Fluctuating groundwater table enhances N₂O emission from incomplete denitrification in a floodplain fen

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Nitrous oxide, a major greenhouse gas, is found to be emitted largely from organic soils. We have investigated the effects of water table and soil oxygen (O₂) content on N₂O fluxes from a drained floodplain fen in Estonia. We also studied the effects on natural abundance of nitrogen isotopes ¹⁵N & ¹⁴N in the soil to understand how the isotopic nature changes during nitrification and denitrification as we raise the water table and decrease O₂ in the peat. During the field experiments in autumn 2018, we studied three soil environments under varying O₂ content which were: oxic, suboxic and anoxic. Opaque truncated conical manual chambers (65 l) were used to sample gas from each site during one-hour sessions. The suboxic environment was connected to variation in water table, both in time and depth. We created an anoxic environment by experimental flooding. We observed low N₂O emissions under oxic conditions. Under suboxic conditions (0.4–6 mg O₂/l) N₂O emissions peaked at 6 mg O₂/l and decreased gradually with decreasing O₂. In the anoxic soil (<0.4 mg O₂/l) N₂O emissions were found to be lowest. The isotopic analysis of peat showed high ¹⁵N content in the top 10 cm layer which gradually decreased with depth to 30 cm for anoxic soil. In the suboxic soil, ¹⁵N was found to be increasing with depth. In the soil fluctuating between suboxic and anoxic, ¹⁵N was abundant (δ¹⁵N = 7–9‰ air N₂) indicating intensive microbial processing of nitrogen. The results indicate incomplete denitrification in the suboxic soil as the source of N₂O. We will conduct the same experiments in laboratory by creating mesocosms in 12 columns containing peat samples from the same site.