



Sentinel-5p+ Innovation Theme 6: Solar Induced Chlorophyll Fluorescence (SIF)

TROPOSIF: global sun-induced fluorescence from the Sentinel-5P TROPOMI mission

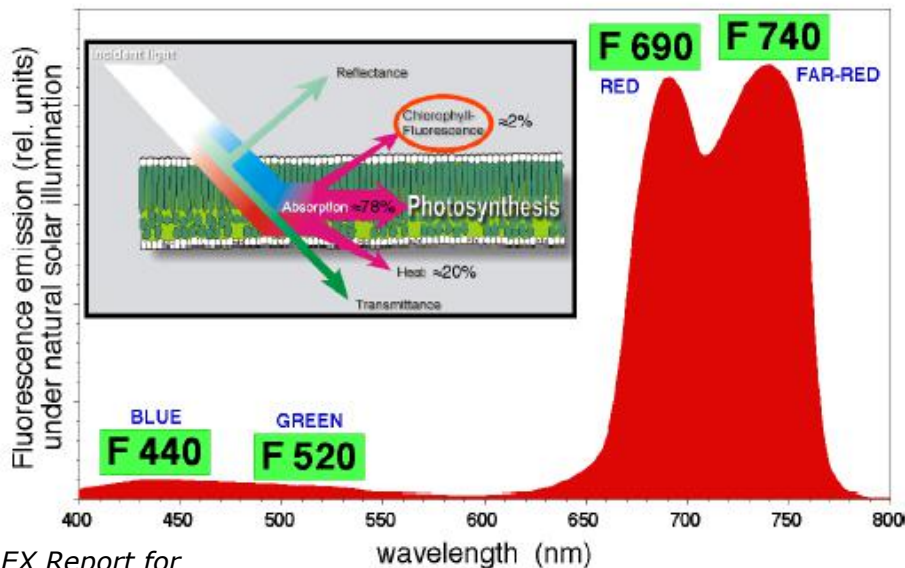
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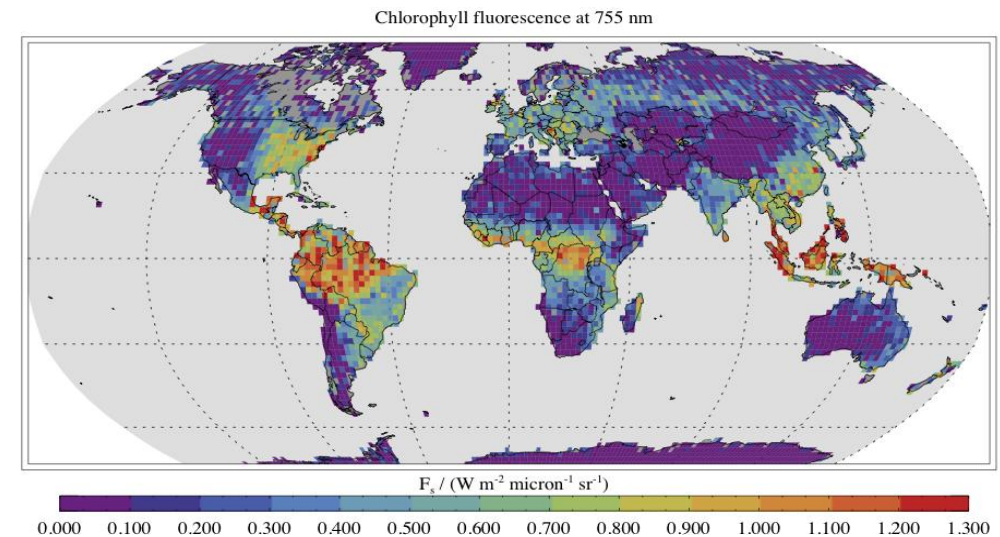


Context of the study

- **Solar-induced chlorophyll fluorescence (SIF)** is an electromagnetic signal emitted by the photosynthetic machinery of green plants that can be linked to instantaneous photosynthesis
- **First global measurements of SIF over land achieved in 2011** from GOSAT spectra (Frankenberg et al., Joiner et al.)
- At the global scale, SIF has been proven to be a **better indicator of terrestrial gross primary production (GPP)** than reflectance-based vegetation indices. However, spatio-temporal sampling and SNR of most satellite-based SIF data sets limit its scientific exploitation
- **Sentinel-5P/TROPOMI**: great potential for global SIF monitoring



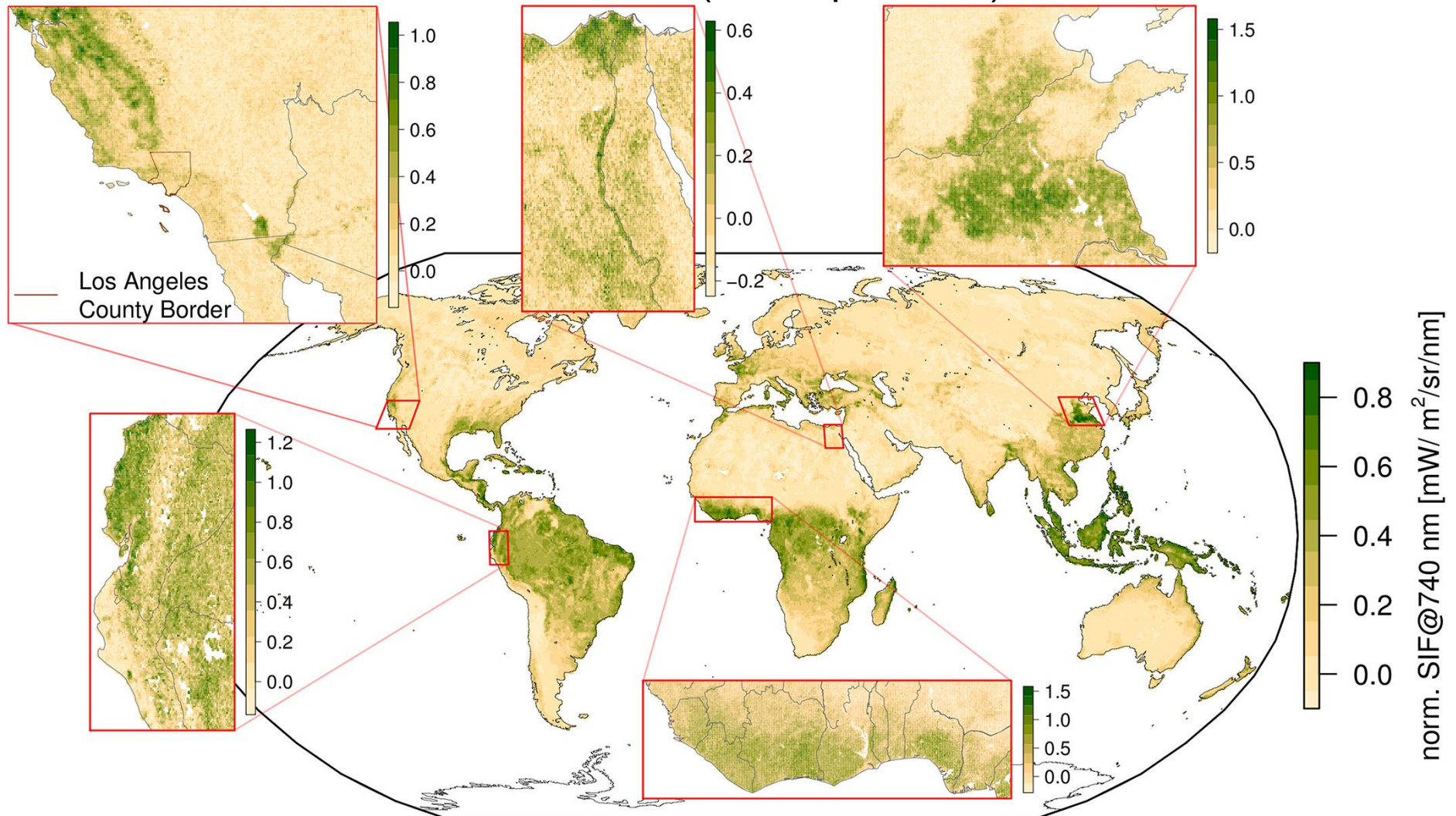
FLEX Report for
Assessment (2008)



Frankenberg et al. (2011)

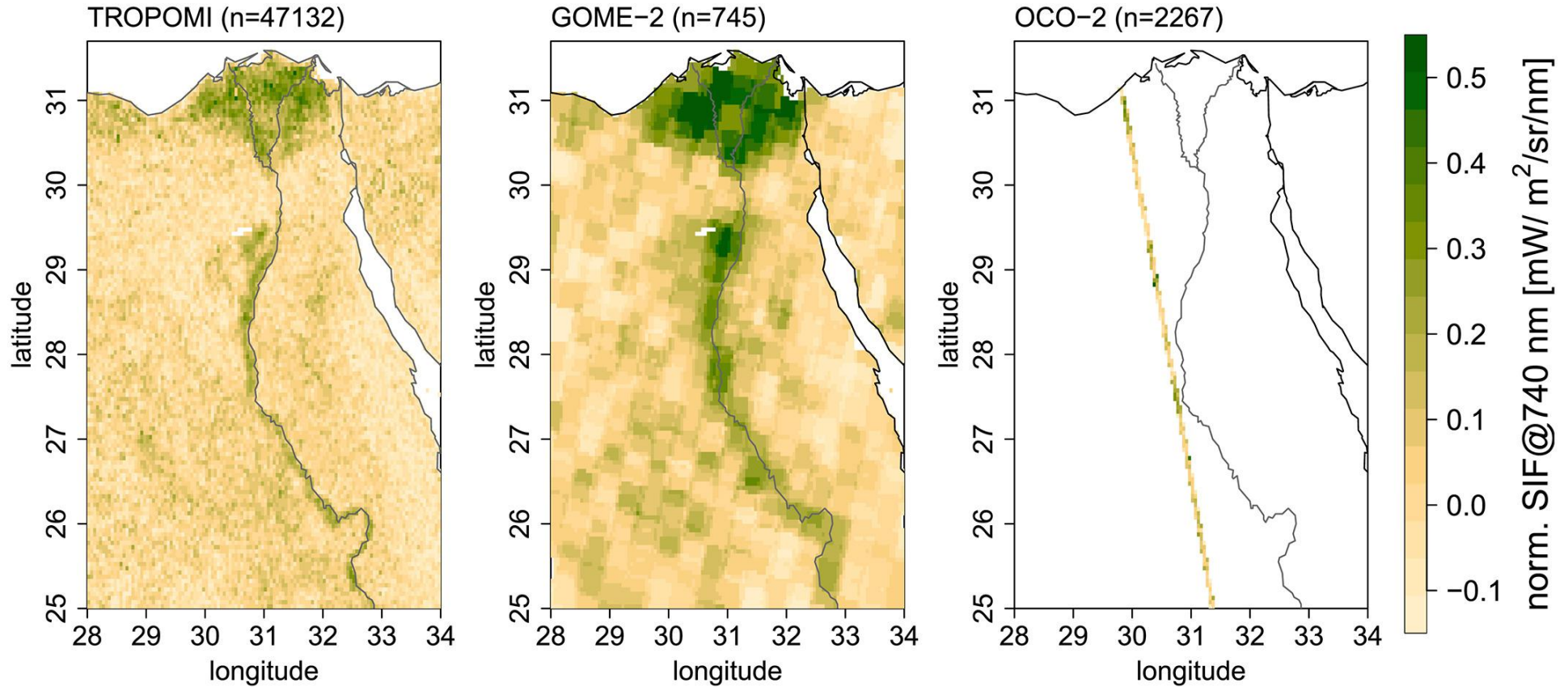
First SIF data set from TROPOMI

TROPOMI SIF (8-15 April 2018)



Köhler et al., GRL 2018

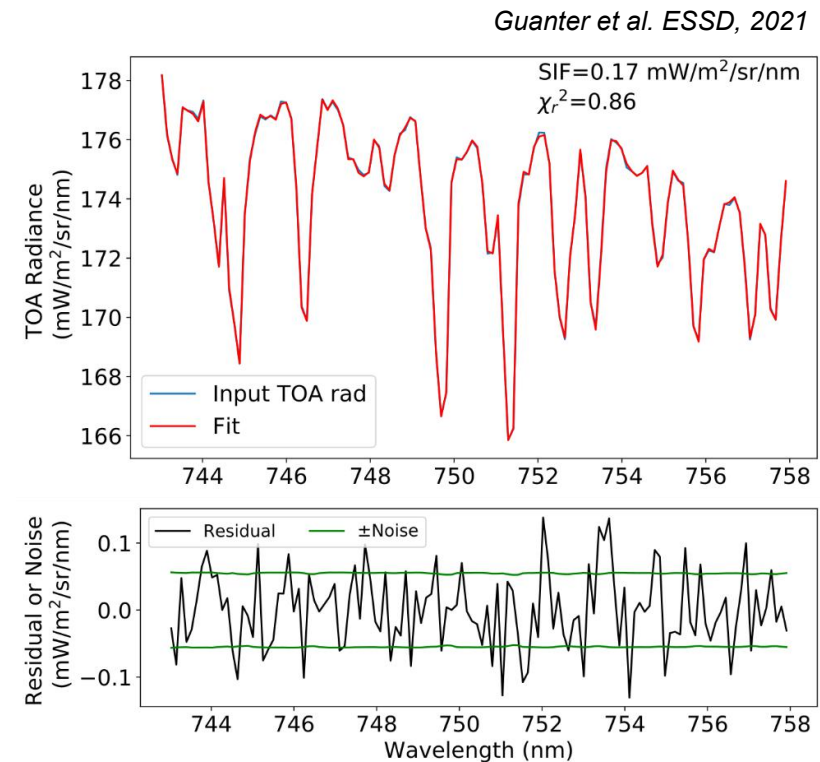
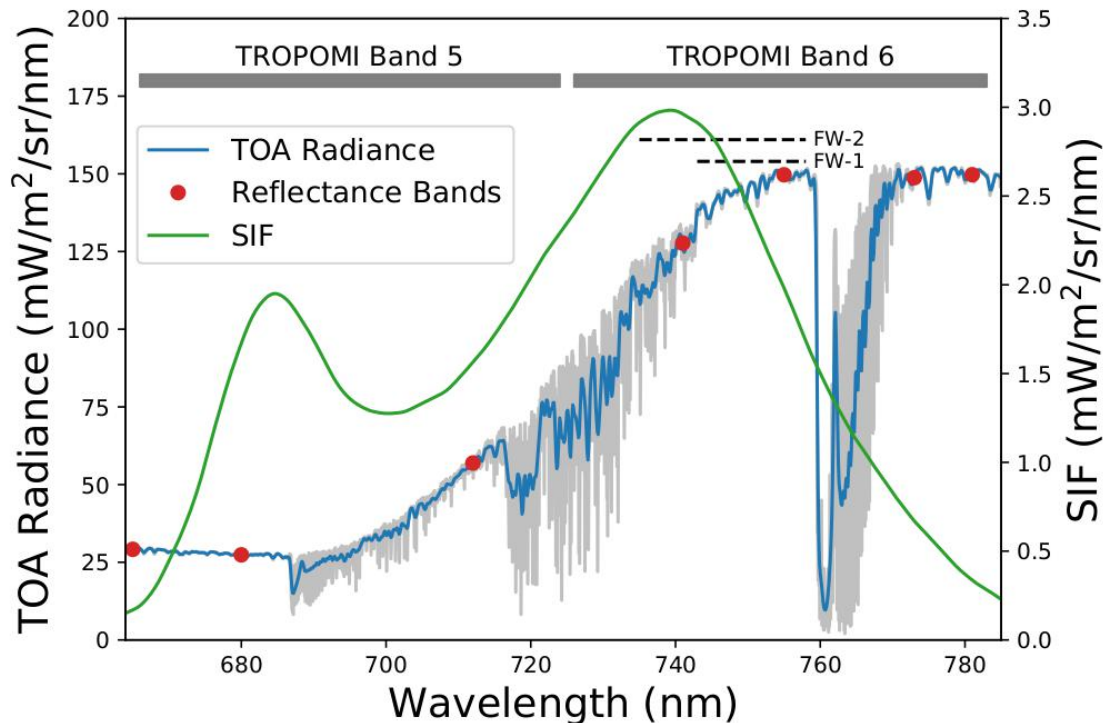
Why is TROPOMI so great for SIF monitoring?



Köhler et al., GRL, 2018

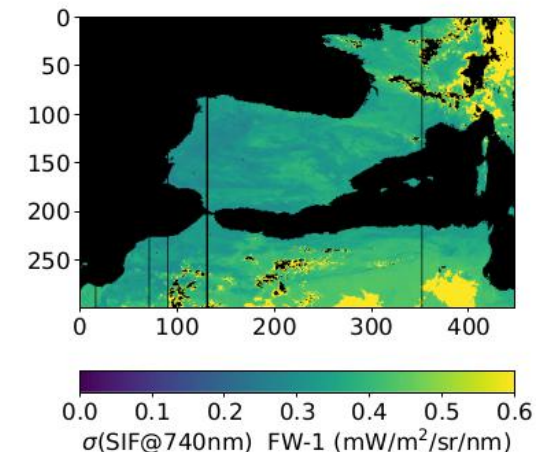
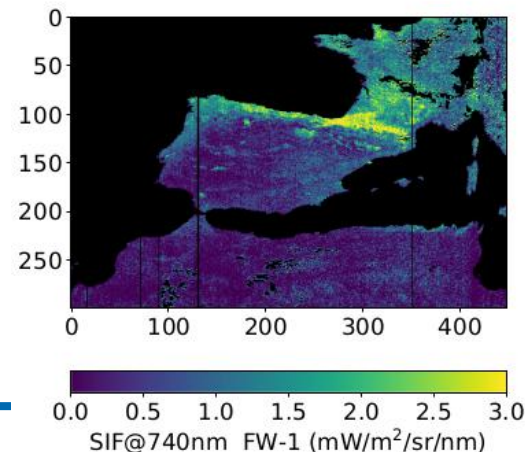
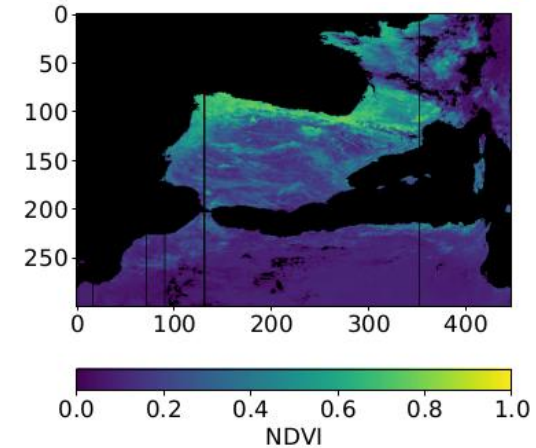
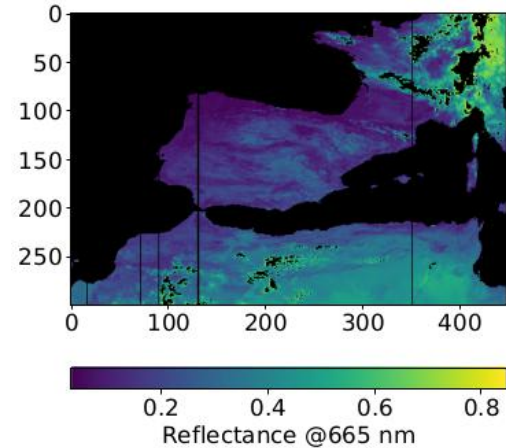
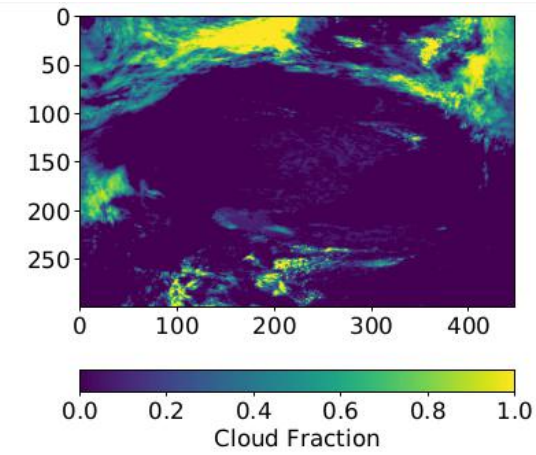
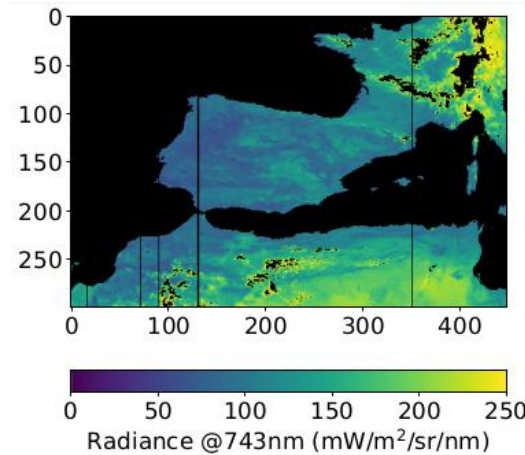
TROPOSIF - SIF and reflectance retrieval

- ❖ **TROPOSIF:** ESA S5P+ Innovation Project for the implementation of an operational SIF+reflectance product from TROPOMI
- ❖ **SIF retrieval:** Models the fractional depth of solar Fraunhofer lines in 743-758 nm → not affected by atmospheric scattering, simple modelling
- ❖ **Spectral reflectance retrieval:** TOA reflectance at 7 atmospheric windows in the 675-780 nm range



The TROPOSIF product

- **L2 product** (orbit files):
 - Ungridded data available for each TROPOSIF orbit
 - SIF estimates at 740 nm from the two fitting windows and associated retrieval error
 - **743-748 nm**: baseline product
 - **735-748 nm**: «experimental»
 - Daily corrected SIF in the two fitting windows
 - Surface reflectance at 665, 680, 712, 741, 755, 773 and 781 nm
 - Solar and view angles, TOA radiance, Cloud fraction
 - Quality flag
- **L2B product** (user product):
 - Ungridded daily files with only valid retrievals
- Time period: **May 2018 to April 2021**
- NetCDF-4 format

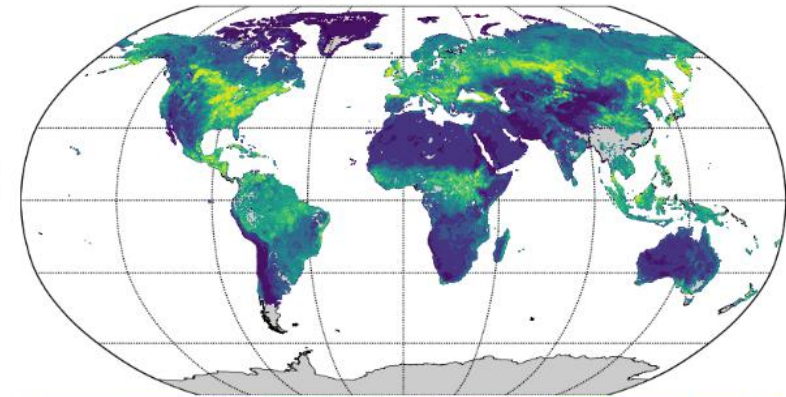
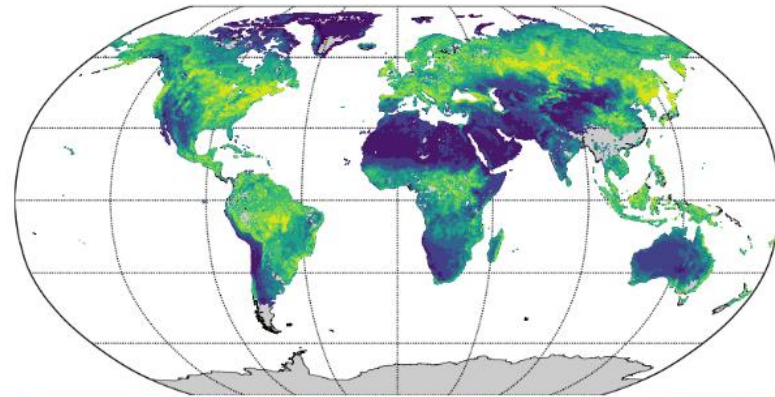
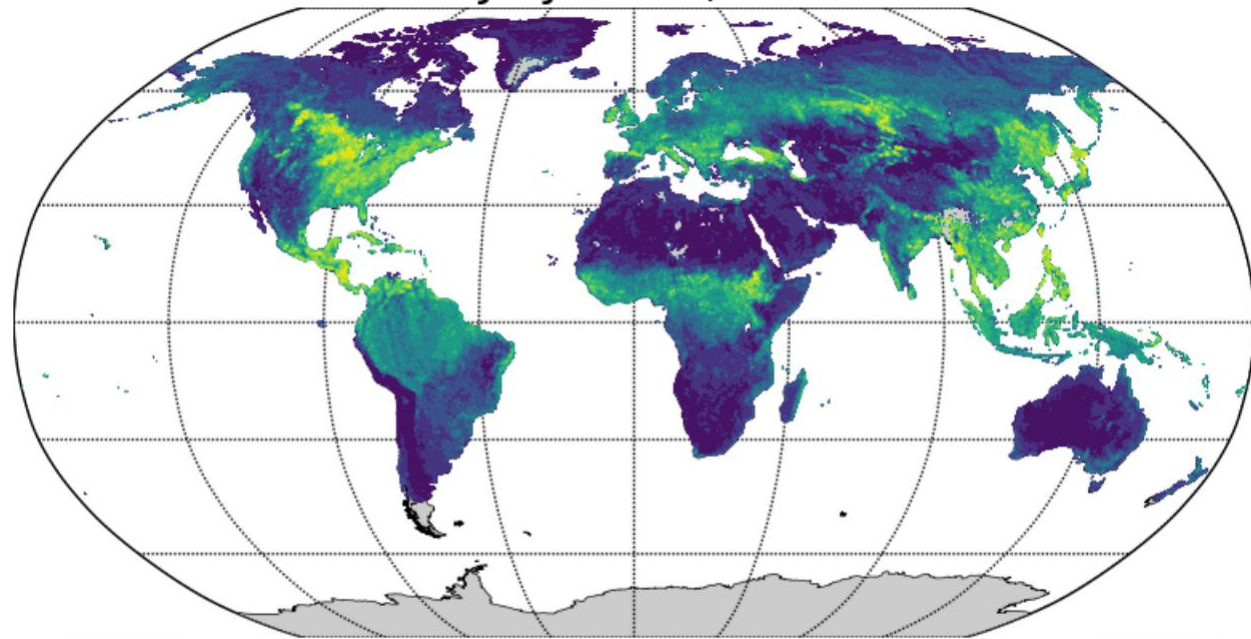


8-15 July 2019, CF<0.5

TROPOSIF

Spatio-temporal composites of SIF & VIs

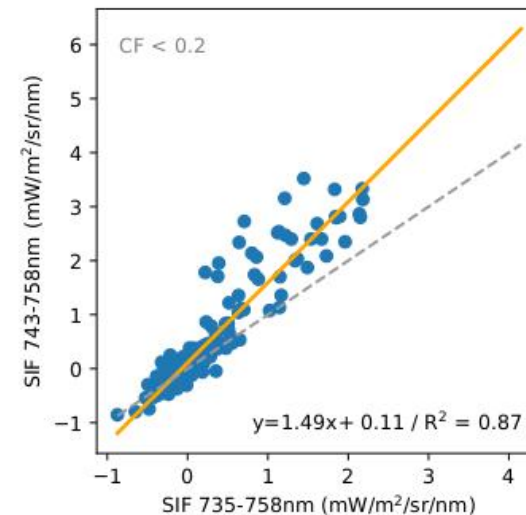
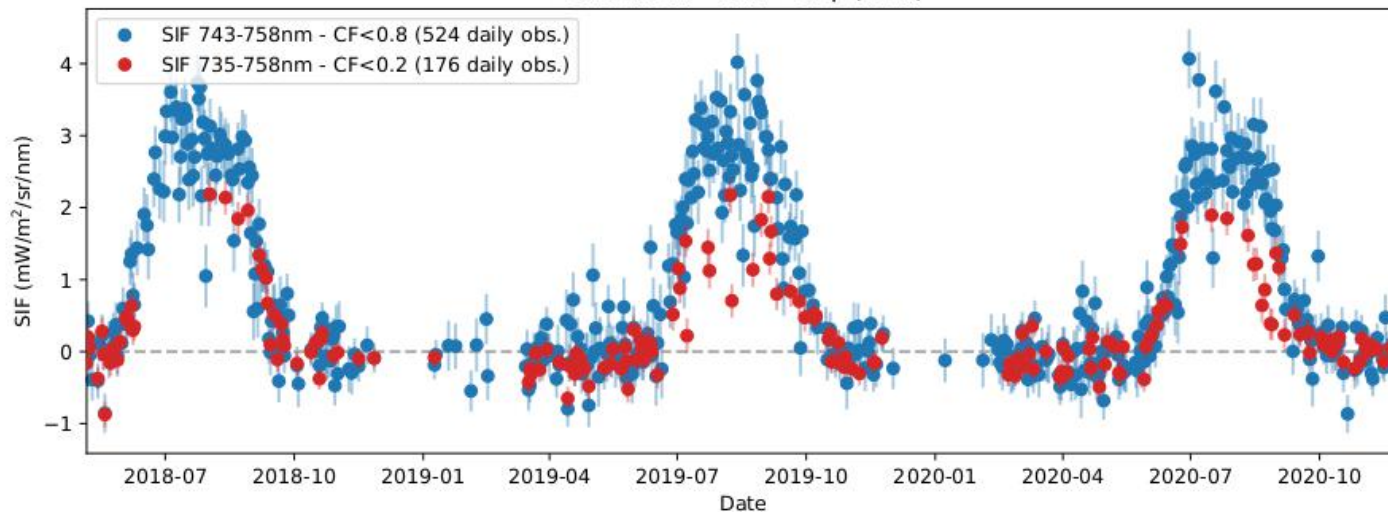
102 orbits (8-15/07/2015)
gridded in 0.2° global
composites



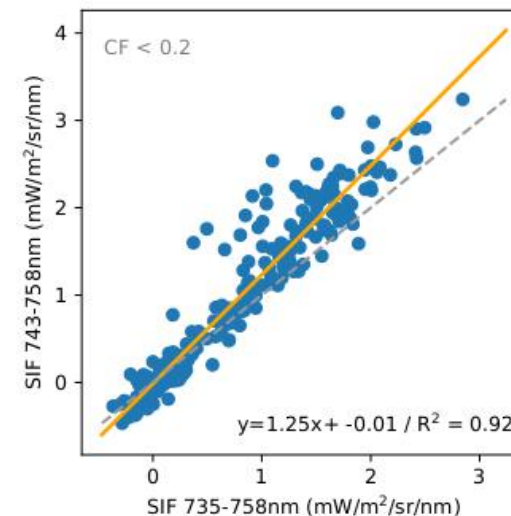
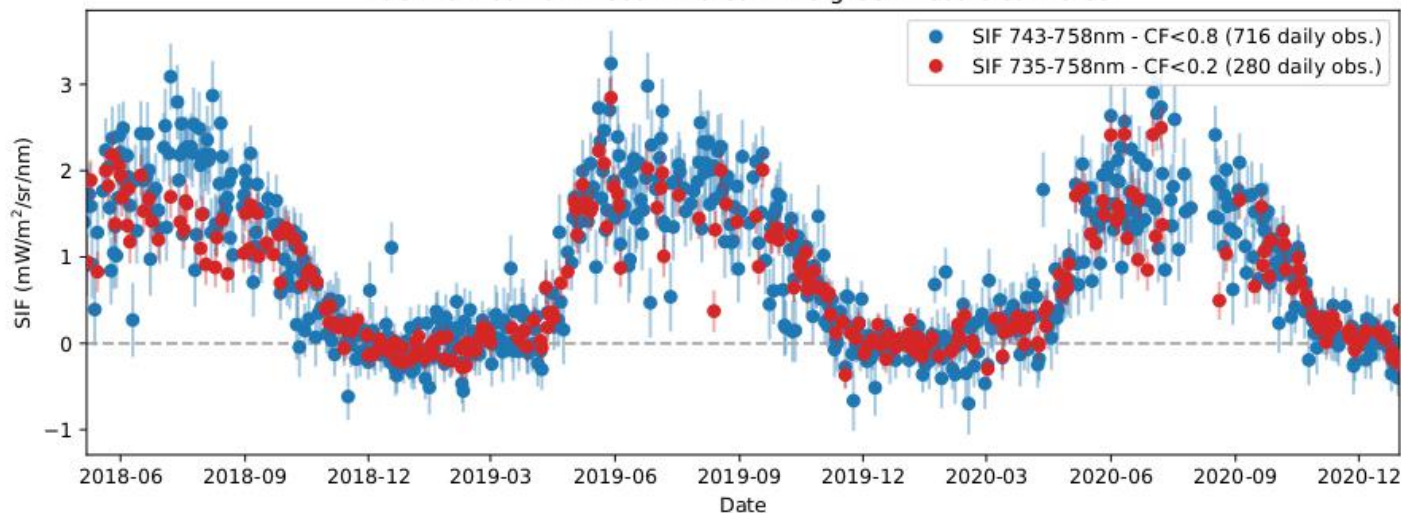
Guanter et al. ESSD, 2021

TROPOSIF time series (updated May 2018 - April 2021)

Coles Field - USA - Crop (corn)



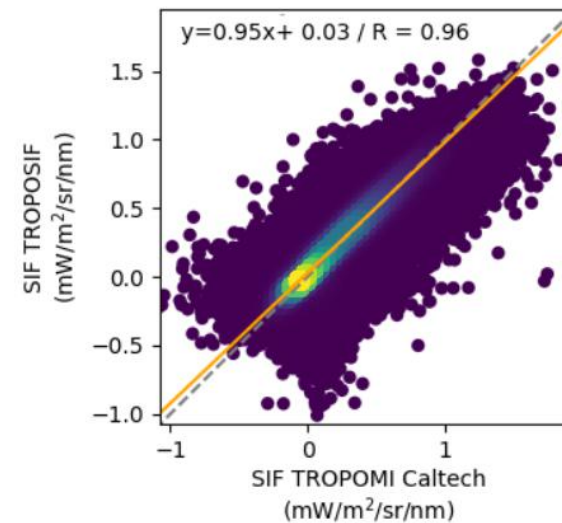
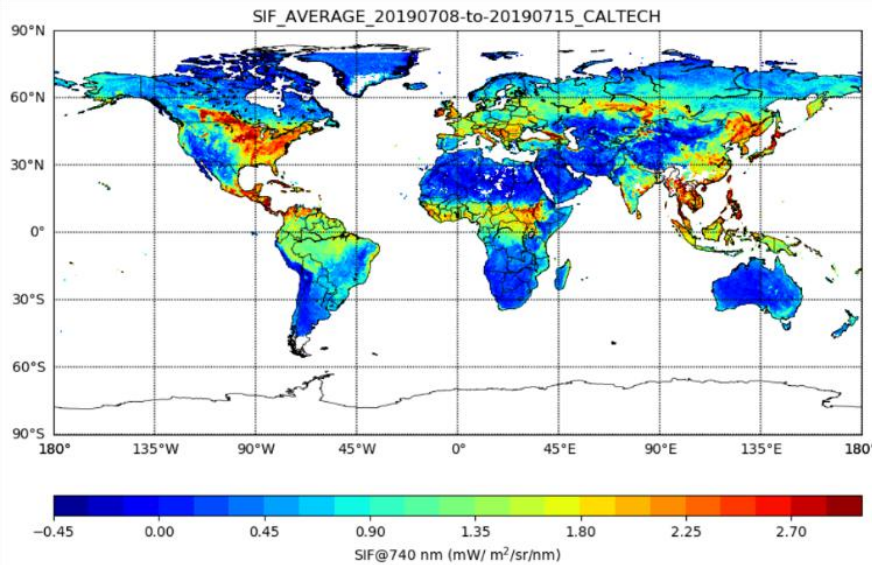
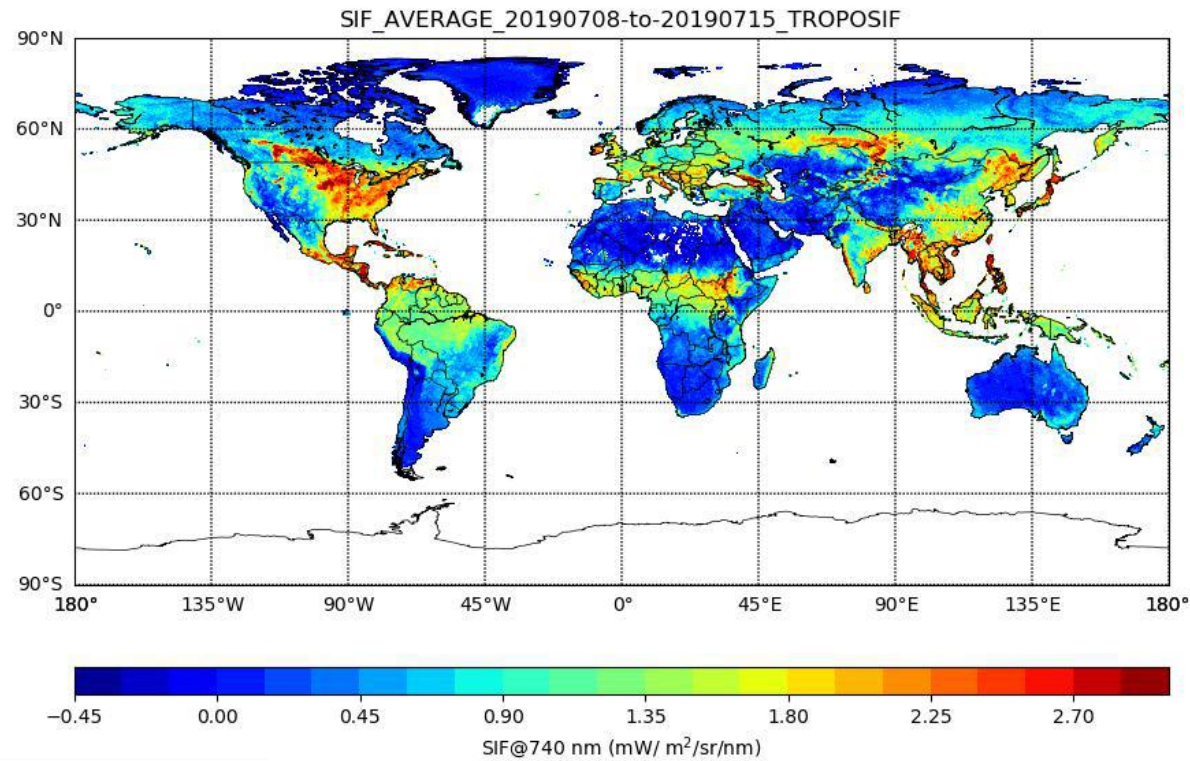
Taehwa Mountain - South Korea - Evergreen Needleleaf Forest



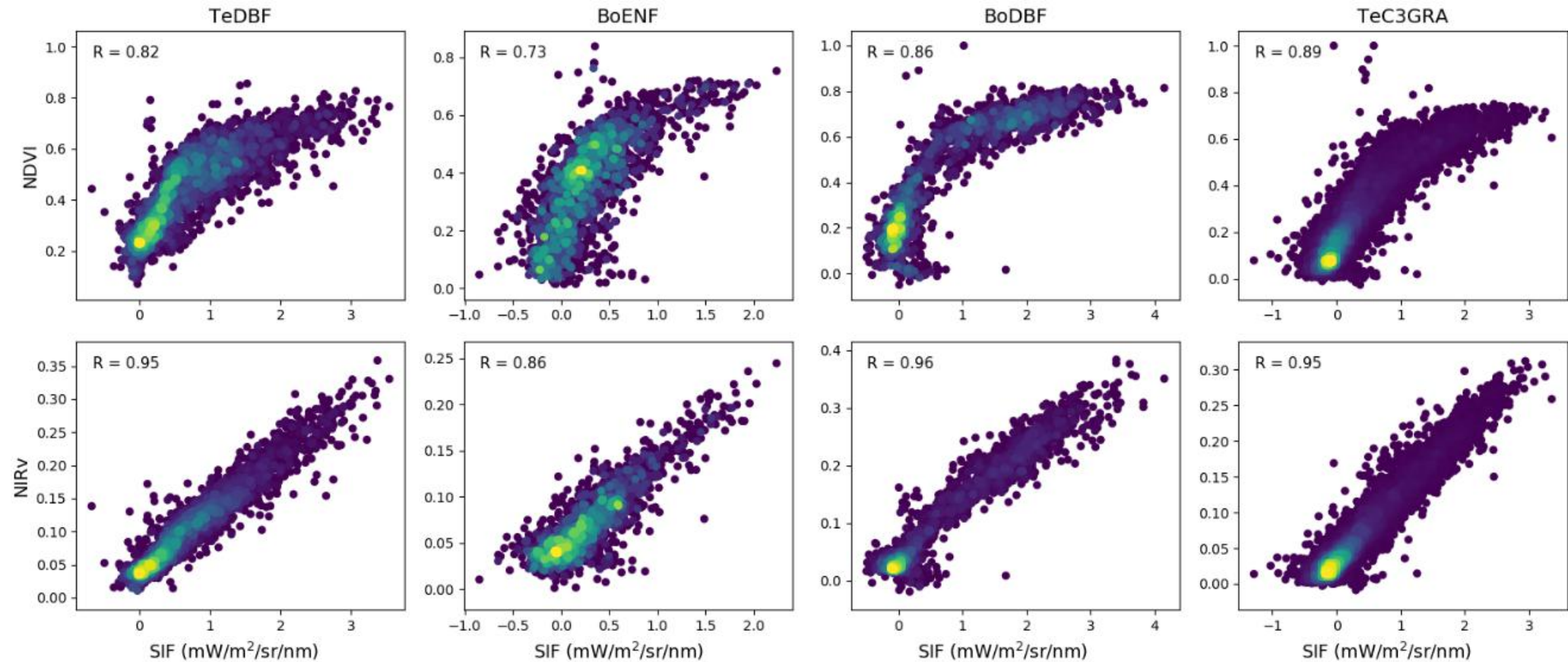
Validation:

Comparison with the Caltech SIF product

Very good comparison with the Caltech-TROPOMI product for both spatial patterns and range of SIF values



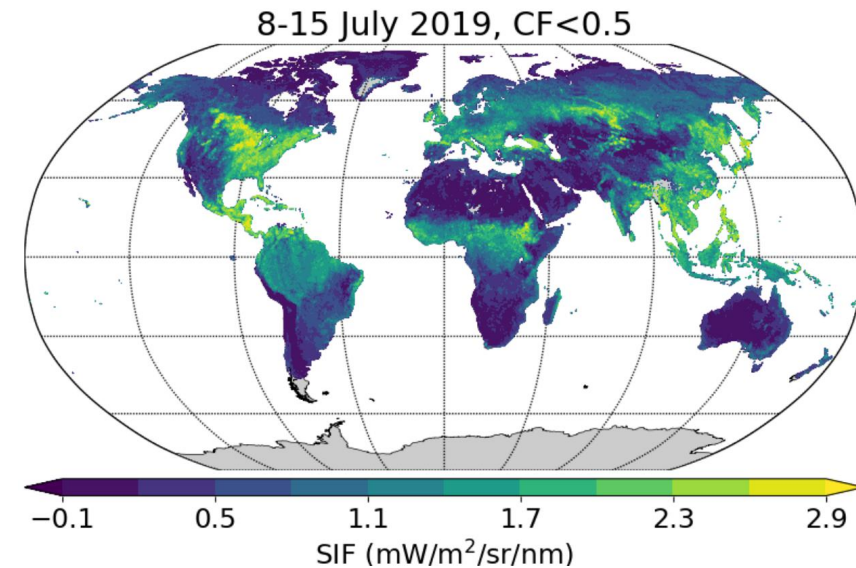
Comparison of TROPOMI-based SIF and VIs



- ❖ Reflectance spectra from TROPISIF used to calculate spectral VIs - Per-biome comparisons show the expected higher linearity of SIF-NIRv wrt SIF-NDVI
- ❖ Spectral reflectance in the 675-785 nm region expected to be instrumental for the proper exploitation and interpretation of SIF data (e.g. normalization of canopy structure effects and estimation of SIF yield)

Take home messages

- S5P/TROPOMI is a great mission for global SIF monitoring
- A SIF & reflectance data set has been produced within ESA's S5P+ Innovation project TROPOSIF
- The joint exploitation of SIF and reflectance spectra from TROPOSIF expected to enhance the potential of SIF as a proxy for vegetation productivity



Data availability

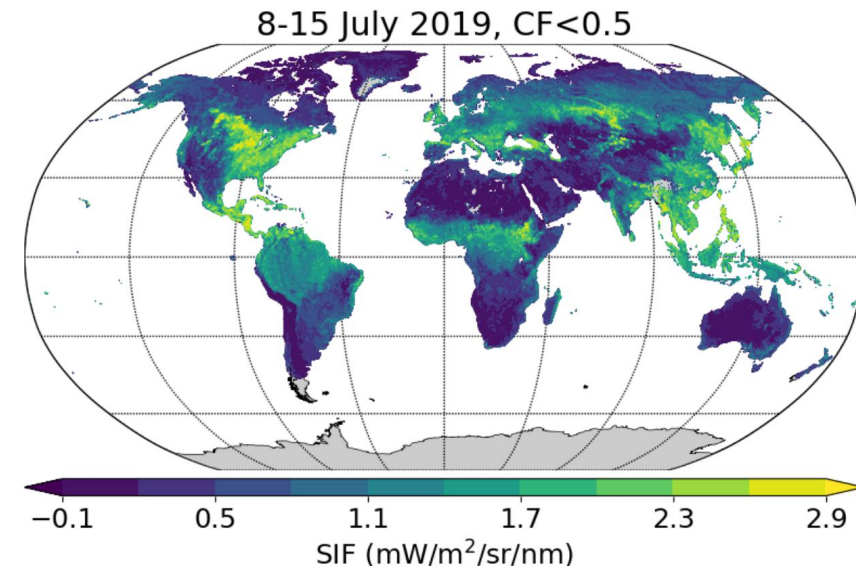
- Project web site: <https://s5p-troposif.noveltis.fr/>
- L2B data (for now): <ftp://ftp.sron.nl/open-access-data-2/TROPOMI/tropomi/sif/v2.0/l2b/>
- *The TROPOSIF product is expected to be generated and distributed to users by S5P-PAL in an operational manner in the near- future.*

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**Thank you for
your attention!**