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Greenhouse gas fluxes influenced by a penguin colony on Bird Island/Antarctica

Julia Drewer, Sim Tang, Margaret Anderson, Christine Braban, Ulrike Dragosits, and Ute Skiba
NERC CEH, Biogeochemistry, Penicuik, United Kingdom (juew@ceh.ac.uk)

The influence of reactive nitrogen (N_r) emissions from a penguin colony on local greenhouse gas (GHG) fluxes was investigated on the remote sub-Antarctic Bird Island (54˚00'S, 38˚03'W) in November and December 2010 (8 weeks). Bird Island has a hilly topography and a maximum elevation of 350 m. Winds predominate from the west, however, due to the local topography there were expected to be a significant influences from the local marine environment and local fauna such as seabirds (40,000 pairs of Macaroni penguins at the colony, and other more disperse species) and seals who ranged over the area. Measurements of N_2O and CH_4 were made using static chambers along a transect with sampling points at a distance of 23, 36, 70, 143 and 338 m downwind from the penguin colony. Gas samples were taken in 3 ml pre-evacuated exetainers and sent back to the UK for analysis on GC-ECD/FID. In addition, parameters including soil moisture, soil respiration, soil and air temperature, total C/N in vegetation and soil, and NO_3/NH_4 in soil were measured. Mean air temperature was 3.1 ˚C with minimum and maximum of -1.9 and 9 ˚C.

Laboratory incubations were carried out on soil cores taken from the chambers at the end of the measurement campaign. Soils were very shallow and cores collected close to the colony were a mixture of decomposing litter and soil, whereas further inland they consisted of organic soils. Cores were defrosted very slowly to simulate spring warming to 2 ^{o}C for 5 days, then to 5 ˚C for 3 days and subsequently to 10 ˚C for 2 days. Soil moisture was kept constant during this time to investigate the influence of temperature on NO and GHG emissions. After 10 days soils were left to dry out.

Mean CH_4 fluxes from 8 different days in the field were in the range of -5.5 to 245 μg m^{-2} h^{-1},with minimum and maximum fluxes of -83 and 4065 μg m^{-2} h^{-1}. Mean N_2O fluxes ranged from 7 to 23 μg N_2O-N m^{-2} h^{-1}, with minimum and maximum fluxes of -0.6 and 226 μg N_2O-N m^{-2} h^{-1}. NO fluxes ranged from 5 to 60 ng NO-N g^{-1} dry soil h^{-1} and were highly spatially variable. Direct N_r emissions from the penguin colony were predominantly ammonia (NH_3), and the highest concentrations were close to the penguin colony and decreased exponentially with distance away. Both *in situ* chamber GHG fluxes and incubated soil cores results show a high spatial variability. The highest N_2O fluxes were measured 143 m away from the penguin colony, while the highest $CH_4$and NO fluxes were measured 143-338 m away from the colony and therefore did not directly correlate to the NH_3 concentration. Thus large variability of vegetation cover, topography, soil depth and moisture content along the transect appeared to influence GHG and NO production and flux rates more than raised atmospheric NH_3 concentrations.