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An improved method for analysis of biogenic NO emissions from hyper-arid and arid soils (Gobi desert, Mongolia and Taklimakan desert, Xinjiang/China)

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Within the metabolism of micro organisms in the uppermost soil layer, nitric oxide (NO) is produced and consumed. There is the well established experimental assumption, that the NO production rate in the soil is independent from the NO mixing ratio in the atmosphere and the NO consumption rate in soil is of pseudo-first order. Therefore, both quantities can be determined from the results of at least two fumigation experiments with dynamic soil chambers. With the help of the Galbally-Johansson algorithm the net potential NO flux dependent on the soil temperature and -moisture can be determined. In doing so, it is assumed that both processes proceed at the same time and in the same soil layer. However, in natural soils of the hyper-arid and arid regions of Mongolia and Xinjiang biogenic NO net release rates are very low per-se. Variation of the NO release rates due to variations of atmospheric (head space) NO mixing ratio, soil temperature and soil moisture is also low, therefore requiring substantial improvement of the existing soil dynamic chamber method.

Until now, determination of the net potential NO flux for one soil sample by the existing method needed (time-consuming) measurements on at least four subsamples (mainly due to difficult control of the soil moisture). The existing method was mainly improved by application of a sophisticated valve system, so that the response of the soil to all parameters (NO mixing ratio, soil temperature and moisture) can now be measured from one soil sample only.

A humidification system was integrated to facilitate measurements of soil response for each parameter over the individual full scales. Preliminary results of the natural soils from the hyper-arid and arid regions of the Gobi and Taklimakan deserts in the earlier setup showed a low reproducibility of the net NO-release rates. It has been suggested, that this might be due to different compositions of micro organisms in each soil sub-sample, which may establish after the usual soil incubation of several hours. For a set of different incubation times (0h, 3h, 12h, 48h, 192h), it was observed in three repeated experiments (incubation conditions: 25°C soil temperature & field capacity of the disturbed soil) that the highest reproducibility was achieved during measurements without any incubation. The shorter the incubation time the better the comparability between each replication. Therefore it seems reasonable that the samples should be measured without incubation.

We will present a detailed description of the improved dynamic soil chamber fumigation system and the results from optimizing the system for the precise determination of small biogenic net NO releases from hyper-arid and arid soils.