Modelling nitrous oxide emissions from grazed grasslands in New Zealand

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Introduction Spatial and temporal variability are major difficulties when quantifying annual N_2O fluxes at the field scale. New Zealand currently relies on the IPCC default methodology (National Inventory Report, 2004). This methodology is too simplistic and generalised as it ignores all site-specific controls, but is also not sufficiently flexible to allow mitigation options to be assessed. Therefore, a more robust, process-based approach is required to quantify N_2O emissions more accurately at the field level. Denitrification-decomposition (DNDC) is a process-based model originally developed (Li *et al*., 1992) to quantify agricultural nitrous oxide (N_2O) emissions across climatic zones, soil types, and management regimes. This has been modified to represent New Zealand grazed grassland systems (Saggar *et al*., 2004). More recent modifications include measured biomass C and N parameters in perennial pasture and compaction impacts on the soil water dynamics. Further validation tests have been conducted against observed soil moisture and gas fluxes. Here we i) assess the ability of a modified DNDC model "NZ-DNDC" to simulate N_2O emissions; ii) compare the measured, modelled and IPCC-estimated N_2O emissions from dairy- and sheep-grazed pastures; and iii) give preliminary results for upscaling the model to provide preliminary regional emissions estimates.

Materials and methods Nitrous oxide measurements were made periodically between April 2001 and June 2003 from sheep- and dairy-grazed and ungrazed areas at three sites. To account for the spatial variability, 18 chambers were randomly located *c*. 20 m apart along a Z-shaped transect to measure the fluxes of N_2O from the grazed area (~1 ha); two chambers were located in the ungrazed area (~0.005 ha). The modified DNDC model, hereafter named "NZ-DNDC", was then used to simulate N_2O emissions from the pastures grazed by dairy cattle. Full descriptions of the experimental methodology used and the model modifications are reported in Saggar *et al*. (2004).

Results Large spatial and temporal variations were observed in the N_2O fluxes measured from the grazed area over all sites. Large fluxes were generally observed after each grazing and rainfall event, and were followed by a decline. The modified NZ-DNDC model simulated well the average daily N_2O fluxes from the control and grazed grassland sites. Significant differences in emission rates between the sheep-grazed and dairy pastures exist. The NZ-DNDC was able to predict the annual measured emissions from all the sheep- and dairy-grazed and ungrazed grassland sites very well. The NZ-DNDC model was also able to pick up the differences in emissions resulting from differences in soil texture and grazing regime (Figure 1). The IPCC methodology cannot account for such influences. The model will be used to provide regional estimates of N_2O emissions.

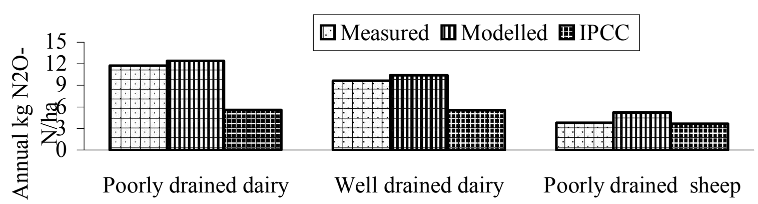

Figure 1 Measured, modelled and IPCC calculated emissions

Conclusions The overall comparisons of predicted and measured annual emissions indicate NZ-DNDC should be applicable to the simulation of N_2O emissions from a range of grazed grasslands. NZ-DNDC offers a solid beginning to develop regional- and national-scale inventories with known levels of uncertainties.

References

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