

Point-by-point responses to Reviewer

Responses to the Comment of the Reviewer CC1:

1. The comparison between the top-down inversion and bottom-up inventories is one of the manuscript's strengths. The spatial patterns of disagreement are well analyzed, particularly in the PRD urban core. However, the discussion could be deepened by offering more interpretation of why certain inventories, especially MEIC, show large underestimations in core cities. Even a qualitative sectoral explanation would help contextualize these differences and enhance the relevance for inventory developers and policymakers.

Response to question 1:

We thank the reviewer for the encouraging feedback and for the constructive suggestion to deepen the discussion on why certain inventories, especially MEIC, show large underestimations in core cities.

In the revised manuscript, we have added a sectoral comparison between EDGAR v8.0 and MEIC for the PRD region (Figure S10). We show that MEIC presents a relatively small contribution from the power sector (31 % of total emissions), whereas industrial and transportation sectors dominate (64 %). In contrast, EDGAR v8.0 maintains a persistently high power-sector proportion (53 %) throughout the year. These structural divergences suggest that MEIC's pronounced underestimation in urban cores is closely linked to inconsistent emission factors, heterogeneous activity data, and insufficient representation of small-scale industrial sources.

To support this interpretation, we cite two independent studies. Yang et al. (2025) demonstrated that MEIC yields the lowest national CO₂ estimates among six commonly used bottom-up inventories. Jin et al. (2024) reported that OCO-2-derived emissions are on average 1.39 times higher than MEIC estimates across China, attributing the discrepancy to incomplete emission statistics, poorly resolved diurnal variability, and simplified terrain parameterization. Furthermore, we note that MEIC employs spatially coarse disaggregation proxies, which limit its ability to resolve intense emission hotspots within densely urbanized areas.

These additions are included in the revised manuscript (see the sectoral analysis paragraph, which now spans **lines 488–498**). We believe this enhanced discussion provides the qualitative sectoral explanation requested and improves the practical relevance for inventory developers and policymakers.

We thank the reviewer again for helping us strengthen the manuscript.

2. To strengthen the discussion on urban emission heterogeneity and the challenges of

capturing mobile source contributions (specifically mentioned in Section 3.3 regarding traffic emissions), I strongly suggest that the authors cite the following paper:

Response to question 2:

We greatly appreciate this valuable suggestion. We have cited the relevant literature in the revised manuscript, as shown in Lines 46–47.

Lines 46-47: Ponomarev et al. (2026) estimated CO₂ fluxes in the cities of Zurich and Paris using the ICON-ART CTDAS inverse modelling framework.