

Attributing and Verifying European and National Greenhouse gas and aerosol Emissions and Reconciliation with Statistical boom-up estimates



The Terrestrial Carbon Community Assimilation System - TCCAS

A project funded by European Union's Horizon Europe research and innovation programme

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AVEYPA webinar, RS of the biosphere*

26 May 2026



Funded by
the European Union

Coordinated by

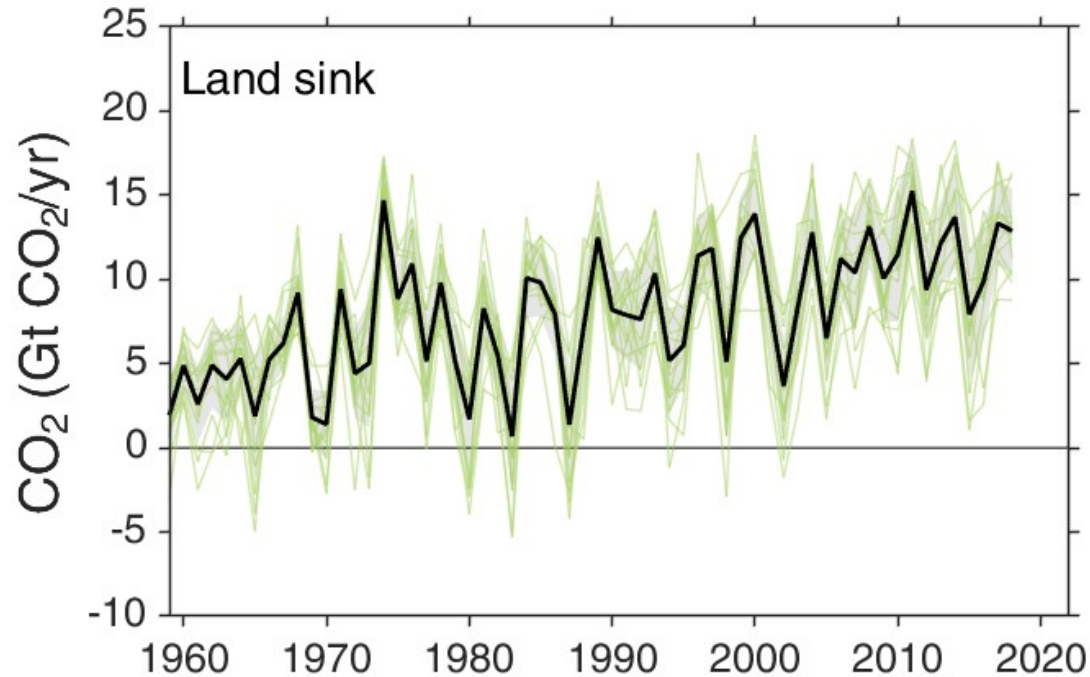


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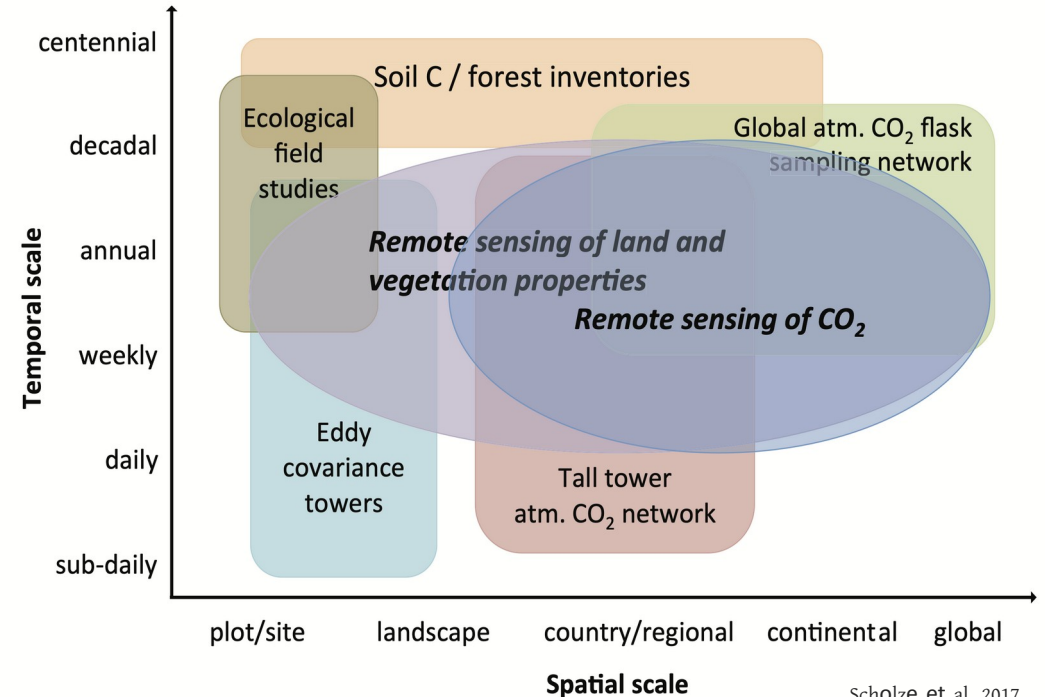


The case for data assimilation

Large uncertainty from land to predict C-balance (GCP)



Friedlingstein et al. 2019



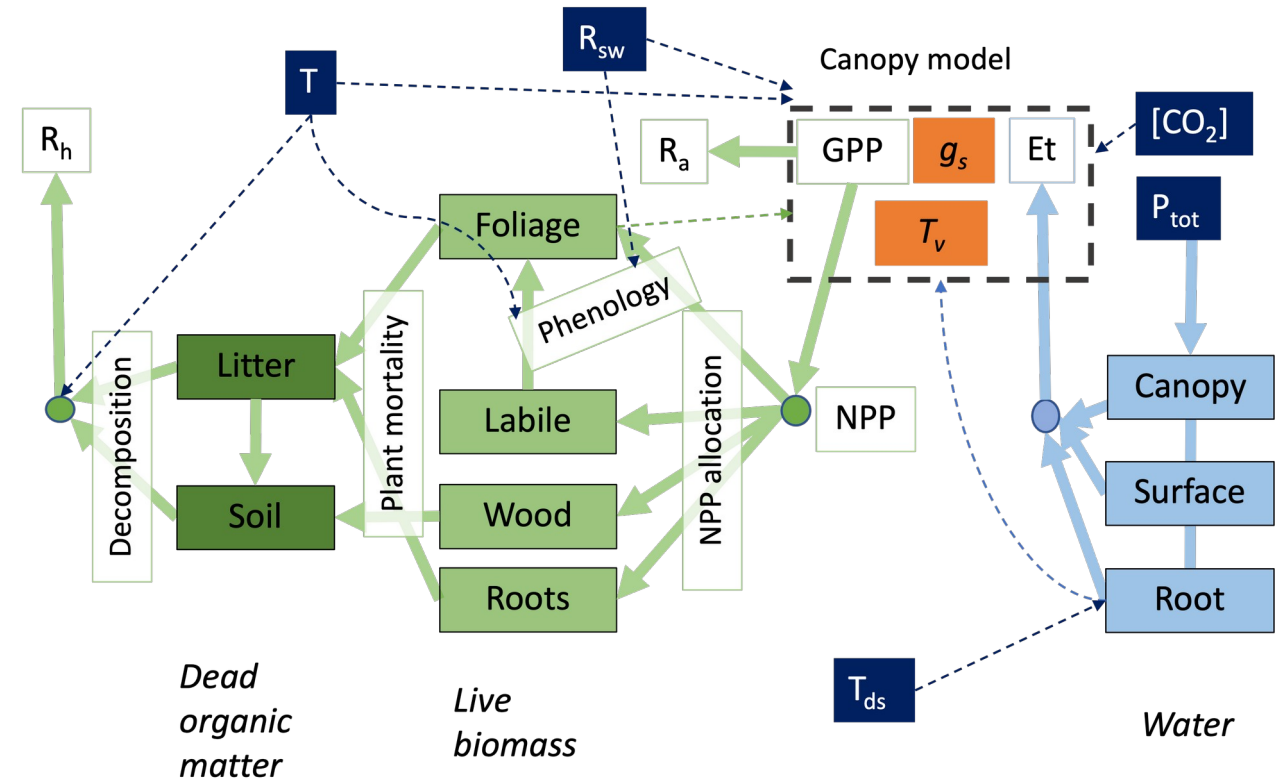
Scholze et al. 2017

⇒ **Terristrial Carbon Community Data Assimilation System**

= **ecophysiological constraints from forward modelling**

What is TCCAS?

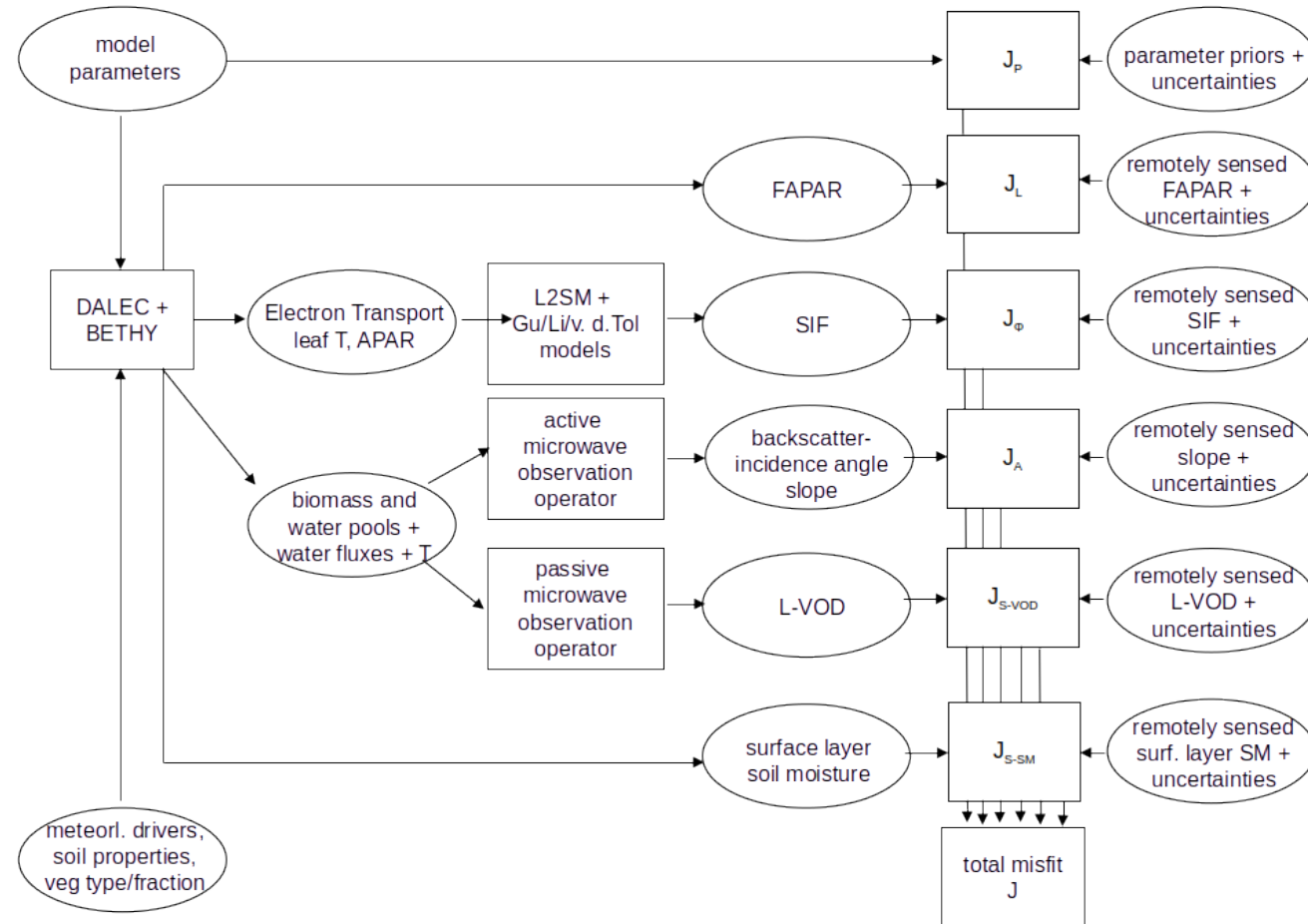
- **The Terrestrial Carbon Community Assimilation System (TCCAS) is built around the newly developed D&B terrestrial biosphere model.**
- **The focus of TCCAS is the combination of a diverse array of observational data streams with the D&B model to yield a consistent picture of the terrestrial carbon, water and energy cycles.**
- **The development of TCCAS was funded through the carbon cluster of the European Space Agency**





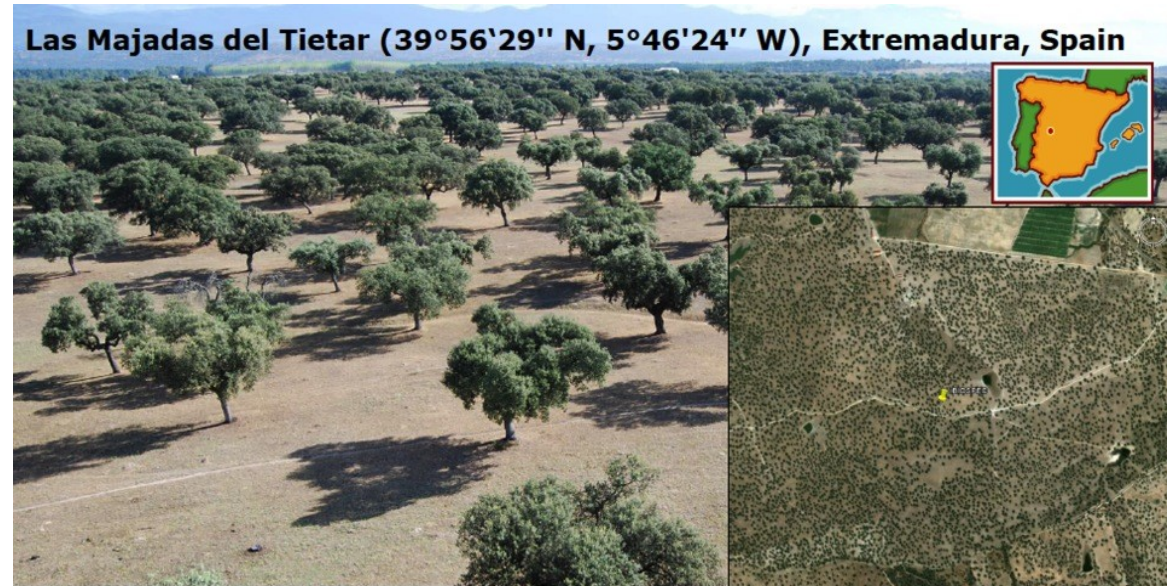
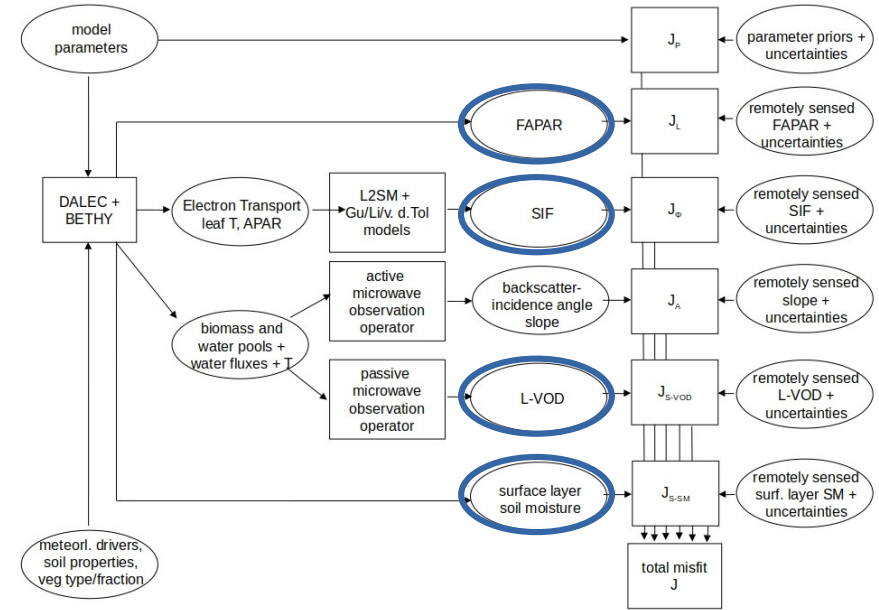
What does TCCAS offer?

- **Open source community system**
- **Observation operators for optical as well as active and passive microwave observations**
- **Assimilation on the footprint**
- **Tangent and adjoint codes**
- **Modular setup**
- **Computational efficiency**
- **Tested on point to regional scales**
- **Can operate at high resolution**
- **Documentation**
- **User support and training**



Assimilation example: Majadas de Tietar

- Savannah site in Extremadura, Spain
- C3 grass and temperate evergreen trees
- Spin up 2015+2016
- Assimilation window 2017-2021
- Joint assimilation of:
 - **FAPAR: JRC-TIP, twostream RT**
 - SIF: TROPOSIF, Gu model
 - **L-VOD: SMOS, empirical**
 - surface layer soil moisture: SMOS

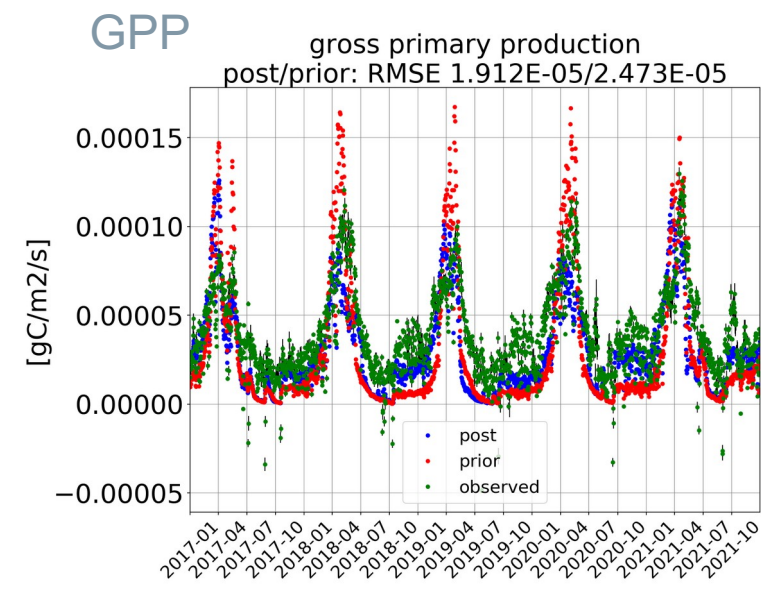
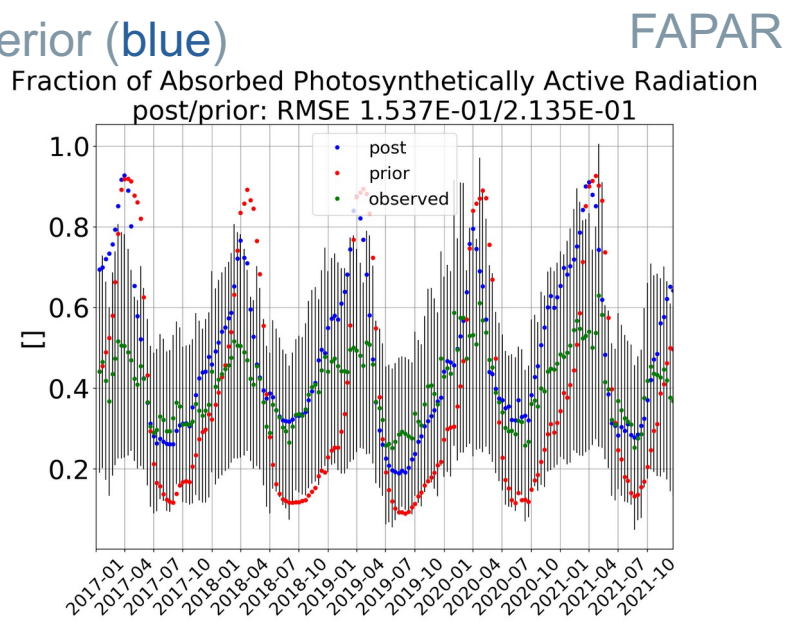
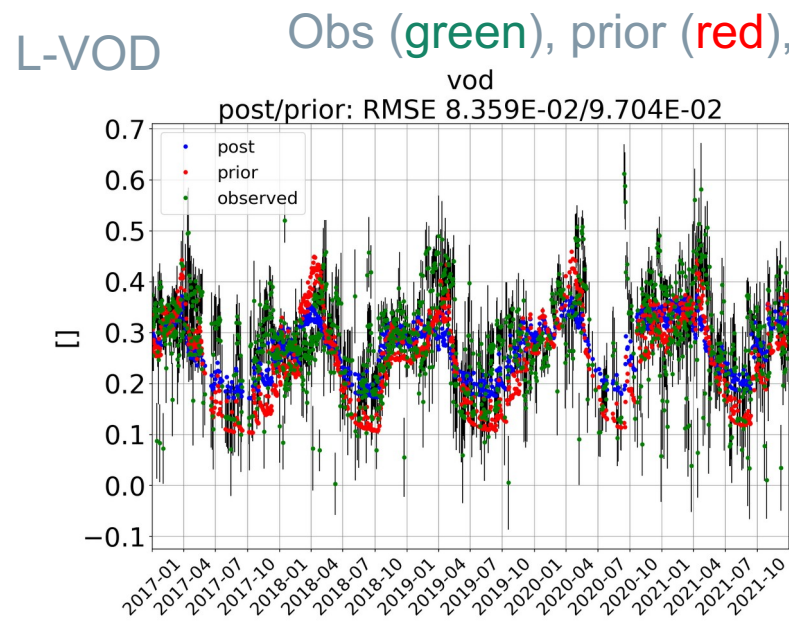
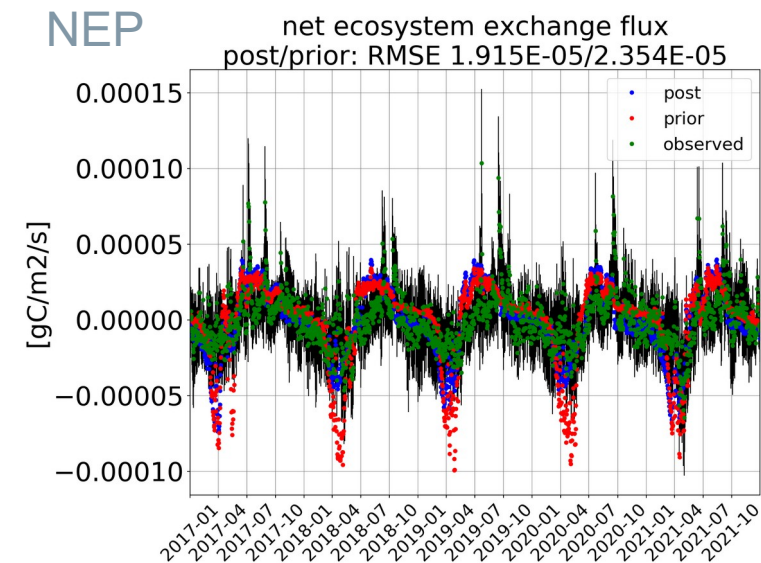
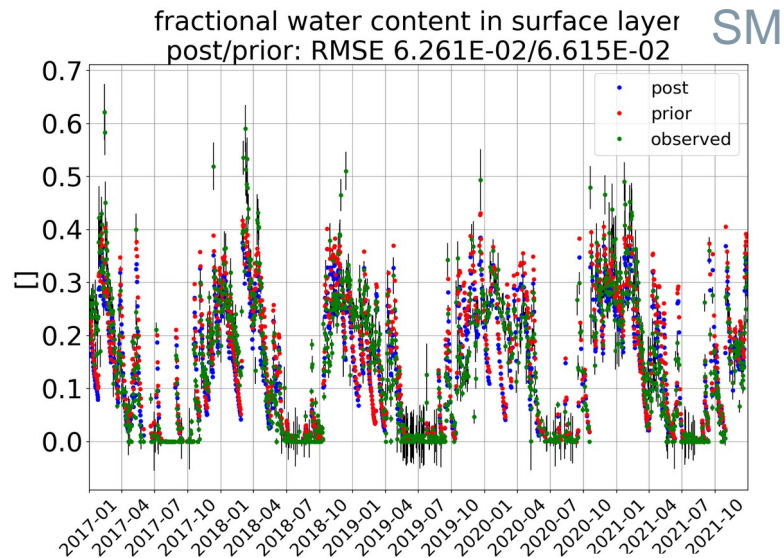
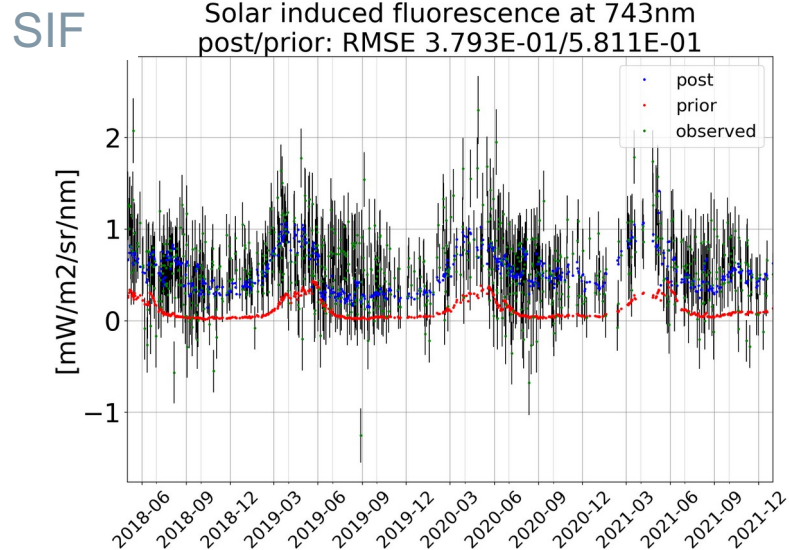


Ecosystem: **dehesa** Mediterranean Holm Oak open woodland (Savanna)



Assimilation at local scale example: Majadas de Tietar

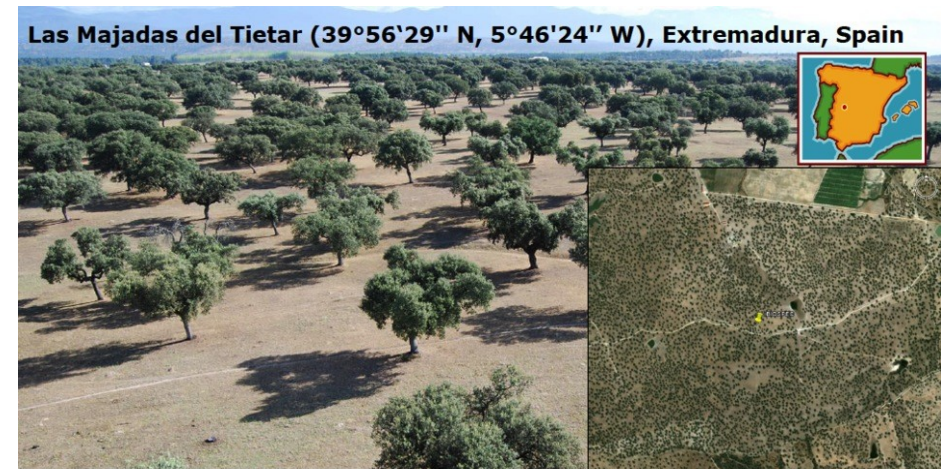
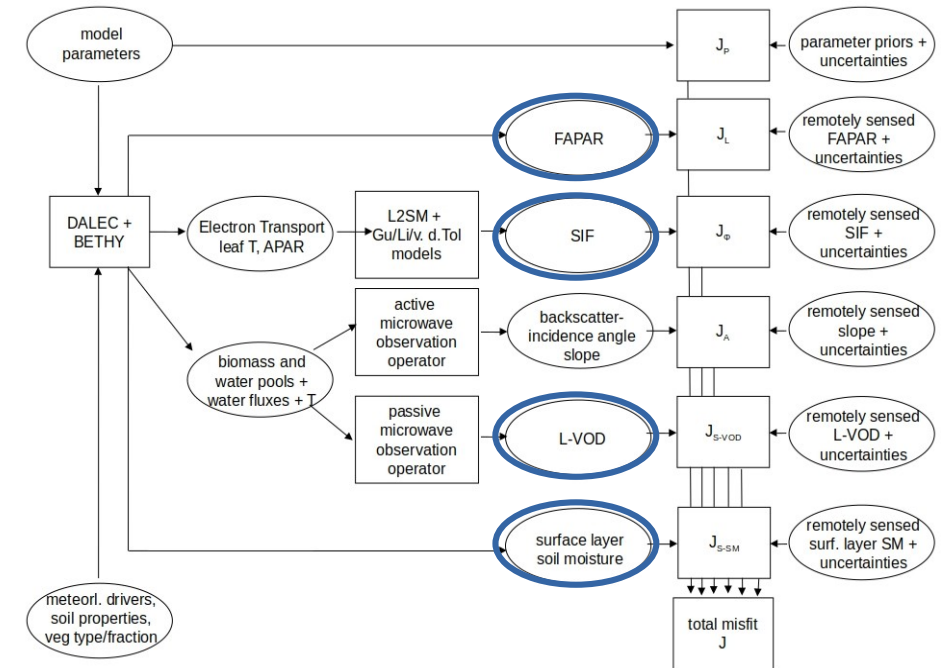
Assimilation (left/middle) and validation (right) variables



Example: Majadas de Tietar Hypothetical Intervention

How much extra carbon can be stored through a (hypothetical) intervention?

- We convert a fraction of the area from grass to trees by replacing the grass with small trees.
- We perform simulations for the intervention case based on the posterior parameter set and initial pools sizes. For the converted fraction, the initial size of dead pools is taken from the grass and for the living pools have 1% of the sizes of the adult trees.
- We compute the effect of intervention on carbon uptake for 25 year time horizon by subtracting the counterfactual case from the intervention case.

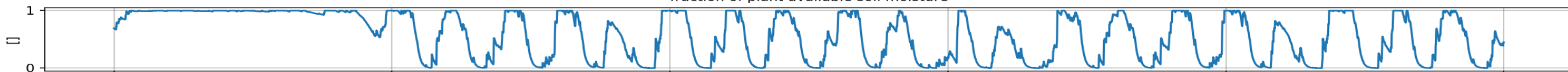


Ecosystem: *dehesa* Mediterranean Holm Oak open woodland (Savanna)

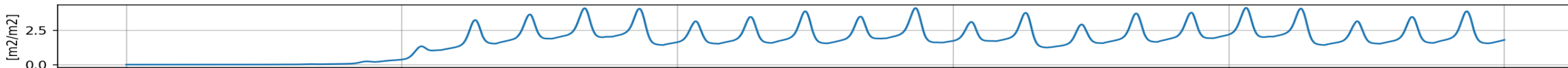


Hypothetical Intervention planting young saplings

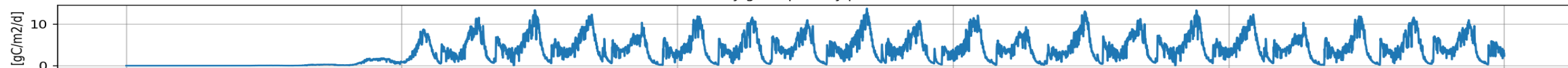
D&B simulation (pft=TmSg)
fraction of plant available soil moisture



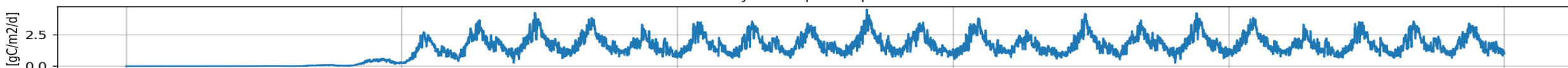
Leaf area index



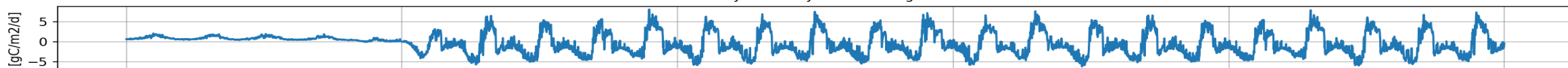
daily gross primary production



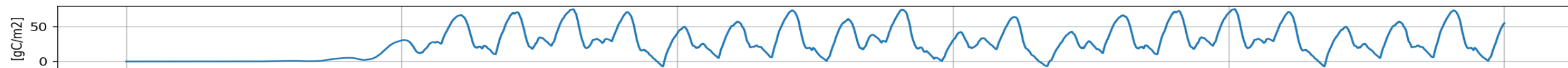
daily autotrophic respiration



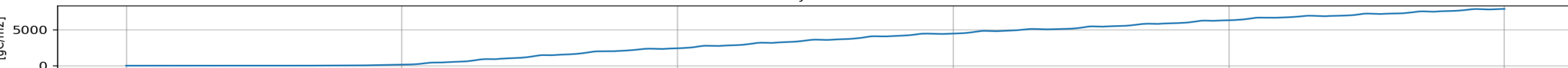
daily net ecosystem exchange



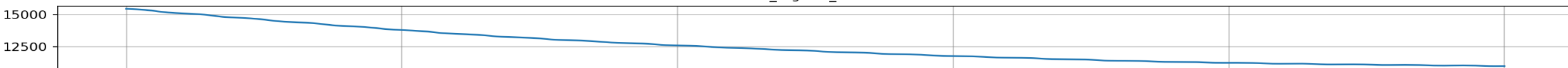
labile biomass



woody biomass



soil_organic_matter



2015

2020

2025

2030

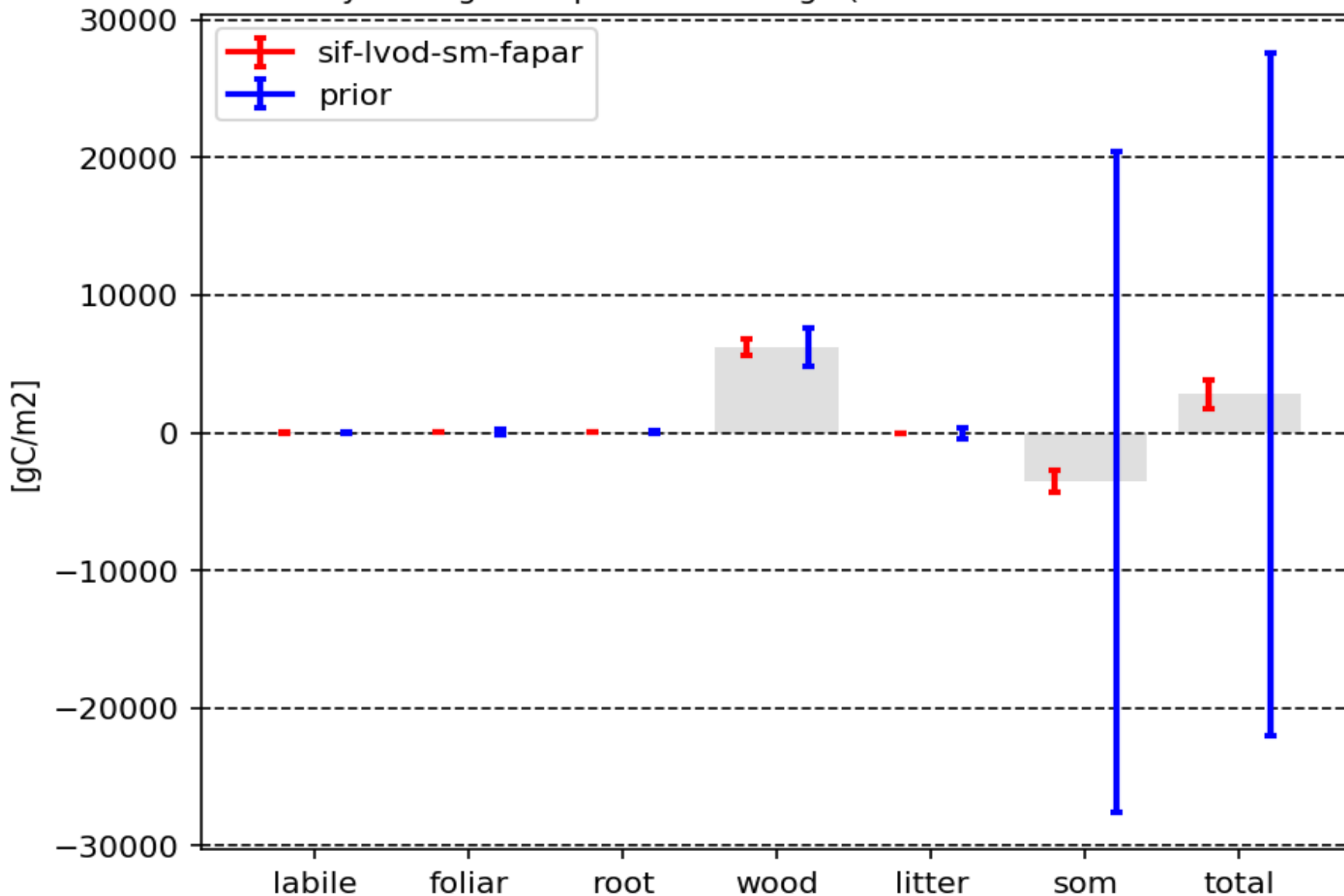
2035

2040



Example: Majadas de Tietar Hypothetical Intervention

uncertainty in long-term pool size change (difference intervention-baseline)



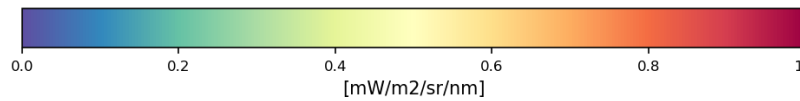
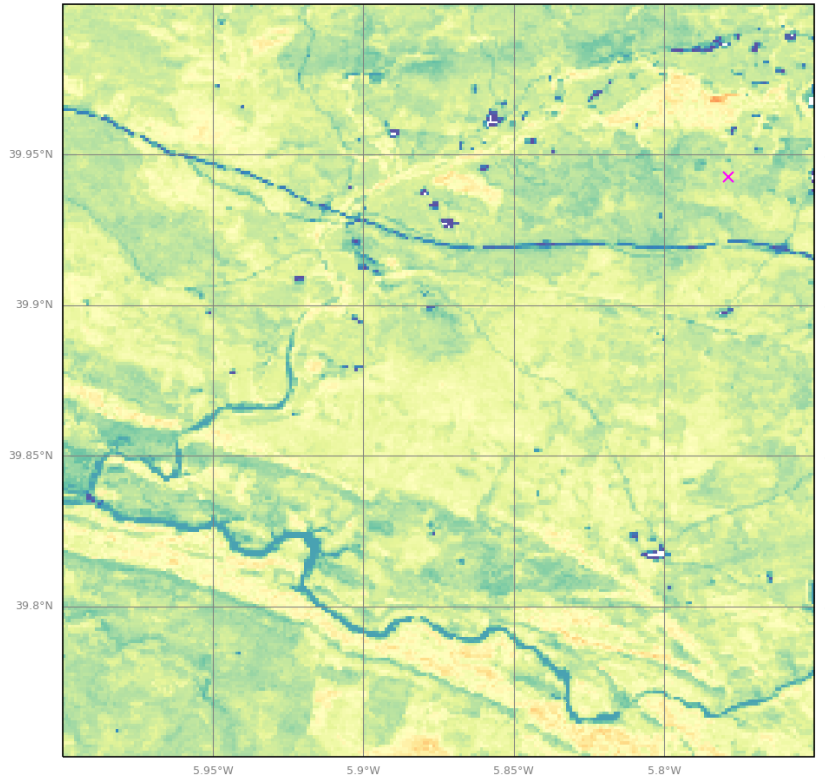
Difference in pool size changes over 25 years (intervention-baseline)



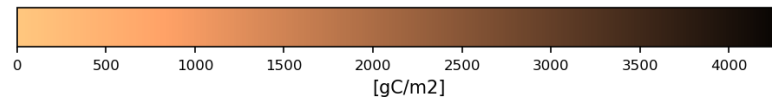
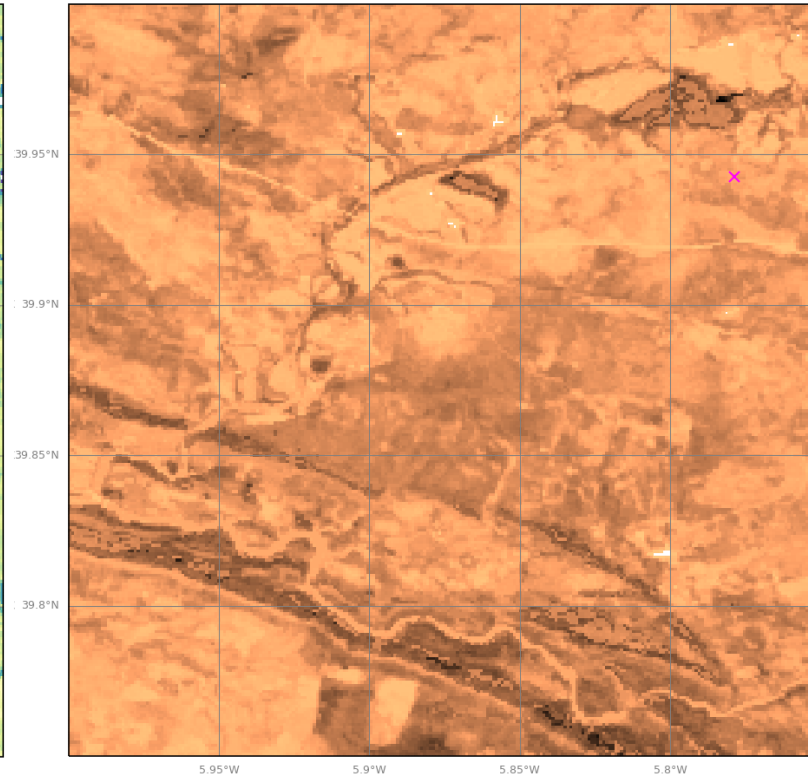
Posterior simulation at high resolution over a region in Spain

SIF (left), Woody biomass (middle), NEE (right) at 100m

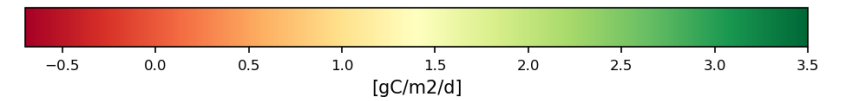
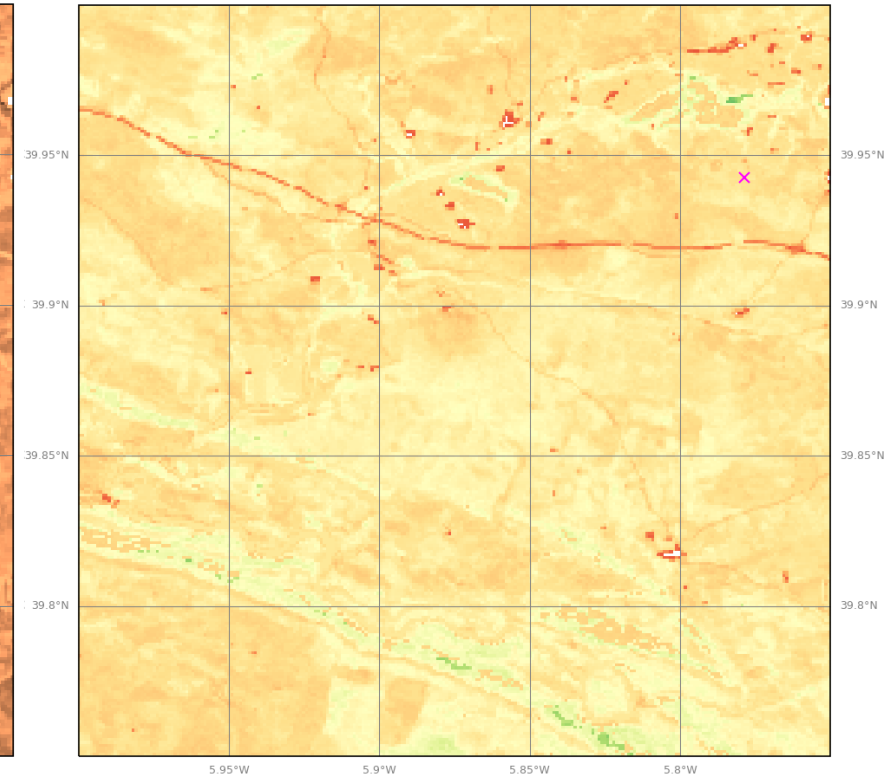
D&B simulated sif743 (20180901)



D&B simulated woody_biomass (20180901)



D&B simulated nee (20180901)





Assimilation example: Lapland

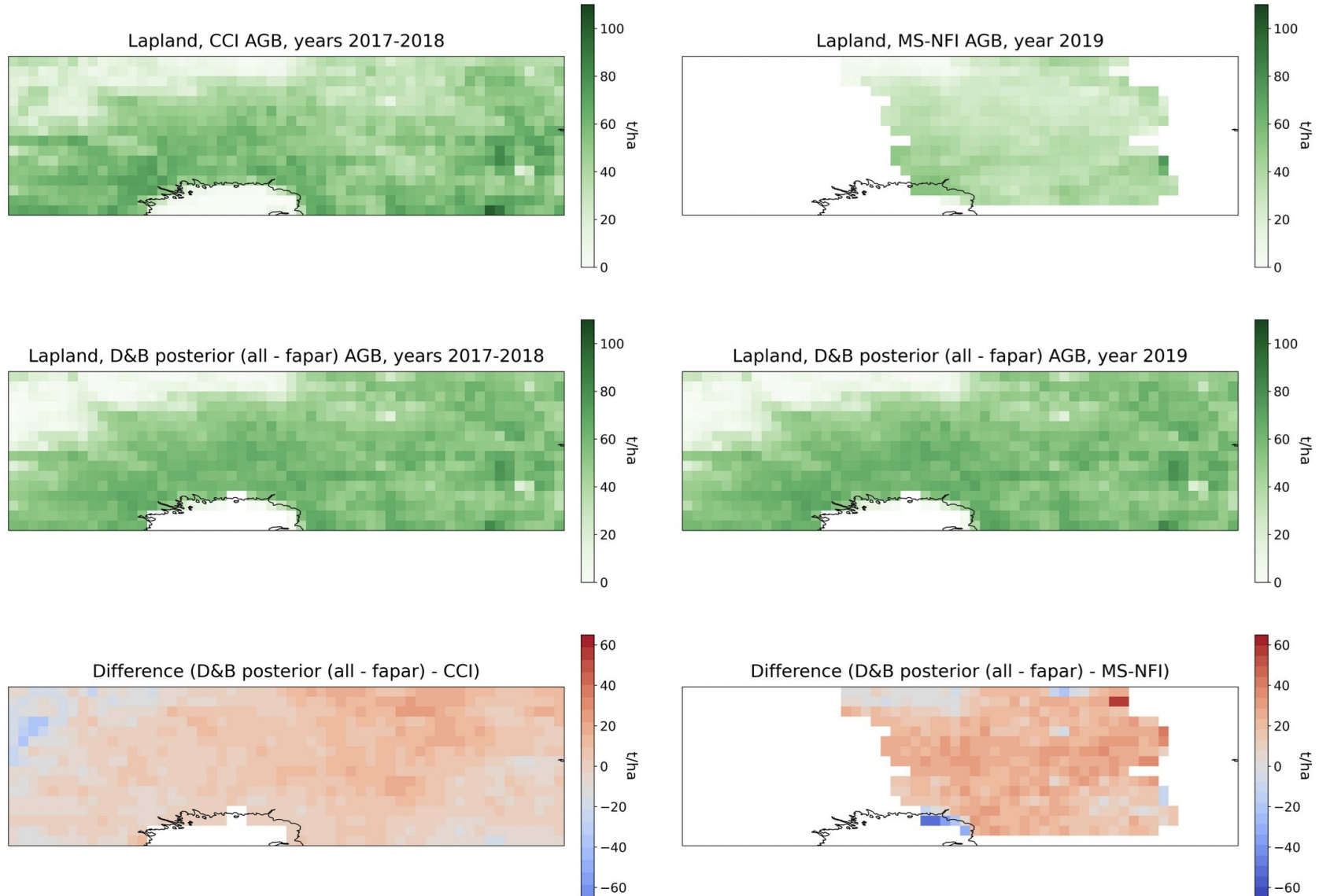
- **Local scale: ICOS site Sodankylä**
- Regional scale: 500 km x 500 km area around the site at 0.25 deg resolution
- Spin up 2015/16, assimilation window 2017-21
- Prior Uncertainty: 20% for all process parameters and 80% for all initial pool sizes
- **Joint assimilation of:**
 - surface layer soil moisture (SMOS)
 - **L-VOD (SMOS)**
 - **FAPAR (JRC-TIP)**
 - SIF (TROPOMI)





Assimilation at regional scale example: Lapland

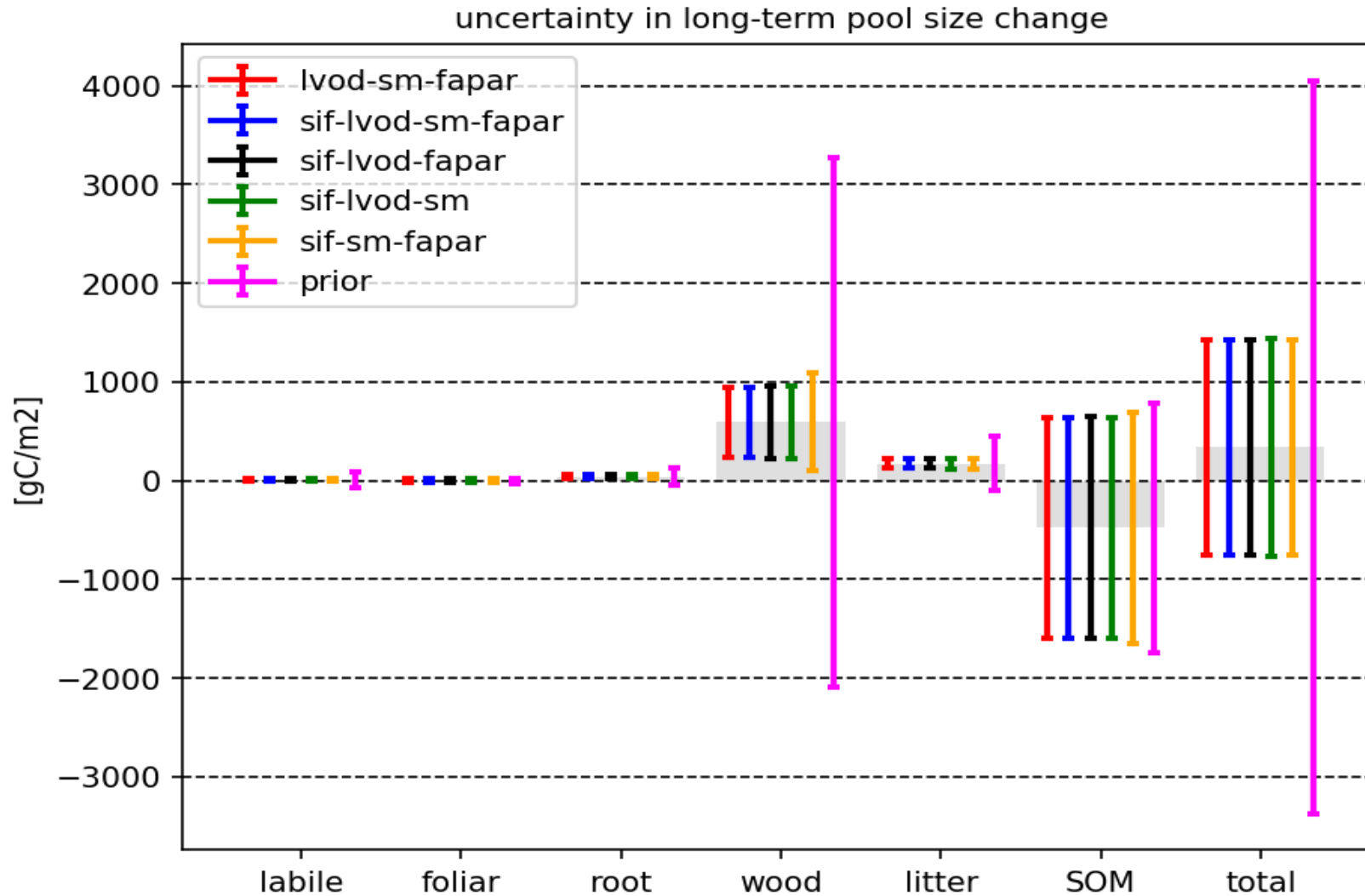
Posterior validation against two AGB products





Assessment of information content at local scale, Sodankylä

Reduction in uncertainty relative to prior of increase in carbon pools over integration period





Summary and further information

Summary

- **TCCAS provides an integrated perspective on carbon, water and energy cycles**
- **Combines information from multiple missions (synergy) with D&B process understanding**
- **Can monitor relevant variables – including gross and net carbon fluxes - in space and time**
- **Particularly suited to assess potential interventions and additionality of observations**
- **Documented and Open Source**

Further information

- **[hps://tccas.inversion-lab.com](https://tccas.inversion-lab.com)**



iLab



THANK YOU!

<https://avengers-project.eu>

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