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A new inference method to quantify NH_3 emissions from multi-agronomic treatments with low-cost samplers

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Ammonia (NH_3) is a highly reactive gas that is mostly produced by agricultural activities. Management of livestock excreta including application in the field, together with the spreading of mineral fertilisers, are the main emitting sources consisting in a considerable loss of nitrogen. In recent decades many studies were addressed to evaluate NH_3 emissions at plot or field scales, exploring only a single combination of management: a fertiliser type, an application method, or a soil cover. These experimental designs are not capable to quantify emissions from agronomic replicates nor multiple treatments in the same pedoclimatic conditions, because they try to prevent any possible local advection from nearby sources to increase in representativeness.
A novel method based on the combination of low-cost concentration-based passive sensors and a short-range inverse dispersion model, is proposed to quantify NH_3 emission from multiple sources design. This method was tested *in silico* through a 9×9 block scheme composed by three treatments with three repeated sources, mimicking real emissions. Different patterns (constant, linear decreasing, exponential decreasing, and Gaussian emission potentials) and strengths (ratios between sources up to 100) were simulated in a range of 28-days periods over a year in semi-oceanic meteorological conditions.
In order to assess the method, the size of the plot (from 25 to 200 m^2), the height (from 0.5 to 2 m) and the integration time of the concentration samplers (from 3 hours to a week), as well as sources strengths and background concentrations have been taken into account. This method revealed suitable for estimating NH_3 emissions from replicated agronomic plots, and in line with the uncertainty fo other measurement methods. Results shown an overall underestimations of $-8\,\% \pm 6\,\%$ of the emissions for a typical western European climate. For multiple plots, we find that this method would lead to median underestimations of -16% with an interquartile $[-8\,\%\ -22\,\%]$ for two treatments differing by a factor of up to 20 and a control treatment with no emissions. The method was further evaluated varying background concentrations and NH_3 emission patterns and demonstrate the low sensitivity of the method to these factors. A Bayesien calculation with the introduction of a surface resistance approach were also evaluated.