Characterization of size-segregated particles turbulent flux and deposition velocity by eddy correlation method at an Arctic site

We thank the Reviewers for their comments and feedback and for taking the time to help improve this manuscript.

Responses to Reviewer #2.

I commend the authors for significantly improving the manuscript by paying close attention to the reviewers' questions and recommendations. In my opinion the paper is now ready for publication, despite some outstanding issues that are difficult to fix after the fact, as outlined below. As long as there is a record (in these online comments) of some reservations, the value this paper adds to the literature on aerosol fluxes outweighs the problems.

Authors thank the Reviewer for the positive and encouraging evaluation of this work, and for giving us the chance to improve the paper. We appreciate that the Reviewer found our work interesting and relevant for the Journal and the aerosol community.

Adding photos and a schematic of the setup clarified some of the issues. It is unfortunate that there were essentially no winds from between 330° and 120°, which are the directions for which the building may have caused the least wind distortion. Judging from the new Fig. S1, any flow from between 120° and 330° would be crossing the roof to some extent, which may explain some of the positive momentum fluxes observed, particularly during strong winds. Rather than not performing a rotation for angles of attack greater than 15°, it may be safer to just exclude these data (which only account for 3% anyway).

As can be seen from Fig.3f, winds coming from the mentioned sector are uncommon (about 5% of quality assured data measured in this campaign). However, we'd like to remark that the momentum flux for the roof wind sector (identified more specifically in the range 180°-240°) did not actually show positive anomalies as shown in R.Fig.2a (https://doi.org/10.5194/acp-2022-768-AC1). Furthermore, an analysis has been performed on spectra for u, v, and w wind components from the roof sector (see R.Fig.2b, https://doi.org/10.5194/acp-2022-768-AC1): both the vertical and horizontal wind components follow very well the trend line (black dashed line) at -5/3 in the inertial subrange, without any evident anomaly. Thus, there doesn't seem to be any important flow distortion arising from the roof sector. For these reasons the Authors decided to take in consideration all the quality assured dataset, including the wind sector corresponding to the roof area. Looking at the graph of the momentum flux time series (Fig.S5) as a function of the wind direction (on colormap), a particular event can be observed (first red circle from left), with positive values of momentum flux. This positive peak corresponds to a very well-defined wind sector W (from 250° to 270°), that is, air masses coming from the glacier Brøggerbreen, SW of our measurement site, with relatively high velocity (on average 8 m s^{-1}). The same can be said for the second (in time) red circle event in Fig.S5.

The covariance spectra in Fig. 2 are still troublesome. Assuming that aerosols are transported by similar mechanisms as sensible heat (which we know is a stretch sometimes), why do the aerosol

covariances drop by 6 orders of magnitude from fn = 0.001 to 1, whereas heat flux covariances drop by only 2?

We believe, as specified in the description of the field setup, that the limiting factor for the frequency loss lies in the low time response of the instruments used, that are suitable for eddy covariance measurements, but still cannot cover the full turbulence spectrum. Nevertheless, the impact of such losses on our results has been minimized by applying corrections based on the approach proposed by Horst (1997)

Horst, T.W.: A simple formula for attenuation of eddy fluxes measured with first order-response scalar sensor. Boundary-Layer Meteorol. 82, 219–233, https://doi.org/10.1023/A:100022913, 1997.

The inertial subrange (where the -7/3 slope applies) should be in the same frequency range. The fact that the ogives look good is nice, but they represent normalized fractions and don't say much about the total flux which may be seriously underestimated, due to various losses. It would have been interesting to compare the aerosol to gas flux spectra, if available, which would be a better case for the assumption of similarity; perhaps a consideration for future projects.

Unfortunately, no other gaseous species were measured at the same location, to be used in comparison for better understanding the PM dynamics. However, sensible heat flux does give important information on the same turbulent exchanges involving PM, hence its extended use in eddy covariance studies. We agree that, in principle, comparing with gas fluxes could provide additional relevant information.