

Atmos. Chem. Phys. Discuss., referee comment RC1
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Comment on acp-2022-549

Anonymous Referee #1

Referee comment on "Global warming will largely increase waste treatment CH₄ emissions in Chinese megacities: insight from the first city-scale CH₄ concentration observation network in Hangzhou, China" by Cheng Hu et al., Atmos. Chem. Phys. Discuss., <https://doi.org/10.5194/acp-2022-549-RC1>, 2022

This study uses continuously measured methane measurements at three tower locations in and around Hangzhou, China, to investigate temporal variations of emissions, especially from the treatment of waste. The authors use the WRF-STILT (Weather Research and Forecasting – Stochastic Time-Inverted Lagrangian Transport) model combined with a Bayesian inversion framework to compare the data driven results with the prior emissions inventory. They conclude that emissions have been overestimated for the city of Hangzhou and that there is a seasonality to the emissions that can only be explained by the waste treatment sector.

This topic is very timely and important for understanding the influence of climate change on emissions of this high global warming potential pollutant, but several issues in this paper need clarification before publication.

- Of the three sites, it appears that only one is in the city (Hangzhou), and one is on a relatively remote mountain (Damingshan). Is the third site, Linan, in a suburb or also background region, as stated on line 177? If this is true, then there is only one site that is truly relevant to determining emissions from the city, since the other two are described as background sites. However, background values are taken from much more remote sites. There can be significant sources between the very remote sites and the urban region being studied, including large cities such as nearby Shanghai between Hangzhou and TAP and RYO, the latter being used almost always as background. The footprint for the Damingshan site is only slightly influenced by emissions in the urban core.
- What emissions did you use for the prior? It seems like you used the EDGAR v6.0 inventory for anthropogenic sources (except rice patties) and WetCHARTs for wetland emissions, including from rice patties. Please state explicitly how you calculated the prior – “a priori” is not mentioned in the WRF-STILT model setup section.
- A major assumption of the paper is that waste treatment is the dominant source of emissions and the other anthropogenic sources do not contribute to the seasonality of the observed CH₄ measurements. What you show in Figure 4d is that waste treatment contributes most to the CH₄ signal, but the other sources are also important. Perhaps

you can show a map of the locations of the anthropogenic sources – power plants (especially natural gas powered), landfills, wastewater treatment plants, distribution lines for natural gas, refineries, dairies, rice paddies – especially close to the urban center. Enlarge the urban center to show locations. I am not convinced that you have enough information to discount the influence of other CH₄ emissions sources or to characterize the sources in the urban center with only one site, especially when the reader does not know the sources in the region or the general seasonal wind patterns. A measurement that you might consider for the future is ethane, since fossil-fuel-derived CH₄ contains measurable C₂H₆, whereas biological sources (including waste treatment and wetlands) do not. Seasonality due to fossil CH₄ is observed in cities, even as far south as Los Angeles. Is rice cultivation seasonal – should you expect some seasonality from this sector?

- This paper uses all of the diurnal cycle of the measurements. I definitely agree that emissions at night are not captured if only afternoon measurements are used, as is commonly done. However, one reason most investigations don't use the entire 24-hour record is that WRF does not do a good job with the transport parameters at night, specifically the planetary boundary layer height (PBLH). It is very important to get this right for modeling to produce meaningful results. You don't show how your model performed for this critical parameter. Can you show how the modelled PBLH compares with measurements, even if only a limited number of measurements are available?

More detailed comments follow:

Abstract: mention the types of waste included in this study

Line 72: Out of curiosity, what are the top five anthropogenic sources of CH₄ in China?

Line 91: USEPA

Line 106: replace "absence" with "omission"

Lines 143-145: City-scale studies have not focused on waste treatment sources because there are many sources, as in Hangzhou. Yadav et al. (2019; JGR Atmospheres) were able to see the effects of the closure of a landfill in the Los Angeles, CA area that was included in the prior inventory and not seen in the modelled results.

Pages 6-7: In the description of the sites, please summarize the regional, seasonal wind patterns and any differences between the sites.

Lines 188-190: How frequently were standards run? What uncertainty, including both

precision and accuracy, did you assign for the measurements?

Line 238: What does "fuel exploitation from coal, oil, and natural gas" include? Extraction, transportation, refining, distribution, and combustion, or some subset of these?

Line 239: How and where is the energy for buildings generated? E.g., natural gas power plants in the suburbs, coal burned in the buildings, ...?

Lines 241-245: Is 0.5° high enough spatial resolution for your study region?

Line 287: reference for CCGCRV? Thoning et al., 1989, JGR 94, 8549-8565; <https://gml.noaa.gov/ccgg/mb/crvfit/crvfit.html>

Line 295: Is it meaningful to give an annual average when 1-2 months are missing data?

Line 295: replace "variations" with "trends"

Line 296: What are the "similar atmospheric transport processes?" Summarize seasonal wind direction and speed patterns.

Line 309: replace "YON" with "TAP"

Line 310: replace "temporal" with "spatial"

Lines 320-321: Figure 3 does not show significant differences in the size of the footprints at the different sites. You might want to expand the scale to show this.

Lines 323-326: Cities shown significant diurnal variation in PBLH.

Line 345: Not sure what you mean by "amplitudes" here – amplitude of the seasonal variations? I don't see obvious differences. The absolute average abundances are

different.

Line 348: The simulated data for Linan actually approximate the observations very well!

Line 364: It is very much to be expected that the Hangzhou site is more influenced by local emissions since it is in the urban core. What are the major emitters within 5-10 km of the site?

Lines 366-368: How did you show that the Linan and Damingshan sites are influenced by emissions from a much larger region? The footprints don't indicate this.

Lines 375-378: Can you give a reference for the statement that waste treatment emissions are larger during the daytime than at night?

Line 420: Emissions from waste treatment dominated the total CH₄ and the seasonal pattern, but you do show significant seasonal variations for the other anthropogenic sources in Figure 7a. Can you split those up at all? Can you say anything about the natural gas distribution infrastructure – more leaks in winter than summer, ...?

Line 479: Where are these values of SFs shown? They are not from Table S2.

Figures: In general, please improve the resolution of the figures. It is very difficult to impossible to read the small text, even when expanding the figures on the screen.

Figure 1: What are the divisions within Hangzhou City?

Figure 2: Use the same color schemes on all figures and parts within figures for the same sites.

Figure 3: Replace "lg" with "log." Are the waste treatment CH₄ emissions in panel (e) also from EDGAR v6.0?

Figure 4: Need higher resolution graphics, especially for panel (d) and (e). The note at the end of the caption may be incorrect. In panel (e), is it true that the blue color for the bar charts include all of Zhejiang, including Hangzhou? Do the blue regions in the pie charts represent Zhejiang minus Hangzhou?

Figure 8: What region is this figure describing?