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A new Helium soil core incubation system with transparent chambers to directly quantify soil denitrification in presence of active plants

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Quantification of denitrification has been notoriously difficult because of the severe difficulties involved in measuring soil emissions of the dominant denitrification product dinitrogen (N2) against the huge atmospheric N2 background. A key approach to directly measure denitrification thus has been the establishment of soil and headspace Helium/oxygen atmospheres in extremely gastight incubation vessels so that soil N2 emissions are made detectable without disturbing atmospheric N2 background. However, due to the large engineering efforts needed to build such a Helium soil core incubation system with sufficient gas tightness, the few available systems have only small soil cores and do not allow for presence of light, i.e. cannot be run with plants. Plants however are assumed to significantly control soil denitrification, e.g., via competition for nitrate, via rhizodeposition of labile C compounds and via root respiration and water uptake.

To overcome these limitations, we developed and built a modified Helium soil core incubation system that has sufficient tightness against intrusion of atmospheric N2 despite large (30 cm diameter, 1 m height) and transparent incubation vessels that contain soil with living plants in Helium/O_2/CO_2 atmosphere. Manipulating light availability allows to directly assess plant effects on denitrification rates and N gas product ratios.

In this presentation, we describe the setup of the system and the emerged technical challenges and engineering efforts needed for its realization. Furthermore, system performance, e.g., with regard to detection limit of N gas fluxes and time needed to exchange the soil/headspace atmosphere, is illustrated. Finally results of first incubation experiments will be shown.