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Isotope and microbiome analysis indicates variety of N-cycle processes controlling N2O fluxes in a drained peatland forest soil

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Nitrous oxide (N2O) is a major greenhouse gas whose presence in atmosphere is continuously increasing. Hence it's important to understand its production and consumption mechanisms. During the summer of 2020, we conducted lab experiments using heavy nitrogen tracers of Potassium Nitrate 15N 98% atom (Sigma Aldrich) and Ammonium Chloride 15N 98% atom (Sigma Aldrich) under different moisture conditions to get an insight into N2O production mechanisms and on their dependence on soil moisture. We applied the tracer to peat samples (Kärevere, Estonia) placed in 36 (12 control, 12 nitrate treatment & 12 ammonia treatment) plastic buckets (radius-10cm, height-20cm) with soil height of 10 cm and a 10 cm head space left for gas collection. We installed oxygen sensors, water table indicators and temperature sensors on all buckets. We focused on studying physical conditions (soil oxygen, temperature, water table and soil moisture), gas (N2O) emission data, soil chemistry, gas isotope 15N, soil isotope and soil microbiology to get a complete picture of the processes involved in production of N2O gas. Under the ammonia treatment, emissions increased more than ten-fold which could be due to multiple processes of the nitrogen cycle in play. N2O emissions increased as the oxygen conditions shifted from anoxic (Omg/L=0) to sub-oxic (Omg/L=0.5–6) and then decreased as oxygen conditions reached the oxic (Omg/L>6) state. Furthermore, we witnessed negative site preference and 18O values during the nitrate treatment indicating nitrifier-denitrification. Under the ammonia treatment, we recorded both negative as well as high positive site preference values indicating presence of multiple production mechanisms. This was expected as ammonia triggers multiple processes in the nitrogen cycle. In some samples, we observed N2O consumption with little change in site preference as compared to the N2O producing samples. This indicates some bacterial-denitrification along with the prevailing nitrifier-denitrification. We also observed that under both treatments, heavy oxygen increased with increasing site preference. This indicates reduction of N2O (Ostrom et al, 2007) as redox supports 15N and 18O enrichments. After these lab experiments, we conducted the same experiment at a large scale in a drained peatland forest in Agali, Estonia. In this experiment, we established 1m2 triangle-shape mesocosms using experimental draining and flooding to achieve varying oxygen conditions. Preliminary results of qPCR analysis of N-cycle control genes support the domination of ammonia oxidation and denitrification as sources of N2O.