

This study presents an estimation and analysis of vertical aerosol fluxes using the eddy covariance (EC) technique applied to Doppler lidar measurements, with additional data from a microwave radiometer and a disdrometer used for data screening and quality control.

The study is highly interesting and relevant for several reasons. The proposed methodology could potentially be applied at other ACTRIS Cloudnet stations, significantly broadening its applicability and increasing the scientific value of the resulting observations. Ultimately, such efforts could contribute to improving the representation of aerosol processes in atmospheric composition models.

However, several important points should be addressed before the manuscript can be considered for publication.

### **General comments**

The title does not adequately reflect the content of the manuscript. The study does not specifically address the characteristics of an urban ecosystem, apart from the location of the measurement station. In particular, the authors do not investigate how, or to what extent, the results might differ in other environments. The reference to an “urban ecosystem” in the title therefore appears misleading.

The second part of the title, “How far can we push Doppler lidar aerosol observations?”, raises expectations of a novel measurement approach or a substantial extension of the range over which Doppler lidar observations can be used to estimate aerosol fluxes. However, the authors rely on a methodology that has already been published. Although the methodology used to estimate aerosol fluxes may be relevant and rigorously implemented, the manuscript does not appear to deliver on the broader ambition suggested by the title. The authors should therefore either better substantiate the novelty and scope implied by the title or revise the title to more accurately reflect the actual contributions of the study.

The authors focus on aerosol resuspension and sedimentation. Clear definitions of these two terms are essential to ensure the conceptual clarity of the manuscript. Eddy covariance (EC) method allows the estimation of vertical fluxes. It is unclear why upward fluxes are interpreted as resuspension rather than more generally as aerosol emission or vertical transport. An upward aerosol flux does not necessarily imply resuspension from a surface.

This distinction is particularly important given that negative values of the resuspension velocity are reported in Fig. 8 and that resuspension velocities are presented at altitudes as high as 1500 m above mean sea level (Fig. 7). The authors should clarify how resuspension and sedimentation are defined and quantified in their analysis, explain the physical interpretation of the sign of the estimated velocities, and justify the use of the term “resuspension velocity” at such altitudes.

The research gap and the specific contributions of this study are not clearly articulated in the Introduction. This is particularly important given the ambition suggested by the title. The authors should explicitly identify the limitations of previous studies, explain which knowledge gaps remain, and clarify how the present study addresses them.

The specific role of each instrument should be better explained and the innovation brought by the methodology should be made more explicitly. Furthermore, the respective roles of the different instruments should be described more clearly, including how the measurements from the Doppler lidar, microwave radiometer, and disdrometer are used in the analysis. Finally, the methodological novelty and added value of the proposed approach should be stated more explicitly, distinguishing the original contributions of this study from methods and findings already reported in the literature.

### **Specific comments**

L111–113: A brief description of the in-house method used to calculate aerosol fluxes would be helpful, as this method is central to the study. The authors should summarize its main principles and clarify how it differs from existing approaches, with appropriate references to the relevant methodological details.

L124–125: *“Aerosol flux velocities are classified as resuspension and sedimentation processes, representing upward and downward transport, respectively.”*

As mentioned in the general comments, it is unclear why upward aerosol fluxes are systematically classified as resuspension. Why is aerosol emission not considered as a possible source of upward fluxes? More generally, can upward transport be described as resuspension when the aerosols have not previously been deposited on a surface? The authors should clarify the physical basis for this classification and justify the terminology used.

L140: *“To address this, a cost function for estimating the optimal filtering threshold was applied.”* For clarity, I suggest explicitly stating that this filtering procedure aims to exclude conditions under which hygroscopic growth may significantly affect the aerosol backscatter signal. Although this objective can be inferred from the context, making it explicit would help readers understand the purpose of the filtering procedure.

L143–145: *“The cost function was defined as the sum of the relative standard deviation of the filtered record frequency (normalized to 0–1) and the fraction of remaining data (normalized to 0–1), balancing temporal variability preservation against data loss.”*

The objective of the proposed cost function and the rationale for combining these two terms are unclear and require further explanation. In particular, how does this cost function ensure that fluctuations in the aerosol backscatter coefficient ( $\beta_p$ ) associated with hygroscopic growth are reduced, rather than simply optimizing the number and temporal distribution of retained observations? The authors should clarify the physical

rationale underlying the cost function and explain how its minimization contributes to the intended filtering objective.

L146-151: The rationale for using a fixed RH threshold to identify and exclude conditions potentially affected by hygroscopic growth should be briefly explained.

L146-151: Please clarify that  $\Delta RH$  refers to the temporal variation in relative humidity and specify the temporal resolution at which it is calculated (i.e. the time interval over which the variation is evaluated).

L146–151: Are there other situations, beyond high RH and strong temporal RH variations, in which hygroscopic growth could affect aerosol flux estimates? For instance, could vertical RH gradients, combined with turbulent mixing, generate fluctuations in the aerosol backscatter coefficient that are correlated with vertical velocity and thereby affect the covariance used to estimate aerosol fluxes?

L141: Is there a contradiction between the statement that “a fixed RH threshold is not feasible due to the lack of information about aerosol type” and the use of fixed RH thresholds, as described in Table 1?

L174-175: *“Consequently, the results indicate that RH data filtering is unlikely to distort the overall statistics, especially for strong aerosol flux events”*

Could the RH filtering nevertheless introduce a bias in the estimated flux statistics? Hygroscopic growth increases aerosol particle size and can affect sedimentation velocity. Excluding periods of high RH, when hygroscopic growth may be significant, could therefore preferentially remove conditions associated with enhanced downward aerosol transport.

L176: Please briefly describe the stationarity test, including the criterion used and its purpose in the analysis.

L204-205: *“Filtering for advection effects and gravitational waves was also bypassed, as these processes do not represent predominant phenomena in our dataset. Due to the large volume of data, such sporadic events do not significantly alter the findings.”* Are advective effects, understood here as horizontal transport, necessarily sporadic?