SCOPE MODEL INVERSION FOR SENTINEL-3 DATA RETRIEVAL

S3.5
PLANT TRAITS AND BIOCHEMICAL CYCLES

ICEI 2018, Jena

TRUSTEE training

training on Remote Sensing for **Ecosystem** modelling

25.09.2017

ITC – University of Twente

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UNIVERSITY OF TWENTE. | BICOCCA | ITC | CSIC | FONDAZIONE EDMUND MACH | EXETER | vito | JÜLICH

Sentinel-3

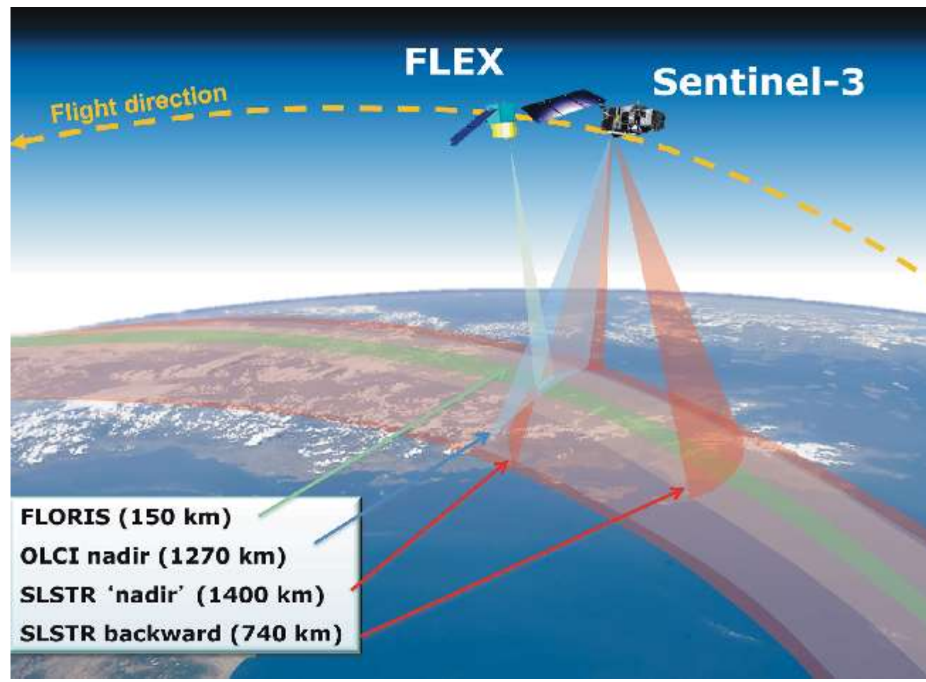
Sentinel-3 is waiting for…

2 instruments
> 30 bands
revisit time 1 day

spatial resolution 300-500m

http://www.esa.int/spaceinimages/Images/2016/01/Sentinel-3

The FLuorescence EXplorer Mission 2022



Drusch et al., 2017

User-available Sentinel-3 products (Level-2)

#	products	abbreviation
1	fAPAR	OGVI
2	chlorophylls	OTCI
3	reflectance @681, 865	RC681, RC865
4	water vapor	IWV
5	aerosols	AOD
6	surface temperature	LST, WST
7	fire radiative power	FRP

ESA uses a couple of bands to produce each product

Scientific question

Can we use all bands of Sentinel-3 to get more products?

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Following steps

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TRUSTEE training
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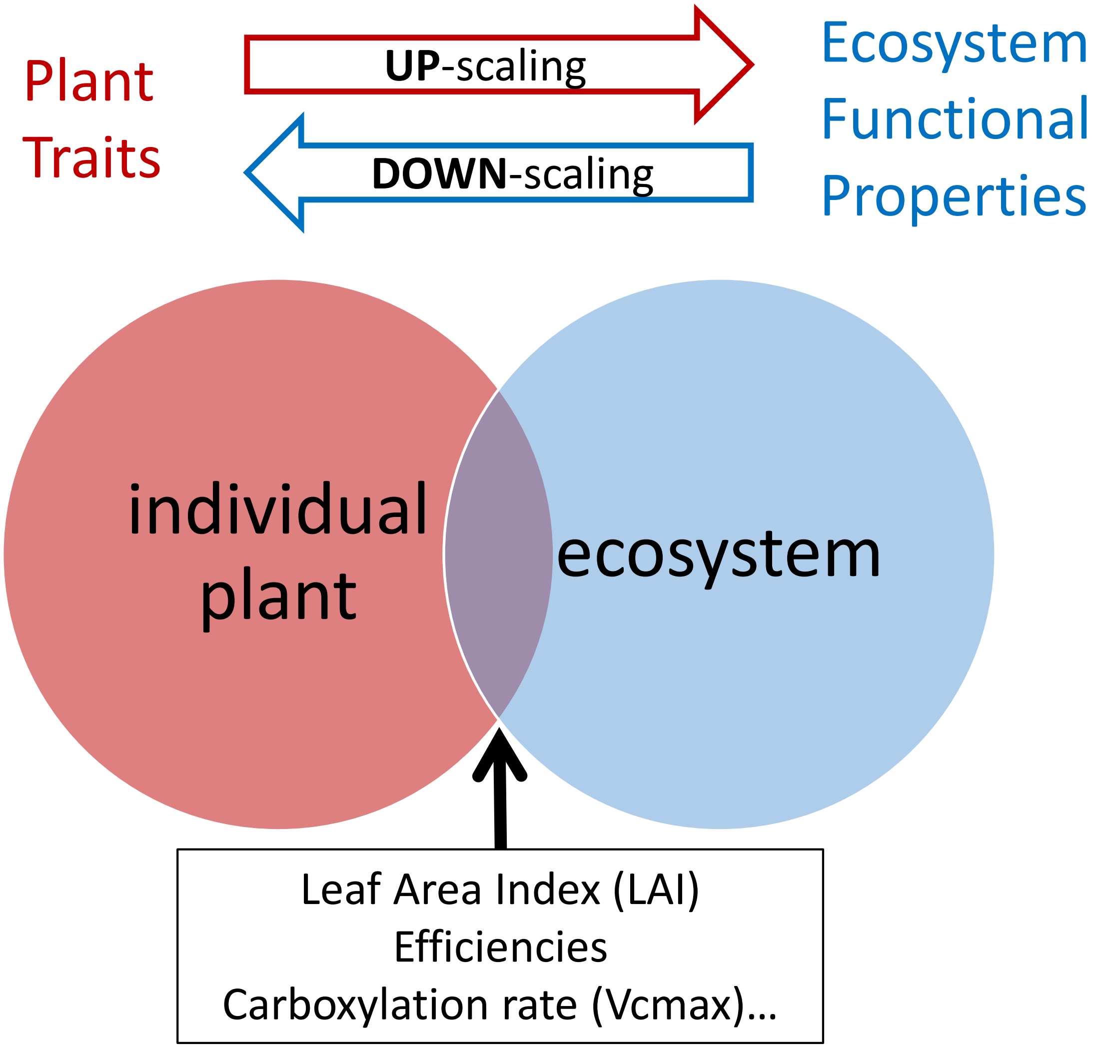

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Objectives

To test an algorithm for the retrieval of plant traits from Sentinel-3 data

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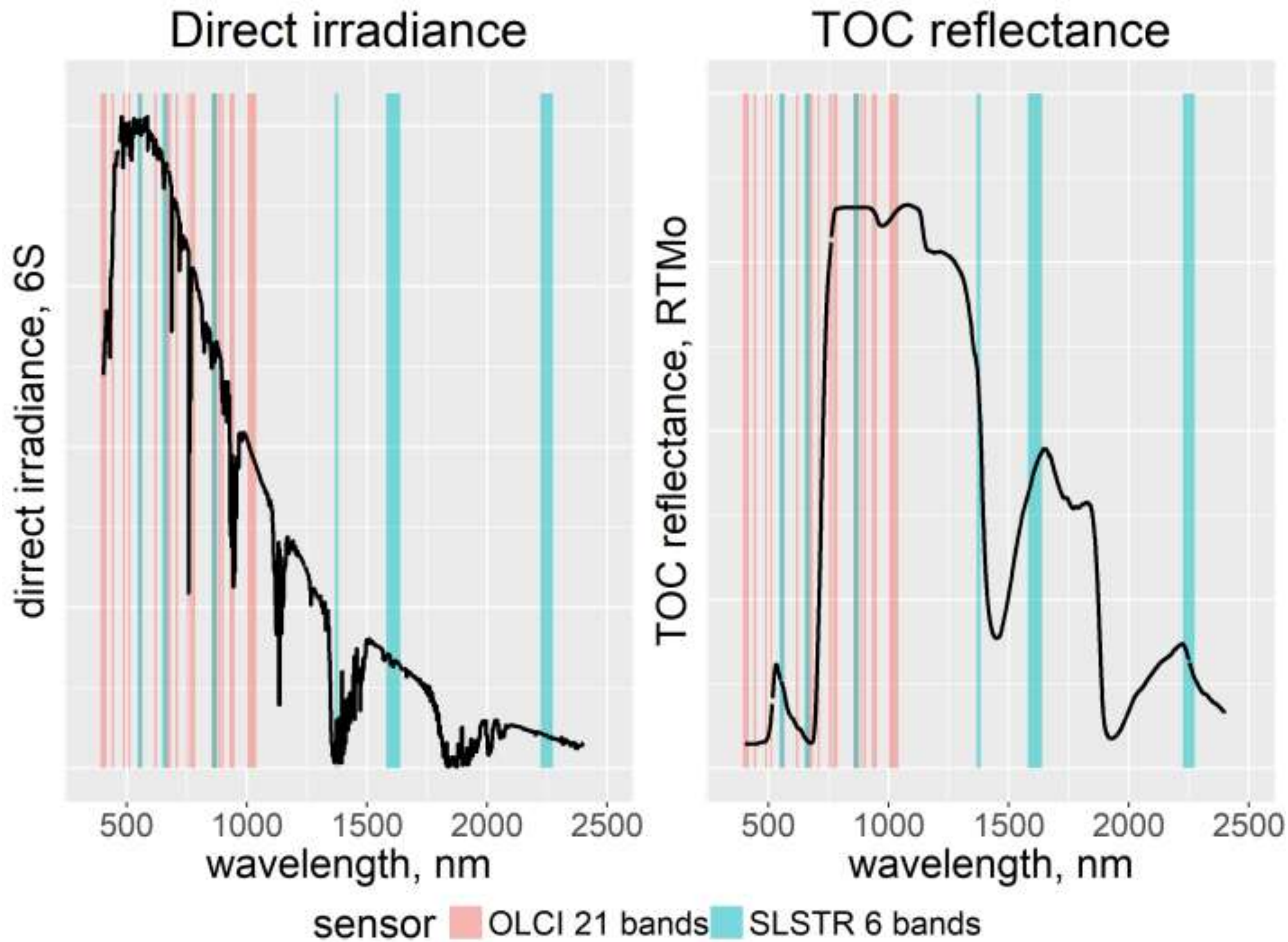
	Ocean and Land Colour Instrument	Sea and Land Surface Temperature Radiometer
abbreviation	OLCI	SLSTR
bands	21	9 x 2
spatial resolution	300m	500-1000m

http://www.esa.int/spaceinimages/Images/2016/01/Sentinel-3

Methods


Direct irradiance
direrct irradiance, 6S
wavelength, nm
500
1000
1500
2000
2500
TOC reflectance
TOC reflectance, RTMo
wavelength, nm
500
1000
1500
2000
2500
sensor
OLCI 21 bands
SLSTR 6 bands

S6 atmospheric model (Vermote et al., 1997)

Second Simulation of a Satellite Signal in the Solar Spectrum

Py6S (Wilson, 2013)

- Aerosols (aerosol profile)
  - the nearest weather station
- Atmospheric profile
  - “us standard 62”
- Water and Ozone
  - satellite products
- Geometry
  - satellite products

SCOPE model

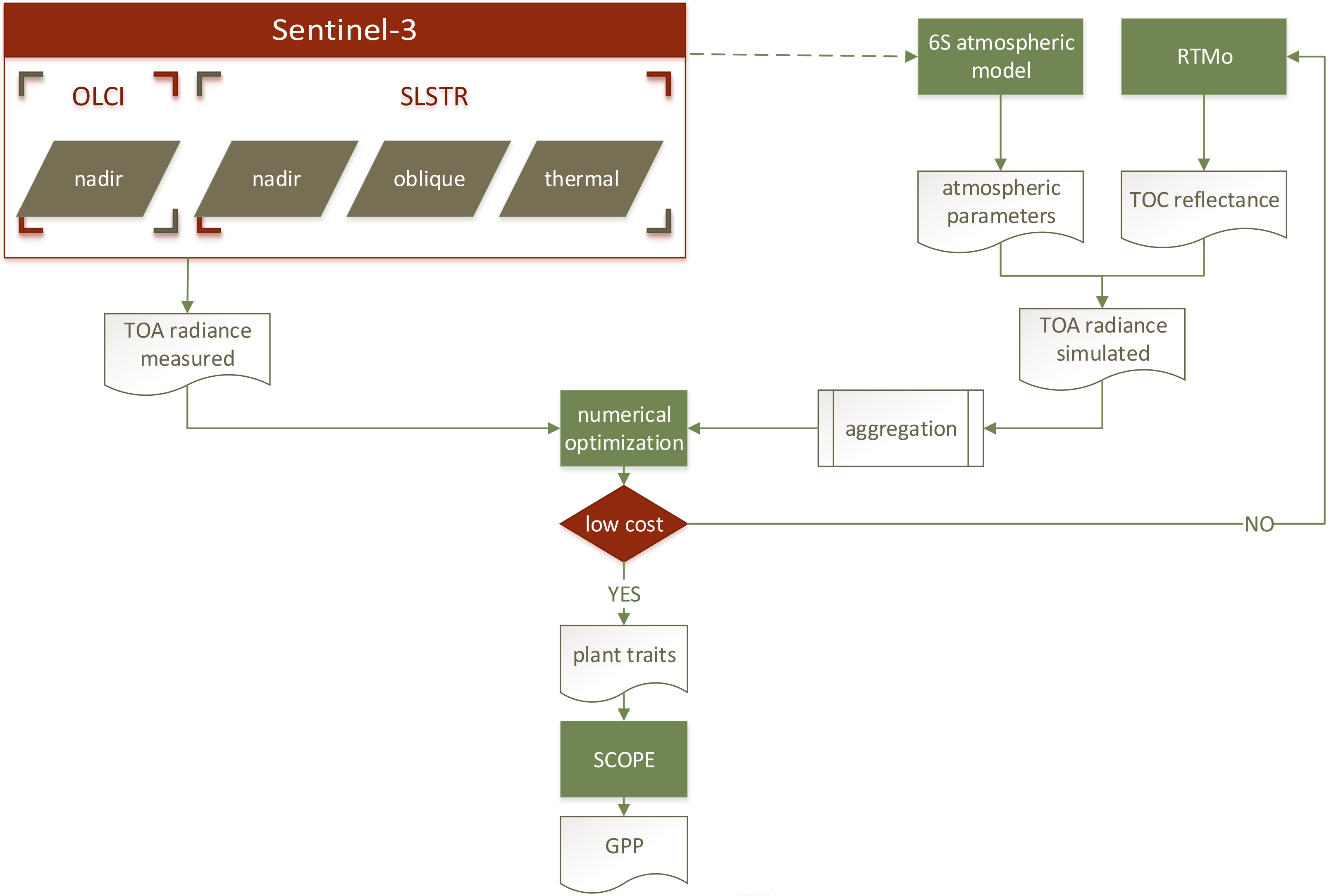
Soil
Canopy
Observation,
Photochemistry and
Energy fluxes
(Van der Tol et al., 2009)

Radiative
Transfer
Module
optical part –
RTMo –
Simulation of top of a
canopy reflectance

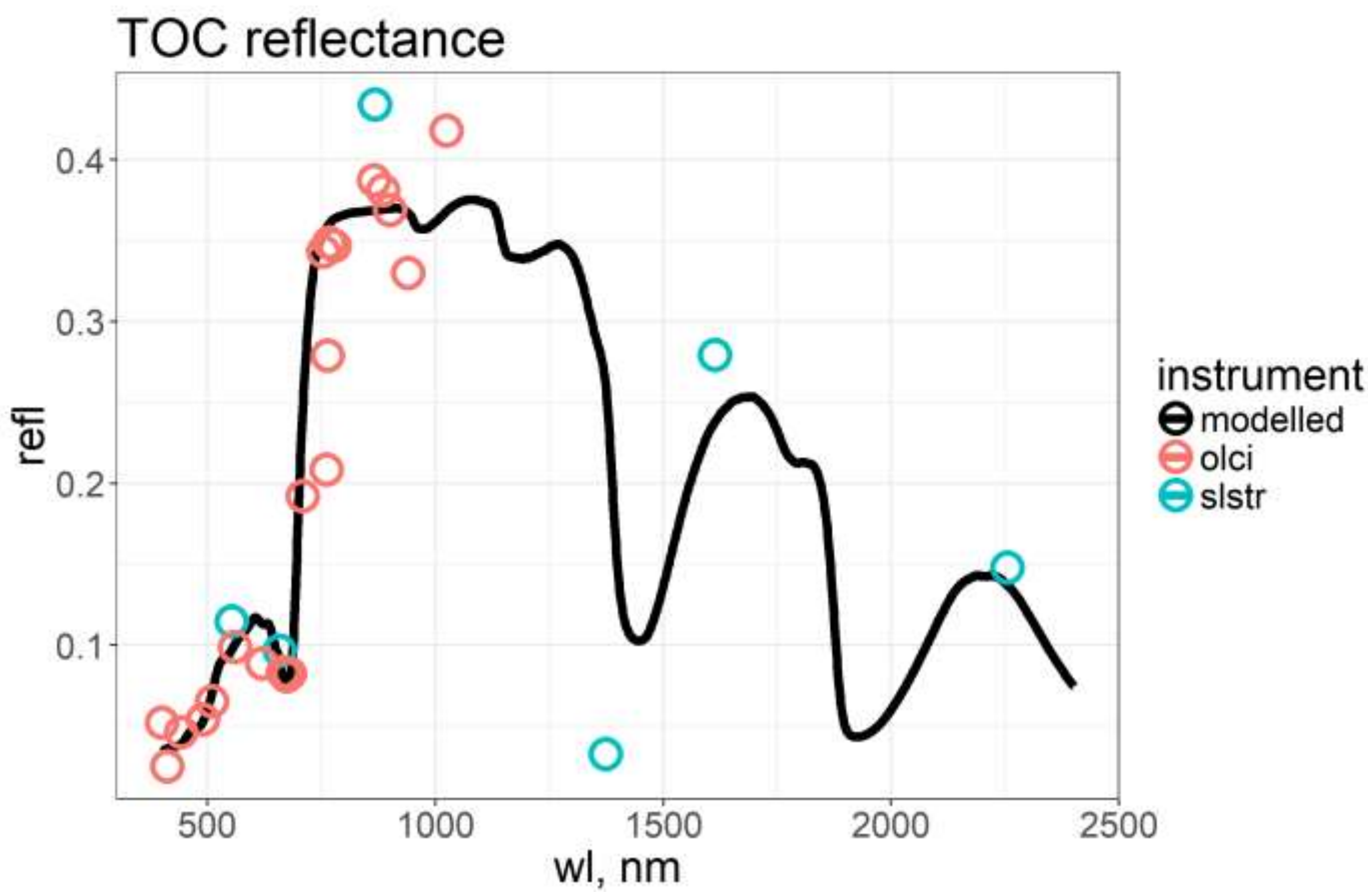
Parameter	Definition	Unit	Min	Max	Default
	Leaf traits				
Cab	Chlorophylls	µg cm^{-2}	0	100	40
Cca	Carotenoids	µg cm^{-2}	0	25	5
Cdm	Dry matter	g cm^{-2}	0	0.02	0.0012
Cw	Water thickness	cm	0	0.2	0.009
Cs	Senscent fraction	-	0	0.4	0
Cant	Antocyanins	µg cm^{-2}	0	40	1
N	Mesophyll structure	-	1	3.5	1.4
	Canopy traits				
LAI	Leaf area index	m^2 m^{-2}	0	7	3
hc	Canopy height	m	0.1	2	1
LIDFa	Leaf Inclination Distribution Function parameters	-	-1	1	0.35
LIDFb		-	-1	1	-0.15
leafwidth	Leaf width	m	0.01	0.1	0.1

retrieved parameters
fixed parameters

Methods


Sentinel-3
OLCI
SLSTR
nadir
nadir
oblique
thermal
6S atmospheric model
RTMo
atmospheric parameters
TOC reflectance
TOA radiance measured
TOA radiance simulated
numerical optimization
aggregation
low cost
NO
YES
plant traits
SCOPE
GPP

Example of a curve fitting



Study site – Majadas
(39.9415, -5.7734)

field data collection from 2009

tree-grass ecosystem

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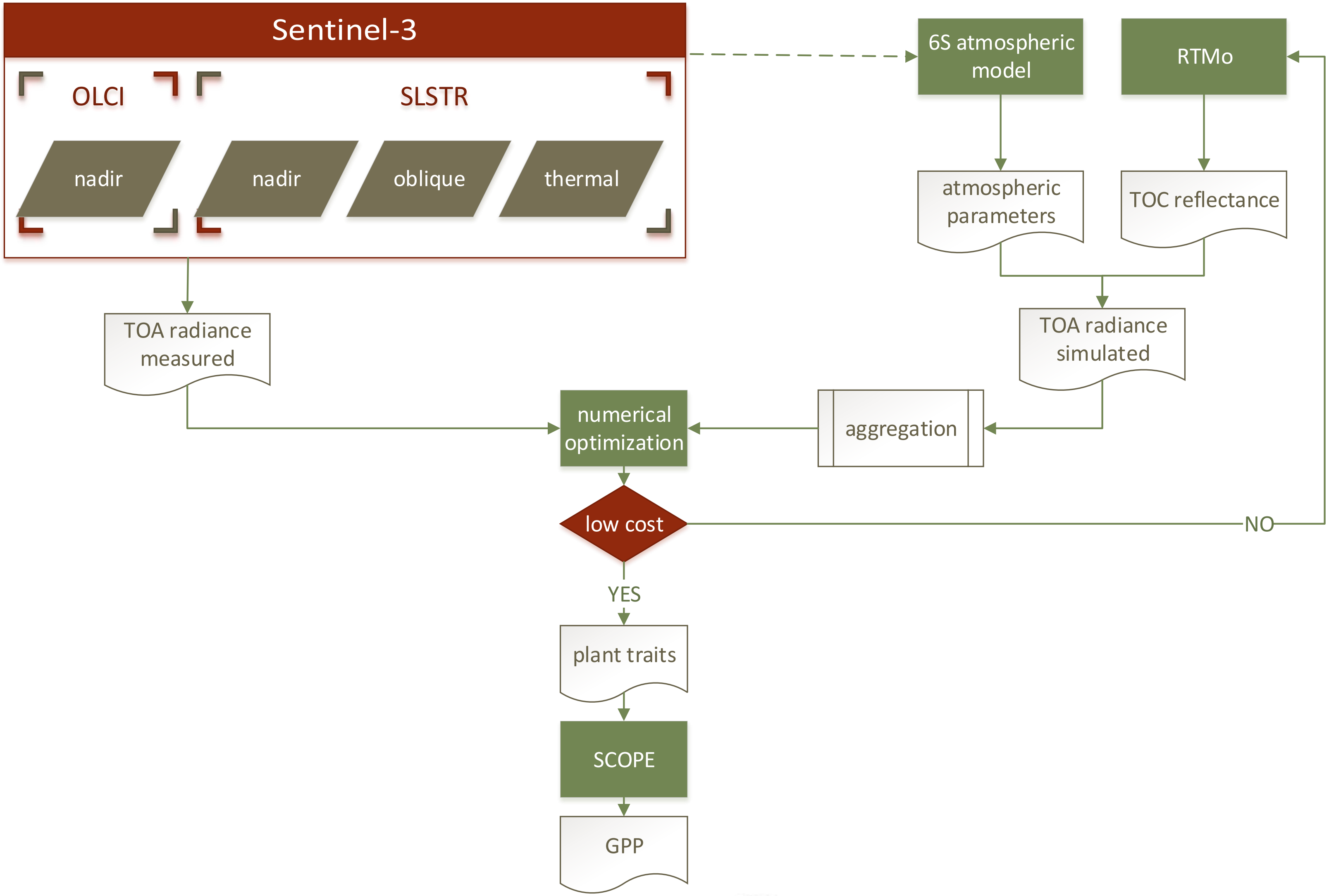
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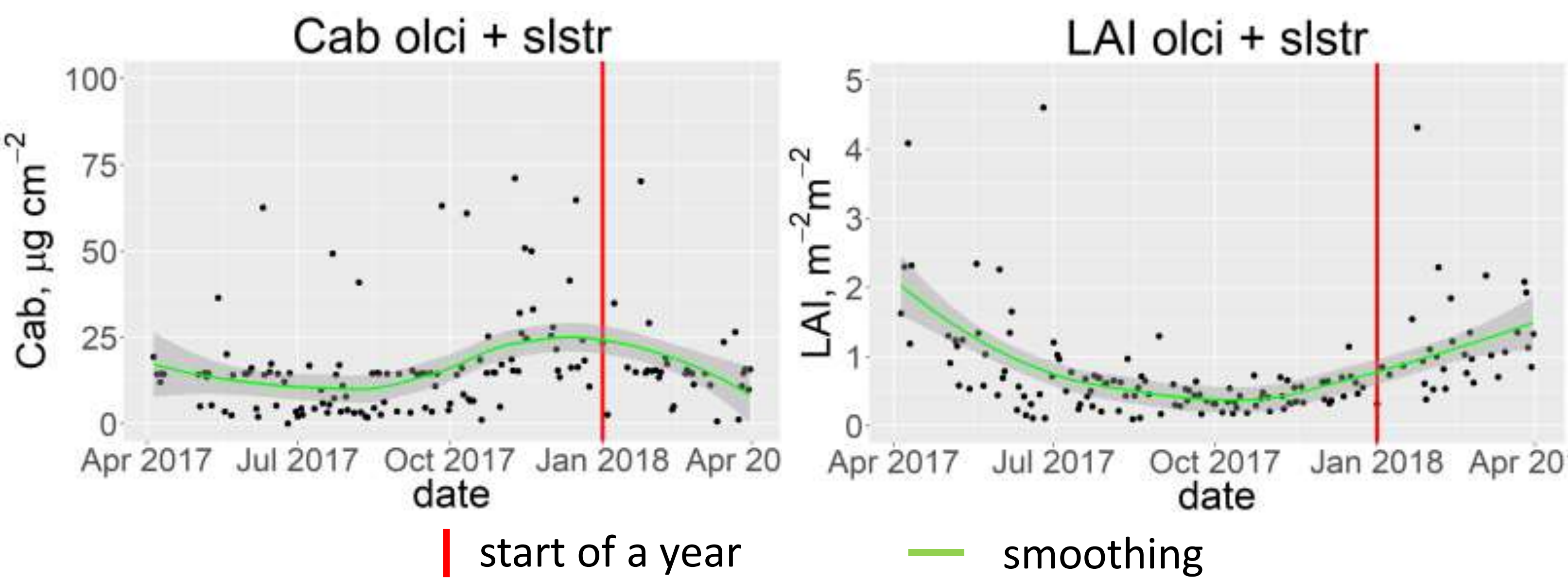
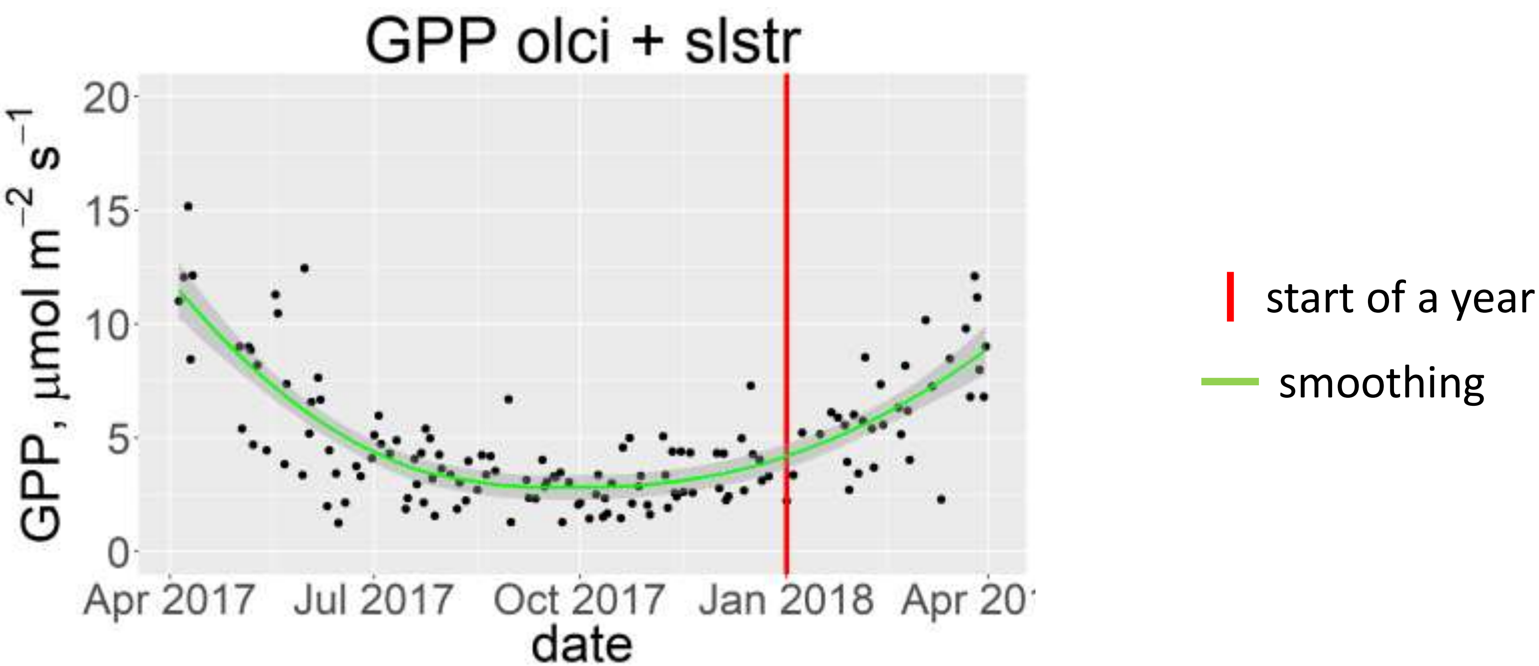
Results

Plant traits retrieved from a collection of Sentinel-3 images over Majadas site with the RTMo module of the SCOPE model from April 2017 to April 2018

instrument	# pixels	not measured	clouded	valid pixels	exceptions	high NRMSE	fitted pixels
OLCI + SLSTR	214	12	42	168	9	13	146



Gross Primary Productivity (GPP) calculated in a forward simulation of the SCOPE model with the parameters retrieved from Sentinel-3 images from April 2017 to April 2018



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Future steps

1. Validation with ground measurements of:
    - atmospheric correction with 6S model
    - retrieved plant traits (chlorophylls, LAI)
    - simulated ecosystem property (GPP)
2. Improve of the retrieval algorithm
    - addition of “close to the previous” constraint
    - look-up table approach
3. What is the uncertainty of our retrieval?
4. Shall we use higher resolution of the Sentinel-2 satellite (20-60m)?

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https://pixabay.com/p-49909/?no_redirect

TRUSTEE project
www.trusteenetwork.eu

Training on remote sensing for ecosystem modelling

- 12 PhD students
  1. identification of plant traits and ecosystem functional properties
  2. assessment of photosynthetic activity by fluorescence
  3. integration of multisource remote sensing data into ecosystem models
  4. upscaling: plant traits -> ecosystem functional properties

Merci!

Спасибо!

Danke!

¡Gracias!

Thank you!

شكريه

Ευχαριστώ!

Bedankt!

Grazie!

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