

Interactive comment on “Investigating uptake of N₂O in agricultural soils using a high-precision dynamic chamber method” by N. J. Cowan et al.

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Received and published: 13 September 2014

General comments

This paper investigate net N₂O uptake fluxes in agricultural soil of the UK using a combination of a precise and fast N₂O analyzer with a flushed static chamber. The chamber method is commonly viewed as a “poor men’s” approach, while Aerodyne’s QCL system is a high end system. The combination allows to reach technically new precisions with chamber measurements with low detection limits for short closure time of only 3 minutes. A very similar technique is reported by Hensen et al. (2006) that should be referenced.

The paper is clearly written and the conclusions that for the investigated soils N₂O

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uptake is almost undetectable is justified. It is important to give more details on the operation of the chambers, how they are placed on the collar and how the closure mechanism is designed.

The uptake capacity is limited by the diffusivity of atmospheric N₂O molecules to the denitrification site in the soil. An upper limit is in the order of -50 microgram N₂O-N m⁻²h⁻¹ (Neftel et al. 2010). The presented data show only three cases with uptake fluxes larger than the detection limit and even these fluxes are small. Net uptake fluxes are small due to physical restrictions. Thus the reported observation are consistent with this limitation.

The associated concentration change in the headspace over 120 sec is ca. 0.5 ppb. I judge that these three negative fluxes could also be regarded as being within the expected fluctuation under the assumption of a net zero flux. It has also to be kept in mind that the placement of the chamber and the start of the flow is a disturbance and the visible decreasing trend in the concentration could be a swinging back of an initial increase due to the placement of the chamber. It is remarkable that in figures 3a-3c at the beginning an increase of the concentration is visible. But changes in the order of 0.5 ppb over 2 minutes are within drifts that must be expected of these types of instruments.

Intensively managed agricultural soil do have a high N supply and favorable situations for N uptake requiring a limitation by nitrate are rare. Generally I would assume that chances to measure net N₂O uptake fluxes on the chamber scale is larger than on the field scale with an Eddy Covariance flux approach due to the well documented existence of production hotspots of N₂O in agricultural soils. Nevertheless the generalization that most reported uptake fluxes are due to instrumental limitations has to be differentiated. Measurements of the N₂O concentrations in the open pore space do show persistent values below the atmospheric concentration (Schmid et al., 2001, Flechard et al., 2005) demonstrating that complete denitrification is an important on-going process, especially for situation with low inorganic N substrate and thus small

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uptake fluxes are likely to exist.

I do recommend this paper for publication in AMT after minor revisions.

Specific comments:

p 8129 first paragraph: How exactly the closing of the chamber is done, was a lid manually placed or automatically closed?

P 8129 lines 13-16: t_0 seems to be the time after 60s of the start of the air flow. I would not call it “initial flux”.

P 8130 lines 9-10: A more precise description of the extraction method is needed (?KCl extraction, ratio of extraction solution to soil etc.) I also have not seen results of the NH_4^+ concentrations.

P 8132 lines 10 -15

Correlation of N_2O fluxes with bulk NH_4^+ and NO_3^- (KCl extraction) concentration of the first 5cm are not too meaningful by two reasons: i) NH_4^+ concentrations are not quantitative (see e.g. Müller et al. 2004) and ii) the net N_2O flux is determined by the first few mm of the soil, especially for heavy soils (Neftel et al. JGR 2000).

P 8133 lines 10 -15

There seems a slight mismatch between negative fluxes and statistical fluctuations of the flux determination. Assuming that the real net flux is far below the detection limit, the distribution of the fluxes will be around zero with half of the fluxes being negative (under the assumption of a Gaussian distribution).

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Interactive comment on *Atmos. Meas. Tech. Discuss.*, 7, 8125, 2014.

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