Supplementary Information for

Global warming will largely increase CH_4 emissions from waste treatment: insight from the first city scale CH_4 concentration observation network in Hangzhou, China

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Section S1. Choice of background based on monthly footprint

We carefully choose the CH_4 background for each month by identifying the main air flows from monthly footprint (Figure S3). The final choice is displayed in Table S2. And we should note because the difference between YON and other four sites of TAP, RYO, WLG and UUM sites were larger as 100 ppb from May to August, which indicates there is large uncertainty when air flows come from directions of both YON site and other four sites. We found the footprint in July showed obvious air follows both from the South China Sea (YON site) and north east (RYO site), and to reduce the potential large uncertainty in CH_4 simulations, we used the averages of both sites as the background in July.

Section S2. Multiplicative scaling factor method

We also used the multiplicative scaling factor (hereafter MSF) method to constrain emissions by using observations at Linan site, which has been applied broadly to constrain greenhouse gas and other tracer gas emissions. The MSF SFs were derived by dividing the observed enhancement by the simulated enhancement (Sargent et al., 2018; He et al., 2020),

$$SF(CH_4) = \frac{CH_{4\_obs} - CH_{4\_bg} - \Delta CH_{4\_\text{wetland}}}{\Delta CH_{4\_anthro}} \quad (3)$$

where $SF(CH_4)$ is the scaling factor for anthropogenic CH_4 emissions (excluding agricultural soil in this study), and CH_{4_obs}, CH_{4_bg}, $\Delta CH_{4\_wetland}$ and ΔCH_{4_anthro} are the CH_4 concentration observations, background CH_4, simulated wetland CH_4 enhancement, and simulated anthropogenic CH_4 enhancement (excluding agricultural soil), respectively.

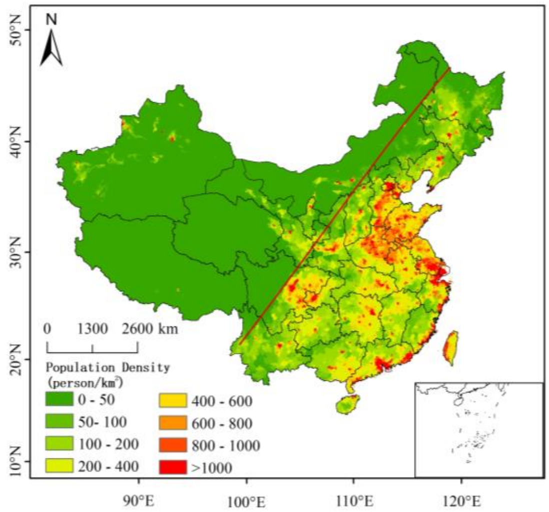

Figure S1. Population density for China in year of 2019, with the red line represents Heihe-Tengchong line, with 94% of national total population lived in the east of this line.

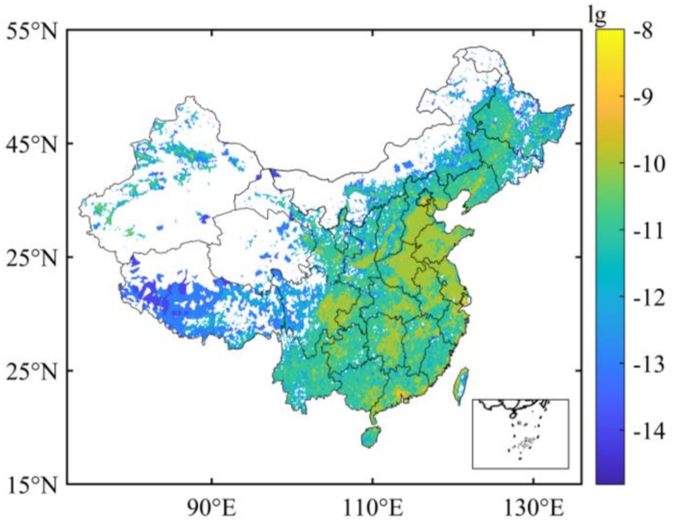

Figure S2. Waste treatment CH_4 emissions in EDGAR v6.0 inventory, units for emissions: kg m^{-2} s^{-1}.

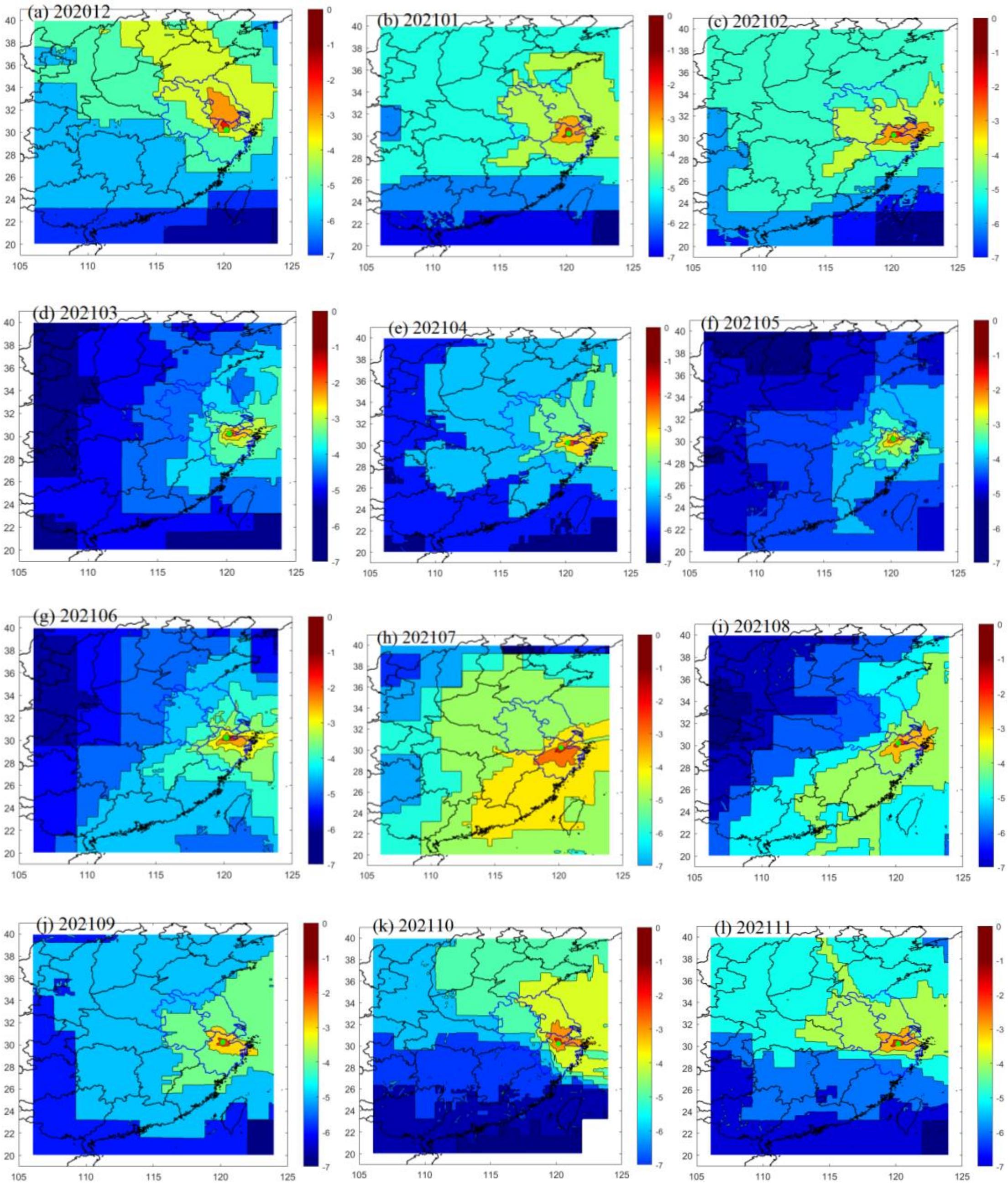

Figure S3. Monthly averaged footprint from December, 2020 to November, 2021.

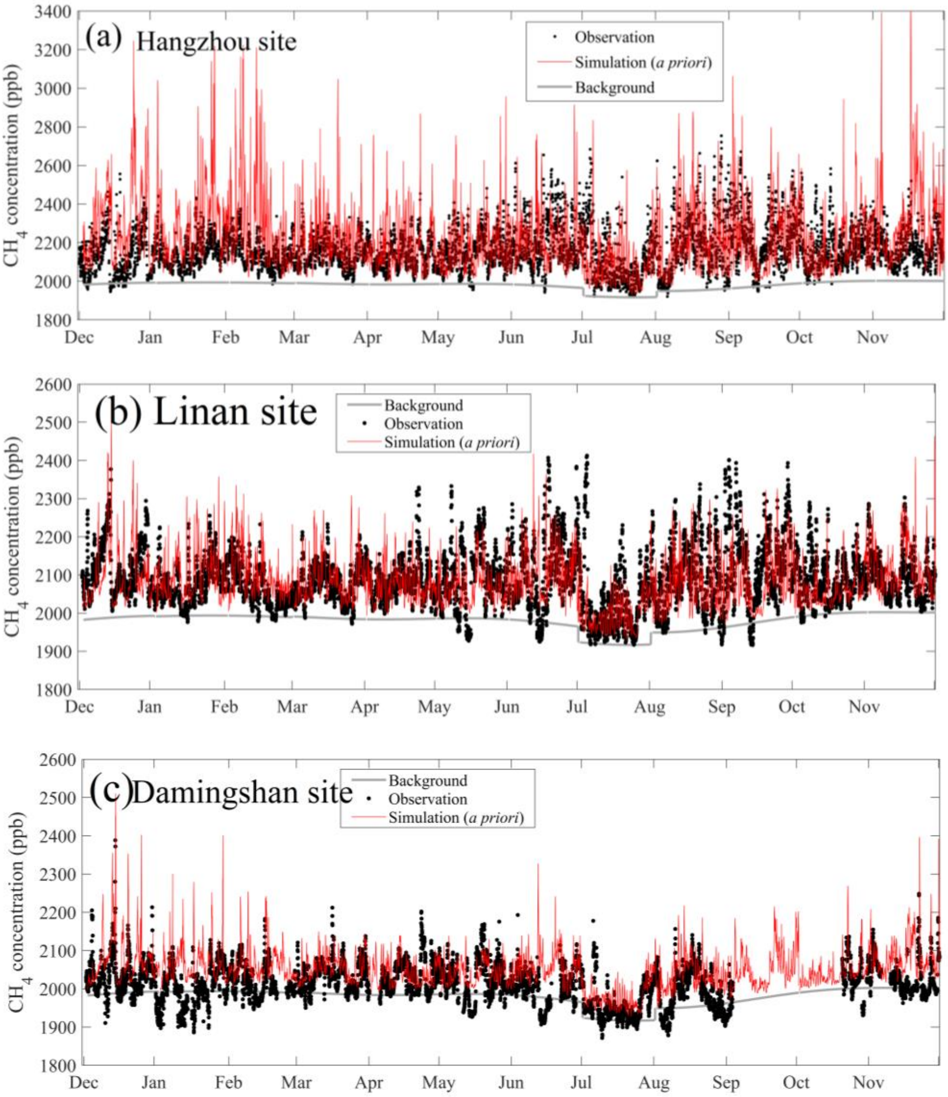

Figure S4. Comparisons between hourly CH_4 concentration simulations and observations at three sites.

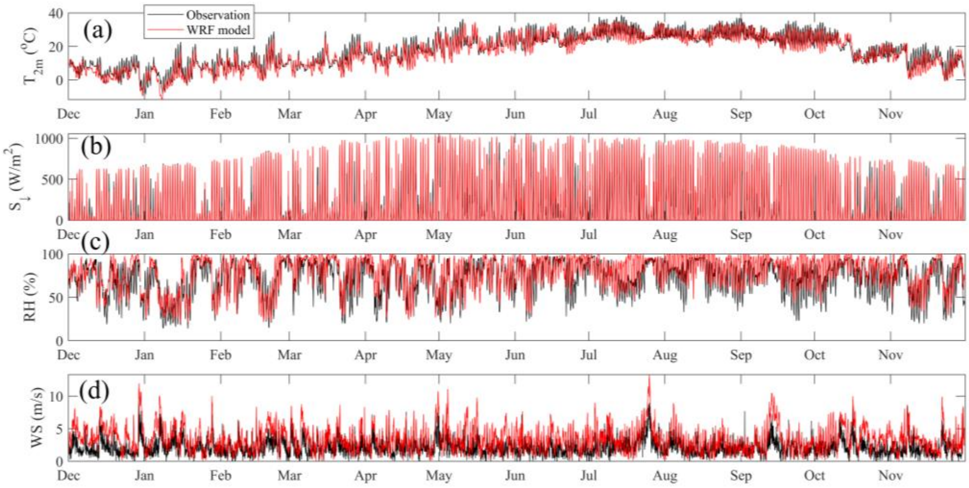

Figure S5. Comparisons between observed and simulated meteorological fields for air temperature at 2 m (T_{2m}), relative humidity (RH), downward solar radiation (S↓), and wind speed (WS) at 10 m height

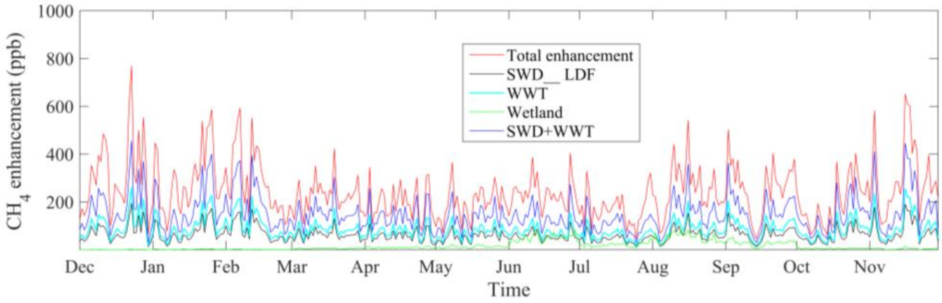

Figure S6. Daily variations of simulated CH_4 enhancements from different categories for Hangzhou site.

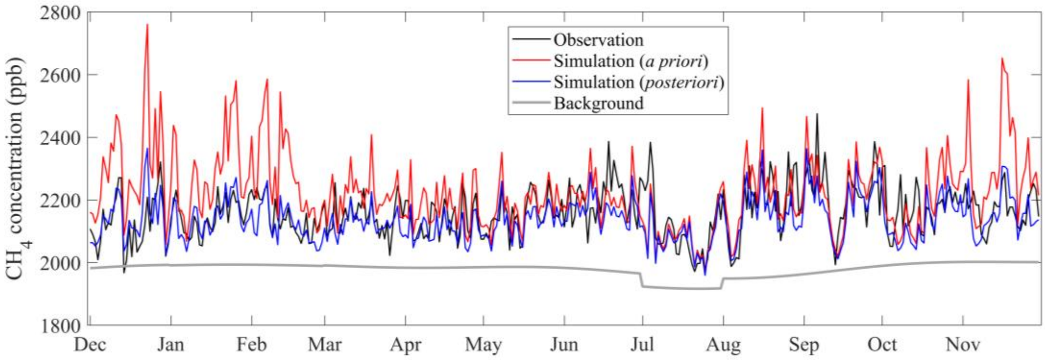

Figure S7. Daily CH_4 concentrations comparisons using both *a priori* and *posteriori* emissions.

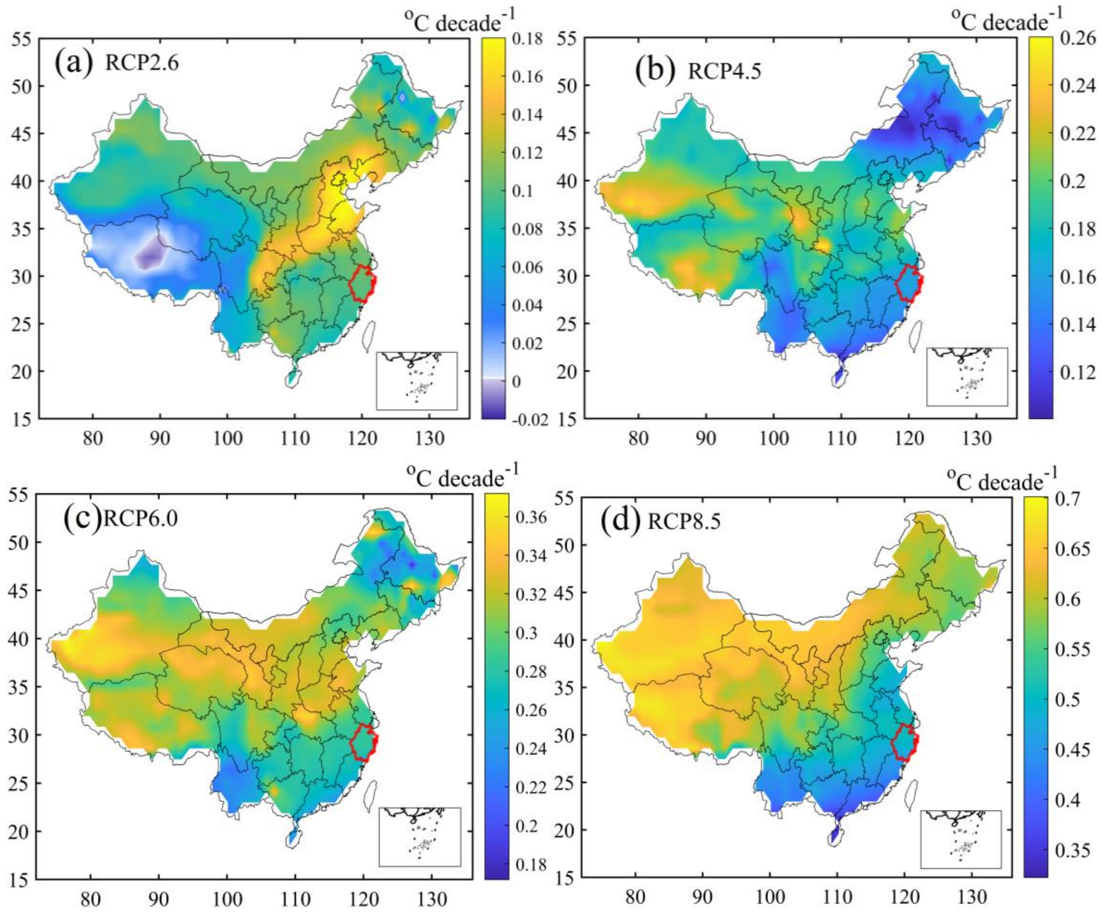

Figure S8. Spatial distributions of air temperature trends in China for (a) RCP2.6, (b) RCP4.5, (c) RCP6.0, and (d) RCP8.5 scenarios. Note the red boundary is Zhejiang province, and the trends represents years from 2020 to 2100.

Table S1. The choice of CH_4 background based on simulated monthly footprint, ‘Y’ indicates concentration at this background site (or averages of both) will be used as CH4 background for this month.

Sites	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov
TAP												
YON								Y				
RYO		Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
WLG												
UUM	Y	Y										

Table S2. Normalized monthly CH_4 SFs based on annual averages for waste treatment, note we calculate the normalized monthly SFs by dividing monthly SFs by annual averages.

Month	Case 1	Case 2	Case 3	Average(±STD)
1	0.59	0.64	0.72	0.65(±0.13)
2	0.40	0.49	0.54	0.48(±0.14)
3	0.79	0.87	0.83	0.83(±0.08)
4	0.93	0.91	0.88	0.91(±0.05)
5	1.25	1.21	1.17	1.21(±0.08)
6	1.19	1.21	1.15	1.18(±0.06)
7	1.78	1.66	1.60	1.68(±0.18)
8	1.25	1.25	1.21	1.24(±0.04)
9	1.43	1.38	1.33	1.38(±0.10)
10	1.21	1.15	1.12	1.16(±0.09)
11	0.55	0.60	0.67	0.61(±0.12)
12	0.63	0.62	0.77	0.67(±0.15)