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Effect of headspace mixing in static chambers and sampling protocol on calculated CH4 fluxes from soils

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Closed static chambers are often used for greenhouse gas flux measurements from soils. The type of chamber, chamber handling and sampling protocol can influence the measurements. In most cases the calculated fluxes are suspected to be underestimated mainly because of reduction of gas diffusion from the soil to chamber headspace due to changed trace gas concentration gradient. Thus, fans are often applied to obtain better mixing of the air inside the chamber headspace and in turn reduce the negative effect of decreased concentration gradient. The open question is, however, to which extent the fluxes are changed by fans and whether they still remain underestimated or may even be overestimated? On the other hand, different sampling protocols are used assuming that they do not affect the flux measurements.

To test different types of static chambers and different sampling procedures applied for measurement of greenhouse gas (CH4 and N2O) fluxes a chamber calibration campaign was organized at Hyytiälä Forestry Field Station in Southern Finland during August-October 2008. The main aim of the campaign was to quantitatively assess the uncertaintities and errors related to static chamber measurements. During this campaign static chambers were tested for 5 different CH4 and N2O flux levels with 3 different soil conditions (moisture and porosity) in a calibration tank described by Pumpanen et al. (2004). Among the different experiments, several special tests were carried out with the closed static chambers. Here, results of two special tests are presented to document whether 1) the air mixing inside the chamber headspace, 2) different sampling procedures influence the CH4 fluxes, and 3) how different calculation methods lead to varying results. Two static chambers of different volumes (65.5 and 195 liters) but with the same circular shape and surface area were connected to a LOS GATOS fats methane analyzer. The CH4 concentration inside the chamber headspace was monitored continuously with 1Hz frequency. Additionally, two different manual samplings procedures were tested and gas samples from chamber headspace were taken for gas chromatograph (GC) and analysed in two different laboratories. Gas concentrations in the calibration tank were monitored with a GC and an automatic gas analyzer (INNOVA).

The preliminary results showed that air mixing inside the chamber headspace, the way of chamber handling and sampling procedures could have pronounced influence on the trace gas concentration detection inside a chamber, and as a consequence the calculated chamber fluxes. The moment of chamber enclosure can lead to a rapid increase in CH4 concentration due to a pressure effect in the chambers without a vent tube. Thus, it is essential to critically estimate the time of the first sampling so that it is early enough after chamber enclosure, but not disturbed by the initial chamber handling. It was also observed that manual sampling of gas can change the CH4 concentration in the chamber headspace. When mixing the chamber headspace air by a syringe, the subsequent gas sampling in the syringe may affect the diffusion of gas between the soil and the chamber headspace, and hence affect the calculated fluxes. It was observed that mixing the chamber headspace with a fan instead of syringes, reduced this effect during the chamber enclosure. Overall, fluxes measured with chamber equipped with

a fan always gave higher fluxes (up to 40%) as compared to fluxes measured from chambers without a fan. Results of our experiment lead to the assumption that these differences were generally larger the higher the chamber was, the less porous the soil was, and the higher the fluxes were. We conclude from our experiment that static chambers used for greenhouse gas flux measurements should be equipped with at least one fan and a vent tube to increase mixing and reduce pressure propagation in the chamber-soil system, and that special attention should be paid to the handling of the chamber and to the timing of the gas sampling.

References:
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