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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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We thank Reviewer #2 for their overall positive feedback on our manuscript. We addressed their comments as follows:

Comment: *Page 2, Line 5: In addition to Europe, the Great Salt Lake Region also experienced an ammonium salts rich condition, as suggested by another paper of the authors (Moravek et al., 2019). This is also the case in North China (Li et al., 2019). It*

is better to mention this worldwide situation here.

Response: We mention Europe here, since Pozzer et al. (2017) found for Europe the highest PM2.5 reduction when reducing ammonia emissions on continental scale (maximum of 34 % compared to 16 % for North America and 13 % for East Asia). However, we agree with the reviewer that ammonium containing aerosols do comprise large portions of PM2.5 in many other regions as well. We therefore added a note on the more regional importance of ammonium aerosols, including the references the reviewer suggested.

Comment: *Page 2, Lines 7-10: The major sources of ammonia are from agriculture globally and regionally. On an urban scale, however, the sources may be non-agricultural emissions (Pan et al., 2016). So the mitigation strategy for improving air quality may be not work if only controlling agricultural sources. Although I agree with the authors that measuring the flux is critical to reduce uncertainty of the ammonia inventory, identifying the major sources is also important.*

Response: We agree that identifying the major NH_3 sources is essential as well. To give a more complete picture on possible NH_3 sources, we added a sentence on the fossil-fuel based NH_3 emissions.

Comment: *Page 2, Lines 14-15: Classic references may be required here for the readers' convenience, rather than shown them together at lines 18-19.*

Response: Since not all references on the eddy covariance method report successful flux measurements, we found it is better to mention them in the respective section below, rather listing them here in the first sentence of the paragraph. Consequently, we listed the references for the gradient and REA method also below at lines 18-19. We found grouping them together was the best way to give an overview on the performed

gradient and REA studies.

Comment: *Page 2, Line 16: change ammonia to NH_3.*

Response: We made the requested change.

Comment: *Page 4, Line 2: change particulate matter to PM, as defined at Page 2 Line 5.*

Response: Since "particulate matter" is only used three time in the manuscript, we removed the acronym definition on page 2.

Comment: *Page 4, Line 7: Just a comment, 5.5 m may be too long for ammonia determination.*

Response: The intake line for ammonia measurements should be kept as short as possible to reduce wall interactions. 5.5 m was the minimal inlet length we could use for our setup to ensure the stable operation of the QCL and optimal location of the sonic anemometer. In this paper we evaluate the effect of the wall interaction on the high frequency NH_3 measurements and show that NH_3 can be measured with a sufficiently high time response to obtain NH_3 fluxes.

Comment: *Page 4, Line 7: Heated to 40 oC?*

Response: Since the information on the heating temperature is given in the method section, we think it is sufficient to mention it there.

Comment: *Page 6: Did the authors perform calibration of ammonia with known con-*

centrations?

Response: Since the shape of NH_3 absorption line is known from the HITRAN database, the ammonia mixing ratio can be derived directly by fitting it to the absorption spectrum measured by the QCL using sample cell pressure. The measurement therefore represents an absolute measurement technique, which does not require a calibration to obtain the NH_3 mixing ratio. Still quality checks with a known NH_3 calibration source are advisable, also to exclude potential systematic effects of the inlet system. We intended to use a continuously running NH_3 permeation oven for this, however due to problems with its stability (mixing ratios varied by 20 %) we could not use the results. Instead the QCL measurements was compared to manual denuder measurements made at the QCL inlet, where we found an agreement of 15%.

Comment: *Page 7, Line 26: change ammonia to NH_3, check through the text.*

Response: We changed ammonia to NH_3 where applicable.

Comment: *Page 11, Results: I suggest the authors detail diurnal variations of ammonia flux.*

Response: Since the scope of this manuscript is the measurement and quality control of NH_3 fluxes, we do not describe the measured fluxes here in detail. The discussion of flux magnitudes will be presented in a subsequent paper by authors. Still, in reaction to the comment made by Neftel Hensen, we gave more details on the plausibility of measured NH_3 fluxes.

Comment: *Finally, this reviewer is wondering if an early morning pulse of ammonia flux/ concentration was observed during this campaign. And is it possible using ammonia flux determination in this study to support the ideas proposed by Wentworth et*

al. (2016), who are also from Jennifer's group, that dew is a night-time reservoir and morning.

Response: Since it is not in the scope of this manuscript, the detailed discussion of the fluxes and their underlying processes will be presented in a subsequent paper by the authors. This will also include the discussion of potential sources such from evaporating dew.

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