Geophysical Research Abstracts
Vol. 19, EGU2017-18889, 2017
EGU General Assembly 2017

Full uncertainty quantification of N_2O and NO emissions using the biogeochemical model LandscapeDNDC on site and regional scale

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Numerical simulation models are increasingly used to estimate greenhouse gas emissions at site to regional / national scale and are outlined as the most advanced methodology (Tier 3) in the framework of UNFCCC reporting. Process-based models incorporate the major processes of the carbon and nitrogen cycle of terrestrial ecosystems and are thus thought to be widely applicable at various conditions and spatial scales. Process based modelling requires high spatial resolution input data on soil properties, climate drivers and management information. The acceptance of model based inventory calculations depends on the assessment of the inventory's uncertainty (model, input data and parameter induced uncertainties). In this study we fully quantify the uncertainty in modelling soil N_2O and NO emissions from arable, grassland and forest soils using the biogeochemical model LandscapeDNDC. We address model induced uncertainty (MU) by contrasting two different soil biogeochemistry modules within LandscapeDNDC. The parameter induced uncertainty (PU) was assessed by using joint parameter distributions for key parameters describing microbial C and N turnover processes as obtained by different Bayesian calibration studies for each model configuration. Input data induced uncertainty (DU) was addressed by Bayesian calibration of soil properties, climate drivers and agricultural management practices data. For the MU, DU and PU we performed several hundred simulations each to contribute to the individual uncertainty assessment. For the overall uncertainty quantification we assessed the model prediction probability, followed by sampled sets of input datasets and parameter distributions. Statistical analysis of the simulation results have been used to quantify the overall full uncertainty of the modelling approach. With this study we can contrast the variation in model results to the different sources of uncertainties for each ecosystem. Further we have been able to perform a fully uncertainty analysis for modelling N_2O and NO emissions from arable, grassland and forest soils necessary for the comprehensibility of modelling results. We have applied the methodology to a regional inventory to assess the overall modelling uncertainty for a regional N_2O and NO emissions inventory for the state of Saxony, Germany.