**Theme: ??**

**Potential of the DNDC model to predict long-term changes in N2O emissions and SOC in permanent grassland**

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Modelling approaches can minimise the largescale variability of greenhouse gases (GHGs), particularly nitrous oxide (N2O) emissions , as well as estimates of soil organic carbon (SOC) in agricultural soils. Their precise quantification and reporting using higher tiers remains a complicated challenge and the identification of an advanced tool to simulate the net balance and potential of GHGs and SOC for mitigation, offsetting and policy formulation is a global concern. We tested the Denitrification-Decomposition (DNDC95) model, a process-based model, to simulate both N2O emissions and SOC density (SOCρ), and their annual changes in soil under moist temperate grass silage managed with inorganic and organic fertilizers over 45 years. The model performed well for urea, cattle slurry and pig slurry applied at variable rates with N2O emission factors (EFs) of 0.35±0.02, 1.80±0.28 and 1.53±0.41%, respectively, which are close to national and IPCC estimates. The measured data for SOCρ at a 0-15 cm depth for unfertilized and urea-fertilized fields (73-77 t-C-ha-1) were significantly higher than the simulated ones (54-55). However, the model-estimates showed good agreement with the measured values (R2=0.66), and revealed increased C sequestration with increasing added-C (0.46±0.06 vs. 0.37±0.01 t-C-ha-1-yr-1). Variations in the derived-EFs and simulated-SOCρ could be explained mainly by differences in nitrogen inputs (49%) and added-C (62%), respectively, where the impact of rainfall (15-16%) and temperature (10-11%) was identical. Commonly, N2O EFs and SOCρ were sensitive to soil texture, pH, bulk density and organic carbon (R2=0.77-0.99) but ΔSOCρ decreased with the latter two (R2=-0.99). Strategic replacement of slurry either after the second or third silage cuts by urea decreased N2O EFs significantly and autumn applications of slurry resulted in more C being sequesteredThese findings show that DNDC95 could provide an accurate representation of the key drivers influencing both N2O fluxes and SOCρ.

***Keywords:*** DNDC model, Greenhouse gas, SOC density, Sensitivity analysis, Grass silage.