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### ► To cite this version:

Polina Voylokov, Benjamin Loubet, Sabine Houot, Antoine Savoie, Sophie Générumont. Comparing ammonia volatilisation of livestock effluents having undergone different treatments in field conditions. 20th N Workshop and Side event, Jun 2018, Rennes, France. , 2018. hal-01826832

**HAL Id: hal-01826832**

**<https://hal.science/hal-01826832>**

Submitted on 5 Jun 2020

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# COMPARING AMMONIA VOLATILISATION OF LIVESTOCK EFFLUENTS HAVING UNDERGONE DIFFERENT TREATMENTS IN FIELD CONDITIONS

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## INTRODUCTION

The study presented here is part of the MetaMetha project, designed to evaluate the impact of including an anaerobic digestion step in manure treatment on C and N cycles in agriculture [see Savoie et al., this workshop]. The series of experiments undertaken in the spring and summer of 2017 sought to compare nitrogen use efficiency NUE for a range of treated and raw digestates and non-digested manure and slurry as well as conventional mineral fertiliser applied to crops. NUE is diminished both due to volatilisation as NH<sub>3</sub> and N<sub>2</sub>O or leaching which have adverse effects on the environment and also constitute a loss of fertiliser and potentially yield for the farmers.

A novel method of gaseous emission measurement based on the inversion of the FIDES model (Loubet et al, 2017) [see Loubet et al., in the side event] and the use of passive ammonia samplers (ALPHA, Tang et al., 2001) was implemented to quantify the ammonia emission fluxes. This method indeed is convenient for this sort of experiment where numerous treatments are applied to small parcels. The experimental site was over-equipped in the objective to tests assumptions made for the calculations, and to undertake an analysis of the method performed on this set of data.

## MATERIAL AND METHODS

The experiment took place from March 2017 to August 2017 on 5 experimental plots located in Nouzilly near a biogas plant (INRA, Centre-Val de Loire region, France). There were three fertiliser application events (2017/03/22, 2017/04/19 and 2017/08/02). During the first two events, four treatments were applied to parcels of about 1800 m<sup>2</sup> each, with an additional parcel serving as a control with no treatments. The treatments were bovine slurry, a mineral fertiliser, a raw digestate obtained after the anaerobic digestion of various organic products including pig, cow and horse effluents and the separated liquid fraction of the same digestate. During the last application event, the treatments were a bovine manure, the solid fraction of the same digestate and the raw digestate, likewise with a control treatment.

The parcels were divided into three sections serving as replicates and each section contained a mast with passive sensors (ALPHA badges) attached at different heights. During the first experiment, a setup of 1 to 3 sensor heights was tested. During the remaining two, each section had sensors at two heights. Samplers measured integrated concentrations over periods ranging from several hours just after application to several days at the end of the volatilisation event. The badges were analysed using the FloRRia analyser. Raw micrometeorological data collected using a Gill sonic anemometer, was processed using LabView and EddyPro software in order to obtain the necessary parameters used to calculate the transfer resistance of each sensor/parcel using the FIDES model. This model is based on a semi-analytical solution of the advection-diffusion equation in the surface layer. The sources are subdivided into grid cells each contributing to the observed concentration at the measurement heights. These transfer resistances were used along with concentrations in order to calculate instantaneous ammonia flux from each parcel by least square inference (QR decomposition). Using this data, a sensitivity analysis to several FIDES parameters was performed. The resolution (mesh size) was tested as well as choice of the lateral dispersion function sigma Y (according to Sutton, BNL or Briggs), minimum Monin-Obukhov length, minimum roughness length, and the number of sensors used.

## RESULTS AND DISCUSSION

Raw digestate tended to have the highest ammonia losses followed by liquid digestate, and slurry for the first two experiments. During the third stage, solid manure, solid digestate and raw digestate had significantly higher emissions than the control.

The sensitivity analysis has not yet been fully performed. The following ANOVA was performed on the results of the first period. These results were obtained, using 0.03 and 0.05 m as minimum roughness length, 1, 2 and 5 as min MO length, 0.5, 1, 2 and 5 m as mesh size and using sigma Y calculations according to Sutton, BNL and Briggs. The mesh size is of a particular interest as it would be helpful to know what the best resolution is given the parcel surface area. The minimum roughness length appears to be significant as well.

Analysis of Variance Table	Response:		Emissions kg ha <sup>-1</sup>		
	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Mesh	3	1.9	0.65	6.3897	0.0002999
Sigma	3	0.1	0.03	0.2584	0.8553095
Lmin	2	0	0.01	0.1309	0.8772953
z0min	1	0.9	0.9	8.8334	0.0031108
Treatment	4	8808.9	2202.22	21702.8178	<2.2E-16
Residuals	466	47.3	0.1		

## CONCLUSION

This method is well suited for the comparison of different treatments in the field and its deployment should help evaluate ammonia volatilization after slurry and manure as well as mineral fertilizer applications in various French agricultural contexts and elaborating strategies of reduction. Concerning the effect of the treatment process before application, treated manure gave higher ammonia emissions due to greater ammonia content. The N losses due to ammonia volatilization will be compiled in the global N budget calculations of the MetaMetha project.

**Acknowledgements:** The MetaMetha project, funded by Centre Val de Loire(conv. n° 2016 – 00108447). The authors warmly acknowledge intern A. Lemekhova, and the lab technicians B. Esnault, C. Decuq, E. Vachet and Y. Delaunay.

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