**InGOS TNA 1-2 Activity Report**

**Soil N2O chamber inter-comparison campaign 2014**

**Project leader: Mari Pihlatie and** **Janne F. Korhonen**

**Application nr. 796**

**Introduction and motivation**

The applicant Carolyn-Monika Görres participated in a lab-based inter-comparison campaign of soil N2O chamber systems organized by Mari Pihlatie and Janne F. Korhonen from the University of Helsinki (Finland). Soil chamber techniques are widely used for estimating soil trace gas fluxes, e.g. N2O fluxes. Together with the eddy covariance technique, they provide the best way to quantify trace gas fluxes from ecosystems and to study the underlying processes. However as with any other measurement technique, flux measurements by chamber techniques are associated with systematic and random uncertainties (e.g. Wang et al. 2013). These have to be properly quantified and accounted for to provide reliable trace gas flux estimates. The major sources of flux uncertainty are related to systematic errors of the single chamber measurement, as well as errors associated with the large spatial variability of the soil source/sink and low spatial coverage of the measurements.

The applicant herself has employed manual and automated soil chamber techniques to estimate CO2, CH4 and N2O fluxes from different ecosystems. Besides studying the processes underlying soil greenhouse gas fluxes, the applicant has also experience in estimating flux uncertainties related to systematic and random errors (Görres et al. 2014). The applicant’s motivation to join this particular chamber inter-comparison campaign was the circumstance that at the same time, she was comparing the performance of a custom-made automated chamber system for simultaneous measurements of soil CO2, CH4 and N2O fluxes (AGPS, Umwelt- und Ingenieurtechnik GmbH Dresden, Germany; FGGA and N2O/CO analyzer, Los Gatos Research, Moutain View, CA, USA) with an off-the-shelf automated chamber system for soil CO2 fluxes (LI-8100 and LI-8100-104, LI-COR Biosciences, Lincoln, NE, USA) under field conditions. Testing the AGPS under constant laboratory conditions during the soil N2O chamber inter-comparison campaign perfectly complemented the field tests. Especially since LI-COR Biosciences participated in the inter-comparison campaign as well to test the LI-8100-104 chamber under laboratory conditions.

**Scientific objectives**

The main objectives of the inter-comparison campaign were to gain more knowledge on the errors related to N2O chambers, and to provide methods to control them. Specifically, (1) to evaluate the importance of storage effects to the systematic error of the flux estimate; (2) to evaluate the methods of extrapolating the flux to undisturbed flux ; (3) to compare the ways of estimating the saturation of the flux during chamber measurement, (4) to test if it makes sense to use linear fit for flux estimation, and correcting the systematic error, (5) to test if exponential fit with low number of points gives systematic error; and (6) to test if soil gas concentration can be used to estimate flux. Participants brought their own chambers for sensitivity tests of systematic errors related to chamber leaking, and pressure changes caused by gas storage in the soil underneath the chamber. The sensitivity of the chambers to errors are going to be estimated by combining data from the different chambers into one dataset. The dataset will be used to further develop ideas how to deal with the errors, and to test if soil N2O concentrations can be used to estimate soil N2O fluxes. The applicant’s personal objective was to check if the AGPS chamber underestimates soil N2O fluxes due to leakage since she had observed not properly sealed chambers several times in the field. The laboratory test data is going to be used for quality checking and quality assurance of her own field comparison campaign dataset.

**Reason for choosing station**

The inter-comparison campaign of soil N2O chamber systems followed the studies of Pumpanen et al. (2004), Christiansen et al. (2011), and Pihlatie et al. (2013), which dealt with the quantification of systematic errors of soil chambers used for CO2 and CH4 flux measurements. All these studies have been conducted at the Hyytiala SMEAR II station in Finland because they relied on the infrastructure provided by that station.

**Method and experimental set-up**

In total 22 soil chamber systems differing in size, shape and material were tested during the inter-comparison campaign. The testing was performed on a chamber calibration system present at the experimental station in Hyytiala (for description see Pumpanen et al. 2004, Christiansen et al. 2011, Pihlatie et al. 2013). In short, it consisted of a stainless-steel tank (diameter 1.6 m, height 1.0 m, volume 2.6 m3) which contained known concentrations of N2O, and which was covered with a perforated lid on which a layer of sand was set to act as porous media. The chambers were placed on top of the sand bed for the single measurements. The known reference flux of N2O through the sand bed can be compared with the simultaneously measured soil chamber flux on the top sand surface, thus allowing direct comparison between both fluxes, and subsequent determination of the possible under-/over-estimations of tested chambers (Pihlatie et al. 2013). The depth of the sand bed was adjustable to simulate different soil transport coefficients. Additionally, the chambers were subjected to different wind speeds to check for possible disturbance effects on the flux rates.

The complete test for a single chamber consisted of so-called ‘protocol measurements’ to which each chamber was subjected for the inter-comparison, and extra tests during which the participants could try out additional measurement conditions to meet their own objectives. Each chamber measurement lasted 10 minutes with a 20 minutes stabilization period between the single measurements. Furthermore, the leak rates of each chamber was measured by placing it with its collar into a water bath, injecting 1000 ppb N2O into the chamber headspace, and measuring the decline in N2O concentration in the headspace over one hour. Nitrous oxide concentrations were determined using laser N2O gas analysers. The N2O fluxes are going to be calculated according to Pumpanen et al. (2004), Christiansen et al. (2011) and Pihlatie et al. (2013). The applicant’s measurement plan for the AGPS during her stay at Hyytiala SMEAR II station is listed in the table below.

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| Date | Protocol measurements | Extra tests |
| 06.07.2014 | Preparation of chamber and measurement set-up  Chamber placed overnight on the tank, sand depth 20 cm |  |
| 07.07.2014 | Sand depth 20 cm, no wind (6 replicates)  Sand depth 20 cm, 1.5 m/s wind (6 replicates)  Leak test in water bath (1 replicate)  Change of sand bed depth to 10 cm  Chamber placed overnight on the tank | 2 additional leak tests in water bath with artificial leaks |
| 08.07.2014 | Sand depth 10 cm, no wind (6 replicates)  Sand depth 10 cm, 1.5 m/s wind (6 replicates) | Sand depth 10 cm, 1.5 m/s wind, vent open, imperfect sealing (3 replicates)  Sand depth 10 cm, 1.5 m/s wind, vent closed, imperfect sealing (3 replicates)  Sand depth 10 cm, no wind, vent closed, imperfect sealing (3 replicates) |
| 09.07.2014 | Preparing chamber for transport back to Belgium |  |

**Preliminary results and conclusions**

The dataset is currently being analysed by the project leaders at the University of Helsinki. Results are not available yet for all participants of the campaign, but the available results will be presented for the first time at a plenary session at the InGOS project meeting in Florence, Italy, on October 15th. Preliminary results for the applicant’s AGPS chamber show an underestimation of the N2O flux when calculated using linear regression, and a slight overestimation when applying an exponential flux calculation. However, these preliminary results present only an average of all chamber measurements and do not distinguish yet between different sand bed depths and wind conditions.

**Outcome and future studies**

In the future, a workshop will be organized at which the results of the soil N2O chamber inter-comparison campaign will be presented to all participants. The organizers of the inter-comparison campaign expect to publish peer-reviewed publications based on the campaign – as has been done for the CO2 and CH4 inter-comparison campaigns - and all the participants are invited to participate as (co)authors. The results will also be submitted to the InGOS database of specific measurements. The applicant will use the specific results for her chamber for the analysis of her field inter-comparison between the AGPS and the Licor chambers. The field comparison was finished beginning of September and is going to result in one peer-reviewed publication.

**References**

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