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Assimilation of fluorescence products to constrain gross primary production in the terrestrial biosphere model ORCHIDEE

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Since a few years solar-induced fluorescence (SIF) products derived from satellite observations are available at global scale. They show a very high correlation with the mean-tree ensemble FLUXNET GPP global product at large spatial and temporal scales, relevant to terrestrial biosphere models (TBMs). Hence, assimilation of fluorescence appears as a promising way to constrain gross primary production (GPP) simulated by TBMs. We have thus led several studies to explore the potentials of space-borne SIF products for reducing the uncertainty in the uptake of carbon by vegetation at global scale.

(i) Comparing several SIF products, we have investigated the possible impact of their differences on model parameter optimization.
(ii) We have developed a processed-based fluorescence model in the ORCHIDEE TBM (from the leaf to the canopy level), allowing calibrating the model with respect to in situ or space-borne fluorescence observations.
(iii) We have assimilated OCO-2 and GOME-2 SIF products at global scale using this mechanistic SIF model and also using a simpler linear model between SIF and GPP.

We assess the uncertainty reduction on GPP following the assimilation of SIF data, and analyse the results of our model simulations and assimilations in the context of the major remaining questions in the carbon cycle community relating to global carbon uptake, including the bias in mean global GPP in models, the partitioning of GPP between tropical and high latitude forests, and plant phenology.

We discuss the challenges and opportunities we face in using SIF data to constrain TBMs and the benefits of SIF with regards to other available observations.