EGU21-12249
https://doi.org/10.5194/egusphere-egu21-12249
EGU General Assembly 2021

Modelling of greenhouse gas emissions from European croplands with the biogeochemical model ECOSSE

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Greenhouse gas (GHG) emissions contribute to climate change. Agricultural production contributes 10 – 14 % of the global anthropogenic GHG emission, including 37 % from soils (Paustian et al., 2016). Monitoring and analysis of emissions from agriculture is the basis for reducing GHG emissions and applying mitigation options. Measuring and estimating emissions from the agricultural sector are challenging and modelling is a useful tool to capture the heterogeneity of the dynamics. Agricultural management is the main driver for the carbon and nitrogen dynamics in croplands, which makes model approaches difficult, as potentially there is great heterogeneity in the influencing factors, but also a lack of robust data for management data for larger scales. Additionally, measurements of GHG emissions are scarce, on small (spatial and temporal) scales, or do not reflect the entire range of system variable combinations. This hinders the evaluation of large scale simulation results. The objective of the study was to simulate the GHG emissions (CO_2 and N_2O) for European croplands and use national inventory data for the evaluation of the results. We used the model ECOSSE which is based on the carbon model RothC and the nitrogen model SUNDIAL. For yield production, the primary production model MIAMI is coupled with ECOSSE. The model structure allows small scale differences (resolution for simulation is 0.1°) to be captured, while simulating monthly time steps. This balances the uncertainty of the available input data with the accuracy of the simulated results. The model shows reasonable results for the CO_2 emissions, but underestimates heterotrophic respiration, which leads to an overestimation of carbon fluxes to the soil. Nitrogen emissions are underestimated due to underestimation of fertilizer applications in some hot spots. The comparison with national inventories that depend mainly on statistics using simpler approaches shows differences to the simulation approach, which indicates the strong dependency of the emissions on the management data. The model approach provides the spatial distribution of the emissions as well as inter-annual dynamics. The changes on the model showed already the improved performances by the model and the extension to include more target variables. More sub-national and sub-annual data sets for evaluation will allow a further improvement of the model performance.