Role of modelling and data assimilation for constraining the terrestrial carbon cycle

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4th Carbon From Space Meeting

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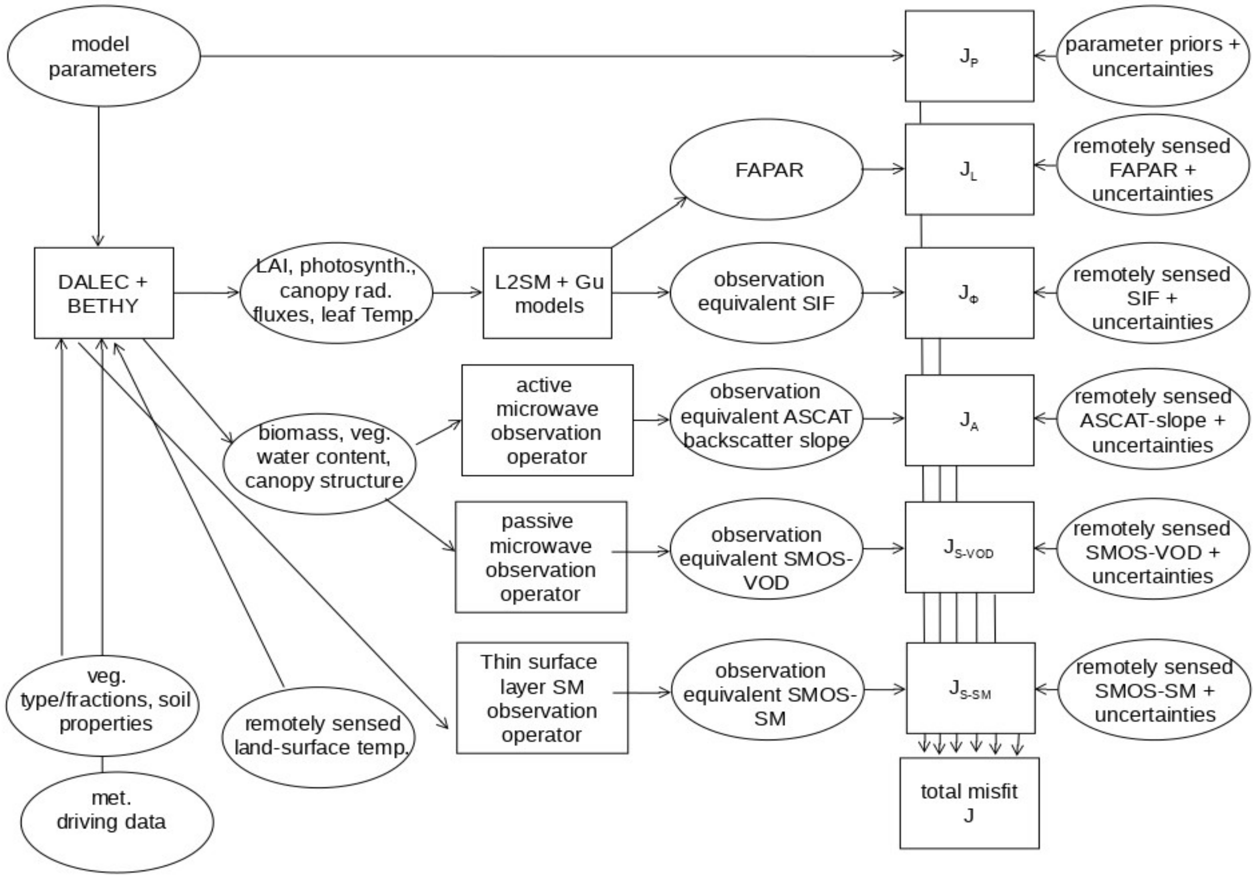
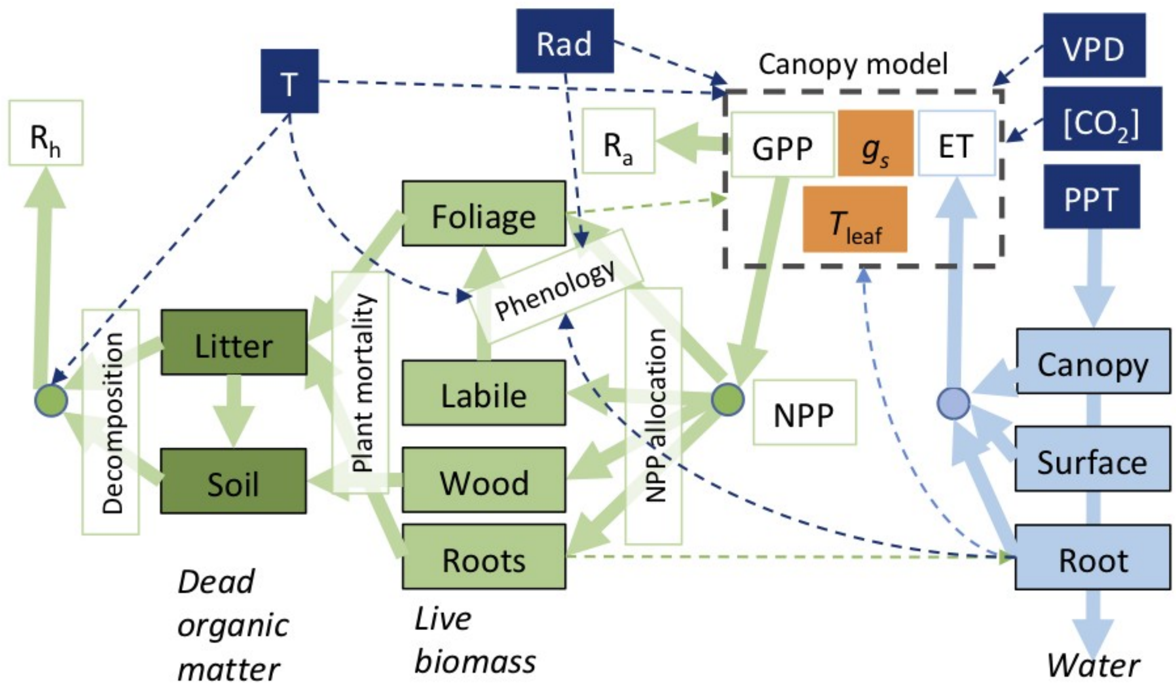
Observation operators and data assimilation (on the swath)

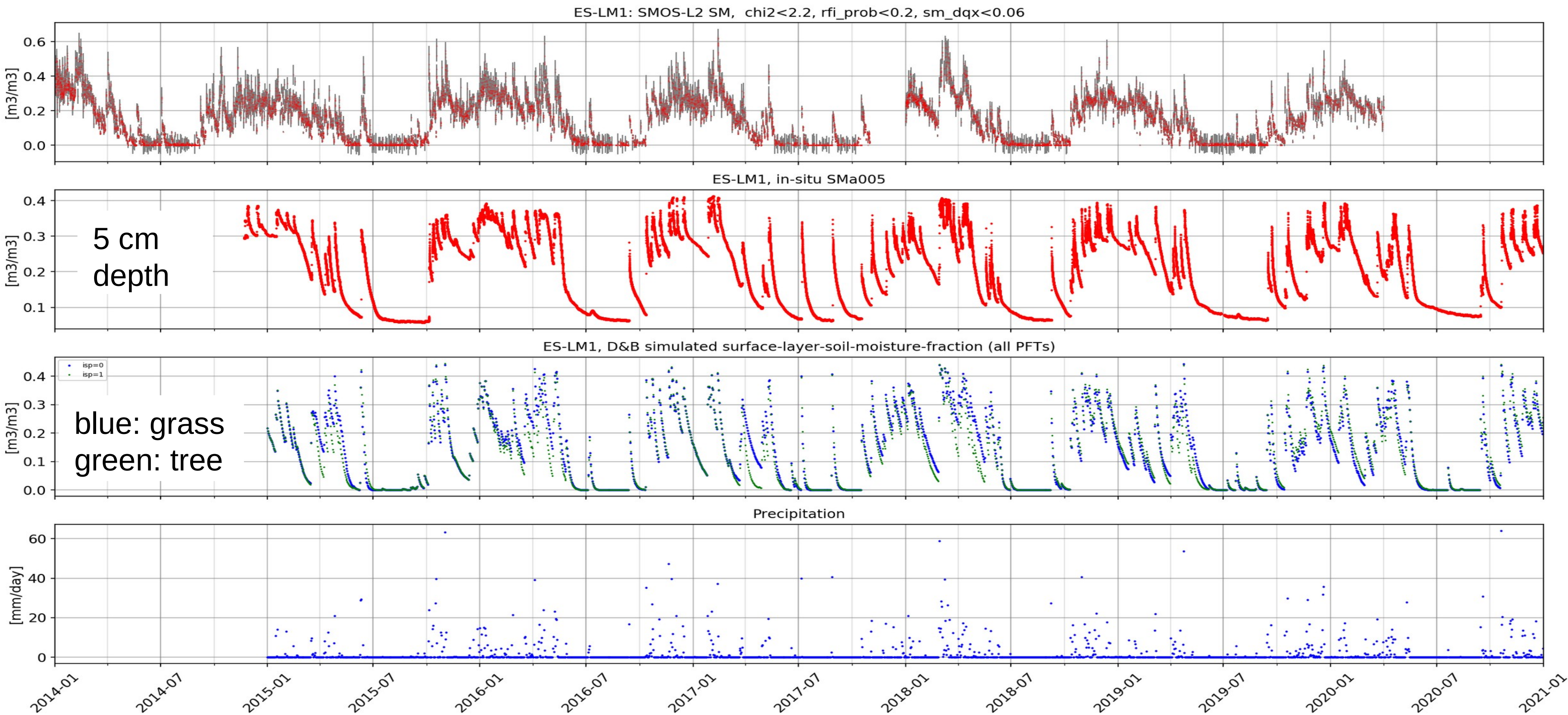


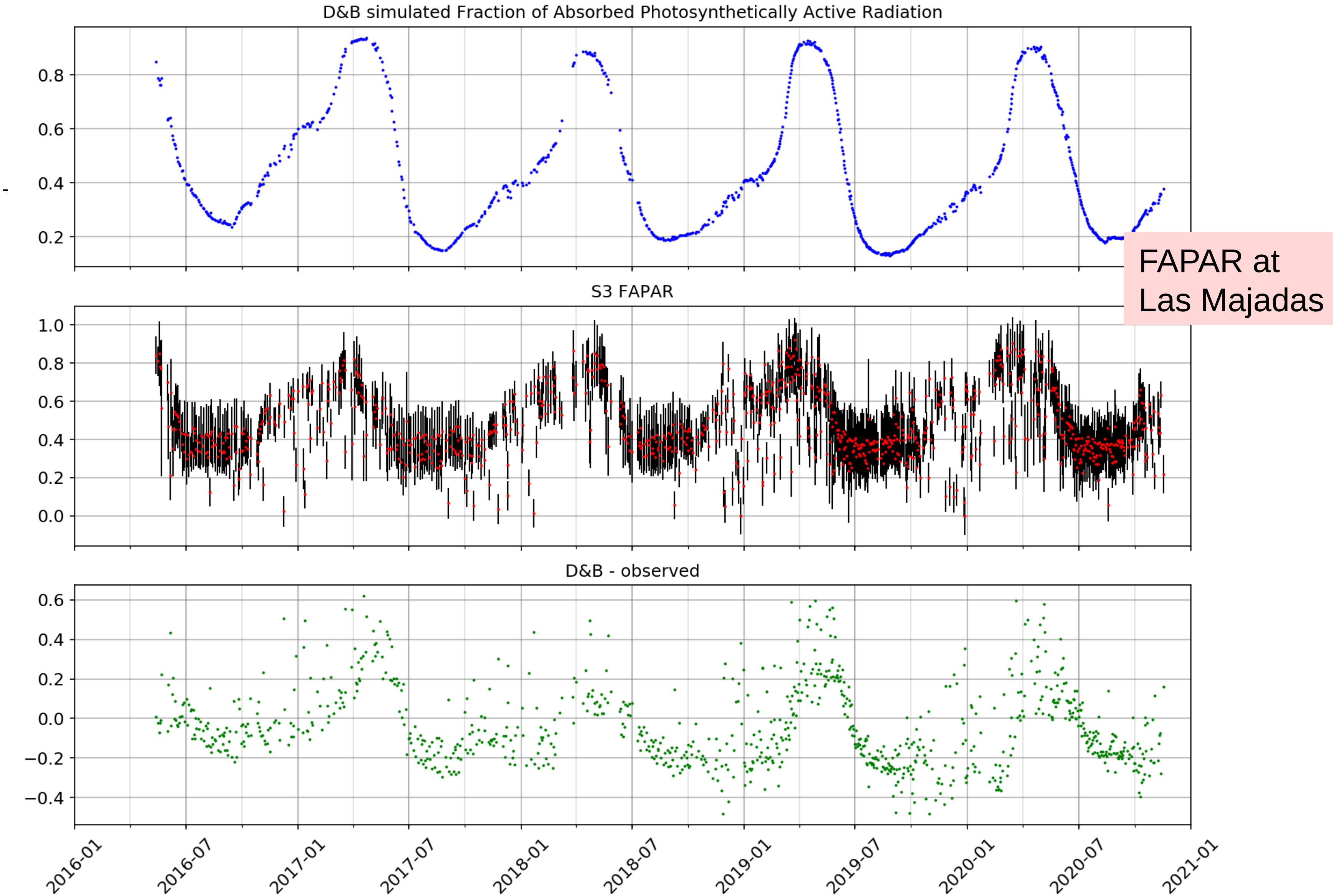
Community land surface model: D&B model

Based on a coupling of DALEC and BETHY



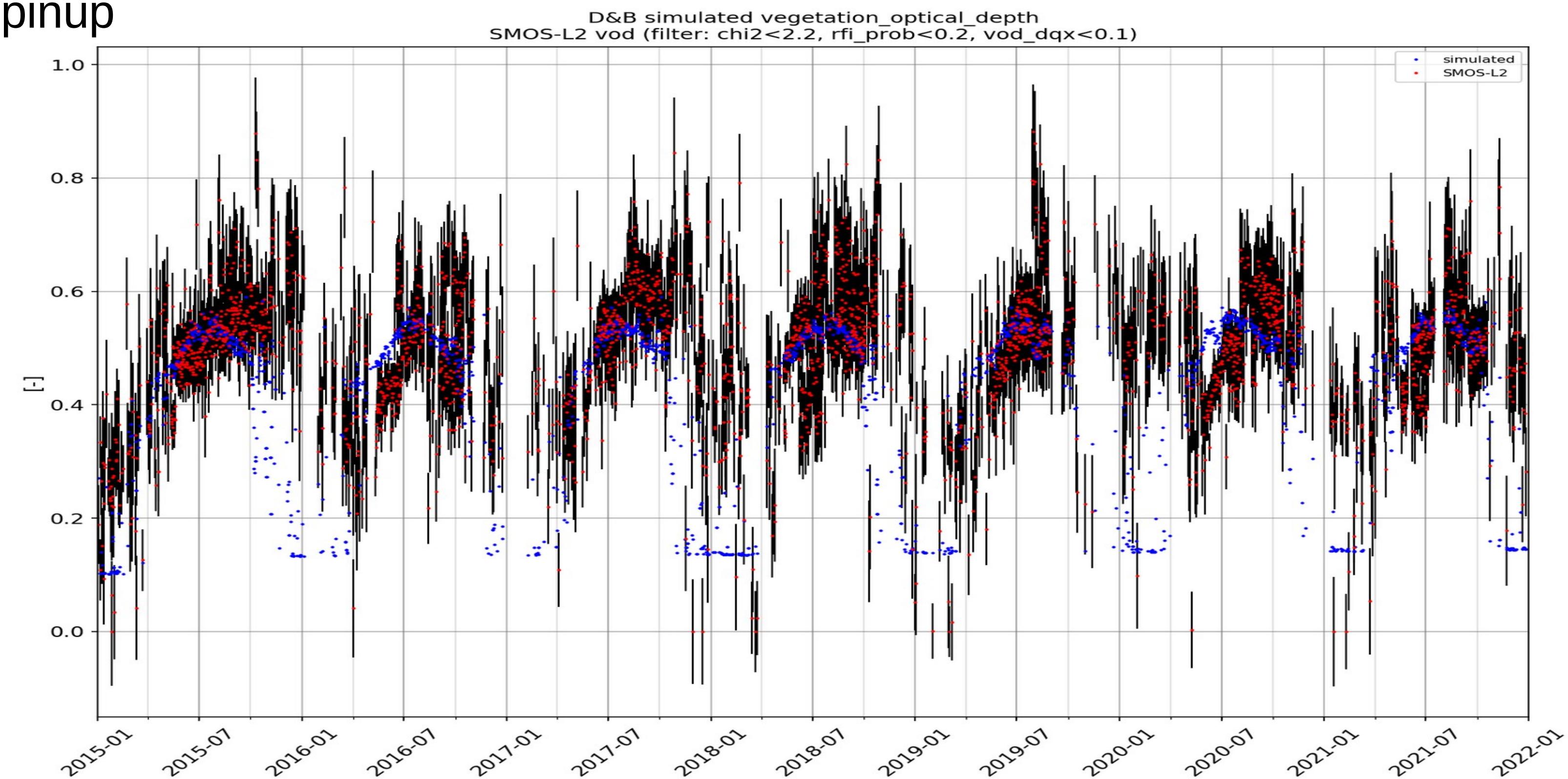
Observation Operator for surface layer soil moisture Las Majadas




D&B simulated Fraction of Absorbed Photosynthetically Active Radiation
S3 FAPAR
D&B - observed
FAPAR at
Las Majadas
2016-01
2016-07
2017-01
2017-07
2018-01
2018-07
2019-01
2019-07
2020-01
2020-07
2021-01

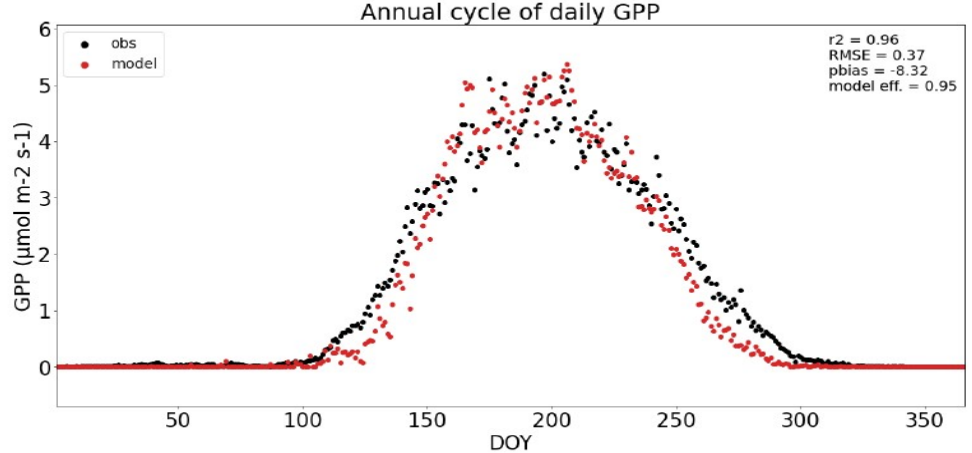
Observation Operator for L-VOD, calibrated Sodankylä

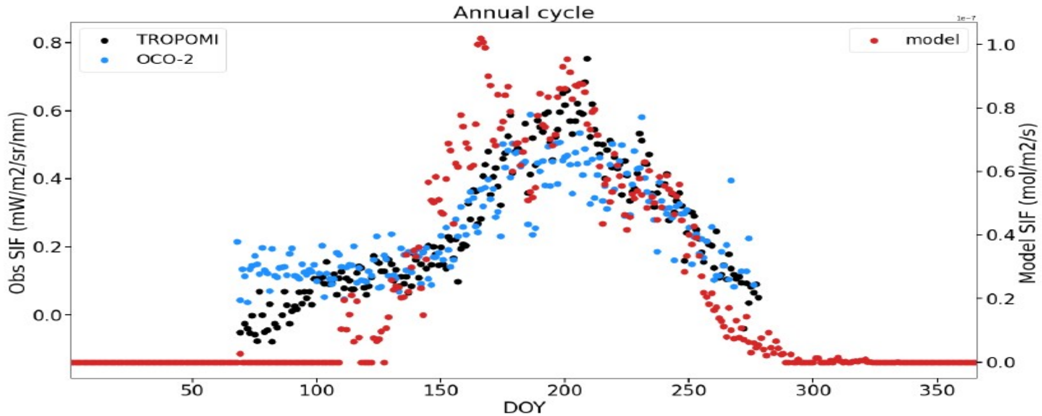
2 y spinup



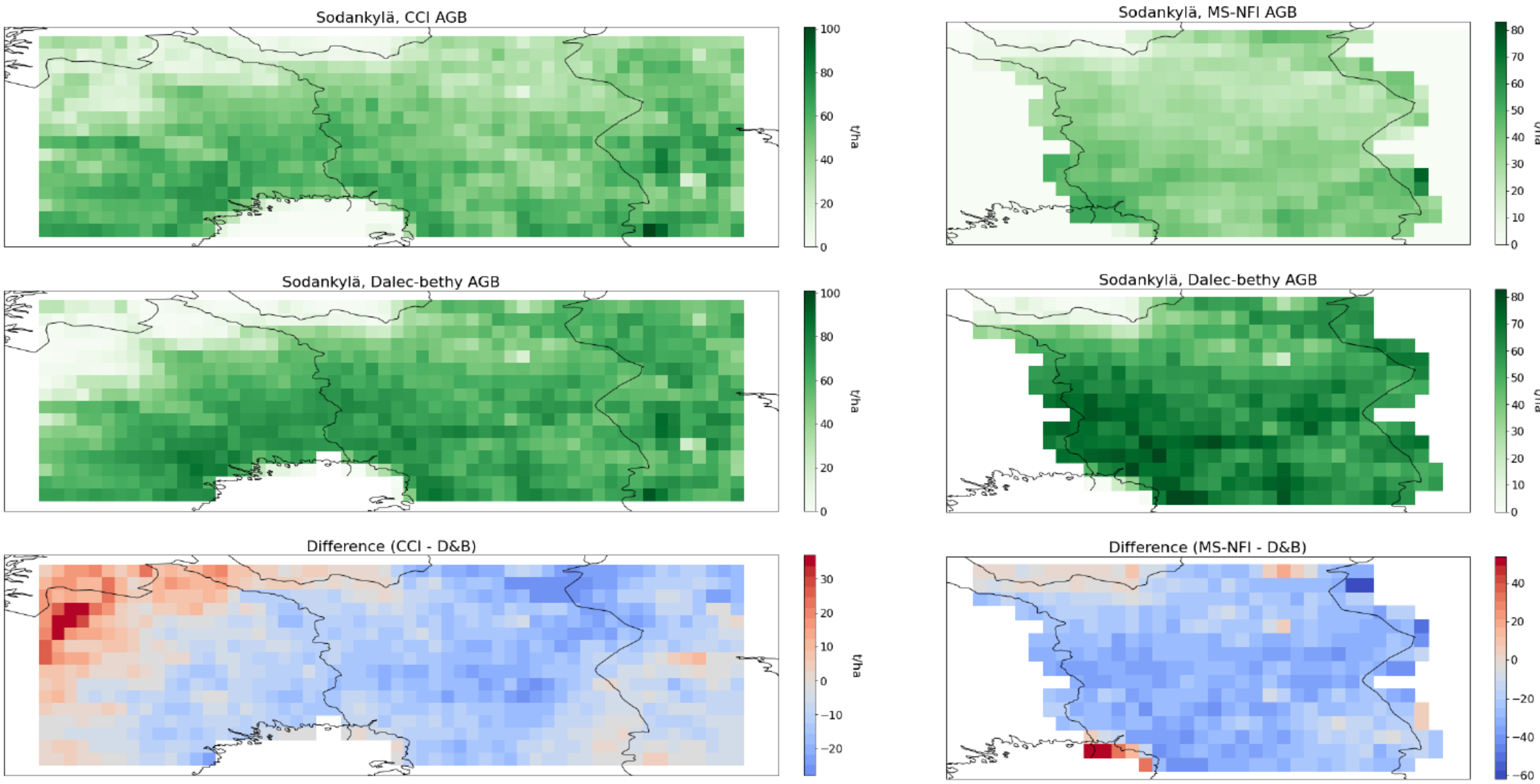
$VOD_\lambda(t) = g_\lambda(T) * f_\lambda(B_w, h_s, B_l, h_f) = g_\lambda(T) * (a_0 + a_1 B_w + a_2 h_s + a_3 B_l + a_4 h_f)$, a_0 - a_4 global

GPP and SIF at Sodankylä

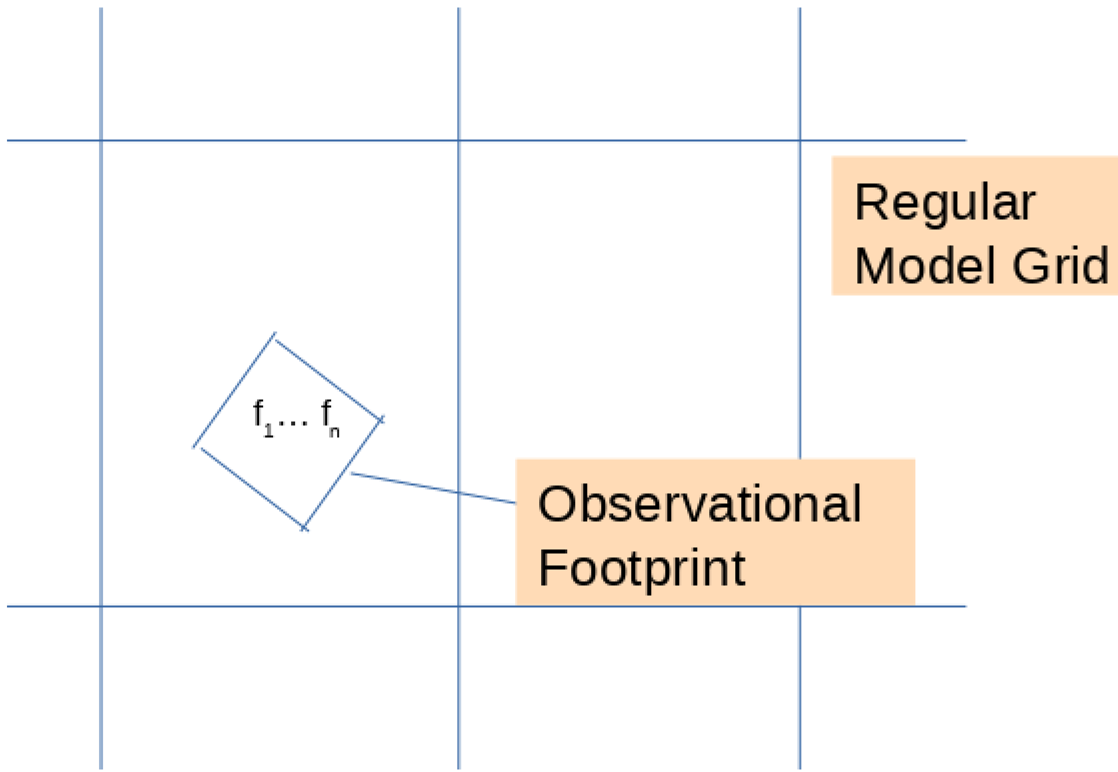




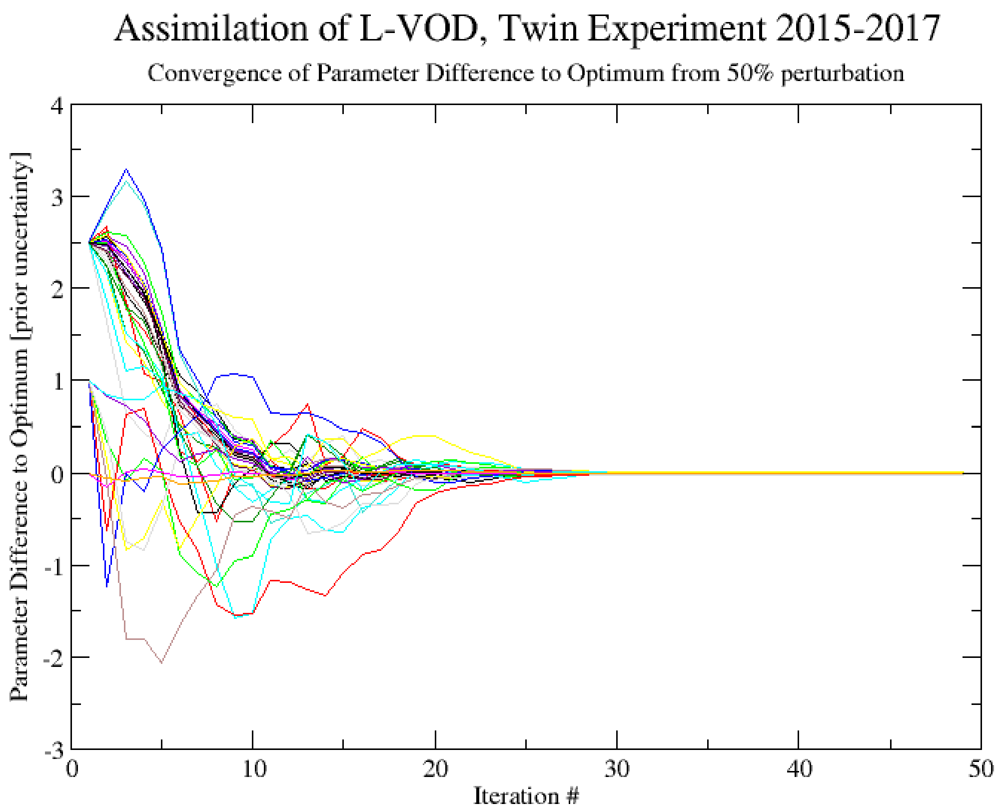
AGB over Finnish region against CCI and NFI



Simulation on footprint/target area based on PFT fractions f_i



Adjoint Based variational optimisation
Example: VOD – identical twin experiment



Summary D&B Model

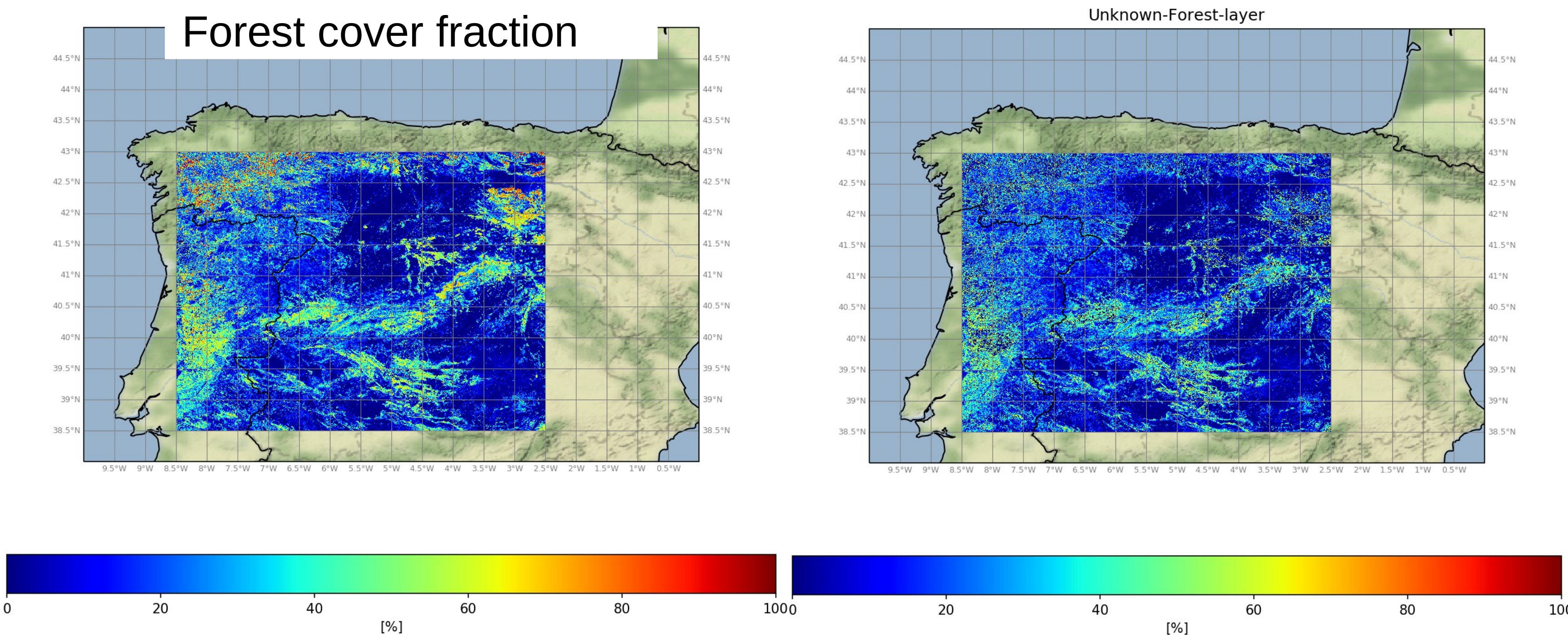
DALEC & BETHY model:

- developed for simulation and assimilation of EO and field data
- to provide an integrated perspective on terrestrial carbon and water cycles
- includes observation operators “on the swath” to exploit information from a diverse array of observations
- **includes tangent and adjoint codes** for efficient data assimilation (system needs to be applicable at high spatial resolution)
- **to be released to public domain as community model** for use by larger group beyond the LCC team

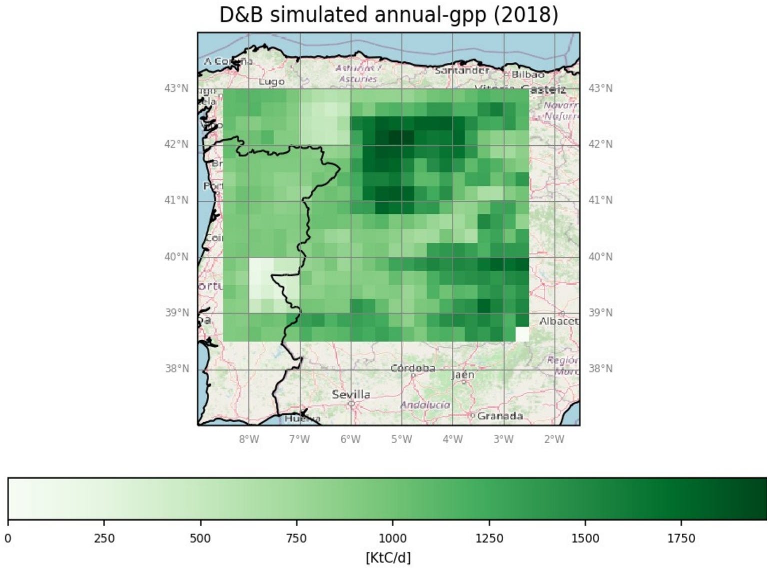
Working in the LCC team, which combines experts in field work, remote sensing, modelling, and data assimilation is **CHALLENGING, FRUITFUL**, and **FUN,** much more than working isolated within the respective communities

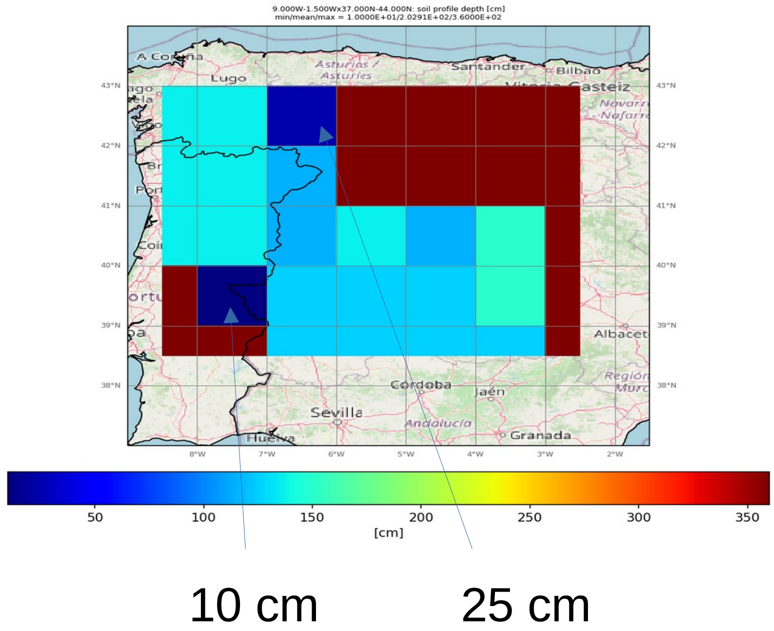
Analysis of Copernicus Land Cover

In Majadas, most forest is identified as 'unknown'

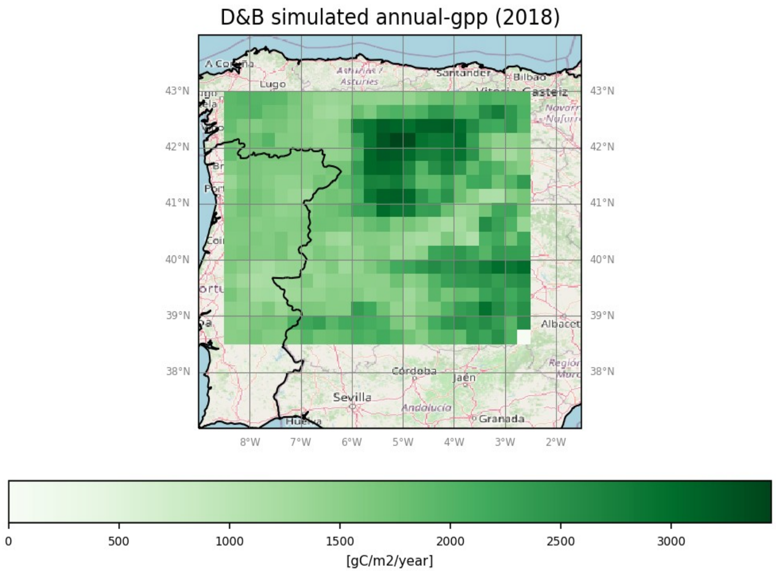


Soil depth and GPP per PFT



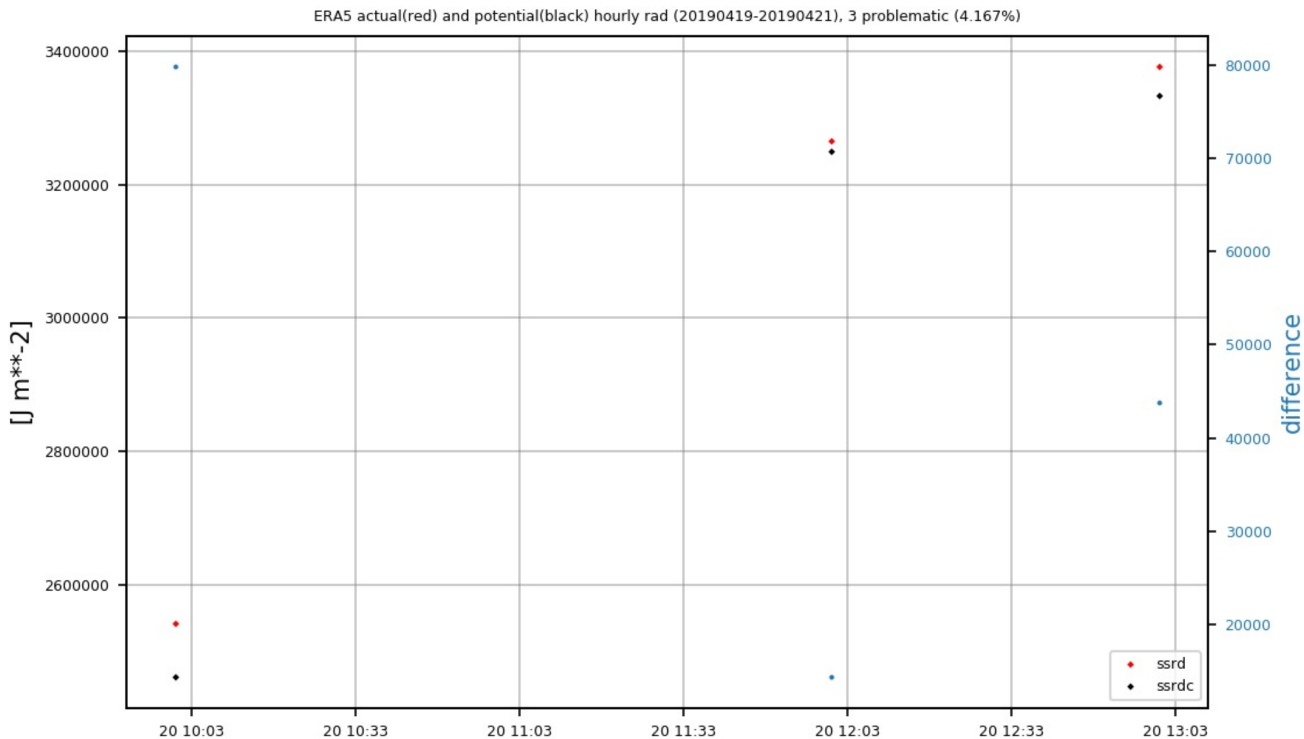


Soil depth and GPP per PFT



With soil depth floor of 115 cm

Radiation from ERA5
Actual exceeds potential solar incoming radiation



Points for Discussion

- Quality of input/driving data is relevant, examples:
  - soil depth
  - landcover map to simulate footprints
  - radiation input relevant
- Field data are essential for model development
- Interdisciplinary project concept is useful

Land Surface Carbon Constellation Study

Project | Partners | Publications | Links | Internal | Contact

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

Project Description

The carbon cycle is central to the Earth system, being inextricably coupled with climate, the water cycle, nutrient cycles and the pro[…] land and in the oceans. In the natural system the balance among carbon in the atmosphere, the land and the ocean is regulated throug[…] 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.