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The effect of random and systematic measurement uncertainties on temporal and spatial upscaling of N2O fluxes

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The addition of reactive nitrogen to agricultural soils in the form of artificial fertilisers or animal waste is the largest global source of anthropogenic N2O emissions. Emission factors are commonly used to evaluate N2O emissions released after the application of nitrogen fertilisers on a global scale based on records of fertiliser use. Currently these emission factors are estimated primarily by a combination of results of experiments in which flux chamber methodology is used to estimate annual cumulative fluxes of N2O after nitrogen fertiliser applications on agricultural soils. The use of the eddy covariance method to measure N2O and estimate emission factors is also becoming more common in the flux community as modern rapid gas analyser instruments advance.

The aim of the presentation is to highlight the weaknesses and potential systematic biases in current flux measurement methodology. This is important for GHG accounting and for accurate model calibration and verification. The growing interest in top-down / bottom-up comparisons of tall tower and conventional N2O flux measurements is also an area of research in which the uncertainties in flux measurements needs to be properly quantified.

The large and unpredictable spatial and temporal variability of N2O fluxes from agricultural soils leads to a significant source of uncertainty in emission factor estimates. N2O flux measurements typically show poor relationships with explanatory co-variates. The true uncertainties in flux measurements at the plot scale are often difficult to propagate to field scale and the annual time scale. This results in very uncertain cumulative flux (emission factor) estimates. Cumulative fluxes estimated using flux chamber and eddy covariance methods can also differ significantly which complicates the matter further.

In this presentation, we examine some effects that spatial and temporal variability of N2O fluxes can have on the estimation of emission factors and describe how relatively small uncertainties can become significant when propagated to the temporal/spatial scale of interest. These uncertainties may be random (i.e. instrument noise) or systematic (i.e. artefacts of measurement methodology). The latter are significant in estimating emission factors as they introduce bias. The presentation addresses uncertainties in both flux chamber and eddy covariance methods which are the two most commonly used methods in literature.