Estimates of N_2O emissions and mitigation potential from a spring maize field based on DNDC model

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Abstract: Agricultural production plays an important role in affecting atmospheric nitrous oxide (N_2O) concentrations. Field measurements were conducted in Dalian City, Liaoning Province in the Northeast China from two consecutive years (2009 and 2010) to estimate N_2O emissions from a spring maize field, a main cropping system across the Chinese agricultural regions. The observed flux data in conjunction with the local climate, soil and management information were utilized to test a process-based model, Denitrification–Decomposition or DNDC, for its applicability for the cropping system. The validated DNDC was then used for exploring strategies to reduce N_2O emissions from the target field. The results showed that the major N_2O pulse emissions occurred with duration of about 3-5 days after fertilizer application in both the year 2009 and 2010, which on average accounted for about 60% of the total N_2O emissions each year. Rainfall and fertilizer application were the major factors influencing the N_2O emissions from spring maize field. The average N_2O fluxes from the CK (control plot, without fertilization) and FP (traditional chemical N fertilizer) treatments were 23.1 and 60.6 $\mu g \cdot m^{-2} \cdot h^{-1}$ in 2009, respectively, and 21.5 and 64.3 $\mu g \cdot m^{-2} \cdot h^{-1}$ in 2010, respectively. The emission factors (EFs) of the applied N fertilizer (270 kg N/ha) as N_2O-N were 0.62% in 2009 and 0.77% in 2010, respectively. The comparison of modeled daily N_2O emission fluxes against observations indicated that the DNDC model had a good performance even if without adjusting the internal parameters. The modeled results showed that management practices such as no-till, changing timing or rate of fertilizer application, increasing residue incorporation, and other technically applicable measures could effectively reduce N_2O emissions from the tested fields. Our study indicated that avoiding application of N fertilizers at heavy rainfall events or splitting the fertilizer into more applications would be the most feasible approaches to reduce N_2O emissions from spring maize production in Northeast China.

Keywords: Spring maize, N_2O, DNDC, mitigation measures, Northeast China.