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Quantifying NH3 and CH4 emissions from a dairy housing using backward Lagrangian stochastic modelling

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Inverse dispersion modelling (IDM) using a backward Lagrangian stochastic (bLS) dispersion model has been successfully applied to quantify emissions from confined ground sources e.g. as for ammonia (NH_3) loss after manure spreading. The most widely used bLS model for emission measurements of NH_3 and methane (CH_4) from agricultural sources such as lagoons and livestock buildings is based on Flesch et al. (2004). For such applications, the model assumptions of a diffusive ground source within a homogeneous turbulence field, which implies absence of obstacles as e.g. buildings disturbing the flow, is clearly not fulfilled. It remains unclear to what extend these violations introduce bias into the emission estimates. Further, the model by Flesch et al. does not include deposition removal, which for NH_3, can induce an underestimation of the emission from the source (Häni et al., 2018). Häni et al. extended the standard bLS calculation model with an optional dry deposition mechanism.

In a field campaign between mid-September and mid-December 2018, CH_4 and NH_3 emissions from a natural ventilated dairy housing with 40 cows were quantified using the IDM method with the bLS model by Häni et al. (2018). From the three-month period, results for 63 measurement days at 30-minute resolution were evaluated and thereof 71% of the data points were discarded from the emission calculation due to inapplicable turbulence conditions or instrument failure.

NH_3 and CH_4 concentrations were analysed with open-path instruments (NH_3: miniDOAS,; CH_4: GasFinder, Boreal Laser, Inc., Edmonton, Alberta, Canada) (aligned in parallel) with 50 m path lengths (distance between sensor and reflector). During part of the field campaign (24 days), simultaneous in-house measurements of CH_4 and NH_3 emissions using the tracer ratio method (iTM) (SF_6 and SF_5CF_3, Mohn et al., 2018) were conducted and results compared with the estimates retrieved by the IDM method. Overall, the results from the IDM method compare well to the results of the in-house measurements, with mean daily emissions of 18.3 kg CH_4/d (IDM) and 17.9 kg CH_4/d (iTM) and 1.08 kg NH_3/d (IDM) and 1.56 kg NH_3/d (iTM), respectively. Regarding NH_3, the IDM method was run without the inclusion of a dry deposition mechanism. First results from IDM

calculations with the inclusion of dry deposition indicate, that dry deposition modelling may explain the difference in NH_3 emissions between the IDM method and the iTM.

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