OPT-MPC

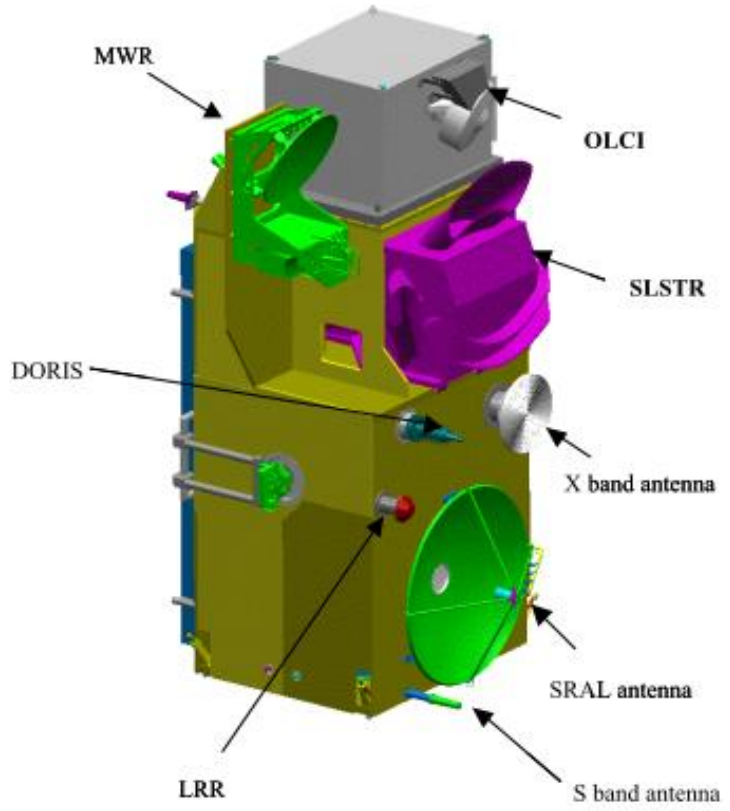
Copernicus Sentinel

Optical Mission Performance Cluster

# OLCI Level 1 Processor & Products
# Recent and Coming Evolutions

## IOCCG Ocean Colour sensors calibration Task Force
## 15 November 2023

L. Bourg and the OLCI L1 ESL




**Disclaimer**

The work performed in the frame of this contract is carried out with funding by the European Union. The views expressed herein can in no way be taken to reflect the official opinion of either the European Union or the European Space Agency.

esa EUMETSAT

# Content

- **OLCI Level 1 processing recent evolutions**
  - Per pixel uncertainties
  - Spatial regridding
  - Saturation detection and handling
- **OLCI Level 1 processing coming evolutions**
  - Spectral temporal model
  - Change of Reference Solar Irradiance reference spectrum

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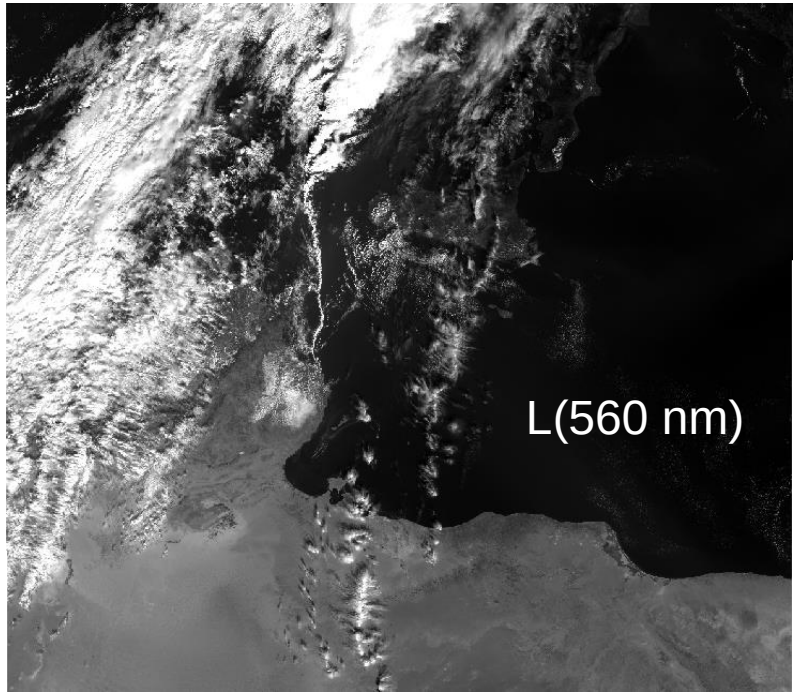
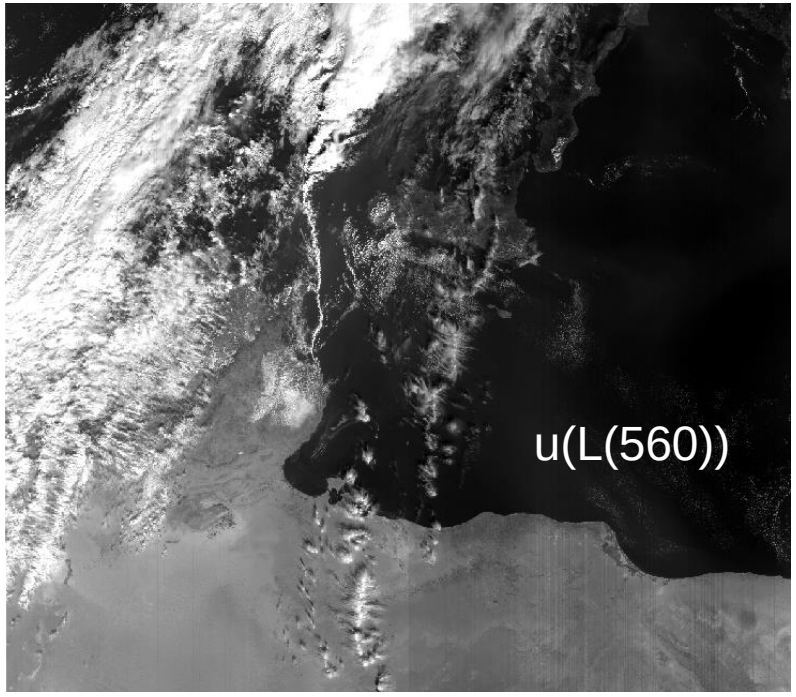
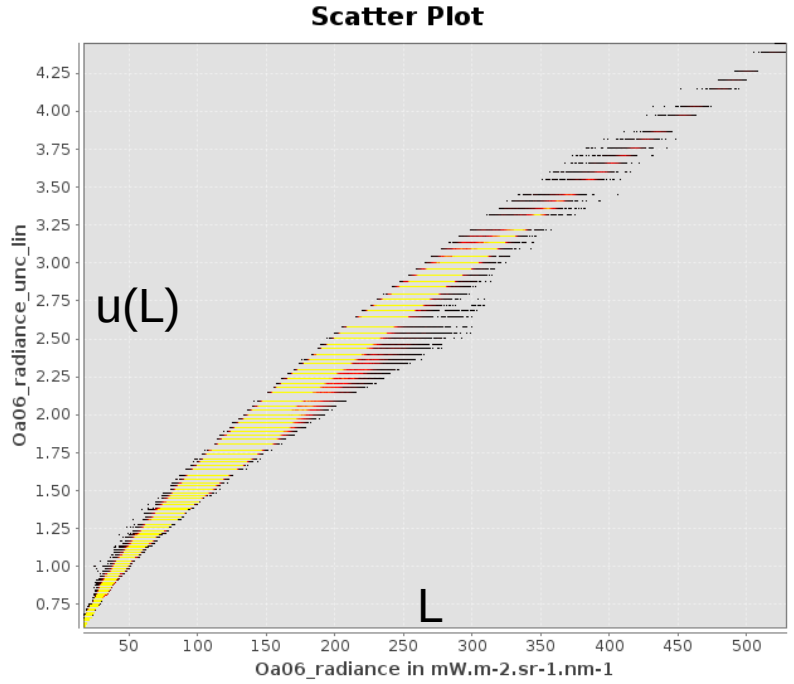
# OLCI Level 1 processing recent evolutions

## Per pixel uncertainties

- In Operation since 08/2022 @ESA, not yet @EUMETSAT
- Metrological uncertainty propagation through the radiometric processing chain → prognostic uncertainty @ pixel in radiance units (log-scaled to preserve relative accuracy)



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# OLCI Level 1 processing recent evolutions

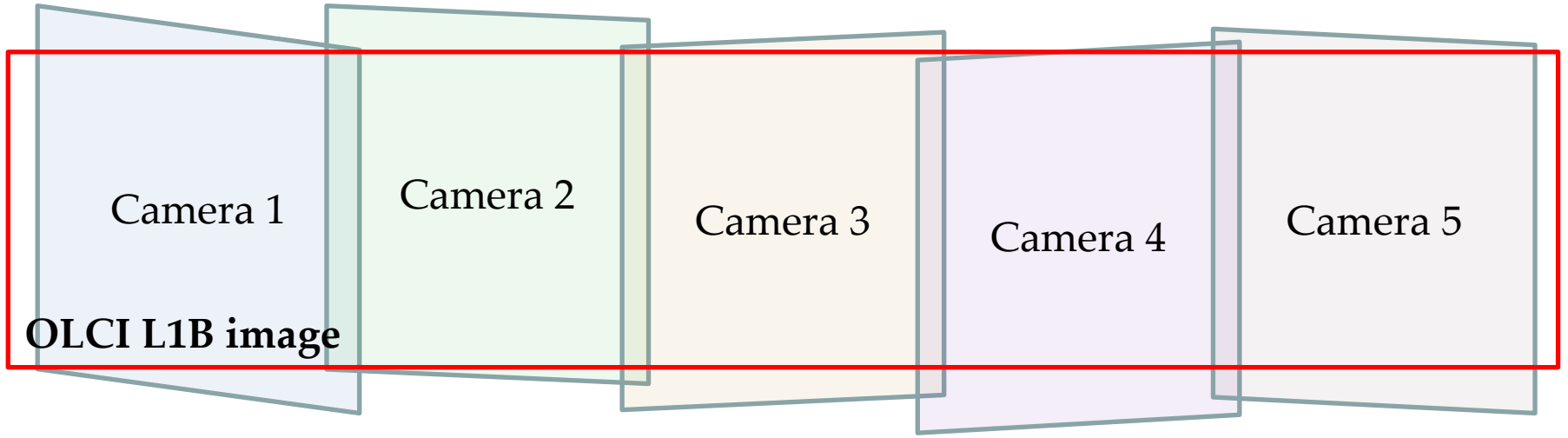
## Spatial regridding

- In Operation since 08/2023 @ESA, not yet @EUMETSAT
- Improvement in handling OLCI thermoelastic deformations during spatial regridding:
  - ✓ Data is unchanged (same spectrum has same georeferencing information)
  - ✓ Better spatial continuity at camera interfaces in product images

# OLCI Level 1 processing recent evolutions

## Spatial re-gridding: principle

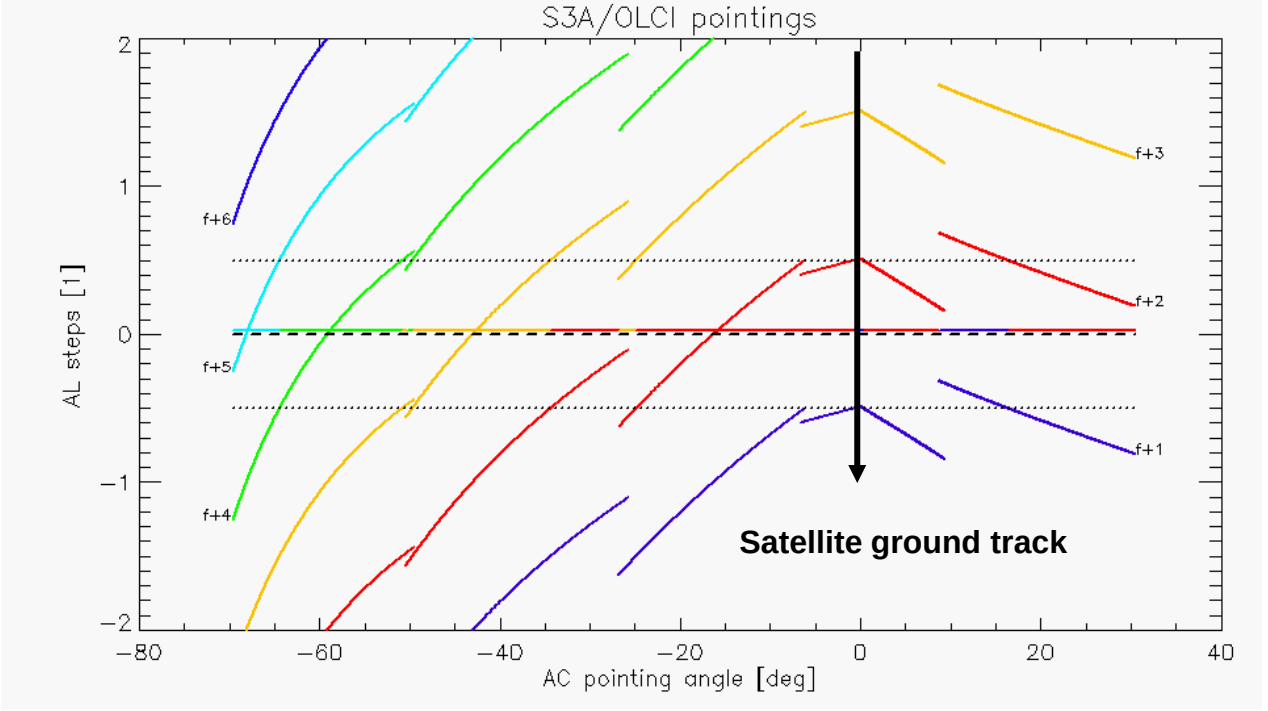
- Re-builds ideal swath from actual pixel pointings:



# OLCI Level 1 processing recent evolutions

## Spatial re-gridding: principle

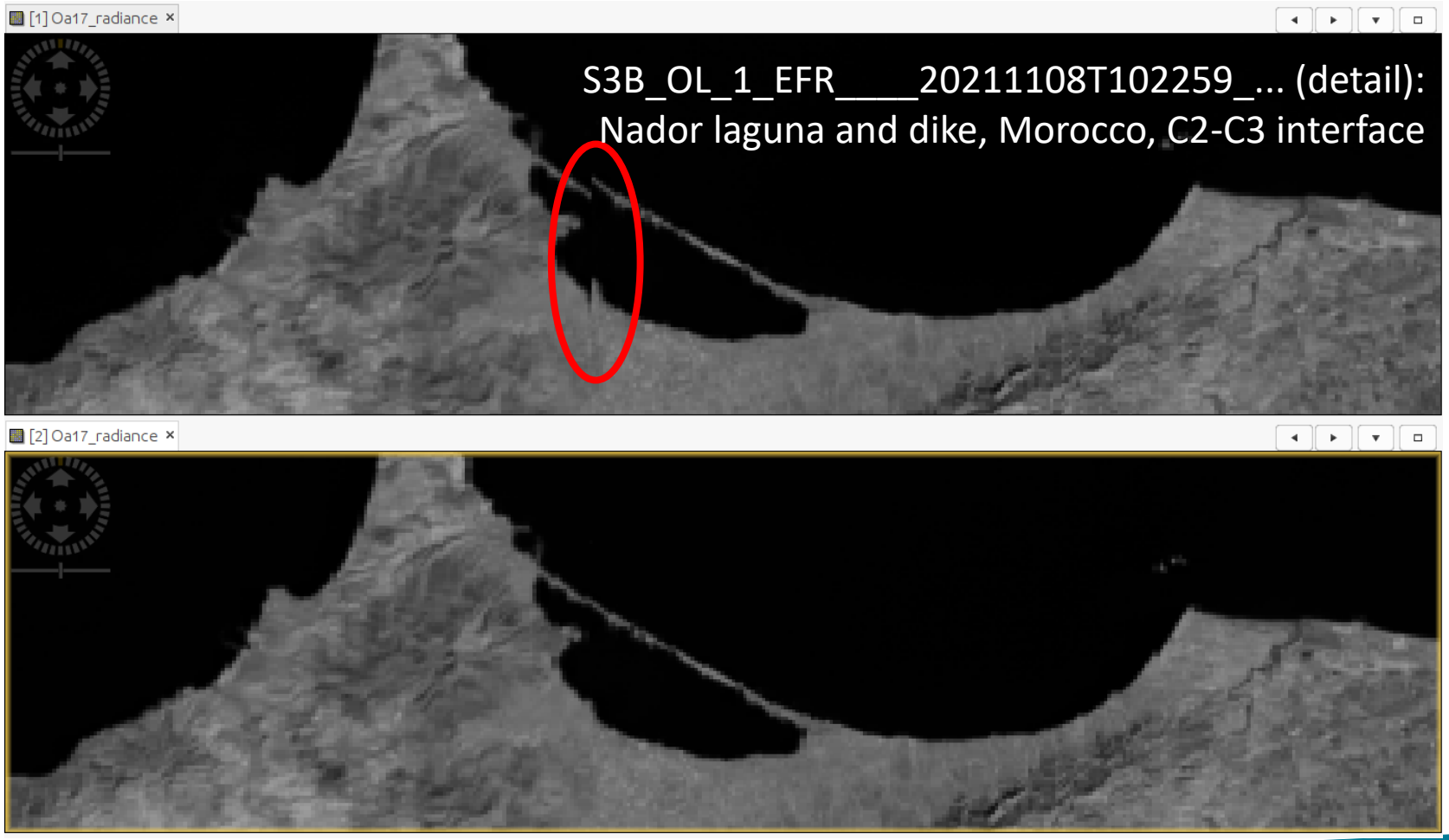
- **Re-builds ideal swath from actual pixel pointings:**
- **Preserves instrument measurements: nearest neighbour**
- **To fill-in a given product pixel:**
  - Across-track: detector column selected comparing across-track pointing angle, priority to west pixels at interfaces
  - Along-track: frame offset determined from known de-pointing of selected column
  - Those already used on same product row flagged DUPLICATE



# OLCI Level 1 processing recent evolutions

## Spatial regridding: impact of upgrade

- With “global” thermoelastic correction (old)
- With “per camera” thermoelastic correction (new)



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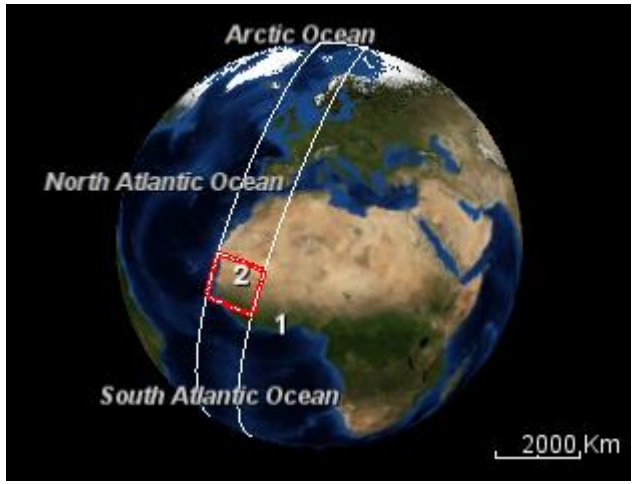
# OLCI Level 1 processing recent evolutions

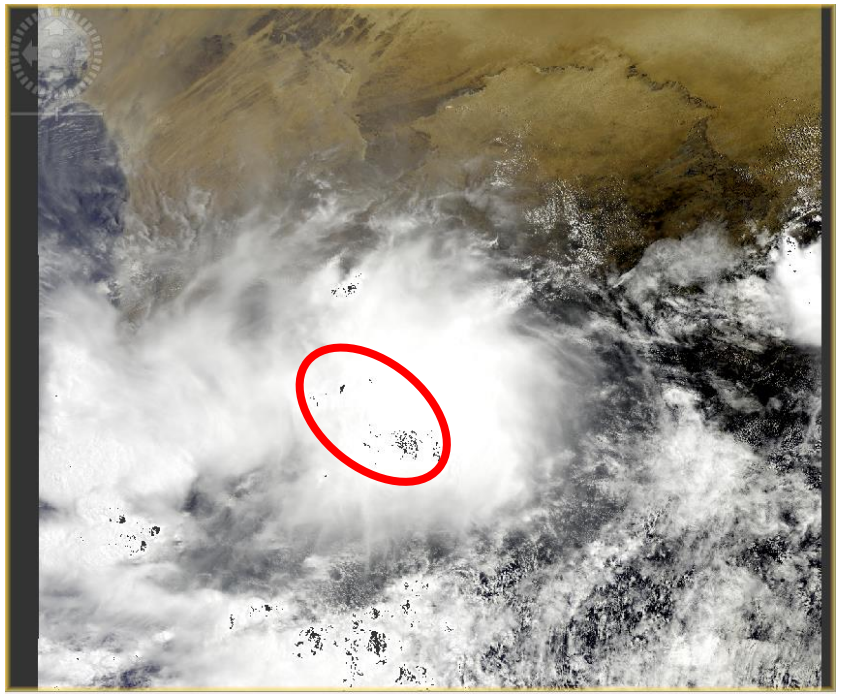
## Saturation detection and handling: principle

- In Operation since 08/2023 @ESA, not yet @EUMETSAT
- Improvement saturation detection:
  - ✓ Partly saturated samples detected ("partly" meaning "not all acquired micro-channels") by analysis of spectral continuity
- Change in saturation flagging:
  - ✓ No more per-channel flags but two flags for each pixel: Saturated or Partly saturated
  - ✓ Saturated and Partly Saturated samples now set to "no data" (netCDF's _FillValue)
  - ✓ Per channel flag can be rebuilt as:
    Saturated_Oaxx(i,j) = (Saturated(i,j) **OR** Partially_Saturated(i,j)) AND (radiance_Oaxx == _FillValue)

# OLCI Level 1 processing recent evolutions

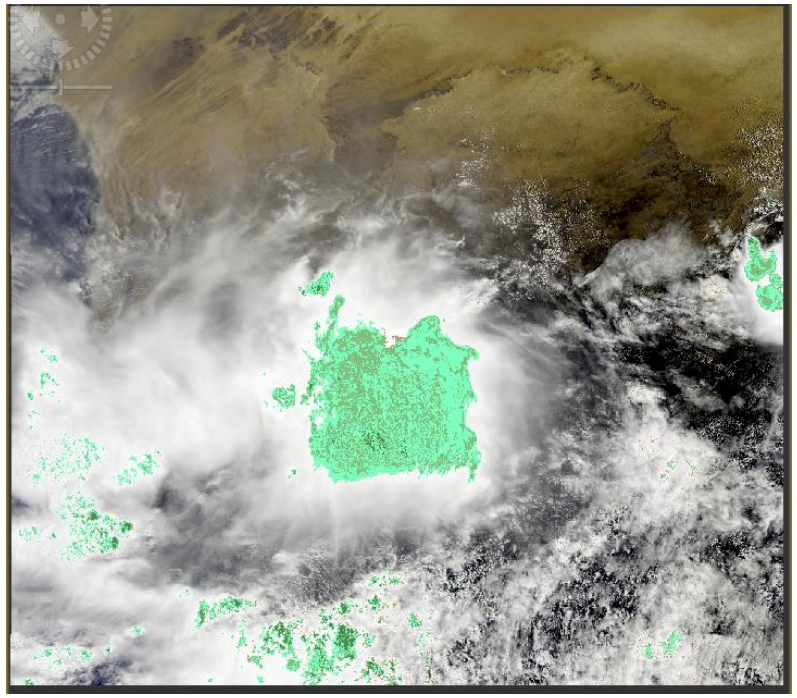
## Saturation detection and handling: illustrations



**“no data” digs holes**

on RGB, depends on bands



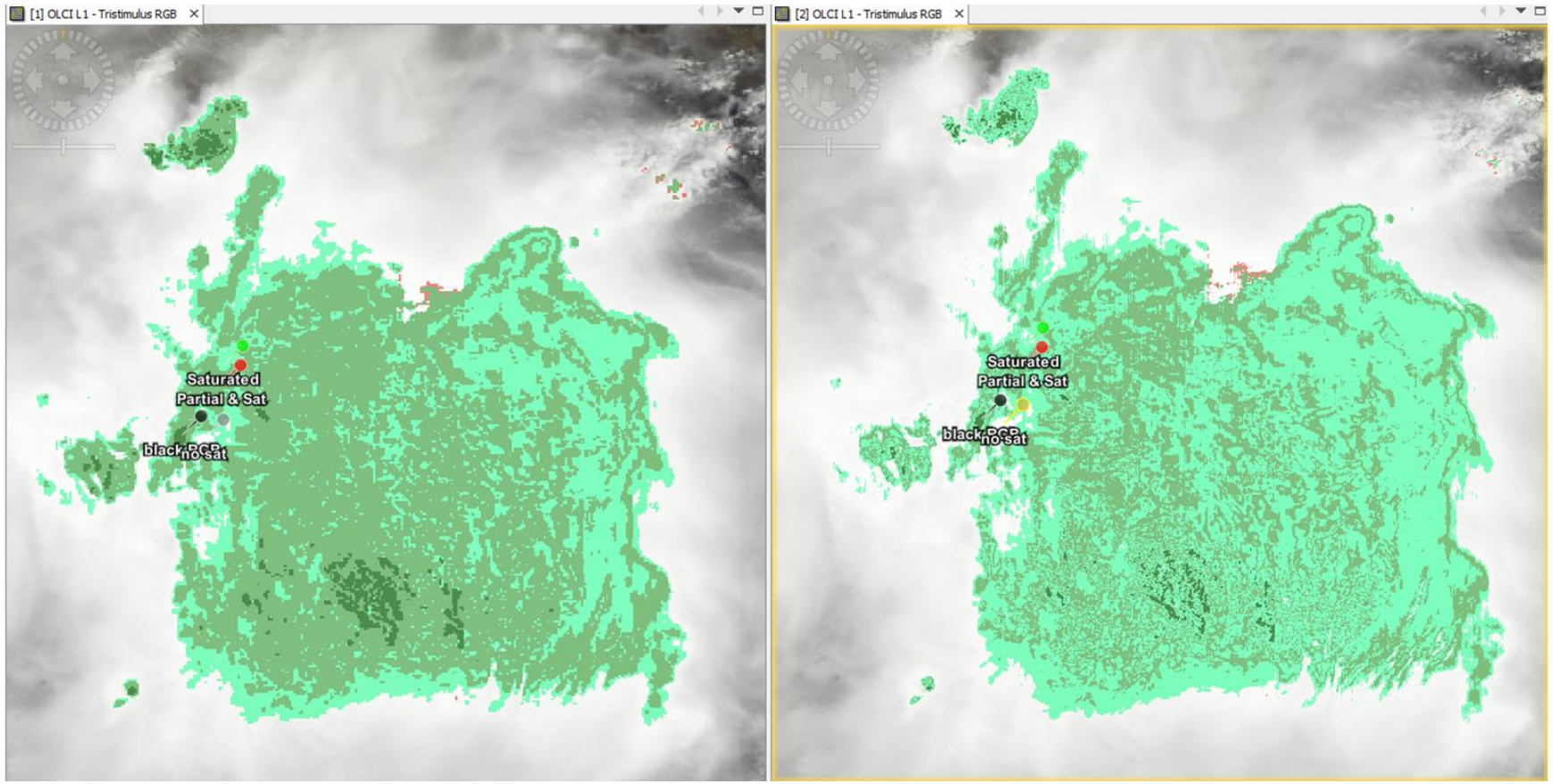
**enclosed in larger saturation areas**

saturated in red, partly saturated in red

# OLCI Level 1 processing recent evolutions

## Saturation detection and handling: illustrations

- Saturated (green) and Partially Saturated (red) flags, RR (left) and FR (right)
- 4 pins in same area:
  - No sat
  - Sat only
  - Sat + partial
  - Black RGB



# OLCI Level 1 processing recent evolutions

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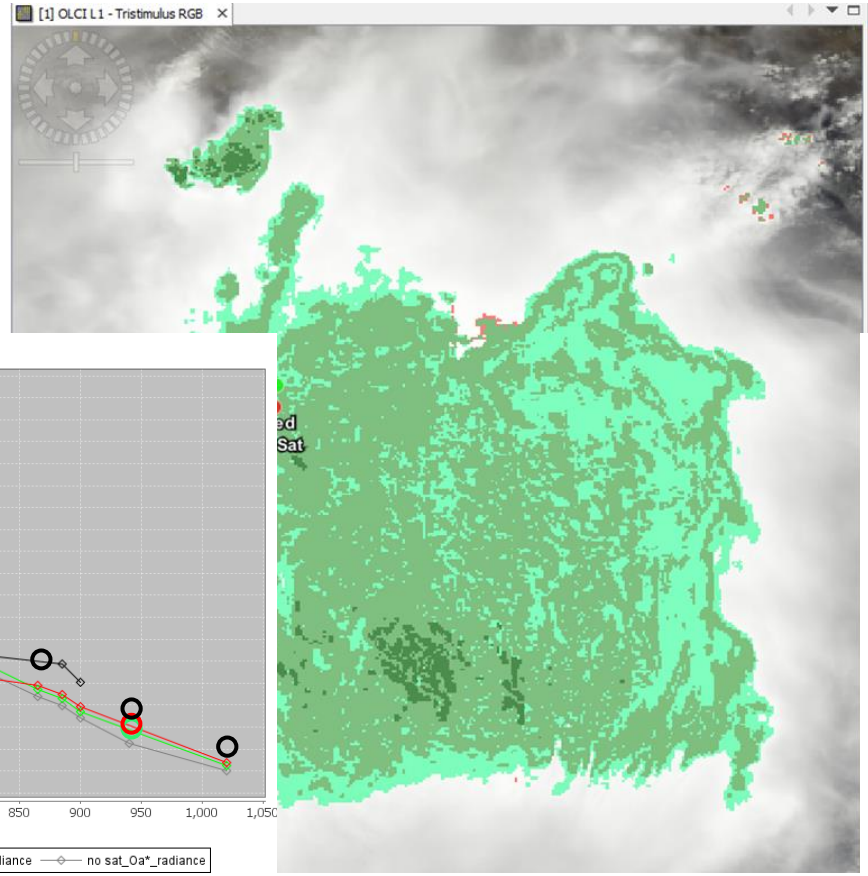


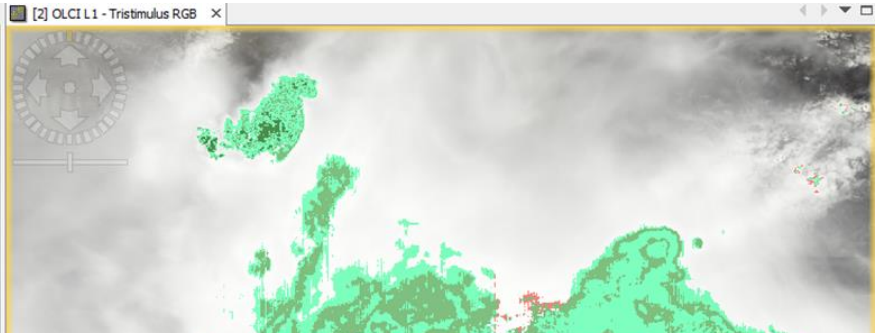


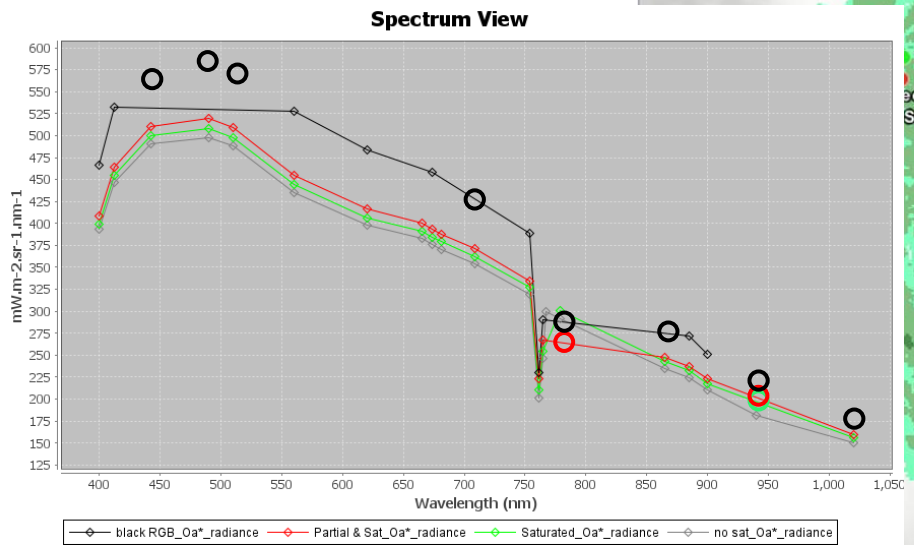


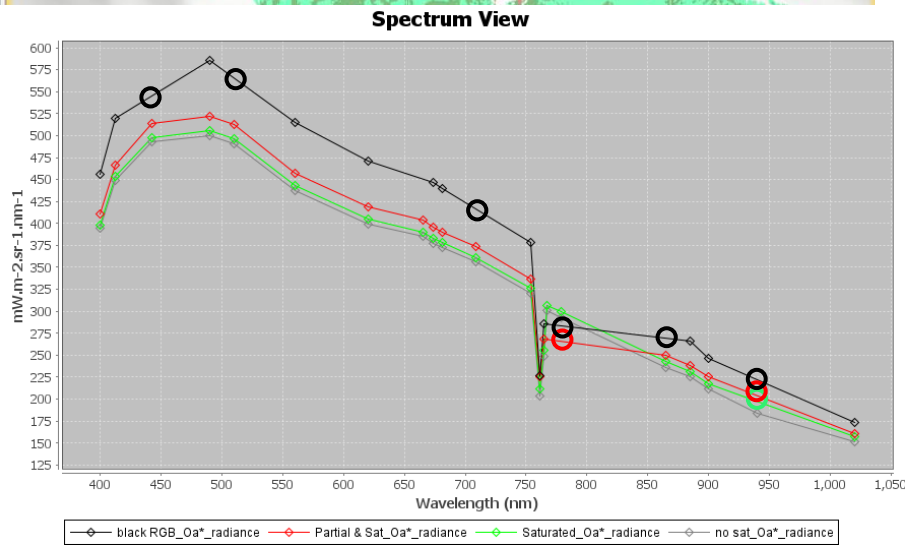

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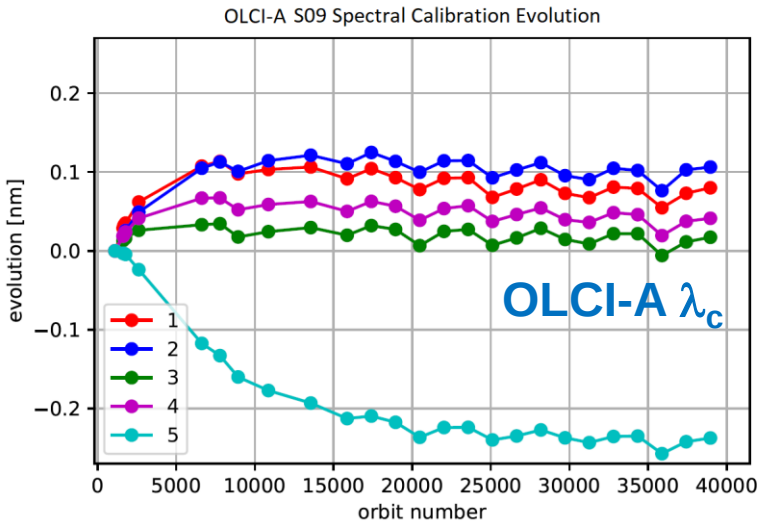
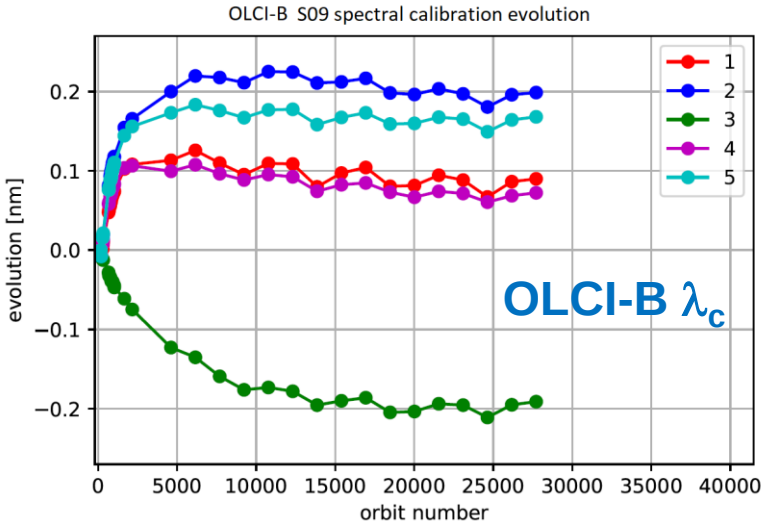
# OLCI Level 1 processing coming evolutions

## ❖ Spectral temporal model: rationale

- **OLCI is spectrally characterized in-flight on a regular basis**
  **Earth observations with dedicated channels definition matching Fraunhofer lines and $O_2$-A at 1.25 nm sampling**
- **Channels' central wavelengths but also bandwidths slowly evolve with time, with an impact on in-band irradiance (hence calibration) and some L2 applications**

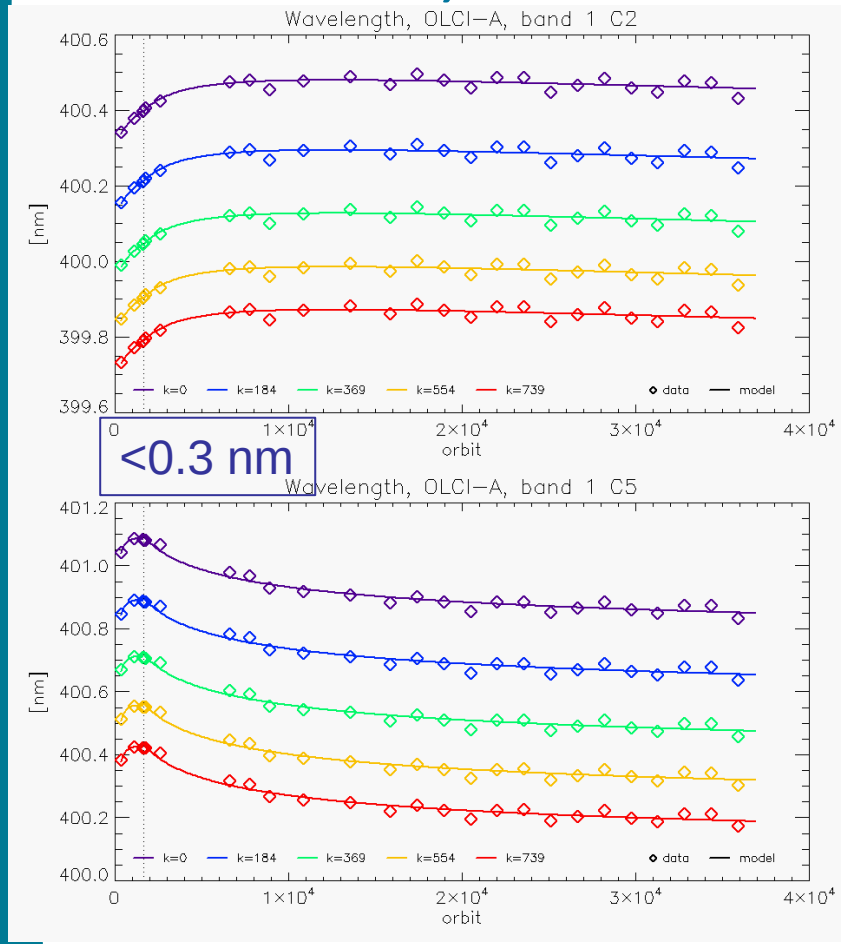


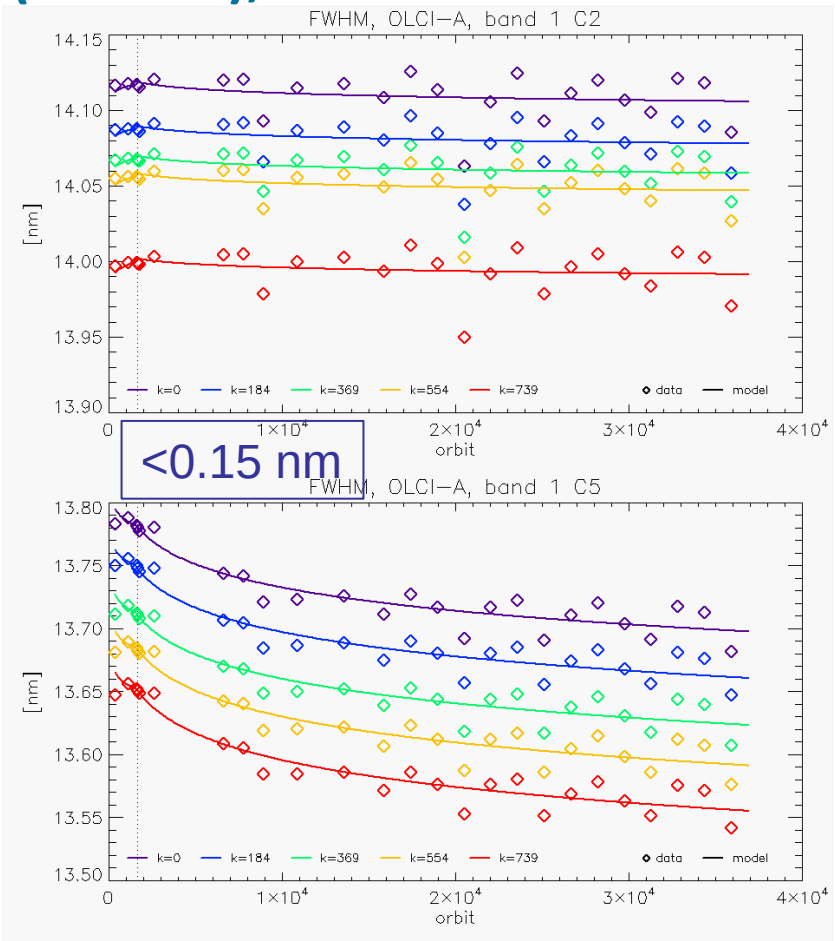



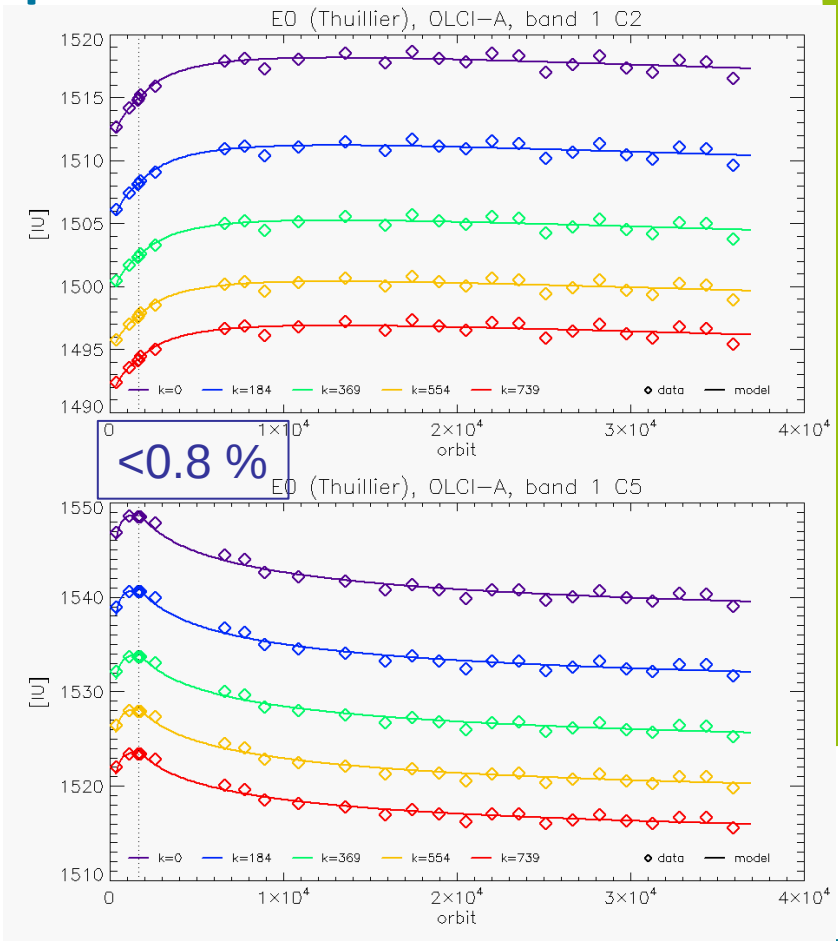

- **The 3 spectral parameters ($\lambda_c$, $\delta\lambda$ & $E_0$) are easily modelled as polynomials of ln(orbit)**

# OLCI Level 1 processing coming evolutions

## Spectral temporal model examples: $\lambda_c$, $\delta\lambda$ & $E_0$ for 5 pixels across the FOV of OLCI-A cameras 2 & 5, channel Oa01 (400 nm), irradiance reference spectrum Thuillier













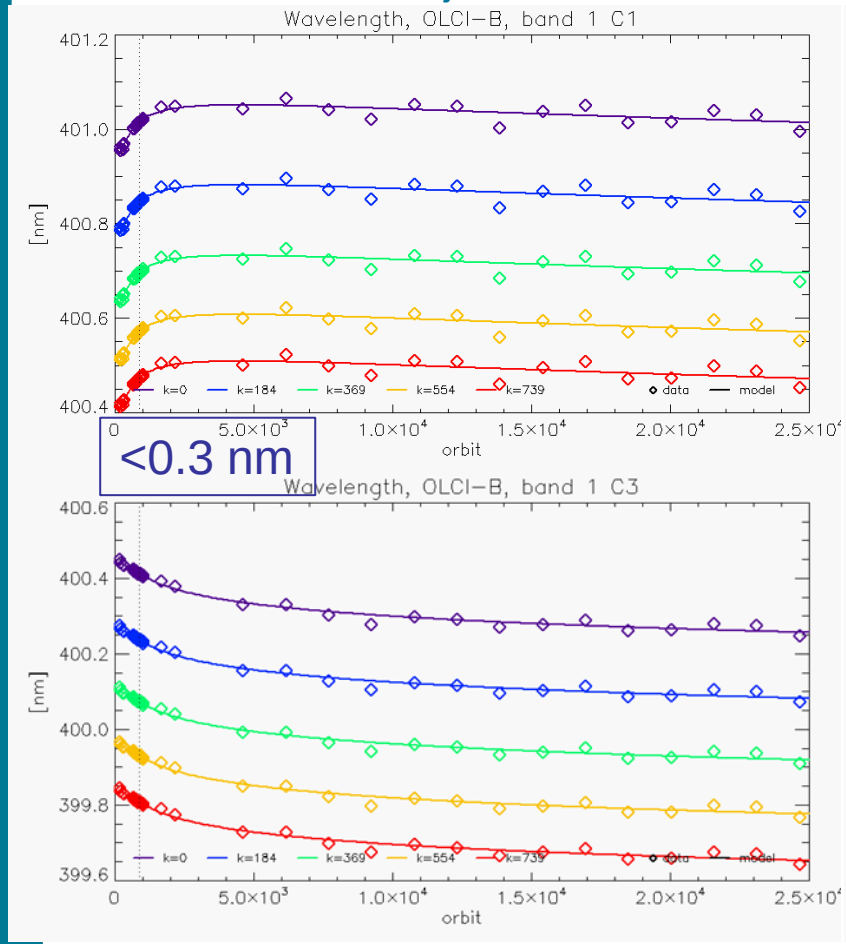
<0.3 nm

<0.15 nm

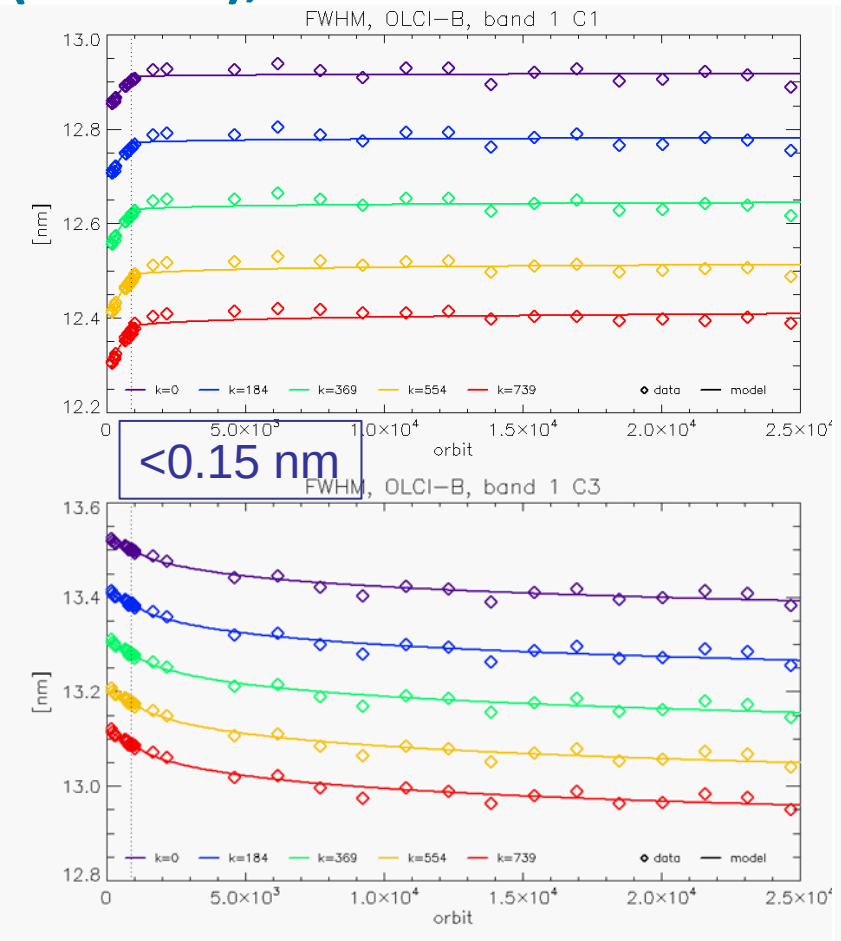
<0.8 %

# OLCI Level 1 processing coming evolutions

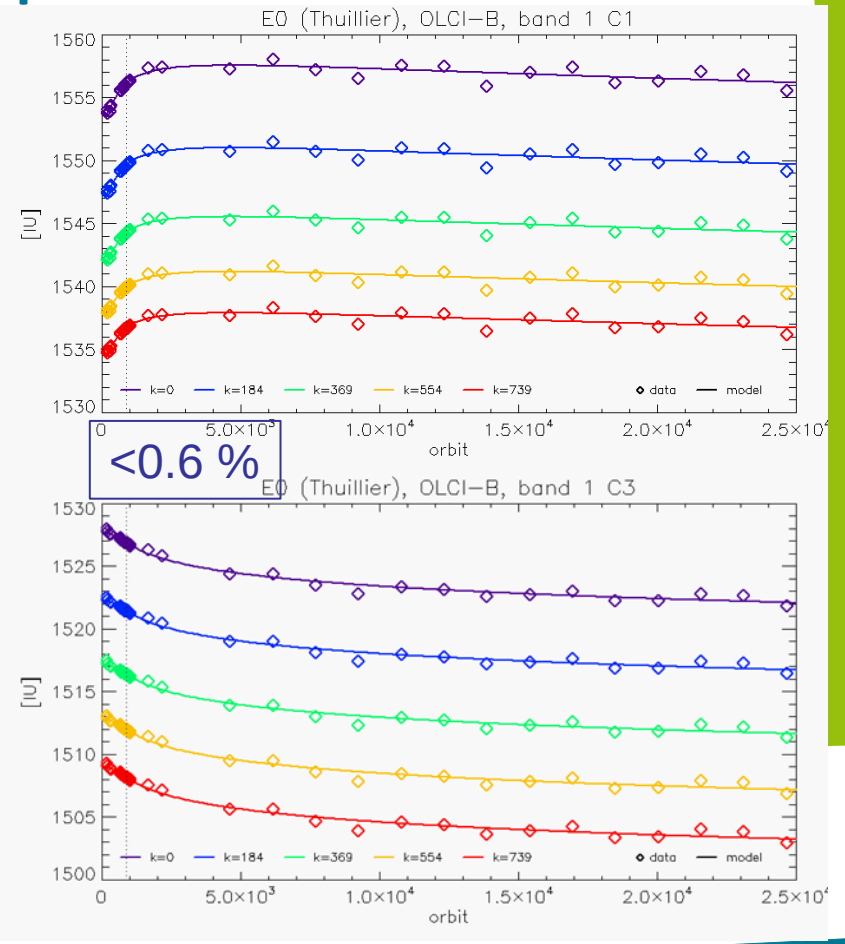
## Spectral temporal model examples: $\lambda_c$, $\delta\lambda$ & $E_0$ for 5 pixels across the FOV of OLCI-B cameras 1 & 3, channel Oa01 (400 nm), irradiance reference spectrum Thuillier




<0.3 nm




<0.15 nm




<0.6 %

# OLCI Level 1 processing coming evolutions

## Spectral temporal model: impact on products

❖ At L1:

- small change in radiance, linked to in-band irradiance
- Second order change through impact on radiometric gain modelling (small change in long-term trends that include in-band irradiance variations)

❖ At L2:

- as L1 bears spectral information, TOA reflectance remains unchanged
- Very small change to be expected due to wavelength dependent corrections in some algorithms (smile correction, Rayleigh, …)

❖ Deployment planned December 2023 (@ESA), Spring 2024 (@EUM)

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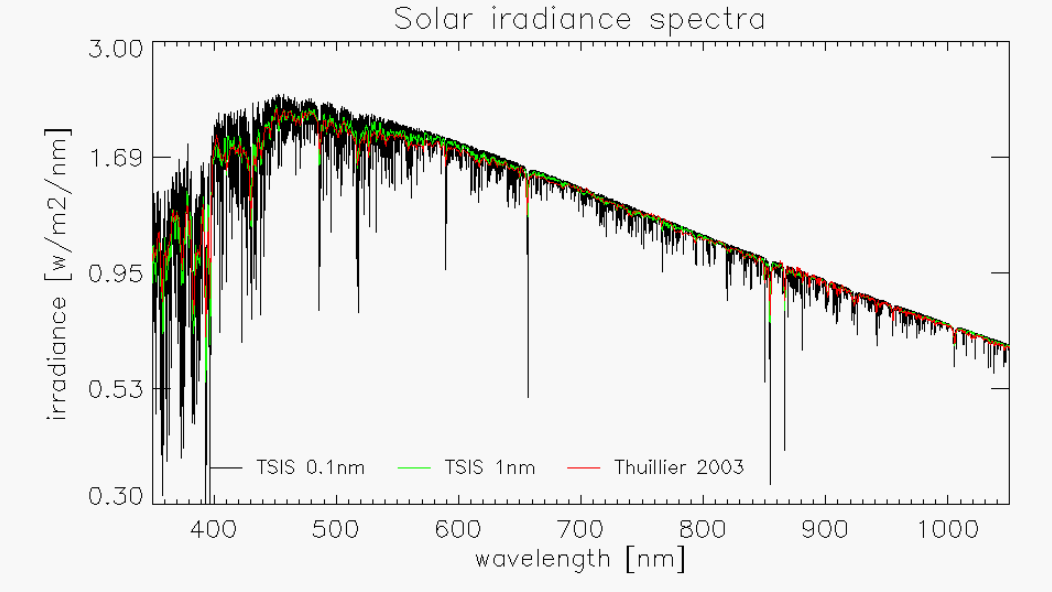
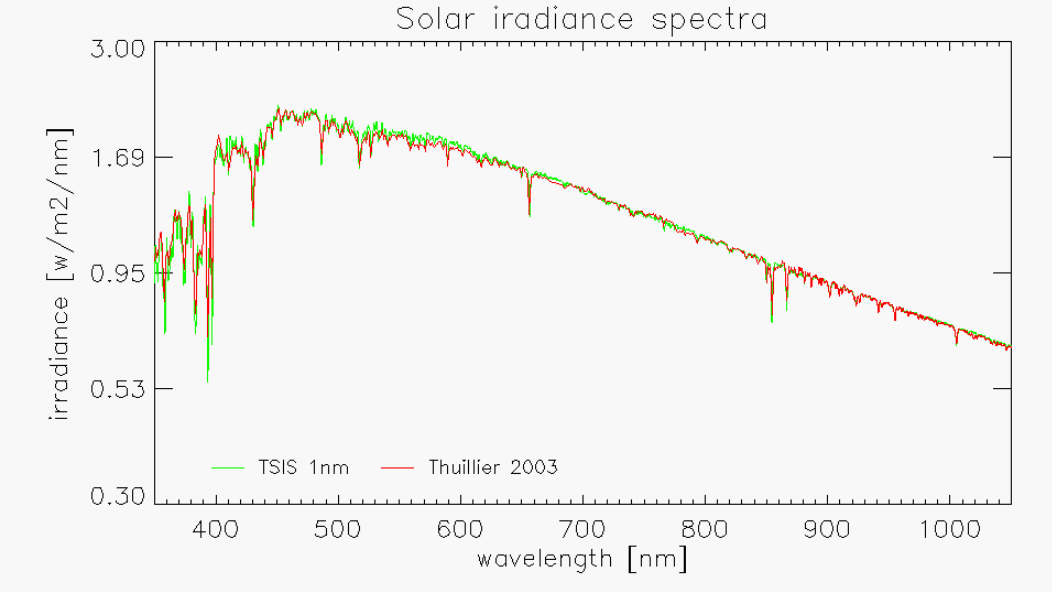
  - Change of Reference Solar Irradiance reference spectrum

# OLCI Level 1 processing coming evolutions

## ❖ Change of Reference Solar Irradiance reference spectrum: rationale

- OLCI current reference solar spectrum is Thuillier 2003
- GSICS and CEOS recommend to adopt as reference the TSIS-1 HRSR 2021 Solar Irradiance Spectrum (Coddington 2021 Bhatt, 2021)
- The change can be significant, depending on wavelength: up to ±4% (next slide)

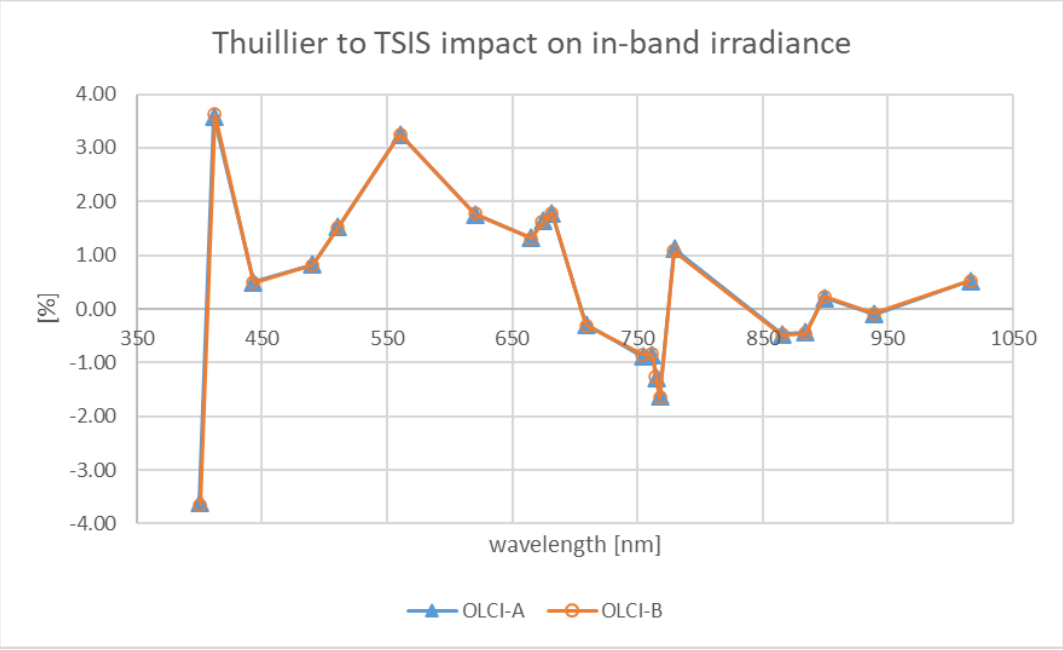


# OLCI Level 1 processing coming evolutions

## ❖ Change of Reference Solar Irradiance reference spectrum: impact

- OLCI's calibration being based on a reference diffuser (reflectance) the reference solar spectrum drives calibrated radiance $\frac{L_{EO}^{TS}(b)}{L_{EO}^{TH}(b)} = \frac{E_0^{TS}(b)}{E_0^{TH}(b)} + o(SL)$
- On the basis of unchanged SRFs, one gets:




| Band | OLCI-A $\lambda_c$ | OLCI-A $E_0$ Th. | OLCI-A $E_0$ TSIS | OLCI-A rDiff [%] | OLCI-B $\lambda_c$ | OLCI-B $E_0$ Th. | OLCI-B $E_0$ TSIS | OLCI-B rDiff [%] |
|---|---|---|---|---|---|---|---|---|
| Oa01 | 400.30 | 1.513 | 1.459 | -3.60 | 400.60 | 1.535 | 1.478 | -3.65 |
| Oa02 | 411.85 | 1.704 | 1.765 | 3.59 | 411.95 | 1.706 | 1.767 | 3.62 |
| Oa03 | 442.96 | 1.889 | 1.899 | 0.50 | 442.99 | 1.890 | 1.899 | 0.49 |
| Oa04 | 490.49 | 1.935 | 1.951 | 0.82 | 490.40 | 1.933 | 1.949 | 0.81 |
| Oa05 | 510.47 | 1.926 | 1.955 | 1.53 | 510.40 | 1.927 | 1.956 | 1.51 |
| Oa06 | 560.45 | 1.796 | 1.854 | 3.25 | 560.37 | 1.797 | 1.855 | 3.25 |
| Oa07 | 620.41 | 1.649 | 1.678 | 1.76 | 620.28 | 1.649 | 1.678 | 1.78 |
| Oa08 | 665.28 | 1.530 | 1.551 | 1.32 | 665.13 | 1.531 | 1.551 | 1.32 |
| Oa09 | 674.03 | 1.495 | 1.519 | 1.64 | 673.87 | 1.495 | 1.520 | 1.62 |
| Oa10 | 681.57 | 1.469 | 1.495 | 1.77 | 681.39 | 1.470 | 1.496 | 1.78 |
| Oa11 | 709.12 | 1.403 | 1.399 | -0.29 | 708.98 | 1.404 | 1.400 | -0.31 |
| Oa12 | 754.18 | 1.266 | 1.255 | -0.88 | 754.03 | 1.266 | 1.256 | -0.85 |
| Oa13 | 761.73 | 1.247 | 1.236 | -0.85 | 761.56 | 1.247 | 1.237 | -0.84 |
| Oa14 | 764.83 | 1.239 | 1.223 | -1.29 | 764.69 | 1.240 | 1.224 | -1.26 |
| Oa15 | 767.92 | 1.230 | 1.210 | -1.63 | 767.82 | 1.230 | 1.210 | -1.65 |
| Oa16 | 779.26 | 1.174 | 1.187 | 1.11 | 779.08 | 1.175 | 1.187 | 1.07 |
| Oa17 | 865.43 | 0.960 | 0.955 | -0.47 | 865.27 | 0.960 | 0.955 | -0.48 |
| Oa18 | 884.31 | 0.931 | 0.927 | -0.44 | 884.13 | 0.931 | 0.927 | -0.46 |
| Oa19 | 899.31 | 0.896 | 0.898 | 0.21 | 899.12 | 0.896 | 0.898 | 0.23 |
| Oa20 | 938.97 | 0.826 | 0.826 | -0.09 | 938.80 | 0.827 | 0.826 | -0.09 |
| Oa21 | 1015.80 | 0.700 | 0.703 | 0.53 | 1015.74 | 0.700 | 0.703 | 0.53 |

# OLCI Level 1 processing coming evolutions

## Change of Reference Solar Irradiance reference spectrum: impact

❖ **At L1:**

- **significant change in radiance, linked to in-band irradiance (up to ~4%)**
- **Second order change through impact on stray light correction (via inter-channel exchanges, <0.1%)**

❖ **At L2:**

- **as L1 bears spectral information, TOA reflectance remains unchanged**

# OLCI Level 1 processing coming evolutions

## Implementation plan

- The TSIS solar spectrum will be implemented jointly with the Temporal Spectral Model
- TSIS impact on L1 TOA radiance introduces a severe discontinuity in the L1 mission: <u>it requires a global reprocessing</u>
- The upgraded processor, including Spectral Temporal Model with TSIS as the reference solar spectrum is planned to be deployed in Spring 2024
- The mission reprocessing is being prepared, should start soon and be completed within first half of 2024 (TBC)

# THANK YOU FOR YOUR ATTENTION