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Integration of flux tower data and remotely sensed data into the SCOPE simulator: A Bayesian approach

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Quantification of gross primary production (GPP) together with the continuous monitoring of its temporal variations are indispensable to obtain reliable data for indicating the capacity of forests to sequester carbon. GPP can be quantified using two sources: (a) process-based simulator (PBS); and (b) flux tower measurements of the net ecosystem exchange (NEE) of CO₂. Additionally, remotely sensed optical data, which can be linked to the vegetation properties, carry valuable information to express canopy photosynthesis (i.e., GPP). A PBS has an advantage over flux tower and remotely sensed optical data because it can be run at time scales beyond the limit of direct measurements. Simulation of GPP by PBS at a high accuracy, however, depends upon how well the parameterization is achieved. A process-based simulator SCOPE (Soil-Canopy-Observation of Photosynthesis and Energy balance) links top of canopy observations of radiance with land surface processes (that include GPP simulation). Some parameters of SCOPE are difficult to obtain from field observations. Reliable estimates of parameters can, however, be obtained using calibration against observations of output. In this study, we present a Bayesian framework to calibrate SCOPE simulator against the estimates of GPP (separated from NEE), and the top of canopy reflectance retrieved from the remote sensing images. This framework has been tested for spruce dominated forest site at Bílý Kříž, Czech Republic. We focus on the retrieval of parameters, on which GPP are expected to be most sensitive, such as leaf area index, leaf chlorophyll content, leaf water content, leaf dry matter content, senescent material content, maximum carboxylation capacity, and stomatal conductance. A Bayesian framework also allowed to estimate the uncertainties of both the SCOPE parameters and the simulated GPP, which is important in the sense that it helps to determine how much confidence can be placed in the results of forest carbon-related studies.