Referee 1:

Overall good research and worthwhile of publication with revisions. Further details needed about the experiment setup and how correction coefficients were established. Given the current details it would be difficult for a reader to replicate this work. Additionally, minor spelling and language changes are needed.

Despite these notes, having a 30-month analysis alongside a CRDS for low-cost sensors is impressive, significant, and worth publication. I was excited to see this work, and long time-frame pieces like this can further the research community.

Response: We thank you for your understanding and appreciation of this paper. We have revised the grammar and expression issues suggested by you, and updated the co-located system diagram and related explanations. We have provided detailed responses to some comments regarding the experimental setup and result analyses.

We provided all the Picarro and SENSE-IAP data used in this paper (publicly available at https://doi.org/10.6084/m9.figshare.29310890.v3). We added more descriptions on the calibration algorithm and procedures in the main text (lines 135-141), and these descriptions were also provided in several published paper (Bao et al., 2020; Han et al., 2024; Liu et al., 2021; Martin et al., 2017), and similar methods and precision were achieved in other studies (Lian et al., 2024; Shusterman et al., 2016). However, due to the commercial confidential requirements (Beijing, Jinan, Fuzhou, and several other cities' LCS networks we served), the detailed calculation formulas cannot be disclosed in this research paper. We hope these revisions and explanations can satisfy the reviewer.

Comments:

Line 49: When referencing Picarro or ABB-LGR, might want to reference measurement techniques those instruments use (CRDS, etc.)

Response: Thank you for your comment. We have add the techniques of the sensors.

Line 50: Awkward phrasing for cost comparison, might want to use a direct cost range instead

Response: We modified the section of introduction. We added a table (Table 1) to clearly compare the cost, accuracy, and deployment status (including key cities with dense networks) of different low- and mid-cost CO_2 sensors.

Line 58: Which cities in particular are being referenced?

Response: We added the cities such as Paris, California, Zurich, and Beijing in lines 65-89 (Table 1).

Line 76: "deployed to co-locate" is awkward, should this be "colocated" instead?

Response: Thank you for this advice, we revised accordingly.

Line 83: Section 2 title is awkward - application to what?
Response: Thank you for your comment. We added descriptions for clarity.
The title of section 2 is: “The application of SenseAir K30 sensors for urban CO_2 monitoring”

Line 87: references “higher-quality” while majority of paper references higher precision
Response: Thank you for your comment. Using 'precision' would be more appropriate. We have revised.

Line 94: What is the JJJ network? This is the only time it is mentioned
Response: Sorry for this abbreviation, which means the Beijing-Tianjin-Hebei area, short for Jing-Jin-Ji (JJJ), and we added the full name of ‘JJJ’.

Line 102: Check capitalization for Bao
Response: The capitalization issues have been fixed.

Lines 107 - 110: How does air move in the box? Is it passive? Later experiment mentioned a pump used to move air into the box but nothing mentioned here about that. Is the system designed to be used passively or will it have to be used with a pump when deployed in the field?
Response: Thank you for this question. We added more descriptions in the main text. The SENSE-IAP instrument can be deployed for both active and passive ways, and we tested the passive way in this study, and the active way was also tested in a previous study which showed similar results. Specifically, ambient air was firstly passively diffused into three K30 sensors in the SENSE-IAP instrument (pi688), then a 4 mm-diameter Teflon tube connected to the pi688 allows an air pump to actively draw ambient air from the inside of this pi688 instrument box. The air flow is then split by a three-way valve, delivering a 5 L/min flow of air to both the inside of pi736 box and the Picarro analyzer.
We have improved the diagram of gas flow for the observation system in Figure 4 and provided more detailed descriptions of the instrument's ventilation method in lines 225-232.

Lines 154 - 157: More details are needed about how the sensitivity correction is done - a reader can’t replicate a similar experiment based on what is provided here. Was this done with an environmental chamber or on lab bench sampling

ambient conditions? How long was this comparison done for, and at what temperature steps?

Response: Thank you for this question, and we added more descriptions in lines 183-184 and 135-141. Environmental calibration was done in an environmental controlled chamber. The procedure includes temperature correction, which is set at 5 steps from 10-50°C, and humidity correction, which is set at 9 steps from 10%-90% RH. The calibration is based on sensitivity test results obtained from this controlled environmental chamber. Through nonlinear fitting and iterative processing, unique parameters are derived for each individual sensor. From the controlled environmental experiments to post-stage precision and accuracy check, the sensors undergo continuous monitoring and is co-located with a Picarro 2401 analyzer.

Lines 193 - 196: More details are also needed about how the experiment works. Does the SENSE-IAP system have it's own pump? Is the outflow from the main pump being directed into the SENSE-IAP systems and the Picarro siphoning off them?

Response: We have improved the diagram of gas flow design for the observation system in Figure 4 and provided a more detailed description of the instrument's air flow and ventilation in the last paragraph in section 3.

Line 194: What kind of dryer is being used?

Response: A capsule filter (COBETTER 92WM-LPF1000) is used to remove particulate matter, and a Nafion drying tube is used to remove moisture for Picarro use, and for the SENSE-IAP instrument, moisture is not removed. The relevant information has been revised in the main text (line 229-230).

Figure 4b: This figure is confusing - Which is the pump in the figure and where is it located? Also which is the 4-way valve?

Response: We have improved the diagram of gas flow design for the observation system in Figure 4c. There are two pumps in the system, one is the main pump before the 4-way valve, the other is a Picarro pump only used for Picarro air flow control.

Figure 6: This figure is good but I found the order confusing. Figure 6 is showing corrected results while 7 shows uncorrected results. It was difficult for me to follow the analysis with the shuffling back and forth.

Response: Thank you for this question, and we added more explanations at the beginning of Section 4 and 5. Figure 6 presents the results of short-term calibration, statistically presenting the daily consistency between the LCSs and Picarro analyzer throughout the entire observation period. These results illustrate both the efficacy of environmental sensitivity calibration and the stability of its corrective effects. And in

order to only focus on checking the environmental corrections, we removed long-term drifts here and discussed this important issue separately in the following section.
Figure 7 illustrates the long-term drift characteristics of the LCSs. The data presented in Figure 7 have undergone environmental sensitivity calibration but remain uncorrected for the long-term drift.

Line 238: "with [a] Picarro"
Response: Thank you. We revised.

Line 240: "effectively corrects the impacts of diurnal environmental changes" - need to back this up with either a figure or analysis from a previous section
Response: Thank you for this comment. Lines 265-272, 282 and Figure 6 demonstrate the effectiveness of the calibration methodology for diurnal environmental changes.

Lines 267 - 273: It was not clear to me if the RMSE evaluation was done on the same period used to do the drift corrections or another independent dataset.
Response: It was done on the same period for drift correction and we clarified it in line 293-294. Lines 310-317 elaborates on the specific methodology we employed for drift correction using functions 6-7.

Line 296: "manufacturer"
Response: Thank you and revised.
Line 364: Capitalization of names
Response: Thank you and revised.

Bao, Z., Han, P., Zeng, N., et al., 2020. Observation and modeling of vertical carbon dioxide distribution in a heavily polluted suburban environment. Atmospheric and Oceanic Science Letters, 1-9.

Han, P., Yao, B., Cai, Q., et al., 2024. Support Carbon Neutral Goal with a High-Resolution Carbon Monitoring System in Beijing. Bulletin of the American Meteorological Society 105 (12), E2461-E2481.

Lian, J., Laurent, O., Chariot, M., et al., 2024. Development and deployment of a mid-cost CO2 sensor monitoring network to support atmospheric inverse modeling for quantifying urban CO2 emissions in Paris. Atmos. Meas. Tech. 17 (19), 5821-5839.

Liu, D., Sun, W., Zeng, N., et al., 2021. Observed decreases in on-road CO2 concentrations in Beijing during COVID-19 restrictions. Atmospheric Chemistry and Physics 21 (6), 4599-4614.

Martin, C.R., Zeng, N., Karion, A., et al., 2017. Evaluation and environmental correction of ambient CO(2) measurements from a low-cost NDIR sensor. Atmospheric measurement techniques 10.

Shusterman, A.A., Teige, V.E., Turner, A.J., et al., 2016. The BErkeley Atmospheric CO2 Observation Network: initial evaluation. Atmos. Chem. Phys. 16 (21), 13449-13463.