

Interactive comment on “Direct measurements of black carbon fluxes in central Beijing using the eddy-covariance method” by Rutambhara Joshi et al.

Anonymous Referee #1

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The authors present the first application of the eddy covariance method to measure black carbon (BC) fluxes in an urban environment. They report turbulent BC number and mass fluxes in the winter and summer seasons, and identify traffic as the dominant source during both seasons at their site in central Beijing. The authors also compare observed BC fluxes as well as BC/NO_x and BC/CO emission ratios with a 2013 emission inventory (MEIC) and show similar temporal patterns but large discrepancies in emission strength. The manuscript is well written, the method and its limitations are thoroughly discussed, and the presented results are original. The manuscript is a very important contribution to the field. Therefore, it should be published in ACP after minor revisions:

Specific comments: The title of Section 3.1 is "Stability, stationarity and storage corrections" but this section only deals with the storage correction term. I suggest to change the section title to "Storage correction". Stationarity is not mentioned at all. I would encourage the authors to add a brief paragraph on stationarity.

I very much appreciate the spectral analysis presented in section 3.2. The authors state that "BC mass co-spectra follow sensible heat co-spectra until the attenuation due to noise at around a non-dimensional frequency of 1, suggesting that scalar transport occurs from energy transporting eddies." I am not sure if I understand the second part of this statement correctly. There is spectral similarity up to a non-dimensional frequency of 1 but it's important to point out that the spectral peak and the major fraction of the cospectral density is found at lower frequencies in order to suggest that scalar transport is mainly with energy-transporting eddies. The spectral peak is mentioned only after this conclusion. Also, in lines 219/220, it should be added that the $-4/3$ slope in the inertial subrange is evident for the sensible heat flux.

In section 4.1, the authors introduce four different BC modes identified by Liu et al. (2019) who "suggested that thinly coated particles were related to traffic-related activities and, thickly coated and large thinly coated particles were related to solid fuel burning". The authors continue to introduce two new groups, heavily coated referring to thickly coated and moderately coated particles from solid fuel burning, and lightly coated referring to small thinly coated and large thinly coated from traffic particles. There is a contradiction regarding large thinly coated particles, related to solid fuel burning in line 238 but to traffic in line 254. Please clarify!

In the top panel of Figure 4a), there seems to be a systematic change in the difference between tower and ground-based measurements in the winter campaign from 25 November. Could you briefly discuss what might have happened? Also, in Figure 4b) please introduce the meaning of a and b as offset and slope, or remove.

Section 4.2 presents very interesting BC flux data, and I agree that while there is some

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uncertainty due to poor counting statistics, averaging can yield meaningful statistics. What is striking in Figure 6 is the much larger amplitude of net fluxes (both number and mass) in winter compared to summer. I recommend adding a brief passage that discusses the fraction of net deposition fluxes during the winter and summer campaigns, and the stronger net emission flux peaks in winter compared to summer. In Figure 7, please add a 1 km scale and indicate the two major roads mentioned in the text to make the map more meaningful.

In Section 4.4, line 335, the authors state that "average flux values between the two seasons were similar, indicating a similar source between seasons". In my opinion, the second part is an overstatement.

Section 4.5 is very interesting and original but I was left wondering whether or not seasonal differences occurred. I would strongly recommend to present Table 2 for the winter and summer seasons separately. This could also add to the discussion of a similar dominant source in the winter and summer seasons, which is also mentioned in the Conclusions in line 449. In Table 2, use the term "heavily coated" instead of "highly coated" for consistency, and in the second column, exchange the associated sources given in parentheses, i.e. heavily coated (solid fuel) and lightly coated (traffic).

Technical comments: Put table captions above tables. l. 39: Remove "." between "diseases" and "(" l. 39: "exposure limit" instead of "exposure limits". l. 43: Check units of "a 1 μm^3 increase". l. 45: "with warming potential to the climate second only to CO₂" - the term "warming potential" is confusing. I suggest using "radiative forcing" instead. l. 97: Remove "W." from reference Bond and Bergstrom (2006). l. 106: Remove "." between "Kondo" and "(" l. 164: "constant time-lag" instead of "constant time-lags". l. 169: Remove "." between "Sims" and "(" l. 212: "an instruments' response" instead of "an instruments response". l. 263: What do you mean by "precession limits"? l. 269: "with associated standard error" instead of "which associated standard error". l. 273: Remove ")" before ". The uncertainty..." l. 275: Remove "." between "Sims" and "(" l. 284: "before performing" instead of "before preforming". l. 314: "error bars represent"

instead of "error bars represents". l. 315: "ensemble average" instead of "ensample average". l. 318: I recommend "for each hour of the day" instead of "for each time of the day". l. 330: Figure caption should read "Diurnal cycles for (a) number and (b) mass flux...". l. 346, Figure 9: What are the units of the color scale? l. 357: "heavily coated" instead of "highly coated". l. 360: Instead of "almost negligible", I recommend "smaller than 8 %". In my opinion, a contribution of 7.7 % is not negligible in this context. l. 379/380: "discussed by Squires et al. (2020)" instead of "discussed by (Squires et al., 2020)". l. 380: Values for BC/NO_x ratios given in this line are not in agreement with values presented in Figure 10a). l. 388: Remove "the" after "in the literature for". Table 3: On p. 18, Table 3, I recommend adding the observed values for direct comparison. l. 398: In Table 3, in the third row, China V change "0.0057/0/009" to "0.0057/0.009", and in the last row, China III change "0.027/0/017" to "0.027/0.017" l. 408: Remove parentheses around "Zhang et al., 2015". l. 410: "BC emissions for the year 2013" instead of "BC emissions for year 2013". l. 436: "may reflect the limited suitability" instead of "may reflect the suitability". l. 459: Add "." between "inferred" and "The BC/NO_x". l. 467: "This indicates" instead of "Indicating". l. 474: Remove "x" in "Atmxospheric".

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