Source portioning of $\text{N}_2\text{O}$ emissions after long term elevation of soil temperature in a permanent grassland soil

Anne Jansen-Willems (1,2), Gary Lanigan (1), Timothy Clough (3), Louise Andresen (2), Christoph Müller (2,4)
(1) Teagasc Johnstown Castle, Wexford, Co. Wexford, Ireland (Anne.jansen@teagasc.ie), (2) Department of Plant Ecology, Justus Liebig University Giessen, Heinrich-Buff-Ring 26, 35392 Giessen, Germany (pflanzenoekologie@bio.uni-giessen.de), (3) Department of Soil and Physical Sciences, Faculty of Agriculture and Life Sciences, New Zealand (Timothy.Clough@lincoln.ac.nz), (4) School of Biology and Environmental Science, University College Dublin, Dublin, Ireland (Christoph.mueller@ucd.ie)

Several methods, such as source portioning, have been used to quantify the contributions of individual N pools to $\text{N}_2\text{O}$ emissions. These methods however, assume the absence of hybrid reactions such as co-denitrification, which were previously identified as important. A straightforward method portioning $\text{N}_2\text{O}$ fluxes into four different production processes, including a hybrid reaction, was therefore developed. This method portioned the $\text{N}_2\text{O}$ fluxes in nitrification, denitrification, oxidation of organic matter and co-denitrification, using data on $^{45}\text{R}$ and $^{46}\text{R}$ of the $\text{N}_2\text{O}$ flux and the $^{15}\text{N}$ content of the $\text{NO}_3^-$ and $\text{NH}_4^+$ in the soil. This newly developed method was used to analyse the $\text{N}_2\text{O}$ emissions from incubated soil, which was previously subjected to 6 years of elevated soil temperature of +0, +1, +2 or +3 $^\circ$C. $\text{N}_2\text{O}$ emissions were measured and analysed at four time points in the six days following, $\text{NO}_3^{15}\text{NH}_4$ Gly or $\text{NO}_3\text{NH}_4$ Gly, label addition. The oxidation of organic N was found to be the main source of $\text{N}_2\text{O}$ fluxes at all sampling dates, comprising between 63 and 85% of the total $\text{N}_2\text{O}$ flux. The percentage contribution made by organic N to $\text{N}_2\text{O}$ fluxes increased over the sampling period, rising from a minimum of 40% in the control treatment, to virtually 100% across all treatments by Day 6. Compared to the control treatment, denitrification contributed less to $\text{N}_2\text{O}$ fluxes in soil subjected to +2 or +3 $^\circ$C warming ($p<0.0001$ and $p=0.002$, respectively). Co-denitrification only contributed to the $\text{N}_2\text{O}$ flux during the first day after substrate addition. The highest amount of $\text{N}_2\text{O}$ produced via co-denitrification was found under the control treatment. From soil subjected to +2 and +3 $^\circ$C treatments, the contribution of co-denitrification was minor. However, these differences in co-denitrification were not significant. This research showed the importance of the oxidation of organic N in $\text{N}_2\text{O}$ emissions. It should therefore not be omitted as a potential source in source portioning. Emissions of $\text{N}_2\text{O}$ in the first six days after fertilisation decreased for soils previously subjected to higher temperatures as a consequence of a reduction in the rates of denitrification and the oxidation of organic N.