



Supplement of

**Representing improved tropospheric ozone distribution
over the Northern Hemisphere by including lightning
NO_x emissions in CHIMERE**

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Table S1. Zonally averaged tropopause height and cloud top height in model averaged across three latitude bands over the NH. The model top height is 12.03 km.

Latitude band	0°–30° N	30° N–60° N	60° N–90° N
Tropopause height (km)	15.6	11.3	10.5
Cloud top height (km)	11.6	10.7	9.1

Table S2. Annual mean O₃ from LNOx-CTH and LNOx-ICEFLUX, and percentage changes in O₃. ΔO_3 represents changes in O₃ from experiment LNOx-CTH with respect to that from experiment noLNOx; positive and negative values represent the increase and decrease in O₃ mixing ratio, respectively.

Latitude band	0°–30° N	30° N–60° N	60° N–90° N	0°–30° N	30° N–60° N	60° N–90° N
Altitude band (hPa)	annual mean O ₃ from LNOx-CTH in ppbv (ΔO_3^* in %)			annual mean O ₃ from LNOx-ICEFLUX in ppbv (LNOx-ICEFLUX – LNOx-CTH (%))		
500–200	53.2 (10.7)	92.1 (3.89)	96.4 (2.05)	55.96 (5.25)	94.49 (2.63)	97.85 (1.49)
750–500	42.7 (19.2)	58.1 (5.80)	45.7 (1.9)	45.97 (7.59)	60.12 (3.52)	46.48 (1.73)
900–750	35.3 (12.1)	47.2 (3.07)	37.3 (0.77)	37.42 (5.84)	48.4 (2.58)	37.29 (1.05)
998–900	32.4 (6.4)	41.0 (1.13)	31.8 (0.51)	33.80 (4.16)	41.83 (1.92)	32.07 (0.84)

Table S3. Evaluation of simulated O₃ from experiments noLNOx, LNOx-CTH and LNOx-ICEFLUX with respect to observed data from WOUDC ozone sonde

Latitude band	0°–30° N	30° N–60° N	60° N–90° N	0°–30° N	30° N–60° N	60° N–90° N	0°–30° N	30° N–60° N	60° N–90° N
Altitude band (hPa)	mean absolute bias in ppbv in simulated O ₃ from expt. noLNOx			mean absolute bias in ppbv in simulated O ₃ from expt. LNOx-CTH*			mean absolute bias in ppbv in simulated O ₃ from expt. LNOx-ICEFLUX*		
500–200	–4.5	–41.3	–44.6	0.63	–37.8	–42.5	3.42	–35.43	–42.3
750–500	–5.6	–0.2	–2.5	1.2	2.9	–1.7	4.47	5.00	–0.91
900–750	–5.4	–1.3	–1.4	–1.6	0.1	–1.1	0.46	1.31	–0.73
998–900	3.4	4.3	6.4	5.4	4.7	6.6	6.75	5.56	6.86

*Reduction in absolute biases in the experiment 'LNOx-CTH' and 'LNOx-ICEFLUX' w.r.t. 'noLNOx' (i) ≥ 3 ppbv and ≤ 6 ppbv: bold; (ii) ≥ 6 ppbv: bold, italics; positive and negative values of absolute bias show that the simulated O₃ is higher and lower than the measurements, respectively.

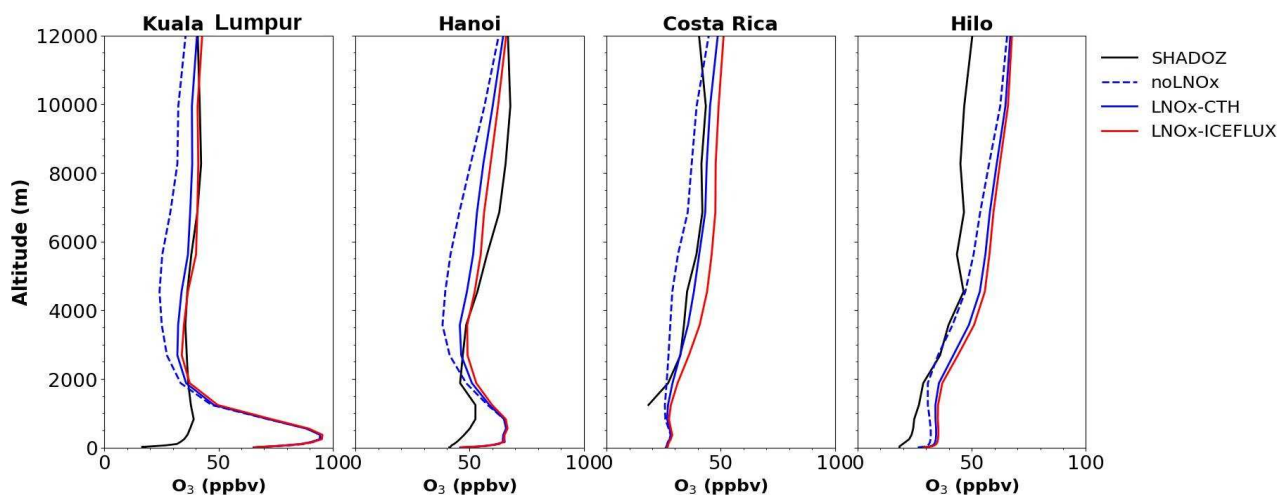


Figure S1. Vertical profile of annual mean of O_3 mixing ratio from noLNOx (blue dashed line), LNOx-CTH (blue solid line) and LNOx-ICEFLUX (red solid line) simulations and comparison with the ozone sonde measurements (black solid line) from Southern Hemisphere Additional OZonesondes (SHADOZ) at stations Kuala Lumpur (3.14°N, 101.69°E), Hanoi (21.02°N, 105.80°E), Costa Rica (9.62°N, -84.25°E) and Hilo (19.72°N, -155.08°E).

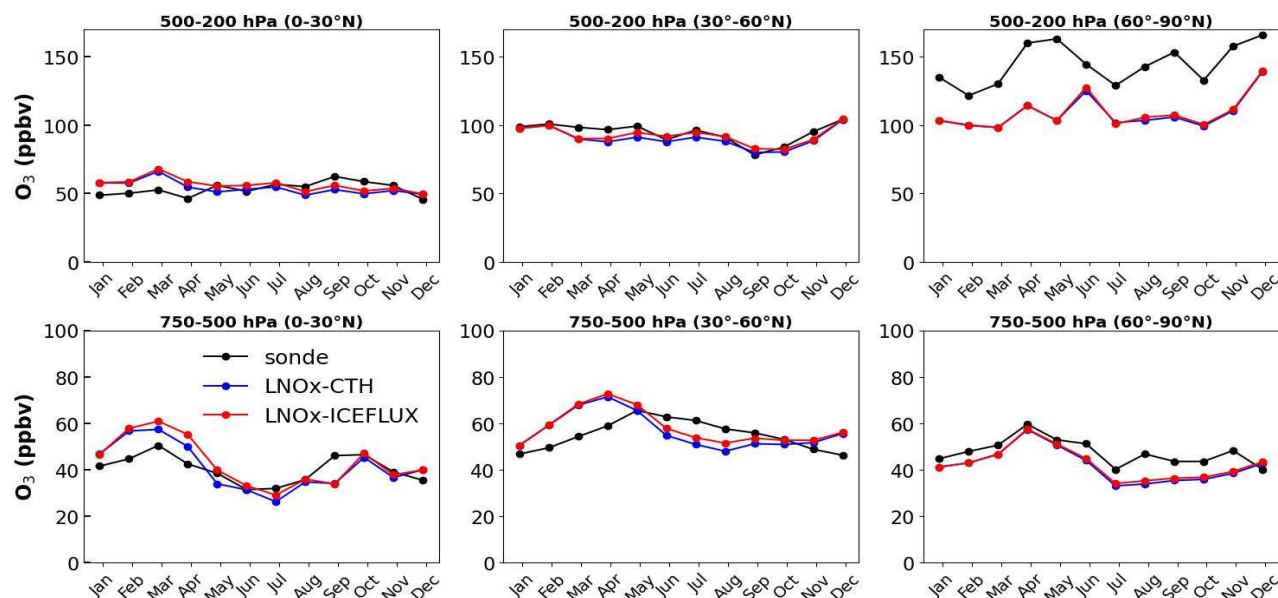


Figure S2. Comparison of monthly mean simulated O_3 from LNOx-CTH and LNOx-ICEFLUX with that from WUOZC ozone-sonde, obtained for the year of 2018, averaged over two altitude bands (500–200 hPa and 750–500 hPa) and three latitude bands (0°–30°N, 30°N–60°N and 60°N–90°N).

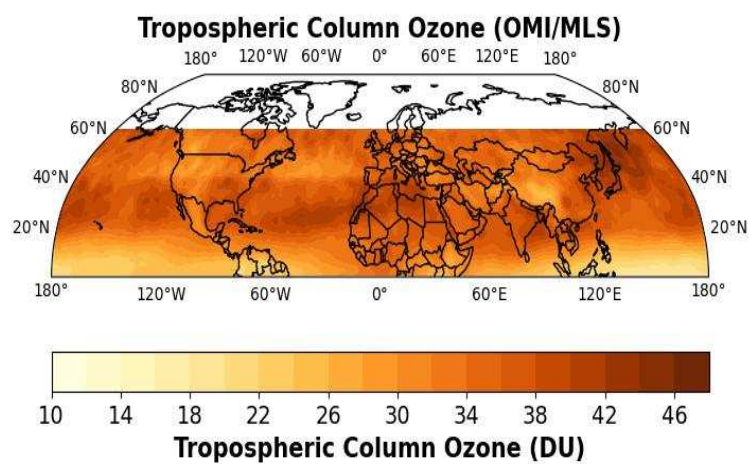


Figure S3. Spatial distribution of total column of ozone (TCO) over NH from OMI/MLS.

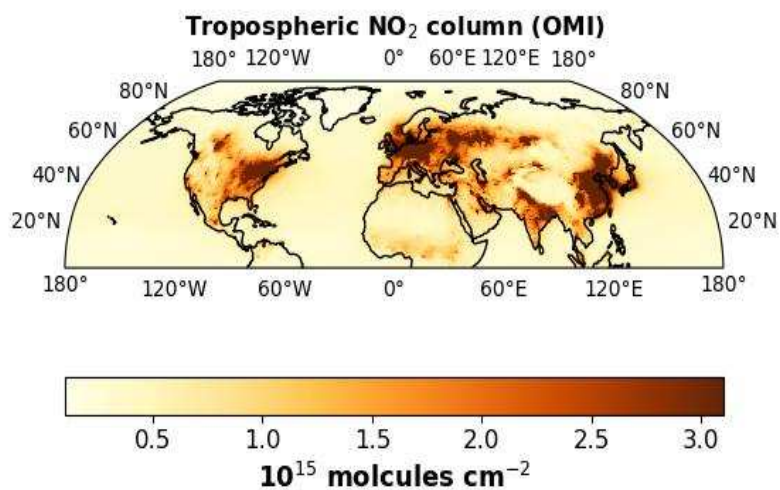


Figure S4. Spatial distribution of NO₂ column density over NH from OMI.

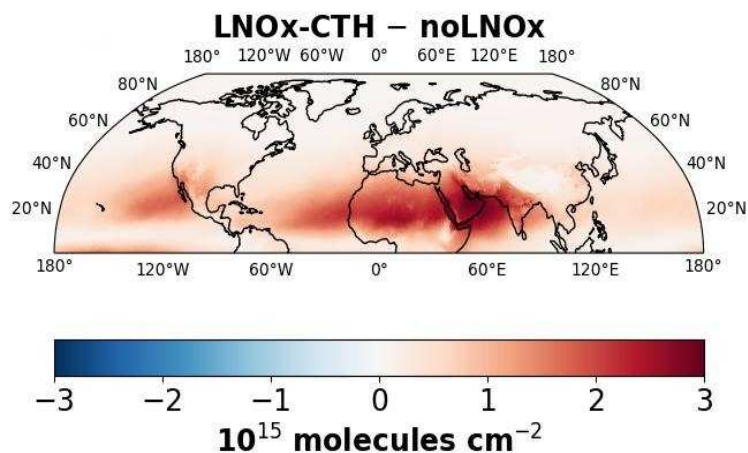


Figure S5. Spatial distribution of changes in simulated HNO_3 column density from experiment LNOx-CTH with respect to noLNOx simulation.

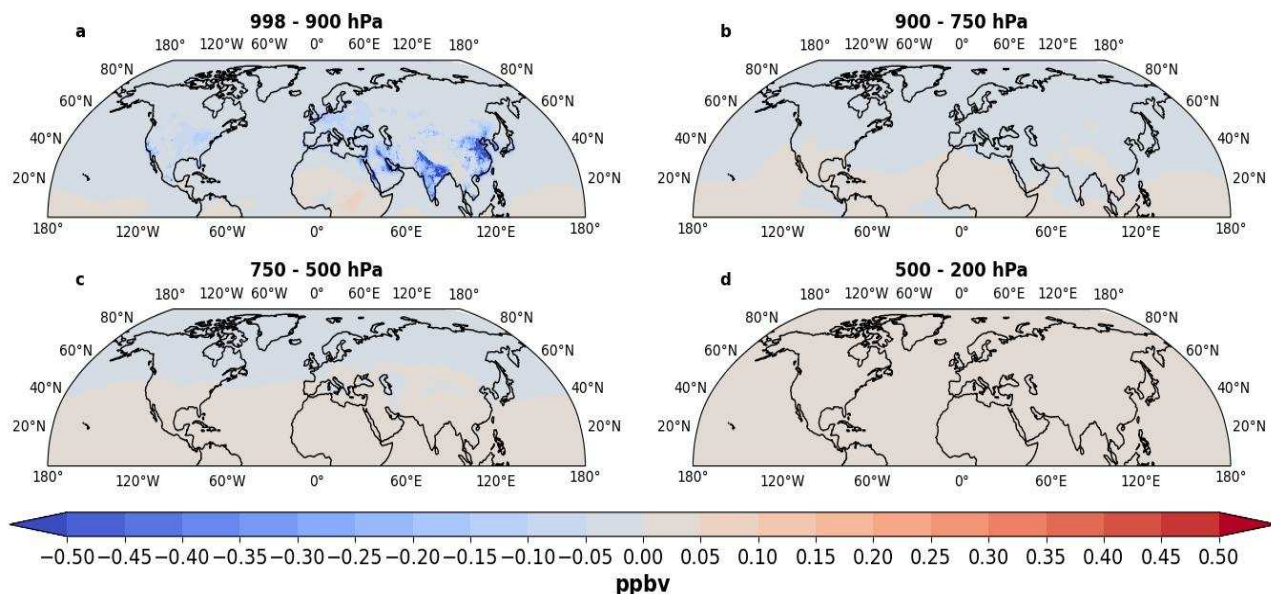


Figure S6. Changes in annual mean of NO_2 mixing ratio from experiment 'LNOx-CTH' with respect to 'noLNOx' at the altitude bands of (a) 998–900 hPa, (b) 900–750 hPa, (c) 750–500 hPa and (d) 500–200 hPa; positive and negative values represent the increase and decrease in the NO_2 mixing ratio, respectively.

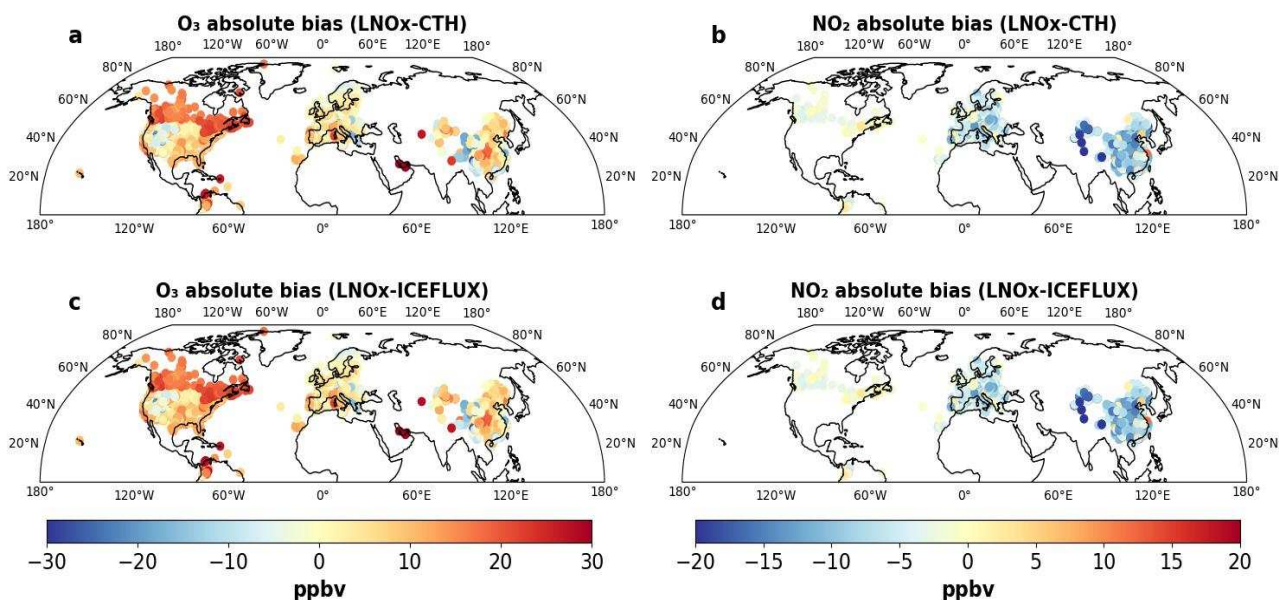


Figure S7. Absolute bias in simulated mixing ratio at surface at available stations (a, c) for O_3 from (a) LNOx-CTH and (c) LNOx-ICEFLUX, (b, d) for NO_2 from (b) LNOx-CTH and (d) LNOx-ICEFLUX; positive and negative values of absolute bias represent that simulated O_3 and NO_2 are higher and lower than the measurements, respectively.

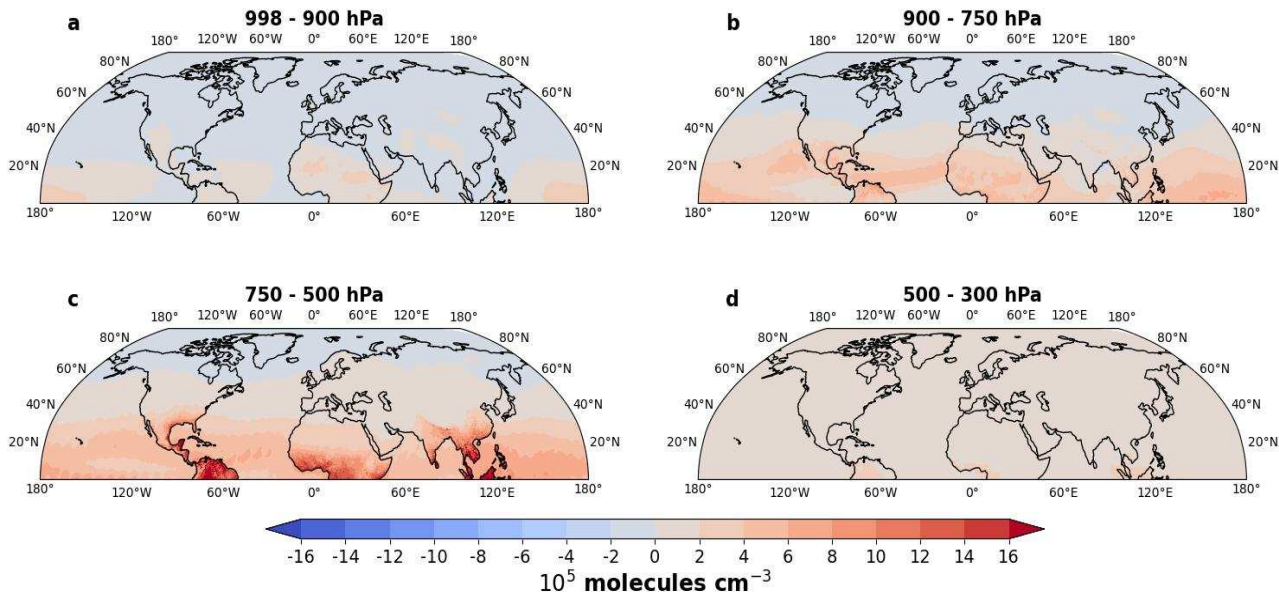


Figure S8. Changes in annual mean of OH concentration from experiment 'LNOx-CTH' with respect to 'noLNOx' (ΔOH) at the altitude bands of (a) 998–900 hPa, (b) 900–750 hPa, (c) 750–500 hPa and (d) 500–200 hPa; positive and negative values represent the increase and decrease in the OH concentration, respectively.

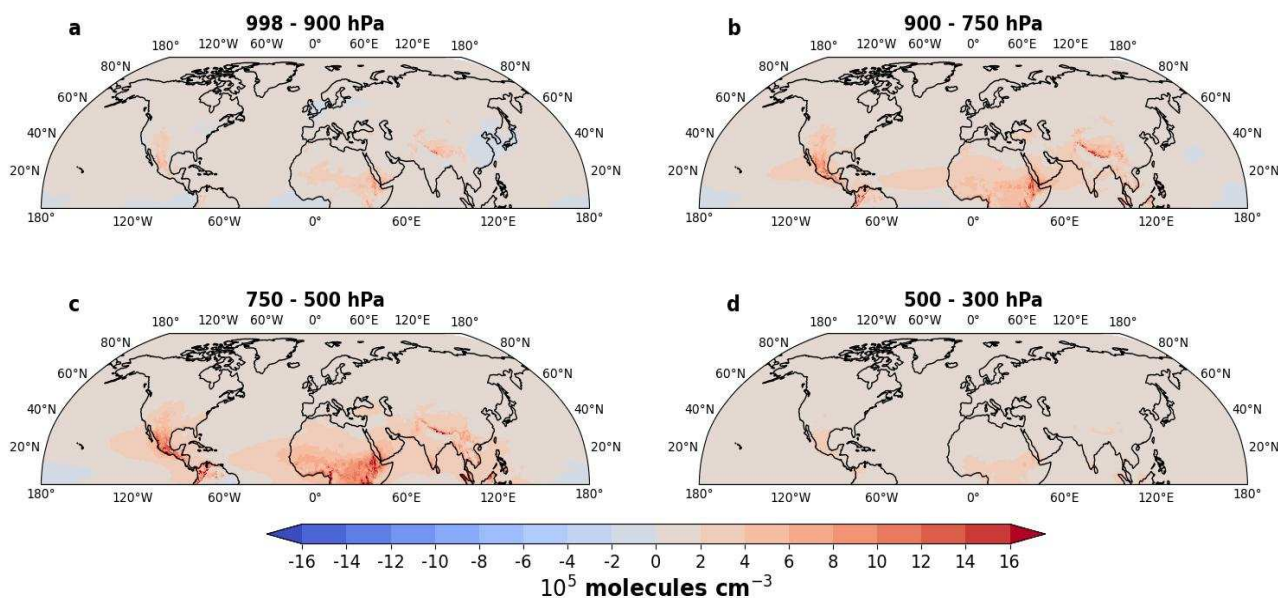


Figure S9. Changes in annual mean of OH concentration from experiment 'LNOx-ICEFLUX' with respect to 'LNOx-CTH' at the altitude bands of (a) 998–900 hPa, (b) 900–750 hPa, (c) 750–500 hPa and (d) 500–200 hPa; positive and negative values represent the increase and decrease in the OH concentration, respectively.

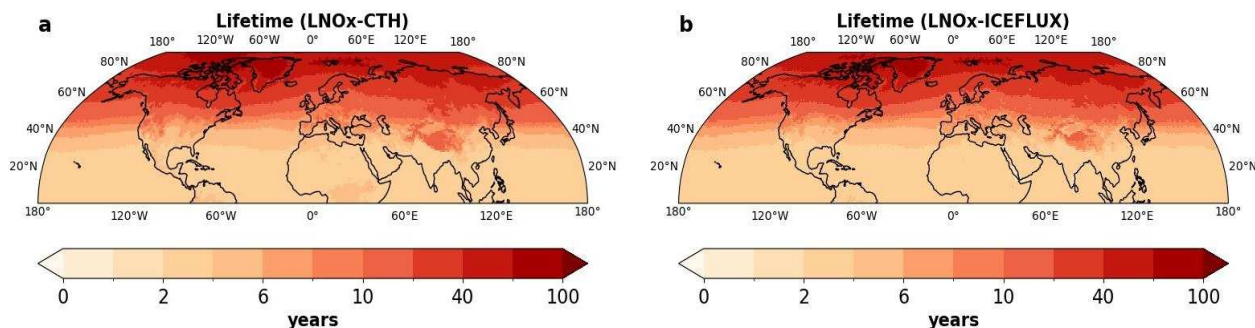


Figure S10. Spatial distribution of CH_4 lifetime over NH estimated from (a) LNOx-CTH and (b) LNOx-ICEFLUX.