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Modeling oxygen and soil moisture effects on denitrification

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Nitrogen compounds and fertilizers are widely used in agriculture and industry, leading to increased N availability in natural systems. This often results in eutrophication of water bodies and nitrous oxide (N2O) emissions. The driving forces and biogeochemical activity that produces N2O fluxes are inherently complex and highly coupled, making the understanding and modeling of N2O sources and transport in the unsaturated zone a major challenge. In particular, soil moisture is a key driver in N2O emission because it influences oxygen supply, which in turn feeds back on the N2O sources (e.g., nitrification versus denitrification) and sinks (reduction to N2). Here we present a stochastic modeling framework which couples oxygen and soil water dynamics with the aim of quantifying the importance of biochemical reaction and oxygen consumption on trace gases emission at short time scale. The model accounts for N2O production from nitrification and denitrification, as well as the competition for nitrate by denitrification and dissimilatory reduction of nitrate to ammonium (DNRA). Preliminary results indicate that neglecting oxygen dynamics may significantly alter the rate of trace gas emission, while considering rainfall variability and its feedbacks on soil moisture fluctuations is fundamental to predict the subsequent peaks in trace gas emissions.