DOCUMENTATION FOR ANY PURPOSE. THEY ASSUME NO RESPONSIBILITY (1) FOR THE USE OF THE SOFTWARE AND DOCUMENTATION; OR (2) TO PROVIDE TECHNICAL SUPPORT TO USERS.

## REVISION HISTORY

06/04/2015 Initial Version prepared for NCDC

## USAGE

```
result=group_by_function(structures, hash_function)
```

## 18. SOLAR\_IRRADIANCE\_FCDR/group\_by\_tag.pro [ Programs ]

[ [Top](#) ] [ Programs ]

### NAME

**group\_by\_tag.pro**

### PURPOSE

Given an array of structures and the name (a tag) in those structures, creates a Hash where each value of that tag becomes a key and the value for each key is an array of the structures that has that value of that tag. Does not modify the original structures.

### DESCRIPTION

Called by [process\\_sunspot\\_blocking.pro](#)  
 Makes a Hash mapping for a tag that becomes a key and the value for each key is an array of structures that has the value of that tag. For example, USAF station name can be used as a key and the value for that key is an array of structures holding observations by that station.

### INPUTS

```
structures - A structure containing, for each day of records in the USAF data:
  mjd - Modified Julian Date
  lat - latitude of sunspot group
  lon - longitude of sunspot group
  group - sunspot group number
  area - recorded sunspot area
  station - station name
tag - an array of USAF station names
```

### OUTPUTS

```
result - an IDL Hash (compound data type of key-value pair) where the key is the USAF
station name and
        the value is a List of sunspot records for that station (for a particular day).
```

## AUTHOR

Odele Coddington, Laboratory for Atmospheric and Space Physics, Boulder, CO  
Doug Lindholm, Laboratory for Atmospheric and Space Physics, Boulder, CO  
Judith Lean, Space Science Division, Naval Research Laboratory, Washington, DC

## COPYRIGHT

THIS SOFTWARE AND ITS DOCUMENTATION ARE CONSIDERED TO BE IN THE PUBLIC DOMAIN AND THUS ARE AVAILABLE FOR UNRESTRICTED PUBLIC USE. THEY ARE FURNISHED "AS IS." THE AUTHORS, THE UNITED STATES GOVERNMENT, ITS INSTRUMENTALITIES, OFFICERS, EMPLOYEES, AND AGENTS MAKE NO WARRANTY, EXPRESS OR IMPLIED, AS TO THE USEFULNESS OF THE SOFTWARE AND DOCUMENTATION FOR ANY PURPOSE. THEY ASSUME NO RESPONSIBILITY (1) FOR THE USE OF THE SOFTWARE AND DOCUMENTATION; OR (2) TO PROVIDE TECHNICAL SUPPORT TO USERS.

## REVISION HISTORY

06/04/2015 Initial Version prepared for NCDC

## USAGE

```
result=group_by_tag(structures, tag)
```

## 19. SOLAR\_IRRADIANCE\_FCDR/iso\_date2mjdn.pro [ Programs ]

[ [Top](#) ] [ Programs ]

### NAME

iso\_date2mjdn

### PURPOSE

Converts time from ISO 8601 standard to Modified Julian Date

### DESCRIPTION

Converts time from ISO 8601 standard to Modified Julian Date.  
Uses the ITT/IDL library routine julday.pro, which calculates the julian day number for a given month, day, and year.

### INPUTS

ymd - a value for time in ISO format ('yyyy-mm-dd')

### OUTPUTS

mjd - Modified Julian Date

## AUTHOR

Odele Coddington, Laboratory for Atmospheric and Space Physics, Boulder, CO  
Doug Lindholm, Laboratory for Atmospheric and Space Physics, Boulder, CO  
Judith Lean, Space Science Division, Naval Research Laboratory, Washington, DC

## COPYRIGHT

THIS SOFTWARE AND ITS DOCUMENTATION ARE CONSIDERED TO BE IN THE PUBLIC DOMAIN AND THUS ARE AVAILABLE FOR UNRESTRICTED PUBLIC USE. THEY ARE FURNISHED "AS IS." THE AUTHORS, THE UNITED STATES GOVERNMENT, ITS INSTRUMENTALITIES, OFFICERS, EMPLOYEES, AND AGENTS MAKE NO WARRANTY, EXPRESS OR IMPLIED, AS TO THE USEFULNESS OF THE SOFTWARE AND DOCUMENTATION FOR ANY PURPOSE. THEY ASSUME NO RESPONSIBILITY (1) FOR THE USE OF THE SOFTWARE AND DOCUMENTATION; OR (2) TO PROVIDE TECHNICAL SUPPORT TO USERS.

## REVISION HISTORY

06/04/2015 Initial Version prepared for NCDC

## USAGE

```
result=iso_date2mjd(ymd)
```

## 20. SOLAR\_IRRADIANCE\_FCDR/jd2iso\_date.pro [ Programs ]

[ [Top](#) ] [ Programs ]

### NAME

jd2iso\_date

### PURPOSE

Converts time from Julian Date (integer) to ISO 8601 standard, 'yyyy-mm-dd'

### DESCRIPTION

Converts time from Julian Date (integer) to ISO 8601 standard, 'yyyy-mm-dd'.  
Uses ITT IDL library routine caldat.pro, which return the calendar date given julian date.

### INPUTS

jd - Julian Date

### OUTPUTS

a value for time in ISO format ('yyyy-mm-dd')

### AUTHOR

Odele Coddington, Laboratory for Atmospheric and Space Physics, Boulder, CO  
Doug Lindholm, Laboratory for Atmospheric and Space Physics, Boulder, CO  
Judith Lean, Space Science Division, Naval Research Laboratory, Washington, DC

## COPYRIGHT

THIS SOFTWARE AND ITS DOCUMENTATION ARE CONSIDERED TO BE IN THE PUBLIC DOMAIN AND THUS ARE AVAILABLE FOR UNRESTRICTED PUBLIC USE. THEY ARE FURNISHED "AS IS." THE AUTHORS, THE UNITED STATES GOVERNMENT, ITS INSTRUMENTALITIES, OFFICERS, EMPLOYEES, AND AGENTS MAKE NO WARRANTY, EXPRESS OR IMPLIED, AS TO THE USEFULNESS OF THE SOFTWARE AND DOCUMENTATION FOR ANY PURPOSE. THEY ASSUME NO RESPONSIBILITY (1) FOR THE USE OF THE SOFTWARE AND DOCUMENTATION; OR (2) TO PROVIDE TECHNICAL SUPPORT TO USERS.

## REVISION HISTORY

06/04/2015 Initial Version prepared for NCDC

## USAGE

```
result=jd2iso_date(jd)
```

## 21. SOLAR\_IRRADIANCE\_FCDR/jd2mmdd.pro [ Programs ]

[ [Top](#) ] [ Programs ]

### NAME

jd2mmdd

### PURPOSE

Converts time from Julian Date to a month and day string (mmdd).

### DESCRIPTION

Converts time from Julian Date to a month and day string (mmdd).

### INPUTS

jd - time value in Julian Date

### OUTPUTS

mmdd - a month and day string

### AUTHOR

Judith Lean, Space Science Division, Naval Research Laboratory, Washington, DC  
Odele Coddington, Laboratory for Atmospheric and Space Physics, Boulder, CO  
Doug Lindholm, Laboratory for Atmospheric and Space Physics, Boulder, CO

## COPYRIGHT

THIS SOFTWARE AND ITS DOCUMENTATION ARE CONSIDERED TO BE IN THE PUBLIC DOMAIN AND THUS ARE AVAILABLE FOR UNRESTRICTED PUBLIC USE. THEY ARE

FURNISHED "AS IS." THE AUTHORS, THE UNITED STATES GOVERNMENT, ITS INSTRUMENTALITIES, OFFICERS, EMPLOYEES, AND AGENTS MAKE NO WARRANTY, EXPRESS OR IMPLIED, AS TO THE USEFULNESS OF THE SOFTWARE AND DOCUMENTATION FOR ANY PURPOSE. THEY ASSUME NO RESPONSIBILITY (1) FOR THE USE OF THE SOFTWARE AND DOCUMENTATION; OR (2) TO PROVIDE TECHNICAL SUPPORT TO USERS.

## REVISION HISTORY

06/04/2015 Initial Version prepared for NCDC

## USAGE

```
result=jd2mmd(jd)
```

# 22. SOLAR\_IRRADIANCE\_FCDR/mjd2iso\_date.pro [ Programs ]

[ [Top](#) ] [ Programs ]

## NAME

mjd2iso\_date

## PURPOSE

Converts time from Modified Julian Date (integer) to ISO 8601 time standard, 'yyyy-mm-dd'

## DESCRIPTION

Converts time from Modified Julian Date (integer) to ISO 8601 time standard, 'yyyy-mm-dd'  
Uses the ITT/IDL library routine caldat.pro, which returns the calendar date given julian day

## INPUTS

mjd - Modified Julian Date

## OUTPUTS

a value for time in ISO format ('yyyy-mm-dd')

## AUTHOR

Odele Coddington, Laboratory for Atmospheric and Space Physics, Boulder, CO  
Doug Lindholm, Laboratory for Atmospheric and Space Physics, Boulder, CO  
Judith Lean, Space Science Division, Naval Research Laboratory, Washington, DC

## COPYRIGHT

THIS SOFTWARE AND ITS DOCUMENTATION ARE CONSIDERED TO BE IN THE PUBLIC DOMAIN AND THUS ARE AVAILABLE FOR UNRESTRICTED PUBLIC USE. THEY ARE FURNISHED "AS IS." THE AUTHORS, THE UNITED STATES GOVERNMENT, ITS INSTRUMENTALITIES, OFFICERS, EMPLOYEES, AND AGENTS MAKE NO WARRANTY, EXPRESS OR IMPLIED, AS TO THE USEFULNESS OF THE SOFTWARE AND DOCUMENTATION FOR ANY PURPOSE. THEY ASSUME NO RESPONSIBILITY (1) FOR

THE USE OF THE SOFTWARE AND DOCUMENTATION; OR (2) TO PROVIDE TECHNICAL SUPPORT TO USERS.

## REVISION HISTORY

06/04/2015 Initial Version prepared for NCDC

## USAGE

```
result=mjd2iso_date(mjd)
```

# 23. SOLAR\_IRRADIANCE\_FCDR/mjd2iso\_yyyy.pro [ Programs ]

[ [Top](#) ] [ Programs ]

## NAME

mjd2iso\_yyyy

## PURPOSE

Converts time from Modified Julian Date (integer) to a 4 digit year in ISO 8601 standard, 'YYYY'

## DESCRIPTION

Converts time from Modified Julian Date (integer) to 4 digit year ISO 8601 standard, 'YYYY'

## INPUTS

mjd - Modified Julian Date

## OUTPUTS

a value for year in ISO format ('yyyy')

## AUTHOR

Judith Lean, Space Science Division, Naval Research Laboratory, Washington, DC  
Odele Coddington, Laboratory for Atmospheric and Space Physics, Boulder, CO  
Doug Lindholm, Laboratory for Atmospheric and Space Physics, Boulder, CO

## COPYRIGHT

THIS SOFTWARE AND ITS DOCUMENTATION ARE CONSIDERED TO BE IN THE PUBLIC DOMAIN AND THUS ARE AVAILABLE FOR UNRESTRICTED PUBLIC USE. THEY ARE FURNISHED "AS IS." THE AUTHORS, THE UNITED STATES GOVERNMENT, ITS INSTRUMENTALITIES, OFFICERS, EMPLOYEES, AND AGENTS MAKE NO WARRANTY, EXPRESS OR IMPLIED, AS TO THE USEFULNESS OF THE SOFTWARE AND DOCUMENTATION FOR ANY PURPOSE. THEY ASSUME NO RESPONSIBILITY (1) FOR THE USE OF THE SOFTWARE AND DOCUMENTATION; OR (2) TO PROVIDE TECHNICAL SUPPORT TO USERS.



## REVISION HISTORY

06/04/2015 Initial Version prepared for NCDC

## USAGE

```
result=mjd2iso_yyyy(mjd)
```

# 24. SOLAR\_IRRADIANCE\_FCDR/mjd2iso\_yyyymm.pro [ Programs ]

[ [Top](#) ] [ Programs ]

## NAME

mjd2iso\_yyyymm

## PURPOSE

Converts time from Modified Julian Date (integer) to a 4 digit year and 2 digit month in ISO 8601 standard, 'yyyy-mm'

## DESCRIPTION

Converts time from Modified Julian Date (integer) to a 4 digit year and 2 digit month in ISO 8601 standard, 'yyyy-mm-dd'

## INPUTS

mjd - Modified Julian Date

## OUTPUTS

a value for year and month in ISO format ('yyyy-mm')

## AUTHOR

Judith Lean, Space Science Division, Naval Research Laboratory, Washington, DC  
Odele Coddington, Laboratory for Atmospheric and Space Physics, Boulder, CO  
Doug Lindholm, Laboratory for Atmospheric and Space Physics, Boulder, CO

## COPYRIGHT

THIS SOFTWARE AND ITS DOCUMENTATION ARE CONSIDERED TO BE IN THE PUBLIC DOMAIN AND THUS ARE AVAILABLE FOR UNRESTRICTED PUBLIC USE. THEY ARE FURNISHED "AS IS." THE AUTHORS, THE UNITED STATES GOVERNMENT, ITS INSTRUMENTALITIES, OFFICERS, EMPLOYEES, AND AGENTS MAKE NO WARRANTY, EXPRESS OR IMPLIED, AS TO THE USEFULNESS OF THE SOFTWARE AND DOCUMENTATION FOR ANY PURPOSE. THEY ASSUME NO RESPONSIBILITY (1) FOR THE USE OF THE SOFTWARE AND DOCUMENTATION; OR (2) TO PROVIDE TECHNICAL SUPPORT TO USERS.

## REVISION HISTORY

## USAGE

```
result=mjd2iso_yyyyymm(mjd)
```

## 25. SOLAR\_IRRADIANCE\_FCDR/nrl2\_to\_irradiance.pro [ Programs ]

[ [Top](#) ] [ Programs ]

## NAME

```
nrl2_to_irradiance
```

## PURPOSE

The **nrl2\_to\_irradiance.pro** is the main driver procedure. It calls subfunctions to compute Total Solar Irradiance (TSI) and Solar Spectral Irradiance (SSI) to write the data output to NetCDF4 formatted files.

## DESCRIPTION

The **nrl2\_to\_irradiance.pro** is the main driver procedure. It calls subfunctions to compute Total Solar Irradiance (TSI) and Solar Spectral Irradiance (SSI) to write the data output to NetCDF4 formatted files.

## INPUTS

```
ymd1      - starting time range respective to midnight GMT of the given day, of the form  
'yyyy-mm-dd'  
ymd2      - ending time range respective to midnight GMT of the given day (i.e. in NOT  
inclusive), of the form 'yyyy-mm-dd'.  
final      - Data processing is delegated to the LaTiS server for accessing final released  
values of model inputs.  
time_bin   - A value of 'year', 'month', or 'day' that defines the time-averaging  
performed for the given data records.  
             'day' is the default.  
version    - version and revision number of the NRLTSI2 and NRLSSI2 models (e.g., v02r00)  
output_dir - path to data output directory.
```

## OUTPUTS

## AUTHOR

Odele Coddington, Laboratory for Atmospheric and Space Physics, Boulder, CO  
Doug Lindholm, Laboratory for Atmospheric and Space Physics, Boulder, CO  
Judith Lean, Space Science Division, Naval Research Laboratory, Washington, DC

## COPYRIGHT

THIS SOFTWARE AND ITS DOCUMENTATION ARE CONSIDERED TO BE IN THE PUBLIC DOMAIN AND THUS ARE AVAILABLE FOR UNRESTRICTED PUBLIC USE. THEY ARE FURNISHED "AS IS." THE AUTHORS, THE UNITED STATES GOVERNMENT, ITS INSTRUMENTALITIES, OFFICERS, EMPLOYEES, AND AGENTS MAKE NO WARRANTY, EXPRESS OR IMPLIED, AS TO THE USEFULNESS OF THE SOFTWARE AND DOCUMENTATION FOR ANY PURPOSE. THEY ASSUME NO RESPONSIBILITY (1) FOR THE USE OF THE SOFTWARE AND DOCUMENTATION; OR (2) TO PROVIDE TECHNICAL SUPPORT TO USERS.

## REVISION HISTORY

06/04/2015 Initial Version prepared for NCDC

## USAGE

```
nrl2_to_irradiance, ymd1, ymd2, final=final, time_bin=time_bin, version=version,
output_dir=output_dir
```

## 26. SOLAR\_IRRADIANCE\_FCDR/process\_irradiance.pro [ Programs ]

[ [Top](#) ] [ Programs ]

### NAME

process\_irradiance

### PURPOSE

The **process\_irradiance.pro** procedure calls a series of functions to compute the Total Solar Irradiance (TSI) and Solar Spectral Irradiance (SSI) using the NRLTSI2 and NRLSSI2 models.

### DESCRIPTION

The **process\_irradiance.pro** procedure calls a series of functions to compute the Total Solar Irradiance (TSI) and Solar Spectral Irradiance (SSI) using the NRLTSI2 and NRLSSI2 models.

### INPUTS

```
ymd1      - starting time range respective to midnight GMT of the given day, of the form
'yyyy-mm-dd'
ymd2      - ending time range respective to midnight GMT of the given day (i.e. in NOT
inclusive), of the form 'yyyy-mm-dd'.
final     - Data processing is delegated to the LaTiS server for accessing final released
values of model inputs.
dev       - Data processing is delegated to processing routines for computing preliminary
model input data.
time_bin  - A value of 'year', 'month', or 'day' that defines the time-averaging
performed for the given data records.
           'day' is the default.
```

### OUTPUTS

```
data      - A structure containing the irradiance data and the spectral bins:
  mjd      - Modified Julian Date
  iso      - iso 8601 formatted time
  tsi      - Modeled Total Solar Irradiance
  ssi      - Modeled Solar Spectral Irradiance (in wavelength bins)
  ssitot   - Integral of the Modeled Solar Spectral Irradiance
  nband    - number of spectral bands, for a variable wavelength grid, that the NRLSSI2
model bins 1 nm solar spectral irradiance onto.
  bandcenter - the bandcenters (nm) of the variable wavelength grid.
  bandwidth  - the bandwidths (delta wavelength, nm) of the variable wavelength grid,
centered on bandcenter.
```

### AUTHOR

Odele Coddington, Laboratory for Atmospheric and Space Physics, Boulder, CO  
 Doug Lindholm, Laboratory for Atmospheric and Space Physics, Boulder, CO  
 Judith Lean, Space Science Division, Naval Research Laboratory, Washington, DC

## COPYRIGHT

THIS SOFTWARE AND ITS DOCUMENTATION ARE CONSIDERED TO BE IN THE PUBLIC DOMAIN AND THUS ARE AVAILABLE FOR UNRESTRICTED PUBLIC USE. THEY ARE FURNISHED "AS IS." THE AUTHORS, THE UNITED STATES GOVERNMENT, ITS INSTRUMENTALITIES, OFFICERS, EMPLOYEES, AND AGENTS MAKE NO WARRANTY, EXPRESS OR IMPLIED, AS TO THE USEFULNESS OF THE SOFTWARE AND DOCUMENTATION FOR ANY PURPOSE. THEY ASSUME NO RESPONSIBILITY (1) FOR THE USE OF THE SOFTWARE AND DOCUMENTATION; OR (2) TO PROVIDE TECHNICAL SUPPORT TO USERS.

## REVISION HISTORY

06/04/2015 Initial Version prepared for NCDC

## USAGE

```
result=process_irradiance(ymd1, ymd2, final=final, dev=dev, time_bin=time_bin)
```

## 27. SOLAR\_IRRADIANCE\_FCDR/process\_sunspot\_blocking.pro [ Programs ]

[ [Top](#) ] [ Programs ]

### NAME

**process\_sunspot\_blocking.pro**

### PURPOSE

The **process\_sunspot\_blocking.pro** procedure computes the sunspot blocking function from U.S. Air Force White Light sunspot region data (obtained from a NOAA/NGDC web repository via ftp access-point of contact: Bill Denig).

### DESCRIPTION

This routine computes the sunspot darkening index, which is passed by structure, 'sunspot\_blocking\_data', to the calling function, 'get\_sunspot\_blocking' for preliminary data. This routine calls a series of subroutines with the names and purposes, summarized below:

- [get\\_sunspot\\_data.pro](#) - acquire USAF white light sunspot region data from NOAA/NGDC web repository and store in a structure, 'sunspot\_data', identified by index -> (jd, lat, lon, area, station)
- An optional keyword, 'stations', is used to restrict data to a user-defined particular station(s). By default, all stations are used in computing the sunspot darkening index.
- [group\\_by\\_day.pro](#) - group the USAF white light data by Julian date: jdn -> (jd, lat, lon, area, station)
- Stored in structure, 'daily\_sunspot\_data'
- get\_solar\_latitude.pro - Obtains the ecliptic plane correction, B0, for the given day. The B0 factor is used to correct the heliocentric latitude of the sunspot grouping, 'lat' for an

approximate +/- 7 degree annual  
 perpendicular of the line from the  
 rotation of the Sun. The B0 correction is an  
 latitude = latitude - B0  
[compute\\_sunspot\\_blocking.pro](#) - The delta change (reduction) in irradiance computed from  
 the latitude/longitude and  
 sunspot area for daily recorded  
 sunspot area computed from the individual measurements of  
 group\_and\_sum.pro - The total delta change in irradiance due to sunspots is the sum of the  
 sunspot blocking over each measuring station.  
 If a station is missing data for a particular sunspot grouping, a  
 quality flag to indicate missing data is set.  
[write\\_sunspot\\_blocking\\_data.pro](#) - If optional 'output\_dir' keyword is defined, the sunspot  
 darkening index, and its standard deviation  
 of the is output to intermediate ascii file  
 ('sunspot\_blocking\_YMD1\_YMD2\_VER.txt'), where time  
 ranges specify start/end date of desired time range.  
 'VER' is a hardcoded development version value to help  
 keep track of data output. Intermediate file  
 output used for QA analysis.

Note\*\*: Input time periods of YYYY-MM-DD format are internally converted to Modified  
 Julian Date for these routines.

## INPUTS

ymd1 - starting time range respective to midnight GMT of the given day, in Modified  
 Julian day (converted from 'yyyy-mm-dd' in main driver).  
 ymd2 - ending time range respective to midnight GMT of the given day  
 stations = stations - Optional keyword to restrict sunspot darkening index to specified  
 monitoring stations in the USAF white light network.  
 If omitted (default), these stations are used:  
 'LEAR', 'CULG', 'SVTO', 'RAMY', 'BOUL', 'HOLL', 'PALE', 'MANI', 'ATHN'.  
 Used for QA analysis.  
 output\_dir=output\_dir - Optional keyword to specify directory path to store sunspot  
 darkening index in a text file. If omitted (default), output  
 is not written to intermediate file. Used for QA analysis.

## OUTPUTS

sunspot\_blocking\_data - a structure containing the following variables:  
 mjd - the modified julian date  
 ssbt - the sunspot darkening index (a mean value of the reporting stations)  
 dssbt - the standard deviation of the sunspot darkening index of the reporting stations  
 quality flag - a value of 0 or 1 (1 = missing data or duplicate data); Used for QA  
 analysis.  
 if optional keyword 'output\_dir' is defined, an intermediate text file of the naming  
 convention, 'sunspot\_blocking\_YMD1\_YMD2\_VER.txt',  
 contains the structure data listed above, where version is a defined developmental version  
 - Used for QA monitoring.

## AUTHOR

Odele Coddington, Laboratory for Atmospheric and Space Physics, Boulder, CO  
 Doug Lindholm, Laboratory for Atmospheric and Space Physics, Boulder, CO  
 Judith Lean, Space Science Division, Naval Research Laboratory, Washington, DC

## COPYRIGHT

THIS SOFTWARE AND ITS DOCUMENTATION ARE CONSIDERED TO BE IN THE PUBLIC  
 DOMAIN AND THUS ARE AVAILABLE FOR UNRESTRICTED PUBLIC USE. THEY ARE  
 FURNISHED "AS IS." THE AUTHORS, THE UNITED STATES GOVERNMENT, ITS  
 INSTRUMENTALITIES, OFFICERS, EMPLOYEES, AND AGENTS MAKE NO WARRANTY,  
 EXPRESS OR IMPLIED, AS TO THE USEFULNESS OF THE SOFTWARE AND  
 DOCUMENTATION FOR ANY PURPOSE. THEY ASSUME NO RESPONSIBILITY (1) FOR  
 THE USE OF THE SOFTWARE AND DOCUMENTATION; OR (2) TO PROVIDE TECHNICAL  
 SUPPORT TO USERS.

## REVISION HISTORY

06/04/2015 Initial Version prepared for NCDC

## USAGE

```
result=process_sunspot_blocking(ymd1,ymd2,stations=stations,output_dir=output_dir)
```

## 28. SOLAR\_IRRADIANCE\_FCDR/read\_latis\_data.pro [ Programs ]

[ [Top](#) ] [ Programs ]

### NAME

read\_latis\_data

### PURPOSE

The **read\_latis\_data.pro** is a function that gets data from the LASP Time Series Server as a list of structures

### DESCRIPTION

The **read\_latis\_data.pro** is a function that gets data from the LASP Time Series Server as a list of structures

Data is parsed from LASP's time-series server, LaTiS, via an IDL net URL.

### INPUTS

dataset	- The name of the dataset
start_time	- starting time range to aquire the data, in 'yyyy-mm-dd' format.
end_time	- ending time range to aquire the data, in 'yyyy-mm-dd' format.
host	- name of the server host
port	- the port on the server machine
base_path	- Directory path on server to the dataset
query	- query parameters used to convert time or rename parameters to match the structures in LaTiS.

### OUTPUTS

list	- an IDL list containing the dataset values
------	---

### AUTHOR

Odele Coddington, Laboratory for Atmospheric and Space Physics, Boulder, CO  
Doug Lindholm, Laboratory for Atmospheric and Space Physics, Boulder, CO  
Judith Lean, Space Science Division, Naval Research Laboratory, Washington, DC

### COPYRIGHT

THIS SOFTWARE AND ITS DOCUMENTATION ARE CONSIDERED TO BE IN THE PUBLIC DOMAIN AND THUS ARE AVAILABLE FOR UNRESTRICTED PUBLIC USE. THEY ARE FURNISHED "AS IS." THE AUTHORS, THE UNITED STATES GOVERNMENT, ITS INSTRUMENTALITIES, OFFICERS, EMPLOYEES, AND AGENTS MAKE NO WARRANTY,

EXPRESS OR IMPLIED, AS TO THE USEFULNESS OF THE SOFTWARE AND DOCUMENTATION FOR ANY PURPOSE. THEY ASSUME NO RESPONSIBILITY (1) FOR THE USE OF THE SOFTWARE AND DOCUMENTATION; OR (2) TO PROVIDE TECHNICAL SUPPORT TO USERS.

## REVISION HISTORY

06/04/2015 Initial Version prepared for NCDC

## USAGE

```
result=read_latis_data(dataset, start_time, end_time, host=host, port=port,
base_path=base_path, query=query)
```

## 29. SOLAR\_IRRADIANCE\_FCDR/remove\_duplicate\_records.pro [ Programs ]

[ [Top](#) ] [ Programs ]

### NAME

**remove\_duplicate\_records.pro**

### PURPOSE

Checks for duplicate sunspot station records in the USAF white light observations. Removes duplicate records if found.

### DESCRIPTION

Called by [process\\_sunspot\\_blocking.pro](#)  
If duplicate records are found, reports the number of duplicates

### INPUTS

ssdata\_by\_station - An IDL hash observations by that station:  
mjd - Modified Julian Date  
lat - latitude of sunspot group  
lon - longitude of sunspot group  
group - sunspot group number  
area - recorded sunspot area  
station - station name

### OUTPUTS

result - an IDL hash (an IDL Hash (compound data type of key-value pair) where the key is the Julian Day Number  
and the value is a List of records with duplicate records removed  
ndup - an integer value of the number of duplicate records found (default = 0)

### AUTHOR

Odele Coddington, Laboratory for Atmospheric and Space Physics, Boulder, CO  
Doug Lindholm, Laboratory for Atmospheric and Space Physics, Boulder, CO  
Judith Lean, Space Science Division, Naval Research Laboratory, Washington, DC



## COPYRIGHT

THIS SOFTWARE AND ITS DOCUMENTATION ARE CONSIDERED TO BE IN THE PUBLIC DOMAIN AND THUS ARE AVAILABLE FOR UNRESTRICTED PUBLIC USE. THEY ARE FURNISHED "AS IS." THE AUTHORS, THE UNITED STATES GOVERNMENT, ITS INSTRUMENTALITIES, OFFICERS, EMPLOYEES, AND AGENTS MAKE NO WARRANTY, EXPRESS OR IMPLIED, AS TO THE USEFULNESS OF THE SOFTWARE AND DOCUMENTATION FOR ANY PURPOSE. THEY ASSUME NO RESPONSIBILITY (1) FOR THE USE OF THE SOFTWARE AND DOCUMENTATION; OR (2) TO PROVIDE TECHNICAL SUPPORT TO USERS.

## REVISION HISTORY

06/04/2015 Initial Version prepared for NCDC

## USAGE

```
result=remove_duplicate_records(ssdata_by_station, ndup)
```

## 30. SOLAR\_IRRADIANCE\_FCDR/remove\_hyphens.pro [ Programs ]

[ [Top](#) ] [ Programs ]

### NAME

remove\_hypens

### PURPOSE

Removes hyphens from the ISO 8601 date standard 'YYYY-MM-DD' to create 'YYYYMMDD' format

### DESCRIPTION

Removes hyphens in the ISO 8601 time standard.  
Used for formatting ISO 8601 time for dynamic filename creation.

### INPUTS

string - a value for time in ISO format ('yyyy-mm-dd')

### OUTPUTS

result - ISO format without hyphens

### AUTHOR

Odele Coddington, Laboratory for Atmospheric and Space Physics, Boulder, CO  
Doug Lindholm, Laboratory for Atmospheric and Space Physics, Boulder, CO  
Judith Lean, Space Science Division, Naval Research Laboratory, Washington, DC

## COPYRIGHT

THIS SOFTWARE AND ITS DOCUMENTATION ARE CONSIDERED TO BE IN THE PUBLIC DOMAIN AND THUS ARE AVAILABLE FOR UNRESTRICTED PUBLIC USE. THEY ARE FURNISHED "AS IS." THE AUTHORS, THE UNITED STATES GOVERNMENT, ITS INSTRUMENTALITIES, OFFICERS, EMPLOYEES, AND AGENTS MAKE NO WARRANTY, EXPRESS OR IMPLIED, AS TO THE USEFULNESS OF THE SOFTWARE AND DOCUMENTATION FOR ANY PURPOSE. THEY ASSUME NO RESPONSIBILITY (1) FOR THE USE OF THE SOFTWARE AND DOCUMENTATION; OR (2) TO PROVIDE TECHNICAL SUPPORT TO USERS.

REVISION HISTORY

06/04/2015 Initial Version prepared for NCDC

USAGE

result=remove\_hyphens(string)

31. SOLAR\_IRRADIANCE\_FCDR/unix2mjd.pro [ Programs ]

[ [Top](#) ] [ Programs ]

NAME

unix2mjd

PURPOSE

Converts time from UNIX standard (with epoch 1970-01-01T00:00:00Z) to Modified Julian Date

DESCRIPTION

Converts time from UNIX standard (with epoch 1970-01-01T00:00:00Z) to Modified Julian Date

INPUTS

unix\_time - a value for time in UNIX format (with epoch 1970-01-01T00:00:00Z)

OUTPUTS

mjd - Modified Julian Date

AUTHOR

Odele Coddington, Laboratory for Atmospheric and Space Physics, Boulder, CO  
Doug Lindholm, Laboratory for Atmospheric and Space Physics, Boulder, CO  
Judith Lean, Space Science Division, Naval Research Laboratory, Washington, DC

COPYRIGHT

THIS SOFTWARE AND ITS DOCUMENTATION ARE CONSIDERED TO BE IN THE PUBLIC DOMAIN AND THUS ARE AVAILABLE FOR UNRESTRICTED PUBLIC USE. THEY ARE FURNISHED "AS IS." THE AUTHORS, THE UNITED STATES GOVERNMENT, ITS INSTRUMENTALITIES, OFFICERS, EMPLOYEES, AND AGENTS MAKE NO WARRANTY, EXPRESS OR IMPLIED, AS TO THE USEFULNESS OF THE SOFTWARE AND DOCUMENTATION FOR ANY PURPOSE. THEY ASSUME NO RESPONSIBILITY (1) FOR

THE USE OF THE SOFTWARE AND DOCUMENTATION; OR (2) TO PROVIDE TECHNICAL SUPPORT TO USERS.

## REVISION HISTORY

06/04/2015 Initial Version prepared for NCDC

## USAGE

```
result=unix2mjd(unix_time)
```

## 32. SOLAR\_IRRADIANCE\_FCDR/write\_irradiance\_data.pro [ Programs ]

[ [Top](#) ] [ Programs ]

## NAME

```
write_irradiance_data
```

## PURPOSE

The **write\_irradiance\_data.pro** function is the driver routine for writing irradiance output to netCDF4 output

## DESCRIPTION

The **write\_irradiance\_data.pro** function is the driver routine for writing irradiance output to netCDF4 output

## INPUTS

```

ymd1          - starting time range respective to midnight GMT of the given day, of the
form 'yyyy-mm-dd'
ymd2          - ending time range respective to midnight GMT of the given day (i.e. in
NOT inclusive), of the form 'yyyy-mm-dd'.
irradiance_data - a structure containing the following variables
  mjd          - Modified Julian Date
  iso          - iso 8601 formatted time
  tsi          - Modeled Total Solar Irradiance
  ssi          - Modeled Solar Spectral Irradiance (in wavelength bins)
  ssitot       - Integral of the Modeled Solar Spectral Irradiance
  nband        - number of spectral bands, for a variable wavelength grid, that the NRLSSI2
model bins 1 nm solar spectral irradiance onto.
  bandcenter   - the bandcenters (nm) of the variable wavelength grid.
  bandwidth    - the bandwidths (delta wavelength, nm) of the variable wavelength grid,
centered on bandcenter.
  version      - version and revision number of the NRLTSI2 and NRLSSI2 models (e.g.,
v02r00)
  time_bin     - A value of 'year', 'month', or 'day' that defines the time-averaging
performed for the given data records.
                  'day' is the default.
  output_dir   - Directory path for irradiance files

```

## OUTPUTS

## AUTHOR

Odele Coddington, Laboratory for Atmospheric and Space Physics, Boulder, CO  
Doug Lindholm, Laboratory for Atmospheric and Space Physics, Boulder, CO  
Judith Lean, Space Science Division, Naval Research Laboratory, Washington, DC

## COPYRIGHT

THIS SOFTWARE AND ITS DOCUMENTATION ARE CONSIDERED TO BE IN THE PUBLIC DOMAIN AND THUS ARE AVAILABLE FOR UNRESTRICTED PUBLIC USE. THEY ARE FURNISHED "AS IS." THE AUTHORS, THE UNITED STATES GOVERNMENT, ITS INSTRUMENTALITIES, OFFICERS, EMPLOYEES, AND AGENTS MAKE NO WARRANTY, EXPRESS OR IMPLIED, AS TO THE USEFULNESS OF THE SOFTWARE AND DOCUMENTATION FOR ANY PURPOSE. THEY ASSUME NO RESPONSIBILITY (1) FOR THE USE OF THE SOFTWARE AND DOCUMENTATION; OR (2) TO PROVIDE TECHNICAL SUPPORT TO USERS.

## REVISION HISTORY

06/04/2015 Initial Version prepared for NCDC

## USAGE

```
result=write_irradiance_data(ymd1,ymd2,irradiance_data, version, time_bin=time_bin,
output_dir=output_dir)
```

## 33. SOLAR\_IRRADIANCE\_FCDR/write\_monthly\_average\_ssi\_to\_netcdf2.pro [ Programs ]

[ [Top](#) ] [ Programs ]

## NAME

**write\_monthly\_average\_ssi\_to\_netcdf2.pro**

## PURPOSE

The **write\_monthly\_average\_ssi\_to\_netcdf2.pro** function outputs monthly-averaged Solar Spectral Irradiance to a netcdf4 file. This function is called from the routine, [write\\_irradiance\\_data.pro](#).

## DESCRIPTION

The **write\_monthly\_average\_ssi\_to\_netcdf2.pro** function outputs monthly-averaged Solar Spectral Irradiance to a netcdf4 file and (midpoint) date (YYYY-MM) to a netcdf4 formatted file. The time format variables is seconds since a 1610-01-01 00:00:00 epoch  
Missing values (NaN's or '0's) are defined as -99.0.

## INPUTS

```
ymd1 - starting time (yyyy-mm-dd)
ymd2 - ending time (yyyy-mm-dd)
ymd3 - creation date (yyyy-mm-dd)
version - version and revision number of the NRLSSI2 model (e.g., v02r00)
irradiance_data - a structure containing the following variables
  mjd - Modified Julian Date
```

```
iso      - iso 8601 formatted time
tsi      - Modeled Total Solar Irradiance
tsiunc   - Uncertainty in total solar irradiance
ssi      - Modeled Solar Spectral Irradiance (in wavelength bins)
ssitot   - Integral of the Modeled Solar Spectral Irradiance
spectral_bins - a structure containing the following variables
nband    - number of spectral bands, for a variable wavelength grid, that the NRL2
model_bins 1 nm solar spectral irradiance onto.
bandcenter - the bandcenters (nm) of the variable wavelength grid.
bandwidth  - the bandwidths (delta wavelength, nm) of the variable wavelength grid.
output_dir - Directory path for output file
file      - filename (dynamically created from write\_irradiance\_data.pro)
```

## OUTPUTS

## AUTHOR

Judith Lean, Space Science Division, Naval Research Laboratory, Washington, DC  
Odele Coddington, Laboratory for Atmospheric and Space Physics, Boulder, CO  
Doug Lindholm, Laboratory for Atmospheric and Space Physics, Boulder, CO

## COPYRIGHT

THIS SOFTWARE AND ITS DOCUMENTATION ARE CONSIDERED TO BE IN THE PUBLIC DOMAIN AND THUS ARE AVAILABLE FOR UNRESTRICTED PUBLIC USE. THEY ARE FURNISHED "AS IS." THE AUTHORS, THE UNITED STATES GOVERNMENT, ITS INSTRUMENTALITIES, OFFICERS, EMPLOYEES, AND AGENTS MAKE NO WARRANTY, EXPRESS OR IMPLIED, AS TO THE USEFULNESS OF THE SOFTWARE AND DOCUMENTATION FOR ANY PURPOSE. THEY ASSUME NO RESPONSIBILITY (1) FOR THE USE OF THE SOFTWARE AND DOCUMENTATION; OR (2) TO PROVIDE TECHNICAL SUPPORT TO USERS.

## REVISION HISTORY

06/04/2015 Initial Version prepared for NCDC

## USAGE

```
result=write_monthly_average_ssi_to_netcdf2(ymd1, ymd2, ymd3, version, irradiance_data,
output_dir=output_dir, file)
```

# 34. SOLAR\_IRRADIANCE\_FCDR/write\_monthly\_average\_tsi\_to\_netcdf2.pro [ Programs ]

[ [Top](#) ] [ Programs ]

## NAME

**write\_monthly\_average\_tsi\_to\_netcdf2.pro**

## PURPOSE

The **write\_monthly\_average\_tsi\_to\_netcdf2.pro** function outputs monthly-averaged Total Solar Irradiance to a netcdf4 file. This function is called from the routine, [write\\_irradiance\\_data.pro](#).

## DESCRIPTION

The `write_monthly_average_tsi_to_netcdf2.pro` function outputs monthly-averaged Total Solar Irradiance to a netcdf4 file and (midpoint) date (YYYY-MM) to a netcdf4 formatted file. The time format variables is seconds since a 1610-01-01 00:00:00 epoch. Missing values (NaN's or '0's) are defined as -99.0.

## INPUTS

```
ymd1 - starting time (yyyy-mm-dd)
ymd2 - ending time (yyyy-mm-dd)
ymd3 - creation date (yyyy-mm-dd)
version - version and revision number of the NRLTSI2 model (e.g., v02r00)
irradiance_data - a structure containing the following variables
    mjd - Modified Julian Date
    iso - iso 8601 formatted time
    tsi - Modeled Total Solar Irradiance
    tsiunc - Uncertainty in total solar irradiance
    ssi - Modeled Solar Spectral Irradiance (in wavelength bins)
    ssitot - Integral of the Modeled Solar Spectral Irradiance
spectral_bins - a structure containing the following variables
    nband - number of spectral bands, for a variable wavelength grid, that the NRL2
model bins 1 nm solar spectral irradiance onto.
    bandcenter - the bandcenters (nm) of the variable wavelength grid.
    bandwidth - the bandwidths (delta wavelength, nm) of the variable wavelength grid.
output_dir - Directory path for output file
file - filename (dynamically created from write\_irradiance\_data.pro)
```

## OUTPUTS

## AUTHOR

Judith Lean, Space Science Division, Naval Research Laboratory, Washington, DC  
 Odele Coddington, Laboratory for Atmospheric and Space Physics, Boulder, CO  
 Doug Lindholm, Laboratory for Atmospheric and Space Physics, Boulder, CO

## COPYRIGHT

THIS SOFTWARE AND ITS DOCUMENTATION ARE CONSIDERED TO BE IN THE PUBLIC DOMAIN AND THUS ARE AVAILABLE FOR UNRESTRICTED PUBLIC USE. THEY ARE FURNISHED "AS IS." THE AUTHORS, THE UNITED STATES GOVERNMENT, ITS INSTRUMENTALITIES, OFFICERS, EMPLOYEES, AND AGENTS MAKE NO WARRANTY, EXPRESS OR IMPLIED, AS TO THE USEFULNESS OF THE SOFTWARE AND DOCUMENTATION FOR ANY PURPOSE. THEY ASSUME NO RESPONSIBILITY (1) FOR THE USE OF THE SOFTWARE AND DOCUMENTATION; OR (2) TO PROVIDE TECHNICAL SUPPORT TO USERS.

## REVISION HISTORY

06/04/2015 Initial Version prepared for NCDC

## USAGE

```
result=write_monthly_average_tsi_to_netcdf2(ymd1, ymd2, ymd3, version, irradiance_data,
output_dir=output_dir, file)
```

## 35. SOLAR\_IRRADIANCE\_FCDR/write\_ssi\_model\_to\_netcdf2.pro [ Programs ]

[ [Top](#) ] [ [Programs](#) ]

## NAME

`write_ssi_model_to_netcdf2.pro`

## PURPOSE

The `write_ssi_model_to_netcdf2.pro` function outputs daily Solar Spectral Irradiance to a netcdf4 file. This function is called from the routine, [write\\_irradiance\\_data.pro](#).

## DESCRIPTION

The `write_ssi_model_to_netcdf2.pro` function writes the daily Solar Spectral Irradiance and wavelength information (midpoints and band width) to a netcdf4 formatted file. Also included is the value of total (spectrally) integrated Total Solar Irradiance for the particular date. The time format variables is seconds since a 1610-01-01 00:00:00 epoch. CF-1.6 metadata conventions are used in defining global and variable name attributes. Missing values are defined as -99.0.

## INPUTS

```
ymd1 - starting time (yyyy-mm-dd)
ymd2 - ending time (yyyy-mm-dd)
ymd3 - creation date (yyyy-mm-dd)
version - version and revision number of the NRLSSI2 model (e.g., v02r00)
irradiance_data - a structure containing the following variables
    mjd - Modified Julian Date
    iso - iso 8601 formatted time
    tsi - Modeled Total Solar Irradiance
    tsiunc - Uncertainty in total solar irradiance
    ssi - Modeled Solar Spectral Irradiance (in wavelength bins)
    ssitot - Integral of the Modeled Solar Spectral Irradiance
spectral_bins - a structure containing the following variables
    nband - number of spectral bands, for a variable wavelength grid, that the NRL2
model bins 1 nm solar spectral irradiance onto.
    bandcenter - the bandcenters (nm) of the variable wavelength grid.
    bandwidth - the bandwidths (delta wavelength, nm) of the variable wavelength grid.
output_dir - Directory path for output file
file - filename (dynamically created from write\_irradiance\_data.pro)
```

## OUTPUTS

## AUTHOR

Odele Coddington, Laboratory for Atmospheric and Space Physics, Boulder, CO  
 Doug Lindholm, Laboratory for Atmospheric and Space Physics, Boulder, CO  
 Judith Lean, Space Science Division, Naval Research Laboratory, Washington, DC

## COPYRIGHT

THIS SOFTWARE AND ITS DOCUMENTATION ARE CONSIDERED TO BE IN THE PUBLIC DOMAIN AND THUS ARE AVAILABLE FOR UNRESTRICTED PUBLIC USE. THEY ARE FURNISHED "AS IS." THE AUTHORS, THE UNITED STATES GOVERNMENT, ITS INSTRUMENTALITIES, OFFICERS, EMPLOYEES, AND AGENTS MAKE NO WARRANTY, EXPRESS OR IMPLIED, AS TO THE USEFULNESS OF THE SOFTWARE AND DOCUMENTATION FOR ANY PURPOSE. THEY ASSUME NO RESPONSIBILITY (1) FOR THE USE OF THE SOFTWARE AND DOCUMENTATION; OR (2) TO PROVIDE TECHNICAL SUPPORT TO USERS.

## REVISION HISTORY

## USAGE

```
result=write_ssi_model_to_netcdf2(ymd1,ymd2,ymd3,version,  
irradiance_data,output_dir=output_dir, file)
```

## 36. SOLAR\_IRRADIANCE\_FCDR/write\_sunspot\_blocking.pro [ Programs ]

[ [Top](#) ] [ Programs ]

## NAME

**write\_sunspot\_blocking.pro**

## PURPOSE

The **write\_sunspot\_blocking.pro** procedure outputs time (in iso yyyy-mm-dd format), sunspot darkening index, the standard deviation of the sunspot darkening index, and a quality flag to an output text file.

It is an optional routine utilized if the keyword parameter, output\_dir, is defined in [process\\_sunspot\\_blocking.pro](#)

## DESCRIPTION

This routine is executed only if an optional keyword input, 'output\_dir', is set in [process\\_sunspot\\_blocking.pro](#).

The **write\_sunspot\_blocking.pro** procedure outputs time, sunspot darkening index, the standard deviation of the sunspot darkening index, and a quality flag to an output text file. This intermediate file is used in QA analysis.

The file- naming convention of the output follows 'sunspot\_blocking\_YMD1\_YMD2\_VER.txt', where time ranges specify start/end date of the time range over which the sunspot darkening is computed, and 'VER' is a hardcoded development version value to help keep track of data output (i.e. 'VER' may differ from version of the NRL2 model).

## INPUTS

sunspot\_blocking\_data - a structure containing the following variables:

- mjdn - the modified julian date
- ssbt - the sunspot darkening index (a mean value of the reporting stations)
- dssbt - the standard deviation of the sunspot darkening index of the reporting stations
- quality flag - a value of 0 or 1 (1 = missing data); Used for QA analysis.
- file - defined file name of the convention, 'sunspot\_blocking\_YMD1\_YMD2\_VER.txt', where version is a defined developmental version - Used for QA monitoring.

## OUTPUTS

file - a text file of the data in the sunspot\_blocking\_data structure, of the convention, 'sunspot\_blocking\_YMD1\_YMD2\_VER.txt', where version is a defined developmental version - Used for QA monitoring.

## AUTHOR

Odele Coddington, Laboratory for Atmospheric and Space Physics, Boulder, CO  
Doug Lindholm, Laboratory for Atmospheric and Space Physics, Boulder, CO



Judith Lean, Space Science Division, Naval Research Laboratory, Washington, DC

## COPYRIGHT

THIS SOFTWARE AND ITS DOCUMENTATION ARE CONSIDERED TO BE IN THE PUBLIC DOMAIN AND THUS ARE AVAILABLE FOR UNRESTRICTED PUBLIC USE. THEY ARE FURNISHED "AS IS." THE AUTHORS, THE UNITED STATES GOVERNMENT, ITS INSTRUMENTALITIES, OFFICERS, EMPLOYEES, AND AGENTS MAKE NO WARRANTY, EXPRESS OR IMPLIED, AS TO THE USEFULNESS OF THE SOFTWARE AND DOCUMENTATION FOR ANY PURPOSE. THEY ASSUME NO RESPONSIBILITY (1) FOR THE USE OF THE SOFTWARE AND DOCUMENTATION; OR (2) TO PROVIDE TECHNICAL SUPPORT TO USERS.

## REVISION HISTORY

06/04/2015 Initial Version prepared for NCDC

## USAGE

```
result=write_sunspot_blocking(sunspot_blocking_data,file)
```

## 37. SOLAR\_IRRADIANCE\_FCDR/write\_to\_manifest.pro [ Programs ]

[ [Top](#) ] [ Programs ]

### NAME

**write\_to\_manifest.pro**

### PURPOSE

The **write\_to\_manifest.pro** function outputs filename, MD5 checksum, and file size (in bytes) to a manifest (.mnf) file.

### DESCRIPTION

The **write\_to\_manifest.pro** function writes the filename, MD5 checksum, and file size (in bytes) to a manifest (.mnf) file.

### INPUTS

```
output_dir - Directory path for manifest file
filename   - name of data file, for which file size and checksum are reported
filesize   - filesize (in bytes)
checksum    - MD5 checksum for filename
fileout     - output filename for the manifest file
```

### OUTPUTS

```
fileout     - Output manifest file, containing filename, file size, and checksum in a comma
separated list
```

### AUTHOR

Odele Coddington, Laboratory for Atmospheric and Space Physics, Boulder, CO  
Doug Lindholm, Laboratory for Atmospheric and Space Physics, Boulder, CO  
Judith Lean, Space Science Division, Naval Research Laboratory, Washington, DC

## COPYRIGHT

THIS SOFTWARE AND ITS DOCUMENTATION ARE CONSIDERED TO BE IN THE PUBLIC DOMAIN AND THUS ARE AVAILABLE FOR UNRESTRICTED PUBLIC USE. THEY ARE FURNISHED "AS IS." THE AUTHORS, THE UNITED STATES GOVERNMENT, ITS INSTRUMENTALITIES, OFFICERS, EMPLOYEES, AND AGENTS MAKE NO WARRANTY, EXPRESS OR IMPLIED, AS TO THE USEFULNESS OF THE SOFTWARE AND DOCUMENTATION FOR ANY PURPOSE. THEY ASSUME NO RESPONSIBILITY (1) FOR THE USE OF THE SOFTWARE AND DOCUMENTATION; OR (2) TO PROVIDE TECHNICAL SUPPORT TO USERS.

## REVISION HISTORY

06/04/2015 Initial Version prepared for NCDC

## USAGE

```
result=write_to_manifest(output_dir=output_dir, filename, filesize, checksum, fileout)
```

## 38. SOLAR\_IRRADIANCE\_FCDR/write\_tsi\_model\_to\_netcdf2.pro [ Programs ]

[ [Top](#) ] [ Programs ]

### NAME

**write\_tsi\_model\_to\_netcdf2.pro**

### PURPOSE

The **write\_tsi\_model\_to\_netcdf2.pro** function outputs daily Total Solar Irradiance to a netcdf4 file. This function is called from the routine, [write\\_irradiance\\_data.pro](#).

### DESCRIPTION

The write\_tsi\_model\_to\_netcdf.pro function writes the daily Total Solar Irradiance to a netcdf4 formatted file.

The time format variables is seconds since a 1610-01-01 00:00:00 epoch  
CF-1.6 metadata conventions are used in defining global and variable name attributes.  
Missing values are defined as -99.0.

### INPUTS

```
ymd1          - starting time  (yyyy-mm-dd)
ymd2          - ending time   (yyyy-mm-dd)
ymd3          - creation date (yyyy-mm-dd)
version       - version and revision number of the NRLTSI2 model (e.g., v02r00)
irradiance_data - a structure containing the following variables
  mjd         - Modified Julian Date
  iso         - iso 8601 formatted time
  tsi         - Modeled Total Solar Irradiance
  ssi         - Modeled Solar Spectral Irradiance (in wavelength bins)
  ssitot      - Integral of the Modeled Solar Spectral Irradiance
output_dir    - Directory path for output file
```

file - filename (dynamically created from [write\\_irradiance\\_data.pro](#))

## OUTPUTS

## AUTHOR

Odele Coddington, Laboratory for Atmospheric and Space Physics, Boulder, CO  
Doug Lindholm, Laboratory for Atmospheric and Space Physics, Boulder, CO  
Judith Lean, Space Science Division, Naval Research Laboratory, Washington, DC

## COPYRIGHT

THIS SOFTWARE AND ITS DOCUMENTATION ARE CONSIDERED TO BE IN THE PUBLIC DOMAIN AND THUS ARE AVAILABLE FOR UNRESTRICTED PUBLIC USE. THEY ARE FURNISHED "AS IS." THE AUTHORS, THE UNITED STATES GOVERNMENT, ITS INSTRUMENTALITIES, OFFICERS, EMPLOYEES, AND AGENTS MAKE NO WARRANTY, EXPRESS OR IMPLIED, AS TO THE USEFULNESS OF THE SOFTWARE AND DOCUMENTATION FOR ANY PURPOSE. THEY ASSUME NO RESPONSIBILITY (1) FOR THE USE OF THE SOFTWARE AND DOCUMENTATION; OR (2) TO PROVIDE TECHNICAL SUPPORT TO USERS.

## REVISION HISTORY

06/04/2015 Initial Version prepared for NCDC

## USAGE

```
result=write_tsi_model_to_netcdf2(ymd1, ymd2, ymd3, version,  
irradiance_data,output_dir=output_dir, file)
```

## 39. SOLAR\_IRRADIANCE\_FCDR/write\_yearly\_average\_ssi\_to\_netcdf2.pro [ Programs ]

[ [Top](#) ] [ Programs ]

## NAME

**write\_yearly\_average\_ssi\_to\_netcdf2.pro**

## PURPOSE

The **write\_yearly\_average\_ssi\_to\_netcdf2.pro** function outputs yearly-averaged Solar Spectral Irradiance to a netcdf4 file. This function is called from the routine, [write\\_irradiance\\_data.pro](#).

## DESCRIPTION

The **write\_yearly\_average\_ssi\_to\_netcdf2.pro** function outputs yearly-averaged Solar Spectral Irradiance to a netcdf4 file and (midpoint) date (YYYY) to a netcdf4 formatted file. The time format variables is seconds since a 1610-01-01 00:00:00 epoch. Missing values (NaN's or '0's) are defined as -99.0.

## INPUTS

```

ymd1  - starting time  (yyyy-mm-dd)
ymd2  - ending time   (yyyy-mm-dd)
ymd3  - creation date (yyyy-mm-dd)
version - version and revision number of the NRLSSI2 model (e.g., v02r00)
irradiance_data - a structure containing the following variables
    mjd      - Modified Julian Date
    iso      - iso 8601 formatted time
    tsi      - Modeled Total Solar Irradiance
    tsiunc   - Uncertainty in total solar irradiance
    ssi      - Modeled Solar Spectral Irradiance (in wavelength bins)
    ssitot   - Integral of the Modeled Solar Spectral Irradiance
spectral_bins - a structure containing the following variables
    nband    - number of spectral bands, for a variable wavelength grid, that the NRL2
model bins 1 nm solar spectral irradiance onto.
    bandcenter - the bandcenters (nm) of the variable wavelength grid.
    bandwidth  - the bandwidths (delta wavelength, nm) of the variable wavelength grid.
output_dir - Directory path for output file
file       - filename (dynamically created from write\_irradiance\_data.pro)

```

## OUTPUTS

## AUTHOR

Judith Lean, Space Science Division, Naval Research Laboratory, Washington, DC  
 Odele Coddington, Laboratory for Atmospheric and Space Physics, Boulder, CO  
 Doug Lindholm, Laboratory for Atmospheric and Space Physics, Boulder, CO

## COPYRIGHT

THIS SOFTWARE AND ITS DOCUMENTATION ARE CONSIDERED TO BE IN THE PUBLIC DOMAIN AND THUS ARE AVAILABLE FOR UNRESTRICTED PUBLIC USE. THEY ARE FURNISHED "AS IS." THE AUTHORS, THE UNITED STATES GOVERNMENT, ITS INSTRUMENTALITIES, OFFICERS, EMPLOYEES, AND AGENTS MAKE NO WARRANTY, EXPRESS OR IMPLIED, AS TO THE USEFULNESS OF THE SOFTWARE AND DOCUMENTATION FOR ANY PURPOSE. THEY ASSUME NO RESPONSIBILITY (1) FOR THE USE OF THE SOFTWARE AND DOCUMENTATION; OR (2) TO PROVIDE TECHNICAL SUPPORT TO USERS.

## REVISION HISTORY

06/04/2015 Initial Version prepared for NCDC

## USAGE

```

result=write_yearly_average_ssi_to_netcdf2(ymd1, ymd2, ymd3, version, irradiance_data,
output_dir=output_dir, file)

```

40.

**SOLAR\_IRRADIANCE\_FCDR/write\_yearly\_average\_tsi\_to\_netcdf2.pro [ Programs ]**

[ [Top](#) ] [ Programs ]

## NAME

**write\_yearly\_average\_tsi\_to\_netcdf2.pro**

## PURPOSE

The **write\_yearly\_average\_tsi\_to\_netcdf2.pro** function outputs yearly-averaged Total Solar Irradiance to a netcdf4 file. This function is called from the routine, [write\\_irradiance\\_data.pro](#).

## DESCRIPTION

The **write\_yearly\_average\_tsi\_to\_netcdf2.pro** function outputs yearly-averaged Total Solar Irradiance to a netcdf4 file and (midpoint) date (YYYY-MM) to a netcdf4 formatted file. The time format variables is seconds since a 1610-01-01 00:00:00 epoch. Missing values (NaN's or '0's) are defined as -99.0.

## INPUTS

```
ymd1 - starting time (yyyy-mm-dd)
ymd2 - ending time (yyyy-mm-dd)
ymd3 - creation date (yyyy-mm-dd)
version - version and revision number of the NRLTSI2 model (e.g., v02r00)
irradiance_data - a structure containing the following variables
    mjd - Modified Julian Date
    iso - iso 8601 formatted time
    tsi - Modeled Total Solar Irradiance
    tsiunc - Uncertainty in total solar irradiance
    ssi - Modeled Solar Spectral Irradiance (in wavelength bins)
    ssitot - Integral of the Modeled Solar Spectral Irradiance
spectral_bins - a structure containing the following variables
    nband - number of spectral bands, for a variable wavelength grid, that the NRL2
model bins 1 nm solar spectral irradiance onto.
    bandcenter - the bandcenters (nm) of the variable wavelength grid.
    bandwidth - the bandwidths (delta wavelength, nm) of the variable wavelength grid.
output_dir - Directory path for output file
file - filename (dynamically created from write\_irradiance\_data.pro)
```

## OUTPUTS

## AUTHOR

Judith Lean, Space Science Division, Naval Research Laboratory, Washington, DC  
 Odele Coddington, Laboratory for Atmospheric and Space Physics, Boulder, CO  
 Doug Lindholm, Laboratory for Atmospheric and Space Physics, Boulder, CO

## COPYRIGHT

THIS SOFTWARE AND ITS DOCUMENTATION ARE CONSIDERED TO BE IN THE PUBLIC DOMAIN AND THUS ARE AVAILABLE FOR UNRESTRICTED PUBLIC USE. THEY ARE FURNISHED "AS IS." THE AUTHORS, THE UNITED STATES GOVERNMENT, ITS INSTRUMENTALITIES, OFFICERS, EMPLOYEES, AND AGENTS MAKE NO WARRANTY, EXPRESS OR IMPLIED, AS TO THE USEFULNESS OF THE SOFTWARE AND DOCUMENTATION FOR ANY PURPOSE. THEY ASSUME NO RESPONSIBILITY (1) FOR THE USE OF THE SOFTWARE AND DOCUMENTATION; OR (2) TO PROVIDE TECHNICAL SUPPORT TO USERS.

## REVISION HISTORY

11/10/2014 Initial Version prepared for NCDC

## USAGE

```
result=write_yearly_average_tsi_to_netcdf2(ymd1, ymd2, ymd3, version, irradiance_data,
output_dir=output_dir, file)
```

## 41. SOLAR\_IRRADIANCE\_FCDR/yymmdd2mjd.pro [ Programs ]

[ [Top](#) ] [ Programs ]

### NAME

yymmdd2mjd

### PURPOSE

Converts time from ISO 8601 standard to a Modified Julian Day (integer).

### DESCRIPTION

Converts time from ISO 8601 standard to a Modified Julian Day (integer).

### INPUTS

yymmdd - time value in ISO standard

### OUTPUTS

mjd - Modified Julian Date (integer)

### AUTHOR

Odele Coddington, Laboratory for Atmospheric and Space Physics, Boulder, CO  
Doug Lindholm, Laboratory for Atmospheric and Space Physics, Boulder, CO  
Judith Lean, Space Science Division, Naval Research Laboratory, Washington, DC

### COPYRIGHT

THIS SOFTWARE AND ITS DOCUMENTATION ARE CONSIDERED TO BE IN THE PUBLIC DOMAIN AND THUS ARE AVAILABLE FOR UNRESTRICTED PUBLIC USE. THEY ARE FURNISHED "AS IS." THE AUTHORS, THE UNITED STATES GOVERNMENT, ITS INSTRUMENTALITIES, OFFICERS, EMPLOYEES, AND AGENTS MAKE NO WARRANTY, EXPRESS OR IMPLIED, AS TO THE USEFULNESS OF THE SOFTWARE AND DOCUMENTATION FOR ANY PURPOSE. THEY ASSUME NO RESPONSIBILITY (1) FOR THE USE OF THE SOFTWARE AND DOCUMENTATION; OR (2) TO PROVIDE TECHNICAL SUPPORT TO USERS.

### REVISION HISTORY

06/04/2015 Initial Version prepared for NCDC

### USAGE

yymmdd2mjd, yymmdd

## 42. TSI\_FCDR/get\_sunspot\_data.pro [ Programs ]

[ [Top](#) ] [ [Programs](#) ]

## NAME

`get_sunspot_data.pro`

## PURPOSE

Acquire U.S. Air Force white Light sunspot region data from a NOAA/NGDC web repository-point of contact: Bill Denig.

[http://www.ngdc.noaa.gov/stp/space-weather/solar-data/solar-features/sunspot-regions/usaf\\_mwl/](http://www.ngdc.noaa.gov/stp/space-weather/solar-data/solar-features/sunspot-regions/usaf_mwl/)

## DESCRIPTION

This routine is called from the function, [process\\_sunspot\\_blocking.pro](#) for the case of preliminary data.

It accesses the above url and parses the given record into a data structure. Each record is for a sunspot group

measurement. The time (YYMMDD), solar latitude and longitude, sunspot area, and station ID are parsed from each record.

## INPUTS

ymd1 - starting time range respective to midnight GMT of the given day, in Modified Julian day (converted from 'yyyy-mm-dd' in main driver).

ymd2 - ending time range respective to midnight GMT of the given day

stations = stations - Optional keyword to restrict sunspot darkening index to specified monitoring stations in the USAF white light network.

If omitted (default), these stations are used:

'LEAR', 'CULG', 'SVTO', 'RAMY', 'BOUL', 'HOLL', 'PALE', 'MANI', 'ATHN'.

Used for QA analysis.

## OUTPUTS

'data' - a structure containing (for each record in the USAF data) is returned to process\_sunspot\_blocking

```
mjd      - Modified Julian Date
lat       - latitude of sunspot group
lon       - longitude of sunspot group
group     - sunspot group number
area      - sunspot area
station   - station name
```

## AUTHOR

Odele Coddington, Laboratory for Atmospheric and Space Physics, Boulder, CO

Doug Lindholm, Laboratory for Atmospheric and Space Physics, Boulder, CO

Judith Lean, Space Science Division, Naval Research Laboratory, Washington, DC

## COPYRIGHT

THIS SOFTWARE AND ITS DOCUMENTATION ARE CONSIDERED TO BE IN THE PUBLIC DOMAIN AND THUS ARE AVAILABLE FOR UNRESTRICTED PUBLIC USE. THEY ARE FURNISHED "AS IS." THE AUTHORS, THE UNITED STATES GOVERNMENT, ITS INSTRUMENTALITIES, OFFICERS, EMPLOYEES, AND AGENTS MAKE NO WARRANTY, EXPRESS OR IMPLIED, AS TO THE USEFULNESS OF THE SOFTWARE AND DOCUMENTATION FOR ANY PURPOSE. THEY ASSUME NO RESPONSIBILITY (1) FOR THE USE OF THE SOFTWARE AND DOCUMENTATION; OR (2) TO PROVIDE TECHNICAL SUPPORT TO USERS.

## REVISION HISTORY

## USAGE

```
result=get_sunspot_data(ymd1, ymd2, stations=stations)
```

## 43. TSI\_FCDR/replace\_nan\_with\_value.pro [ Programs ]

[ [Top](#) ] [ Programs ]

## NAME

```
replace_nan_with_value.pro
```

## PURPOSE

The **replace\_nan\_with\_value.pro** function returns a float array containing the given data with NaN replaced with user designated missing value.

## DESCRIPTION

The **replace\_nan\_with\_value.pro** function returns a float array containing the given data with NaN replaced with user designated missing value.  
A copy of the input data as floats is made so the 'data' remains immutable.

## INPUTS

data - input data a copy of the data as floats:  
value - the value designated to replace NaN as "missing" values

## OUTPUTS

result - a copy of the input data, with NaNs replaced by missing values

## AUTHOR

Odele Coddington, Laboratory for Atmospheric and Space Physics, Boulder, CO  
Doug Lindholm, Laboratory for Atmospheric and Space Physics, Boulder, CO  
Judith Lean, Space Science Division, Naval Research Laboratory, Washington, DC

## COPYRIGHT

THIS SOFTWARE AND ITS DOCUMENTATION ARE CONSIDERED TO BE IN THE PUBLIC DOMAIN AND THUS ARE AVAILABLE FOR UNRESTRICTED PUBLIC USE. THEY ARE FURNISHED "AS IS." THE AUTHORS, THE UNITED STATES GOVERNMENT, ITS INSTRUMENTALITIES, OFFICERS, EMPLOYEES, AND AGENTS MAKE NO WARRANTY, EXPRESS OR IMPLIED, AS TO THE USEFULNESS OF THE SOFTWARE AND DOCUMENTATION FOR ANY PURPOSE. THEY ASSUME NO RESPONSIBILITY (1) FOR THE USE OF THE SOFTWARE AND DOCUMENTATION; OR (2) TO PROVIDE TECHNICAL SUPPORT TO USERS.

## REVISION HISTORY



06/04/2015 Initial Version prepared for NCDC

## USAGE

```
replace_nan_with_missing, data, value
```

Generated from ./Source/ on Mon Jun 08 2015 10:21:32