Referee 2:

The manuscript by Liu et al. presents in-situ observations of marine CO_2 concentrations using three low-cost sensors deployed at a sea-air interface buoy platform. The authors applied an environmental correction method to calibrate the sensors, thereby enhancing data quality. Additionally, they analyzed back trajectories to investigate potential sources and transport pathways of air masses influencing the measurements. Overall, this work provides a viable method for monitoring marine CO_2 and shows the potential of low-cost sensors to expand regional oceanic CO_2 observation networks. The study aligns well with the scope of AMT. I recommend that it be accepted after addressing the following general and specific comments.

Response: We sincerely thank the referee for the careful evaluation of our manuscript and the constructive comments. These suggestions have helped us improve the clarity and robustness of the study. All comments have been carefully considered and addressed as detailed below.

General comments:

1. If the sensors still remain deployed on the buyo platform, extending the time series to include the other seasons would enhance the dataset's value by capturing whole seasonal variability.

Response: We thank the referee for this valuable suggestion. We fully agree that extending the time series to cover multiple seasons would significantly enhance the dataset by capturing seasonal variability. However, the present study is designed as a short-term deployment experiment aimed at evaluating the feasibility and performance of low-cost CO_2 sensors on a sea-air interface buoy platform, rather than providing a long-term climatological dataset. At the time of this study, the sensors have already been retrieved, and continuous long-term observations are not yet available.

To clarify this point, we have revised the manuscript in Lines 422-423 as follows: Future work will also aim at long-term buoy deployments to capture seasonal variability and further validate sensor performance under varying environmental conditions.

2. If the sensors have been retrieved, performing a post-deployment laboratory calibration against the Picarro instrument would be highly beneficial. This would allow for a direct assessment of sensor drift and long-term stability, further validating the field data's accuracy.

Response: We thank the referee for this insightful comment. To thoroughly assess sensor drift and long-term stability, we conducted post-deployment laboratory calibrations against the Picarro instrument from March 24 to 26, 2026. The key results of this validation are summarized in the Table 1:

Table 1: Post-deployment laboratory validation results

Data Type	Raw		Corrected		Re-Corrected	
Sensor	Bias	RMSE	Bias	RMSE	Bias	RMSE
CM1	5.90	6.54	-3.89	4.81	0.09	2.82
CM2	44.73	45.04	-14.62	15.14	0.25	3.92
CM3	1.90	2.45	-9.33	9.46	0.16	1.58
mean	17.51	17.79	-9.28	9.67	0.17	2.70

We have added a new Section 5 "Post-deployment laboratory validation" (including Table 1) in the revised manuscript (Lines 375-385), with the following discussion: After marine deployment, noticeable sensor temporal drift is evident in the Corrected data (mean bias: -9.28 ppm, mean RMSE: 9.67 ppm). Performance varied among sensors; CM3 showed reduced accuracy under the original correction compared to its raw data, likely due to individual sensor variability over time. Crucially, sensor sensitivities to temperature, humidity, and pressure remained consistent throughout the deployment. Re-correction by updating the baseline parameter a_0 effectively compensates for this temporal drift, reducing the mean bias to 0.17 ppm and mean RMSE to 2.70 ppm. These results confirm that the environmental correction approach remains reliable for short-term deployments, while periodic re-calibration is essential for maintaining measurement accuracy in long-term marine observations.

3. Discussing the sensors' long-term robustness and effective operational duration in the harsh marine environment would be of great interest to readers, as it is critical for assessing their suitability for sustained observing networks.

Response: We thank the referee for this important comment. We agree that the long-term robustness and operational durability of sensors in harsh marine environments are critical for evaluating their suitability in sustained observing networks. Photographs of the CMs after marine deployment (showing external and internal conditions) are provided below for the referee's reference (Figure R1).

We have added a detailed discussion of the long-term robustness and operational performance of the sensors in the harsh marine environment in the revised manuscript as follows: The buoy platform equipped with CMs has withstood several typhoon events, demonstrating excellent watertightness, mechanical robustness, and stability under wave conditions. During deployment, the sensors maintained nearly 100% operational uptime. Post-recovery inspection revealed only minor corrosion on external metallic components, while internal sensor modules remained intact and free of corrosion, further confirming their robustness and good mechanical strength in the harsh marine environment. (Lines 408-412) While the current short-term deployment confirms satisfactory real-world performance, a comprehensive assessment of long-term operational durability and lifespan requires extended multi-month to multi-year deployments, which will be conducted in future work with periodic recalibration and intercomparison. (Lines 420-423)

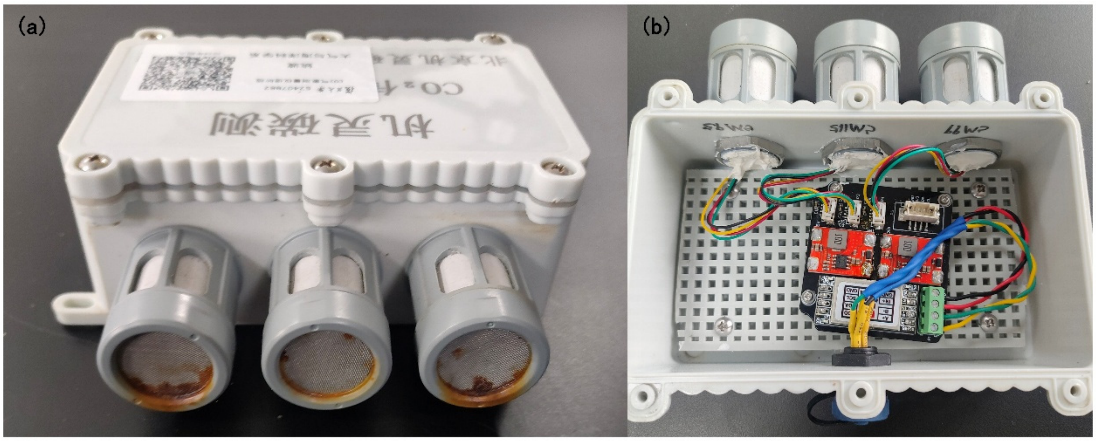

Figure R1. Photos of the CMs after marine deployment: (a) external view showing minor corrosion on metallic parts; (b) internal view showing intact modules with no corrosion.

Specific and technical comments:

Line 193: the mentioned labels of sub figs do not fit to the contents. e.g., "A comparison between the laboratory and field results (Figure 4 c, d) shows that the CMs performed better under laboratory conditions." It looks like to be a, d. "In the stable laboratory environment, ΔCO_2 exhibited no pronounced diurnal variation (Figure 4 c, e)", it looks like to be b, e.

Response: We thank the referee for carefully identifying this inconsistency. We have corrected "(Figure 4 c, d)" to "(Figure 4 a, d)" and "(Figure 4 c, e)" to "(Figure 4 b, e)". In addition, all figure references throughout the manuscript have been carefully checked to ensure accuracy and consistency.

Line 195: ΔCO_2 exhibited higher variability in e (in the field) than in b (in the lab). A temporal trend appears to be present over the 6-day period. This pattern is unlikely to be attributable to aging, given the short duration of the experiment. Please also provide an explanation for this bias

Response: We thank the referee for this insightful observation. As noted, ΔCO_2 shows higher variability under field conditions and exhibits an apparent temporal trend over the ~7-day deployment period, which is unlikely to be caused by sensor aging given the short duration of the experiment.

A closer examination of the environmental conditions indicates that this apparent "drift" is primarily driven by changes in ambient temperature rather than intrinsic sensor instability. As shown in Figure 4e, ΔCO_2 displays a gradual decreasing (downward) trend over time. Meanwhile, Figure 4f shows that, in addition to the diurnal cycle, the ambient temperature exhibits a clear increasing trend over successive days during the field deployment. As discussed in Lines 216-217 of the manuscript, ΔCO_2 is negatively correlated with temperature, meaning that an increase in temperature leads to a decrease in ΔCO_2. Therefore, the observed downward trend in ΔCO_2 is physically consistent with the gradual increase in temperature, indicating that the apparent temporal pattern is a temperature-driven response rather than true sensor drift.

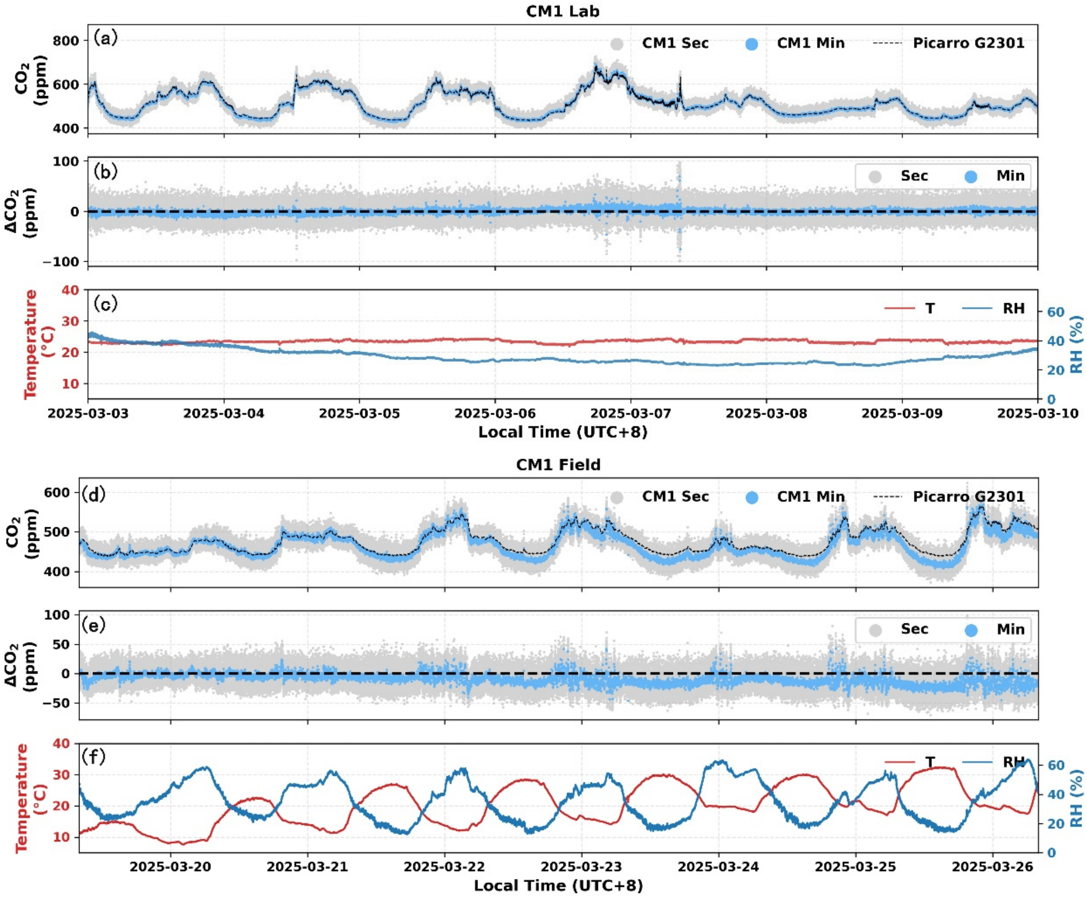

Figure 1: Time series of CM1 data during laboratory (a, c, e) and land-based field (b, d, f) observations. (a, d) CM1-measured CO_2 concentration at second-level resolution (grey dots) and minute-level resolution (blue dots), alongside Picarro-measured CO_2 concentration (black line). (b, e) Time series of CO_2 concentration difference (ΔCO_2=CM1-Picarro) at second-level (grey dots) and minute-level (blue dots) resolution. (c, f) Time series of ambient temperature (T, red line) and relative humidity (RH, blue line).

This interpretation also explains why such behavior is absent in the laboratory measurements, where environmental conditions are stable, and no comparable temperature trend exists. It should also be noted that the results shown in Figure 4 are based on data prior to environmental correction, with only outlier removal and averaging applied. This further highlights the necessity of applying environmental correction. After correction, as shown in Figure 7b, ΔCO_2 no longer exhibits a significant linear trend over time, indicating that the temperature-driven bias has been effectively mitigated.

We have revised the manuscript in Lines 162-167 as follows: In addition, during the field deployment, ΔCO_2 exhibited a gradual downward “temporal trend” over the observation period (Figure 4e), which is closely related to changing environmental conditions. Apart from the diurnal cycle, ambient temperature exhibited a marked upward trend over several consecutive days (Fig. 4f). As will be discussed in Section 3, the ΔCO_2 of CM1is negatively correlated with temperature, indicating that rising temperatures lead to a decrease in ΔCO_2. Therefore, the observed downward trend in ΔCO_2 is physically consistent with the gradual rise in temperature, reflecting a temperature-driven response rather than inherent sensor instability.

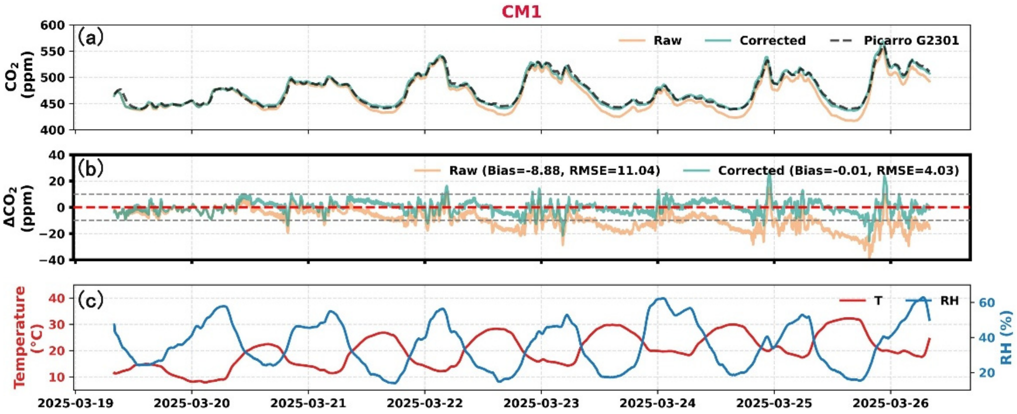

Figure 2: Hourly moving average time series of CM1 (a-c) during land-based field observations: CO_2 concentration of CMs before environmental correction (orange line), after environmental correction (green line) , and CO_2 concentration from Picarro (black dashed line) (a); ΔCO_2 (ΔCO_2=CM-Picarro) of CMs before and after calibration (b); Ambient temperature (T, red line) and relative humidity (RH, blue line) (c).