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Determination of NH3 emissions from confined areas using backward Lagrangian stochastic dispersion modelling

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Employing backward Lagrangian stochastic (bLS) dispersion modelling to infer emission strengths from confined areas using trace gas concentration measurements is a convenient way of emission estimation from field measurements (see Wilson et al., 2012 and references therein). The freely available software 'WindTrax' (www.thunderbeachscientific.com), providing a graphical interface for the application of a bLS model, has spurred its utilisation in the past decade. Investigations include mainly methane (CH_4) and ammonia (NH_3) emissions based on experimental plots with dimensions between approximately 10^2 to 10^4 m^2. Whereas for CH_4 deposition processes can be neglected, NH_3 has a strong affinity to any surface and is therefore efficiently deposited. Neglecting dry deposition will underestimate NH_3 emissions, e.g. with a standard WindTrax approach. We extended the bLS model described in Flesch et al. (2004) by a dry deposition process using a simple, one-directional deposition velocity approach. At every contact of the model trajectories with ground level (here at the height of the roughness length Zo), deposition is modelled as:

$$F_{dep} = v_{dep} \times C_{Traj} \tag{1}$$

where v_{dep} represents deposition velocity, and C_{Traj} is the actual concentration of the specific trajectory at contact. A convenient way to model v_{dep} is given by a resistances approach. The deposition velocity is modelled as the inverse of the sum of a series of different resistances to deposition. The aerodynamic resistance is already implicitly included in the bLS model, thus v_{dep} is given as:

$$v_{dep} = \frac{1}{R_b + R_c} \tag{2}$$

R_b and R_c represent resistances of different model layers between Zo and the surfaces where deposition take place. With this approach we analysed a dataset from measurements with an artificial NH_3 source that consisted of 36 individual orifices mimicking a circular area source with a radius of 10 m. The use of three open-path miniDOAS (Sintermann et al., submitted to AMT) systems allowed to measure a line integrated vertical concentration profile downwind of the source. The inclusion of the deposition process is necessary for a consistent interpretation of the measurements.

References

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