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Developing a regional scale approach for modelling the impacts of fertiliser regime on N2O emissions in Ireland

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Agriculture can be significant contributor to greenhouse gas emissions, this is especially prevalent in Ireland where the agricultural sector accounts for a third of total emissions. The high emissions are linked to both the importance of agriculture in the Irish economy and the focus on dairy and beef production. In order to reduce emissions three main categories are explored: (1) reduction of methane emissions from cattle, (2) reduction of nitrous oxide emissions from fertilisation, and (3) fostering the carbon sequestration potential of soils.
The presented research focuses on the latter two categories, especially changes in fertiliser amount and composition. Soil properties and climate conditions measured at the four experimental sites (two silage and two spring barley) were used to parameterise four biogeochemical models (DayCent, ECOSSE, DNDC 9.4, and DNDC 9.5). All sites had a range of different fertiliser regimes applied. This included changes in amount (0 to 500 kg N/ha on grassland and 0 to 200 kg N/ha on arable fields), fertiliser type (calcium ammonium nitrate and urea), and added inhibitors (the nitrification inhibitor DCD, and the urease inhibitor Agrotain). Overall, 20 different treatments were applied to the grassland sites, and 17 to the arable sites. Nitrous oxide emissions, measured in 2013 and 2014 at all sites using closed chambers, were made available to validate model results for these emissions.
To assess model performance for the daily measurements, the Root Mean Square Error (RMSE) was compared to the measured 95% confidence interval of the measured data (RMSE95). Bias was tested comparing the relative error (RE) the 95 % confidence interval of the relative error (RE95). Preliminary results show mixed model performance, depending on the model, site, and the fertiliser regime. However, with the exception of urea fertilisation and added inhibitors, all scenarios were reproduced by at least one model with no statistically significant total error (RMSE < RMSE95) or bias (RE< RE95). A general trend observed was that model performance declined with increased fertilisation rates. Overall, DayCent showed the best performance, however it does not provide the possibility to model the addition urease inhibitors.
The results suggest that modelling changes in fertiliser regime on a large scale may require a multi-model approach to assure best performance. Ultimately, the research aims to develop a GIS based platform to apply such an approach on a regional scale.