Effect of calcareous and non-calcareous amendments on fertilizer-induced N_2O emissions in a clay loam in SE Norway

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There is ample evidence from laboratory experiments since the 1950s that the N_2O product ratio of soil denitrification decreases with increasing pH, suggesting that N_2O emission can be effectively reduced by liming. Approval of this mitigation option would require rigorous testing by ensembles of dedicated field experiments under realistic agronomic conditions. Here we report a N_2O flux experiment with soils three years after applying calcareous (dolomite, calcite) and non-calcareous (norite, larvikite, olivine) limes in a field experiment in SE Norway. To create homogeneous conditions with respect to drainage, soils from field plots were excavated, homogenized and packed into freely draining pots. After sowing the pots to ryegrass, N_2O fluxes were monitored after subsequent addition of NH_4NO_3 (160 kg N ha-1), $NaNO_3$ (110 kg N ha-1) and simulated ploughing in late autumn, i.e. mixing the grass sward and adding additional KNO_3 (5 g N m-2). Whereas the flux response to NH_4NO_3 was independent of liming treatment (plausibly due to dry summer conditions with no denitrification), N_2O fluxes after KNO_3 addition showed highest fluxes in dolomite (90.2 g N m-2 in 22 weeks) and marble (80.8 g N m-2 in 22 weeks) treatments. The incorporation of grass in autumn was followed by diurnal freezing- and thawing, eliciting N2O fluxes of up to 6677 µg N m-2 h-1, likely originating from denitrification. Under these conditions a clear pH dependency emerged with 50% lower cumulative fluxes (over 22 weeks) in calcite treated soils (pH 6.7) as compared with acid control (pH 4.9) and soils with siliceous amendments, which did not show any pH response. Our results suggest that liming acidic soils can be used to mitigate N_2O emissions during "hot moments" of vigorous denitrification. However, possibilities for precision liming should be investigated in order to reduce the byproduct of $CaCO_3$ dissolution, CO_2 which is a potent greenhouse gas. Site-specific fertilization and liming could regulate emissions derived from denitrification and lower N2O emissions overall.