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On the additional information content of hyperspectral remote sensing data for estimating ecosystem carbon dioxde and energy exchange

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Radiation reflected back from an ecosystem carries a spectral signature resulting from the interaction of radiation with the vegetation canopy and the underlying soil and thus allows drawing conclusions about the structure and functioning of an ecosystem. When this information is linked to a model of the leaf CO_2 exchange, the ecosystem-scale CO_2 exchange can be simulated. A well-known and very simplistic example for this approach is the light-use efficiency (LUE) model proposed by Monteith which links the flux of absorbed photosynthetically active radiation times a LUE parameter, both of which may be estimated based on remote sensing data, to predict the ecosystem gross photosynthesis.

Here we explore the ability of a more elaborate approach by using near-surface remote sensing of hyperspectral reflected radiation, eddy covariance CO_2 and energy flux measurements and a coupled radiative transfer and soil-vegetation-atmosphere-transfer (SVAT) model. Our main objective is to understand to what degree the joint assimilation of hyperspectral reflected radiation and eddy covariance flux measurements into the model helps to better constrain model parameters. To this end we use the SCOPE model, a combination of the well-known PROSAIL model and a SVAT model, and the Bayesian inversion algorithm DREAM. In order to explicitly link reflectance in the visible light and the leaf CO_2 exchange, a novel parameterisation of the maximum carboxylation capacity parameter (Vcmax) on the leaf a+b chlorophyll content parameter of PROSAIL is introduced. Results are discussed with respect to the additional information content the hyperspectral data yield for simulating canopy photosynthesis.