Terrestrial Carbon Community Assimilation System

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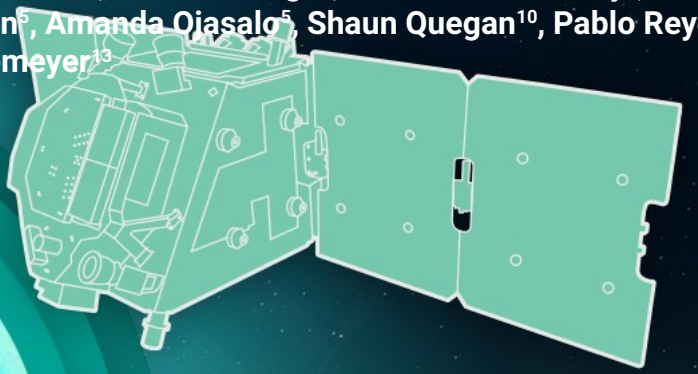
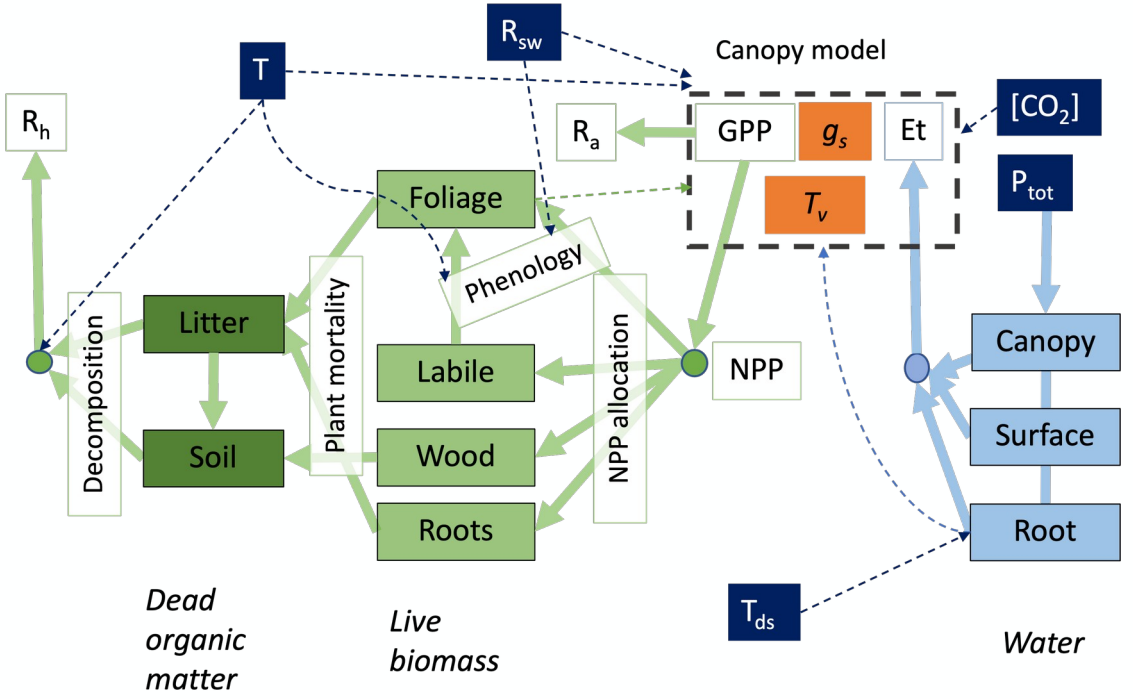


4th annual Land Data Assimilation (DA) Community Virtual Workshop on “Developments in Land Data Assimilation”
June 25, 2024

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 is being funded through the carbon cluster of the European Space Agency



Current TCCAS team

Terrestrial Carbon Community Assimilation System Study

Project | Partners | Publications | Internal | Contact

Partners

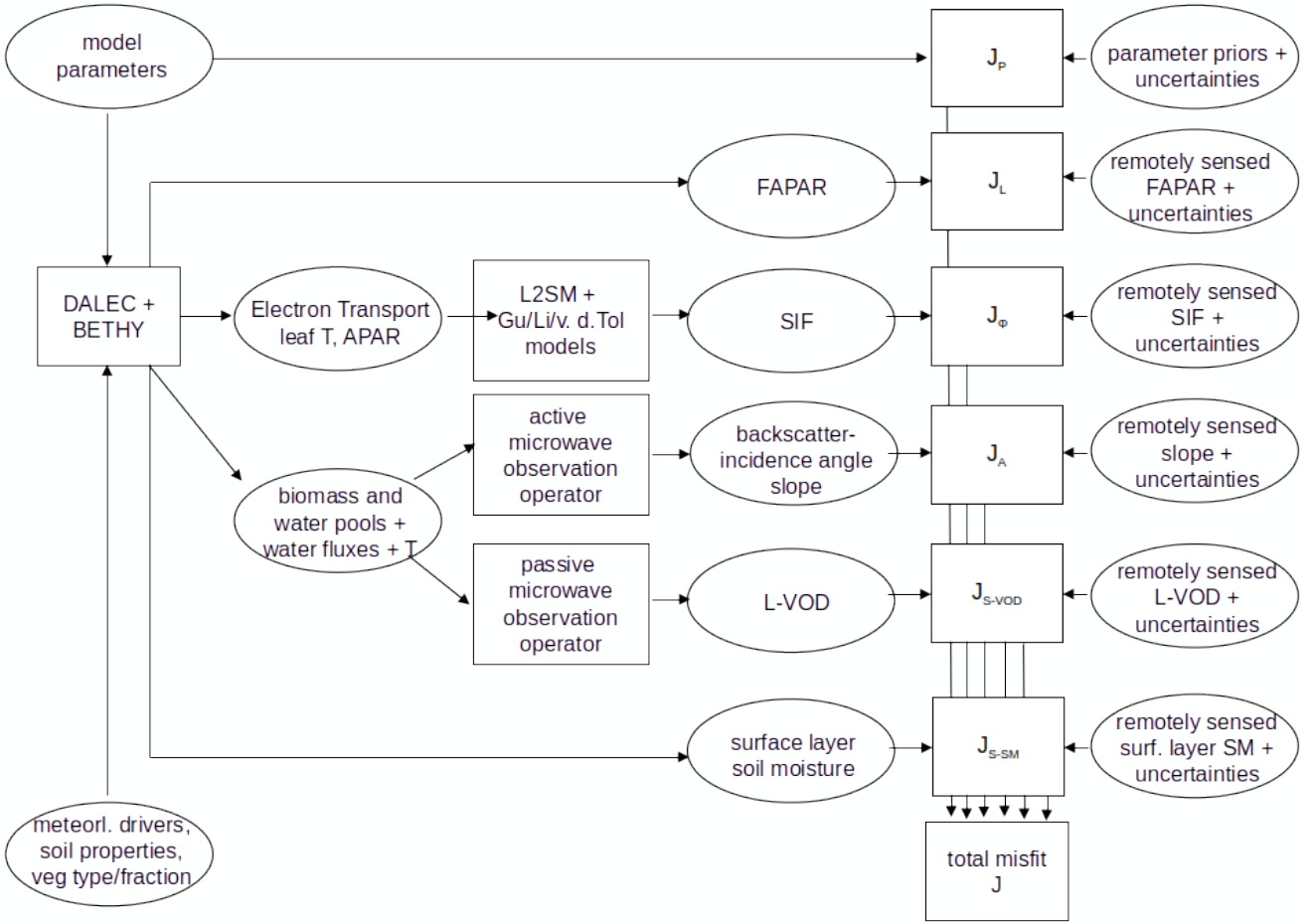
https://tccas-study.inversion-lab.com

The contact points for the individual partners are:

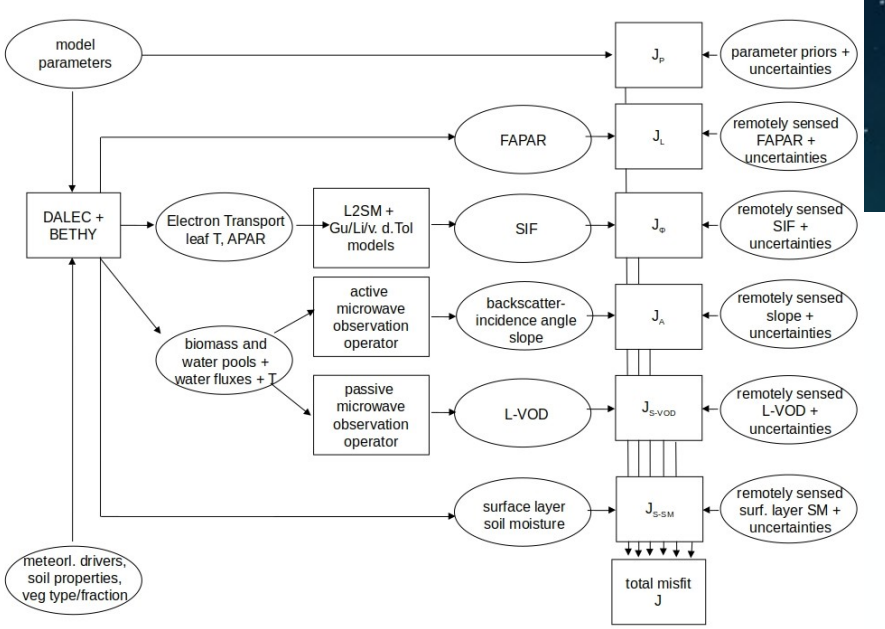
Contact	Company/Organisation	Country
Thomas Kaminski (coordinator)	The Inversion Lab	Germany
Marko Scholze	Lund University	Sweden
Tea Thum	Finnish Meteorological Institute	Finland
Tristan Quaife	University of Reading	UK
Mathew Williams	University of Edinburgh	UK
Sönke Zaehle	Max Planck Institute for Biogeochemistry	Germany

What does TCCAS offer?

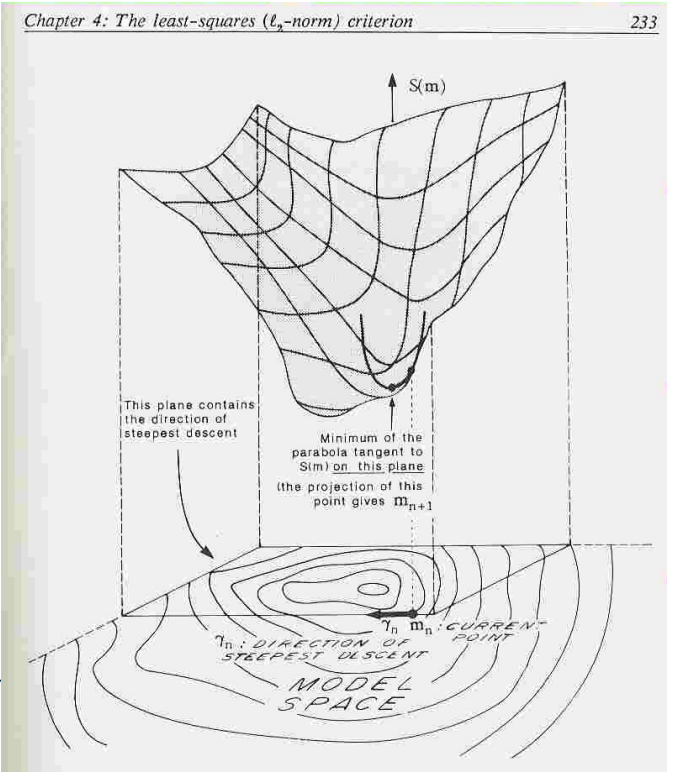
- Open source community system
- Observation operators for optical as well as active and passive microwave observations
- Assimilation on the footprint
- Tangent and adjoint codes
- Modular setup
- Computational efficiency
- Tested on point to regional scales
- Experienced developer team
- Documentation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



Variational Data Assimilation



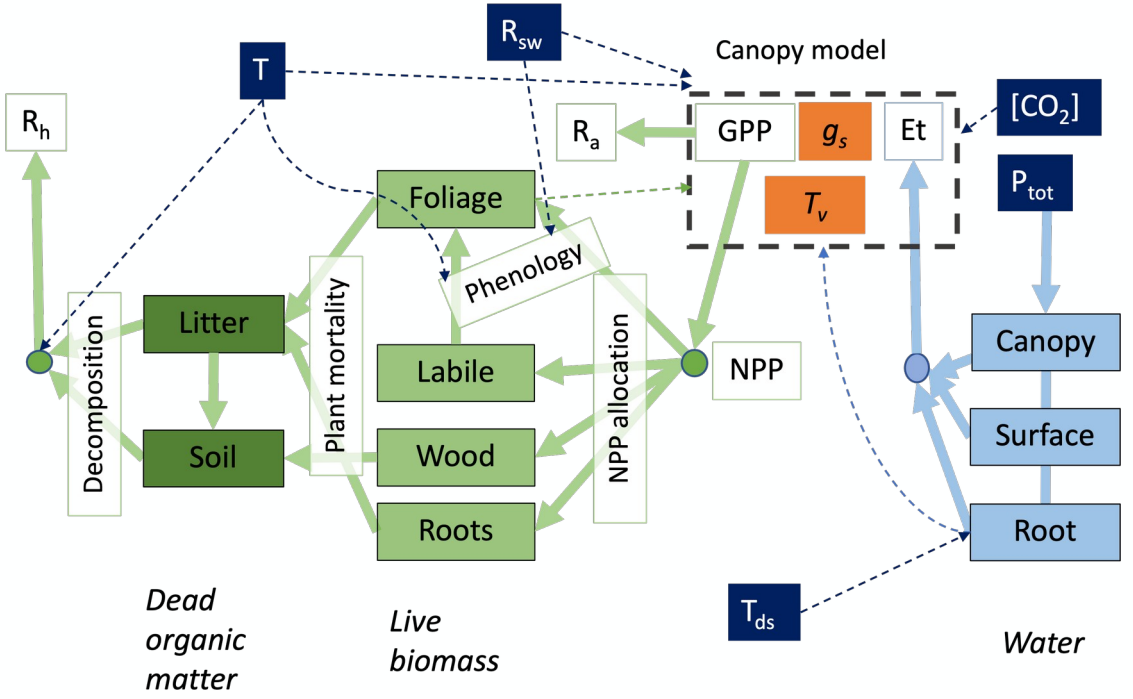
- Assimilating all data in one long assimilation window (need to constrain slow processes)
- Minimisation of a cost function J(x) of a set of process parameters (in core model and observation operators) and initial pool sizes
- Minimisation algorithm uses gradient of J(x) with respect to x
- Gradient efficiently provided by adjoint of D&B



Tarantola 1987

News

- Manuscript on D&B submitted to GMD
- 2 new SIF models
- revised L-VOD observation operator
- Manual
- Will open GitLab repository in next days
- Training



Model and Observation Operators

SIF

- Leaf level source: Gu et al. (2019)
- RT: L2SM, Tristan Quaife
- Spectral conversion: Oak or Pine spectra observed by Magney and Frankenberg (2019)

$$S_n = s_{SIF} J_n \frac{1 - \psi_{PSIImax}}{q_L \psi_{PSIImax} (1 + k_{DF})}$$

- Alternative Leaf level source (TCCAS manual):
  - Van der Tol et al. (2014) or
  - Li et al. (2019)

A comprehensive land surface vegetation model for multi-stream data assimilation, D&B v1.0

Wolfgang Knorr[1], Matthew Williams[2], Tea Thum[3], Thomas Kaminski[1], Michael Voßbeck[1], Marko Scholze[4], Tristan Quaife[5], T. Luke Smallman[2], Susan C. Steele-Dunne[6], Mariette Vreugdenhil[7], Tim Green[2], Sönke Zähle[8], Mika Aurela[3], Alexandre Bouvet[9], Emanuel Bueechi[7], Wouter Dorigo[7], Tarek S. El-Madany[8], Mirco Migliavacca[8,9], Marika Honkanen[3], Yann H. Kerr[10], Anna Kontu[3], Juha Lemmetyinen[3], Hannakaisa Lindqvist[3], Arnaud Mialon[10], Tuuli Miinalainen[3], Gaetan Pique[10], Amanda Ojasalo[3], Shaun Quegan[11], Peter. J. Rayner[1], Pablo Reyez-Muñoz[12], Nemesio Rodríguez-Fernández[9], Mike Schwank[13], Jochem Verrelst[12], Songyan Zhu[2], Dirk Schüttemeyer[14], and Matthias Drusch[14]

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[4]Lund University, Lund, Sweden
[5]University of Reading, Reading, UK
[6]Department of Geosciences and Remote Sensing, Delft University of Technology, The Netherlands
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[8]Max-Planck Institute for Biogeochemistry, Jena, Germany
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[10]Centre d'études Spatiales de la Biosphère (CESBIO), Université de Toulouse 3 Paul Sabatier, Centre National de la Recherche Scientifique, Centre National d'Etudes Spatiales, Institut de Recherche pour le Développement, Institut National de Recherches pour l'Agriculture, l'Alimentation et l'Environnement, Toulouse, France
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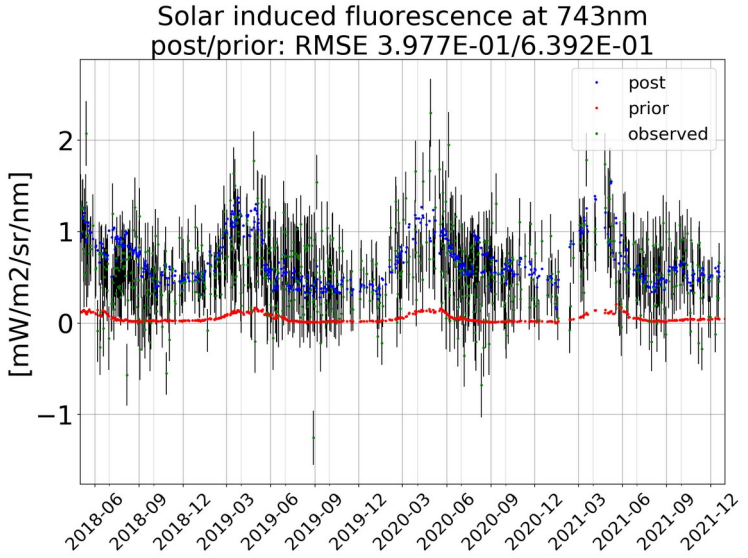
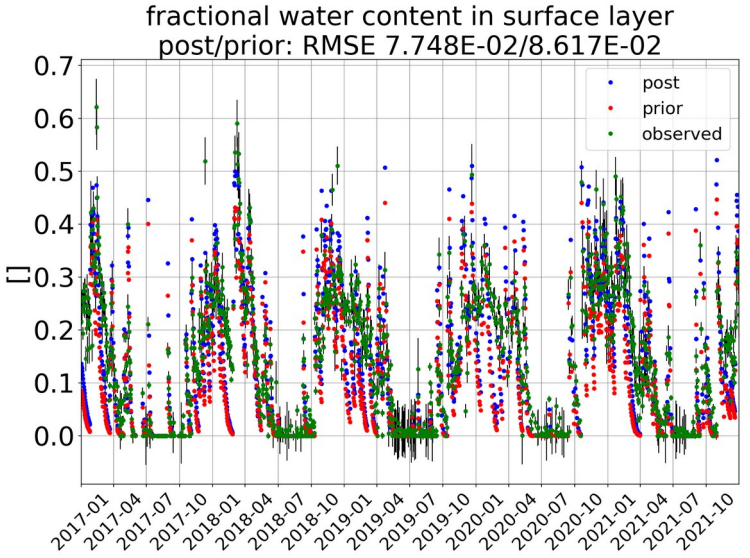
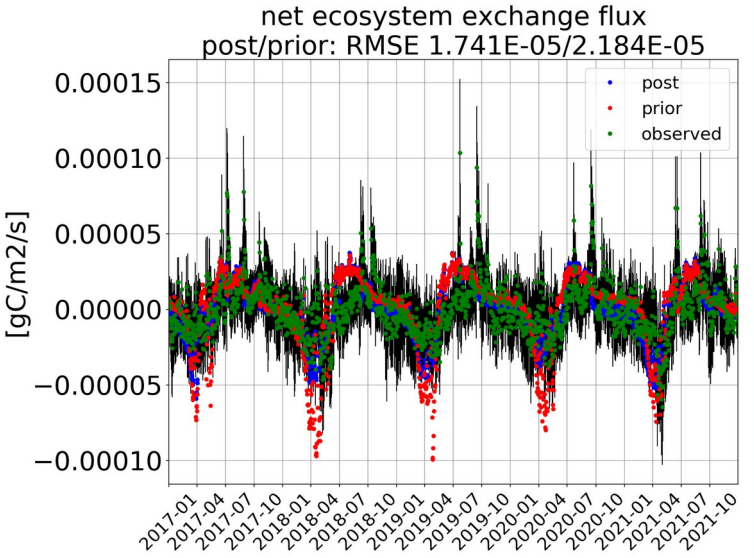
Abstract. Advances in Earth Observation capabilities mean that there is now a multitude of spatially resolved data sets available that can support the quantification of water and carbon pools and fluxes at the land surface. However, such quantification ideally requires efficient synergistic exploitation of those data, which in turn requires carbon and water land-surface models with the capability to simultaneously assimilate several of such data streams. The present article discusses the requirements for such a model and presents one such model based on the combination of the existing DALEC land vegetation carbon cycle model with the BETHY land-surface and terrestrial vegetation scheme. The resulting D&B model, made available as a community model, is presented together with a comprehensive evaluation for two selected study sites of widely varying climate. We then demonstrate the concept of land surface modelling aided by data streams that are available from satellite remote sensing. Here we present D&B with four observation operators that translate model-derived variables into measurements available from such data streams, namely: fraction of photosynthetically active radiation (FAPAR), solar-induced chlorophyll fluorescence

Example: Las Majadas de Tietar
Assimilation (left/middle) and validation (right) variables

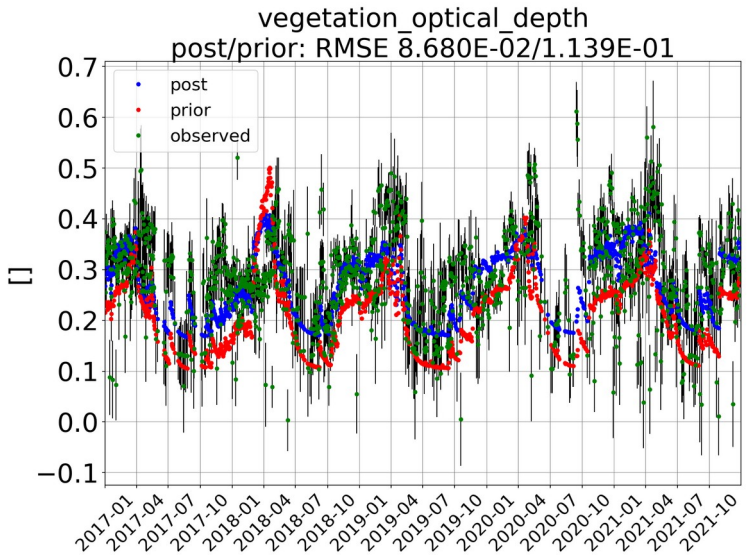
scots pine spectra, new observation operator for L-VOD

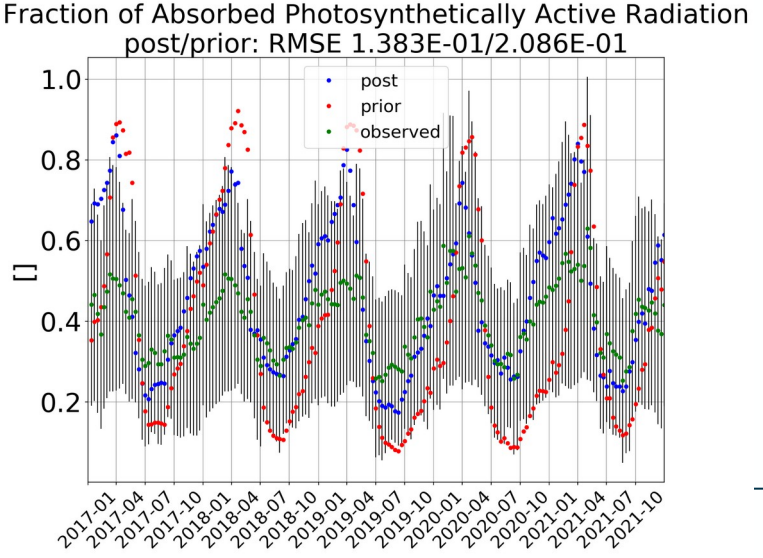




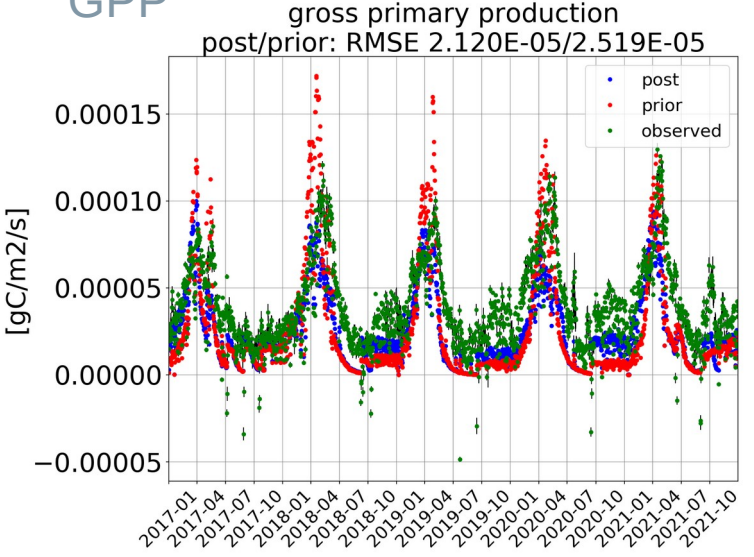


Obs (green), prior (red), posterior (blue)



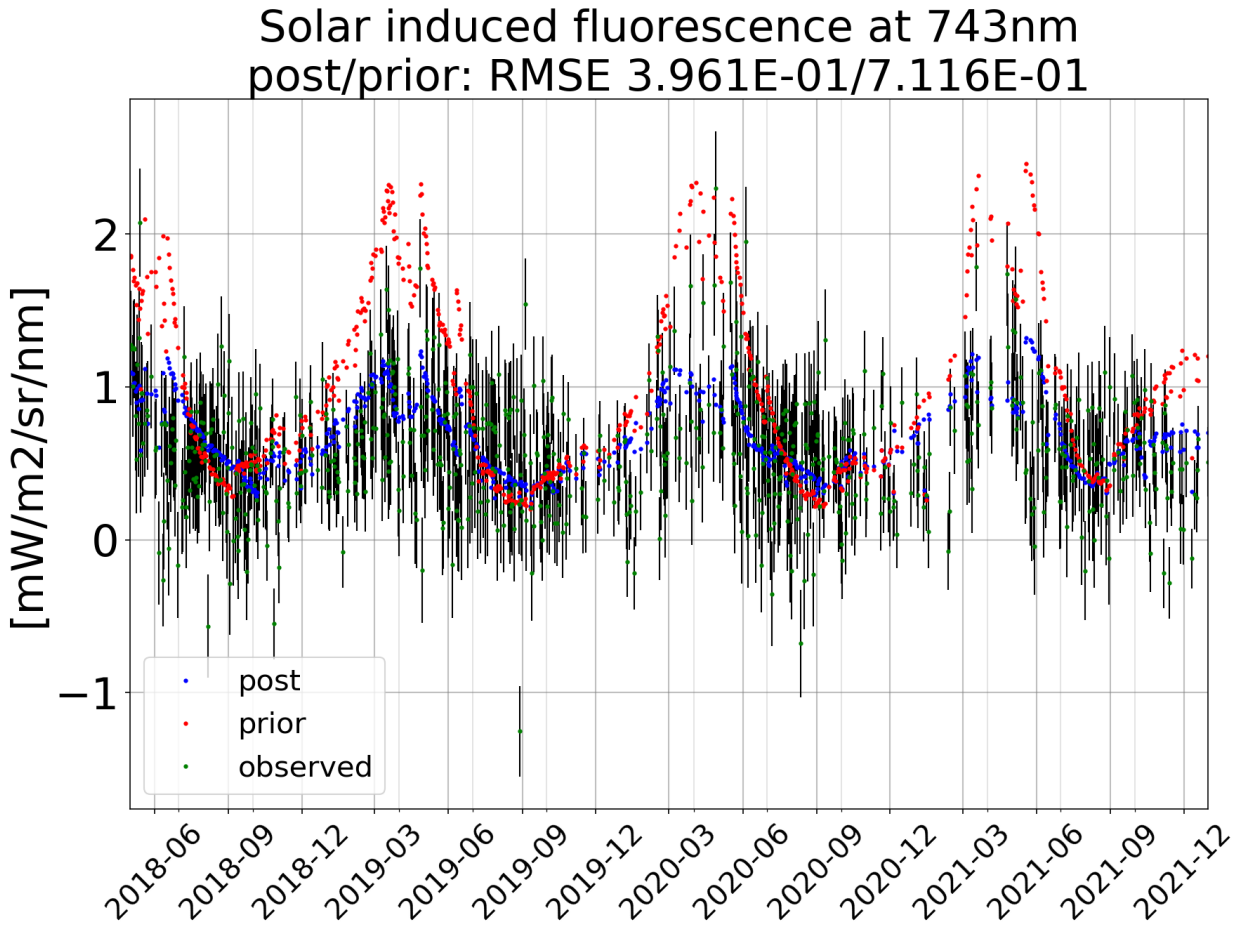


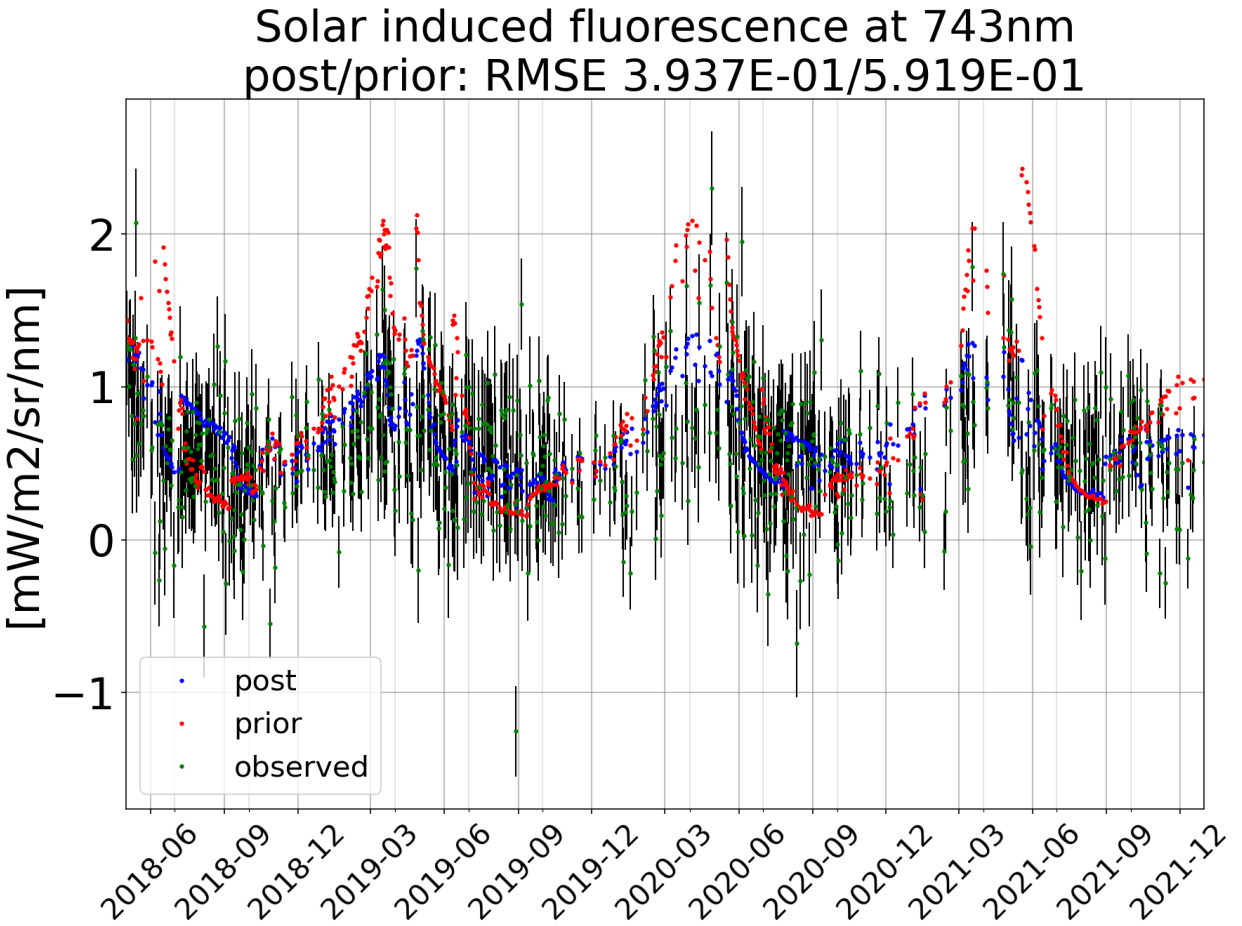
GPP



Example: Las Majadas de Tietar
Assimilation with van der Tol (left) and Li (right) source terms

conversion with Oak spectra





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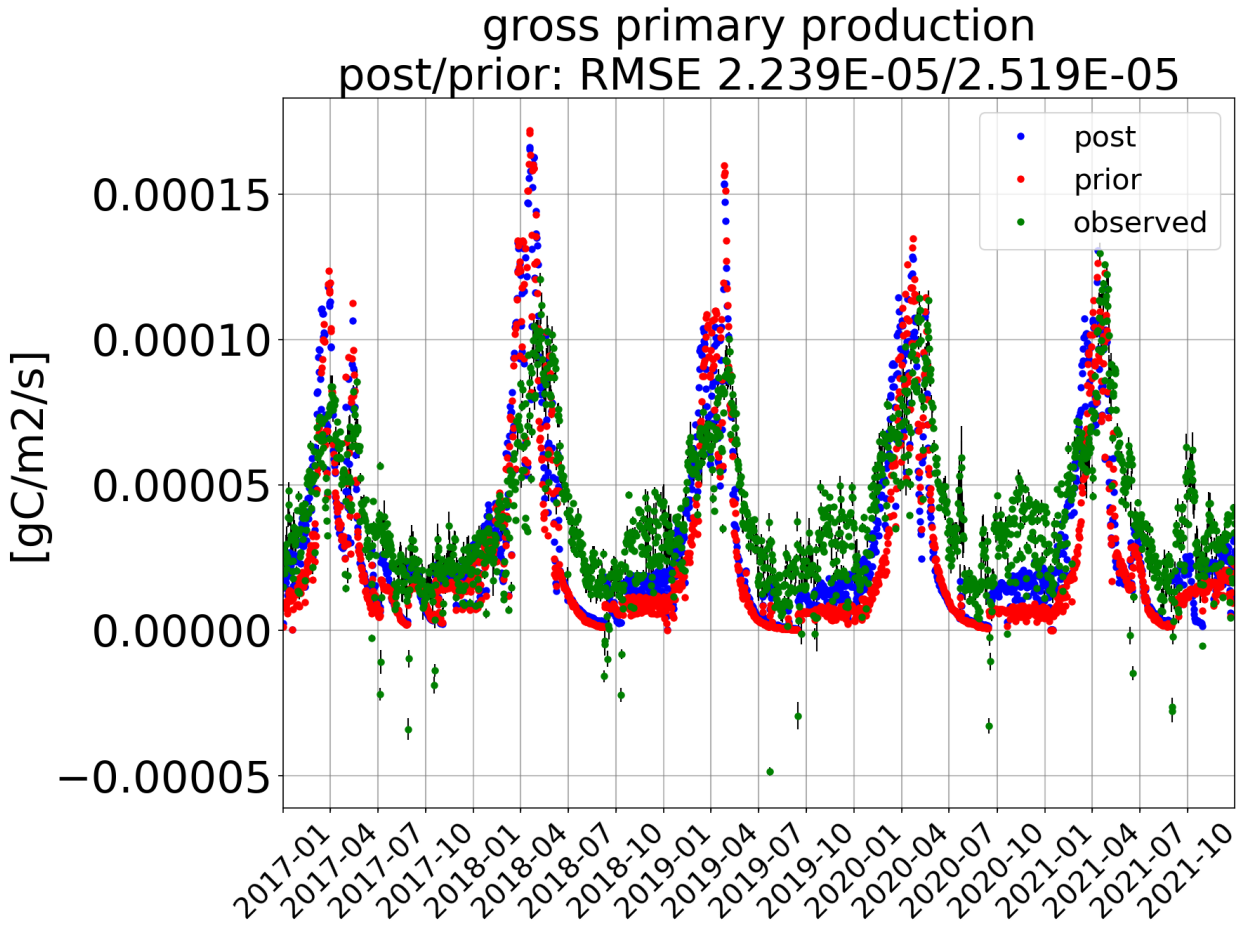
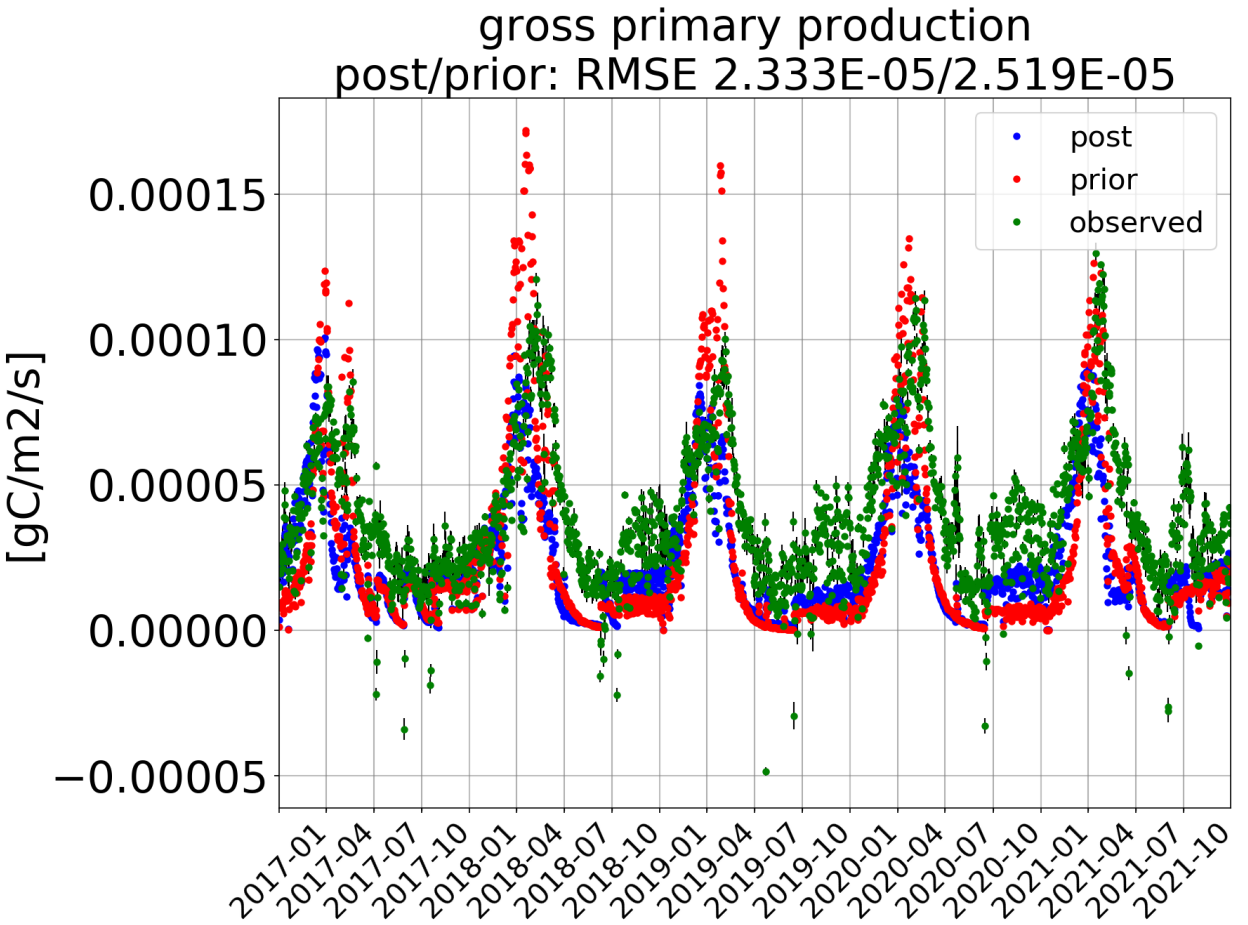
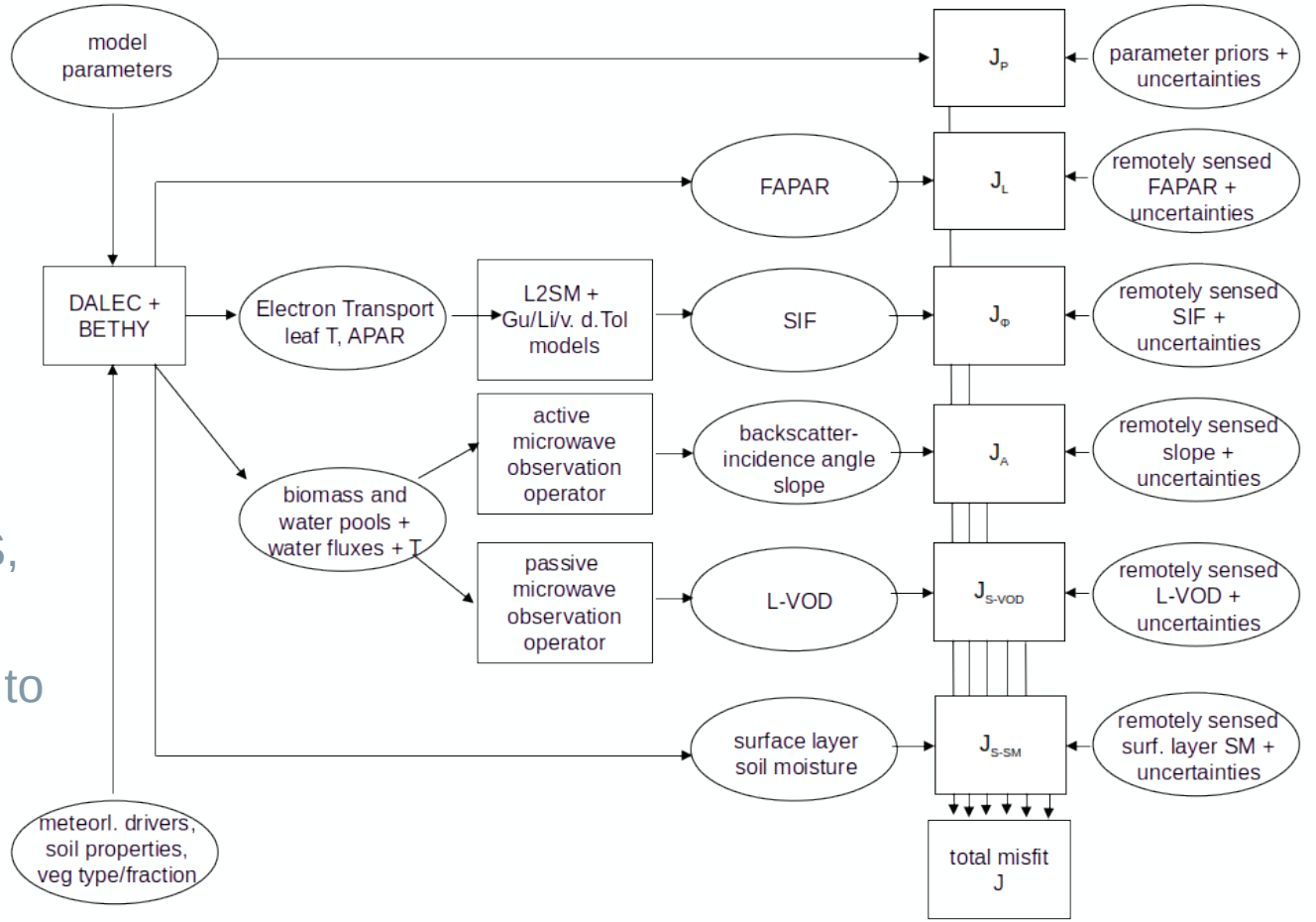




TCCAS training event

- Dates: October 7 and 8, 2024
- Format: Lectures and hands-on work on a central computing platform
- Forms of participation: Hybrid or at ESRIN in Italy
- Content: Terrestrial Carbon Cycle, D&B terrestrial biosphere model, Observation Operators, TCCAS
- Target Audience: From student to senior researcher/professor
- Organisers: ESA's Carbon Science Cluster, AIMES, and project team
- Fee: Participation is free, on site participants need to organise their travel and accomodation
- Application: As soon as possible and via https://tccas-study.inversion-lab.com/training.html
- Notification of Acceptance: August 28, 2024



Further Information

- Hybrid user training event on October 7 and 8; Application opens tomorrow
- https://tccas-study.inversion-lab.com
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- Thomas.Kaminski@Inversion-Lab.com