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Supplement of

Measurements and quality control of ammonia eddy covariance fluxes: a new strategy for high-frequency attenuation correction

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WindTrax simulation

The range of possible NH₃ fluxes during the peak emission periods after fertilization was investigated using WindTrax (Thunder Beach Scientific, Canada). WindTrax uses backward Lagrangian Stochastic (bLS) modelling to infer flux estimates based on the measured trace gas mixing ratios and information on the turbulent transport. For the approach, the background mixing ratio has to be known and the source area (in case of emission) has to be defined.

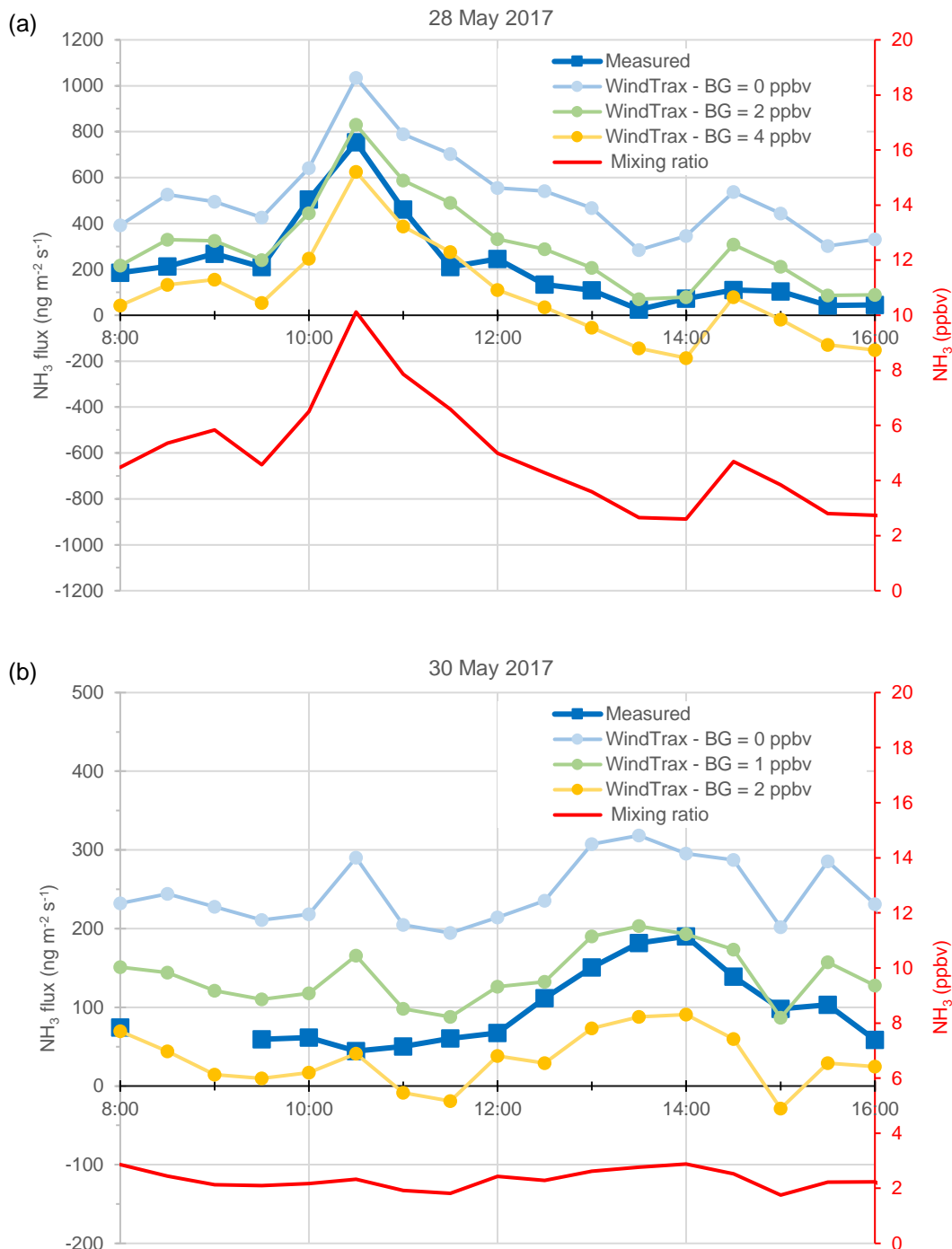
As input we used the NH₃ mixing ratio measured by the QCL and the turbulence statistics by the CSAT3 sonic anemometer at 2.5 m a.g.l. For practicability reasons, we defined the NH₃ source area as a circle with 500 m diameter centred at the measurement location, which approximately represents the average extent of the agricultural field in each wind direction.

Since no background NH₃ measurements were made, which are needed for the flux calculation with WindTrax, we used in different scenarios a NH₃ background mixing ratio between 0 and 4 ppbv. For the analysis, we focused on two days with the highest emission fluxes, 28 and 30 May 2017 (8:00 – 16:00 EST), where the background NH₃ would be expected to have less influence on the NH₃ mixing ratio from QCL than during other conditions.

As shown in Fig. S1, on 28 May NH₃ mixing ratios ranged from 2.7 to 10.2 ppbv, with the peak mixing ratio measured at 10:30 EST. At that time also the highest NH₃ emission flux of 753 ng m⁻² s⁻¹ was observed, indicating that a significant fraction of the measured NH₃ mixing ratio is linked to the emission from the fertilized corn field. Assuming a background mixing ratio of 2 ppbv, which seems a realistic background value given the nighttime NH₃ mixing ratios of about 2 ppbv during that period, the modelled flux using WindTrax is with 829 ng m⁻² s⁻¹ very close to the measured NH₃ flux. Assuming a background mixing ratio of 0 ppbv, which represents the upper limit of possible NH₃ emissions modelled with WindTrax, yields an emission flux of 1034 ng m⁻² s⁻¹ at that time. The 30 min periods before and after the peak show the best match between modelled and measured NH₃ fluxes for NH₃ backgrounds between 2 and 4 ppbv.

On 30 May, the prevailing NH₃ mixing ratios were lower and steadily between 2 and 3 ppbv. Still, the second highest NH₃ emission after fertilizer application was observed on that day, with a peak emission of 190 ng m⁻² s⁻¹ at 14:00 EST. This emission flux matches well with the modelled NH₃ flux of 193 ng m⁻² s⁻¹ using a background of 1 ppbv. Under a background scenario of 0 ppbv, the maximal emission from WindTrax at that time period is 295 ng m⁻² s⁻¹, which is 1.5 times larger than the measured flux.

The analysis with WindTrax, using the two days with the highest NH₃ emissions after fertilization, shows that the expected fluxes are in the range of the measured NH₃ fluxes during those periods. During the peak emissions on both days, the maximal WindTrax emission estimates are about 1.5 times higher than the fluxes measured by the eddy covariance system. Since no background measurements outside of the corn field domain are available, WindTrax could not be used for other periods of the dataset, where the NH₃ emission fluxes were smaller or even deposition was measured.



5 **Figure S1: Estimated NH_3 fluxes (left y-axis) from the corn field using the WindTrax dispersion model. Shown are the daytime (8:00 to 16:00 EST) periods of (a) 28 May and (b) 30 May 2017, which were the periods when the highest NH_3 fluxes were measured. For the model estimates, scenarios with background NH_3 mixing ratios ranging from 0 to 4 ppbv were used together with the measured NH_3 mixing ratios (right y-axis). The measured eddy covariance fluxes, to which the results from the WindTrax model are compared, include the high frequency attenuation correction using the time response method.**