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Assessing data-induced uncertainty of N_2O emissions from arable soils in Europe using a process-based biogeochemical model

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Complex biogeochemical models like MobileDNDC generally require a substantial number of model drivers, which often are not available for large simulation domains or are of poor quality. In order to simulate the C and N soil-atmosphere exchange of arable soils, the process-based biogeochemical model MobileDNDC requires, among other things, detailed information about cropping practices, soil characteristics and daily weather data.

Since spatially explicit information about farm management, prior land-use and local, stratified soil properties is generally not available at these scales, any emission inventory calculated with mechanistic models and based on such model drivers must account for the data-induced uncertainty, which propagates into the simulation results. This is especially true, as some information, like farming practice, often has to be based on “expert knowledge” as no empirical data exists in a spatial manner.

We report our findings obtained when applying MobileDNDC within the NitroEurope IP to simulate the soil-atmosphere exchange of nitrous oxide (N_2O) from arable soils of Europe (EU27 + Norway, Switzerland). Six different, site-specific crop rotations covering the years 1971-2000 were applied to all NitroEurope computation units (NCUs, units of homogeneous land-use, developed within the NitroEurope IP) in order to assess the effect of crop rotation design on the intra-annual variability and European totals of simulated N_2O emissions. Furthermore, we applied the model to a subset of 150 selected NCUs for a full uncertainty study based on parameter variations (crop rotations, manure and fertilizer rates, soil properties). The NitroEurope group provided the dataset of model drivers, which was derived by Monte Carlo methods.

Our results show that assumptions modelers make when designing farming scenarios as well as generalizations and data quality issues of large-scale soil datasets have to be accounted for when reporting budgets of soil-based N_2O emissions for large simulation domains. We found that these model drivers have a profound effect on the predicted N_2O emission inventory totals as well as spatial and temporal variability of these estimates.