Role of Satellite Observations for Constraining the Terrestrial Carbon Cycle

Land surface Carbon Constellation Team:

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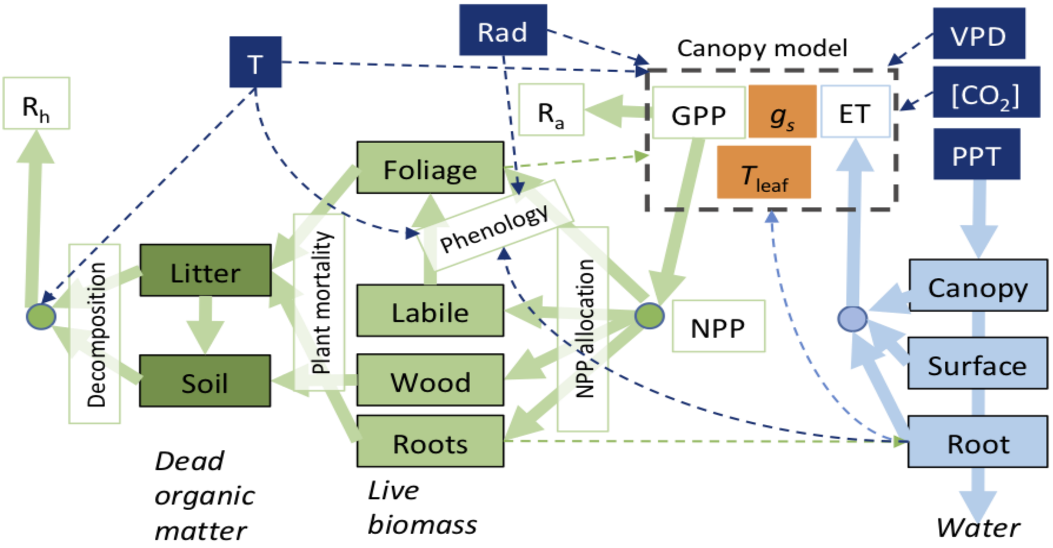
Land Carbon Constellation

DALEC + BETHY



Fast and slow carbon pools

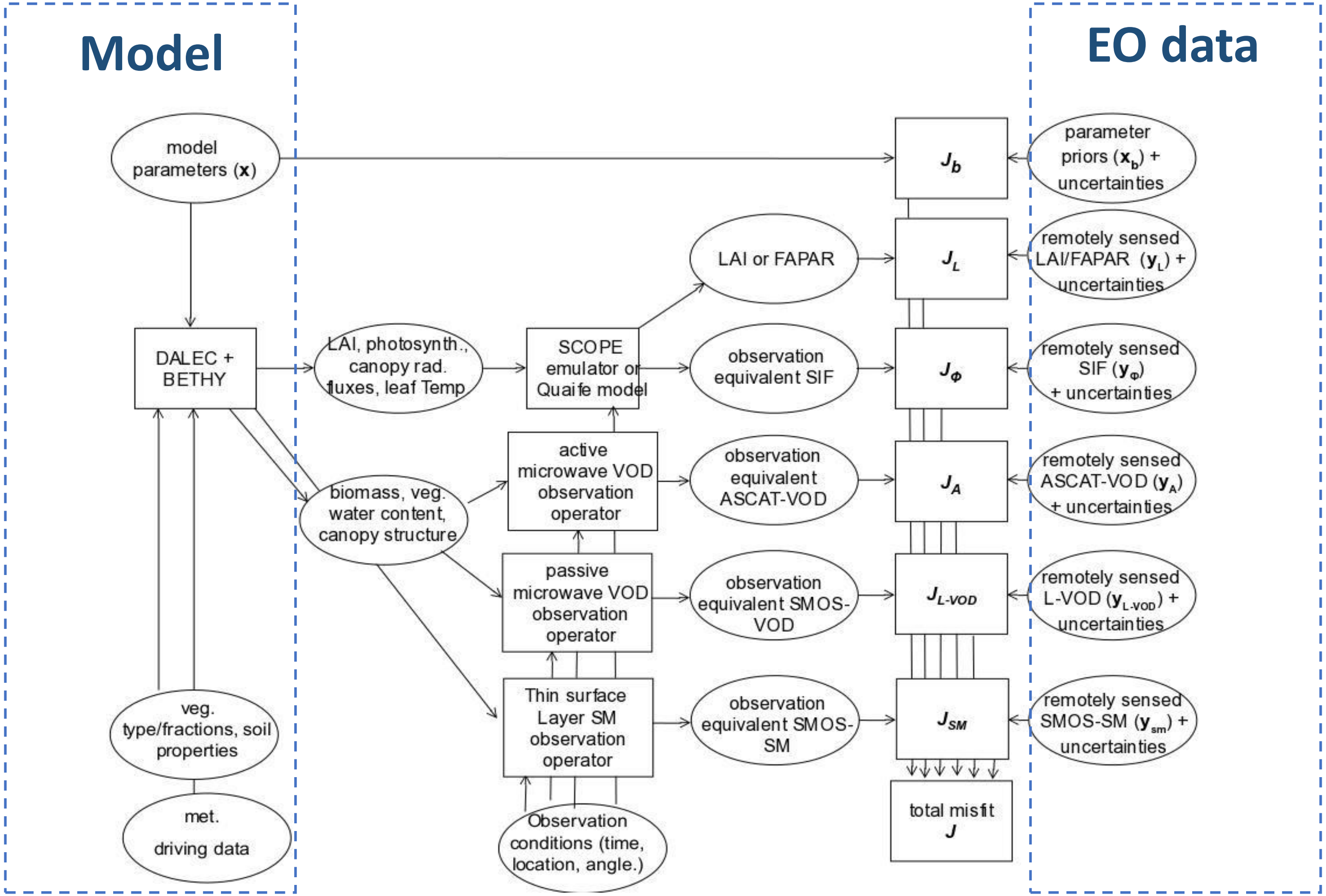
Water & Carbon coupling

Observe multiple perspectives:

- Energy
- Photosynthesis
- Water/Biomass

DALEC + BETHY: Williams et al., 2005; Knorr, 2000

Assimilation Framework

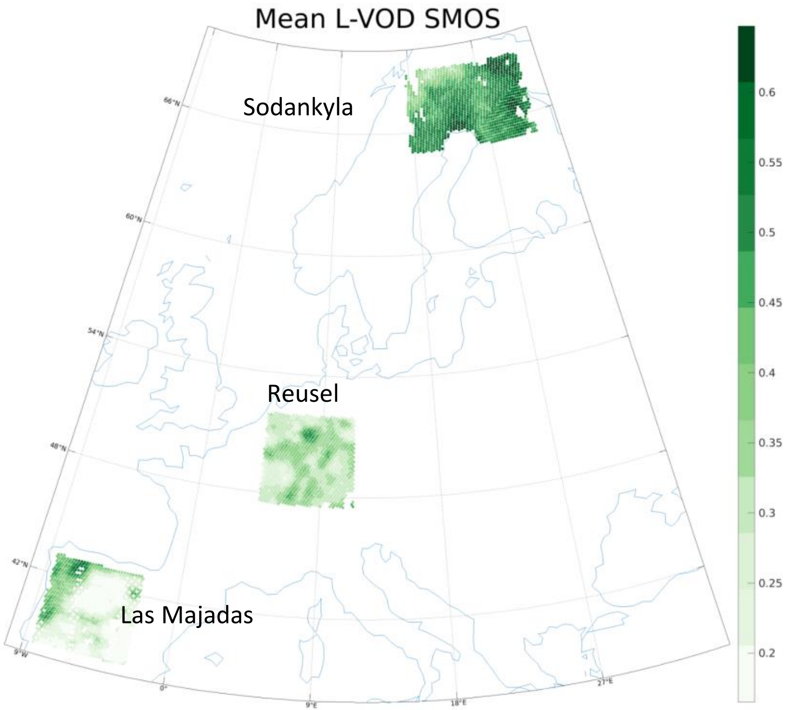


EO Database

Data products

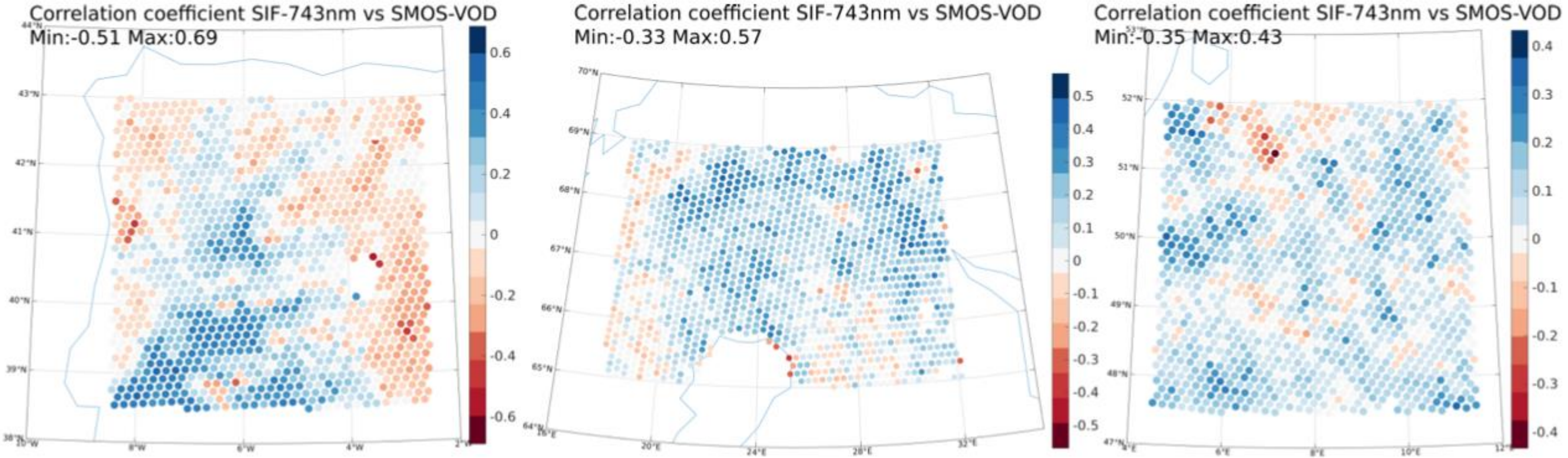
Variable(s)	Dataset	Period
Vegetation Optical Depth	SMOS L-VOD	01/2011 - 12/2021
Vegetation Optical Depth	ASCAT C-VOD	01/2011 - 12/2021
Slope	ASCAT Slope	01/2011 - 12/2021
Solar Induced Chlorophyll Fluorescence	Sentinel 5P	05/2018 - 10/2021
Fraction of absorbed Photosynthetic Active Radiation, Leaf Area Index	Sentinel 3 FAPAR/LAI	04/2016 - 12/2021
Soil moisture	SMOS SM	01/2011 - 12/2021
Solar Induced Chlorophyll Fluorescence	OCO-2 SIF	09/2014 - 10/2021
Backscatter	ASCAT	01/2011 - 12/2021
Brightness temperature	SMOS TB	01/2011 - 12/2021
Vegetation Optical Depth	AMSR-2 VOD	11/2012 - 12/2021
Vegetation Optical Depth	SMOS-IC L-VOD	01/2010 - 12/2016
Soil moisture	SMOS-IC SM	01/2010 - 12/2016
Land Surface Temperature	MODIS LST	01/2011 - 12/2021
Photochemical Reflectance Index	MODIS PRI	01/2011 - 12/2021
Leaf Chlorophyll Content	Sentinel 3 LCC	04/2016 - 12/2021
Fraction of Vegetation Cover	Sentinel 3 FVC	04/2016 - 12/2021
Above Ground Biomass	Globbiomass/CCI	2010, 2017, 2018

3 Regions of Interest

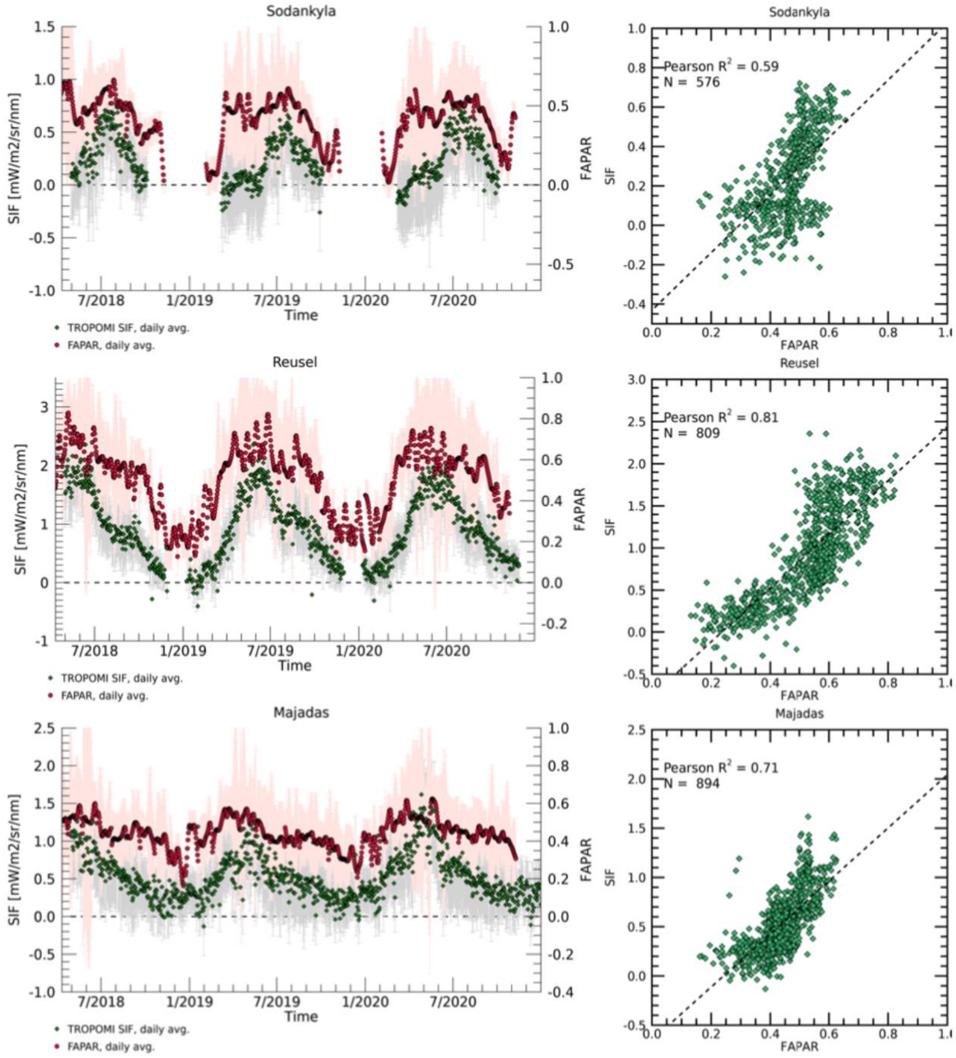


EO Database – EO Product Intercomparison

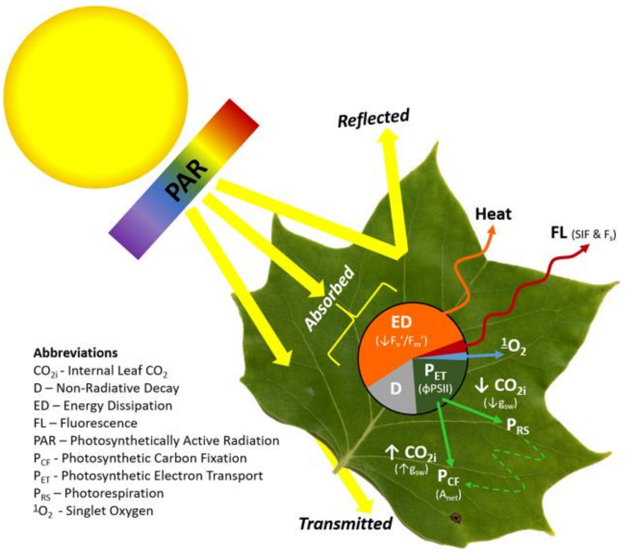
e.g. Correlation (SIF, L-VOD)



EO Database – Understanding

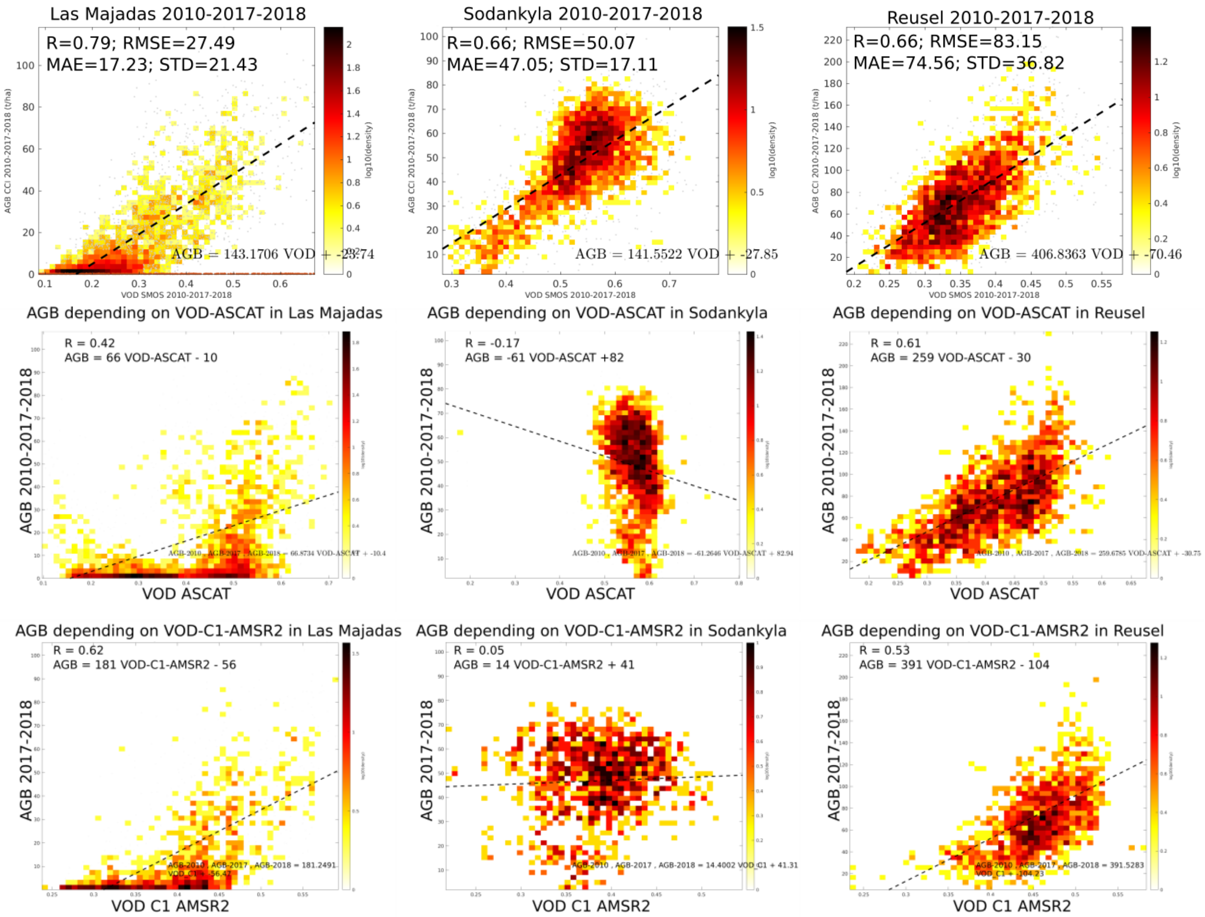


SIF & FAPAR



Marss et al., 2020 (GRL)

EO Database – EO data & geophysical variables

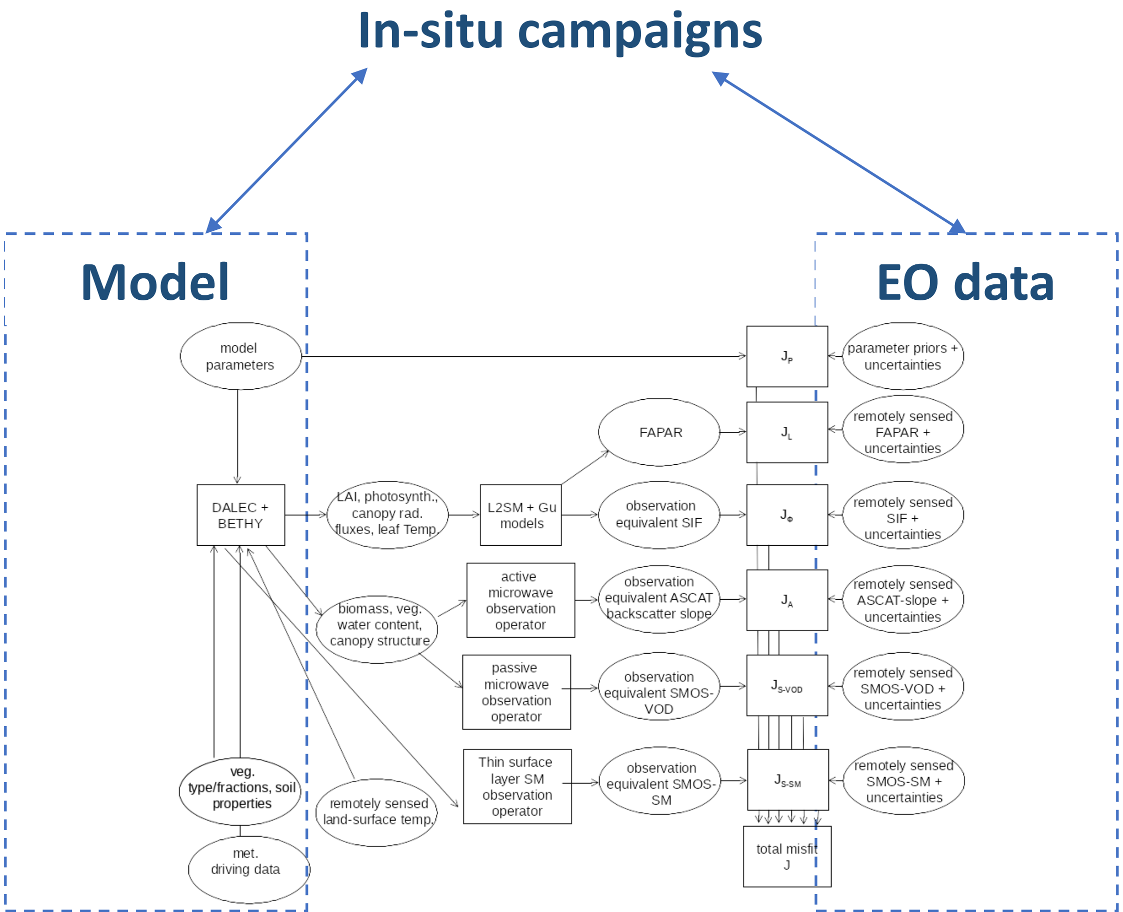


AGB v SMOS L-VOD

AGB v ASCAT VOD

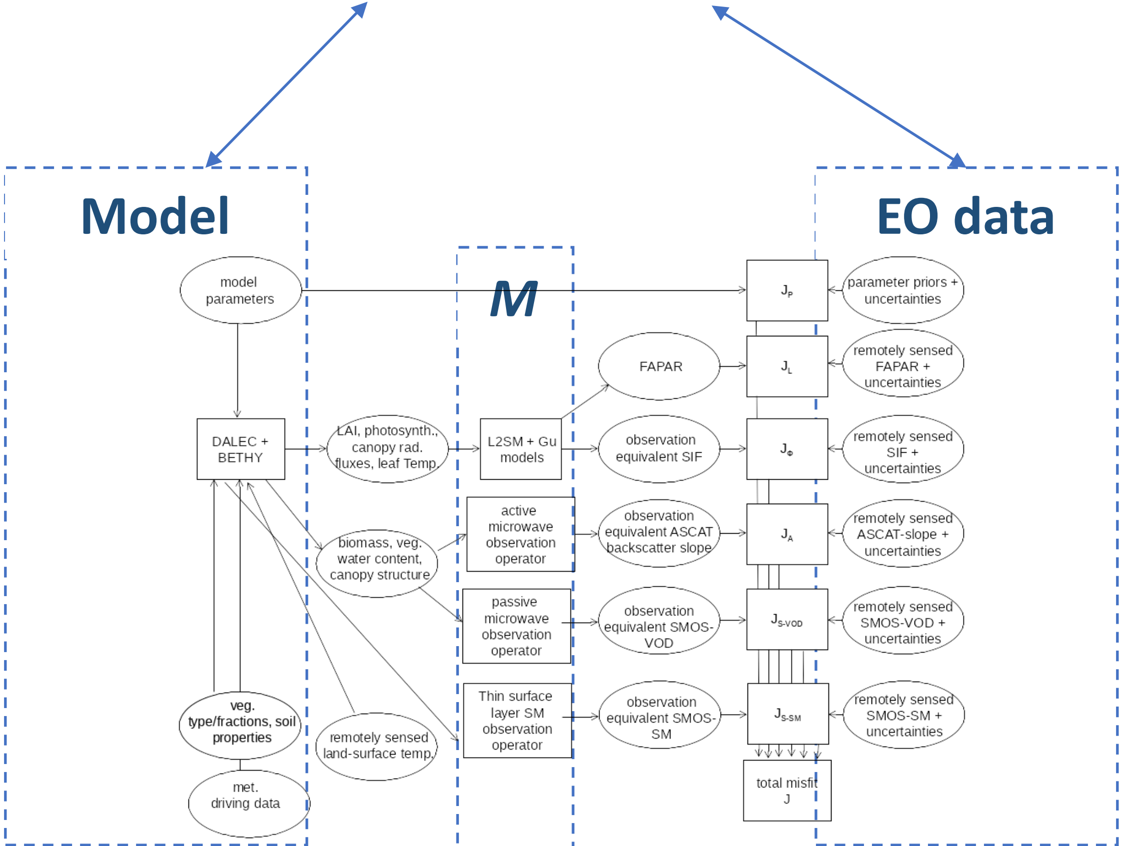
AGB v AMSR2 C1-VOD

Interdisciplinarity

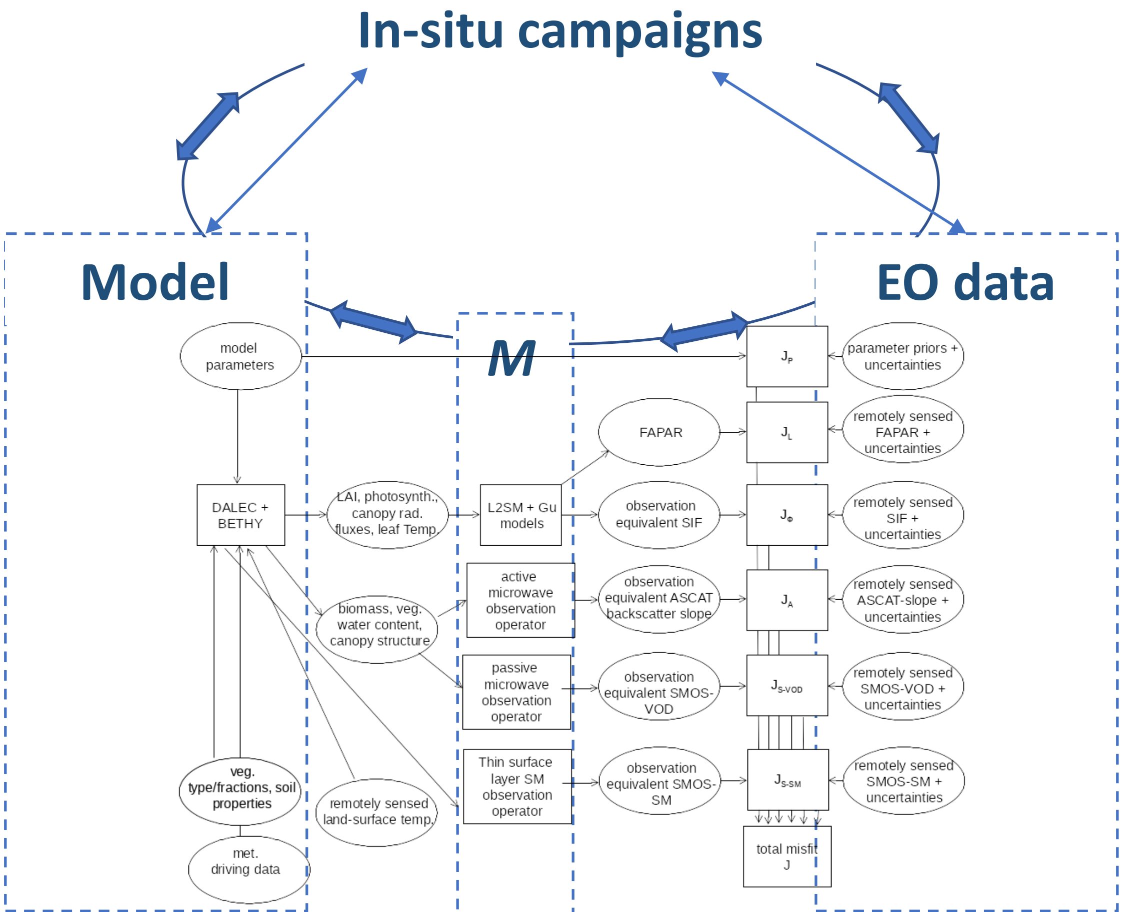


Interdisciplinarity

In-situ campaigns



Interdisciplinarity



Example: Understanding and using ASCAT slope

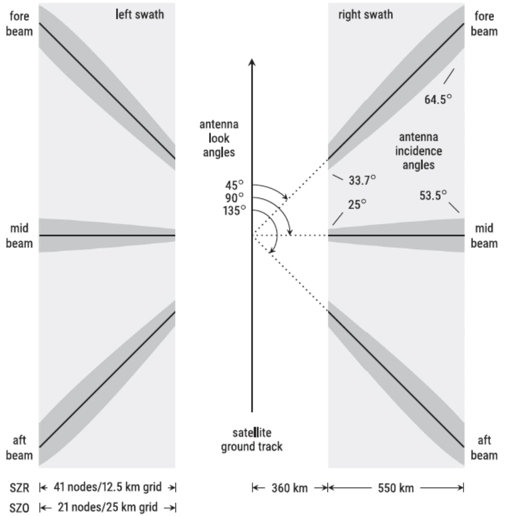
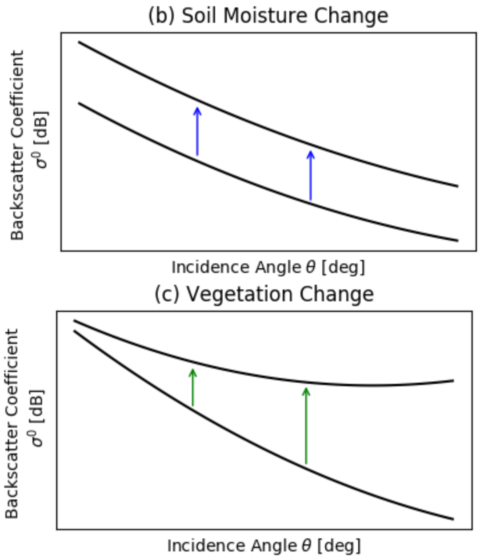
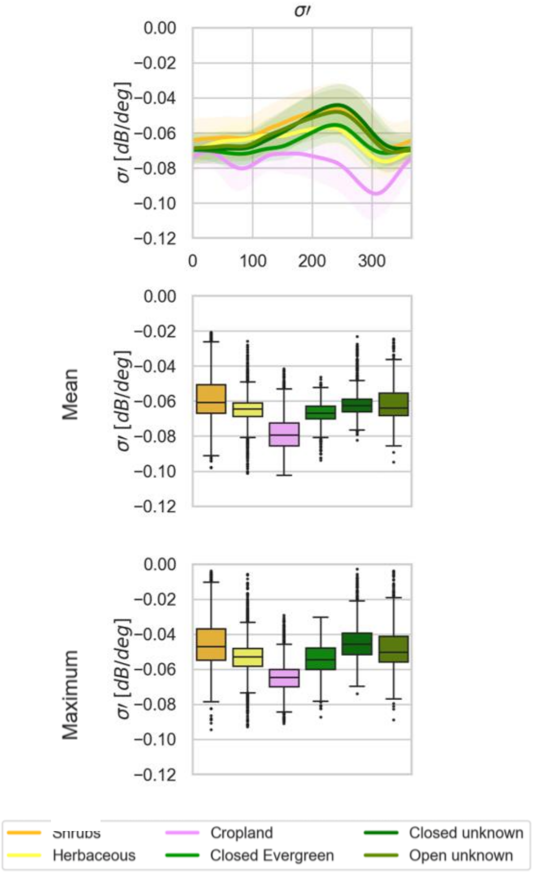


Fig. 4. ASCAT swath geometry for a Metop minimum orbit height (822 km). The dimensions are symmetric with respect to the satellite ground track. Two different horizontal scales and spatial grids are generated from the full-resolution backscatter measurements: 12.5 km sampling with 25 km spatial resolution (SZR) and 25 km sampling with 50 km spatial resolution (SZO) [6].

[Hahn et al. (2017), Figa-Saldana et al. (2002)]

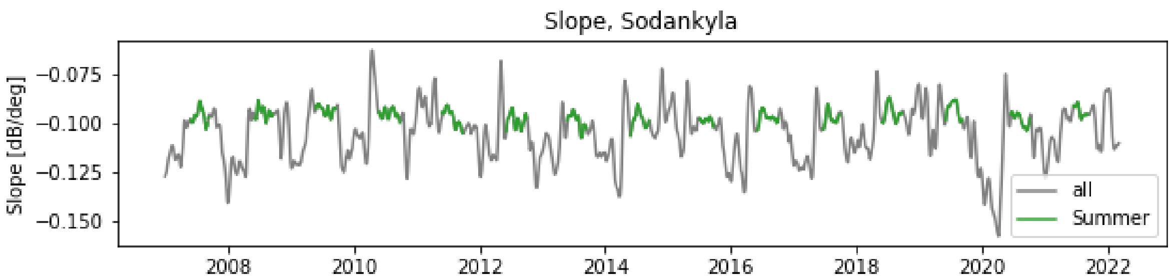


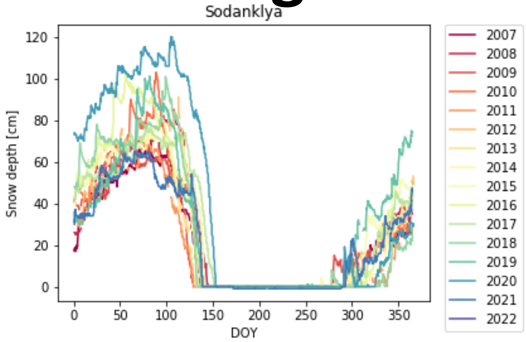
[Steele-Dunne et al. (2019)]

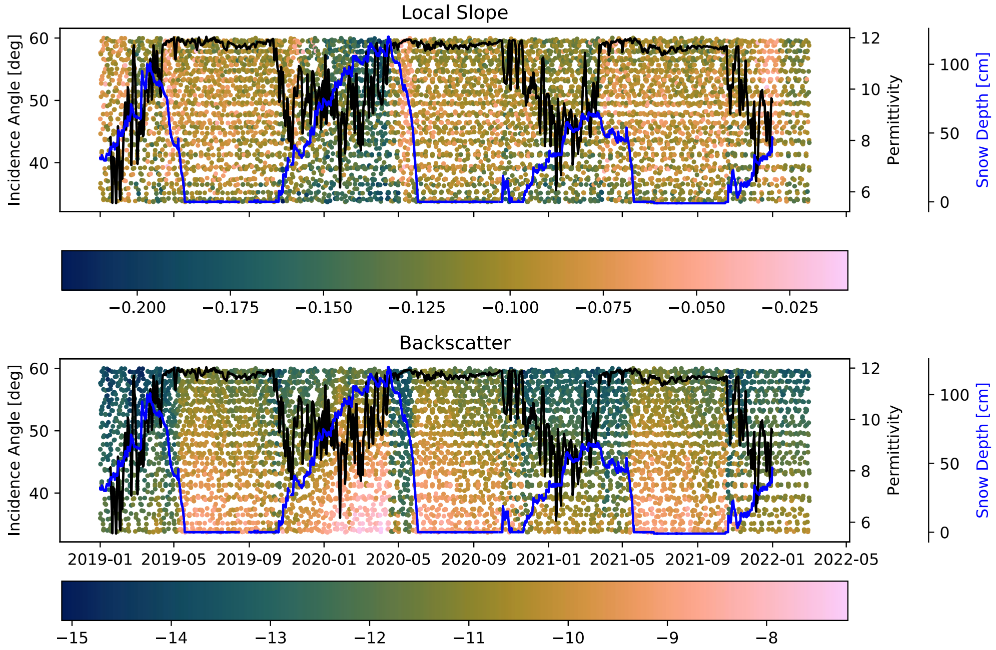


[Petchiappan et al., 2022]
[Vreugdenhil et al. 2022, This meeting!]

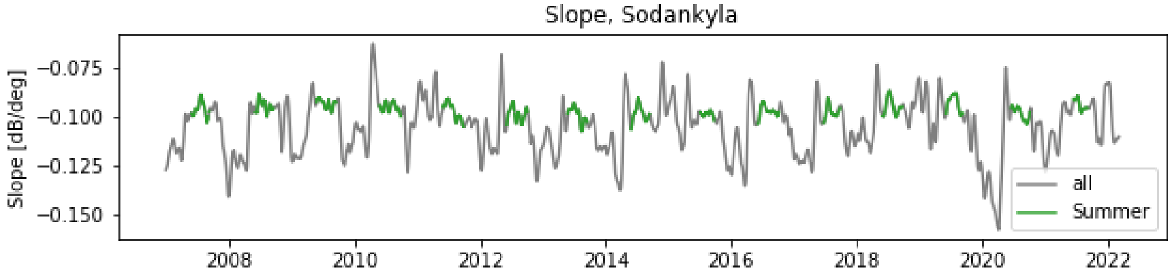
ASCAT slope: In-situ data improve understanding

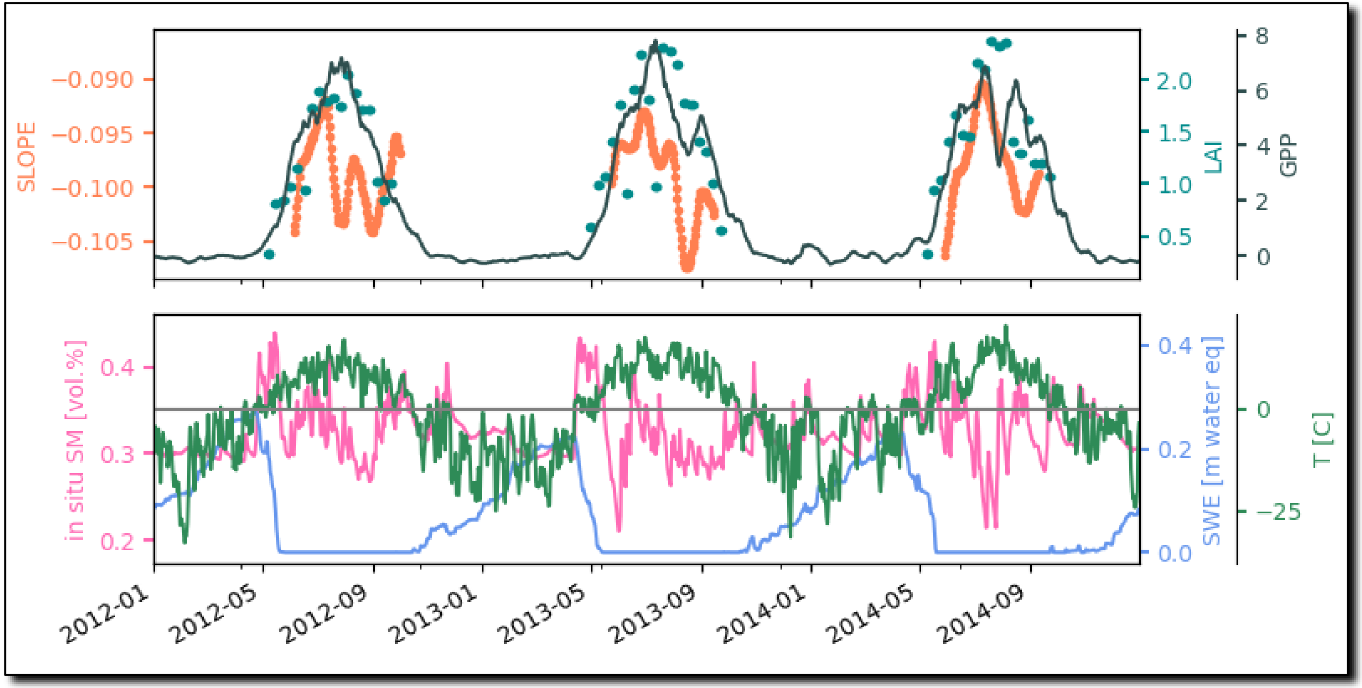




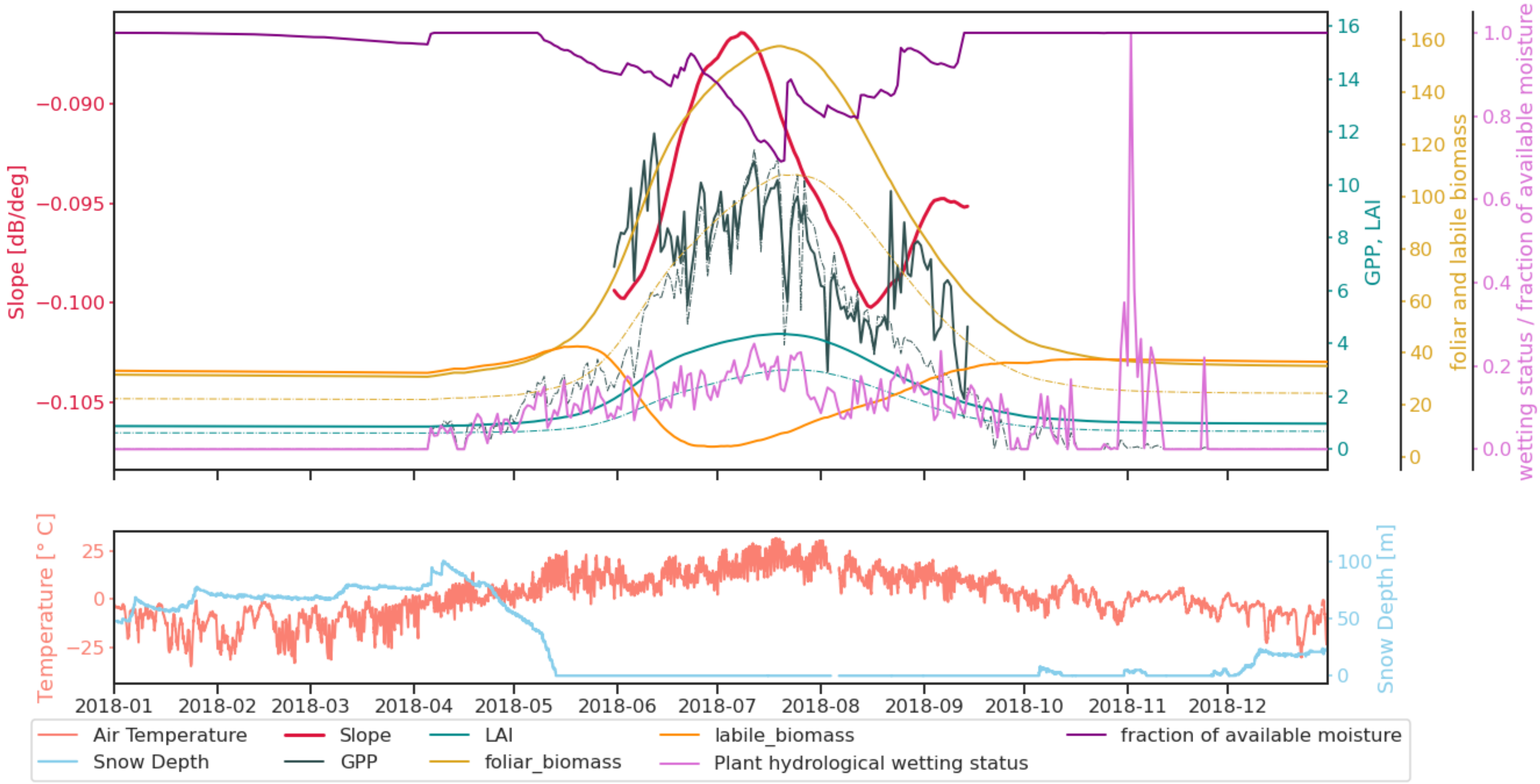


ASCAT slope: In-situ data improve understanding

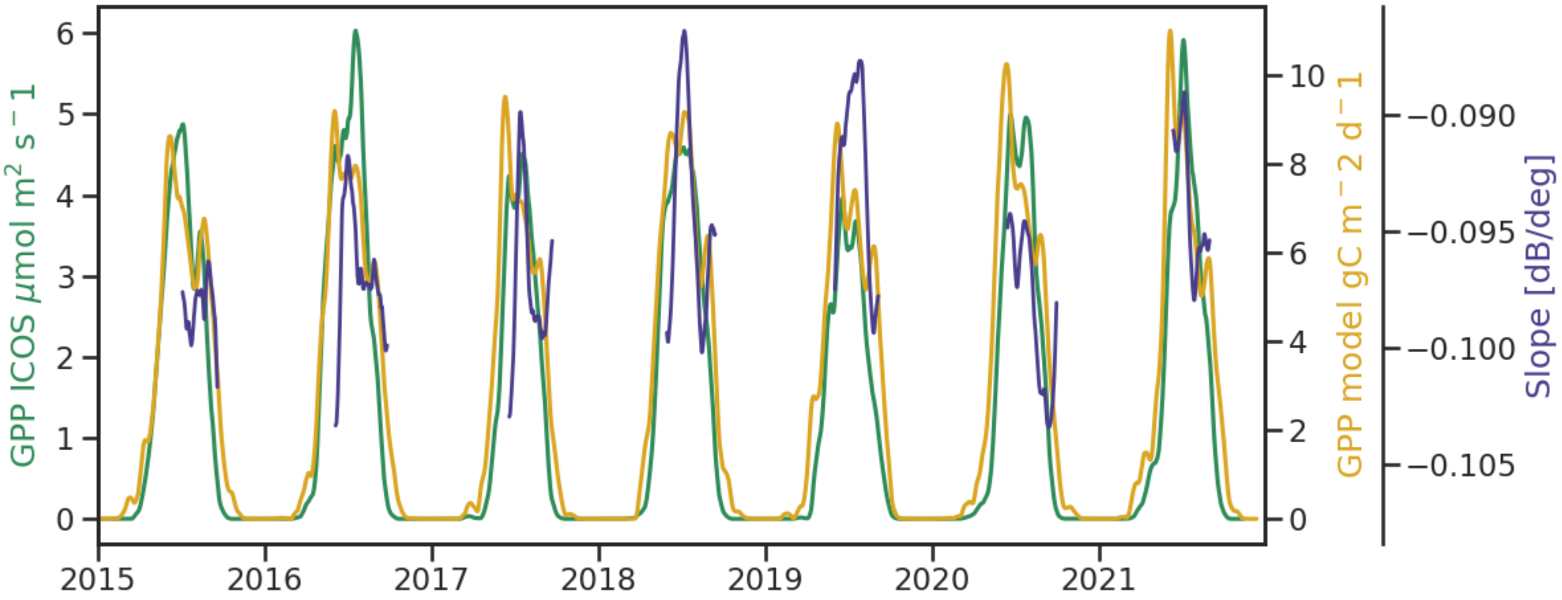




ASCAT slope: Model results improve understanding



ASCAT slope: Combining in-situ & model data is informative



Conclusions & Recommendations

EO Database = data for assimilation

EO Database = asset for understanding, intercomparison and validation

Interdisciplinary approach is essential to optimally combine observations and models for Carbon Science

Working in the interdisciplinary LCC team is challenging, fruitful and fun

To make optimal use of EO data, need seamless connection between models and data => interdisciplinarity.

Additional Information

https://lcc.inversion-lab.com/

Land Surface Carbon Constellation Study

Project | Partners | Publications | Links | Internal | Contact

Project Description

The carbon cycle is central to the Earth system, being inextricably coupled with climate, the water cycle, nutrient cycles and the production of biomass by photosynthesis on land and in the oceans. In the natural system the balance among carbon in the atmosphere, the land and the ocean is regulated through fluxes between these three main reservoirs. In addition to these natural components, there are the flux contributions to the atmosphere from human activities, namely, fossil fuel burning, cement production, and a range of land management practices.

Understanding the patterns of exchanges of carbon between the atmosphere and the land and the underlying processes associated to them such as CO2 fertilization, changes in climate, and changes to natural disturbance regimes, are critical to improving knowledge of the carbon cycle, its direct and indirect impacts on society. Identifying approaches to mitigate and adapt for the consequences of the anthropogenic disturbance of the carbon cycle is hampered by the uncertain uptake of atmospheric carbon by the terrestrial biosphere, and the response of this uptake to climate change itself.

To achieve such understanding and reduce these uncertainties requires an integrated approach to the carbon cycle which exploits both observations (satellite and in situ) and modelling.

The main objective of the Land surface Carbon Constellation (LCC) project is to demonstrate the synergistic exploitation of satellite observations from active and passive microwave sensors together with optical data for an improved understanding of the terrestrial carbon and water cycles. This will be achieved by:

- adapting a numerical land surface model for its application in a data assimilation framework,
- acquisition and analysis of campaign data sets at Sodankylä (Finland) and Majadas de Tietar (Spain) supporting the development of the model and the data assimilation scheme on the local scale.

The LCC Study started in October 2020 and contributes to ESA's Carbon Science Cluster, focussing on its land component.