Atmos. Chem. Phys. Discuss.,
https://doi.org/10.5194/acp-2020-1168-AC2, 2020

Atmospheric Chemistry and Physics Discussions

Interactive comment on "Large-eddy simulation of traffic-related air pollution at a very high-resolution in a mega-city: Evaluation against mobile sensors and insights for influencing factors" *by* Yanxu Zhang et al.

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Received and published: 28 December 2020

Anonymous Referee #2 General Comments This paper presents high-resolution modeling of CO concentrations in a high population urban area and a model performance evaluation based on high time-resolution observations. The research in this paper is a solid scientific study that adds to the knowledge we have of the variability in air concentrations in large urban areas. Below I detail some specific comments that should be addressed by the authors as well as some technical corrections.

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We thank the reviewer for the acknowledgment and the helpful comments and suggestions. Please find our responses below.

Specific Comments -Lines 183-185: please provide more reasoning for your decision to use the minimum CO concentration from the nine air quality monitoring stations. Are any of these stations located away from traffic/industrial sources or upwind of the city? Are any of these truly representative of a background concentration?

We clarified this by adding the following sentences in line 206: “Seven of these stations are located inside the model domain representing different functioning districts of the city. The remaining two are located at the suburbs to the west and northeast of the city center, which could be a reasonable representative for background concentrations depending on wind directions.”

-Figure 4: I can’t understand this plot at all. Why are all of the modeled CO concentrations negative? Why don’t the peaks in the yellow and orange lines match the stated geometric means of 0.17 and 0.28 mg/m3? What do the blue and red portions of the F(C) equation represent? If the black lines represent the total frequency of residential streets + highways, why is the black curve it so similar to the yellow curve with no obvious influence from the orange curve?

We apologize for this confusion. The x-axis is on a log scale. We modified the x-tick values to their actual concentrations instead of their log values.

We used a two-mode Gaussian function to fit the data, i.e. the actual distribution is the sum of two Gaussian functions. The blue and red portions of the F(C) equation represent the yellow and orange modes of Gaussian functions, respectively (sorry we messed up the colors). The overall distribution is dominated by the yellow curve mode, i.e. most of the points are residential streets.

We modified the sentence in 235 as: “. . . follow a two-mode Gaussian distribution (i.e. a sum of two Gaussian functions, Figure 4) . . .” We modified the color of the text in Figure

4 to make the connection between the curves and the modes clearer. We also added a legend to Figure 4. The following sentence was added to the legend of Figure 4: "The yellow (residential streets) and orange (arterial roads, highways, and the nearby regions) curves represent the two Gaussian modes."

-Figure 5 and 221-225: please provide detailed information on the time resolution of the modeled and monitored data used in this plot and the stated statistics. From the methods section, it appears that the model has a time resolution of 6 s, but the taxi data have a resolution of 10 s. How were the data transformed to be of equal time interval?

We compare the time-averaged concentrations only. We had a sentence in line 136: "Hourly average data is achieved and we use the results of the last hour for analysis."

We added a sentence in line 144 to further clarify: "Due to the large computational cost associated with model simulation, we don't run the model for a consecutive time window with actual meteorological conditions. Instead, we choose a selective combination of meteorological scenarios to represent the variability of meteorological conditions at Nanjing."

We also modified the sentence in line 249 as: "We sample the hourly-mean model results with the same location, emission level (rush or non-rush hours), and wind speed/directions as the observations."

-Lines 223-232: the uncertainty for both the modeled and measured CO concentrations are a large percentage of the calculated 0.90 and 0.92 mg/m3 attributed to traffic sources. Combining this with my comment above that in-city monitoring sites may not be the best sources of background CO concentrations leads to the conclusion that the 40% attribution to traffic-related sources is very uncertain at best. I recommend adding further details on the uncertainty of this estimate.

We agree that big uncertainty is associated with our estimate. So we deleted this part

of the discussion as this is irrelevant to our main point of this paragraph.

Technical Corrections -Lines 48-50: please add a citation for this sentence. While the point being made is generally true (i.e., there are few sensors in most major cities), the specific numbers quoted in this sentence must be attributed to the correct location. Also, consider changing the beginning of this sentence to, “For example, in [city],:::”

We added the following sentence in line 50: “For example, there are 9 national air quality stations in Nanjing (http://hbj.nanjing.gov.cn/), and 8 air quality monitors in the City of New York (https://www.epa.gov/outdoor-air-quality-data/interactive-map-air-quality-monitors).”

-Line 67: please clarify that CALPUFF is a puff model, not a Gaussian model.

We modified this sentence as: “Gaussian plume and puff models have been widely used in such purpose for a long history, e.g. regulatory models such as AERMOD and CALPUFF”

-Line 76: the word “dynamics” should be added between “fluid” and “models”.

Revised as suggested.

-Figure 2: this figure is difficult to see and would be improved if it were higher resolution and/or a different color scheme.

We replaced it with a higher-resolution version.

-Figure 4: the legend is missing from this figure. Please include legend definitions for all three items plotted.

Revised as suggested.

-Figure 6: panel Q needs to be clarified. Why is there a legend (mg/m3) on the right hand side? Also, the explanation of the blue, red, and yellow bars does not make sense. R2 values compare the model and station, so there cannot be separate R2

values for the model and the station (i.e., the red and yellow bars).

We added the following sentence to the legend of Figure 6: “Note the color bar for panel A-P is in panel Q.” The sentence in line 271-273 was modified as: “Blue bars represent the regression between measured and model + regional background, while red and yellow bars are for the measured vs model only and measured vs station data only, respectively.”

-Figure 8 and associated text: are these ground-level concentrations or concentrations at 1.5 m (which would match the taxi data)?

It shows the modeled ground-level concentrations, i.e. the first layer (2 m thick, or 1 m high if you consider the middle point of the layer). We added “ground-level (0-2 m above ground)” or “ground-level” throughout the text to make it clear.

-Figure 10. This plot would be improved by using actual concentrations rather than the natural log of concentrations. Using the natural log is not intuitive, as values <1 mg/m3 are negative.

We tried but the concentration decreases rapidly with height, which makes it hard to identify different values. We, therefore, chose a log scale to highlight the vertical structure of CO concentrations. We also modified the color scale label text to the actual concentrations to avoid negative values.

-Figure 11: “longitude” is misspelled.

This typo was revised.

As with Figure 10, concentrations would be a more intuitive item to plot, compared to the natural log of concentrations.

We modified the color scale label text to the actual concentrations similar to Figure 10.

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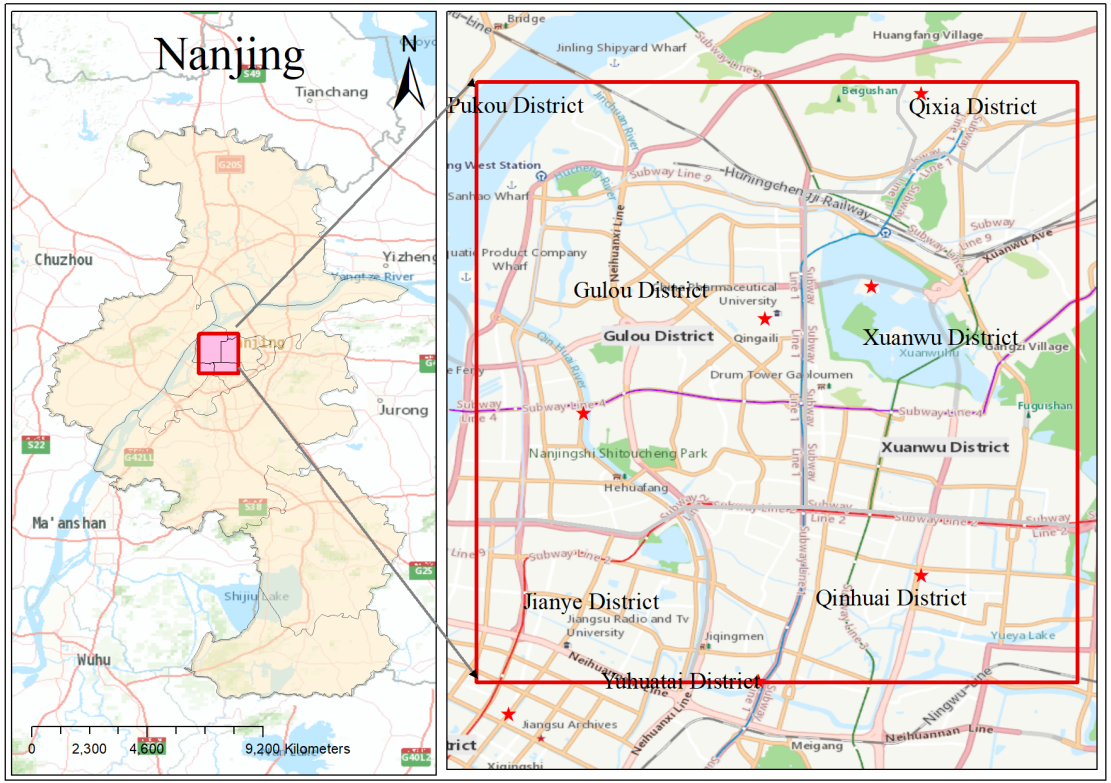

Fig. 1.

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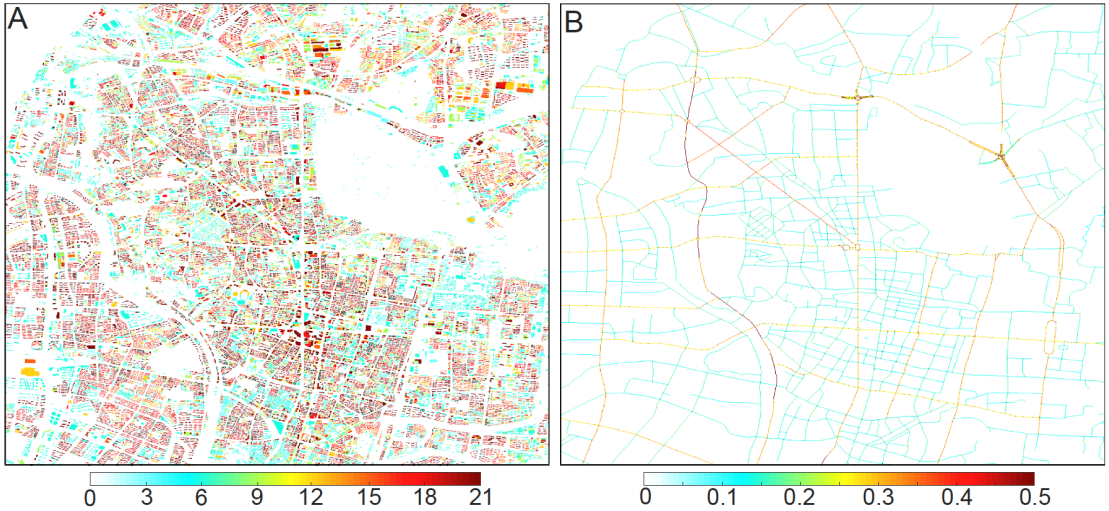

Fig. 2.

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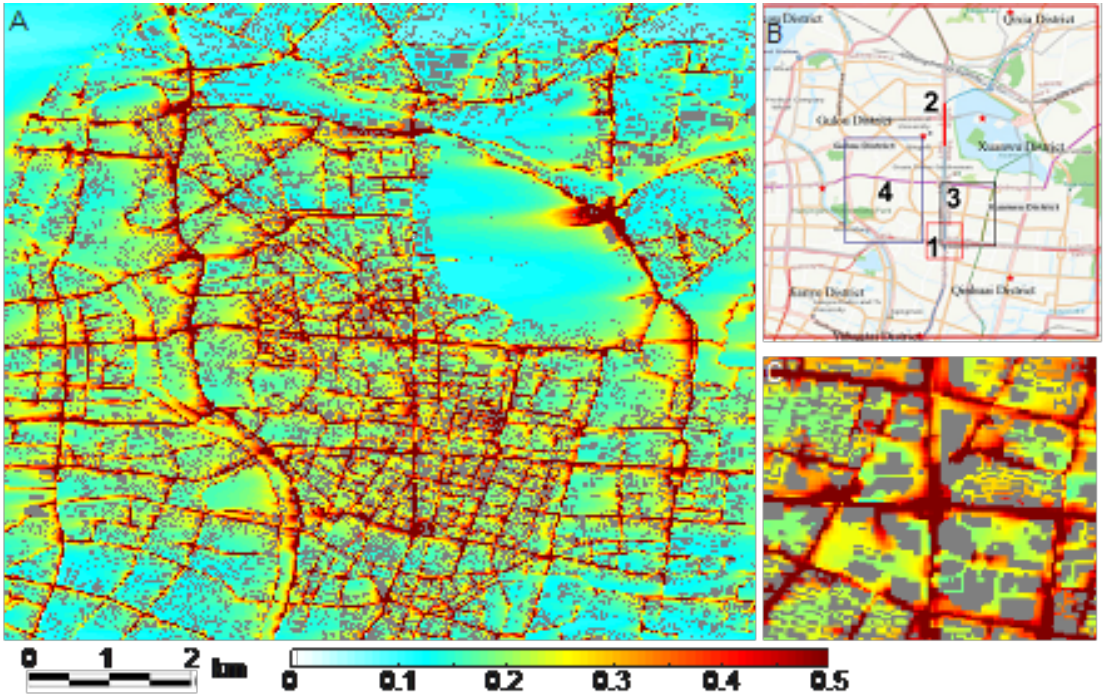

Fig. 3.

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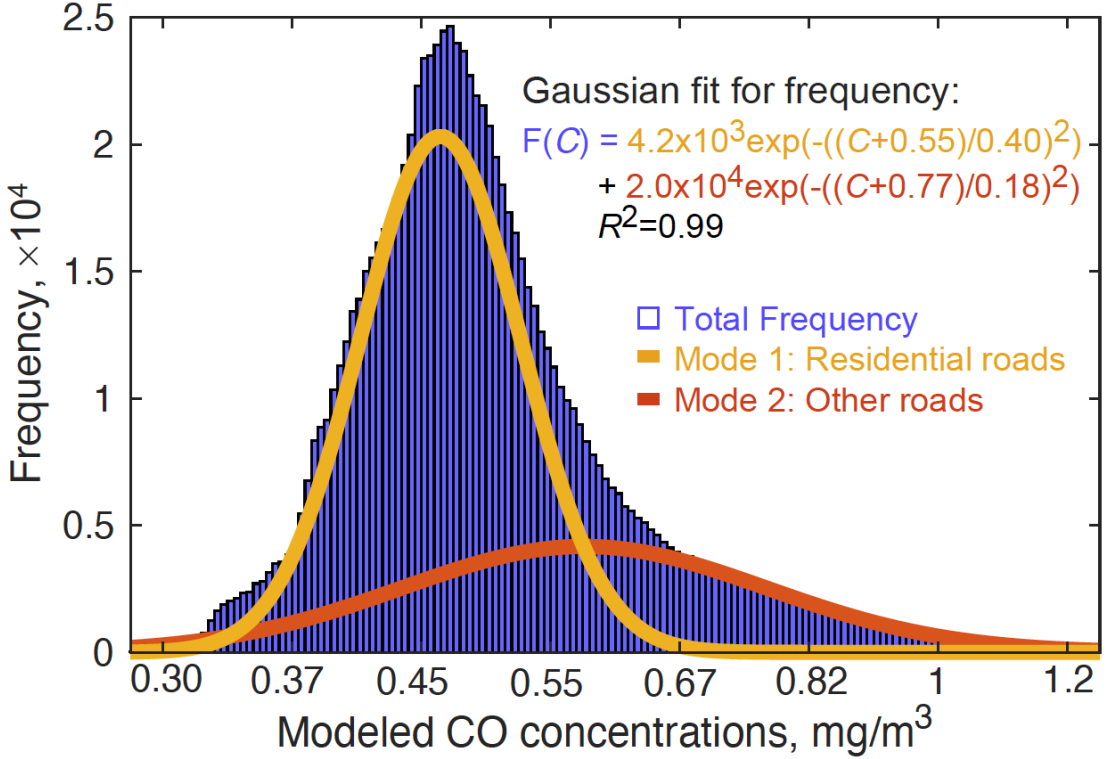

Fig. 4.

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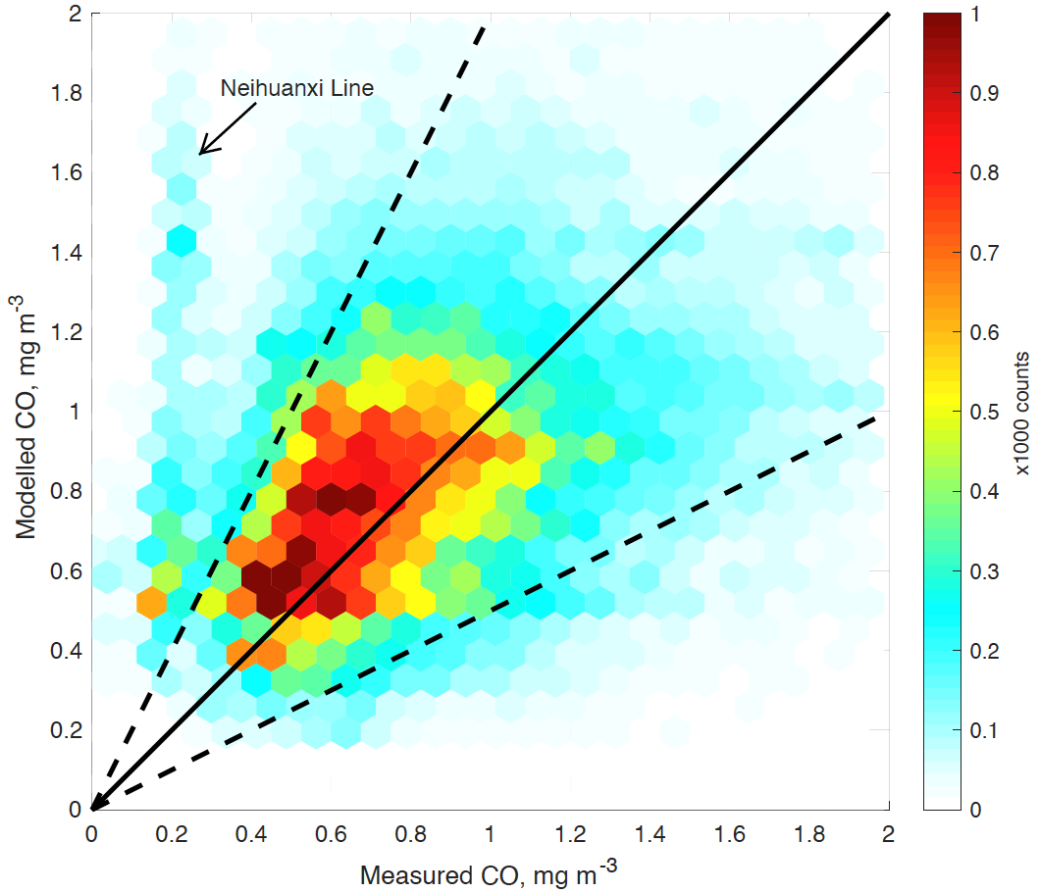

Fig. 5.

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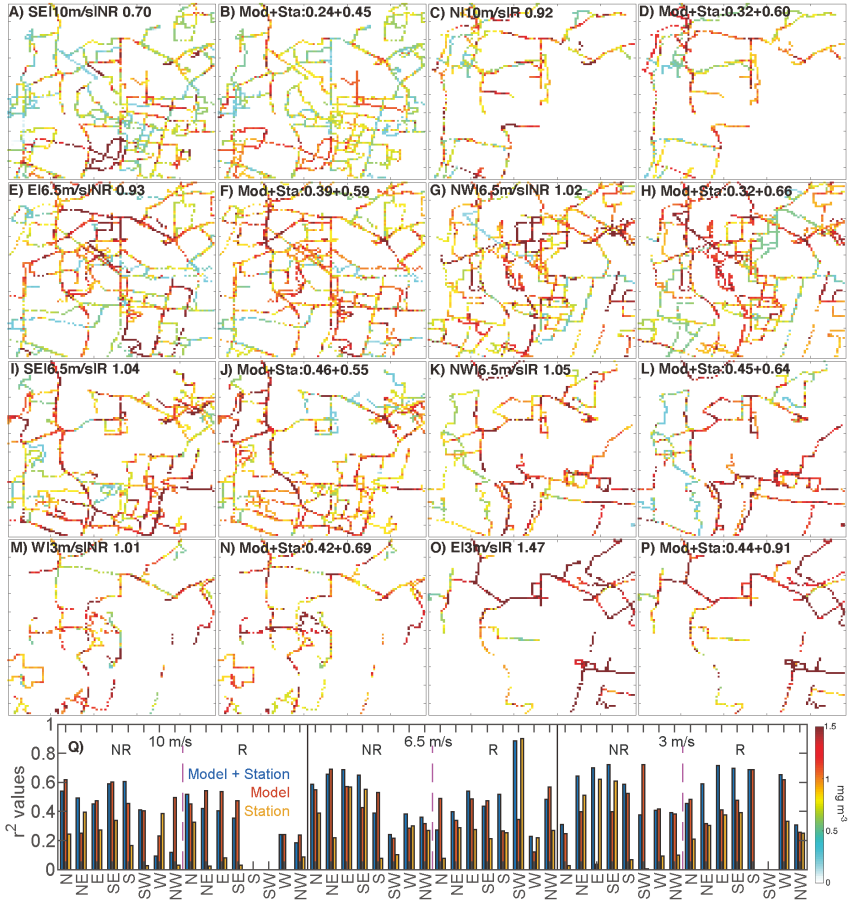

Fig. 6.

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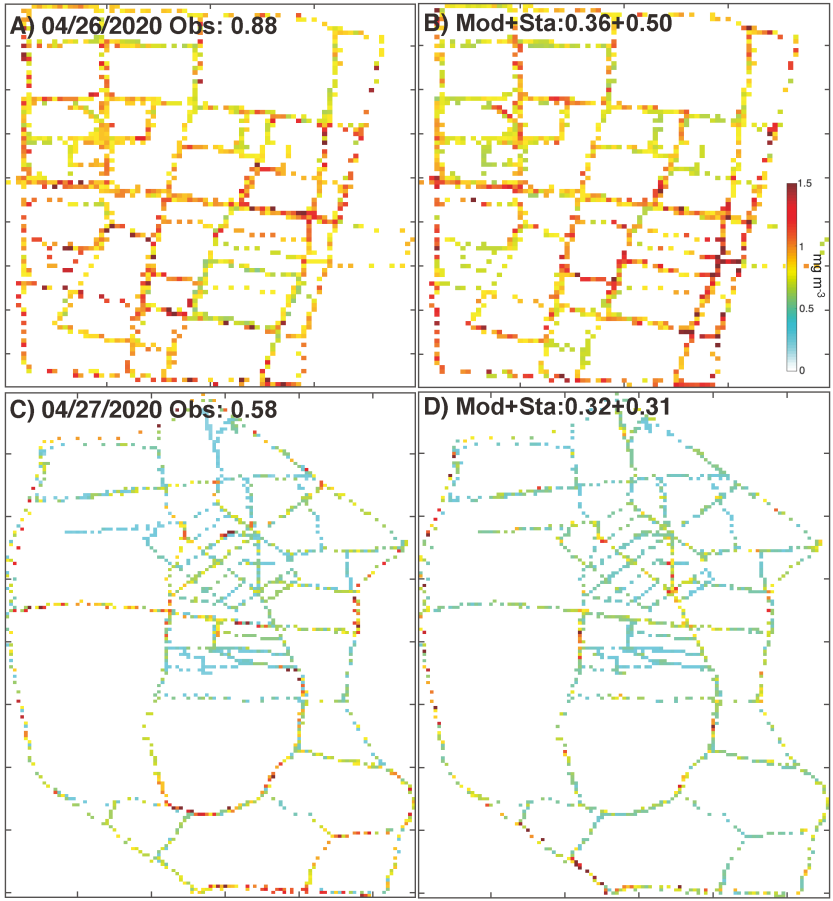

Fig. 7.

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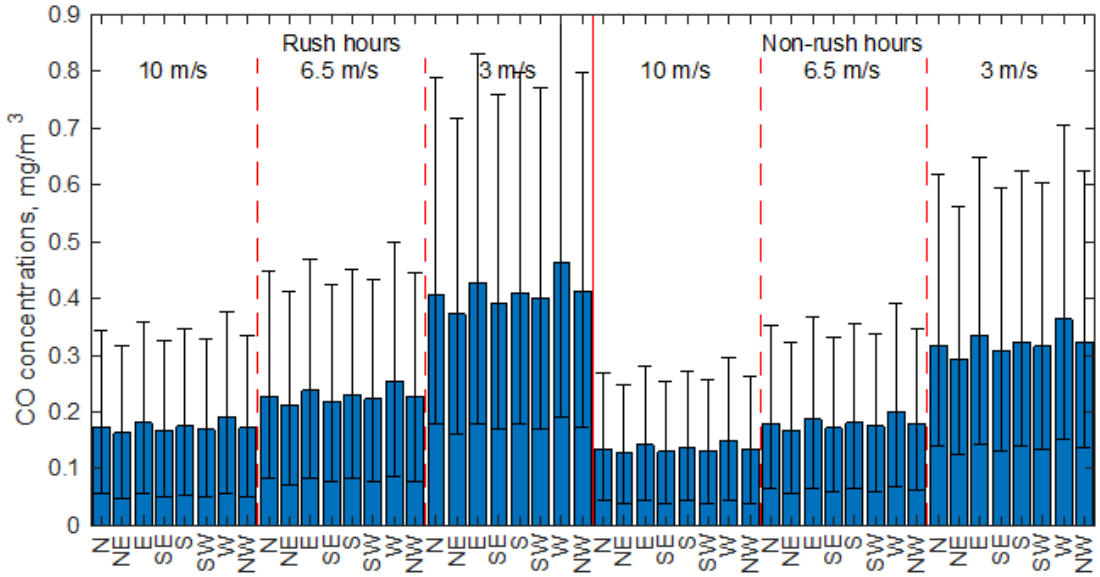

Fig. 8.

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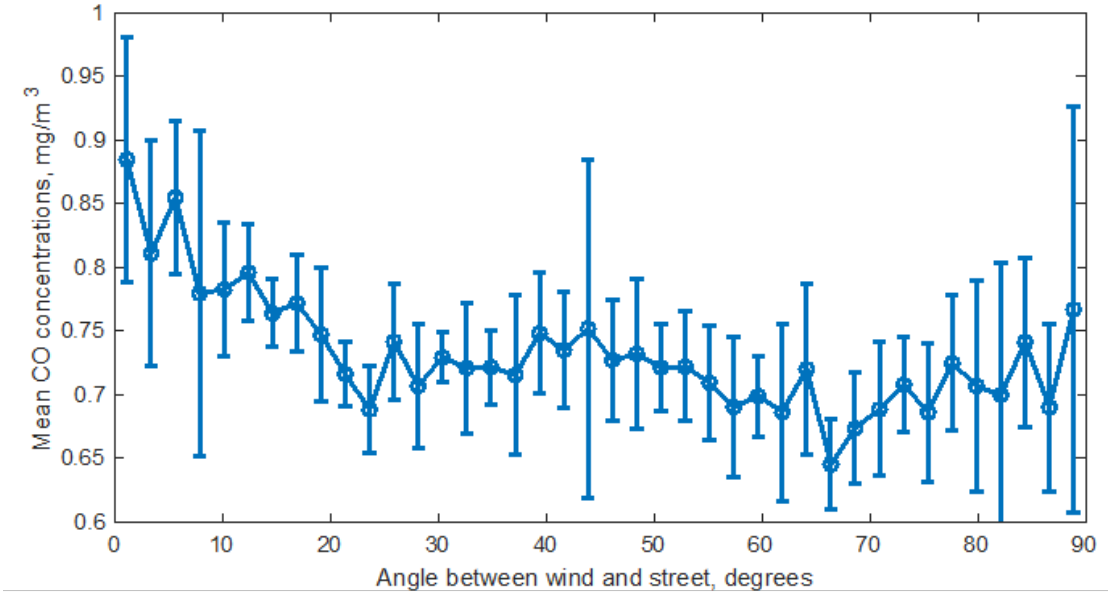

Fig. 9.

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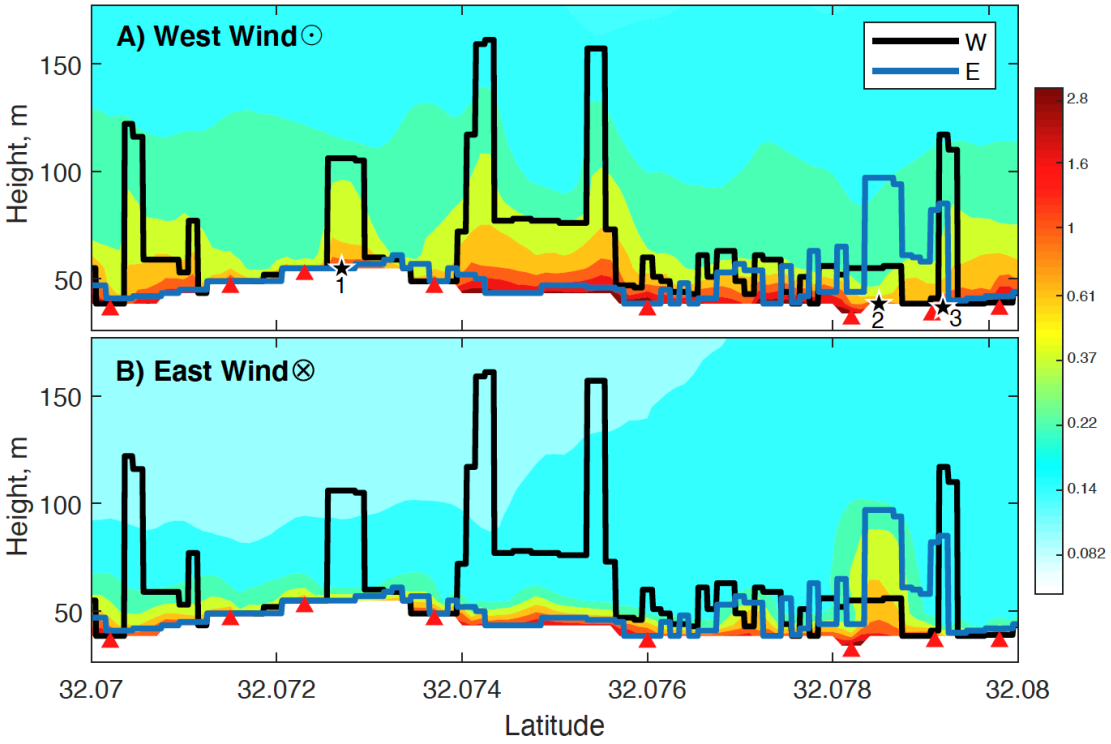

Fig. 10.

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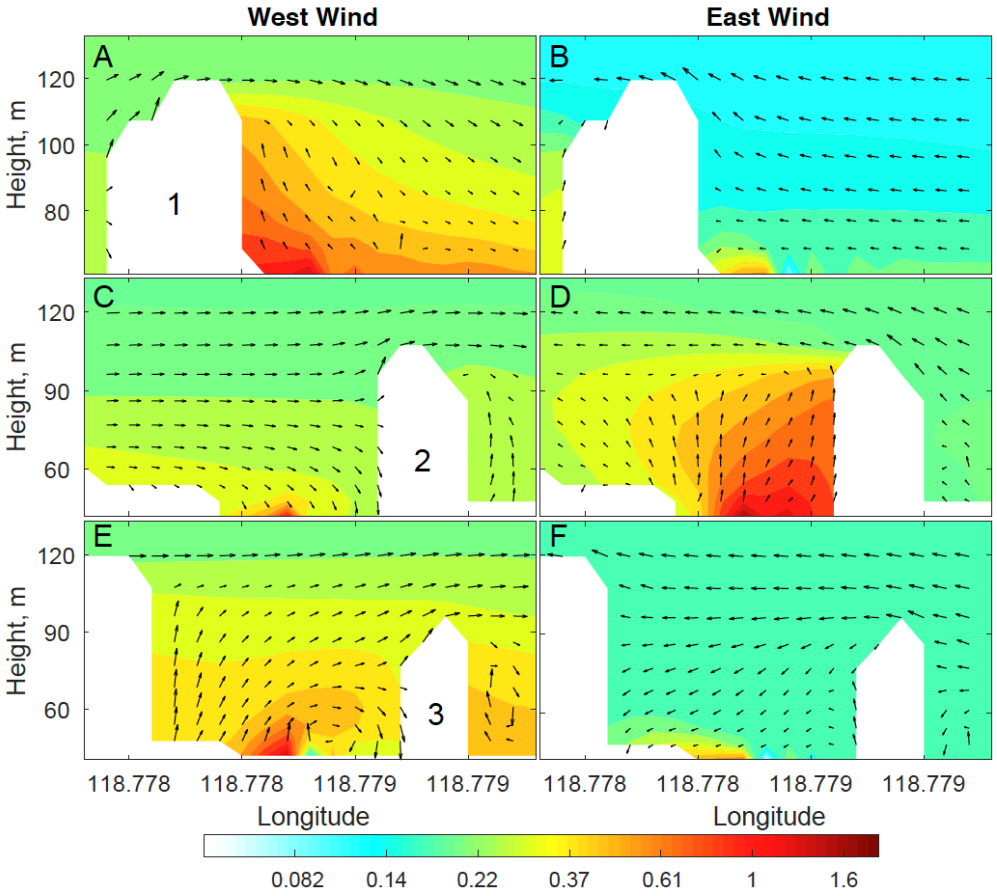

Fig. 11.

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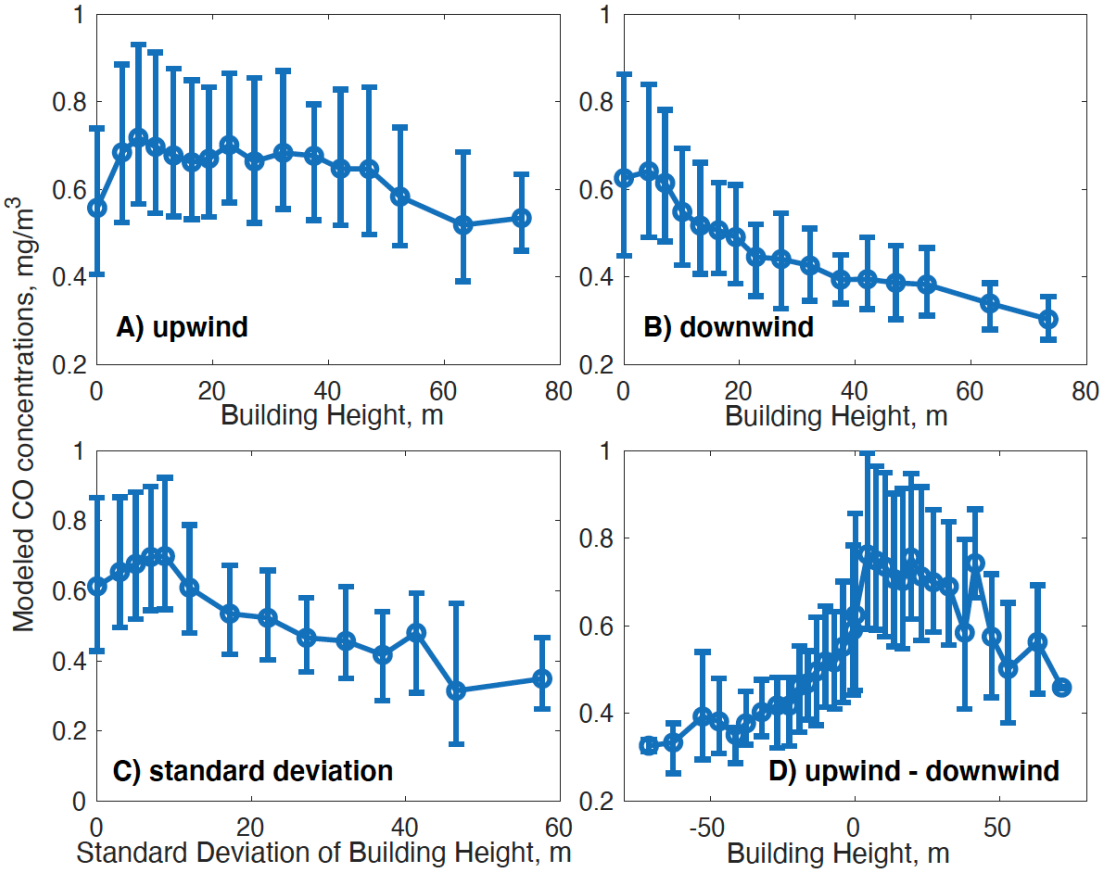

Fig. 12.

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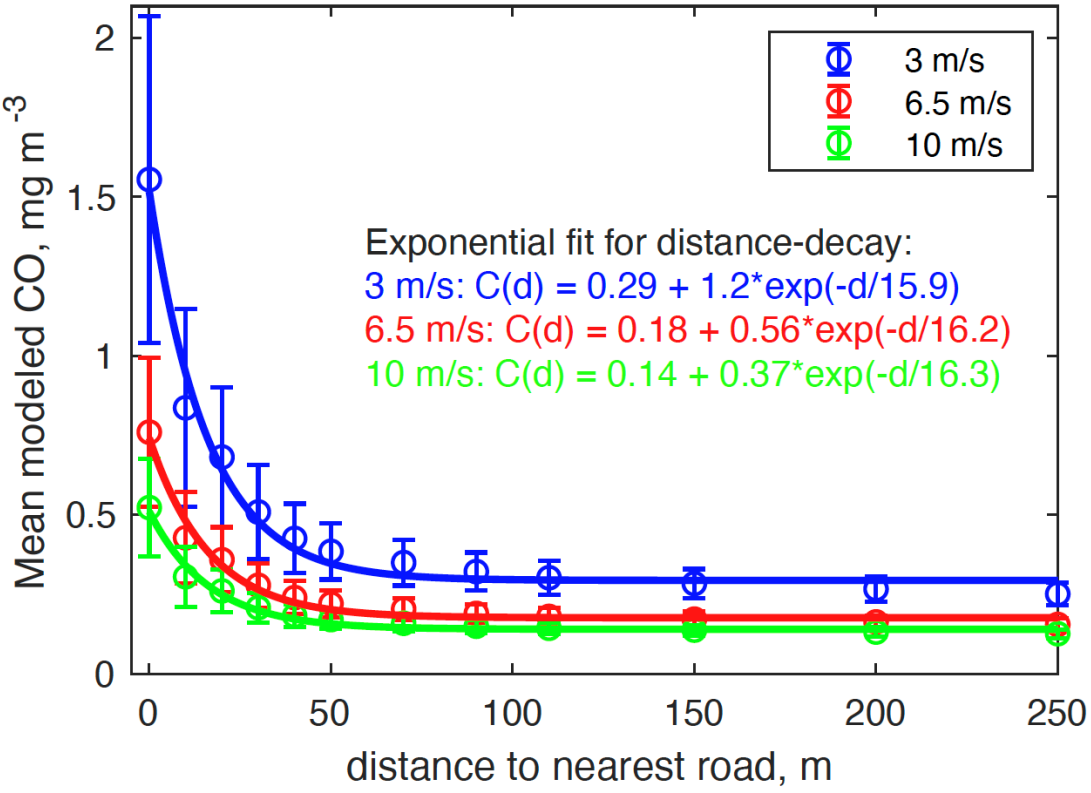

Fig. 13.

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