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Integrating ecosystems measurements from multiple eddy-covariance sites to a simple model of ecosystem process - Are there possibilities for a uniform model calibration?

Francesco Minunno (1), Mikko Peltoniemi (2), Samuli Launiainen (2), and Annikki Mäkelä (1)

(1) University of Helsinki, Department of Forest Sciences, Finland (francesco.minunno@helsinki.fi), (2) METLA, Forest Finnish Institute

Biogeochemical models quantify the material and energy flux exchanges between biosphere, atmosphere and soil, however there is still considerable uncertainty underpinning model structure and parametrization. The increasing availability of data from of multiple sources provides useful information for model calibration and validation at different space and time scales.
We calibrated a simplified ecosystem process model PRELES to data from multiple sites. In this work we had the following objective:
to compare a multi-site calibration and site-specific calibrations, in order to test if PRELES is a model of general applicability, and to test how well one parameterization can predict ecosystem fluxes.
Model calibration and evaluation were carried out by the means of the Bayesian method; Bayesian calibration (BC) and Bayesian model comparison (BMC) were used to quantify the uncertainty in model parameters and model structure. Evapotranspiration (ET) and gross primary production (GPP) measurements collected in 9 sites of Finland and Sweden were used in the study; half dataset was used for model calibrations and half for the comparative analyses.
10 BCs were performed; the model was independently calibrated for each of the nine sites (site-specific calibrations) and a multi-site calibration was achieved using the data from all the sites in one BC. Then 9 BMCs were carried out, one for each site, using output from the multi-site and the site-specific versions of PRELES.
Similar estimates were obtained for the parameters at which model outputs are most sensitive. Not surprisingly, the joint posterior distribution achieved through the multi-site calibration was characterized by lower uncertainty, because more data were involved in the calibration process. No significant differences were encountered in the prediction of the multi-site and site-specific versions of PRELES, and after BMC, we concluded that the model can be reliably used at regional scale to simulate carbon and water fluxes of Boreal forests.
Despite being a simple model, PRELES provided good estimates of GPP and ET; only for one site PRELES multi-site version underestimated water fluxes. Our study implies convergence of GPP and water processes in boreal zone to the extent that their plausible prediction is possible with a simple model using global parameterization.