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Predicting past, present and future N_2O emissions from fertilised grassland

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Nitrous oxide emissions from fertilised grassland in the UK vary non-linearly with soil conditions, depending particularly on water-filled pore space (WFPS), temperature and mineral N content (1). An earlier simple empirical model (2) took account of the log-normal distribution of fluxes commonly observed and allocated fluxes to one of only three exponentially related classes, on the basis of measurements of these three variables. This very simple model has given a better fit to data than the established and much more complex DNDC model, but is limited by its dependence on the infrequency of measurement of the soil variables (usually $\geq$ 1 week). A new hybrid (part process-based, part empirical) version has been developed, using the Simile modelling framework, in which the WFPS and temperature are modelled with a daily timestep, thus allowing the simulation of N_2O emissions also on a daily basis. The site parameters include soil sand, silt and clay content, water content at field capacity and wilting point, and soil bulk density. WFPS is calculated from an adapted soil water balance model, and soil temperature modelled using heat transfer theory. Daily time series of rainfall, minimum and maximum air temperatures, and fertiliser application dates and amounts are also required. A power law regression equation is fitted to the ratio of soil mineral N to the N applied, plotted against days since fertiliser application

The model has been applied to nine site-seasons of N_2O emission data, in which the measured emission factor ranged from 0.4% to 6.9%. Five out of the nine annual estimates were closer than 25% of the measured values, two were within 10%, and the overall relationship was: Modelled values = 0.988 $\times$ Measured values. The results suggest that the emissions from other sites and for other seasons can be modelled with

some confidence.

A very different approach has been used to model past and future trends in N_2O emissions. Regression models of the dependence of emissions on rainfall and temperature were combined with data on past rainfall patterns and future ones predicted by a climate model, and with two different models of the temporal pattern of N fertilisation. The results were put into a GIS, together with data on the spatial pattern of N fertiliser use. Results for total Scottish emissions over the last 40 years show a variation of up to 2-fold between annual totals, caused by variations in amount and/or seasonal distribution in rainfall. Changes in future rainfall predicted by different GCM scenarios have little effect on predicted annual emissions; the impacts of temperature and land use changes may well be larger, but have still to be modelled.

References

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