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The importance of model set-up for simulating tillage effects on N2O emissions

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Agricultural fields are often tilled for seedbed preparation, weed suppression, incorporation of residues, soil aeriation and for improving plant access to water. The resulting changes in physical properties have an effect on soil moisture and temperature, affecting several chemical processes such as greenhouse gas (GHG) emissions. No-tillage is often suggested as a mitigation strategy to reduce GHG emissions and to increase soil organic carbon (SOC). Both modeling and experimental studies have been conducted to evaluate the effects of tillage types on GHG and SOC. Models need to be initialized, e.g. soil nitrogen and carbon pools, so that impacts of management change on ecosystem processes can be reliably represented. Moreover, site specific information on agricultural management (i.e. timing of fertilizers application and irrigation) is required. When operating at the field level, management information and model initialization can be very precise with data from site-specific measurements, whereas for global simulations assumptions have to be made. These assumptions may be a significant contributor to the overall uncertainty in these applications but have rarely been quantified.
In this study, we evaluate different methods for model initialization and test how accuracy in model set up for a particular site affects the assessment of the impacts of tillage on N2O emissions. Therefore, the ecosystem model LPJmL and results from experimental studies are used to estimate N2O emissions under tillage and no-tillage in different configurations, using all, none or some site-specific information (i.e. management, soil carbon and nitrogen pools) in order to estimate which management setting is most important for reducing uncertainty when modeling tillage effects on N2O emissions. As the modeling of N2O is generally challenging, we also test if the site-specific model Daycent, which has been applied at the study sites before, actually performs better. First results indicate substantial uncertainties in both models and that site-specific information does not always improves modelling performance. In cases where site-specific information improved modelling performance, information on fertilizer application and soil pool sizes were most important. We present more detailed results and discuss implications for upscaling management effects on N2O emissions in process-based modeling.