General comments

The study conflates emissions and concentrations by assuming a neat relationship between methane column concentration and emissions without consideration of other controlling factors: wind and the methane chemical sink. I recommend the authors discuss this question in a revised manuscript. OH trends are difficult to quantify, but observed concentrations can vary year to year based only on annual variations in the local wind speed, which is readily quantifiable. The authors could examine a reanalysis product (ERA5, GEOS-FP/MERRA-2) to assess trends in wind speed at their different source locations. This could support the argument that the observed trends in methane column mixing ratio are the result of emission trends.

Reply: Thank you for the suggestion and we totally agree with the points about the influence of winds and OH radical role in controlling the methane concentrations. As suggested, we have included and discussed about the wind trends in the revised manuscript computed at each source location. We have also discussed the chemical influence of OH radical, which acts as a strong sink for CH_4 concentration in the atmosphere.

- In the revised manuscript 10m u-component of wind from ERA5 which is reanalysis product is used for the period 2009-2022. The long-term seasonal plots (2009-2022) of wind speed (ms^{-1}) for coal and thermal power plants along with Long-term spatial trend of winds over the Indian region covering source types (coal and thermal power plants) for the period 2009-2022 are added in the revised manuscript.

The study should better address the very large uncertainties in the BU inventories it cites. The inventory estimates are not observations (despite several passages describing them as such, e.g., L. 29, 455), and EDGAR in particular has previously been shown to contain major spatial errors (e.g., see Maasakkers et al., 2023; https://pubs.acs.org/doi/10.1021/acs.est.3c05138).

Reply: We agree with your suggestion regarding uncertainties in bottom up inventories. In the present study we have used EDGAR inventory to understand the relationship between XCH_4 concentrations against anthropogenic EDGAR values. Maasakkers et al. (2023) reported annual gridded methane emissions inventory over the US at 0.1º×0.1º resolution while meeting the USEPA emission inventory standards which was submitted to UN in 2020. As suggested this article has reported the methane emission over the US region and has improved uncertainties compared standard global EDGAR database. Thanks for advising the article. Similarly, Solazzo et al. (2021) studied the uncertainties in Emissions Database for Global Atmospheric Research emission inventory of GHGs. The results indicate that the globally anthropogenic emissions covered by EDGAR for the combined three main GHGs for the year 2015 are accurate with an interval of -15% to 20%.

- CO_2 emissions which are responsible for 74% of the total GHG emissions account for ~ 11% of global uncertainty share.
- Wetlands are responsible for largest absolute uncertainty from all the CH_4 emission categories with a range of 107 Tg CH_4 year^{-1}, approximately 49.3% of the global total estimate. Large discrepancies exist in spatio-temporal variation of estimated CH_4

emission. One of the largest uncertainties in estimates of CH_4 emission comes from differences in wetland spatial extent (Zhang et al., 2017).

Specific comments

L. 29: No CH_4 flux is observed by WetCHARTS. Inventory values are reported, not observed.

Reply: It is corrected in the revised manuscript.

L. 57-60: What is the citation for these figures / the decadal budget?

Reply: Thank you for the suggestion. The citation for the above mentioned lines is given in the revised manuscript.

L. 146: The meaning of Ramsar is not immediately clear. I suggest writing "(see below)" or similar so readers know the term will be explained shortly.

Reply: Thank you for the suggestion. The same has been incorporated in the revised manuscript.

L. 147: How can a number of coal mines vary, and why is the range so large? Are these different estimates of coal mine count? If so, the large range is really surprising.

Reply: Thank you for the comment. The coal mines listed in the manuscript are based on the size and their production capacity. Details of coal mines and their classification are also provided in Pai et al. (2021) and Halder et al. (2024).

L. 185-188: These resolutions are not correct for the methane product. The methane product started at 7x7 km^2 resolution and was upgraded to 5.5x7 km^2 resolution at nadir (in contrast with the NO_2 product).

Reply: We agree with your suggestion. TROPOMI (TROPOspheric Monitoring Instrument) on board the Sentinel 5 Precursor satellite provides the methane product with its daily global coverage at a resolution of 7 ×7 km^2 since its launch in October 2017 and which is upgraded to 5.5× 7 km^2 in August 2019. The resolutions are corrected in the revised manuscript.

L. 210: This be cited as Pai et al., not just a dataverse link.

Reply: Thank you for the suggestion. The same has been incorporated in the revised manuscript.

Figure 3 and related text: I assume the study region is shown as the blue box in Fig. 3b. Please clarify and include lat/lon ranges in text to facilitate reproduction of results and comparison with other work.

Reply: Thank you for the comment. The study region in the present work is Indian region covering the different sources (Coal mines, Thermal power plants and wetland sites). The figure 3c shows the probable high XCH_4 concentrations using TROPOMI data wherein 90^{th}

percentile statistical filter is applied. The blue box in figure 3c mainly covering Indian sub-continent (Latitude: 0°-40°; Longitude: 60°-100°).

L. 273-275: Please make these statements more quantitative. With respect to which year are the residuals defined? And how is the acceleration post-2015 diagnosed? The growth looks steady over the period to my eye.

Reply: Thank you for the suggestion. The lines 273-275 describes the anomaly/spatio temporal residuals in XCH_4 concentration which is calculated based on the individual data point for that particular year minus mean value for that particular year. Anomaly values in figure 3b range from -100 ppb to +100 ppb. Negative anomaly values in XCH_4 concentration indicate that particular data point is lower than mean value. Post 2015 the anomaly is on positive side. Based on your suggestion, a revised statement has been updated in the revised manuscript.

Figure 3c and related text: One would expect the tropics to show the highest columnar methane concentrations, because those columns are more sensitive to the troposphere than at higher latitude. I do not think these high concentrations can be said to reflect high emissions. Please clarify if I am misunderstanding what is being shown here.

Reply: Thank you for pointing out. The present study says that high concentrations of CH_4 are observed over the tropical region and do not necessarily indicate the high emission activities in the tropical belt. However, in studies by various researchers on methane emissions, Feng et al. (2023) used methane data from the Japanese Greenhouse gases Observing Satellite (GOSAT) estimate methane surface emissions, and results indicate relative to baseline value in 2019 largest annual increases in methane emissions during 2020 over Eastern Africa (14± 3 Tg), tropical South America (5± 4 Tg), tropical Asia (3±4Tg) and Temperate Eurasia (3±3 Tg). Further, in tropical and temperate South America, emissions increased by 9± 4 Tg and 4± 3 Tg, respectively.

Figure 4: This looks interesting, but the figure is qualitative and should be accompanied by concrete figures; otherwise, it's difficult to articulate the finding. Can you support the claim of "accelerated diffusion of CH_4 to SH" with numerical values? A clearer figure would plot the trend in XCH_4 by latitude (bin) over time.

Reply: Thank you for the suggestion. In the revised manuscript a new figure 4b is added which depicts the trend in XCH_4 globally using GOSAT data. XCH_4 has increased the global mean trend from 7 ppb year^{-1} to 9 ppb year^{-1}. There are hotspots observed in the Tibetan Plateau (8.2 to 9 ppb year^{-1}), South America (8.2 to 8.8 ppb year^{-1}), African continent (8 to 8.4 ppb year^{-1}) and rest of the world XCH_4 trend varied from 6.7 to 8 ppb year^{-1}.

L. 311-313: Earlier in the manuscript, Parker is cited for the claim that seasonal CH_4 variation is dominated by wetland emission variability, but here the effect of seasonal OH trends is highlighted. Suggest discussing the roles of wetlands + OH in both passages.

Reply: Thanks for the comment and suggestions. The present paper discussed about the types of sources and probable sink mechanisms of CH_4. As suggested, we have discussed the mechanism of OH radical availability in the troposphere and its role in removing the CH_4 from the atmosphere.

L. 374-379: These numbers all look very similar. What are the std's / error bars? Are they statistically different? At present I cannot tell if the results are strong enough for a meaningful trend comparison.]

Reply: Thanks for the suggestion. The below table shows the trend ± uncertainty for coal mines sites, thermal power plants and wetland sites calculated and same has been incorporated in the revised manuscript.

Coal Mine locations										
S. No	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
District names	**Korba**	**Singrauli**	**Angul**	**Sonbhadra**	**Jharsuguda**	**Dhanbad**	**Paschim Bardhaman**	**Bhadradri Kothagudem**	**Chatra**	**Cuddalore**
Trend ±Uncertainty (ppb year $^{-1}$)	9.68 ± 0.52	9.4 ± 0.5	9.51 ± 0.5	9.4 ± 0.5	9.39 ± 0.52	9.78 ± 0.53	10.15 ± 0.55	9.5 ± 0.36	9.51 ± 0.56	9.13 ± 0.4
Thermal power stations										
Power station names	**Vindhyachal STPS**	**Mundra TPS**	**Mundra UMPP**	**Sasan UMTPP**	**Tirora TPS**	**Rihans STPS**	**Sipat STPS**	**Chandrapur STPS**	**Anpara TPS**	**Korba STPS**
Trend ±Uncertainty (ppb year $^{-1}$)	9.42 ± 0.50	9.69 ± 0.4	9.72 ± 0.41	9.46 ± 0.51	9.6 ± 0.51	9.42 ± 0.50	9.67 ± 0.50	9.66 ± 0.46	9.36 ± 0.50	9.67 ± 0.50
Wetlands sites										
Wetland locations	**Sundarban Wetland**	**Vembanad-Kol Wetland**	**Chilika Lake**	**Kolleru Lake**	**Bhitarkanika Mangroves**	**Point Calimere Wildlife & Bird Sanctuary**	**Loktak Lake**	**Upper Ganga River**	**Sambhar Lake**	**Wular Lake**
Trend ±Uncertainty (ppb year $^{-1}$)	9.54 ± 0.51	9.69 ± 0.44	9.5± 0.50	9.56 ± 0.45	9.32 ± 0.50	9.67 ± 0.45	9.58 ± 0.49	9.82 ± 0.52	9.52 ± 0.43	8.72 ± 0.3

Figure 8: I cannot read the text inset, and it is not clear to me what is learned from this figure. Is it saying that WetCHARTS doesn't show a trend in wetland emissions, whereas the satellites do? Again, it is essential to also examine potential trends in wind speed.

Reply: Thank you for the suggestion. The text inset is the 10 wetland sites and the figure depicts the seasonal methane emissions over the wetland sites. For better readability the inset figure is made into separate figure (8b) in the revised manuscript. A significant trend is observed over the Wular Lake with an increasing rate of 0.04 mg m^{-2} year-^{1} with a p value of 0.01. An annual trend of *X*CH_4 was over this study is about 8.72 ppb year^{-1}. As suggested, trends in wind speed are estimated using 10m u component from ERA5 reanalysis data for the period 2009-2022. The trend in wind speed over the wetland sites is given in the table 4 in the revised manuscript.

A positive trend over Wular lake (0.20 m/s) $year^{-1}$ and Point Calimere wildlife and Bird Sanctuary (0.25 m/s) $year^{-1}$ is observed.

L. 455: Again, no emissions are being "observed" here. The figure just shows how EDGAR values vary in time.

Reply: Thank you for the suggestion. This has been corrected in the revised manuscript.

Figure 10: What correlation is being plotted? Is this the correlation between annual TROPOMI vs. annual EDGAR per grid cell? Please clarify.

Reply: Thank you for the comment. The figure 12 shows the correlation between annual average TROPOMI vs annual average EDGAR per grid cell.

Corrections

L. 67: "contribute to 20-40%" -> "contribute 20-40%"

Reply: The same has been corrected in the revised manuscript.

L. 104: "Sentienl" -> "Sentinel"

Reply: The same has been corrected in the revised manuscript.