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Nitrous oxide production and sources in response to a simulated fall-freeze-thaw cycle

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Thaw-induced N_2O emissions have been shown to account for 30-90% of N_2O emissions in agricultural fields. Due to the climate change, increased precipitatio is expected in fall and winter seasons for certain regions. As a result, this would in turn enhance the thaw-induced N_2O emissions and aggravate climate change. A mesocosm study was conducted to investigate N_2O production and sources from soils under elevated soil moisture contents in response to a simulated fall-freeze-thaw cycle. Treatments included two levels of N addition (urea versus control) and two different management histories [with (SW) and without (CT) manure additions]. Our results showed that at least 92% of the N_2O emissions during the study were produced during the simulated thawing across all treatments. The thaw-induced N_2O emissions increased with increasing soil water content. The fall-applied urea increased the soil-derived N_2O emissions during thawing, indicating an excessive mineralization of soil organic N. Compared to the CT soils, the SW soils induced more soil-derived N_2O emissions. This could be because the SW soil had more easily decomposable organic matter which was likely due to historical manure additions. Regarding to the daily primed N_2O fluxes, different soil water contents impacted the dynamics of daily priming effect. At the high water content, the soils experienced a shift in daily primed N_2O fluxes from positive to negative and eventually back to positive throughout the simulated thawing, while the soils at lower water contents underwent positive primed fluxes in general. The shift in daily primed fluxes was probably driven by the preference of soil microbes on the labile N substrates. When the microbes switched from easily to moderately decomposed substrates (e.g., from dissolved organic N to plant residuals), they started to uptake inorganic N from the soil due to a relatively high C:N ratio of plant residuals. Therefore, a net N immobilization and negative primed N_2O production occur in the short term in the soils at the high water content.