Geophysical Research Abstracts
Vol. 21, EGU2019-10096, 2019
EGU General Assembly 2019
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Continuous year-round measurement of NO concentrations along a soil depth profile in a temperate forest

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NO_x is a main precursor for tropospheric O_3 and a key substance determining the oxidative capacity of the atmosphere. Soil NO emissions, contributing 15-20% to the global atmospheric NO_x budget (IPCC, 2007), are the result of biogenic, mostly microbial, biochemical and physicochemical N cycling processes. It is known that NO emissions from soils are the result of simultaneously occurring production and consumption processes. Several studies showed that NO emitted from soils mainly originate from the topmost centimetres and that NO produced in deeper soil layers might be consumed during upward diffusion. However, information on NO concentrations and profiles of NO concentrations in soils is extremely scarce and to our knowledge limited to the works of Gut *et al.* (1998, 1999, 2002).

In this study we carried out continuous measurement of NO concentrations over one entire year along a soil depth profile down to approx. 1m. Measurements were done at a spruce forest site in Southern Germany, the Höglwald Forest, exposed to high rates of atmospheric N deposition. Soil gas concentrations of NO were continuously measured at five soil depths using gas permeable tubes. Those measurements were accompanied by continuous soil-atmosphere NO flux measurements using a dynamic chamber approach.

The highest soil NO concentrations, as well as soil surface NO fluxes, were observed during summer times, specifically following rainfall events, which were re-wetting at least the surface soil. Mean NO concentrations from soil surface down to -65 cm differed significantly and ranked as follows: 142 $\pm$ 2.1 ppbv in the litter layer (-5 cm below soil surface) $>$ 112.2 $\pm$ 1.7 ppbv in the mineral topsoil Aeh layer (-12 cm) $>$ 96.1 $\pm$ 1.3 ppbv in moss layer (0 cm; on soil surface) $>$ 27.9 $\pm$ 0.3 ppbv in the mineral Al layer (-30 cm) $>$ 11.4 $\pm$ 0.1 ppbv in subsoil Bt layer (-65 cm soil depth). While mean ground level air NO concentration was 4.1 $\pm$ 0.1 ppbv. The annual mean emission observed within the study period was 63.0 $\pm$ 0.6 μg NO-N m^{-2} h^{-1}.

In this presentation we will present a modified system for soil NO gas monitoring, the main results (incl. the very first continuous data on NO concentration in soil profile), evaluate drivers for NO production/ consumption in the soil, as well as provide hypotheses about the importance of NO production/ consumption processes as drivers of soil microbial and plant processes.

So far it can be said that:

i) the most effective depth of NO production at the studied forest site was around 5 cm (within the organic layer);

ii) temperature was determined as the main driver triggering NO production within the soil and NO emission from the soil;

iii) annual NO concentration level across the soil profile was strongly depending on soil pH;

iv) strong dependence between soil NO emission rate and NO concentrations on the surface and in organic layer was clearly shown;

v) observed soil NO concentrations are high and at those concentrations effects on root growth and root distribution have been observed.