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Validation of flux measurements with artificial sources: simulating CH4 from cows and NH3 emissions from medium plot scales

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Mitigation of ammonia (NH3) emissions with detrimental environmental effects as well as of greenhouse gas emissions (GHG: CO_2, N2O, CH4) are key challenges faced by the agricultural production sector. While NH3 originates mainly from polluted surfaces, e.g. after slurry application, the main source for CH4 emissions are cows and other ruminating animals, representing point sources. There are two widespread state-of-the-art techniques to determine agricultural emissions: eddy covariance (EC) flux measurements and Lagrangian stochastic (LS) dispersion modelling, namely the WindTrax (WT) model. Whereas GHG emissions can be measured with both techniques, NH3 emissions are usually not feasible with EC measurements due to the stickiness of NH3 molecules on surfaces. In addition, point sources render difficulties for the interpretation of EC flux data.

We tested the EC technique and the WT model using artificial sources with known gas release rates.
i) The effect of a point source on EC fluxes was investigated by placing an artificial CH4 source with known release rate upwind of the EC tower at two different heights and during different wind conditions.
ii) The WT model was checked with a NH3 release grid of 314 m2 of known source strength. Ambient NH3 concentrations were measured by open path DOAS systems and impinger sampling.

The CH4 concentration timeseries influenced by the point source showed a similar pattern as in the presence of cows upwind of the EC system. CH4 release rates from the point source were reproduced by the EC flux measurement with stationary background conditions only.
The experiments with the NH3 release showed that WT performs well for emission determination, even in complex terrain (asphalt surrounded by grassland) with associated micrometeorology, given a realistic description of the vertical profile of wind velocity. Calculated gas recoveries ranged between 73 to 105%. Such a result is encouraging considering the immanent uncertainties from a NH3 experiment (variable background concentration, relatively small downwind concentrations, NH3 interception on ground/tubing).