# SENTINEL-3 OLCI AND SLSTR SIMULATED SPECTRAL RESPONSE FUNCTIONS

# (S3-TN-ESA-PL-316)

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## ABSTRACT

Since the Critical Design Review (CDR) of the Sentinel-3 satellite, Spectral Response Functions (SRF) for the optical instruments are available as industry deliveries in the Satellite Calibration and Characterisation Database (SCCDB). After initial tests of SCCDB in the O-SPS (Optical System Performance Simulator) and O-GPP (Optical Ground Processor Prototype) environment, the SRFs are ready to be released to the science community. As official SRFs from the Sentinel-3 Critical Design Review (CDR), the optical spectral transmission and the responsivity of the detectors are based on simulation and component measurements. Hence, the provided SRFs do not constitute the actual flight spectral responses; this is why the functions will be updated in the scope of pre-launch calibration activities. In any case, SRFs can be used to populate and test higher-level processors, Look-Up-Tables (LUT) and support further product algorithm development.

## 1. SENTINEL-3 SPECTRAL RESPONSE FUNCTIONS FOR OPTICAL INSTRUMENTS (VERSION CDR)

### 1.1. OLCI spectral response function

The Satellite Calibration and Characterization Database (SCCDB) contain all the data needed to generate the OLCI spectral response function (Fig.1). The responses were computed from the Instrument Line Shape (ILS), the CCD lines attributed for each band and the CCD line central wavelength. They were corrected taking into account the transmission of the imaging sub-assembly (ground imager, scrambling window), the transmission of the spectrometer and the responsivity of the CCD. The sampling step for each SRF is 0.01 nm.

The OLCI spectral response functions are available in the embedded file:
OLCI_Wavelengths_and_Irradiances_2012.xlsx

### 1.2. OLCI solar in-band irradiances

The SOLSPEC instrument has measured the solar spectral irradiance (Fig. 2) from 200 to 2400 nm with a resolution of 1 nm, during two missions: ATLAS 1 and EURECA. This data /1/ was used (as for ENVISAT MERIS and AATSR) in the following to produce the solar irradiance values weighted for OLCI (and SLSTR) SRFs.

The calculation of the solar irradiance values weighted over OLCI, $I_{0,\lambda}$ is defined by Eq. 1.

$$I_{0,\lambda} = \frac{\int I(\lambda)R(\lambda)d\lambda}{\int \mathrm{R}(\lambda)d\lambda}, [mW.m^{-2}.nm^{-1}] \qquad (1)$$

where R(λ) is the instrument spectral response at wavelength λ and I(λ) is the solar irradiance spectra at wavelength λ.
The integrated solar irradiance $I_{\mathrm{int},\lambda}$ is given by Eq. 2.

$$I_{\mathrm{int},\lambda} = \int I(\lambda)R(\lambda)d\lambda, [mW.m^{-2}] \qquad (2)$$

*Table 1: OLCI bands characterization (center wavelengths, FWHM, solar in-band irradiances, integrated solar irradiances)*

| Band | Center wavelength (nm) | Full width at half maximum (nm) | Solar in-band irradiance (mW/m2/nm) | Integrated solar irradiance (mW/m2) |
|---|---|---|---|---|
| Oa01 | 400.28 | 14.63 | 1485.28 | 19776.80 |
| Oa02 | 412.69 | 9.80 | 1711.16 | 16352.40 |
| Oa03 | 442.49 | 9.91 | 1865.25 | 18198.00 |
| Oa04 | 490.98 | 9.94 | 1934.08 | 19126.00 |
| Oa05 | 510.90 | 9.94 | 1922.50 | 19037.60 |
| Oa06 | 560.74 | 9.95 | 1799.40 | 17880.30 |
| Oa07 | 620.64 | 9.98 | 1649.76 | 16397.00 |
| Oa08 | 665.62 | 9.99 | 1530.72 | 15186.30 |
| Oa09 | 674.36 | 7.48 | 1495.98 | 11147.40 |
| Oa10 | 681.86 | 7.51 | 1470.28 | 11020.40 |
| Oa11 | 709.37 | 9.98 | 1405.20 | 13930.50 |
| Oa12 | 754.39 | 7.49 | 1266.20 | 9468.05 |
| Oa13 | 761.89 | 2.65 | 1249.19 | 3412.14 |
| Oa14 | 764.40 | 3.76 | 1242.39 | 4699.20 |
| Oa15 | 768.15 | 2.65 | 1227.68 | 3352.24 |
| Oa16 | 779.41 | 14.99 | 1175.70 | 17511.80 |
| Oa17 | 865.73 | 19.93 | 958.88 | 18548.90 |
| Oa18 | 885.73 | 9.95 | 929.95 | 9096.45 |
| Oa19 | 900.74 | 9.96 | 895.46 | 8756.14 |
| Oa20 | 940.74 | 19.81 | 825.14 | 15040.90 |
| Oa21 | 1024.67 | 23.89 | 700.63 | 16537.80 |

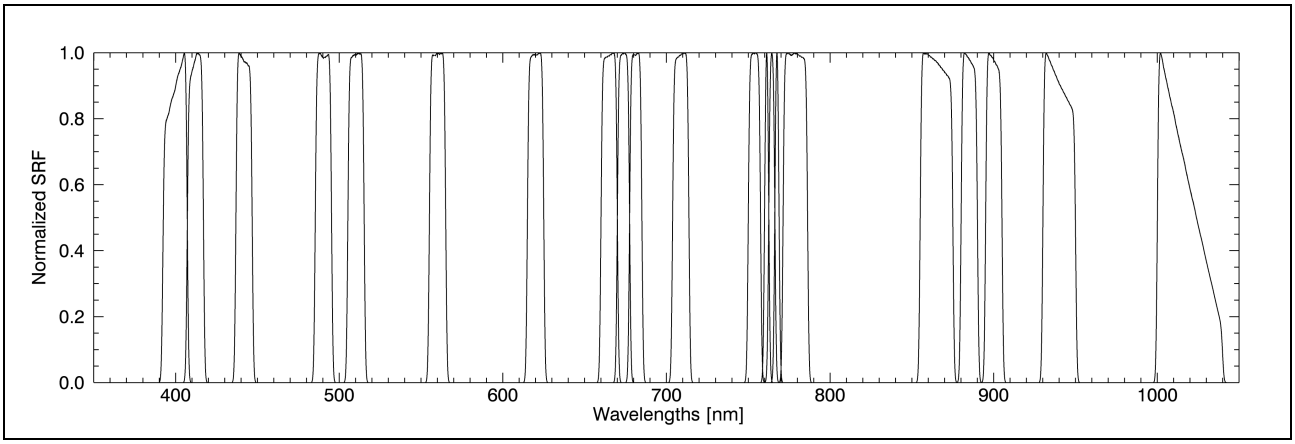


*Figure 1: Normalized OLCI SRFs, bands 1 to 21, plotted versus wavelength [nm].*

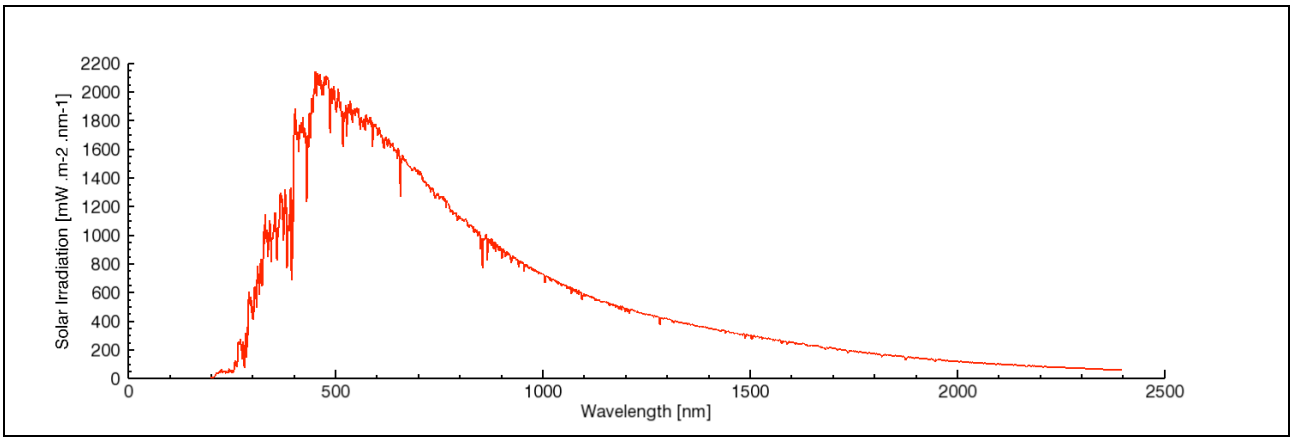


*Figure 2: SOLSPEC Solar Irradiance Spectra for wavelength range 200 nm to 2400 nm.*

### 1.3. SLSTR spectral response function

The SLSTR spectral response functions were provided within the Sentinel-3 SLSTR CDR. Three sets of SRF are available: VIS channels (Fig. 3), SWIR channels (Fig. 4), and MIR & TIR channels (Fig. 5). The sampling step depends of each band (VIS: 1nm, SWIR: 5nm, MIR & TIR: 10nm)

The SLSTR spectral response functions are available in the embedded file:
SLSTR_Wavelengths_and_Irradiances_2012.xls

### 1.4. SLSTR solar in-band irradiances

The same calculation methodology as for OLCI was applied to calculate the SLSTR solar in-band irradiances and integrated solar irradiance.

*Table 2: SLSTR bands characterization (center wavelengths, FWHM, solar in-band irradiances, integrated solar irradiances)*

| Band | Center wavelength (nm) | Full width at half maximum (nm) | Solar in-band irradiance (mW/m2/nm) | Integrated solar irradiance (mW/m2) |
|---|---|---|---|---|
| S1 | 554.93 | 20.05 | 1837.39 | 35457.70 |
| S2 | 659.36 | 20.82 | 1525.94 | 31404.90 |
| S3 | 864.64 | 20.46 | 956.17 | 19270.90 |
| S4 | 1375.25 | 24.05 | 365.90 | 8244.88 |
| S5 | 1609.51 | 65.22 | 248.33 | 15675.60 |
| S6 | 2249.20 | 43.87 | 78.33 | 3452.73 |
| S7 / F1 | 3705.31 | 370.06 | NA | NA |
| S8 / F2 | 10791.30 | 798.62 | NA | NA |
| S9 | 11998.10 | 917.39 | NA | NA |

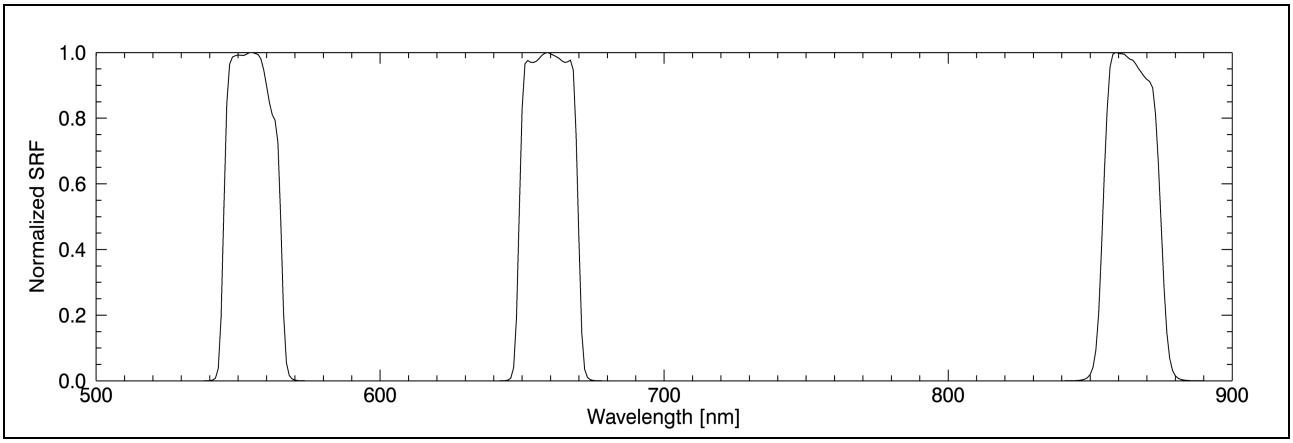


*Figure 3: Normalized SLSTR SRFs, VIS bands (S1, S2, S3), plotted versus wavelength [nm].*

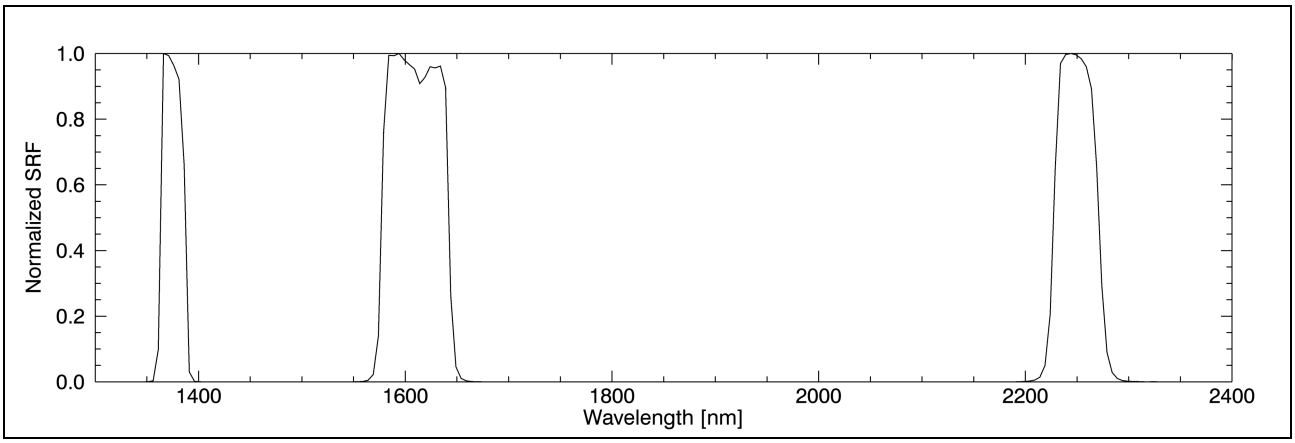


*Figure 4: Normalized SLSTR SRFs, SWIR bands (S4, S5, S6), plotted versus wavelength [nm].*

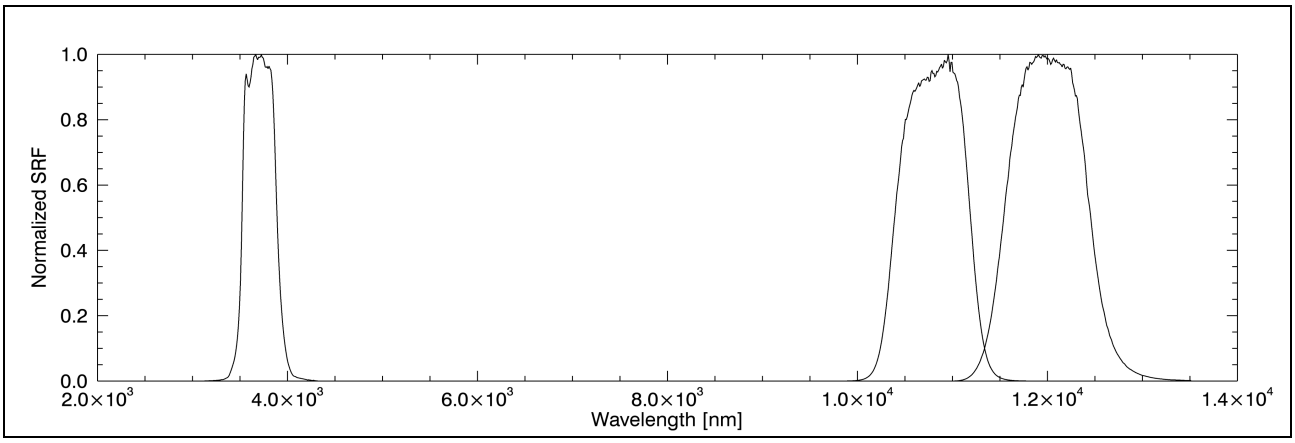


*Figure 5: Normalized SLSTR SRFs, MIR & TIR bands (S7/F1, S8/F2, S9), plotted versus wavelength [nm].*

## 2. SPECTRAL RESPONSE FUNCTION FILE FORMAT

The embedded workbooks on SLSTR (SLSTR_Wavelengths_and_Irradiances_2012) and OLCI (SLSTR_Wavelengths_and_Irradiances_2012) contain 5 data sheets:

1. Sheet "Thuillier_2003": contains the reference Irradiance at 1 AU also used for ENVISAT (Thuillier, G., M. Hersé, D. Labs, T. Foujols, W. Peetermans, D. Gillotay, P. C. Simon, and H. Mandel, 2003, "The solar spectral irradiance from 200 to 2400 nm as measured by the

SOLSPEC spectrometer from the ATLAS and EURECA missions", Sol. Phys., 214: 1-22.).

2. Sheet "Center_wavelengths": contains the central wavelength of each OLCI/SLSTR spectral band.
3. Sheet "FWHM": contains the FWHM (full width at half maximum) of the instrument response functions for each band.
4. Sheet "Solar_irradiances": contains solar in-band irradiances for each band (derived using above computed instrument response functions and reference solar irradiances from sheet 1).
5. Sheet "Integrated_irradiances": contains integrated in-band solar irradiances for each band (derived using following computed instrument response functions and reference solar irradiances from sheet 1).
6. Sheet "SLSTR/OLCI_SRF": contains the spectral response function of SLSTR/OLCI for each band.

Important Notes:
The simulated data contained here correspond to the OLCI/SLSTR Spectral Model CDR derived in 2011.

## 3. RECOMMANDATION

The provided SRFs do not constitute the actual flight spectral responses; hence, the functions will be updated in the scope of pre-launch calibration activities and eventually after launch. In any case, SRFs can be used to populate and test higher-level processors, Look-Up-Tables (LUT) and support product algorithm development.

Provided SLSTR SRFs do not correct for optical beam speed and Focal Plane Assembly (FPA) temperature variation in flight. Further, temperature-to-radiance tables derived from the spectral responses are also not part of the provided data. This information will be made available with a future update of this document.

## REFERENCES

/[1]/ Thuillier G., M. Hersé, D. Labs, T. Foujols, W. Peetermans, D. Gillotay, P. C. Simon, and H. Mandel, "The solar spectral irradiance from 200 to 2400 nm as measured by the SOLSPEC spectrometer from the ATLAS and EURECA missions", Sol. Phys., 214: 1-22 (2003)