Reviewer 1:

The authors have adequately responded to all points raised by this reviewer. The manuscript has been significantly improved and the focus of the study is now clearer.

The topic of Megacity GHG emissions in emerging economies of great importance and this study exemplifies important work on methane emissions in China. I recommend to publish the paper after minor corrections by the authors.

Thanks so much for the overall positive comments, we have further revised this MS following all your suggestions as follows.

Specific/technical comments:

line 38-39: consider rephrasing for clarity.

Done as suggested, we revised this sentence as "and considering the high temperature sensitivity of CH_4 emission factors (EFs) for the biological processes-based sources such as waste treatment, large bias will be caused when estimating future CH_4 emissions under different global warming scenarios.".

line 47: Suggest to change 'But' to 'In contrast, '

Done as suggested.

line 81: suggest to change 'ignorable' to 'negligible'

Done as suggested.

line 100: suggest to change 'supposed' to 'expected'

Done as suggested.

line 102 and elsewhere: change 'east China' to 'East China'

Done as suggested.

line 113: change 'approach' to 'approaches'

Done as suggested.

line 126: same as line 113

Done as suggested.

line 129: change 'retrieval owns' to 'observations have'

Done as suggested.

line 131: change 'nearly' to 'recently'

Done as suggested.

line 141: change 'in' to 'on'

Done as suggested.

line 144: consider removing 'by' and 'and' for clarity

Done as suggested, we have revised this sentence as "There was only one recent study which focused on urban

waste treatment CH_4 emissions".

line 151: please clarify if you are referring to one specific bottom-up approach or to bottom-up approaches in general here.

We have revised it as "compared with "bottom-up" approaches, the "top-down" method can avoid using the factors that lead to large uncertainties of CH_4 emissions especially from waste treatment".

line 230: consider reformatting

Done as suggested.

line 250: change 'provide' to 'provides'

Done as suggested.

line 326: it remains unclear how this uncertainty was calculated

Here the uncertainty is calculated based on the assumption that monthly CH_4 concentration in September and October varied between August and November, we have revised this sentence as "where the uncertainty is calculated based on the assumption that monthly CH_4 concentration in September and October varies between August and November" on lines 332-333.

line 358: change 'retain' to 'remain'

Done as suggested.

line 362: change 'shown' to 'shows'

Done as suggested.

line 408: change 'present' to 'represent'

Done as suggested.

line 419: please correct grammar

Done as suggested, we have revised it as "And total CH_4 emissions will be overestimated when using daytime emissions to represent all-day averages".

line 437: remove 'by'

Done as suggested.

line 471: remove 'by'

Done as suggested.

line 510 to 514: consider rephrasing for clarity

Done as suggested, we have revised this sentence as "After including the constraints from the observed concentrations, the *posteriori* emissions for waste treatment show obvious seasonality with highest emission in July ($7.66 \pm 0.09 \times 10^3$ t) and lowest emission in February ($2.20 \pm 0.87 \times 10^3$ t). And emissions from other anthropogenic categories show much smaller seasonality (highest emission in January of $4.18 \pm 0.69 \times 10^3$ t and lowest emission in August of $2.88 \pm 0.15 \times 10^3$ t) than *a priori* emissions." on lines 537-542.

line 610: remove '-wide'

Done as suggested.

line 615: consider changing 'above' to 'reported'

Done as suggested.

line 637: remove 'mentioned'

Done as suggested.

line 643+: please correct grammar

Done as suggested, we have revised this sentence as “To our best knowledge, there are no inventories that considered the temperature-induced changes on both seasonal variations and annual trends of CH_4 emissions.”

line 653: change 'not' to 'no'

Done as suggested.

line 687: Still a lot of repetition and summarizing in this section. Suggest to change title to 'Summary and Conclusions'

Done as suggested.

Overall, the manuscript switches between past tense and present. Please consider harmonizing the writing.
There is also an overabundant use of 'displays/displayed'

Done as suggested, we have used present tense for these words.

Reviewer 2:

Review of revised manuscript by Cheng Hu, Junqing Zhang, Bing Qi, Rongguang Du, Xiaofei Xu, Haoyu Xiong, Huili Liu, Xinyue Ai, Yiyi Peng, and Wei Xiao New title: Global warming will largely increase waste treatment CH4 emissions in Chinese megacities: insight from the first city scale CH4 concentration observation network in Hangzhou city, China The authors have made many positive improvements to this manuscript, especially adding clarification and references. However, I continue to have significant questions.

Thanks so much for these detailed suggestions. All points have been addressed below (review query in Italic; author response in blue). Changes to the text in the manuscript have been marked in blue.

1. Decomposition of organic waste by methanogens mostly takes at depth within the waste pile and temperatures can be significantly above those at the surface (https://www.atsdr.cdc.gov/hac/landfill/html/ch2.html). If the major types of cover are plastic and metal, both impervious to gas flow through the waste pile, then temperatures could get very high. However, other studies have found that there is a correlation between emissions and ambient temperature (https://rc.library.uta.edu/uta-ir/handle/10106/11641?show=full; CLEEN model) and between emissions and soil temperature (https://journals.sagepub.com/doi/abs/10.1177/0734242X9701500104?journalCode=wmra; Börjesson G, Svensson BH. Seasonal and Diurnal Methane Emissions From a Landfill and Their Regulation By Methane Oxidation. Waste Management & Research. 1997;15(1):33-54. doi:10.1177/0734242X9701500104). Thus, the relationship between emissions fluxes and temperature is very complicated and probably not simply related to ambient temperature. You might want to discuss this more, since temperature is so central to your conclusions.

Thanks so much for pointing it out, we agree that temperature within landfills should be much more related to methanogens activities and CH_4 emissions than T_{2m}. However, considering (1) we do not have direct temperature observations under landfills, (2) only T_{2m} is provided for future climate RCP scenarios, and (3) air temperate can act as good indicator of the general variations for landfill temperature, hence the relationship between waste CH_4 emissions and T_{2m} is constructed and used to predict how does CH_4 emission changes in different RCP scenarios.

To make clarification, we also added more descriptions as "Note decomposition of organic waste by methanogens mostly takes at depth within the landfills and temperature can be higher than at the surface, hence the temperature within landfills should be much more related to methanogens activities and CH_4 emissions than T_{2m}. However, considering (1) we do not have direct temperature observations under landfills, (2) T_{2m} can be used as indicator of methanogens activities, and (3) T_{2m} is commonly used meteorological data that can be provided for future RCP scenarios, hence the relationship between waste CH_4 emissions and T_{2m} is constructed and used to predict how will CH_4 EFs change in different climate scenarios." on lines 572-579.

2. Are there landfill gas collection systems at the facilities in and around Hangzhou? These are a management technique, but might they affect your thesis and conclusions?

There are two main methods to deal with waste in Hangzhou, with the first one burning waste and second one by landfills. And for the second one, we should note the Chinese government constructed waste separation station in each city with density of one station for per 150~200 households (around 450~800 people), usually these waste separation stations are full with waste because domestic garbage can be generated every day, they do not have gas collection systems and can emit large quantity of CH_4 emissions caused by daily biomass waste as area sources (Tian et al., 2022). Besides, there is only one landfill that has gas collection systems, the reported gas collection efficiency was less than 80%, which also indicates large quantity of CH_4 emissions will be directly emitted into the atmosphere and the emissions will be influenced by climate change.

To make clarification, we have added more descriptions on lines 377-384 as "We should note the Chinese government constructed waste separation stations in each city with density of one station for per 150~200 households (around 450~800 people), usually these waste separation stations are full with waste because domestic garbage can be generated every day, they do not have gas collection systems and can emit large quantity of CH_4 emissions caused by daily biomass waste as area sources (Tian et al., 2022). Besides, there is only one landfill that has gas collection systems, the reported gas collection efficiency was less than 80%, which also indicates large quantity of CH_4 emissions will be directly emitted into the atmosphere and the emissions will be influenced by climate change.".

We also revised the sentence on lines 114-117 as "For these "bottom-up" approaches, the high uncertainties were directly attributed to omission of many small point sources and discrepancies of observed site-specific EFs, which varied largely by climate and management technology such as the efficiency of gas collection systems".

3.I have concerns about your model's ability to simulate the nighttime PBLH (planetary boundary layer height), since this is very important to your use of 24-hour data. The plot that you show for your previous study in Nanjing only compares daytime measurements ´ there are no data from nighttime. If the model underestimates the nighttime PBLH, then it will underestimate nighttime emissions and, therefore, full diurnal emissions. Thus, the model would indicate artificially low scaling factors for the waste treatment sector. What do the results suggest if only daytime modeling and data are used?

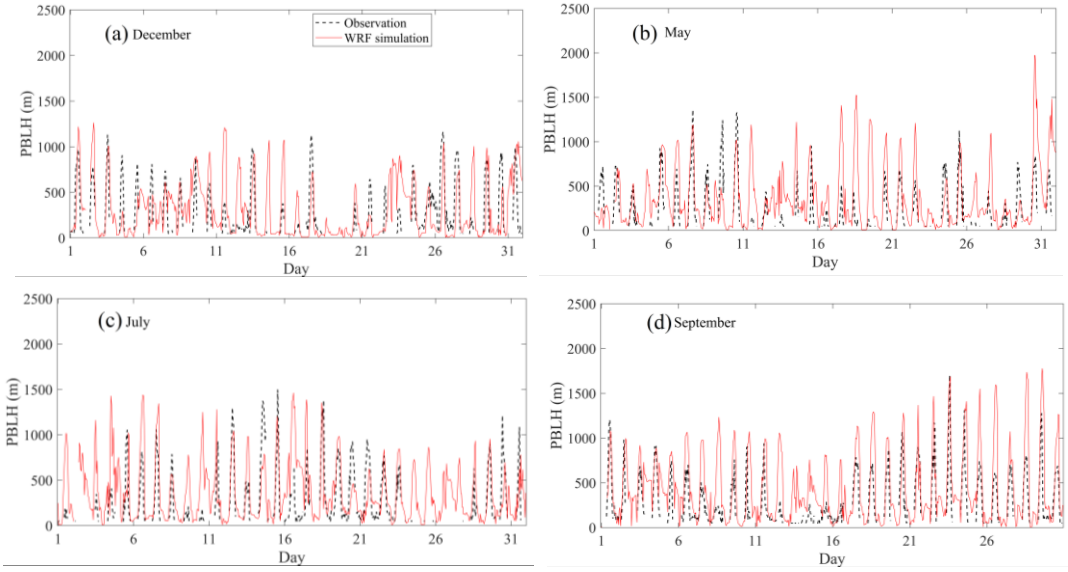

Figure R1. Comparisons between simulated and observed hourly PBLH in (a) December 2020, (b) May 2021, (c) July 2021, and (d) September 2021.

Done as suggested. Firstly, we have contacted with the environmental protection department of Hangzhou city, which provides us with four months (one month in each season) of hourly PBLH observations in study period, and the comparisons between simulated and observed PBLH in each month represent general good performance of WRF model. As displayed in Figure R1, it shows overall good performance for both daytime and nighttime PBLH variations, and indicates our WRF-STILT model can well simulate atmospheric transport processes as found in our previous studies. Secondly, we also only used daytime (11:00-16:00, local time) CH_4 observations and simulations to derive *posteriori* scaling factors and analyzed the temperature sensitivity. Besides, we further analyzed the

temperature sensitivity of CH_4 EFs by only using daytime CH_4 observations and simulations in Figure S10, it still shows strong linear relationship between normalized SFs and T_{2m}, with the slopes of 0.046 and 0.060. These results are in high consistency with using all-day observations of 0.038 and 0.050, indicating similar results of using 24 hours observations and only using daytime observations, and less influence of simulated nighttime PBLH bias on corresponding temperature sensitivity.

To make clarification, we have added "Note PBLH simulations are important in evaluating model performance, we only have four months of PBLH observations (one month in each season), these hourly PBLH observations were used to evaluate the general performance of WRF model. As displayed in Figure S6, it shows overall good performance for both daytime and nighttime PBLH variations." on lines 461-465. All related tables and figures have been added in supplementary file.

Besides, as suggested by reviewer, we also only used daytime CH_4 observations and simulations to derive *posteriori* scaling factors and analyzed the temperature sensitivity. Considering results from Case 2 varied between Case 1 and Case 3, here we only displayed the results from Case 1 and Case 3 in Table R1 and Figure R2. It shows strong linear relationship between temperature, with the slopes of 0.046 and 0.060, these results are similar with using all 24 hours data of 0.038 and 0.050.

We added "Although the evaluations of hourly PBLH simulations have illustrated good performance in both daytime and nighttime (Figure S6), we also conducted inversions by only using daytime observations to constrain CH_4 emissions. Considering results from Case 2 varied between Case 1 and Case 3, here we only display the results from Case 1 and Case 3 (Table S2), it shows similar seasonal variations as using all all-day observations. We notice the values are larger than later, which is reasonable because CH_4 emissions in daytime should be larger than all-day and nighttime emissions. In general, *posteriori* SFs by using all-day concentration observations will be used to represent total CH_4 emissions from monthly to annual scales." on lines 504-512.

Table R1. *Posteriori* Scaling factors by only using daytime (11:00-16:00, local time) observations and simulations.

Month	Case 1			Case 3		
	Wetland	Waste	Others	Wetland	Waste	Others
1	1.00	0.64	0.71	1.00	0.54	0.78
2	1.00	0.44	0.82	1.00	0.33	0.93
3	1.01	0.56	0.98	1.02	0.48	1.06
4	1.12	0.73	1.13	1.13	0.70	1.16
5	1.16	1.23	1.01	1.15	1.26	0.97
6	1.08	0.98	1.18	1.08	0.98	1.18
7	1.04	1.36	1.41	1.01	1.42	1.36
8	1.02	0.95	0.99	1.03	0.94	1.00
9	1.02	0.75	0.97	1.04	0.71	1.01
10	1.08	0.68	1.02	1.08	0.65	1.05
11	1.00	0.37	0.72	1.00	0.23	0.83
12	1.00	0.59	0.66	1.00	0.42	0.74

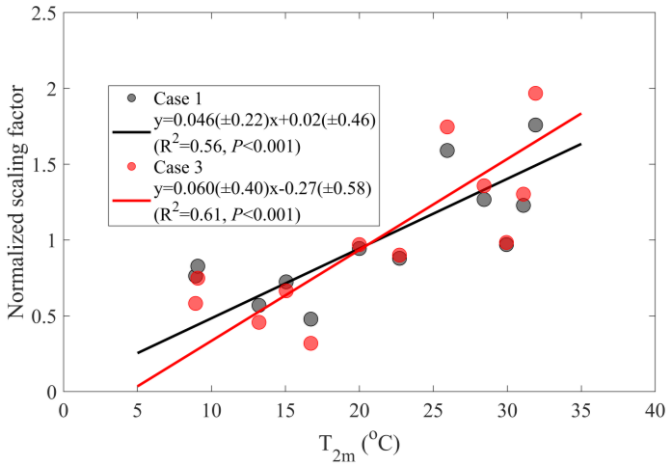

Figure R2. Relationship between the monthly *posteriori* CH_4 emissions and temperature in case 1 and 3, where the emissions are constrained by only using daytime(11:00-16:00, local time) observations.

We also added "We also analyzed the temperature sensitivity by only using daytime CH_4 observations and simulations in Figure S10, it still shows strong linear relationship between normalized SFs and T_{2m}, with the slopes of 0.046 and 0.060. These results are in high consistency with using all-day observations of 0.038 and 0.050, indicating similar results of using 24 hours observations and only using daytime observations, and less influence of simulated nighttime PBLH bias on corresponding temperature sensitivity." on lines 582-587.

4. You need to have a native English speaker proofread the manuscript. There are many places where it can be difficult to understand the meaning. I have made many suggestions in the attached Word document, but you need to make sure meaning wasn't changed mistakenly by these suggestions.

Thanks so much and we really appreciate your help especially for providing these detailed suggestions on corresponding English grammars, we have revised these typos and also asked one native English speaker to proofread it.

5. Should figure S8 be deleted from the Supplementary Information?

Here we added both daily *posteriori* and *priori* CH_4 concentrations to be compared with observation, which aims to illustrate the improvement of CH_4 emissions.