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Emission of nitric oxide from soil: laboratory vs. micrometeorological techniques

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High quality field measurements of the surface exchange of nitric oxide (NO) between soils and the atmosphere usually demand complex instrumentation and considerable power supplies. The latter often impedes such flux measurements at remote sites. However, soil samples could be taken everywhere, and consecutive parameterization of NO emission rates (derived from laboratory incubation of these soil samples) and up-scaling through independent data of soil properties (e.g. soil moisture, soil temperature, soil texture) is an effective alternative to quantify NO emission from soils, particularly from (very) remote sites. These laboratory derived NO emission rates have quite frequently verified through field measurements by the dynamic chamber technique. Here, we will present the first intercomparison between the laboratory and a micrometeorological (gradient) technique.

In August 2006, the field experiment LIBRETTO (LIndenBerg REacTive Trace gas prOfiles) was carried out in cooperation with the German Meteorological Service (DWD) at the field site of the Richard Aßmann Observatory in Lindenberg. At 0.15 m and 2.0 m, concentrations of the trace gases O_3, NO and NO_2 were measured. Applying the modified Bowen ration technique to the measured concentration differences and the directly measured sensible heat flux (eddy covariance data from DWD) yielded the field surface fluxes of the trace gases (corrected for their flux divergence due to fast photochemical reactions during the vertical turbulent transport). Soil humidity and temperature in the top soil were measured at a separate plot at the field site.

Mixed soil samples were taken in May 2008 at the LIBRETTO field site, air-dried, sieved (< 2 mm) and stored at 4° C. All samples were measured within 4 weeks after sampling. The laboratory incubations were conducted at three different soil temperatures (10, 20 and 30° C), two different NO mixing ratios (0 and 50 ppb NO) and over the full range of soil moisture (0–100% WFPS). NO emissions, derived from net NO release rates of the soil samples, were parameterized as functions of soil temperature and soil moisture. Finally, a time series of NO fluxes has been obtained by applying the actually measured field soil moisture and temperature data.

From both, field and laboratory measurements, mean diurnal cycles of 20 days of the LIBRETTO campaign were used for the comparison of both techniques. Results agreed within a factor of 2, with median field and laboratory fluxes reaching 0.1 nmol m^2 s^1 and 0.05 nmol m^2 s^1, respectively.