



Supplement of

Leveraging TROPOMI observations and WRF-GHG modeling towards improving methane emission assessments in India

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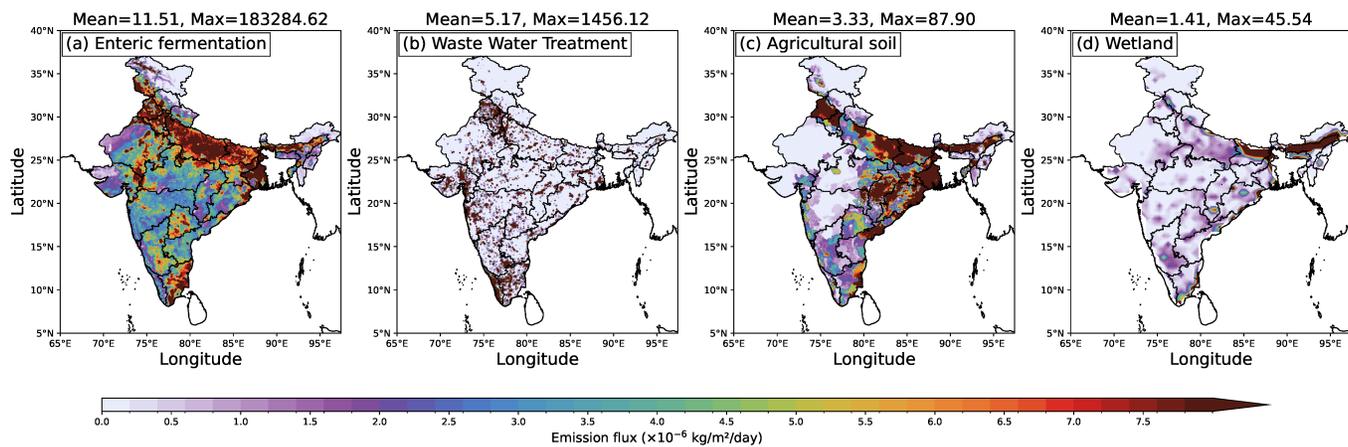


Figure S1. Spatial distribution of annual CH₄ emissions from (a) Enteric Fermentation, (b) Waste Water Treatment, (c) Agriculture soil, and (d) Wetlands for 2018. See Fig. 1 for region-wise delineation.

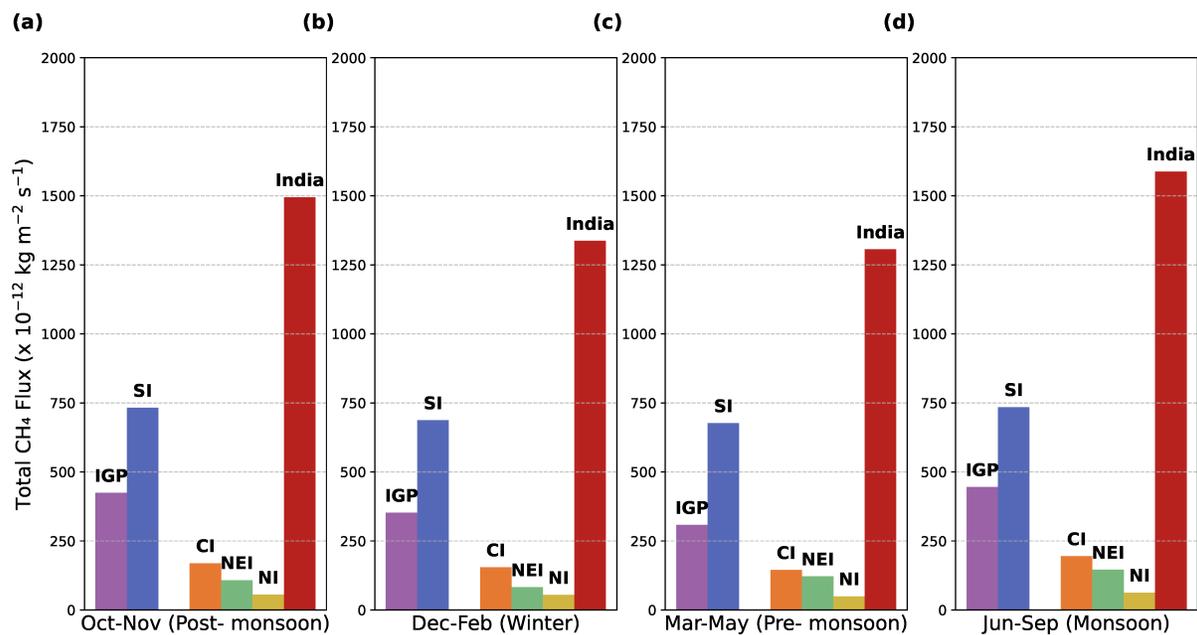


Figure S2. Total of wetland, biomass burning and anthropogenic seasonal fluxes from bottom-up inventory data.

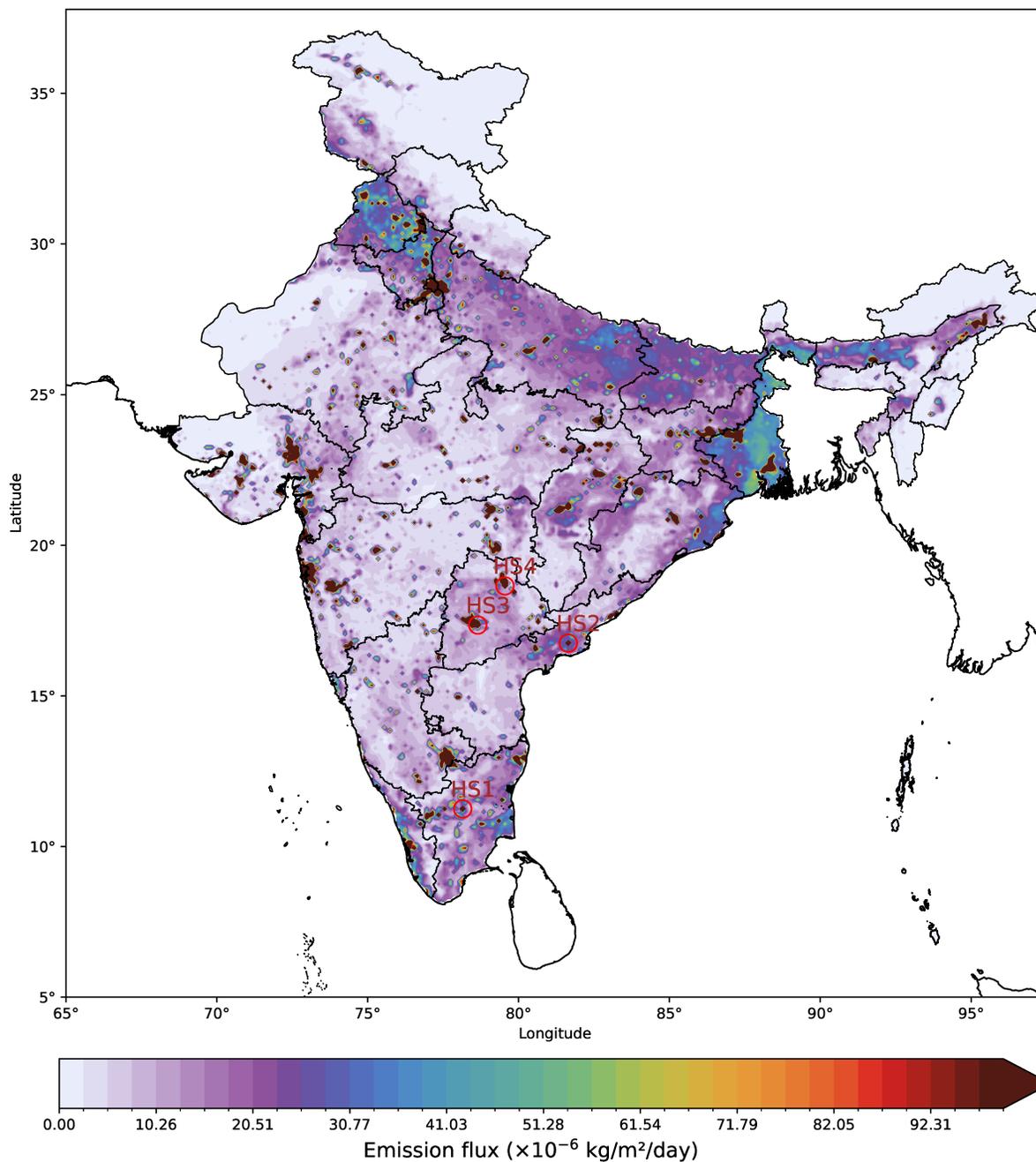


Figure S3. Spatial distribution of CH₄ emission hotspots from annual total anthropogenic flux over SI from EDGAR inventory 2018 data.

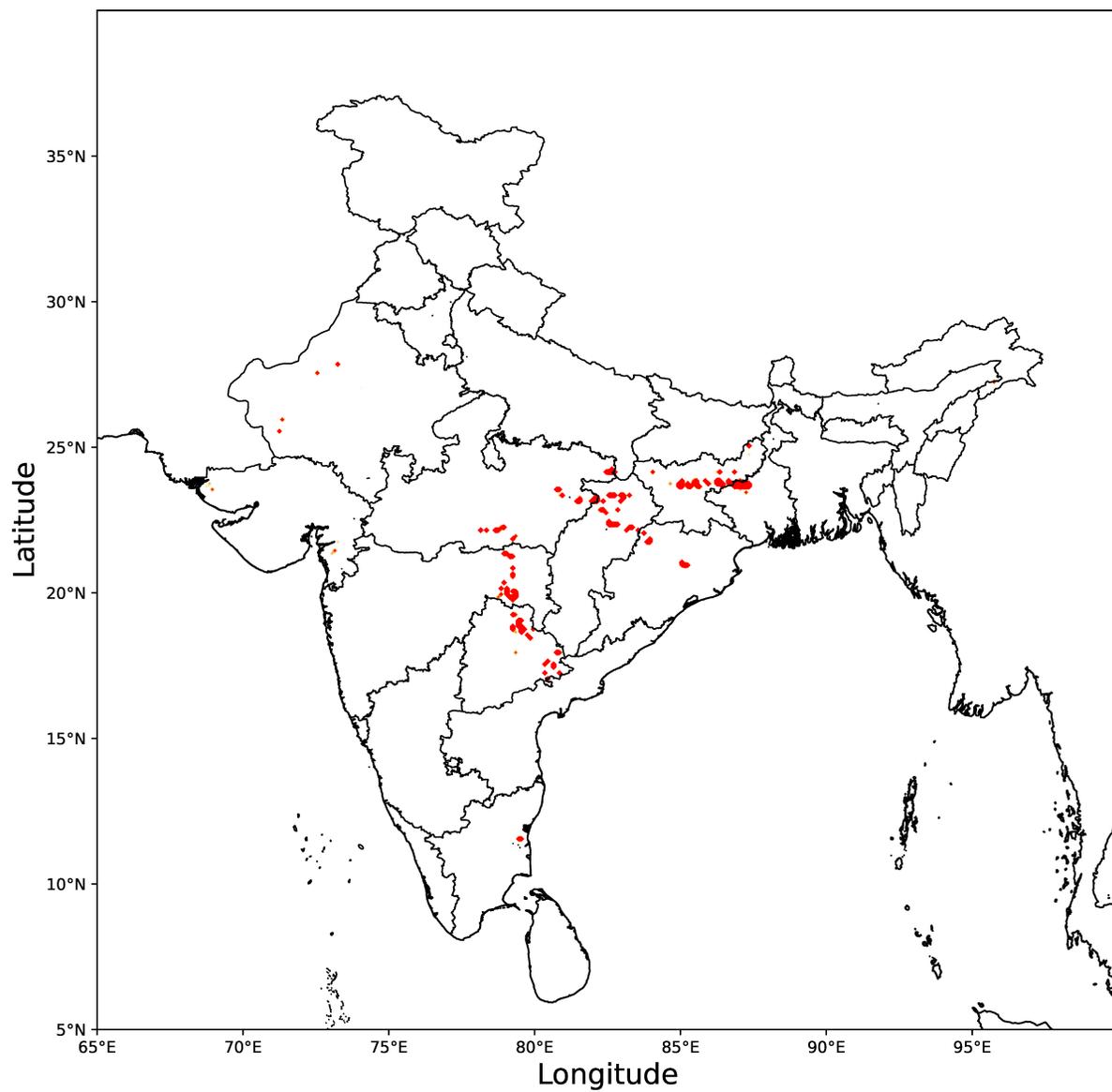


Figure S4. Spatial distribution of CH₄ emission hotspots from coal mines over India from EDGAR inventory 2018 data.

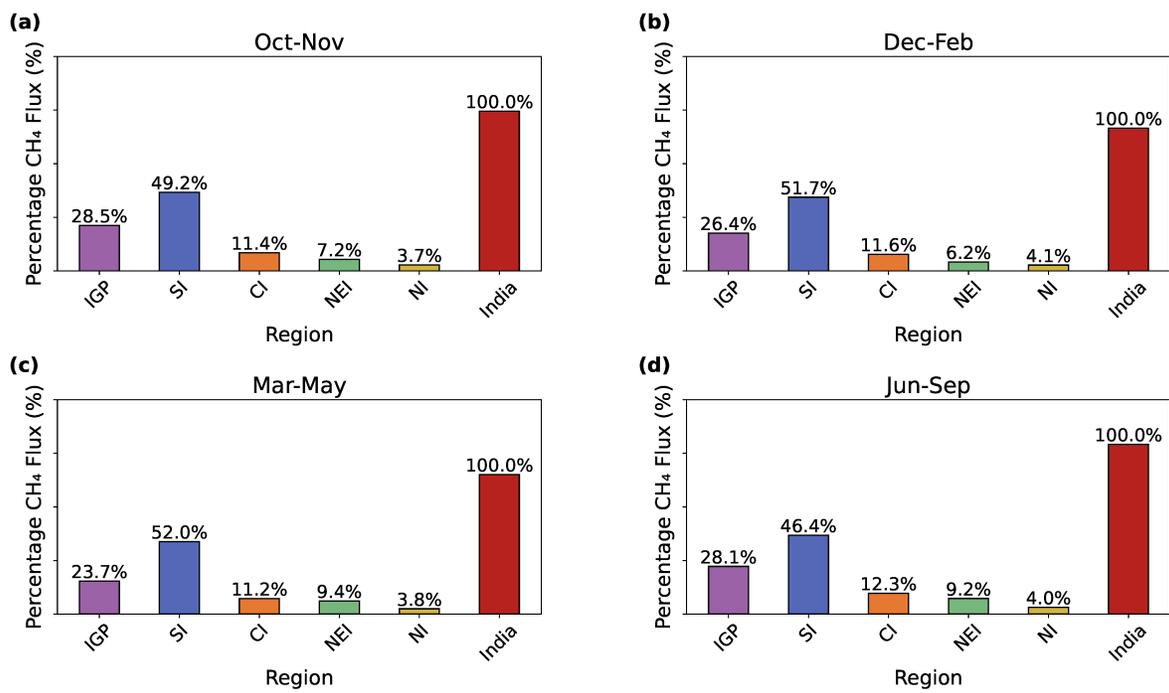


Figure S5. Percentage contribution of seasonal fluxes from bottom-up inventory data.

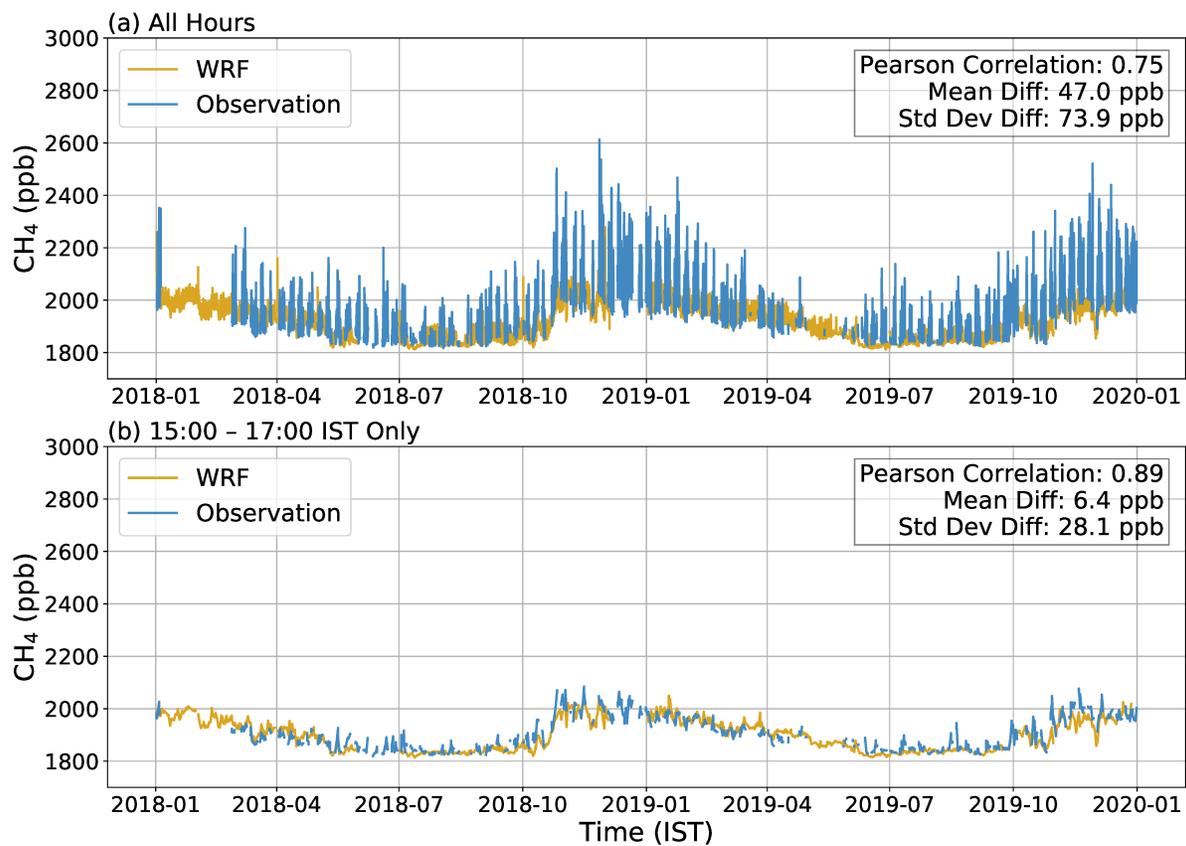


Figure S6. Comparison of the temporal distribution of observed and WRF-GHG simulated CH₄ at Thumba (see the site location as denoted in Fig. 1 for (a) all hours and (b) 15:00 -17:00 IST only).

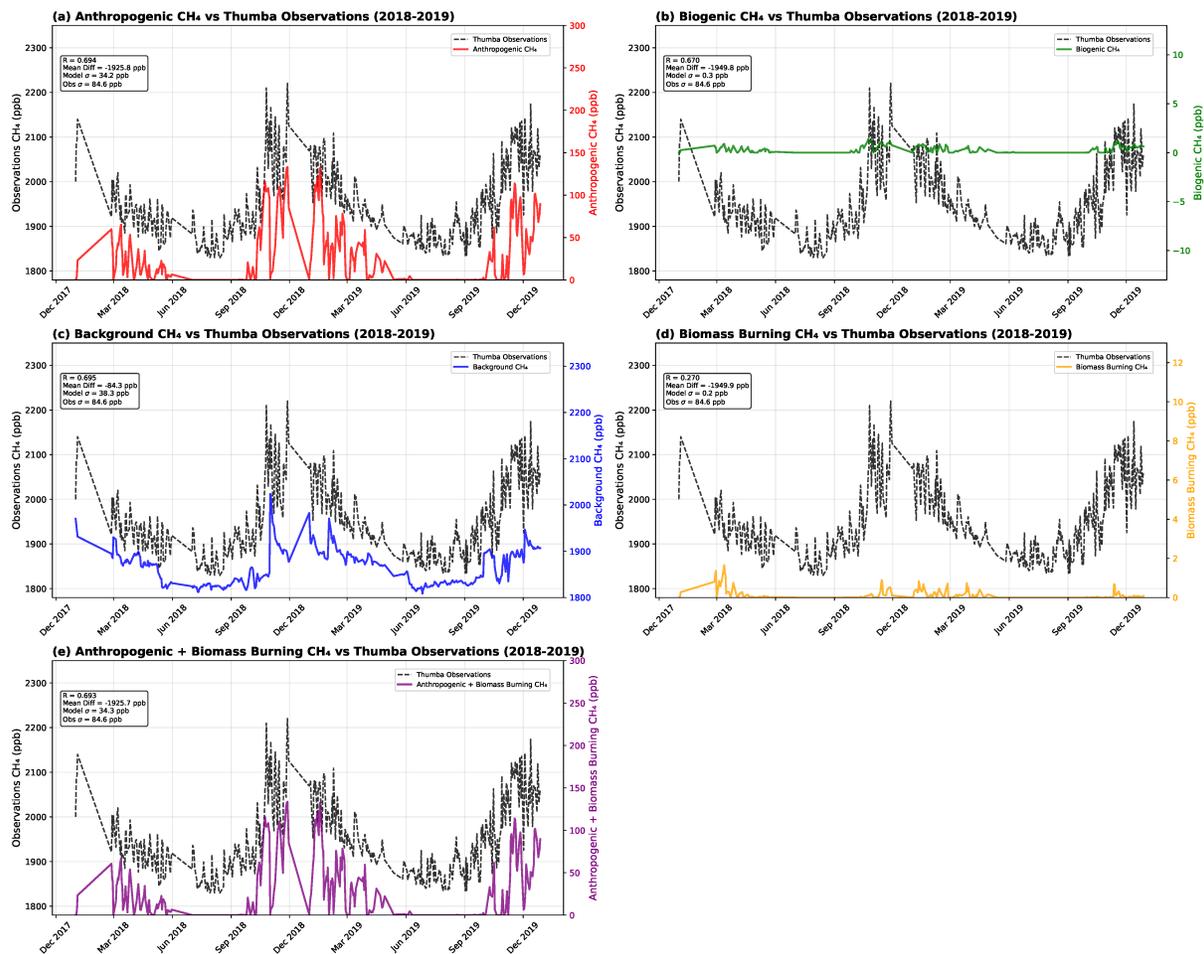


Figure S7. Comparison of the time series of observed and component-wise WRF-GHG simulated CH₄ at Thumba (see the site location as denoted in Fig. 1).

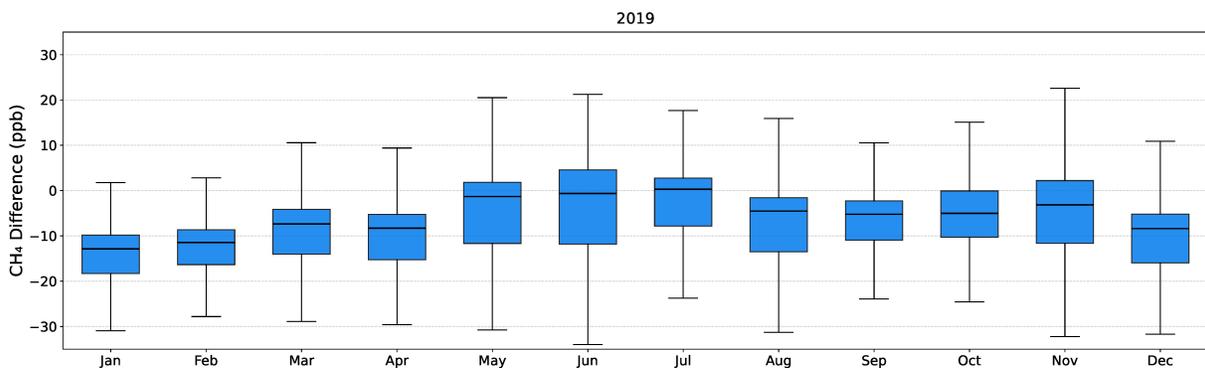


Figure S8. Difference in CAMS EEG4 (reanalysis) and the latest version (data not available for 2018) of inversion optimised dataset (using satellite+ surface-air sampled data) for 2019.

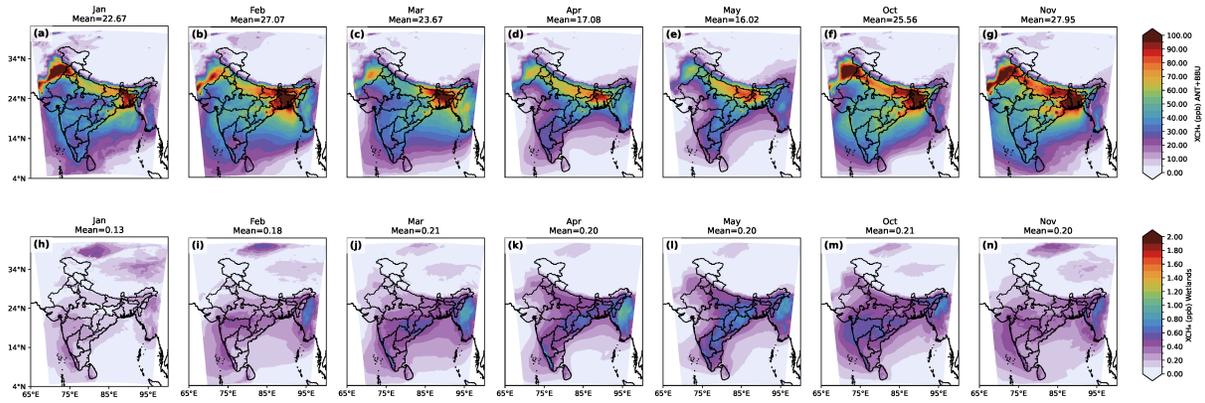


Figure S9. Spatial distribution for WRF-GHG simulated XCH_4 from (a)-(g) anthropogenic + biomass burning and (h)-(n) wetland (biogenic) sources for different months of 2018. The months that are omitted in Fig. 7 are removed here also.

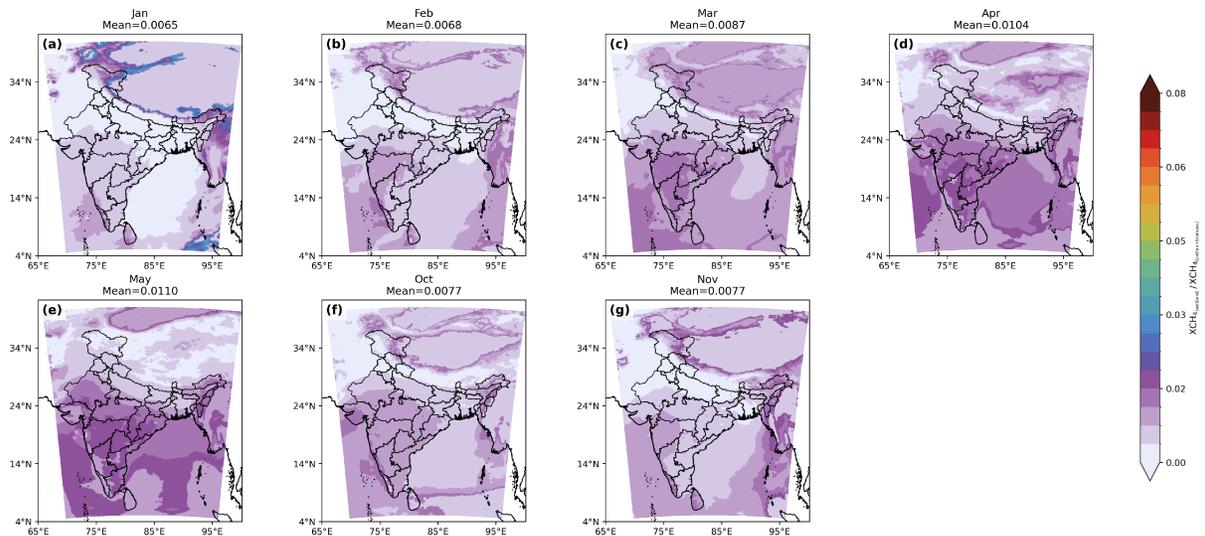


Figure S10. The ratio of simulated XCH_4 contributed from wetland to that from anthropogenic and biomass burning sources (i.e. $XCH_4(\text{wetland})/XCH_4(\text{anthro+biomass})$) for different months of 2018. The months that are omitted in Fig. 7 are excluded here as well.

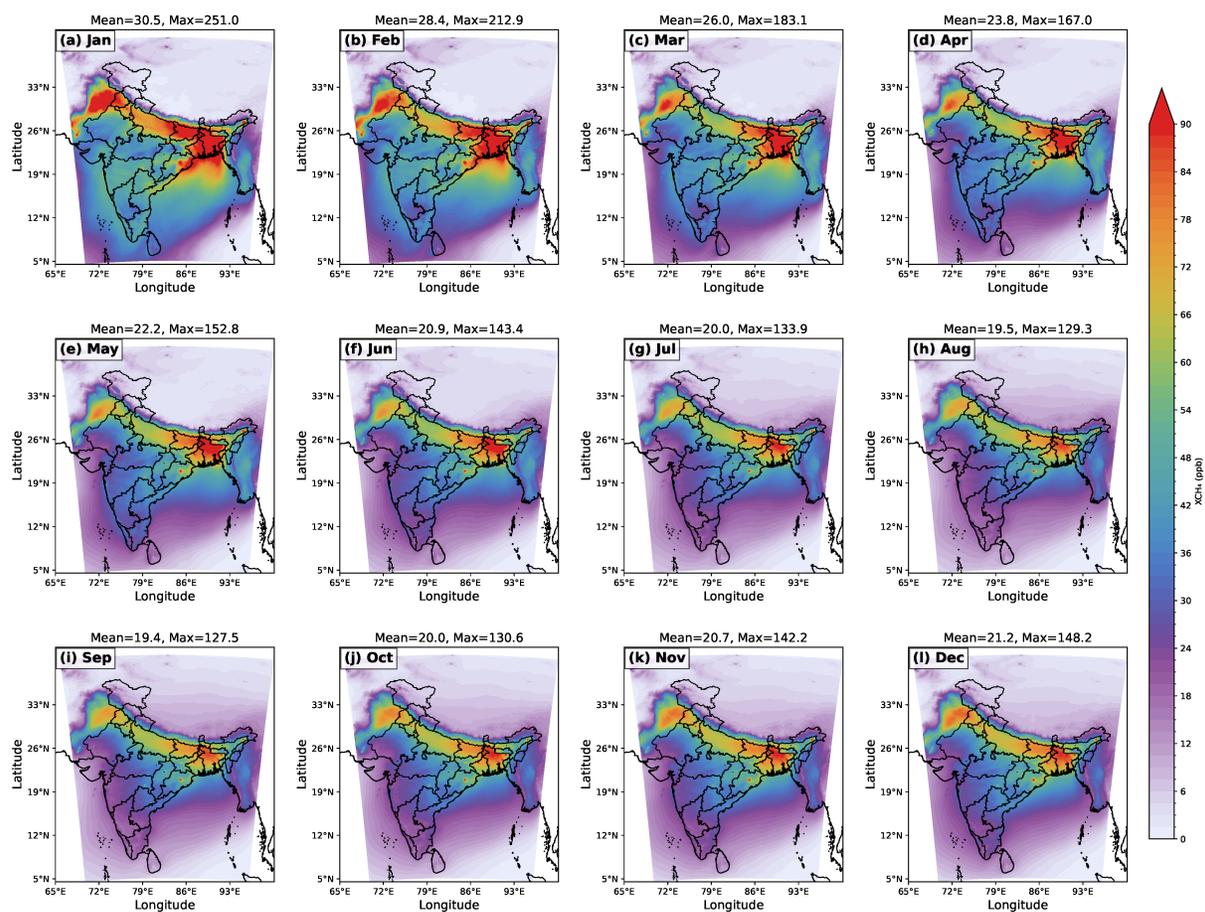


Figure S11. Spatial distribution for WRF-GHG simulated anthropogenic mixing ratio enhancement of XCH₄ (including biomass burning), separated for each month of 2018.

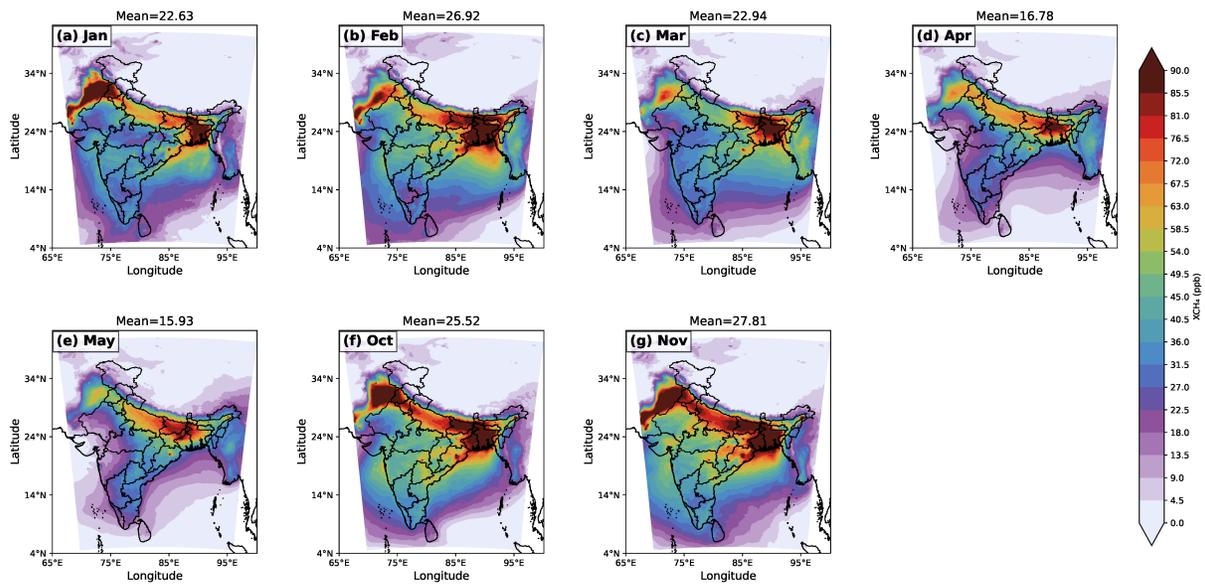


Figure S12. Spatial distribution of WRF-GHG simulated XCH₄ from anthropogenic sources for different months of 2018. The months that are omitted in Fig. 7 are removed here also.

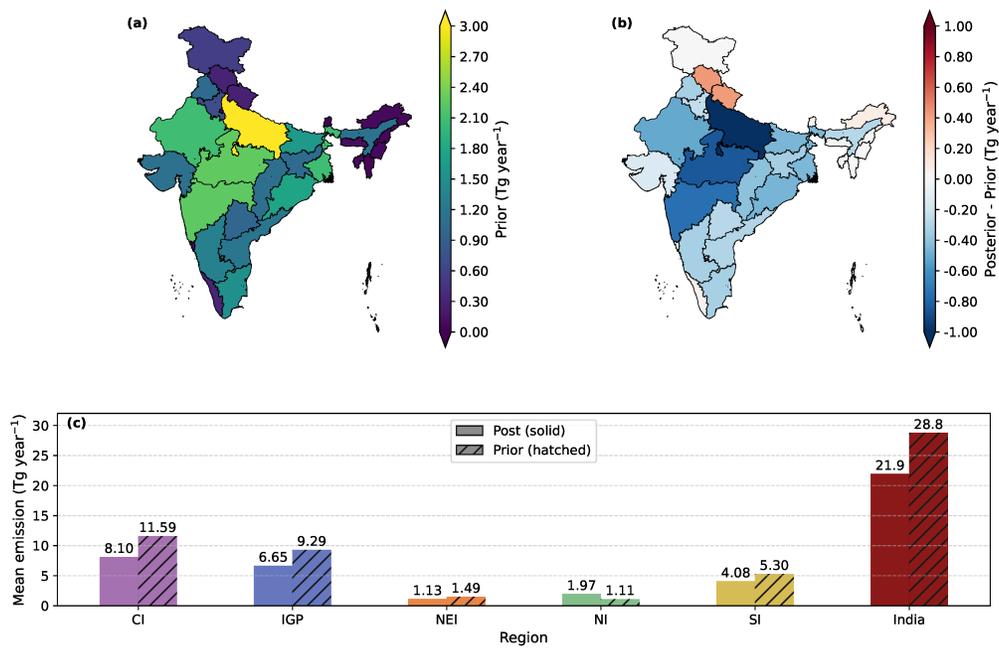


Figure S13. State-wise anthropogenic (a) prior and (b) flux adjustments (posterior *minus* prior) and (c) region-wise annual prior and posterior emission fluxes averaged for 2019.

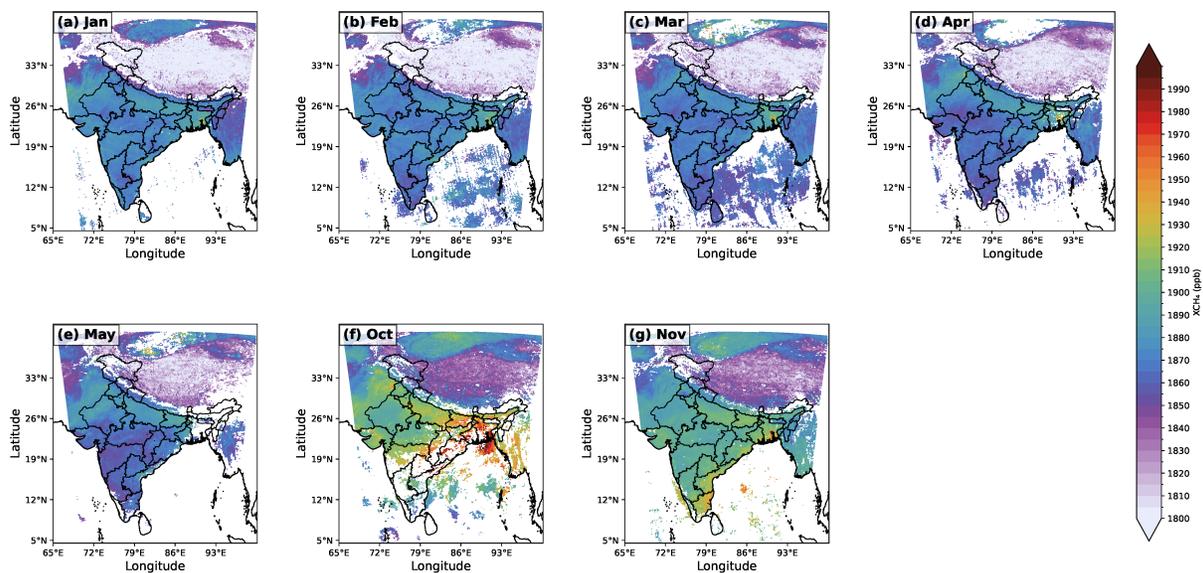


Figure S14. Spatial distribution of the TROPOMI (WFMD) retrievals of XCH₄ for different months of 2019. Some months are omitted due to poor data coverage caused by filtering based on cloud pixels.

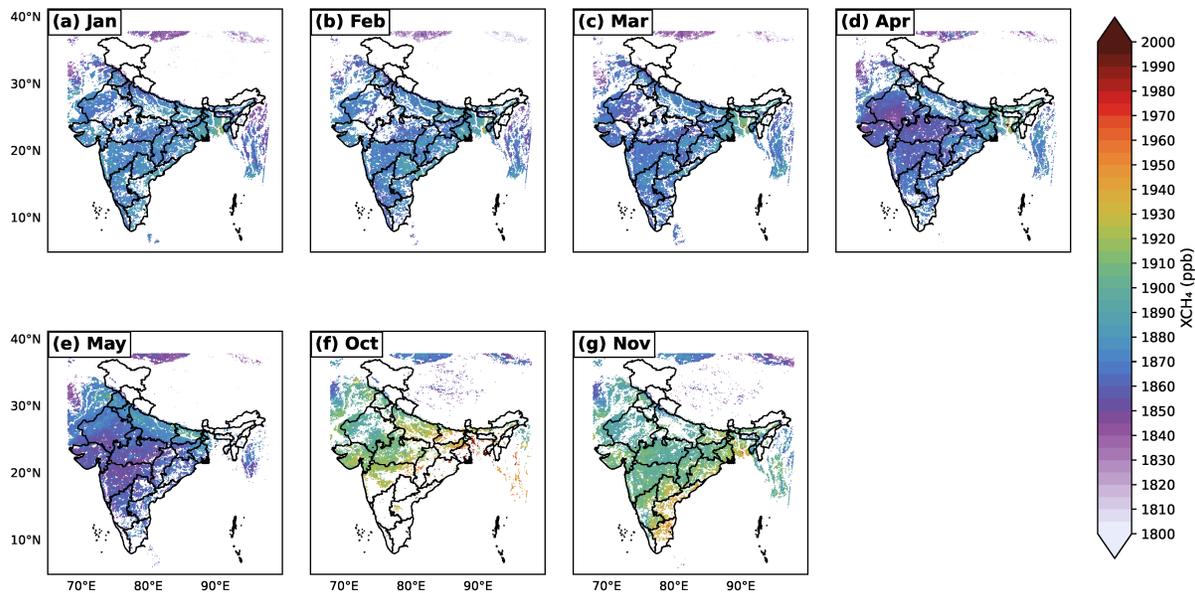


Figure S15. Spatial distribution of the TROPOMI (Operational) retrievals of XCH₄ for different months of 2019. Some months are omitted due to poor data coverage caused by filtering based on cloud pixels.

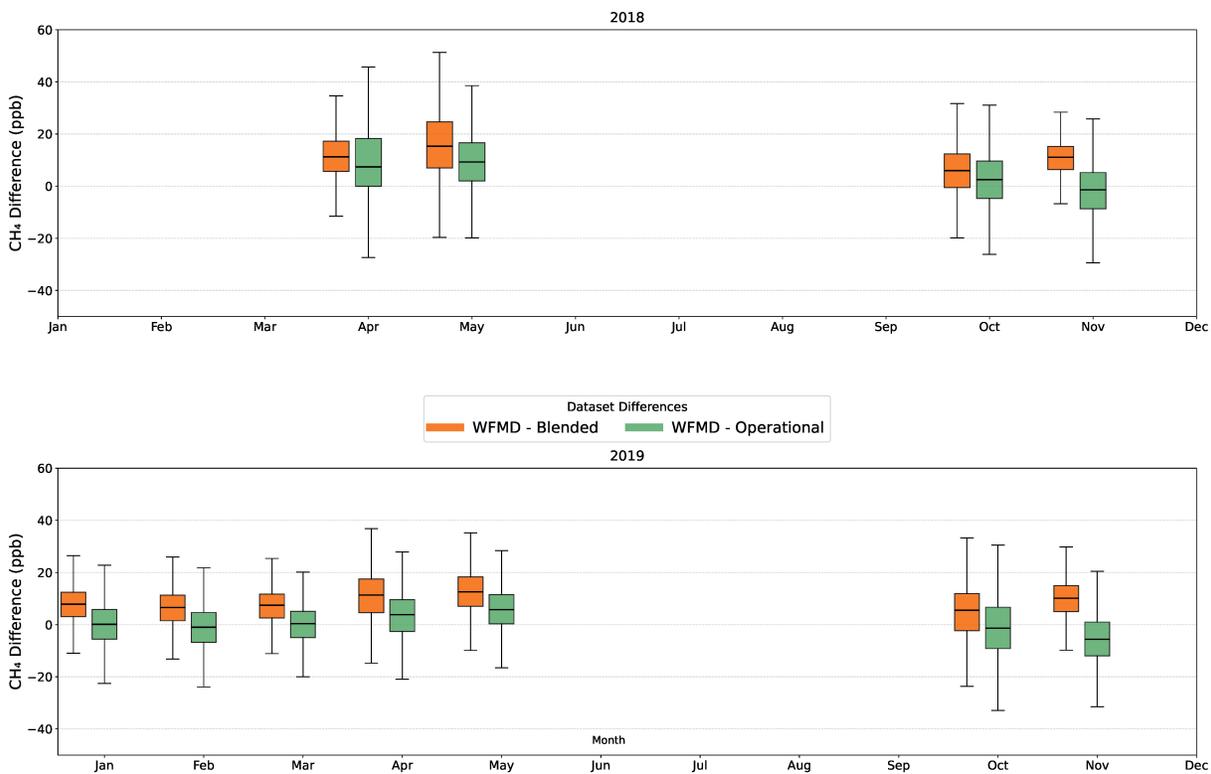


Figure S16. Differences between TROPOMI XCH₄ products (WFMD - blended and WFMD - Operational).

2018			
Month	Tropomi (Mean ± Std Dev)	WRF (Mean ± Std Dev)	Diff (Mean ± Std Dev)
January	1840.13 ± 36.65	1853.17 ± 34.51	-13.03 ± 28.47
February	1840.36 ± 36.06	1867.55 ± 39.89	-27.19 ± 36.68
March	1843.38 ± 32.54	1847.02 ± 49.70	-3.64 ± 40.90
April	1842.35 ± 29.73	1845.95 ± 36.25	-3.60 ± 35.33
May	1845.25 ± 29.71	1842.90 ± 25.10	2.35 ± 27.08
October	1870.58 ± 36.64	1819.10 ± 62.17	51.48 ± 64.00
November	1862.90 ± 31.60	1883.23 ± 41.55	-20.33 ± 29.53
2019			
Month	Tropomi (Mean ± Std Dev)	WRF (Mean ± Std Dev)	Diff (Mean ± Std Dev)
January	1847.95 ± 36.20	1876.88 ± 31.89	-28.93 ± 24.07
February	1848.04 ± 35.55	1864.56 ± 39.45	-16.53 ± 41.86
March	1851.30 ± 29.22	1858.26 ± 43.92	-6.96 ± 43.19
April	1849.99 ± 29.41	1850.17 ± 46.89	-0.18 ± 43.62
May	1852.43 ± 27.48	1857.51 ± 20.12	-5.08 ± 24.73
October	1883.78 ± 37.68	1862.82 ± 54.45	20.97 ± 46.29
November	1876.14 ± 31.91	1873.91 ± 52.02	2.23 ± 46.68

Table S1. The observed and modeled monthly mean XCH₄ and their difference (in ppb) over the entire study domain for 2018 and 2019.