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Modeling N_2O emission from forest soils: A procedure for an automatic calibration of the biogeochemical model Forest-DNDC

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During the last decades, decision makers and policy have increasingly demanded for regional and national inventories of greenhouse gas emissions, such as nitrous oxide (N_2O). Total global N_2O emission from temperate forest soils are estimated to be in the range of 0.1-2.0 Tg N yr^{-1}, or 7 % of the global atmospheric N_2O budget. However, particular at larger scale estimates of N_2O emission have still a high degree of uncertainty due to the temporal, spatial and inter-annual variability of N_2O fluxes. One potential way to overcome this shortcoming is the use of process-based models, such as PnET-N-DNDC or Wetland-DNDC. However, so far, no efforts have been made to automatically calibrate such biogeochemical models. In most studies model calibration is done manually by trial and error. This procedure is time consuming and does not necessarily yield optimal parameters. In the present study, we demonstrate a procedure for an automatic calibration of the Forest-DNDC model. We linked Forest-DNDC with a computer code for universal inverse modelling (UCODE). We calibrated and validated the Forest-DNDC model on the basis of a 4-year field data set of one upland (Endoskeletic cambisol) and two water-logged soils (Humic Gleysol, Histic Gleysol) of a spruce forest ecosystem in the Central Black Forest. Our results show that the software linkage between Forest-DNDC and UCODE yields a useful tool for model calibration. The calibration using inverse techniques considerably improved model performance during the period of calibration (2001-2002) by reducing the error variance by up to a factor of two. For the validation period (2003-2004) and notably for the extremely dry summer in 2003, however, model performance was still partly unsatisfying, in particular with regard to the temporal emission pattern.