



Supplement of

Towards monitoring the CO₂ source–sink distribution over India via inverse modelling: quantifying the fine-scale spatiotemporal variability in the atmospheric CO₂ mole fraction

Vishnu Thilakan et al.

Correspondence to: Dhanyalekshmi Pillai (dhanya@iiserb.ac.in, kdhanya@bgc-jena.mpg.de)

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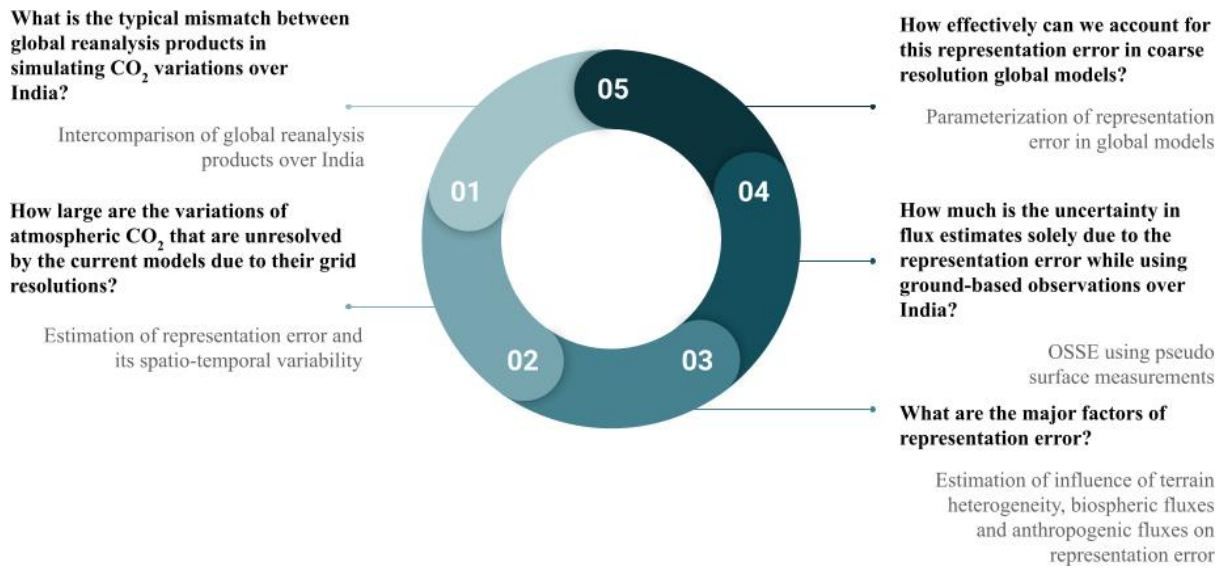


Figure S1: The research workflow employed in the study.

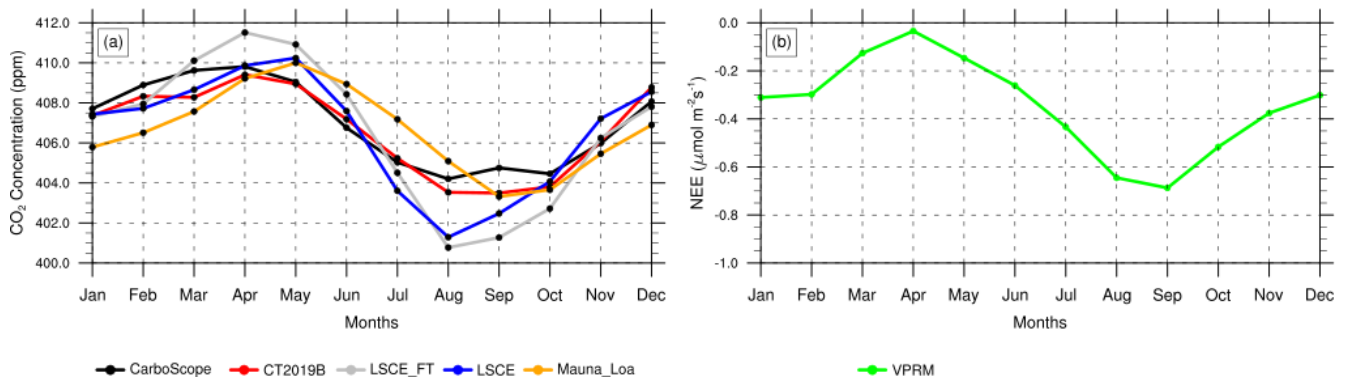


Figure S2: Comparison of the seasonal variability in CO₂ concentration for different global reanalysis products over India with the Mauna Loa observations for the year 2017. (a) Monthly averaged CO₂ concentration over India by different global models and monthly averaged observations of CO₂ concentrations at Mauna Loa (b) NEE over India derived by VPRM model for the year 2017.

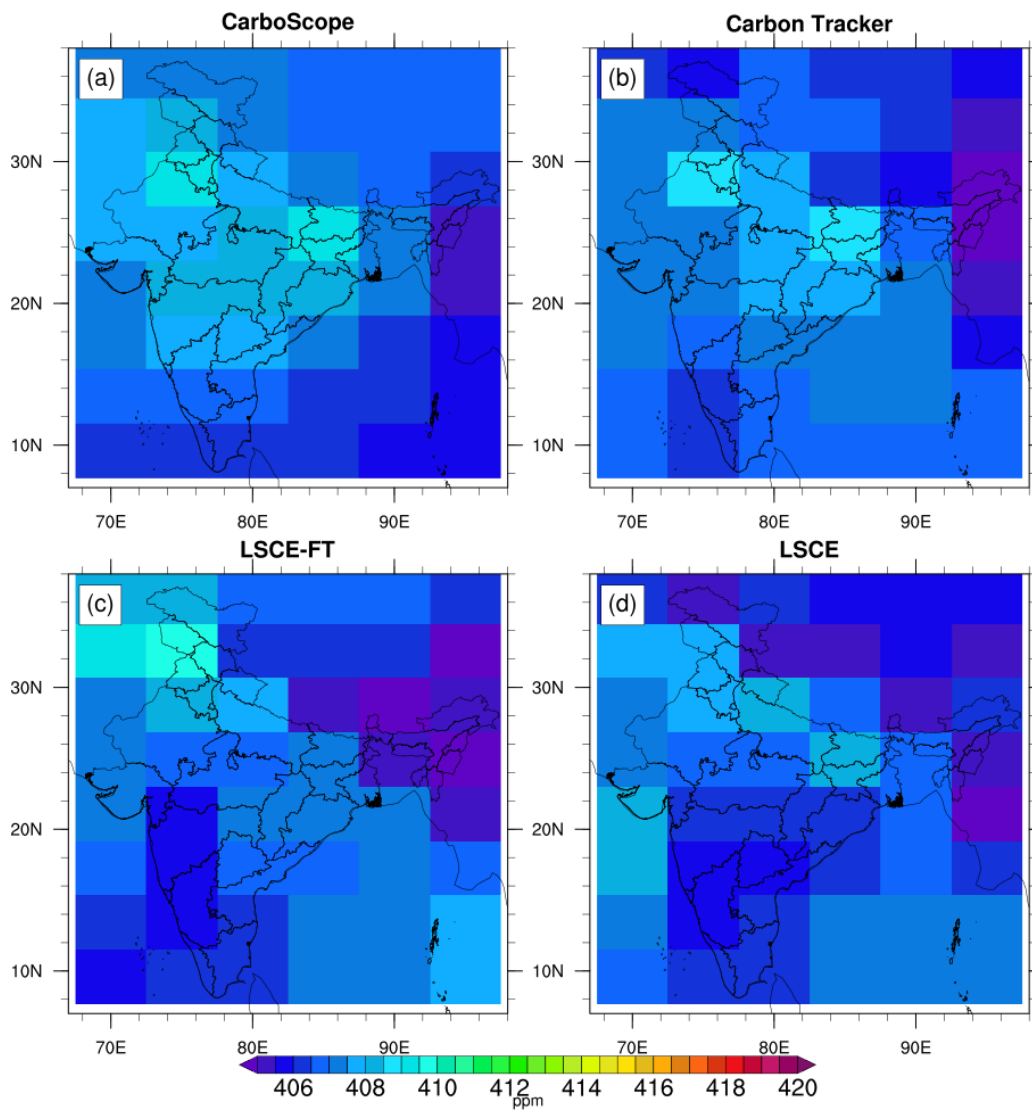


Figure S3: Spatial variability in annual surface CO₂ concentration for different global reanalysis products for the year 2017. (a) CarboScope (~80 m) (b) Carbon Tracker (~100 m) (c) LSCE FT (~150 m) (d) LSCE (~150 m).

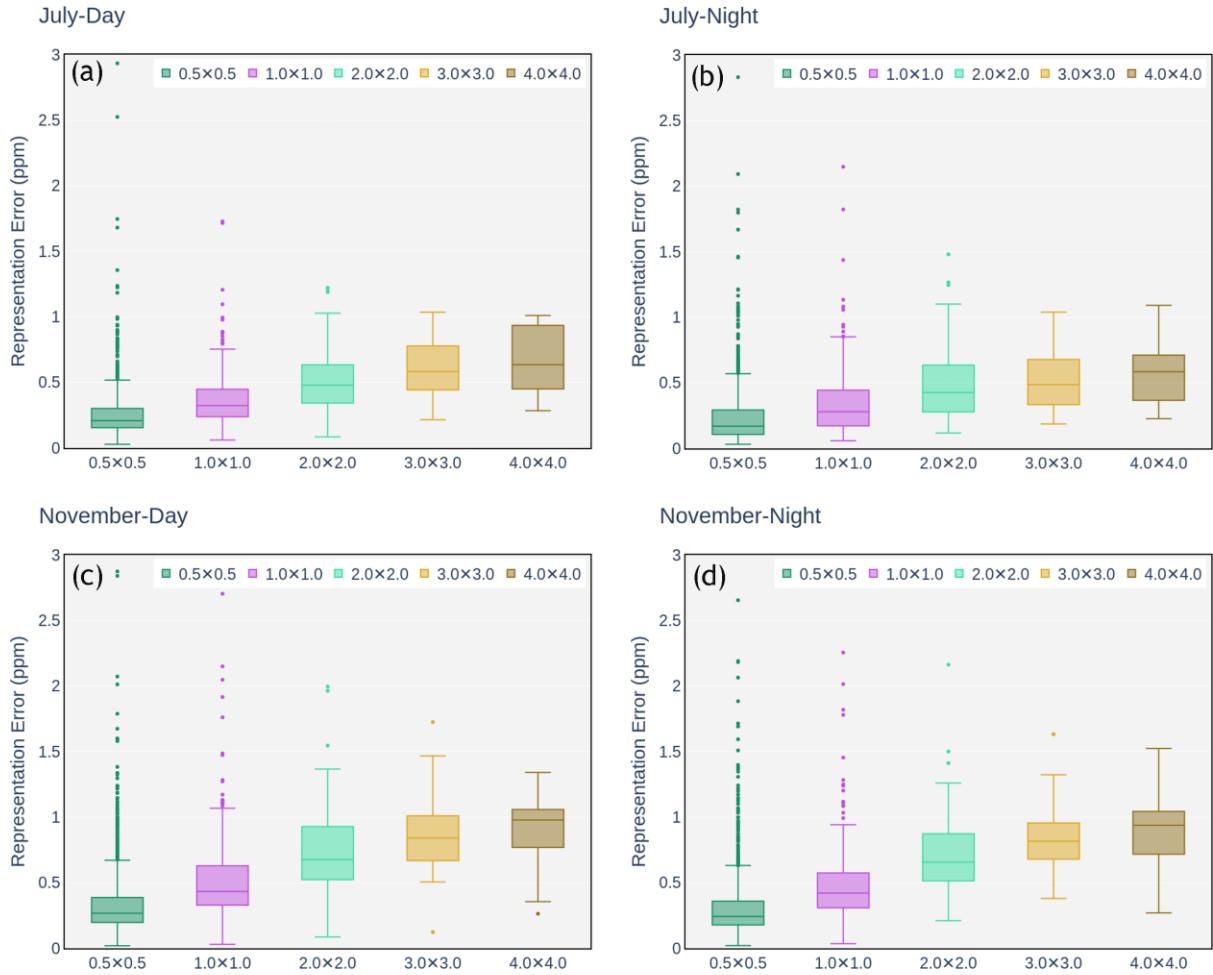


Figure S4: Variability in derived column average representation error over India for different horizontal resolutions. Boxes indicate the central 50%, the bar across the box is median value, and the whiskers indicate the value between 5 and 95 percentiles. Individual data points shown are the outliers. a) Representation error estimated for July daytime. b) July nighttime. c) November daytime. d) November nighttime.

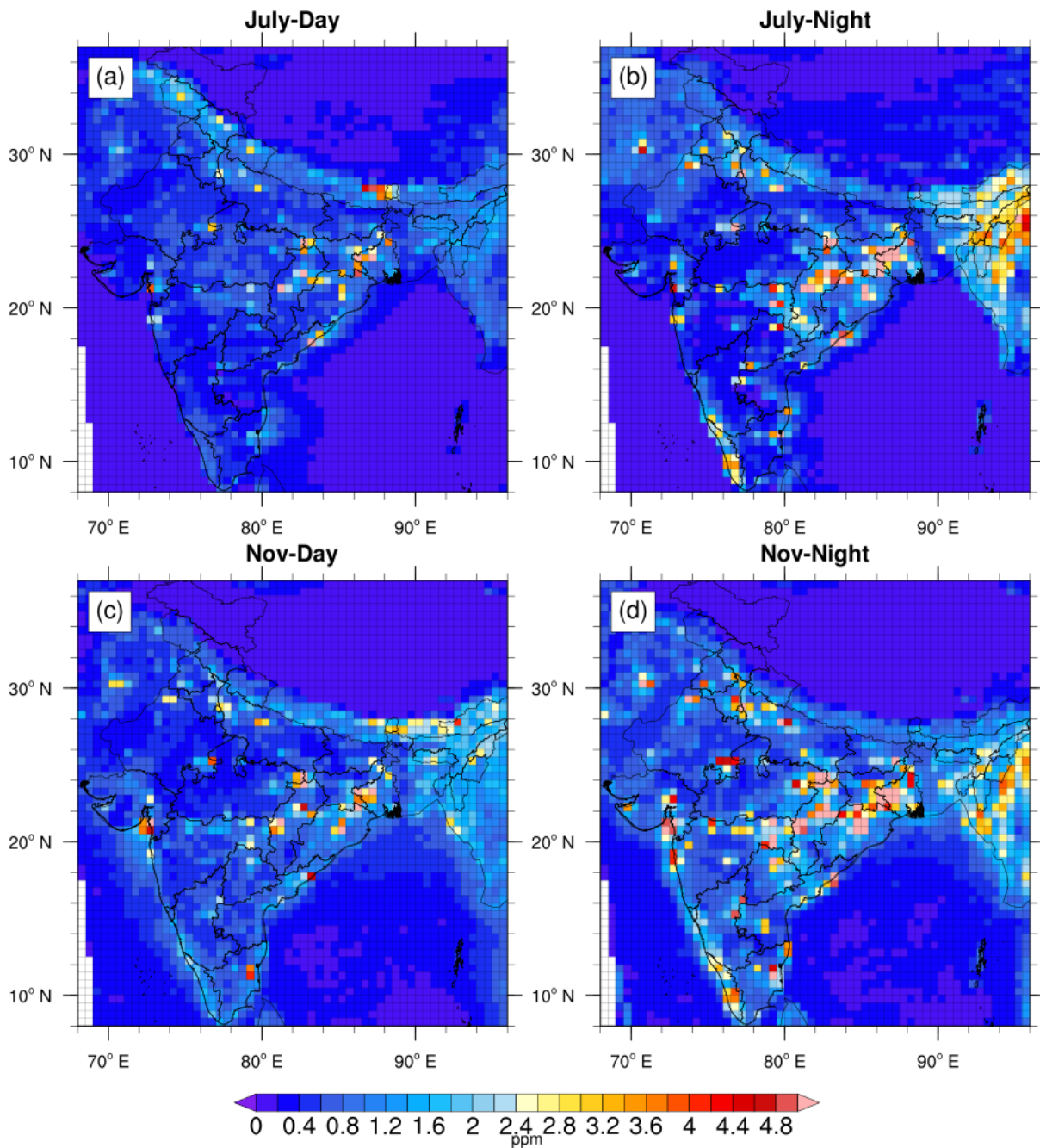


Figure S5: Monthly averaged values of representation error estimated ($0.5^{\circ} \times 0.5^{\circ}$ boxes) for surface CO₂ concentration during 2017. (a) July daytime (11:30 to 16:30 local time). (b) July nighttime (23:30 to 4:30 local time). (c) November daytime. (d) November nighttime.

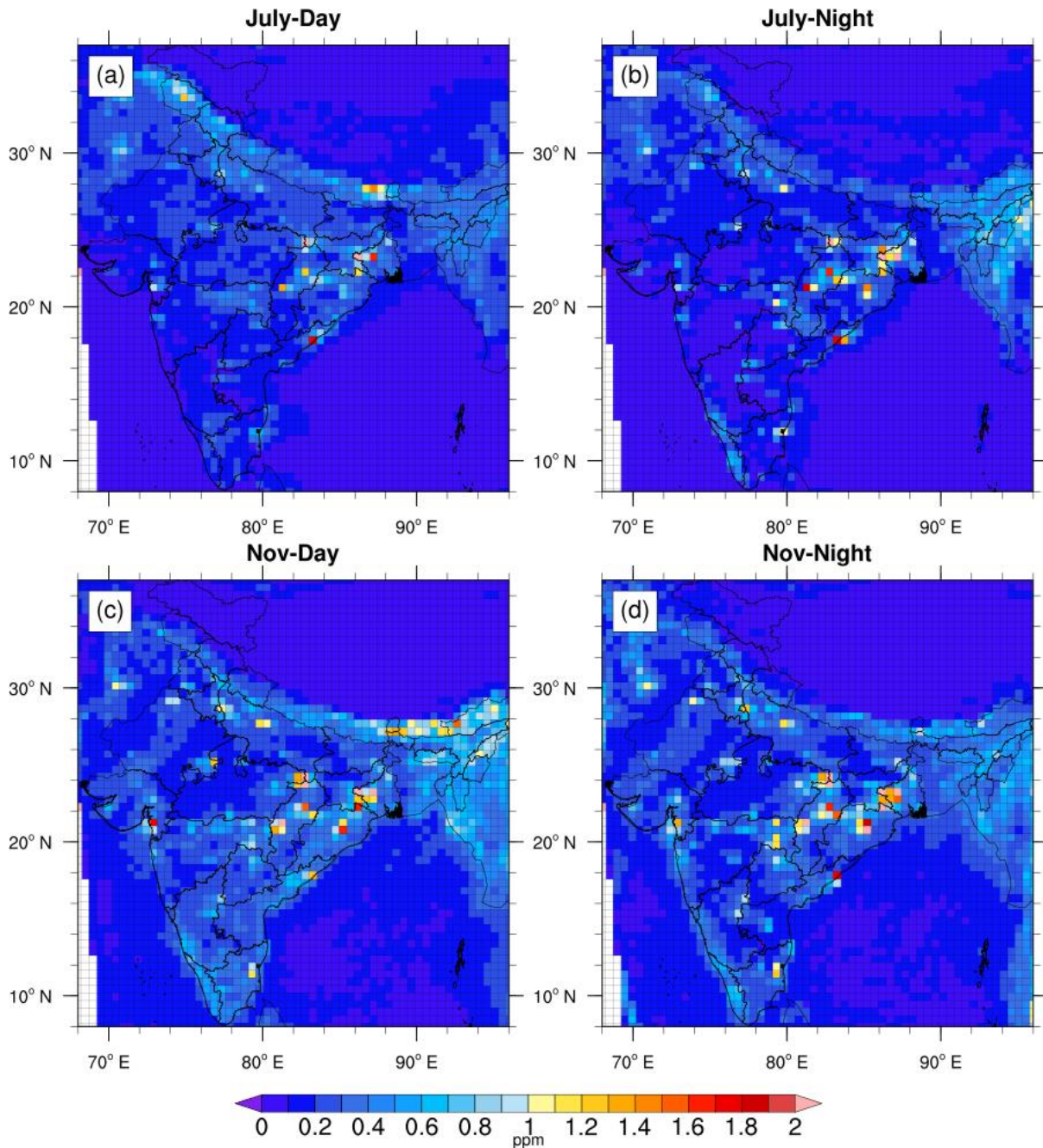


Figure S6: Monthly averaged values of representation error estimated ($0.5^\circ \times 0.5^\circ$ boxes) for column averaged CO_2 concentration during 2017. (a) July daytime (11:30 to 16:30 local time). (b) July nighttime (23:30 to 4:30 local time). (c) November daytime. (d) November nighttime.

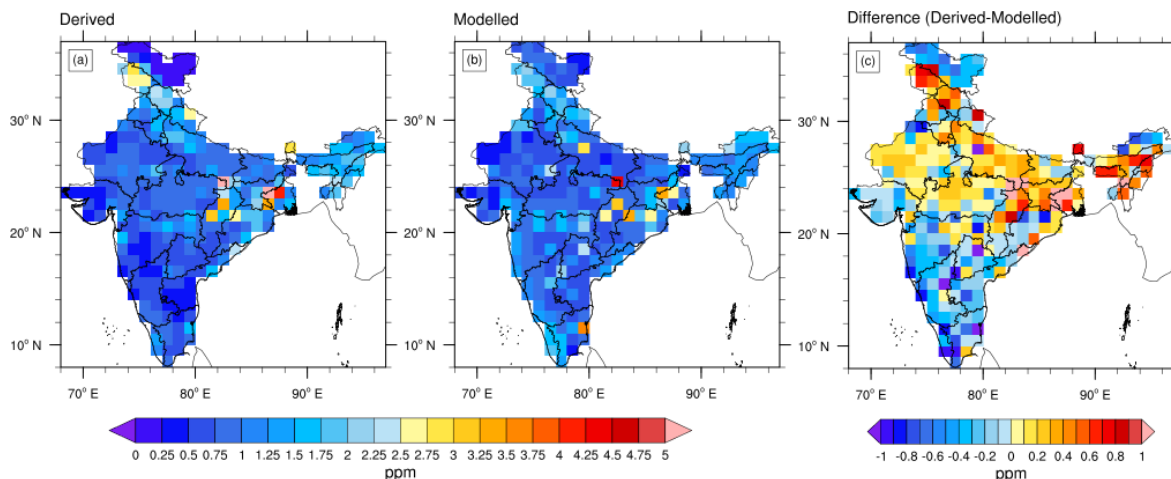


Figure S7: Monthly averaged values of representation error estimated for surface CO₂ concentration during July daytime (11:30 to 16:30 local time) in 2017. (a) Representation error derived from WRF-GHG simulations as explained in Sect. 2.3. (b) Representation error calculated from the multivariate linear model as explained in Sect. 3.5. (c) Difference between (a) and (b).

Table S1: Percentage of agreement between the variations in terrain height (σ_{topo}), biospheric flux (σ_{bio}), anthropogenic flux (σ_{ant}) and modelled representation error using multivariate linear model with the derived representation error (σ_{CO_2}) (see Sect.2.3).

Month	July				November			
	Daytime		Nighttime		Daytime		Nighttime	
	Surface	Column average	Surface	Column average	Surface	Column average	Surface	Column average
σ_{topo}	48	52	20	45	33	52	47	45
σ_{bio}	75	74	62	48	80	66	23	19
σ_{ant}	0	8	29	13	0	2	30	18
Multi variate Model	89	96	65	85	88	59	68	60

Table S2: Percentage of agreement between the variations in terrain height (σ_{topo}), biospheric flux (σ_{bio}), anthropogenic flux (σ_{ant}) and modelled representation error using multivariate linear model with the derived systematic representation error ($\sigma_{CO_2(mon)}$) (Sect.2.3).

Month	July				November			
	Daytime		Nighttime		Daytime		Nighttime	
	Surface	Column average	Surface	Column average	Surface	Column average	Surface	Column average
σ_{topo}	34	39	13	37	41	65	26	25
σ_{bio}	71	72	69	45	61	55	23	7
σ_{ant}	1	7	34	36	0	1	17	12
Multi variate Model	94	93	90	94	87	60	89	86