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Quantify natural gas methane emissions from a city cluster in East China

Yuzhong Zhang¹, Yujia Zhao^{1,2}, Xinlu Wang^{1,2}, Rui Wang¹, Botian Qiu¹, Shuang Zhao¹, Yanli Zhang³, Zhengning Xu², Xiangyu Pei², Zhibin Wang², Youwen Sun⁴, Cheng Huang⁵, and Ying Zhou⁶

¹Westlake University, Hangzhou, China

²Zhejiang University, Hangzhou, China

³Guangzhou Institute of Geochemistry, Chinese Academy of Sciences, Guangzhou, China

⁴Anhui Institute of Optics and Fine Mechanics, HFIPS, Chinese Academy of Sciences, Hefei, China

⁵Shanghai Academy of Environmental Sciences, Shanghai, China

⁶Beijing University of Technology, Beijing

The consumption of natural gas in China, predominantly in cities, has nearly tripled over the past decade. However, there is an absence of measurement-based assessment of methane emissions from natural gas consumption in Chinese cities. Moreover, it is challenging to separate the contribution of natural gas relative to other major urban methane sources (e.g., wastewater, landfills) using only methane observations. Here, we use in-situ and total-column ethane observations across the Yangtze River Delta, one of China's most important metropolitan areas, between 2012 and 2021, to quantify methane emissions from the natural gas sector. Ethane is co-emitted with methane in natural gas and has no significant biogenic sources, and therefore serves as a tracer to separate the contribution of natural gas from other methane sources. To interpret ethane observations, we apply atmospheric chemical transport simulations with the GEOS-Chem model to account for transport, mixing, and chemical decay. Our analysis reveals that surface ethane concentrations have increased by 0.25–0.3 ppb a⁻¹ at city-cluster sites, in contrast to a stable global background concentration and a slightly negative trend in regional total-column measurements. The simulation indicates that a substantial natural gas leakage rate (2.5–4.1%) is required to replicate the observed trend. This leakage rate implies that natural gas consumption emits 0.55–0.9 Tg methane emissions annually in the Yangtze River Delta, accounting for about 5.1–8.4% of the regional total emissions. Our findings indicate that natural gas usage is a substantial contributor to methane emissions and their growth in East China.