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Bayesian calibration of DailyDayCent model to quantify parameter uncertainty and its effects on greenhouse gas simulations

Jagadeesh B. Yeluripati (1), Marcel van Oijen (2), David Cameron (2), Mark L.A. Richards (1), and Pete Smith (1)

(1) Institute of Biological & Environmental Sciences, School of Biological Sciences, University of Aberdeen, Cruickshank Building, St Machar Drive, Aberdeen, AB24 3UU, Scotland, UK (j.yeluripati@abdn.ac.uk), (2) Centre for Ecology and Hydrology, Bush Estate, Midlothian, Penicuik, EH26 0QB, Scotland, UK

The amount of greenhouse gases (GHG) emitted by human activity that remains in the atmosphere is controlled by C and N cycle processes on the land and in the ocean. To evaluate the source or sink strength of GHG emissions or removals requires a capacity to predict GHGs in relation to environmental conditions and land use change. Biophysical models simulating the dynamics of carbon and nitrogen have a unique potential to explore these relationships, but are fraught with high uncertainties in their parameters due to their variations over time and space. A sound and feasible methodology to characterize current and predictive uncertainties in dynamic carbon models is crucial for the design of efficient GHG mitigation strategies. In this study, we demonstrated such a methodology by performing a Bayesian calibration of the DailyDayCent model utilising data from a Forest site (Hoeglwald, Germany) to estimate and reduce the uncertainties associated with the key soil carbon and nitrogen cycle parameters. We used Bayesian calibration by means of the Metropolis–Hastings algorithm , and used this method to calibrate the model parameters of soil organic C and N process against measurements. Bayesian calibration combines prior information about the parameters and measured data on model output variables, to obtain a revised (posterior) probability distribution for the parameters. The model performed much better after calibration of these parameters than with default parameterisation. Posterior distributions for carbon cycle parameters were narrowed down, thus decreasing parameter uncertainty.