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Characterisation of soil NO production and consumption by an improved laboratory technique

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Biogenic NO_x emissions from natural and anthropogenically influenced soils are currently estimated to amount to 9 Tg a-1, hence a significant fraction of global NO_x emissions (45 Tg a-1). During the last three decades, a large number of field measurements have been performed to quantify biogenic NO emissions. To study biogenic NO emissions as a function of soil moisture, soil temperature, and soil nutrients, several laboratory approaches have been developed to estimate local/regional NO emissions by suitable up-scaling. This study pre¬sents an improved and automated laboratory dynamic chamber system (consisting of six individual soil chambers) for investigation and quantification of all quantities necessary to characterize biogenic NO release from soil (i.e. net NO release rate, NO production and consumption rate, and respective Q10-values). In contrast to former versions of the laboratory dynamic chamber system, the four experiments for complete characterization can now be performed on a single soil sample, whereas former studies had to be performed on four sub-samples. This study discovered that the sub-sample variability biased former measurements of net NO release rates tremendously. Furthermore, it was also shown that the previously reported variation of optimum soil moisture (i.e. where a maximum net NO release rates occur) between individual sub-samples is most likely a methodical artefact of former versions of the laboratory dynamic chamber system.

A comprehensive and detailed methodical concept description of the improved laboratory dynamic chamber system is provided. Response of all quantities (necessary to characterize net NO release) to soil temperature and NO mixing ratio of the flushing air-stream are determined by automatic monitoring of these variables during one single drying-out experiment with one single soil sample only. The method requires precise measurements of NO mixing ratio at the inlet and outlet of each soil chamber; finally, four pairs of inlet/outlet NO mixing ratios are sufficient to derive all necessary quantities. Soil samples from drylands exhibit particularly low NO production, but even lower NO consumption rates. However, with the improved laboratory dynamic chamber system those low levels can be quantified, as well as corresponding NO compensation point mixing ratios and respective Q10-values. It could be shown, that the NO compensation point mixing ratio seems to be generally independent of gravimetric soil moisture content, but, particularly for dryland soils, strongly dependent on soil temperature.

New facilities have been included into the improved system (e.g. for investigation of net release rates of other trace gases, namely CO_2 and VOCs). First results are shown for net release rates of acetone (C3H6O), acetaldehyde (C2H4O) and CO_2. This new system is thus able to simultaneously investigate potential mechanistic links between NO, multitudinous VOC and CO_2.