西湖大學
WESTLAKE UNIVERSITY

A32A-03

Assessing China's Methane Emissions with Surface and Satellite Observations

Yuzhong Zhang[#*] (zhangyuzhong@westlake.edu.cn)

With:

Shuangxi Fang[#], Miao Liang*, Jianmeng Chen*, Yi Lin, Yuanyuan Chen, Ruosi Liang, Ke Jiang, Wanqi Sun, Robert Parker, Hartmut Boesch, Jian-Xiong Sheng, Xiao Lu, Shaojie Song, Shushi Peng

Group Website

Acknowledgement

Collaborators

Shuangxi Fang
Yi Lin, Yuanyuan Chen

Miao Liang
Wanqi Sun

Robert Parker,
Hartmut Boesch

Jian-Xiong Sheng (MIT), Xiao Lu (Sun Yat-sen),
Shaojie Song (Harvard), Shushi Peng (PKU),
Ruosi Liang (Westlake), Ke Jiang (Westlake)

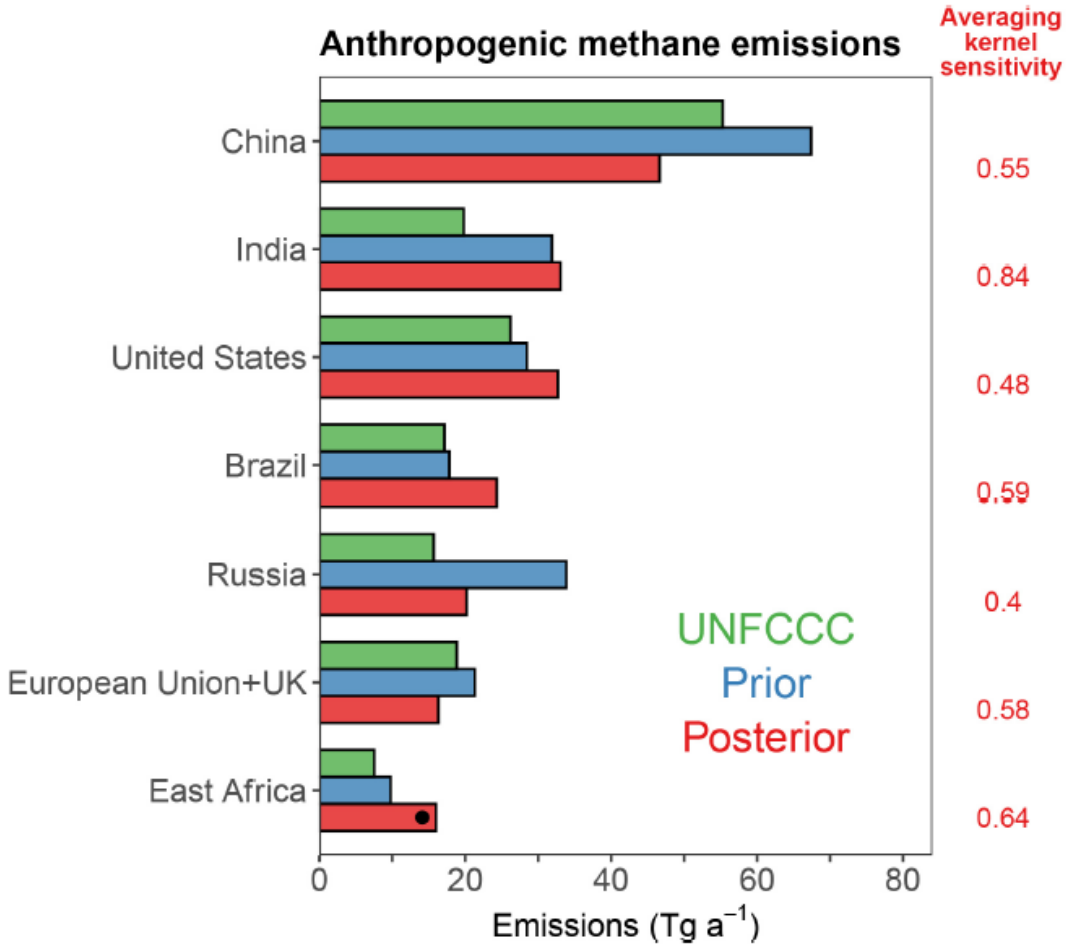
Funding

Ministry of Science and Technology of China National Key Research and Development Program of China (2020YFA0607502)

National Natural Science Foundation of China Project 42007198

Methane emissions in China

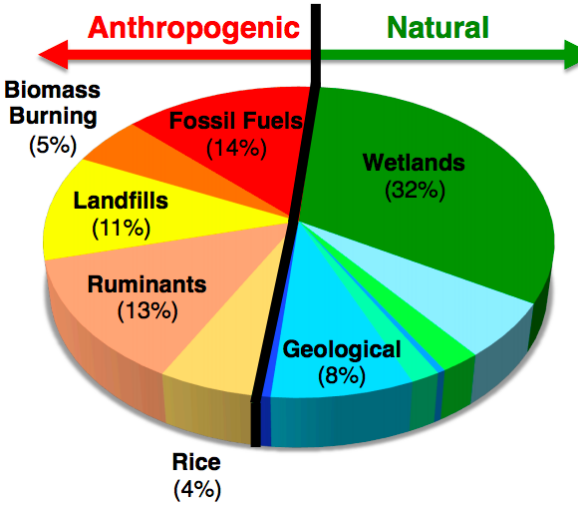
Country with the largest anthropogenic emissions



Zhang et al. (2021)

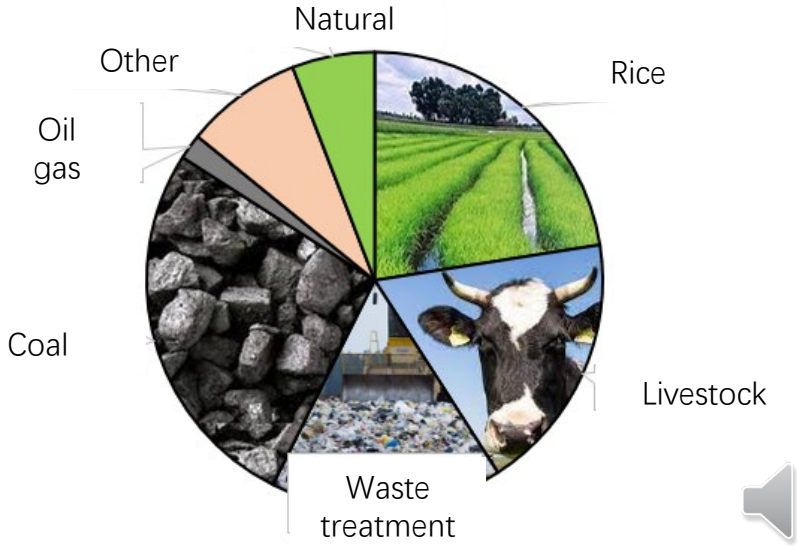
World

~ 550 Tg a^{-1}



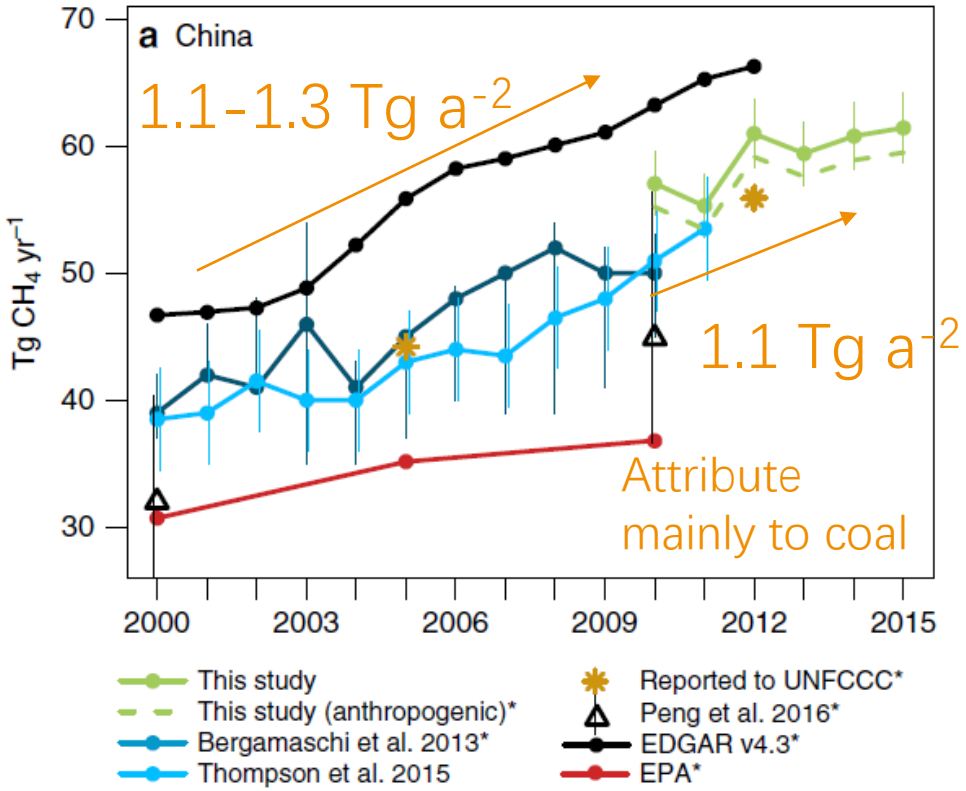
China

~ 55 Tg a^{-1}



Trends in China's methane emissions

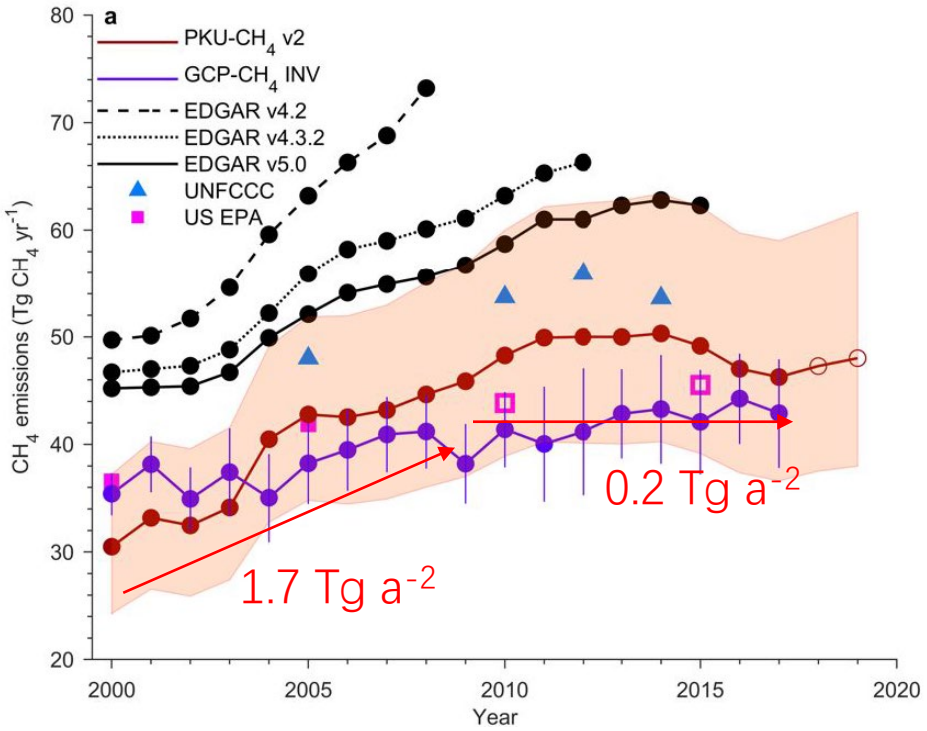
Satellite inversion



Miller et al., 2019

Coarse resolution
Inaccurate prior sectoral distribution

Bottom-up inventory



Liu et al., 2021

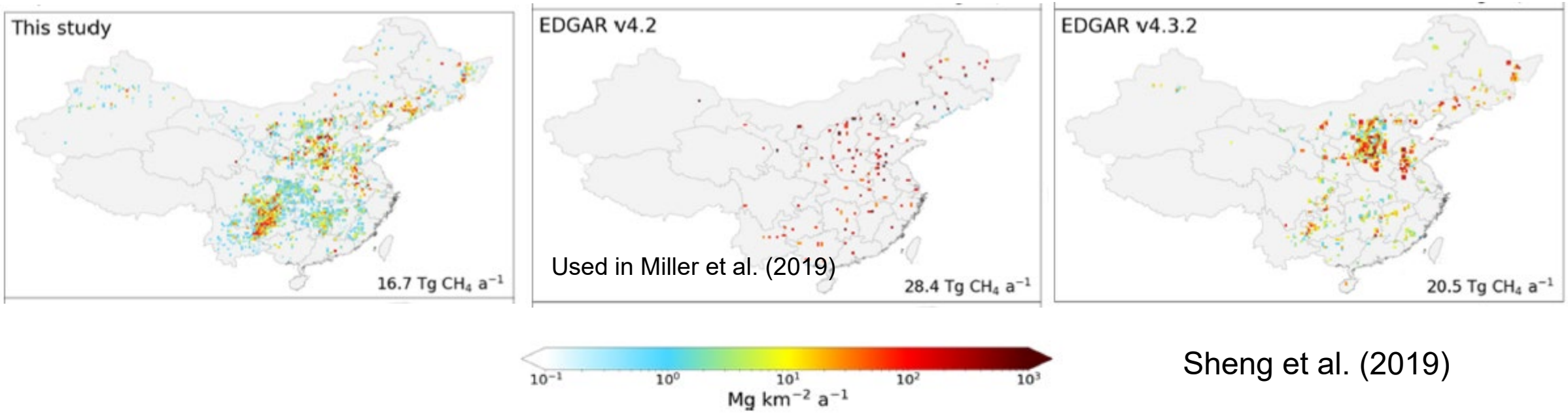
Provincial-level activity data

Changes may not be accounted for in the bottom-up inventories

Uncertainty in sectoral distribution

Affect inference of methane fluxes as well as sector attribution

Distribution of coal mine emissions from different bottom-up inventories



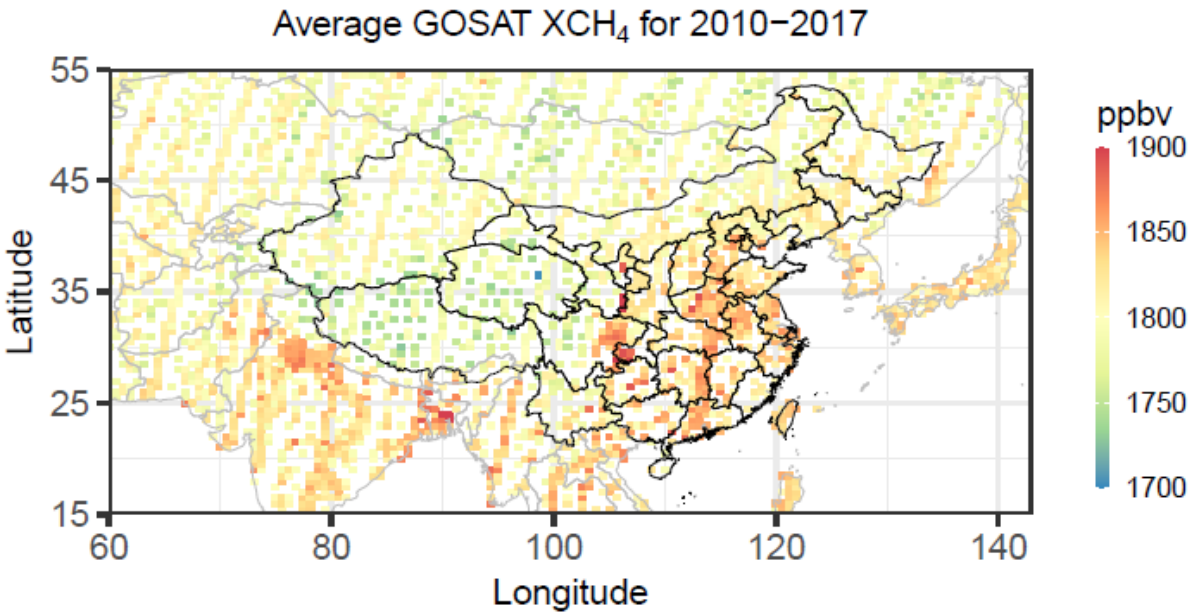
Sheng et al. (2019)

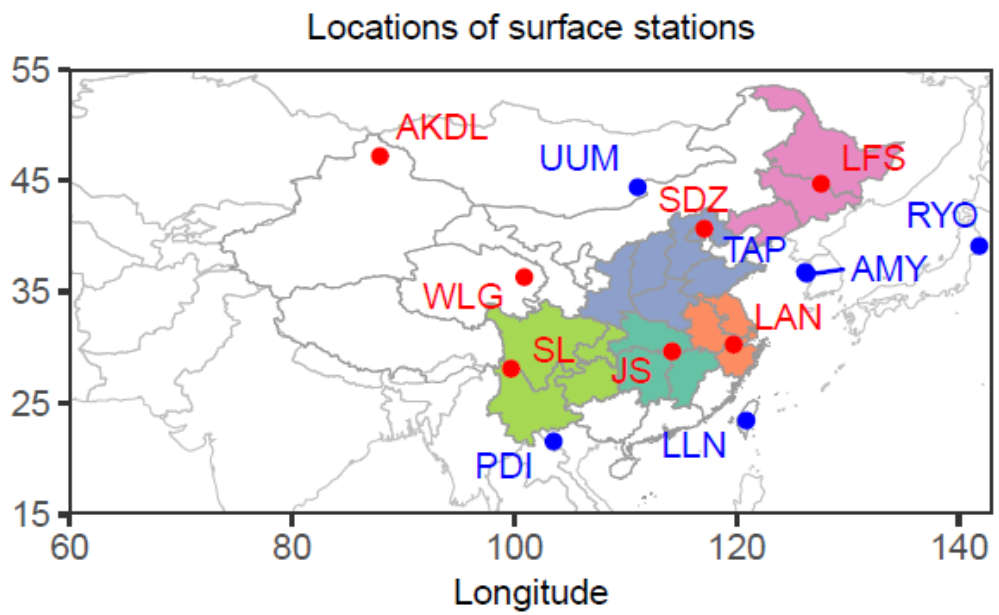
Sheng et al. (2021) derived a trend (0.4 Tg a^{-2}) smaller than Miller et al. (2019) (1.1 Tg a^{-2})

Joint inversion of satellite & surface observations

Observations – satellite + surface network **(2010-2017)**

- GOSAT CO_2 proxy retrieval from University of Leicester
- Surface observation ◆ Mainland China – CMA 7 sites ◆ Surrounding area – WDCGG 6 sites





Better spatial coverage

Better measurement precision
Better sensitivity to surface emissions

Zhang et al. in prep

Joint inversion of satellite & surface observations

Bottom-up estimates

Multiple anthropogenic emission inventories are used as prior for (sensitivity) inversions to explore uncertainties

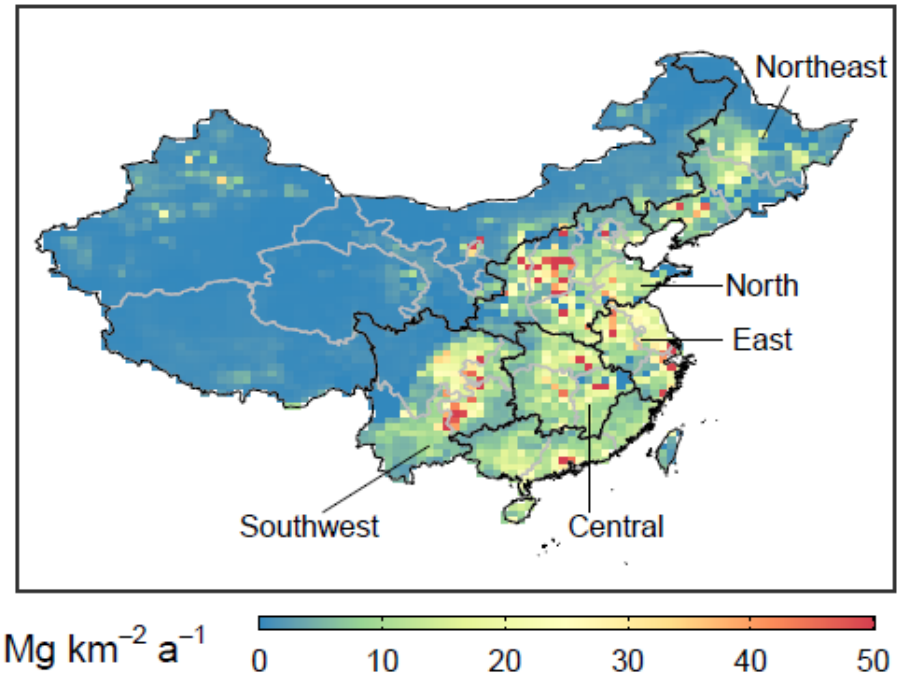
Name	Anthropogenic emissions	Emissions (Tg a^{-1})	Trend (Tg a^{-2})
E1	EDGAR v4.3.2 for 2012, except for coal (Sheng et al., 2019)	59	0
E2	PKU 2010-2017	49	-0.3
E3	EDGAR v5.0 2010-2015	60	+0.4
E4	CEDS v2021-04-21	51	+0.2

Natural emissions are not perturbed in the ensemble

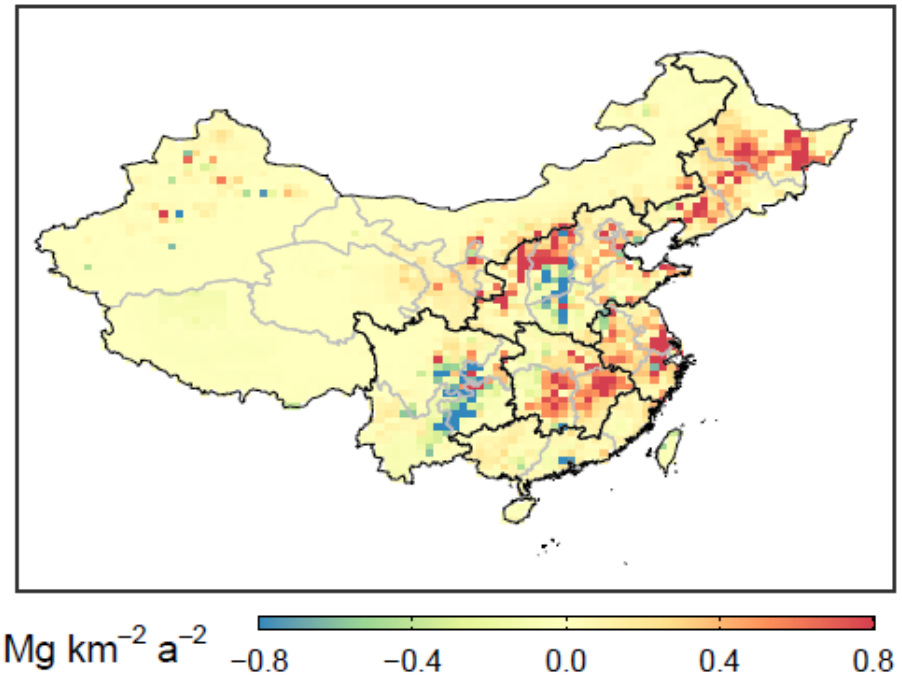
Natural Emissions	Wetland	WETCHARTs
	Biomass burning	GFED4
	Geological seeps	Maasakkers et al.
	Termites	Fung et al.

China’s methane emissions and emission trends

2010–2017 mean methane emissions



2010–2017 methane emission trends

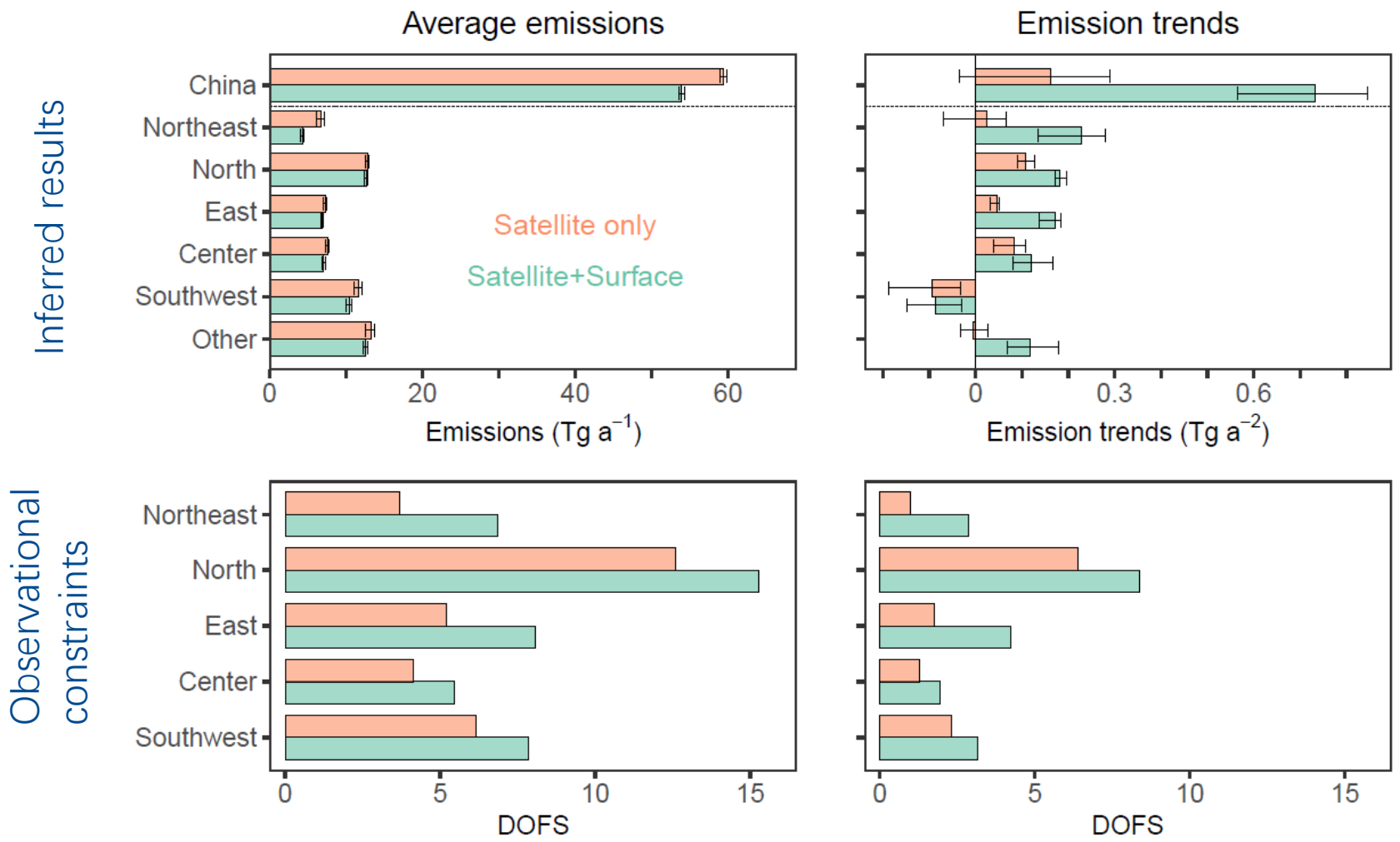


National sum 55 Tg a^{-1} 0.7 Tg a^{-2}

Zhang et al. in prep

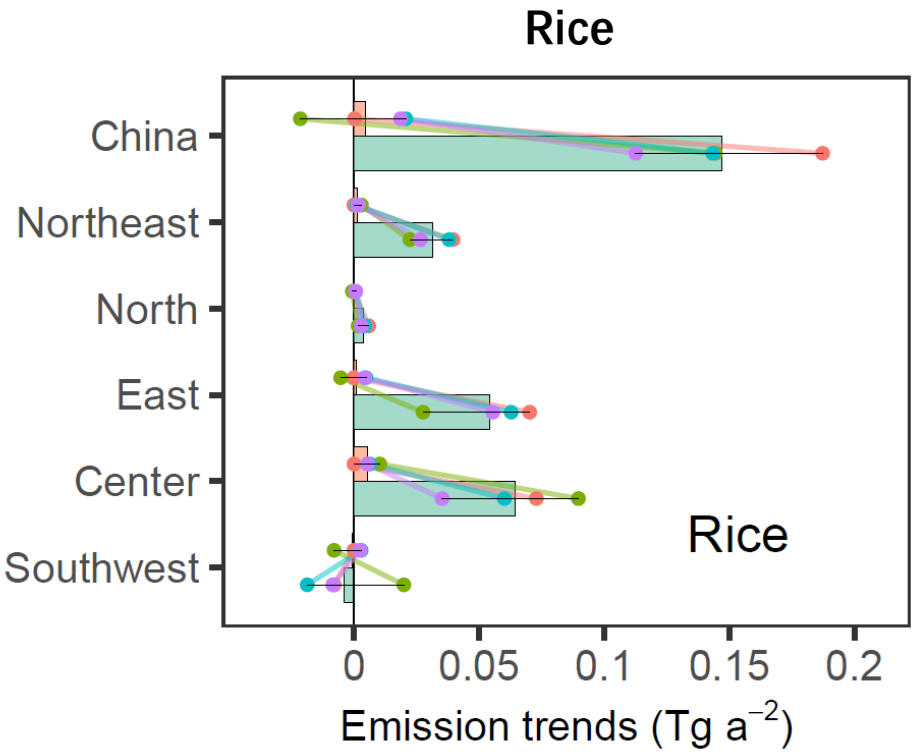
Added value of surface observations

Surface observations provide additional constraints, particularly over South, East and Northeast China

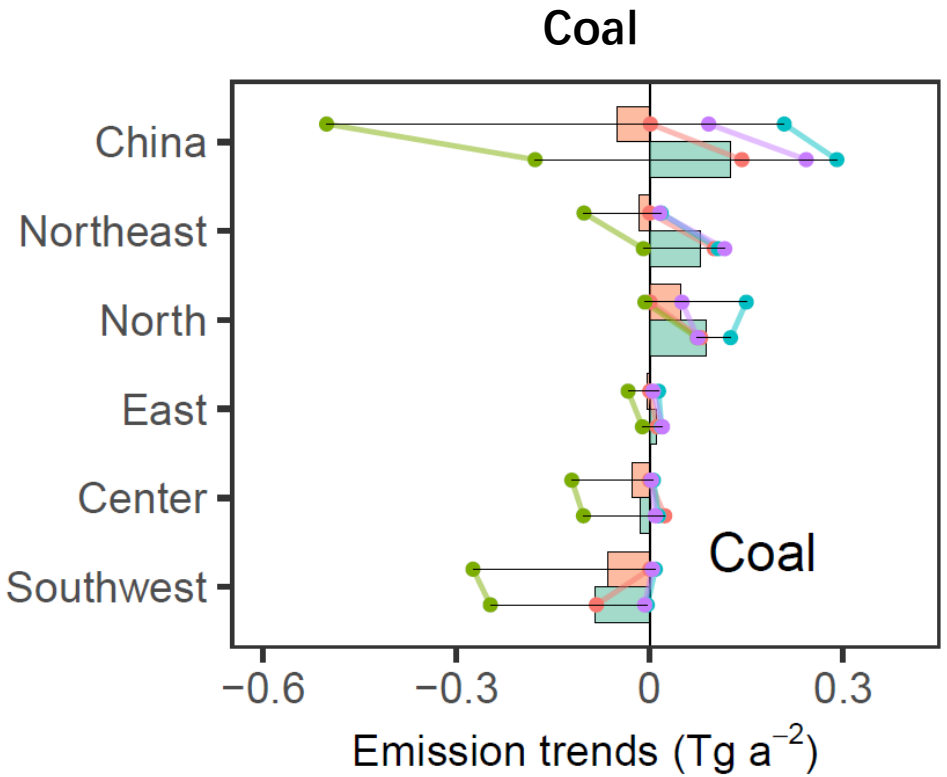


Sectoral attribution of inferred trends, 2010-2017

Unexpected increase in rice cultivation regions



Uncertain & regionally divergent trends from coal



Prior Posterior

Prior inventory E1 E2 E3 E4

Compare inversion of GOSAT and TROPOMI data

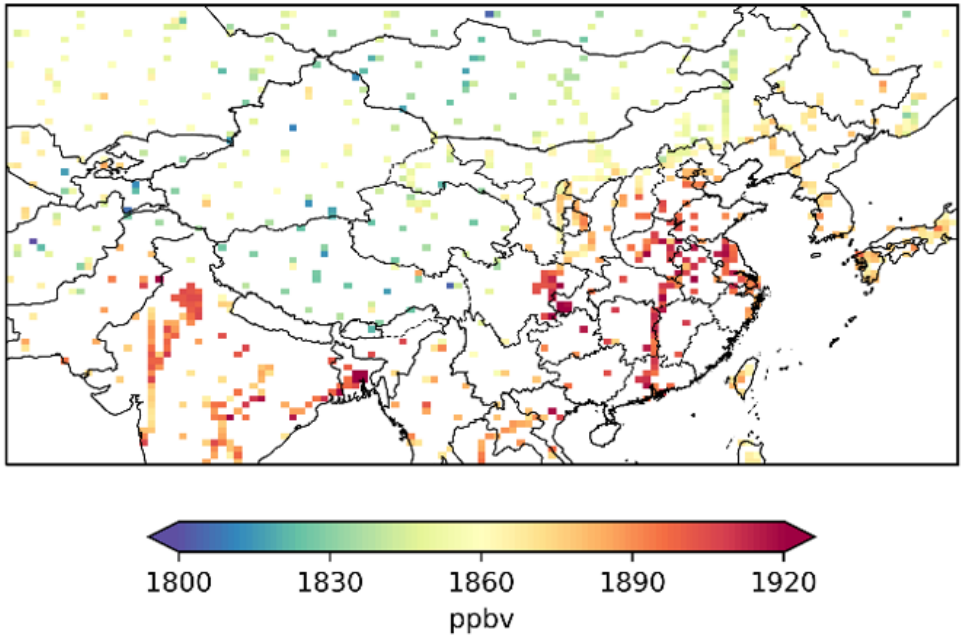
Ruosi Liang

Do TROPOMI and GOSAT provide consistent inversion results?

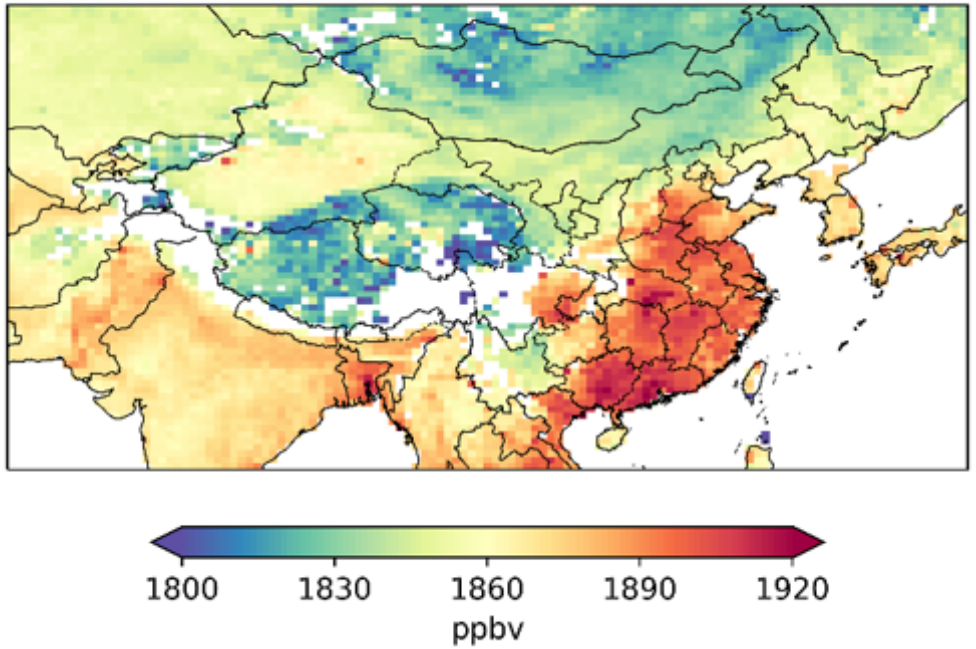
How does the TROPOMI bias correction affect emission inference?

Does TROPOMI help resolve finer spatial distribution?

Mean GOSAT methane in 2019



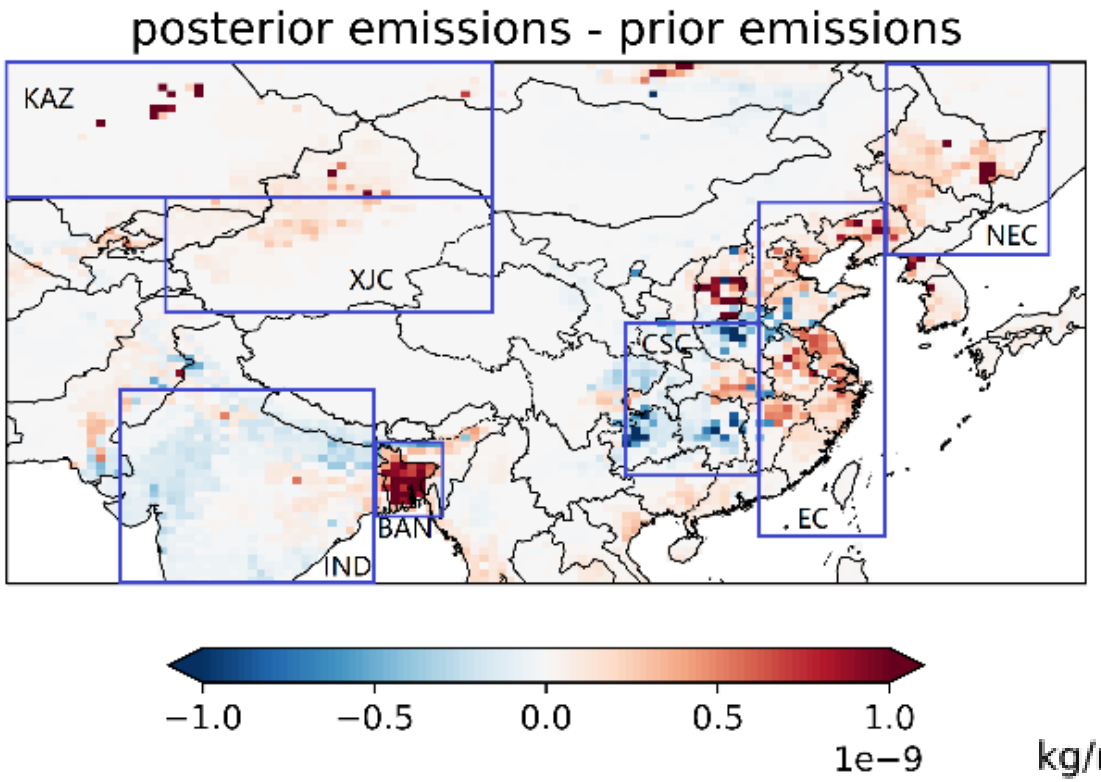
Mean bias corrected TROPOMI methane in 2019



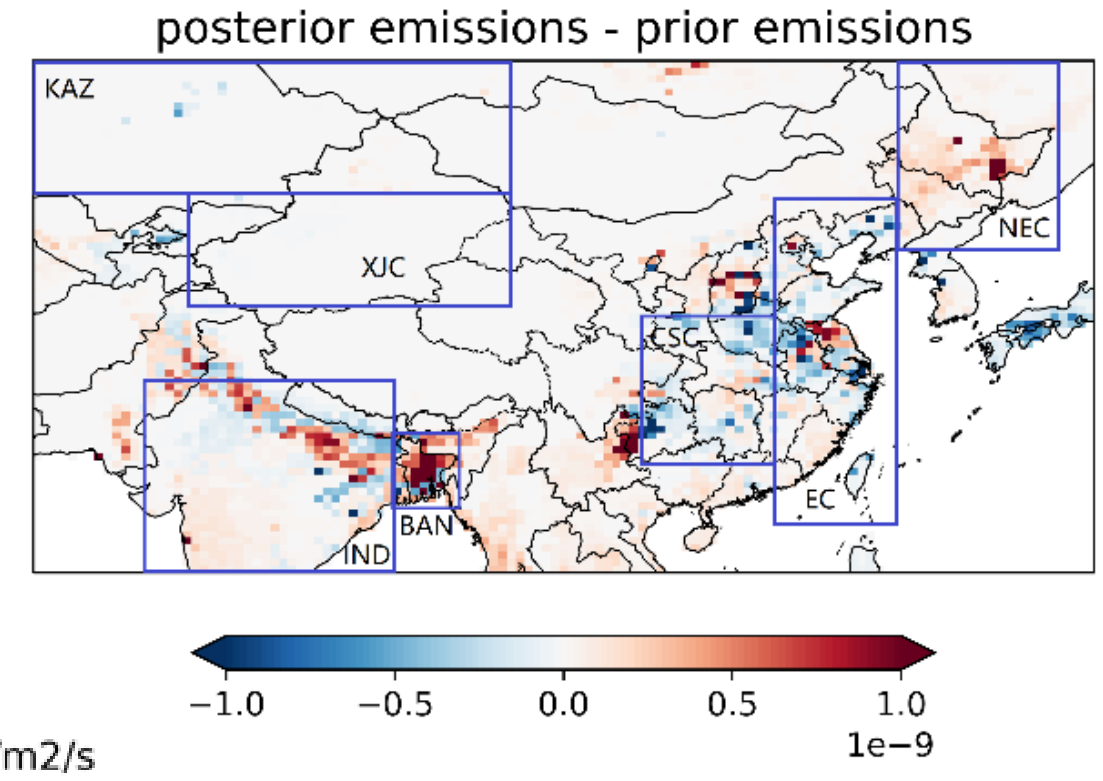
Liang et al., in prep.

Comparison of inversion results

Inversion TROPOMI



Inversion GOSAT



kg/m2/s

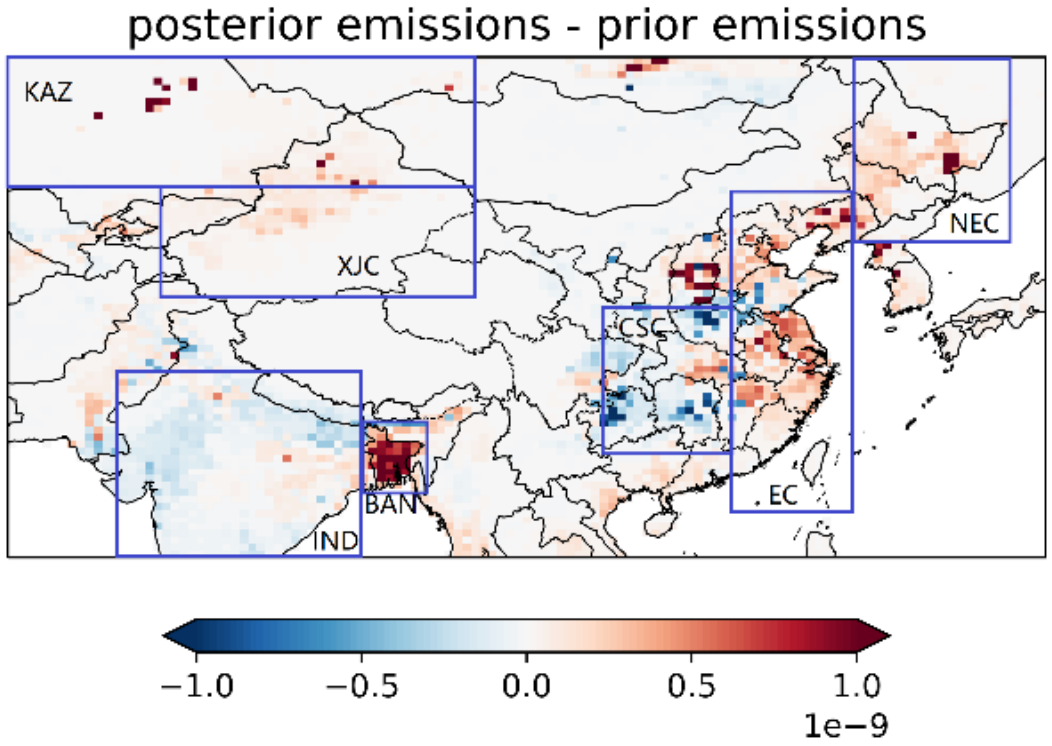
Consistent: NEC, CSC, BAN

Inconsistent: KAZ, XJC, IND, EC

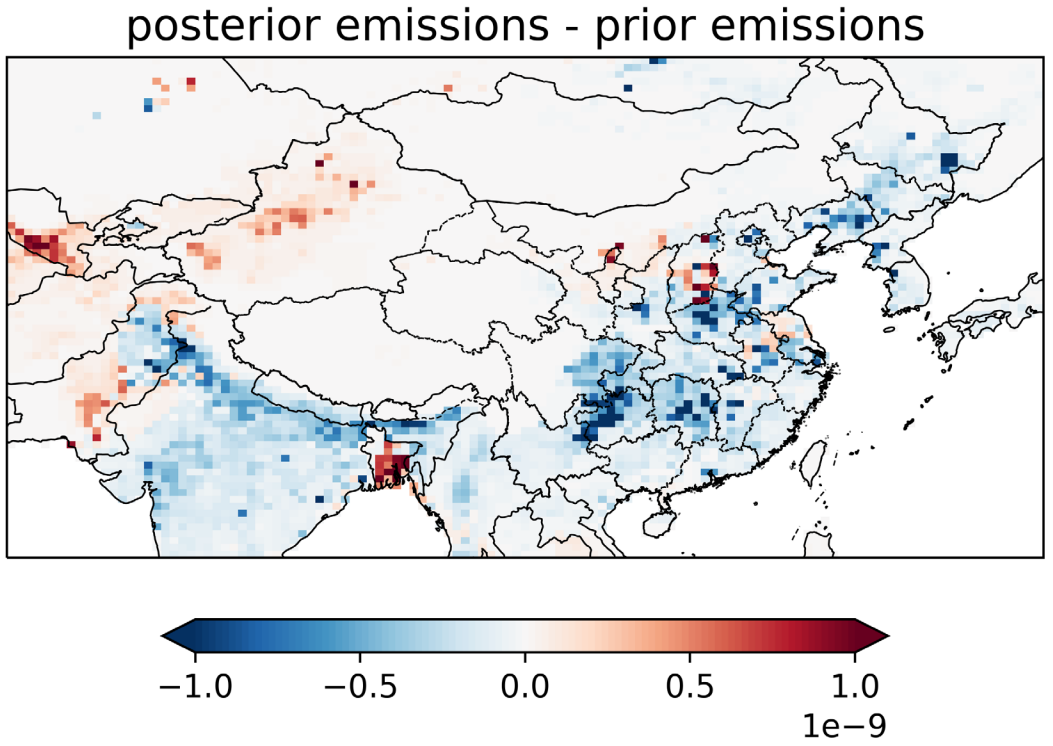
Impact of post bias correction for TROPOMI inversion

Inversion T1 (bias-corrected)

Lorente et al.



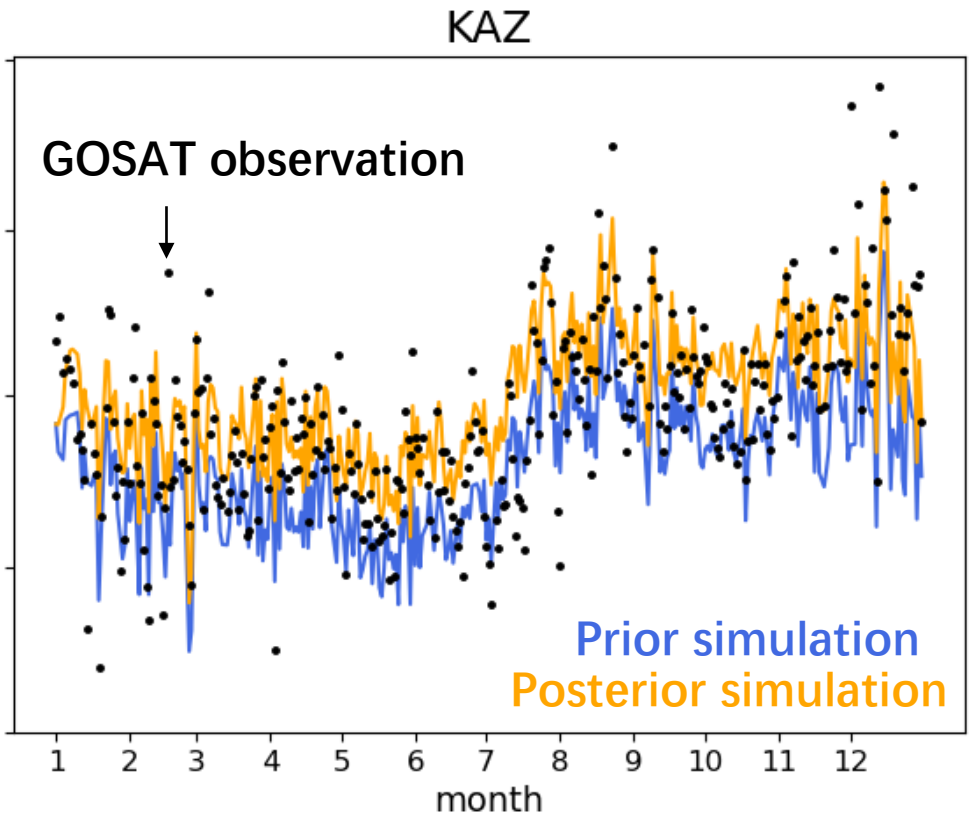
Inversion T4 (un-corrected)



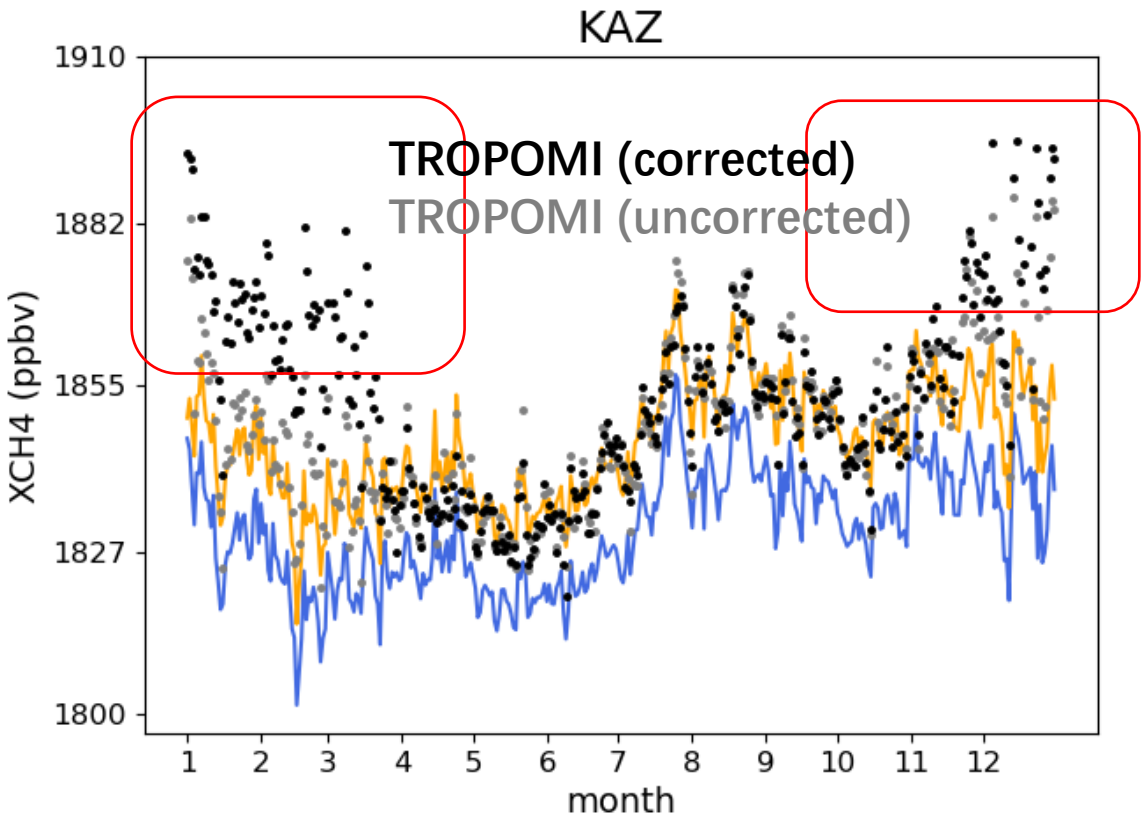
kg/m2/s

Comparison of inversion results: KAZ

Inversion GOSAT



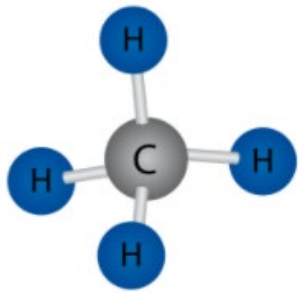
Inversion TROPOMI



There appears to be other factors that needs to be included in the bias correction

西湖大學 WESTLAKE UNIVERSITY

Summary



- Joint inversion of surface and satellite data to infer China's methane emissions during 2010-2017.
- Surface observations add more information to satellite data, especially over southern and northeastern China.
- Unexpected increase in rice cultivation regions; uncertain & divergent trends from the coal sector.
- TROPOMI and GOSAT inversions show generally consistent correction patterns though with varied details