Evaluating the DNDC model for estimating nitrous oxide emissions from a poorly drained soil in the Canadian Prairies

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Abstract: Biogeochemical models are useful tools for integrating the effects that environmental drivers, soil properties and agricultural management have on crop production and GHG emissions. In this study, nitrous oxide measurements estimated using the micrometeorological flux gradient technique from a seven year study in Manitoba were used to test and improve the ability of the DNDC model to simulate emissions from across a variety of crops. The model was tested systematically against measured auxiliary data including soil water content, soil N, soil temperature and crop biomass production. To improve model performance in estimating biomass the empirical growth curves were modified for Canadian cultivars. The partitioning of N in the soil profile was improved by conceptualizing a deep N pool that parallels the existing deep water pool. The DNDC model accurately predicted soil temperature during the growing season and usually simulated soil water dynamics well but sometimes overestimated water contents in the late growing season. The model reasonably estimated the average magnitude of cumulative N_2O emissions for annual crops but overestimated emissions under perennial forage. A multi-linear regression analysis indicated that the primary climatic drivers effecting measured growing season emissions were wind speed>temperature>precipitation>solar radiation. A similar relationship was found when all climatic drivers were simulated in DNDC. Evapotranspiration was heavily influenced by wind speed at this site.

Keywords: DNDC, modeling, nitrous oxide, agricultural management, micrometeorological flux, annual crops, perennial crops.