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A NOVEL PLATFORM PROVIDING SERVICES IN THE MEASUREMENT OF AMMONIA VOLATILISATION FROM MULTIPLE AGRONOMIC PLOTS

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INTRODUCTION

Tropospheric ammonia (NH₃) is a threat to the environment and human health and is mainly emitted by agriculture. Ammonia volatilisation following application of nitrogen in the field accounts for more than 40% of the total ammonia emissions in France. This hence represents a major loss of nitrogen use efficiency which needs to be reduced by appropriate agricultural practices. Measuring ammonia emissions in agricultural fields is however a challenge which often requires trained scientists and state of the art instrumentation (Hassouna et al., 2015). A novel INRA-Transfer platform proposes a service for quantifying ammonia volatilisation in the field from either single or multiple agronomic plots using a novel inference methodology.

DESCRIPTION OF THE METHOD

History of the method development

The methodology is based on the well-studied inverse dispersion inference methodology developed in the 1990's (Flesch et al. 2005). The approach uses an Eulerian dispersion model (FIDES) which was validated for large fields with high frequency ammonia concentration measurements (Loubet et al., 2010). The method was further developed to use low-cost ammonia diffusion samplers (ALPHA badges) and infer emissions from multiple agronomic plots. The method was evaluated *in silico* (Loubet et al., 2017), and under field conditions (see Loubet et al., this workshop). This method was used in several studies (Loubet et al., 2010; Carozzi et al., 2013).

Practical implementation of the method

In the field, three ALPHA badges are placed on a mast in the middle of each plot at around half a meter above ground, while three other masts are placed at around 300 m away from the trial (at 2 m height) to capture incoming ammonia. The geometry of the plots is mapped using high precision GPS. An ultrasonic anemometer is placed in or near the trial together with a met station to characterise the turbulence and the meteorological conditions. After application of nitrogen, ALPHA badges are exposed with increasing durations up to few weeks and then stored in a fridge.

In the lab ALPHA badges are desorbed with deionised water and analysed by conductimetry with separation on semi-permeable membrane for ammonium determination. The ammonia concentration is calculated from exposure time and calibrated air sampling coefficient. The ammonia concentrations, geometry and ultrasonic anemometer are then combined to infer emissions and their uncertainties with the method described above.

RESULTS AND DISCUSSION

Method performance

The method was evaluated for single fields against state of the art methods and showed biases lower than 10% (Loubet et al. 2010). For multiple fields, a theoretical evaluation and field measurements demonstrated that the method has a good reproducibility and a low bias (Loubet et al. 2017). An example

result is given for the SOERE-PRO-Qualiagro with 5 treatments and 4 randomised replicated plots per treatment (Figure 1). It shows a remarkable reproducibility of the inferred emission on each plot with confidence intervals (CI) lower than 5% of the median flux except for the control (CI=16%) which received no nitrogen and had a very small ammonia emission. In this trial we showed small emissions from 0.7 to 8 kg N ha⁻¹, corresponding to 6% to 30% of the N-NH₄⁺ applied, and between 0.5% and 4% of the total N applied.

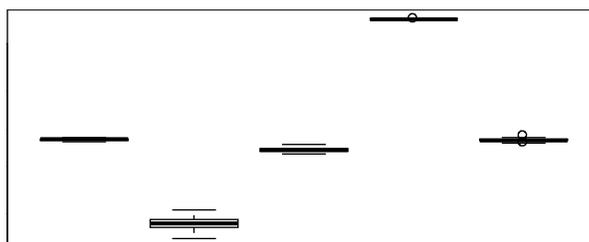


Figure 1. Example ammonia emission inference in the SOERE-PRO Qualiagro. Measurements were performed in September 2015 after application of 13 kg N-NH₄ ha⁻¹ in bio-waste compost (BIOW), 35 kg N-NH₄ ha⁻¹ in green waste and sludge compost (GWS), 10 kg N-NH₄ ha⁻¹ in municipal solid waste compost (MSW) and 2.8 kg N-NH₄ ha⁻¹ in farmyard manure compost (FYM). **CN is the control which received no nitrogen before the trial. Statistics 4 replicates. Bold lines: medians. Error bars: min and max. Boxes: inter-quartiles. Log scale is used to highlight the good reproducibility of the method.**

CONCLUSION

We propose a unique service well suitable for routine measurements of ammonia volatilisation from multiple agronomic plots. This method is thus designed for comparing agronomic practices and acquiring recognised references under field conditions. The method is also adapted for single fields of any size larger than ~400 m². The implementation of the method can be partially or fully taken in charge by our service, including a critical report on the results. This service is a perfect tool for decision making in N fertilisation evaluating environmental impacts. Example results are presented in this workshop (Savoie et al.; Cowan et al.; Voylokov et al.).

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