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Atmospheric Measurement Techniques Discussions

Interactive comment on "Measurements and quality control of ammonia eddy covariance fluxes: A new strategy for high frequency attenuation correction" *by* Alexander Moravek et al.

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Eddy Covariance measurements of NH3 fluxes are a big challenge due to the stickiness of this molecule. The time resolution due to absorption and desorption in the inlet system is the limiting factor and high frequency losses needs to be corrected. The present paper by Moravek et al. presents an impressive approach as the system time response is regularly measured by introducing NH3 free air for 5 minutes. The response function based on a double exponential function is then used to correct the frequency loss. This novel approach is compared with the more conventional "ogive"

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method where the cumulative frequency distribution is compared with an assumed undamped flux measurement. Mostly the heat flux based on the sonic anemometer data is used as reference.

The paper focusses on the frequency behavior of the NH3 covariance function. The paper follows up the work by Shaw et al, 1998 and Ferrara et al. (2012) that had a similar focus. We have question marks regarding the order of magnitude of the presented fluxes in this paper and, indirectly for all these papers. Shaw et al. presented a very well designed and careful analysis of the EC data. All necessary information is given and the inferred correction of 45% due to high frequency damping is convincing. But the NH3 emission fluxes in Shaw et al. are extremely high for a non-fertilized natural grassland situation (145 μgm-2s-1). We rather expect deposition fluxes. We do speculate that Shaw et al. overlooked that their NH3 signal was due to a water interference and thus measured water fluxes that are indeed emission fluxes with the reported signature.

Ferrara et al. 2012 presented EC NH3 flux data using a pulsed Aerodyne QCL system. They focus on different algorithms for the damping correction. Two years later the same authors presented a new flux analysis, this time based on concentration measurements in combination with a dispersion model (bls). Apparently both papers used the same raw data set. But the fluxes in the 2014 paper (bls) are roughly one order of magnitude higher. They are in the expected range of NH3 emission fluxes after fertilization with urea. This is a strong indication that the calculated EC fluxes from the first paper do underestimate the true fluxes by roughly one order of magnitude.

Measurements reported in the present paper covered a five-month period of NH3 fluxes from a large cornfield. The field was fertilized with 155 kg N ha-1 urea on May 25th, the measurements started then on May 28th. The present paper by Moravek et al. unfortunately presents no time series of concentrations and fluxes nor calculates cumulative fluxes. A very generous and rough estimation of the cumulative loss from May 28th to May 31st yield a very low percentage of NH3 loss of the applied urea. Assuming a

persistent flux of 50 ngm-2s-1 over four days yields a cumulative emission of approx. 150g ha-1 or 0.1% of the applied fertilizer., which is an extremely low amount. We hypothesize that a similar situation as in the Ferrara 2012 paper could have occurred: a reasonably looking NH3 flux covariance function where the usual high frequency damping correction algorithms seem to work, is severely underestimating the true flux. The authors do have the possibility for a plausibility control as they have concentrations and turbulence data and could estimate therefore the fluxes with a dispersion model such as Windtrax. As there are no detailed information on the management, nor the meteorological conditions are given, it is impossible for us reader to judge whether the order of magnitude of the presented emission fluxes are in a reasonable range. We are perfectly aware that a plausibility check of the reported deposition fluxes is much more demanding. But time series of deposition velocities at the measurement height would yield interesting information, e.g. on compensation points (see Flechard et al., 2010).

During the Dronten experiment (2016, NL, https://www.youtube.com/watch?v=Sz8FQHv6XX0) we have observed situations where reasonably looking EC NH3 flux data clearly underestimated the fluxes by roughly one order of magnitude. (Hensen, 2018) We used a pulsed Aerodyne QCL system (similar generation as used by Ferrara et al., 2012, 2014). The device was placed in the center of a manured circle (diameter 40m) and the inlet was placed 1m above ground. The scope of the measurements was not the vertical fluxes, but to gain information on the horizontal diffusive flux that is an important correction for the Integrated horizontal flux approach. The evaluated fluxes need to be corrected by three factors: i) similar as in Ferrara et al. (2012) the concentration by the Aerodyne evaluation routine is severely underestimated, most likely due to a wrong fitting routine, ii) a footprint correction, as the measured flux is a mixture of contribution from the fertilized circle and the area around them, iii) the high frequency loss that was calculated with an “ogive” approach. These three corrections yielded roughly an upscaling of the raw flux by a factor of 10. Still compared to three other independent approaches (IHF, plume measurements, bls-approach with line integrated concentration measurements) the EC fluxes turned out to be an order of

magnitude to small (phd thesis Michael Bell:https://www.theses.fr/2017NSARD083). We speculated that in the inlet line, roughly 10% of the ambient NH3 variations passed and are damped as described in this paper. But 90% is so strongly attenuated, that the flux memory is lost. We successfully simulated this by manipulating raw temperature time series from Sonic anemometers. In the supplement we added an extract of the presentations of the results at the EGU 2017 Vienna meeting (https://meetingorganizer.copernicus.org/EGU2017/EGU2017-9321.pdf) As we have no running projects on ammonia available anymore (due to retirement and institutional restructuration) we cannot continue to investigate causes of this behavior and cannot offer a mechanistic explanation which is, in our opinion crucial in order to obtain good EC flux estimates for Ammonia.

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https://www.atmos-meas-tech-discuss.net/amt-2019-193/amt-2019-193-SC1-supplement.pdf

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