RC1

This manuscript offers a robust comparative analysis of six CO_2 emission inventories for China, integrating both local and global datasets. A key strength is its detailed assessment of spatial and temporal uncertainties, an often overlooked but policy-relevant aspect. The study contributes meaningfully by highlighting inventory discrepancies and emphasizing the importance of uncertainty assessments in emission reporting. However, I have the following specific comments that require clarification and revision before the manuscript can be considered for publication.

General comments

The manuscript is clearly written and well structured, with a logical flow that facilitates understanding of the main objectives and findings.

1. However, it is not entirely clear whether the emission inventories selected for analysis are the only relevant options available, or what criteria guided their selection. Since the manuscript references other inventories that were ultimately not included in the comparison, it would strengthen the study to provide a clearer rationale for the choices made.

Response: We sincerely thank the reviewer for this valuable comment regarding the selection criteria of the emission inventories. In this study, we aimed to ensure both temporal completeness and spatial representativeness when selecting inventories. The six inventories included (ODIAC2023, EDGAR2024, MEIC-global-CO2 v1.0, CAMS-GLOB-ANT v6.2, GEMS v1.0, and CEADs) provide continuous time-series covering most of the period from 2000 to 2023 (at least from 2000 to 2019 in GEMS) and have explicit coverage over mainland China. These inventories are also internationally recognized and widely cited in peer-reviewed studies (Li et al., 2017; Han et al., 2020; Liu et al., 2024; Zheng et al., 2025). Besides, they are freely available from official websites. Other inventories mentioned in the text, such as CHRED, were not included because their datasets are not directly accessible. Although the CHRED dataset has been partially integrated into the IPPU accounting platform (https://www.cityghg.com/toCauses?id=4), the platform only provides data for four discrete years (2005, 2010, 2015, and 2020), leaving substantial temporal gaps that prevent a consistent time-series analysis.

In this revision, we also added the national total CO_2 emissions reported by the Chinese government in the National Greenhouse Gas Inventory (NGHGI) submitted to the UNFCCC (from documents China. 2024 Biennial Transparency Report (BTR). BTR1, and China. Biennial Update Report (BUR). BUR 4, available at https://unfccc.int/reports). The NGHGI data are also temporally discontinuous, but provide 8 available years (2005, 2010, 2012, 2014, 2017, 2018, 2020, and 2021). The NGHGIs represent the officially reported values and therefore provide an independent benchmark to evaluate the consistency of the six bottom-up inventories. We have now clarified this rationale for the inventory selection in Section 2.

Revision:

(1) ***Section 2, paragraph 1:*** *"To ensure both temporal completeness and spatial representativeness, the selected emission inventories must provide a continuous time-series covering most of the 2000-2023 period (with at least 2000–2019 coverage in GEMS) and have explicit spatial coverage over mainland China. Six anthropogenic CO2 emission inventories, including five gridded inventories (ODIAC2023, EDGAR2024, MEIC-global-CO2 v1.0, CAMS v6.2, and GEMS v1.0) and one urban total emission inventory (CEADs), are applied to provide estimates of total emissions at the national, provincial, and city levels in China. As internationally recognized and widely used by previous studies (Li et al., 2017b; Han et al., 2020b; Liu et al., 2024; Zheng et al., 2025), these inventories are publicly available from official repositories."*

(2) ***Section 2, paragraph 2:*** *"In addition to these six datasets, the National Greenhouse Gas Inventory (NGHGI) submitted by the Chinese government to the United Nations Framework Convention on Climate Change (UNFCCC, available at: https://unfccc.int/reports) was also collected. The NGHGI provides the officially reported national total emissions and therefore serves as an independent benchmark for evaluating the reliability of the six inventories. As NGHGI covers only discrete years (2005, 2010, 2012, 2014, 2017, 2018, 2020, and 2021), it is not included in the continuous temporal analysis but is used solely for national-level comparison."*

(3) ***Section 2, paragraph 3:*** *"The specific information of the six selected inventories is presented in Section 2.1. …"*

References:

Han, P., Zeng, N., Oda, T., Lin, X., Crippa, M., Guan, D., Janssens-Maenhout, G., Ma, X., Liu, Z., Shan, Y., Tao, S., Wang, H., Wang, R., Wu, L., Yun, X., Zhang, Q., Zhao, F., and Zheng, B.: Evaluating China's fossil-fuel CO_2 emissions from a comprehensive dataset of nine inventories, Atmospheric Chemistry and Physics, 20, 11371–11385, https://doi.org/10.5194/acp-20-11371-2020, 2020.

Li, M., Zhang, Q., Kurokawa, J., Woo, J.-H., He, K., Lu, Z., Ohara, T., Song, Y., Streets, D. G., Carmichael, G. R., Cheng, Y., Hong, C., Huo, H., Jiang, X., Kang, S., Liu, F., Su, H., and Zheng, B.: MIX: a mosaic Asian anthropogenic emission inventory under the international collaboration framework of the MICS-Asia and HTAP, Atmos. Chem. Phys., 17, 935–963, https://doi.org/10.5194/acp-17-935-2017, 2017.

Liu, H., Hu, C., Xiao, Q., Zhang, J., Sun, F., Shi, X., Chen, X., Yang, Y., and Xiao, W.: Analysis of anthropogenic CO2 emission uncertainty and influencing factors at city scale in Yangtze River Delta region: One of the world's largest emission hotspots, Atmospheric Pollution Research, 15, 102281, https://doi.org/10.1016/j.apr.2024.102281, 2024.

Zheng, L., Li, S., Hu, X., Zheng, F., Cai, K., Li, N., and Chen, Y.: Spatiotemporal comparative analysis of three carbon emission inventories in mainland China, Atmospheric Pollution Research, 16, 102417, https://doi.org/10.1016/j.apr.2025.102417, 2025.

2. The relevance of the topic is evident, especially in light of China's pivotal role in global emissions and its commitments under the Paris Agreement. Still, the manuscript would benefit from a more explicit explanation of why comparing the latest versions of these inventories is particularly important. A clearer articulation of what distinguishes this study from previous work (beyond simply the version updates) would improve accessibility, especially for readers less familiar with the topic.

Response: We thank the reviewer for this helpful comment. We have now revised the texts to more clearly state why using the latest inventory versions is essential and how this study differs from previous work. The latest versions incorporate updated activity data, emission factors, and spatial proxies, ensuring greater temporal completeness and accuracy. For example, ODIAC2023 incorporates the latest national fossil-fuel CO_2 estimates from the CDIAC team (AppState, Gilfillan et al. 2021, Hefner and Marland, 2023), covering the period 2000–2022 (available at: https://db.cger.nies.go.jp/dataset/ODIAC/readme/readme_2023_20240605.txt). EDGAR2024 integrates updated activity data from IEA (2023) and FAO (2024), extends the time series of CO_2 emissions to 2023 through a new "Fast Track" approach (Guizzardi et al., 2024; Crippa et al., 2024), and employs enhanced spatial proxies such as the Global Energy Monitor power plant dataset (available at: https://edgar.jrc.ec.europa.eu/dataset_ghg2024). These improvements significantly enhance temporal completeness and spatial accuracy compared to earlier versions (e.g., EDGAR v8.0, ODIAC2022).

We have also addressed our study's distinct contributions compared with earlier analyses (Han et al., 2020; L. Zheng et al., 2025). This work (1) extends the temporal coverage to 2000–2023 and identifies three distinct emission phases reflecting policy and energy structure changes; (2) evaluates inconsistencies within CEADs and recommends using CEADs (sectors) for provincial analyses; (3) reveals sectoral spatial allocation differences—especially between EDGAR and MEIC in the transport sector; (4) quantifies scale-dependent uncertainties, showing that provincial uncertainty (CV) is 2-10 times higher than national uncertainty; and (5) shows that CEADs and MEIC yield consistent estimates across nine representative provinces. At the national scale, CAMS shows the smallest deviation from the NGHGI, while ODIAC agrees most closely with the six-inventory mean during the study period. These revisions have been added to the Section 1 to highlight the rationale for using the latest inversions and to the Section 4 to summarize the new insights and methodological contributions.

Revision

(1) ***Section 1, paragraph 4:*** *"...Moreover, emission inventories are continuously updated to incorporate improved inputs (e.g., activity data, EFs, and refined methodology). Therefore, it is crucial to use the latest versions of the various inventories to* <u>*capture these methodological updates and*</u> *better understand the* <u>*most recent patterns*</u> *of China's anthropogenic CO_2 emissions."*

(2) ***Section 4, paragraph 5:*** *"*<u>*In summary, this study extends previous work by identifying a three-phase trend in China's anthropogenic CO_2 emissions from 2000 to 2023 and quantifying the emission uncertainties (1σ) at both national and provincial levels. At the national level, CAMS shows the closest agreement with the government-reported NGHGI, while ODIAC aligns best with the multi-inventory mean over the study period. At the provincial level, the Chinese local inventories, CEADs and MEIC, provide the most consistent estimates for regional studies. Differences in spatial*</u>

proxies significantly affect the spatial distribution of sectoral emissions, as shown by the contrasting transport emission patterns in EDGAR and MEIC. We also clarify the appropriate use of CEADs for provincial analyses. Our results further underscore the importance of improving the consistency of regional inventories to provide a stronger scientific basis for China's emission mitigation and carbon neutrality policies."

3. The discussion of differences between inventories and their associated uncertainties is engaging and informative. However, a clear take-home message is lacking, particularly regarding which inventories may be considered more reliable or fit for specific purposes. While it is understandable that definitive recommendations may be difficult, the current conclusions are limited, with the mainly strong guidance being to avoid the provincial CEADs inventory. Offering more concrete insights or practical recommendations, especially in the context of supporting policymaking, would significantly strengthen the manuscript.

Response: We thank the reviewer for this constructive suggestion. We agree that identifying which inventories are more reliable is crucial. However, determining the accuracy of each inventory requires direct comparisons with independent observations (e.g., atmospheric CO_2 measurements and inversion results), which is beyond the scope of this study. In this study, we focused on assessing the consistency among inventories and their deviations from independent references.

To strengthen the conclusions, we have now included the National Greenhouse Gas Inventory (NGHGI) data submitted by the Chinese government to the UNFCCC for comparison at the national level. We have revised Figure 1 to include NGHGI data. We assessed the consistency of the six inventories (2000–2023) by calculating mean absolute difference (MAD) of each inventory relative to the NGHGI and the six-inventory mean. Our findings show that CAMS exhibits the greatest consistency with the NGHGI, while ODIAC agrees most closely with the six-inventory mean.

At the provincial level, the uncertainties are 2-10 times higher than that at the national level. While these variations make it difficult to determine an absolute reference, our analysis (Section 3.2.2, paragraph 3) shows that CEADs and MEIC exhibit good agreement in nine representative provinces, particularly in Inner Mongolia, Shandong, Henan, Hubei, and Shanghai. We have revised Section 3.1 and Section 4 accordingly to clearly incorporate these quantitative consistency assessments and provide clearer practical insights

Revision:

(1) ***Section 3.1, paragraph 2:*** "*To further assess the consistency of the six inventories, we calculate the mean absolute difference (MAD), which is defined as the multi-year mean of annual absolute differences between each inventory and either the NGHGI or the six-inventory mean. Compared with NGHGI, the MADs range from 0.156 Gt year^{-1} (CAMS) to 0.835 Gt year^{-1} (MEIC). Against the six-inventory mean, the MADs range from 0.12 Gt year^{-1} (ODIAC) to 0.449 Gt year^{-1} (MEIC). EDGAR reports the highest emissions, which is about 0.370 Gt year^{-1} larger than the mean emission. MEIC shows the lowest emission levels, which is about 0.449 Gt year^{-1} less than the mean emission. Overall, CAMS exhibits the greatest consistency with the NGHGI, being at least 30% lower than that of the other inventories. In comparison, ODIAC agrees most closely with the six-inventory mean, with an MAD at least 58% lower than the others.*"

(2) ***Section 4, paragraph 1:*** *"China's annual anthropogenic CO_2 total emission increases from 3.42 Gt in 2000 to 12.03 Gt in 2023. When compared with the officially reported NGHGI and the six-inventory mean, CAMS shows the smallest deviation from the NGHGI, while ODIAC agrees most closely with the multi-inventory mean. The six inventories display a broadly consistent emission trend, but their discrepancies among the inventories have widened from 0.41 Gt year^{-1} to 1.63 Gt year^{-1}, mainly due to the highest estimates reported from EDGAR and the lowest values estimated from MEIC, especially after 2012. …"*

(3) ***Section 4, paragraph 4:*** *"…The pronouncedly higher emissions in the coastal megacities (e.g., Shanghai, Jiangsu, and Guangdong) by ODIAC and the abnormal increase in CAMS by 50-230% in Liaoning, Hubei, and Shanghai exacerbate this divergence. Despite these inconsistencies, CEADs and MEIC exhibit broadly consistent estimates across nine provinces, especially in Inner Mongolia, Shandong, Henan, Hubei, and Shanghai."*

(4) ***Section 4, paragraph 5:*** *"In summary, this study extends previous work by identifying a three-phase trend in China's anthropogenic CO_2 emissions from 2000 to 2023 and quantifying the emission uncertainties (1σ) at both national and provincial levels. At the national level, CAMS shows the closest agreement with the government-reported NGHGI, while ODIAC aligns best with the multi-inventory mean over the study period. At the provincial level, the Chinese local inventories, CEADs and MEIC, provide the most consistent estimates for regional studies. Differences in spatial proxies significantly affect the spatial distribution of sectoral emissions, as shown by the contrasting transport emission patterns in EDGAR and MEIC. We also clarify the appropriate use of CEADs for provincial analyses. Our results further underscore the importance of improving the consistency of regional inventories to provide a stronger scientific basis for China's emission mitigation and carbon neutrality policies."*

Section 3.1, Figure 1:

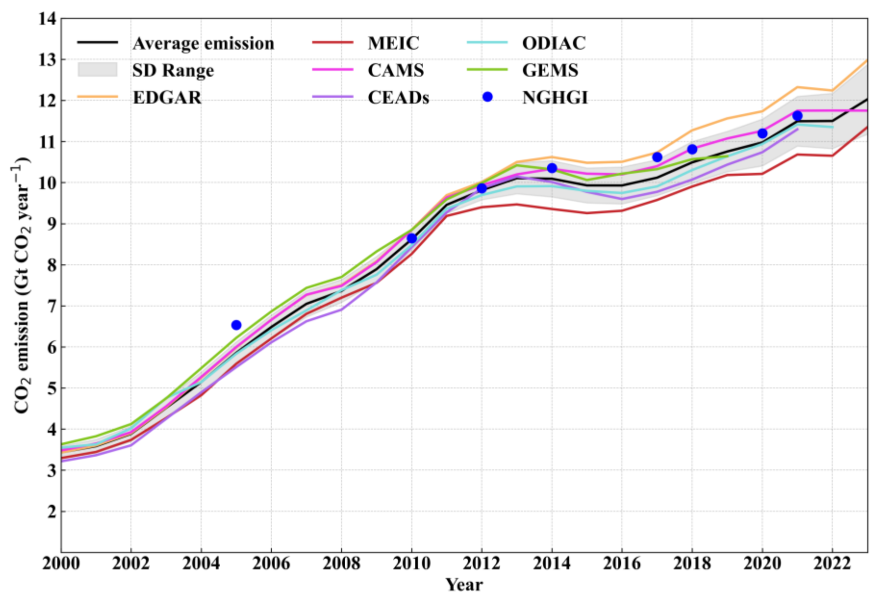


Figure 1. *Annual anthropogenic CO_2 emissions in mainland China from 2000 to 2023, as reported by six emission inventories: EDGAR, MEIC, CAMS, CEADs (up to 2021), ODIAC (up to 2022), and GEMS (up to 2019), and one government-reported data (NGHGI). Apart from ODIAC, all inventories provide national totals directly. We calculated China's emissions by summing the grid values within China for ODIAC. The shaded area indicates the standard deviation of the six inventories. It's noteworthy that the inter-inventory mean and SD were calculated from the above mentioned six inventories.*

Specific Comments

1. Line 35: To highlight China's role in global emissions, please include the percentage of China's anthropogenic emissions relative to global totals.

Response: We appreciate the reviewer's suggestion. According to the Global Carbon Project (GCP, 2024), China accounted for about 32% of global anthropogenic CO_2 emissions in 2023. We have added this information in Introduction section to better emphasize China's role in global emissions.

Revision:

Section 1, paragraph 1: *"…China, which is responsible for about 80% of East Asia's anthropogenic CO_2 emissions (Xia et al., 2025) <u>and about 32% of global CO_2 emissions according to the Global Carbon Project (GCP, 2024; available at: https://globalcarbonbudget.org/)</u>, has committed to reaching peak emissions by 2030 and carbon neutrality by 2060. …"*

2. Line 44: The CAMS inventory should be included in this overview for completeness.

Response: We appreciate the reviewer's suggestion. The CAMS inventory has now been included in the revised manuscript.

Revision:

Section 1, paragraph 2: *"…Global gridded products provide consistent, worldwide estimates with high spatial resolution (1 km or 0.1°), such as the Open-Data Inventory for Anthropogenic Carbon Dioxide (ODIAC) (Oda et al., 2018; Oda and Maksyutov, 2011), the Emissions Database for Global Atmospheric Research (EDGAR) (Janssens-Maenhout et al., 2019), the Global Emission Modeling System (GEMS) (Wang et al., 2013), <u>and the Copernicus Atmosphere Monitoring Service (CAMS-GLOB-ANT, hereafter referred to as CAMS, Soulie et al., 2024)</u>. …"*

3. Line 48: Are there specific reasons for not including CHRED in the analysis? Please clarify.

Response: We thank the reviewer for this comment. Our primary selection criteria required inventories to provide a continuous time-series covering most of the 2000-2023 to ensure temporal completeness. The publicly accessible CHRED dataset (available at: https://www.cityghg.com/toCauses?id=4) only provides data for four discrete years (2005, 2010, 2015, and 2020), which leaves substantial temporal gaps that prevent a consistent time-series analysis. We have added our selection criteria in the revised manuscript.

Revision:

Section 2, paragraph 1: *"<u>To ensure both temporal completeness and spatial representativeness, the selected emission inventories must provide a continuous time-series covering most of the 2000-2023 period (with at least 2000–2019 coverage in GEMS) and have explicit spatial coverage over mainland China.</u> Six anthropogenic CO2 emission inventories, …"*

4. Line 80: Consider introducing the CAMS inventory definition earlier in this section alongside the others, for consistency.

Response: We appreciate this suggestion regarding the CAMS inventory definition. The CAMS definition has been introduced earlier in the revised manuscript to enhance consistency, as suggested in a previous review comment (Specific Comment 2). The CAMS-GLOB-ANT definition, including the abbreviation (CAMS), is now presented in Section 1, Paragraph 2.

5. Line 80: MEIC is initially described (line 47) as a China-specific inventory, but here it is treated as a global inventory. This inconsistency may confuse readers, particularly since line 116 clarifies that the global version of MEIC is used. Please harmonize these descriptions.

Response: We thank the reviewer for pointing out this potential confusion regarding the MEIC inventory. We acknowledge that the distinction between MEIC's China-specific and global products was not sufficiently clarified. The MEIC team produces two distinct CO_2 emission products: a China-specific version (MEIC-China-CO_2) and a global version (MEIC-Global-CO_2). We selected the MEIC-Global-CO_2 product v1.0 based on its two primary advantages: it offers a higher spatial resolution (0.1°×0.1°) compared to the then-latest MEIC-China-CO_2 v1.4 (0.25°×0.25°), and its temporal coverage extends closer to the most recent years (1970–2023 vs 1970–2020). Importantly, while this product is globally scoped, the emissions calculation within the Chinese region retains the accuracy of a local inventory by using Chinese local energy statistics (from the China Energy Statistics Yearbook, CESY)) and emission factors (from the China Emission Accounts and Datasets, CEADs). We have revised content in Section 2.1, paragraph 3 to harmonize these descriptions and clarify that the global version was selected based on its superior technical specifications (spatial resolution and temporal coverage).

Revision:
Section 2.1, paragraph 3: *"...MEIC uses the transportation network data from the China Digital Road Network Map (CDRM) to constrain the distribution of vehicle activity as well as population density, GDP, and land use for other sectors (Li et al., 2017a; Xu et al., 2024b). In this study, we use the latest MEIC-Global-CO_2 product (v1.0), which provides higher spatial resolution (0.1° × 0.1°) and longer temporal coverage (1970-2023) than the MEIC-China-CO_2 product (v1.4; 0.25° × 0.25°, up to 2020). It's noteworthy that although MEIC-Global-CO_2 is a global product, its emissions calculations for China continue to rely on local energy statistics (CESY) and emission factors (CEADs), ensuring consistency with domestic data while improving spatiotemporal details."*

6. Line 122: The mention of the number of species covered by CAMS is not relevant here, as the analysis focuses on a single species. Also, this level of detail is not provided for the other inventories.

Response: We thank the reviewer for this helpful comment. The description of the number of species covered by CAMS has been removed to maintain consistency with the level of detail provided for the other inventories.

7. Line 198: Do you have any hypotheses as to why GEMS diverges from the trends observed in other inventories, especially in the residential and commercial sectors?

Response: We thank the reviewer for this insightful question. We have further investigated the GEMS inventory and consulted with the dataset developers. The residential emissions provided by GEMS are considered more reliable, because the national residential emission survey for the Second National Pollution Source Census was conducted by the GEMS team. Even prior to the census, GEMS team had carried out a comprehensive, representative national survey. These surveys suggested that publicly available statistical sources (such as IEA and FAO) have underestimated the rapid transition of China's residential energy mix (Tao et al., 2018), which likely led to overestimated residential emissions in other inventories. We have revised the manuscript accordingly to clarify this point.

Revision:

Section 3.1, paragraph 5: *"…while a reverse pattern was observed in GEMS. The residential emissions provided by GEMS are considered more reliable, as the national residential emission survey for the Second National Pollution Source Census was conducted by the GEMS team. Data from their surveys indicate that the publicly available statistical sources (such as the IEA and the Food and Agriculture Organization of the United Nations, FAO) have underestimated the rapid transition of China's residential energy mix (Tao et al., 2018), leading to likely overestimated residential emissions in other inventories. The changes in the size of sectoral CO_2 emissions indicate the changes in China's energy structure and economic growth, highlighting the importance of incorporating locally based surveys for residential emissions to improve the accuracy of bottom-up inventories."*

Reference:

Tao, S., Ru, M. Y., Du, W., Zhu, X., Zhong, Q. R., Li, B. G., Shen, G. F., Pan, X. L., Meng, W. J., Chen, Y. L., Shen, H. Z., Lin, N., Su, S., Zhuo, S. J., Huang, T. B., Xu, Y., Yun, X., Liu, J. F., Wang, X. L., Liu, W. X., Cheng, H. F., and Zhu, D. Q.: Quantifying the rural residential energy transition in China from 1992 to 2012 through a representative national survey, Nat Energy, 3, 567–573, https://doi.org/10.1038/s41560-018-0158-4, 2018.

8. Table 1: Time Resolution (GEMS column): Please change "Annually" to "Annual" to align with the other entries.

Response: The term “Annually” in the GEMS column of Table 1 has been corrected to “Annual” in the revised manuscript.

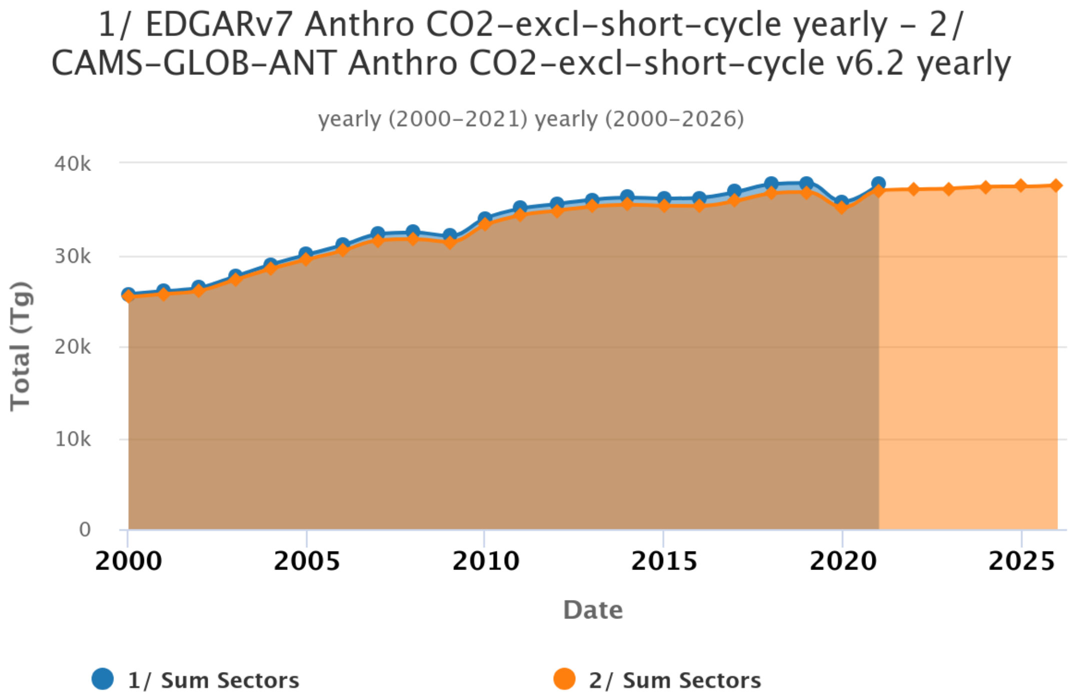
9. Table 1: Data Source row: Since the "last accessed" date is the same for all inventories, consider moving this note to a table footnote (e.g., marked with an asterisk) to streamline the table.

Response: The “last accessed” date has been moved to a table footnote to improve readability and streamline the presentation in Table 1.

10. Figure 3: The growth in electricity and heat production in CAMS appears to stabilize, unlike in other inventories where growth continues. Given CAMS is based on EDGAR, a similar trend would be expected. Could this discrepancy be linked to the use of CAMS-Tempo profiles?

Response: We thank the reviewer for this insightful comment. The stabilization of CO_2 emissions in CAMS arises from its extrapolation approach. Specifically, CAMS uses EDGAR as the base dataset and applies growth factors (q) from the Community Emissions Data System (CEDS) to extend emissions beyond the final EDGAR year (Soulie et al. (2024)). Projected emissions follow exponential growth with base q. Because q values fluctuate around 1 (0.9-1.05), the extrapolated emissions exhibit minimal variation, resulting in nearly linear and stable trends. As shown in figure below (from CAMS official website), we think the CAMS-GLOB-ANT v6.2 used in this study builds on EDGAR v7 (up to 2021) and extrapolates emissions to 2026, showing similar post-2021 stabilization. This stabilization accounts for the flat trend in electricity and heat production in CAMS during 2021–2023. Moreover, the CAMS-GLOB-TEMPO profiles are only used to temporally disaggregate the annual CAMS-GLOB-ANT emissions into monthly values, not for extrapolation. We have clarified this in the revised Data and Methods section.

Revision:
Section 2.1, paragraph 4: “*CAMS is a global inventory developed as part of the Copernicus Atmosphere Monitoring Service project. It builds on EDGAR and integrates several complementary datasets, including the Community Emissions Data System (CEDS) <u>for the extrapolation of the emissions up to the current year</u>, the CAMS-GLOB-TEMPO <u>for monthly variability</u>, and the CAMS-GLOB-SHIP for ship emissions. …*”



Time series of global anthropogenic CO2 emissions from EDGAR v7 and CAMS-GLOB-ANT v6.2 during 2000-2026 (source: https://eccad.sedoo.fr/#/data).

Reference:

Soulie, A., Granier, C., Darras, S., Zilbermann, N., Doumbia, T., Guevara, M., Jalkanen, J.-P., Keita, S., Liousse, C., Crippa, M., Guizzardi, D., Hoesly, R., and Smith, S. J.: Global anthropogenic emissions (CAMS-GLOB-ANT) for the Copernicus Atmosphere Monitoring Service simulations of air quality forecasts and reanalyses, Earth Syst. Sci. Data, 16, 2261–2279, https://doi.org/10.5194/essd-16-2261-2024, 2024.

11. Line 212: It is unclear why MEIC is used as a benchmark for comparison. Please add a brief explanation of this choice.

Response: We thank the reviewer for this valuable comment. Among the five gridded inventories (ODIAC, EDGAR, MEIC, CAMS, and GEMS) used in this study, both MEIC and GEMS are constructed using statistical data from the Chinese government and official departments. Specifically, the energy consumption data in MEIC and GEMS are derived from the China Energy Statistical Yearbook (CESY) and the National Bureau of Statistics of China (NBS), respectively. Given that GEMS is a newly released dataset (2025) and MEIC has been developed and validated for more than a decade, we selected MEIC as the benchmark for comparison. MEIC is widely recognized and used when studying anthropogenic emissions in China. For example, it has been integrated into the MIX inventory as the Chinese component of the Asian anthropogenic emissions (Li et al., 2017) and was used to develop high-resolution (1 km × 1 km) emission maps for 2013 (Zheng et al., 2021). Previous studies have also shown that simulations based on MEIC are more consistent with observations than those using EDGAR or ODIAC in Beijing (Che et al., 2022) and perform better in Xianghe and Xinlong (Yang et al., 2025). We have revised our manuscript for clarifying the rationality of the benchmark choice.

Revision:

Section 3.2.1, paragraph 3: *"To assess spatial consistency, we compared ODIAC, EDGAR, CAMS, and GEMS with MEIC as a benchmark (Fig. 5). MEIC was chosen because it is compiled using local statistics and has been widely applied and validated in previous studies (Li et al., 2017b; Zheng et al., 2021; Che et al., 2022; Yang et al., 2025), making it a reasonable reference for comparison. ..."*

References:

Che, K., Cai, Z., Liu, Y., Wu, L., Yang, D., Chen, Y., Meng, X., Zhou, M., Wang, J., Yao, L., and Wang, P.: Lagrangian inversion of anthropogenic CO_2 emissions from Beijing using differential column measurements, Environ. Res. Lett., 17, 075001, https://doi.org/10.1088/1748-9326/ac7477, 2022.

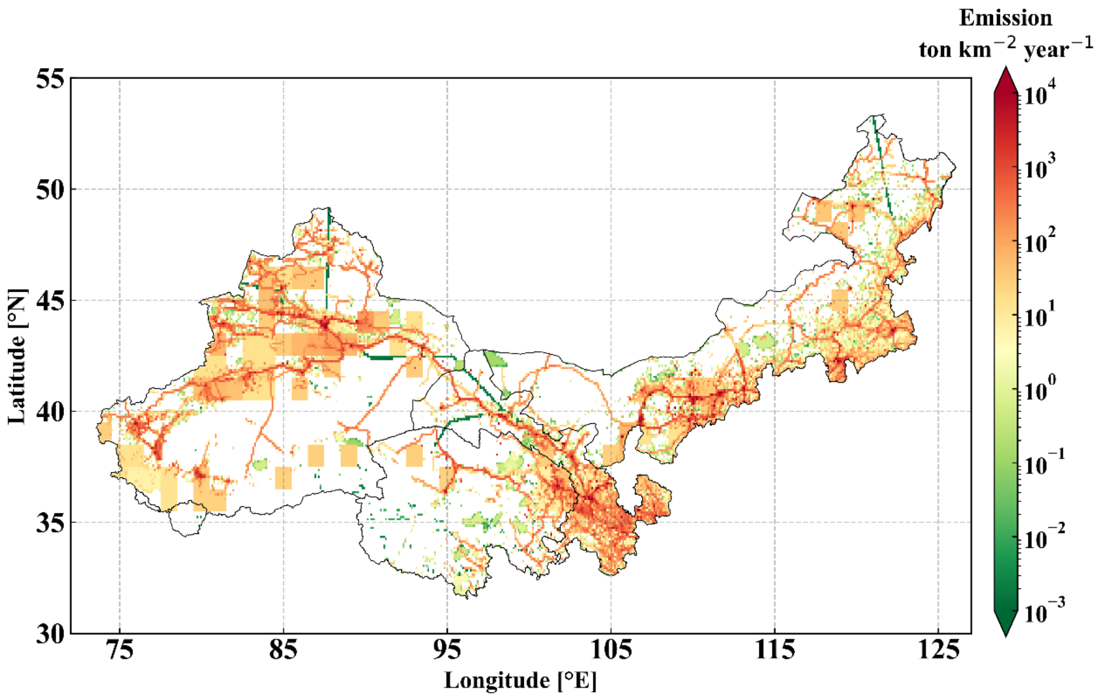
Li, M., Zhang, Q., Kurokawa, J., Woo, J.-H., He, K., Lu, Z., Ohara, T., Song, Y., Streets, D. G., Carmichael, G. R., Cheng, Y., Hong, C., Huo, H., Jiang, X., Kang, S., Liu, F., Su, H., and Zheng, B.: MIX: a mosaic Asian anthropogenic emission inventory under the international collaboration framework of the MICS-Asia and HTAP, Atmos. Chem. Phys., 17, 935–963, https://doi.org/10.5194/acp-17-935-2017, 2017.

Yang, H., Wu, K., Wang, T., Wang, P., and Zhou, M.: Atmospheric anthropogenic CO2 variations observed by tower in-situ measurements and simulated by the STILT model in the Beijing megacity region, Atmospheric Research, 325, 108258, https://doi.org/10.1016/j.atmosres.2025.108258, 2025.

Zheng, B., Cheng, J., Geng, G., Wang, X., Li, M., Shi, Q., Qi, J., Lei, Y., Zhang, Q., and He, K.: Mapping anthropogenic emissions in China at 1 km spatial resolution and its application in air quality modeling, Science Bulletin, 66, 612–620, https://doi.org/10.1016/j.scib.2020.12.008, 2021.

12. Figure 5c: What accounts for the squared patches in this figure? A brief explanation in the caption or main text would help readers interpret the results.

Response: We appreciate the reviewer's careful observation. The squared patches visible in Fig. 5c mainly occur in Xinjiang, Qinghai, Gansu, and Inner Mongolia. To verify their origin, we extracted CAMS emissions for these provinces, as shown in the figure below. The result shows that the squared patterns are inherent to the CAMS dataset itself. When analyzing spatial differences, only grid cells with valid values in both CAMS and MEIC were considered. Therefore, the spatial distribution of CAMS – MEIC in Fig. 5c directly reflects the pattern of CAMS emissions.



CAMS emission distribution in selected provinces (Xinjiang, Qinghai, Gansu, and Inner Mongolia).

13. Figures 4 & 5: In Figure 4, MEIC shows notable emissions over western China (green shading), while ODIAC does not. This difference should manifest as strong negative values (blue) in Figure 5, yet much of this area appears blank, which I assume represents NaN values. Did you apply any filtering? Please clarify.

Response: We thank the reviewer for this valuable comment. A spatial filter was applied before calculating the differences. Specifically, only grid cells with valid emission values in both inventories were retained for the difference maps. Grid cells containing NaN values in either dataset were excluded to ensure consistent comparison. As a result, areas where ODIAC has NaN values, such as parts of western China, appear blank in Fig. 5, even though MEIC reports valid emissions there.

14. Line 241: For clarity, please consider rephrasing this sentence, here is a suggestion: "Across the spatial domain, EDGAR generally reports lower emissions than MEIC, with negative differences prevailing throughout the region."

Response: The sentence has been revised as recommended to improve clarity.

Revision:

Section 3.2.1, paragraph 4: *"Across the spatial domain, EDGAR generally reports lower emissions than MEIC, with negative differences prevailing throughout the region (Fig. 5b). …"*

15. Line 287: Could the discrepancy in Shanxi be attributed to a specific sector? A sectoral analysis, as presented in the previous section, would be valuable here.

Response: We thank the reviewer for this insightful comment. We examined CO_2 emissions from CEADs (sectors) and CEADs (provinces) for Shanxi and found that the large discrepancy mainly arises from differences in raw coal–related emissions, which is the dominant contributor to total emissions (Wei, 2022). As shown in the figure below, CO_2 emissions from raw coal in CEADs (provinces) are on average 664.71 Mt year^{-1} higher than those in CEADs (sectors), leading to an overall mean difference of 512.18 Mt year^{-1} between the two datasets. We have included this figure in the supplementary material and revised the manuscript to clarify the source of the discrepancy in Shanxi's CEADs emissions.

Revision:

Section 3.3.1, paragraph 1: *"…In contrast, the CEADs (sectors) closely matches the other five independent inventories (ODIAC, EDGAR, MEIC, CAMS and GEMS), with its mean emissions deviating by no more than 3.84 Mt year^{-1} from the average of the five inventories. The large discrepancy between CEADs (provinces) and CEADs (sectors) mainly originates from the much higher raw coal–related emissions in CEADs (provinces) (Fig. S3), as coal is the dominant contributor to total emissions (Wei, 2022)."*

Section 7, Figure S3:

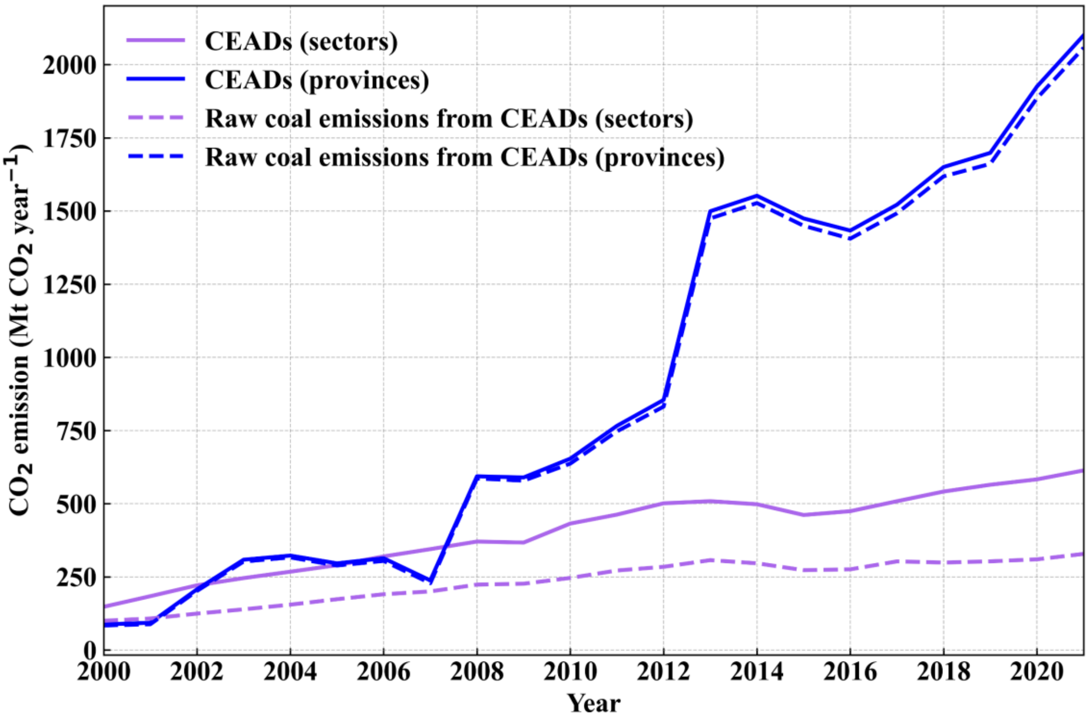


Figure S3. *Comparison of total CO_2 emissions and raw coal–related CO_2 emissions in Shanxi from CEADs (sectors) and CEADs (provinces) during 2000–2020. Solid lines represent total emissions, while dashed lines indicate emissions from raw coal combustion.*

Reference:

Wei, C.: Historical trend and drivers of China's CO2 emissions from 2000 to 2020, Environ Dev Sustain, 1–20, https://doi.org/10.1007/s10668-022-02811-8, 2022.

16. Line 290: Could you comment on the provincial comparison of the two CEADs estimates beyond Shanxi? Do any provinces show consistent agreement between the two datasets, and are these primarily low-emission regions? A colored map showing the differences between the two CEADs estimates by province could be a useful addition

Response: We thank the reviewer for this constructive suggestion. We generated a provincial heatmap showing the differences between CEADs (provinces) and CEADs (sectors). The provinces are sorted by provincial total emissions in descending order (Fig. S2). The results show that Shanxi is a clear outlier, with differences exceeding 900 Mt CO_2 year^{-1} after 2012, while differences in other provinces remain within 400 Mt year^{-1}. Beyond Shanxi, the discrepancies are spatially heterogeneous and do not directly correspond to total provincial emissions. For instance, Guangdong (ranked fourth in total emissions) shows relatively small differences (<100 Mt year^{-1}), whereas some mid-ranked provinces, such as Shaanxi (14th among 30 provinces), exhibit differences greater than 100 Mt year^{-1} in more than half of the years. Large differences (>100 Mt year^{-1}) are mostly concentrated in provinces with higher total emissions, with few exceptions (e.g., Xinjiang in 2021). Provinces with lower total emissions generally show smaller discrepancies (<50 Mt year^{-1}), except for Xinjiang, Guizhou, and Ningxia. Overall, although the spatial pattern is heterogeneous, there is a general tendency for differences to decrease with provincial emission magnitude. We have added this provincial heatmap to the supplementary material and revised the manuscript accordingly.

Revision:

Section 3.3.1, paragraph 1: *"CEADs provides two forms of CO_2 emission estimates for provinces: the "province" series (referred to as CEADs (provinces)), which provides total emissions directly for each province, and the "sectors" series (referred to as CEADs (sectors)), which compiles fuel- and sector-specific emissions before summing them to the provincial totals. <u>Significant discrepancies are observed between these two estimates in some provinces, with Shanxi emerging as a pronounced outlier. After 2012, the difference in Shanxi exceeds 900 Mt year^{-1}, whereas in other provinces it remains below 400 Mt year^{-1} (Fig. S2). To investigate this divergence, we compare both CEADs estimates with other inventories in Shanxi (Fig. 7a). The results indicate that</u> CEADs (provinces) exceeds CEADs (sectors) after 2008, …"*

__Section 7, Figure S2:__

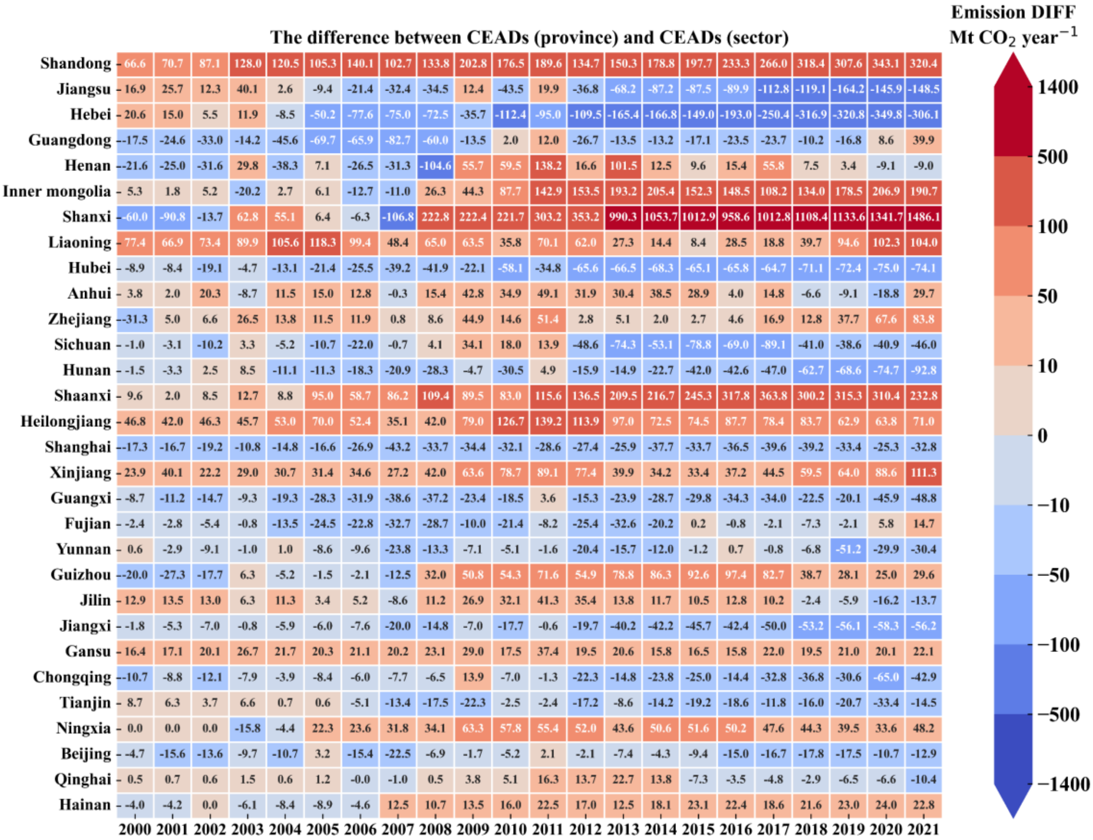


__Figure S2.__ Heatmap of the annual CO_2 emission differences between CEADs (province) and CEADs (sector) for 30 Chinese provinces provided by CEADs during 2000–2021. Provinces are ordered by total emissions from highest to lowest.