A long-term sensitivity analysis of the Denitrification and Decomposition model

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Abstract: Although sensitivity analysis (SA) was conducted on the DeNitrification-DeComposition (DNDC) model, a global SA over a long period of time is lacking. We used a method of Bayesian analysis of computer code outputs (BACCO) with the Gaussian emulation machine for sensitivity analysis software (GEM-SA) to conduct a long-term SA of DNDC for predicting the annual change of soil organic carbon (dSOC), nitrous oxide emission (N_2O) and grain yield of spring wheat. Twenty seven non-weather input parameters with wide ranges were selected for SA using weather data recorded from Three Hills, Alberta over 86 years (1921-2006). The SA had two steps: 1) a preliminary BACCO GEM-SA was conducted to identify a more accurate emulator sampling method and to screen out parameters with insignificant influence on model outcomes; and 2) final BACCO GEM-SA was conducted with optimal input design set for emulator training runs varying only the significant input parameters. Results indicated that the Maximin

Latin Hypercube sampling method outperformed the LP-τ method with higher emulator accuracy. Most of the 27 input parameters contributed little to the three outputs by the first step BACCO GEM-SA.In the second step of BACCO GEM-SA there were only three (in the case of dSOC) and six (in the cases of N_2O and yield) input parameters whose influence contributed to more than 10% of the total output variances by their total effects. Among the selected parameters, initial soil organic carbon and clay content are very important and were important in determining results for all three outputs. Sensitivities of some parameters, such as clay content and urea fertilizer amount changed dramatically over the years. This indicates that a single year SA may overestimate or underestimate a long-term parameter effect on the model prediction. The two-step procedure with the BACCO GEM-SA method improved the accuracy of SA and provided important information for model validation and parameterization.

Keywords: DNDC, long-term, global sensitivity analysis, BACCO GEM-SA.