We would like to thank the reviewer for the comments and suggestions to our manuscript. In the following, we answer to the reviewer's comments and indicate the changes in the manuscript that were implemented according to the recommendations. The comments are in black. Our answers are in blue.

Referee #2:

The manuscript, "Development and deployment of a mid-cost CO_2 sensor monitoring network to support atmospheric inverse modeling for quantifying urban CO_2 emissions in Paris," provides a thorough description of the development and evaluation of a new urban mid-cost sensor monitoring network. This is a well-written document that is useful for those working on greenhouse gas quantification with urban monitoring networks.

Response:

We thank the referee for the positive comments on our manuscript.

The authors should address the following (minor) comments:

Page 4, lines 1-2: The wording is a bit unclear - Is the flushing pump installed or is it not? The text says it "could be" installed, but Figure 1a shows that it is installed.

Response:

The installation of a flushing pump depends on the specific requirements of each site. If the site configuration necessitates a long sampling line, then a flushing pump will be installed upstream of the integrated CO_2 box to boost the flow rate, thereby reducing the residence time in the sampling system. Conversely, for sites that do not require a long sampling line, the installation of a flushing pump is unnecessary.

We have revised the sentence to better clarify this point:

"Optionally, a flushing pump (Figure 1a) could be installed upstream the integrated CO_2 box in order to increase the flow rate and thus decrease the residence time in the sampling system. The necessity of installing this pump depends on the specific conditions at the measurement site. Sites with a long sampling line (EATON Synflex 1300) would benefit from its use, whereas a short line may not need it."

Page 5: In lines 35-37, the authors describe the target gas calibration using only 2 minutes to allow for flushing, but the calibration in parallel with the CRDS instrument requires 7 minutes to flush as described in lines 16-17. Could the authors provide justification for the shorter flushing time?

Response:

We have added the following paragraph in the supplement (Text S1 and Figure S4) to explain the settings for these two flushing times:

"To mitigate delays in sensor responses and ensure stability, thorough CO_2 flushing of the sensor cell is necessary. During the CO_2 correction coefficient IC_1 determination process, we sequentially sampled CO_2 mole fraction for a duration of 10 minutes, with 7 minutes dedicated to flushing and only the last 3 minutes of data used. During the on-site daily target gas injection for the $CO_{2_{offset}}$ calculation, we sampled CO_2 mole fraction for a duration of 3 minutes, with 2 minutes of flushing and only the last minute of data used.

The differences in flushing times are due to two reasons. First, the CO_2 correction coefficient IC_1 is determined through a multipoint CO_2 regression using the seven mole fraction values assigned within the 400-600 ppm range. Conversely, the CO_2 concentration in the target tank (which contains dry compressed natural air, pressurized at 200 bars and calibrated in CO_2) is supposed to be close to the ambient air CO_2 concentration on-site during midday. The step between two different CO_2 concentrations in the IC_1 determination process is greater than that during the target tank injection for drift correction, thus requiring a longer flushing time to achieve stabilization. Second, the CRDS and the mid-cost HPP sensor do not measure at the same flow rate, approximately 0.25 LPM for the CRDS and about 1 LPM for the HPP. They also have different precision targets. The CRDS sensor requires an extended period of target gas measurements to achieve a stability of less than 0.05 ppm, which is suitable for applications beyond this specific intercomparison. Therefore, the flushing time in the IC_1 determination process, when the HPP sensor measures in parallel with the CRDS, is expected to be longer.

Before implementing this setting, we carried out several sensitivity tests on the sensor performance with a daily injection of target gas lasting 5 minutes at LSCE laboratory. The following figure shows the evolution of target gas injection duration in relation to the differences in CO_2 concentration between the other 4 minutes and the 3rd minute at one HPP sensor (HPP3) over 26 days. It demonstrates that a 3-minute target gas injection, specifically utilizing the 3rd minute data, proved to be sufficient. The added value of the 4th- and 5th- minute injection is rather limited. Therefore, the choice of a two-minute flush serves as a good compromise between maintaining good sensor performance (ensuring a target accuracy of 1 ppm) and minimizing gas consumption (thereby extending the lifespan of the tank and reducing associated maintenance requirements)."

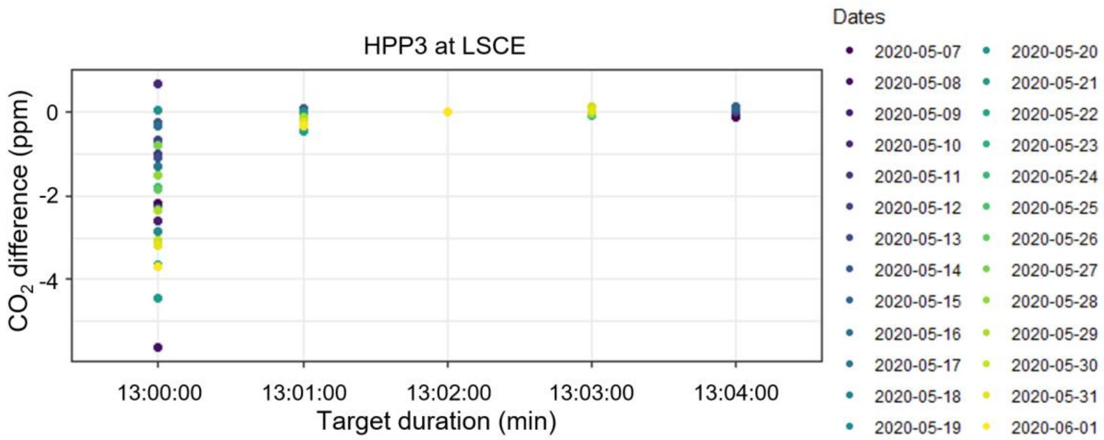

Figure S4. The evolution of target gas injection duration in relation to the differences in CO_2 concentration between the other 4 minutes and the 3rd minute at one HPP sensor (HPP3), with a daily injection of target gas lasting 5 minutes over 26 days at LSCE.

Page 7, lines 15-16: It is unclear why the authors chose to apply one-minute averaging to the data before calibration.

Response:

The HPP instruments sample data approximately every second, resulting in a large amount of data over long periods. To facilitate subsequent data storage, processing, and retrieval, we first average the second-level data into minute-level data. Theoretically, if the amount of data collected per minute is consistent, averaging the second-level data directly into hourly data should yield the same result as first averaging it into minute-level data and then into hourly data. However, due to potential variations in the actual data collection amount, there might be

very slight differences between these two processes. Additionally, since our model outputs data on an hourly basis, the minute-level observation data remains sufficient for comparison with the model. We have revised the sentence to clarify this point:
"These data are averaged at the temporal resolution of one minute to simplify data storage, processing, and retrieval. Following this, a calibration procedure is applied to the one-minute data."
Page 11, lines 18-19: I do not agree with the authors when they state with certainty that the small differences in CO_2 mole fraction between these sites and JUS can be attributed solely to their proximity to the site when OBS, the site closest to JUS, has a substantial difference in mole fraction. I would expect the city center to have substantial heterogeneity in CO_2 mole fraction.
Response:
We agree with the reviewer that the city center is expected to have substantial heterogeneity in CO_2 mole fraction. In fact, the original sentence is inaccurately expressed, which causes a misunderstanding. What we intended to say is that the magnitude in CO_2 mole fraction differences between these urban sites and the urban JUS site are smaller than those between JUS and the suburban sites. We have rephrased the sentence as follows:
"The proximity of the HPP urban sites at BED, MON, CAP, IGR, to the JUS site leads to relatively smaller differences in CO_2 mole fractions, compared to those between JUS and the suburban sites."
Figure 9 and paragraph beginning page 11, line 31: I recommend the authors specify the sign convention of the gradient.
Response:
As suggested, we have clarified it both in the figure captions and main texts. The current order of the subtraction is intended to show that CO_2 concentrations at urban sites are generally higher than those at suburban sites. Note that Figure S9 has become Figure S12 in the revised manuscript.
Figure 9: "The CO_2 differences are calculated as JUS minus the other stations."
Figure S12: "The CO_2 differences are calculated as the other stations minus SAC."
Main text: "Figure 9 shows the observed (green left panels) and modeled (yellow right panels) afternoon CO_2 mole fraction differences between JUS and the other stations, averaged as a function of wind speed and direction from July 2020 and December 2022. The CO_2 differences are calculated as JUS minus the other stations. Additionally, Figure S12 presents a similar comparison, but with CO_2 differences of other stations minus SAC."
Technical comments:
Page 1, line 14: "Its" should be "Their" if the authors are referring to the mid-cost sensors.
Response: Change from "Its measurements" to "These dense measurements".
Figure 4: The tables in each figure should have units.
Response: The units are added as suggested.
Page 8, line 34: The authors are missing an "and" here, and I have a suspicion that they meant to use HPP5 rather than HPP7 as an example for improvement from the p correction.
Response: We have revised this sentence, as well as the two preceding and following sentences, to improve the accuracy of expression.
Figure 6: The text is hard to read because of the small font size and light colors.

Response: Following the suggestion from Reviewer #3, panel (b) with the modeling data was omitted, and the aspect ratio of the figure was adjusted. We also bolded the font for an improved reader experience.

Figures 7 and 9: The wind roses for OBS (both figures) and JUS (Figure 7) are too small to interpret.

Response: The sizes of the wind roses for OBS and JUS were adjusted to avoid overlaps while also trying to keep them as close as possible to their actual spatial locations in the map. We were concerned that enlarging them to the same size as the other sites might lead to unclear geographical location markings. Therefore, in the revised Figures 7, 9 and S12, we moderately increased the sizes of the wind roses for OBS and JUS.

Page 11, line 32: "from July 2020 and December 2022" should be "from July 2020 to December 2022."

Response: Corrected.

Figure S5: A time series of 2 years of hourly data in a figure is hard to interpret. It could be helpful to include some averaging to make it easier to read, maybe in an additional figure.

Response: Following the suggestion, we have revised the figure to show daily CO_2 concentrations instead of the hourly data. Note that Figure S5 has become Figure S7 in the revised manuscript.