Solar Spectral Irradiance: Discussion

- Adoption of recommended spectrum for CEOS
- Location of Recommendation
- Potential impact of choice/change of spectrum (L1/L2)
  - Reminder of Coddington
  - Examples of impact
- Does it matter?
- Do we need to do anything?
  - Communicate to ‘users’?
  - change uncertainties?
  - ?

Endorsed TSIS spectrum

Solar Irradiance Spectrum

CEOS endorsed reference solar irradiance spectrum

For many Earth Observation based applications there is a need to utilise a solar irradiance spectrum. This may be physical 'retrieval' of some form, use of a Radiative transfer code in some way or a conversion in units e.g. radiance cases for any self-contained application the most important requirement is to be consistent in the choice of any irradiance spectrum and to be clear, in any subsequent documentation describing any result of its use, which spectrum In this way, it allows others, in principle to be able to convert and compare similar results which may use different sol However, following requests from both the user community and satellite operators and developers, CEOS in the e establish a CEOS endorsed reference solar Irradiance spectrum, based on a community consensus of the 'best' available. At the time this was a composite spectrum, heavily based on a spectrum from the SOLSPEC missio https://doi.org/10.1023/A:1024048429145. In recommending a spectrum it was noted that this represents a p the solar cycle which is dynamic and follows a nominal 11 yr periodicity. However, the variability in solar spectral irr longer than the near-UV (>~350 nm) of the spectrum, other than during a particularly major short-term event are on < than tenths of a percent and thus not a major impact to most Earth Observation applications at this time. In 2022, satellite missions, particularly the NASA TSIS-1 mission, which provided significantly reduced uncertainty, it was deci reference solar irradiance spectrum to that of Coddington et al (2021) https://doi.org/10.1029/2020GL09 dedicated page) and later to a version 2 which extends the spectral range to thermal infrared in Coc https://doi.org/10.1029/2022EA002637

CEOS Recommendation on use of a solar Irradiance spectrum for EO applications

CEOS recommends that wherever a reference solar irradiance spectrum is used in an Earth Observation applicat spectrum and a link to an accessible, processable version of that spectrum should be included with any documenta use, ideally integrated in the metadata. The methodology used to convolve the chosen solar irradiance spectrum wit and the associated uncertainty should also be documented and made available. For the purposes of harmonisation and interoperability, CEOS

TSIS-1 Hybrid Solar Reference Spectrum (CEOS endorsed)

The Sun's irradiance spectrum is used in many applications, such as constraining the solar forcing in climate models and converting measured satellite radiance to reflectance. A growing body of literature has provided evidence that the currently available solar reference spectra differ by more than their reported uncertainties. Such differences lead to biased results when different reference spectra are adopted in the aforementioned applications. This motivates the work to provide a new high-resolution solar reference spectrum at higher accuracy than any previously reported.

The Total and Spectral Solar Irradiance Sensor-1 (TSIS-1) Hybrid Solar Reference Spectrum (HSRS) has been developed by applying a modified spectral ratio method to normalize very high spectral resolution solar line data to the absolute irradiance scale of the TSIS-1 Spectral Irradiance Monitor (SIM) and the CubeSat Compact SIM (CSIM). The high spectral resolution solar line data are the Air Force Geophysical Laboratory ultraviolet solar irradiance balloon observations, the ground-based Quality Assurance of Spectral Ultraviolet Measurements In Europe Fourier transform spectrometer solar irradiance observations, the Kitt Peak National Observatory solar transmittance atlas, and the semi-empirical Solar Pseudo-Transmittance Spectrum atlas. The TSIS-1 HSRS spans 202–2730 nm at 0.01 to ~0.001 nm spectral resolution with uncertainties of 0.3% between 460 and 2365 nm and 1.3% at wavelengths outside that range.

The ability to produce such a data set is due to the state-of-the-art measurements of the Sun's irradiance spectrum made since March 2018 by the next-generation Spectral Irradiance Monitor (SIM) instrument on the Total and Spectral Solar Irradiance Sensor-1 (TSIS-1) satellite mission and the Compact SIM (CSIM) technology demonstration mission. The TSIS-1 SIM and CSIM have order-of-magnitude reduction in uncertainty relative to predecessor instruments primarily because of a first-of-its-kind spectral radiometric calibration facility capable of characterizing the instruments to higher fidelity.

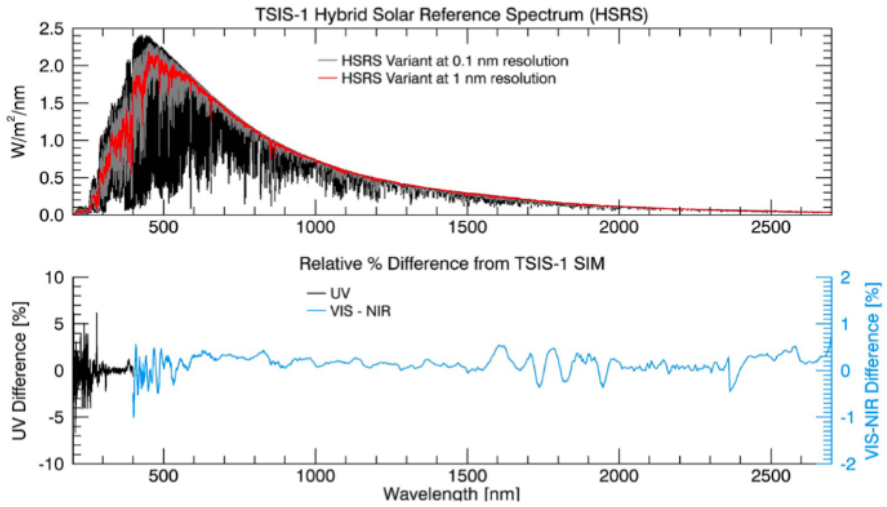


Figure. (top) The TSIS-1 Hybrid Solar Reference Spectrum (black) and two variants at lower resolution. (bottom)

References

Title: The TSIS-1 Hybrid Solar Reference Spectrum

Authors: Coddington, O. M., Richard, E. C., Harber, D., Pilewskie, P., Woods, T. N., Chance, K., et al. (2021).

Geophysical Research Letters, 48, e2020GL091709. https://doi.org/10.1029/2020GL091709

URL: https://lasp.colorado.edu/lisird/data/tsis1_hsrs

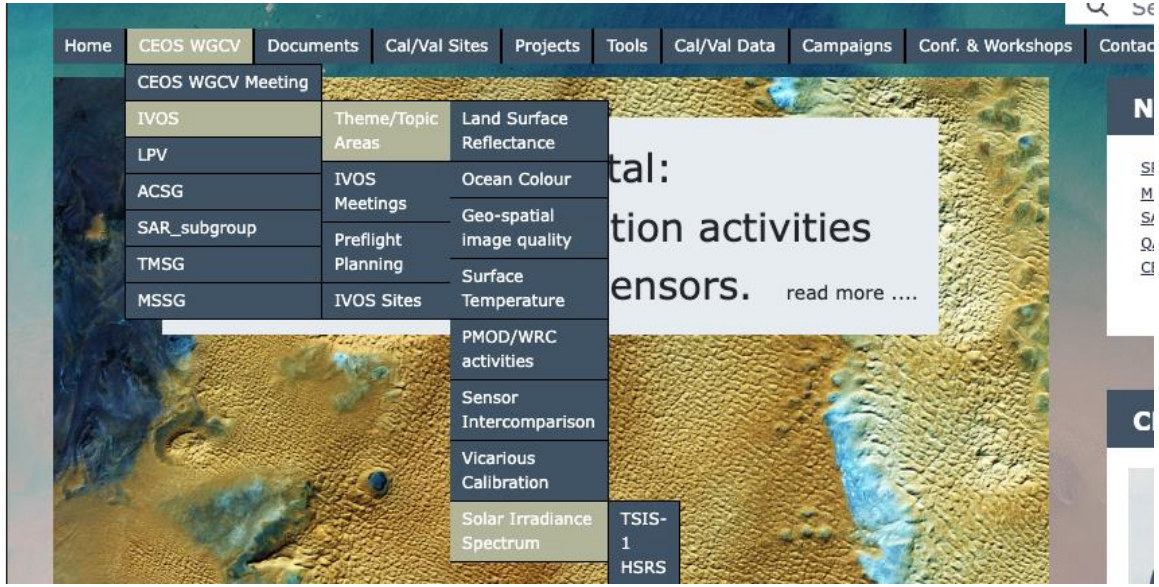
CEOS Reference solar Irradiance Spectrum

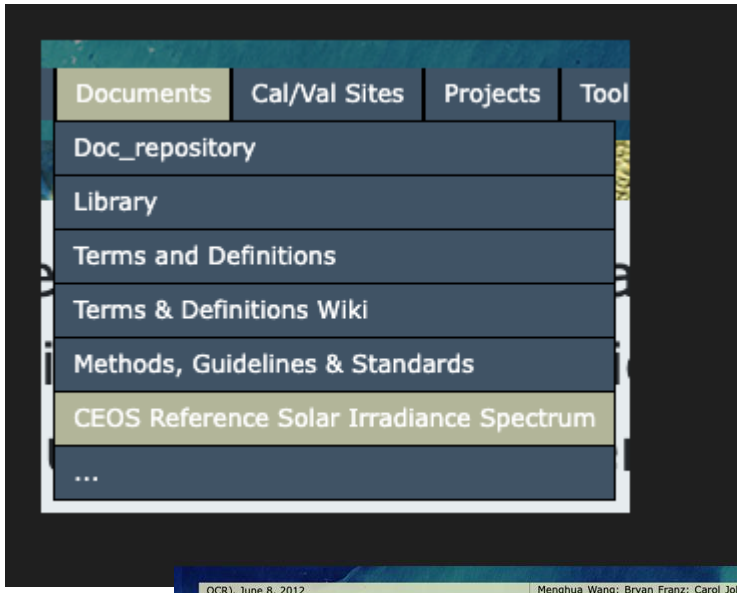
CEOS Recommendation on use of a solar Irradiance spectrum for EO applications

CEOS recommends that wherever a reference solar irradiance spectrum is used in an Earth Observation application, the choice of that spectrum and a link to an accessible, processable version of that spectrum should be included with any documentation associated with its use, ideally integrated in the metadata. The methodology used to convolve the chosen solar irradiance spectrum with that of other EO data and the associated uncertainty should also be documented and made available.

For the purposes of harmonisation and interoperability, CEOS further recommends the use of its reference spectrum and where this is not done that a calculation indicating the difference of the chosen spectrum to that of the CEOS reference spectrum be made available.

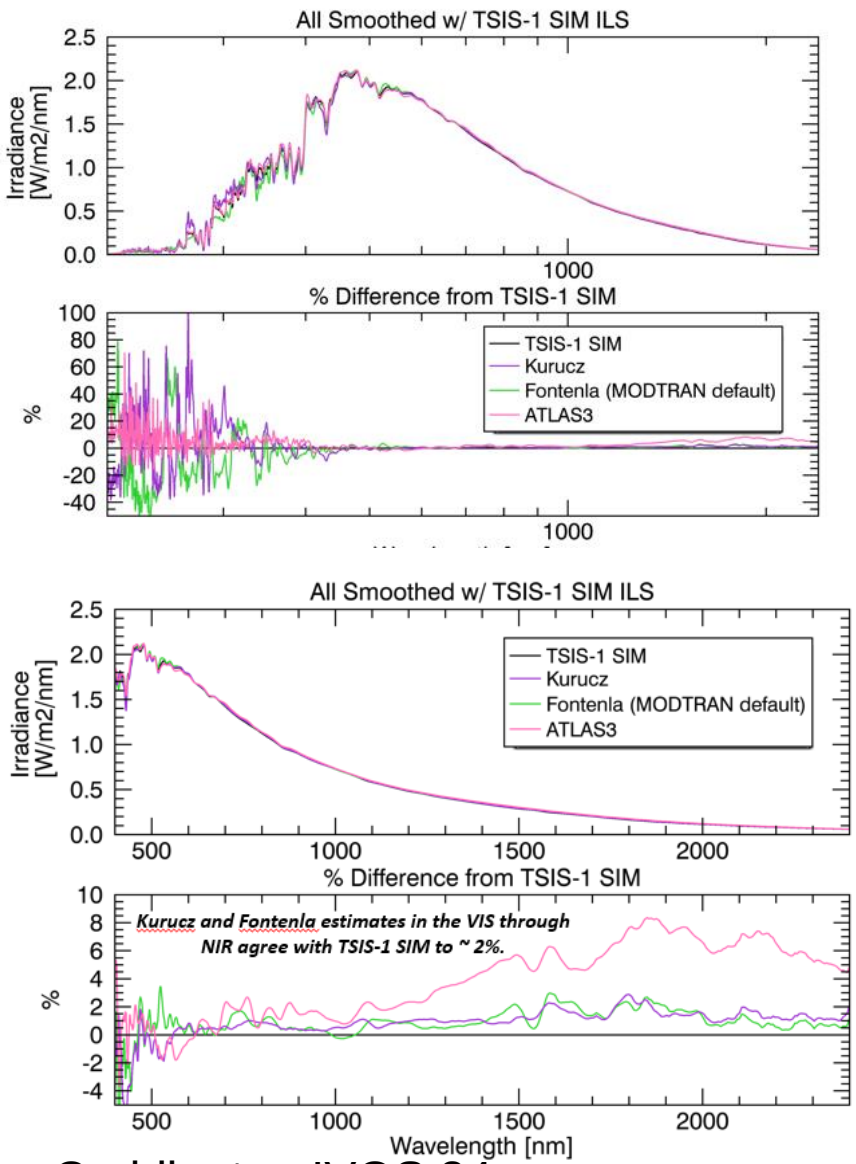
CalVal portal





https://calvalportal.ceos.org/en/web/guest/solar-irrad-spectrum

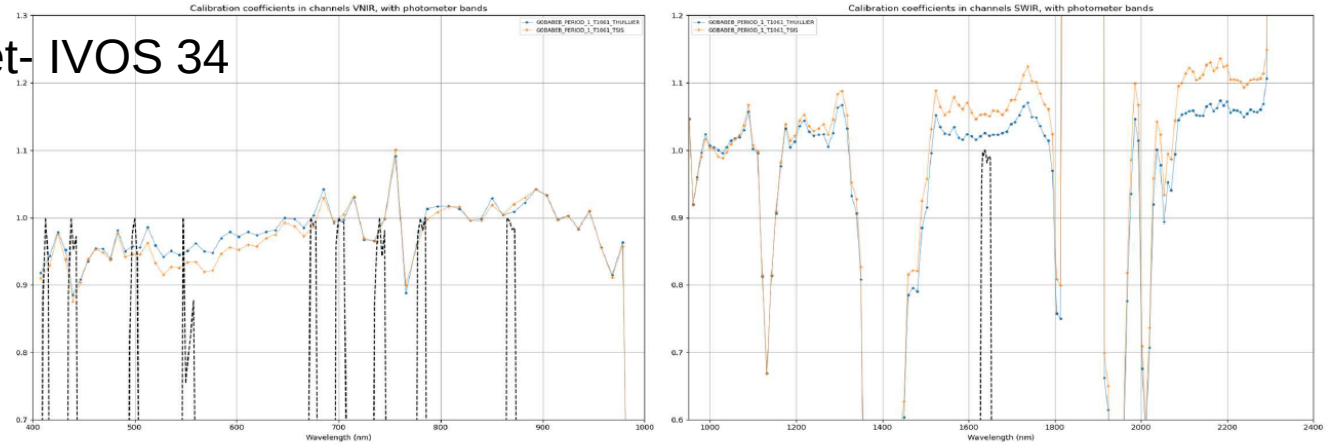
Solar spectral Irradiance



Coddington IVOS 34

PRISMA CALIBRATION BASED ON ROSAS: IMPACT OF THE SOLAR SPECTRUM

Meygret- IVOS 34



- THUILLIER 2002 / TSIS: ⇒ 2-3 % variation around 550nm and 3% variation for SWIR bands

- Make clear on Cal/val portal importance of stating reference
- Make visible potential biases with using Modtran base values
  - Look to encourage Modtran team to include TSIS spectrum
- **Hold workshop to discuss impact on reporting sensor cal particularly updating operational sensors**

Other examples of issues

Discussion

- In the main (exception in SWIR and UV) difference to Thuillier 2003 (previous CEOS ref) within uncertainties
- Do we actively make visible and transparent what the differences mean?
- How much does it matter?
- Which applications does it impact?
- Is the current guidance on CalVal Portal appropriate and adequate?
- Should we be more active to promote use and potential transference to CEOS spectrum for the benefit of interoperability?