Paving the road to FLEX and BIOMASS: The esa Land Surface Carbon Constellation study

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IGARSS 2022

The land surface carbón constellation project

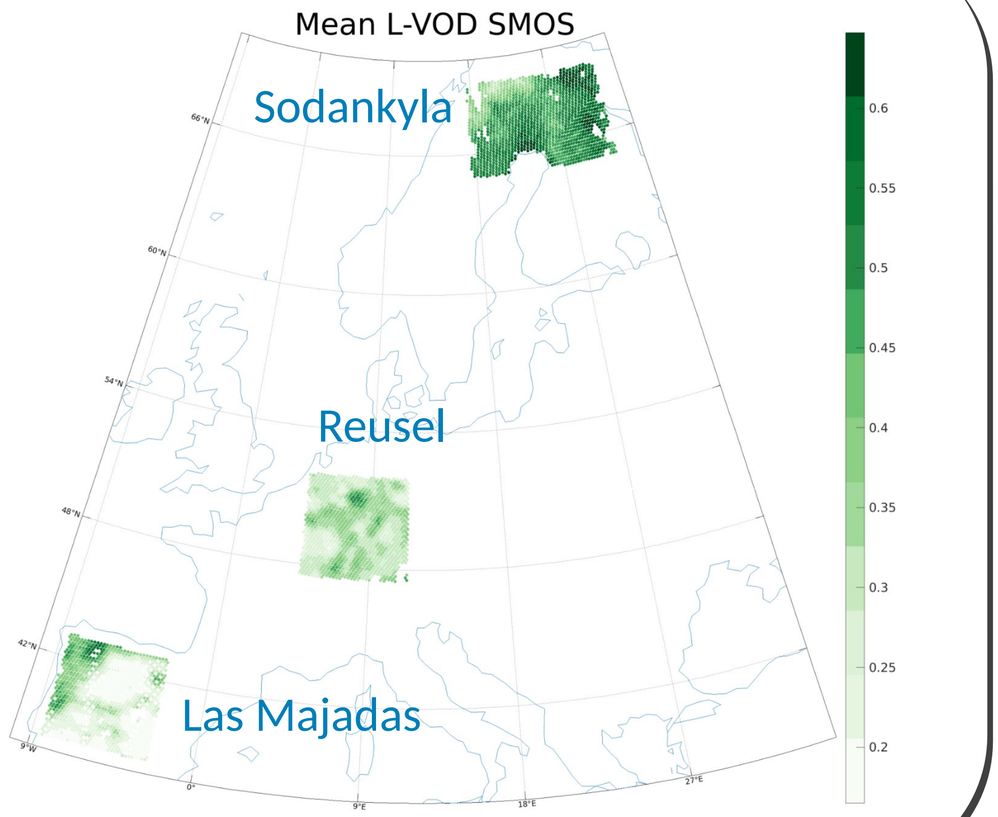
Objectives:

- Investigate the terrestrial biosphere's net ecosystem exchange
- Photosynthetic CO_2 uptake minus respiratory CO_2 release
- Response to climatic drivers

Means :

- Process-based model
- Wide range of observations (in-situ and remotely sensed)

Led by Lund University (M. Scholze)
Follow-up to the SMOS+Vegetation project



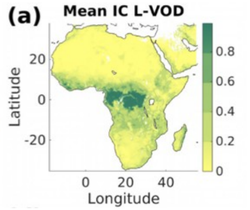
This presentation concerns mainly the Earth observation data

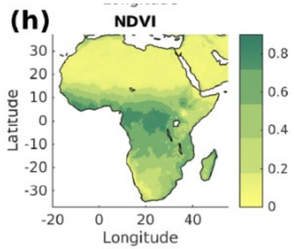
High sensitivity of L-VOD to AGB

SMOS + Veg
esa stse
support to science element

2011-2012 average

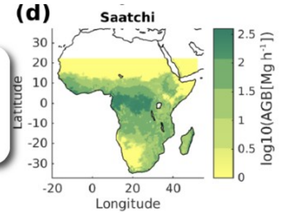
SMOS L-VOD
INRA-CESBIO (IC)
Fernandez-Moran et al.,
Rem. Sensing 2017

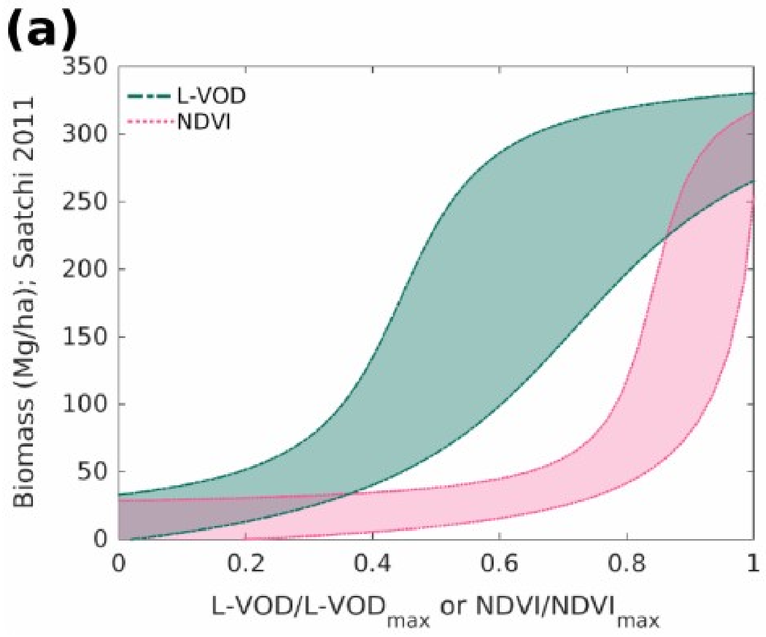


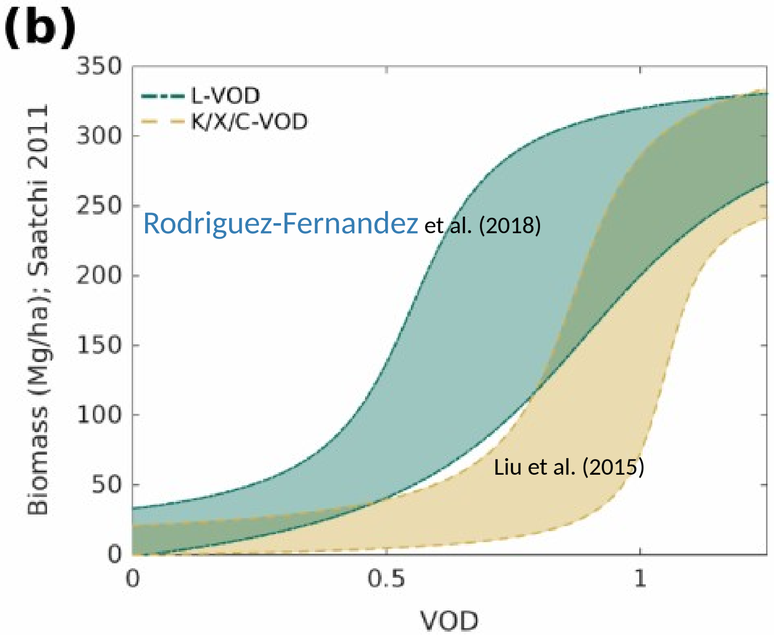


MODIS

Lidar, C-band SAR, in situ plots
Circa 2000



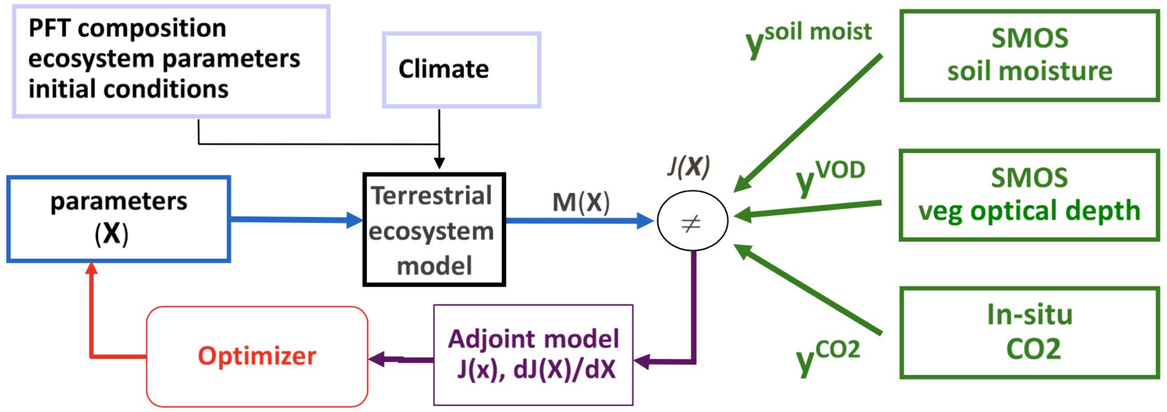




Rodriguez-Fernandez et al. (2018, Biogeosciences)

$$AGB = \frac{a}{(1 + exp(-b\,(vod - c)))} + d,$$

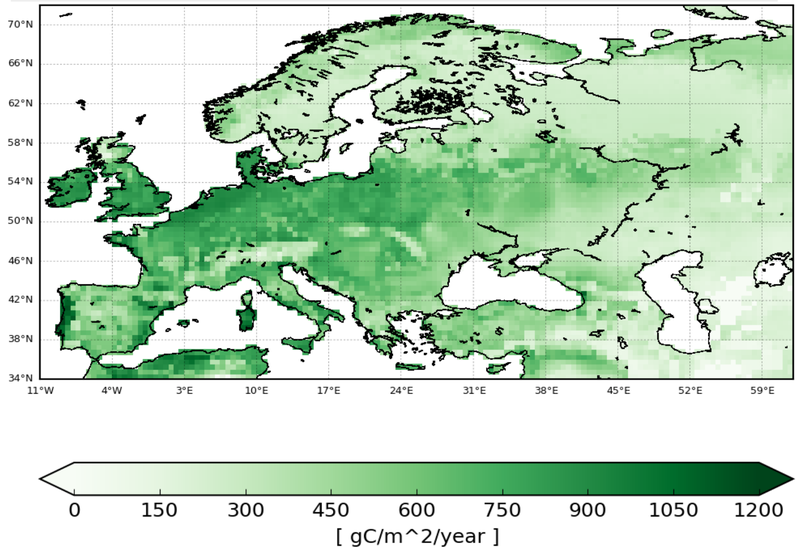
L-VOD data assimilation



BETHY, Knorr, 2000

European carbon sink of 0.303 ± 0.083 Gt C/yr for 2010–2015

Average Annual Mean NPP 2010-2015



Scholze et al., GRL, 2019

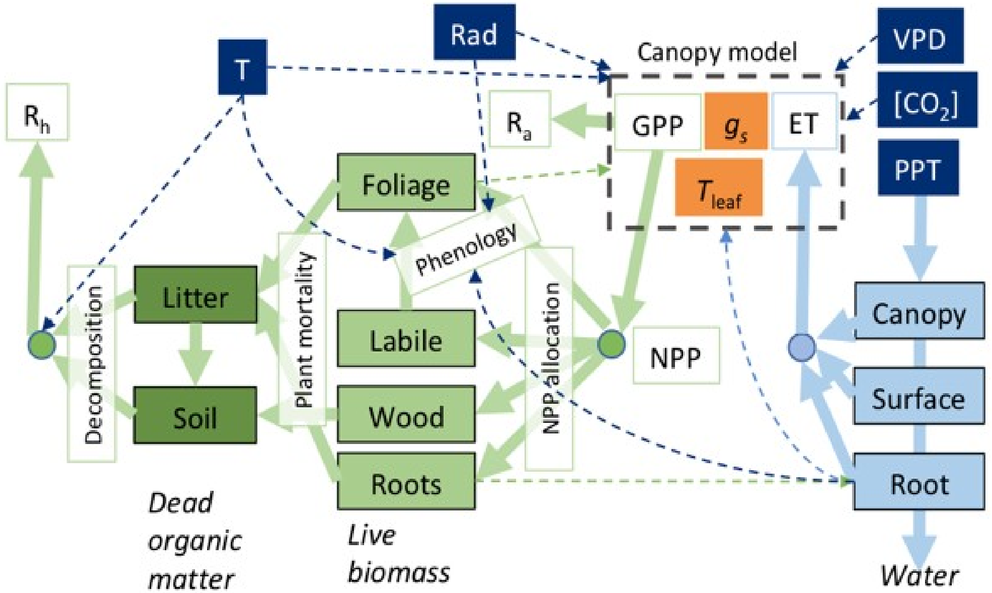
SMOS+Veg Study Team, Scholze, M., & Kaminski, T. (2019). BETHY global Net Ecosystem Production (NEP) maps at 0.25 degr resolution for the period 2010-2015 (1.0) [Data set]. SMOS+Veg Study Team. https://doi.org/10.18160/YD1G-4TRQ

https://meta.icos-cp.eu/objects/D_v0gdeP4LUkkkBDf3L8GfaZ

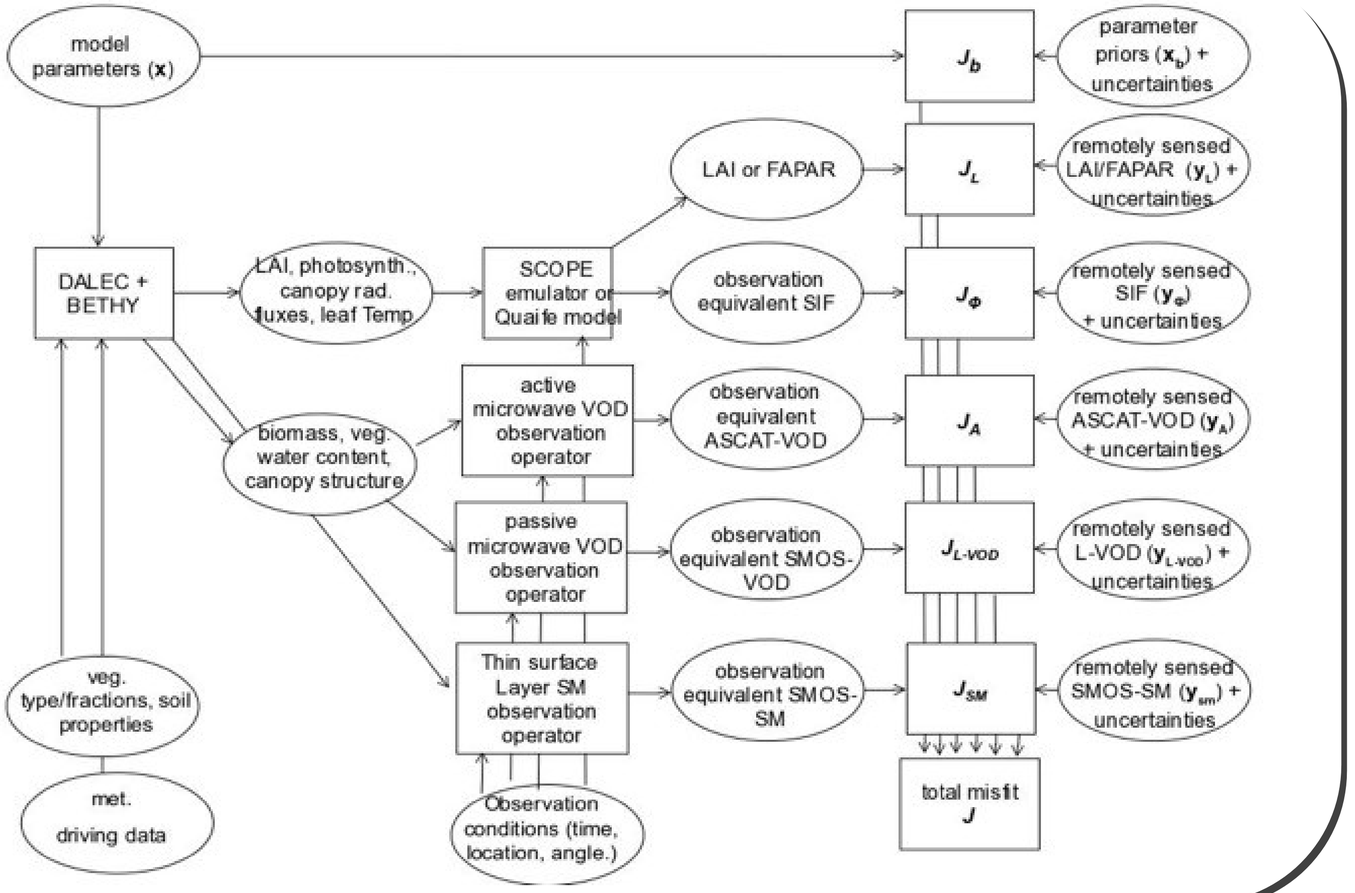
LCC: Community land surface model and data assimilation

DALEC + BETHY

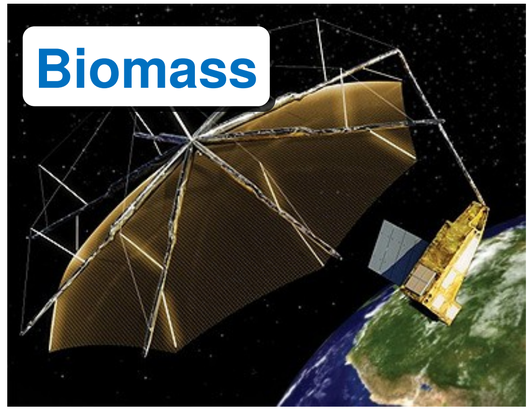
Williams et al., 2005 Knorr, 2000

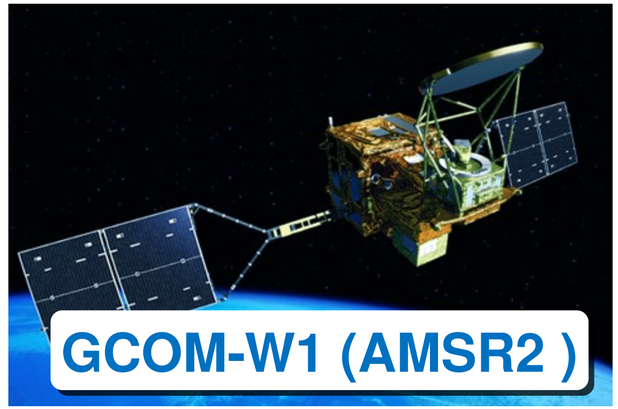


Data assimilation strategy



Present and future Earth Observation data

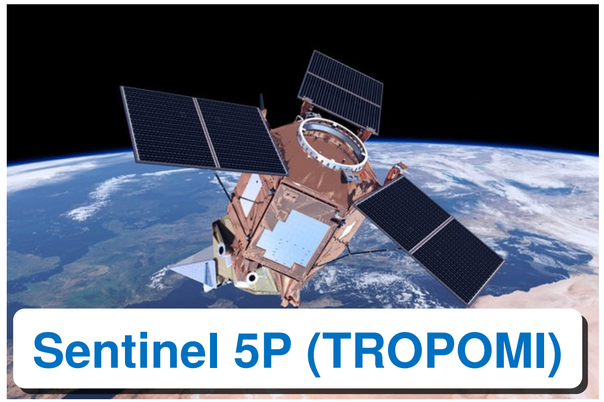




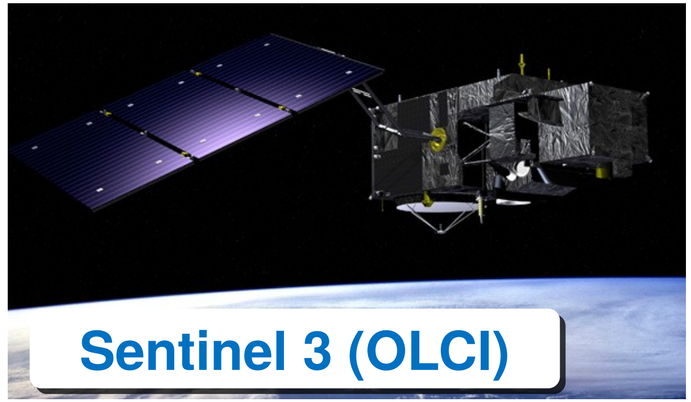
C, X, K-band vegetation optical depth

Soil Moisture and L-VOD (Vegetation optical depth)
Kerr et al., 2012

Slope of the backscattering versus the incidence angle
Vreugdenhil et al., 2017

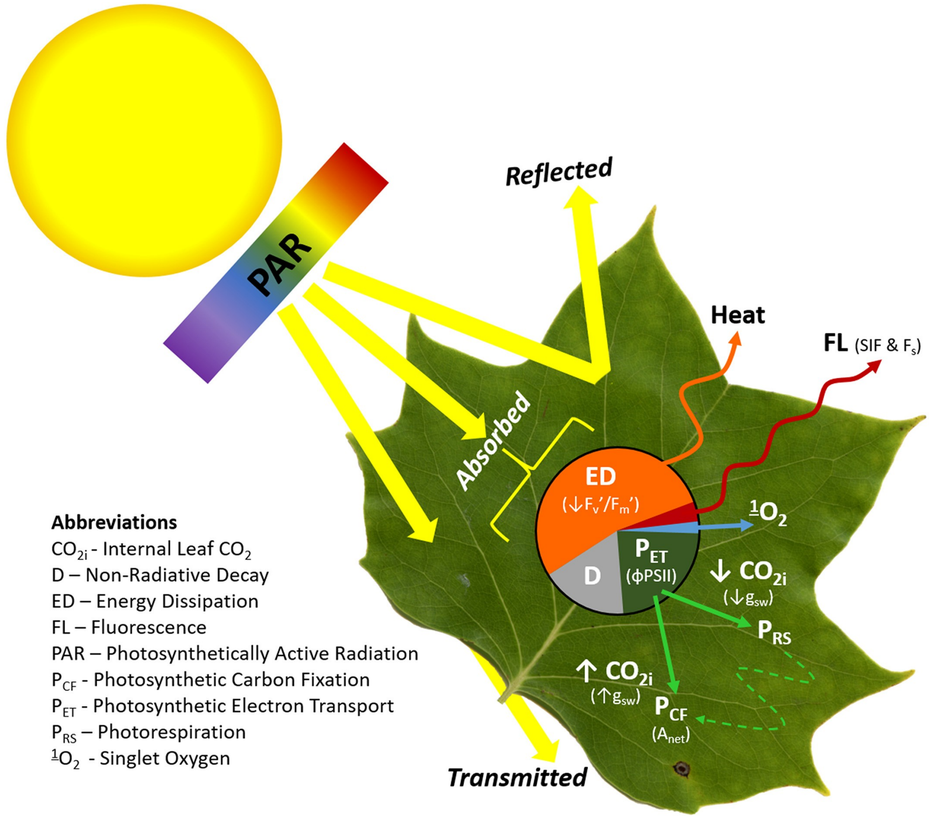


Solar induced fluorescence
ESA TROPOSIF project
Guanter et al., 2021



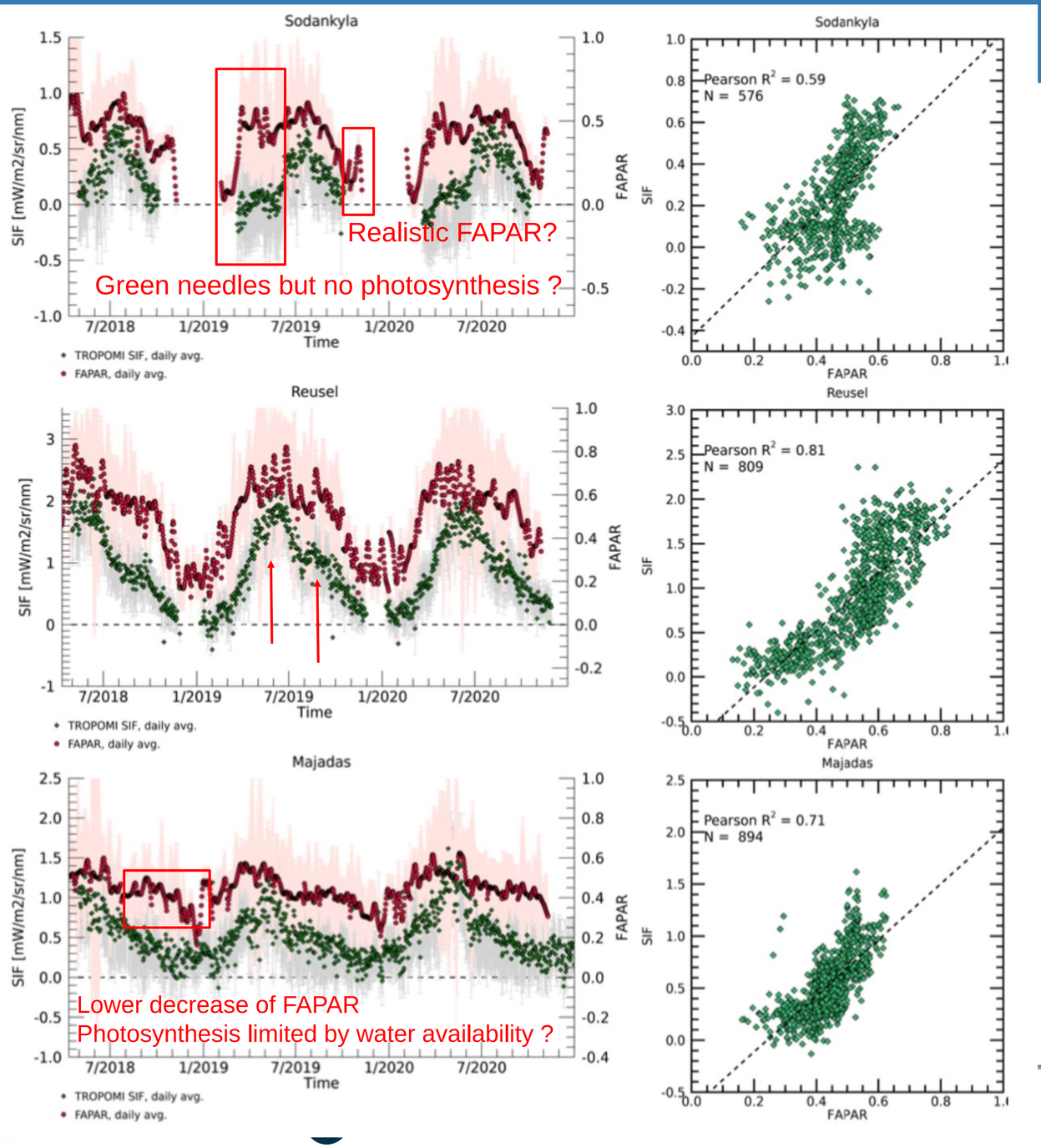
FAPAR, LAI
Reyes-Muñoz et al., 2022

FaPAR and SIF



Abbreviations
CO_{2i} - Internal Leaf CO_2
D – Non-Radiative Decay
ED – Energy Dissipation
FL – Fluorescence
PAR – Photosynthetically Active Radiation
P_{CF} - Photosynthetic Carbon Fixation
P_{ET} - Photosynthetic Electron Transport
P_{RS} – Photorespiration
$^1O_2$ - Singlet Oxygen

Marrs et al. 2020, GRL



Microwaves and vegetation water content

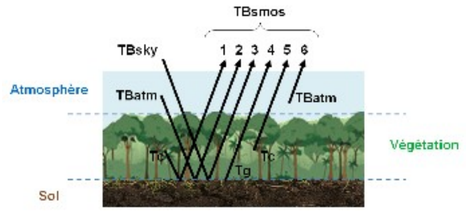
- **Passive microwaves sensors measure the thermal emission from the Earth, which at these frequencies depends mainly of soil moisture and temperature**
- **The radiation is affected by the vegetation water content and structure creating a vegetation optical depth (VOD)**

- **Active microwaves sensors measure the backscattering of the radiation emitted by a coherent source**
- **The radiation is affected by soil roughness, moisture and scattering by water molecules in the vegetation**
- **The slope of the backscattering versus incidence angle depends on the vegetation status**

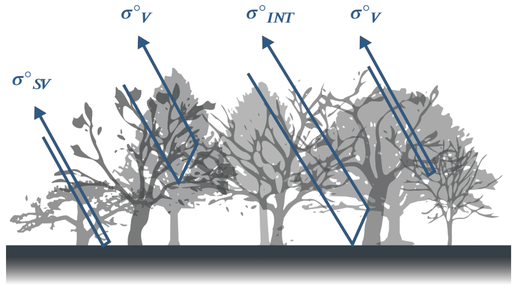
The Vegetation Optical Depth (τ), is frequency dependent

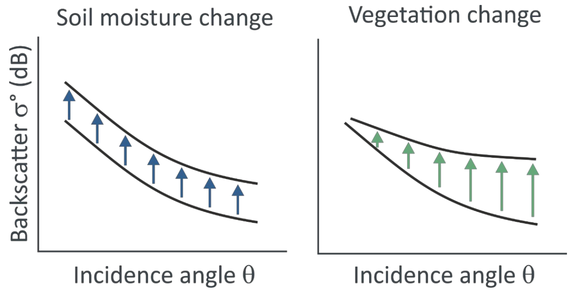
X band λ= 3 cm | L band λ= 21 cm | P band λ= 70 cm | VHF λ>3 m

©Biomass, Thuy Le Toan



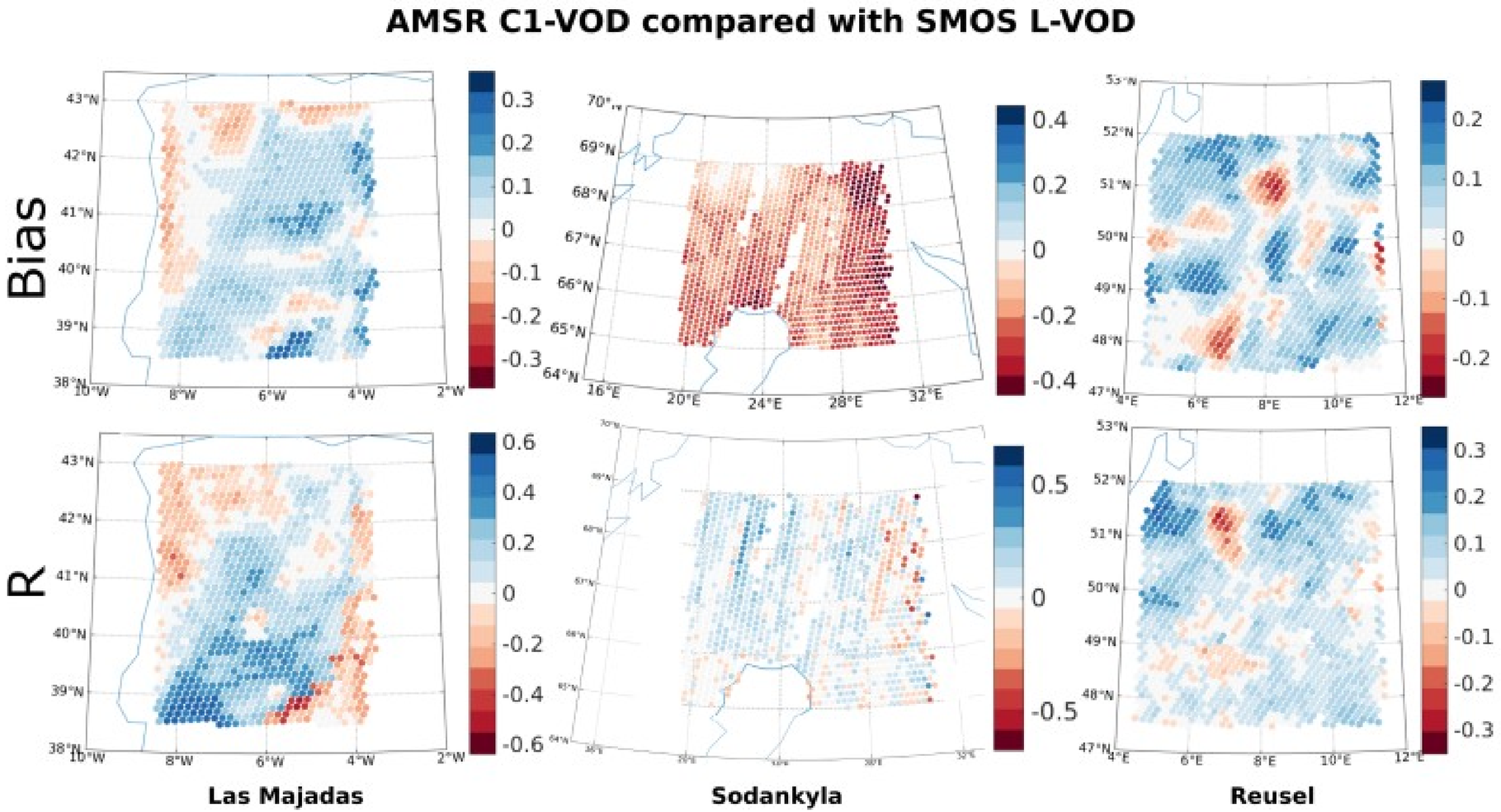
Kerr et al. (2012. TGARS)





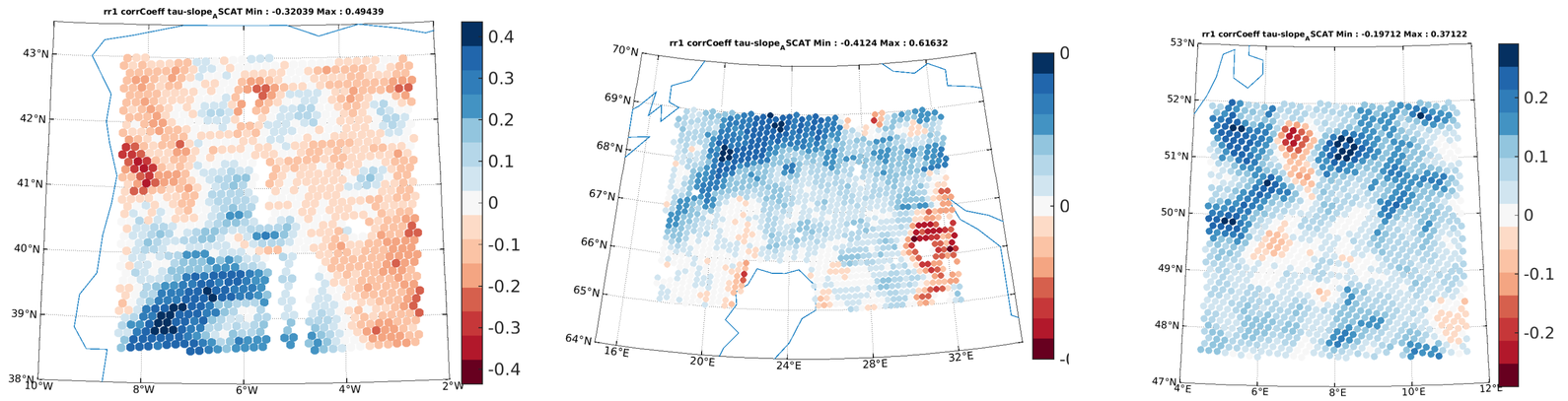
Vreugdenhil et al. 2017

Cross comparison : ASMR2-C1 vs SMOS VOD

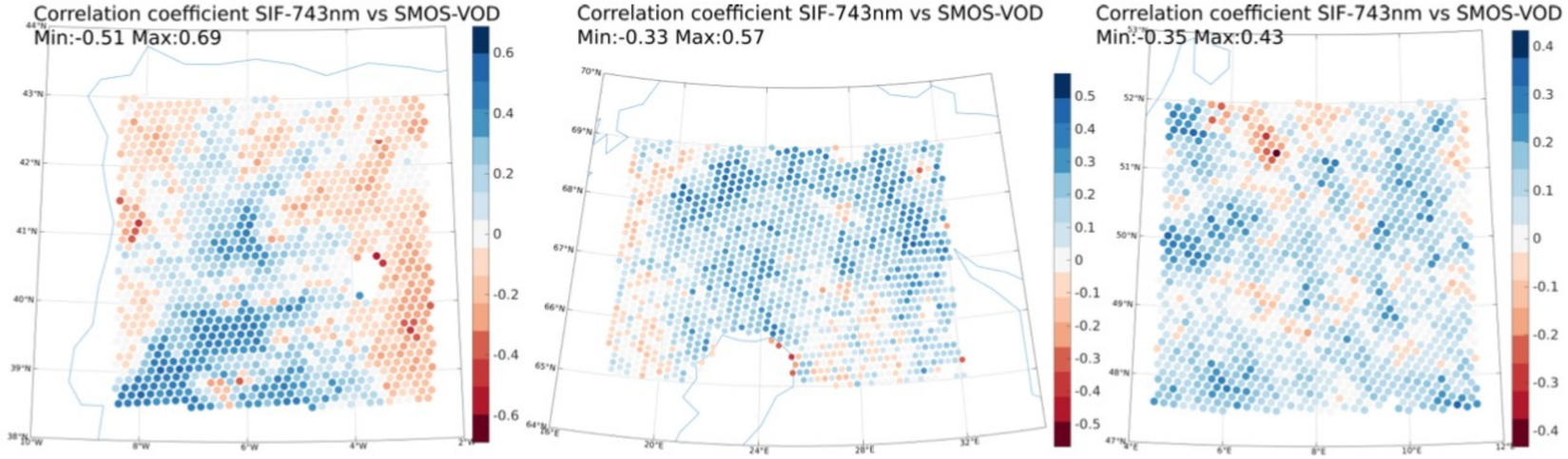


Active microwaves and SIF correlation wrt L-VOD

Correlation: ASCAT slope vs L-VOD

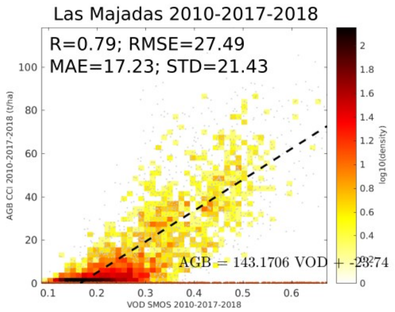


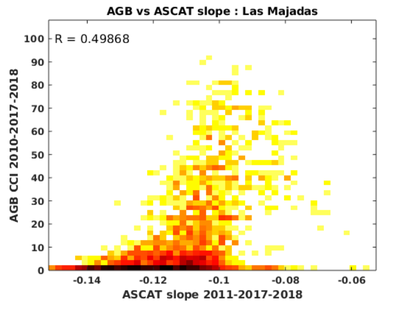
Correlation: SIF vs L-VOD



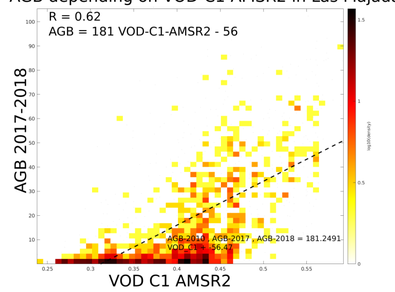
Microwave data versus ESA CCI Above Ground Biomass

Spain

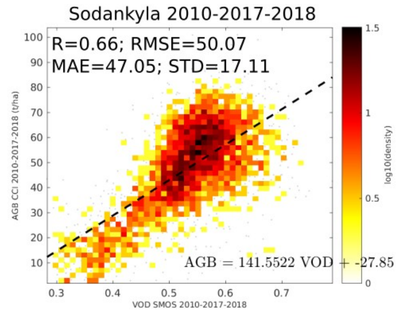


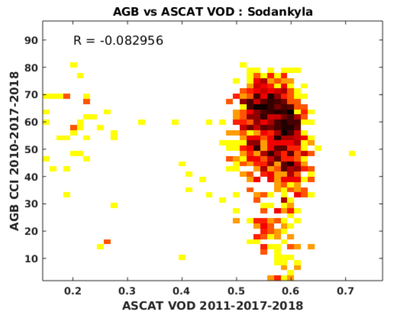


AGB depending on VOD-C1-AMSR2 in Las Majadas

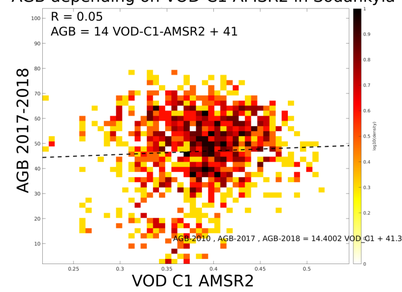


Finland

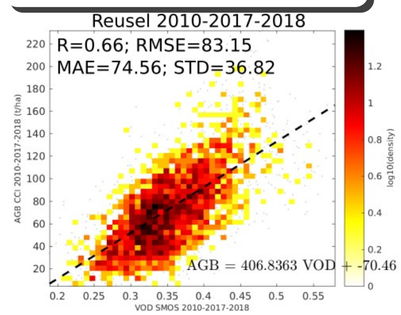


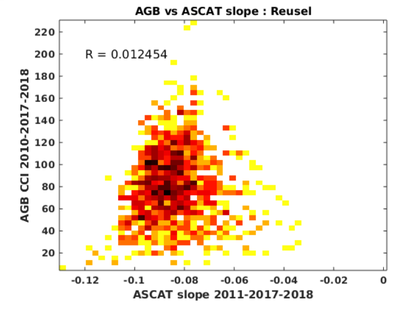


AGB depending on VOD-C1-AMSR2 in Sodankyla

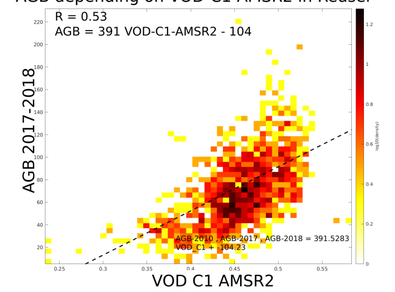


Netherlands





AGB depending on VOD-C1-AMSR2 in Reusel



AGB vs SMOS L-VOD

AGB vs ASCAT slope

AGB vs AMSR2 C1-VOD

Summary

- **The ESA LCC project goal is to constrain the terrestrial biosphere's net ecosystem exchange by data assimilation into a new model (DALEC+BETHY) using in situ measurements (not discussed here) and remote sensing data**
- **The observational data study is on-going. The first results confirm the complementarity of :**
- Passive microwave data vegetation optical depth giving information on vegetation water content (and biomass in the case of SMOS L-VOD)
- FAPAR and SIF related to photosynthesis
- Active microwave (ASCAT backscattering slope) seems to be more related to optical indices (backscattering from the leaves)

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