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Interactive comment on "Top-down estimate of black carbon emissions for city cluster using ground observations: A case study in southern Jiangsu, China" *by* Xuefen Zhao et al.

Anonymous Referee #3

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This is a very nice and detailed work to constrain BC emissions in southern Jiangsu. The approach and uncertainty analysis may be applied to other regions. The paper is well written in general, suitable for ACP. Below are a few suggestions to further improve the paper.

It would be nice to discuss in the conclusion section the potential of applying the method to other regions.

The regression model needs to be further clarified. Are the scaling factors (betta) for each month, day, or hour? Why is there not a term in Eq. 1 for the background (e.g., lateral boundary condition) reflecting the effect of horizontal transport from regions

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other than southern Jiangsu? Table S3 and Fig. S7 show that the sum of southern Jiangsu contributions is much smaller than 100%, implying a large contribution from regions other than southern Jiangsu.

The idea of testing the spatial representativeness of measurements is very nice. Given the spatial representativeness difference between the two sites, is it possible to use Case 3 as your best case? Alternatively, it would be nice to improve the regression model by taking into account the transport path, e.g., by basing on WRF modeled winds to design a model that considers the trajectory of air movement. The much higher bias in JS-posterior than JS-prior in Case 1, which is a concern, is related to this spatial representativeness issue.

A clearer discussion of temporal resolution in bottom up inventories and how this resolution affects the top-down constraint will be very helpful.

Comparison with near-surface measurements is sensitive to WRF/CMAQ modeled vertical processes, including the number of vertical layers within the PBL, the thickness of the first layer, and the model error in vertical mixing representation. WRF/CMAQ may have some issues with PBL mixing (Liu et al., 2018). Please specify these model setups. Please discuss the potential effect of model vertical resolution/mixing/transport errors on the BC constraint.

Table S2 shows that the prevailing winds in all three meteorological sites are southerly or southeasterly. I thought there would be northerly in the cold months (January and October). Please double check.

Minor comments:

Some paragraphs are too long and should be splitted, for example, L71-111, L352-388.

Abstract – please specify that monthly, sector-level and city-level emissions are optimized.

L22 – "observations," should be "observations" (no comma)

C2

Abstract – please specify that WRF/CMAQ is used

L214 – is there is term for background (due to horizontal transport)?

L218 – "domain-wide" – here you optimize the southern Jiangsu emissions, not the domain-wide emissions. Also, as suggested above, an improved regression model may be used to better account for spatial representativeness of measurements.

L256 – "coordinated" should be "coordinate"

L274-288 – please specify the temporal resolution of bottom up emissions.

L283-285 – do you remove emissions in the whole domain, or just southern Jiangsu cities?

L288 – "Scenarios B and S" should be "Scenarios B and S1-S4"

L324 – "double" should be "twice"

L340 – "VIF smaller than 10" – the VIF values in the table are much smaller than 10.

L386-388 – this sentence is not clear

L418-442 – A figure would be much better than a table for this type of analysis.

L426 – what do you mean by "commonly"? The wording may be improved.

L443-446 – The increased bias from JS-prior to JS-posterior at NJU should be discussed in more detail.

L464 – some cases are for other months.

L551 – "initial" should be "a priori". Please revise throughout the text.

L573-604 – the paragraph contains multiple messages, and is better to be splitted.

Figs. S8-11 – the dates of precipitation are also not very well simulated.

L701 – "insignificant" should be "modest"

L715-717 – the increased bias at NJU should be mentioned.

L735-737 – it would be extremely difficult to use satellite AOD to constrain BC emissions.

References: Liu et al., Spatiotemporal variability of NO2 and PM2.5 over Eastern China: observational and model analyses with a novel statistical method, Atmospheric Chemistry and Physics, 18, 12933-12952, doi:10.5194/acp-18-12933-2018, 2018.

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