

Figure S1. The location of EPA sites represented by red circles.

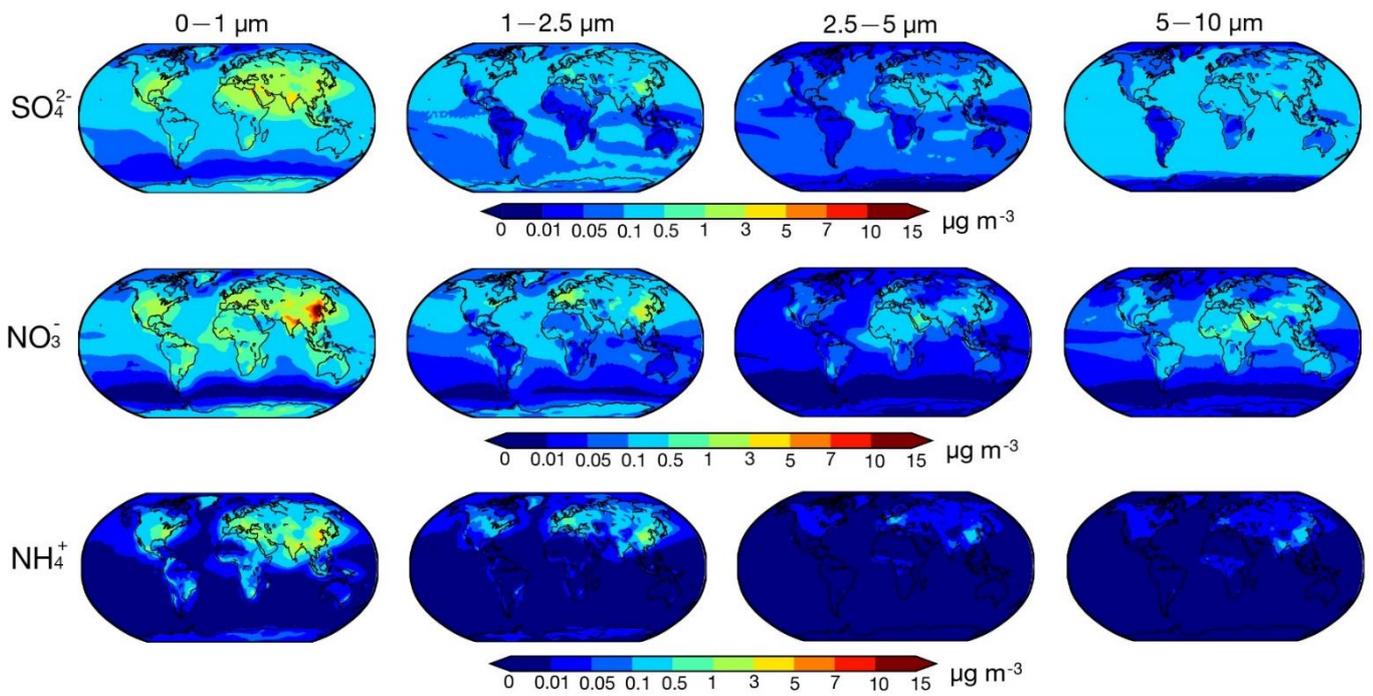


Figure S2. Global distribution maps of SO_4^{2-} , NO_3^- , and NH_4^+ mass concentrations in the size ranges of 0–1 μm , 1–2.5 μm , 2.5–5 μm , and 5–10 μm derived from base case simulation, averaged from 2010 to 2012.

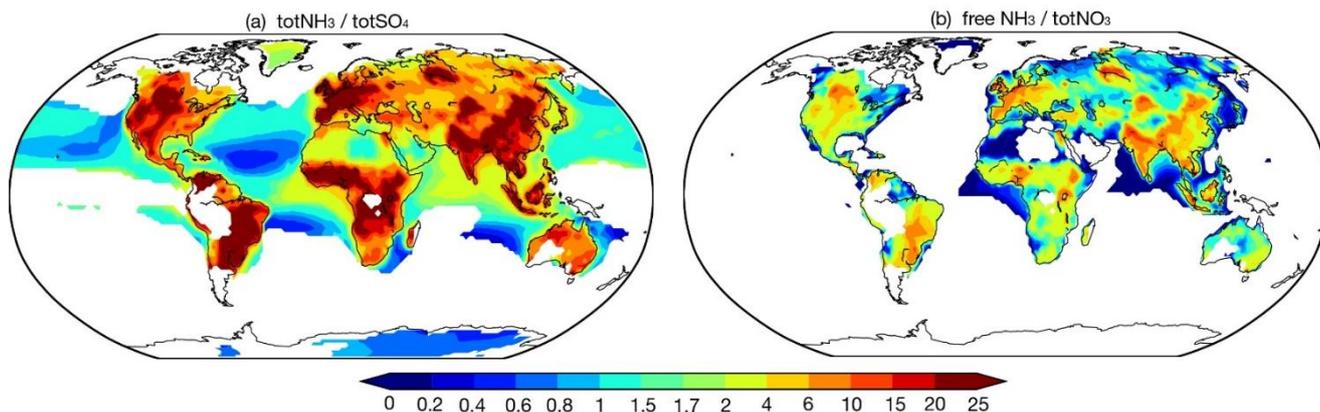


Figure S3. (a) Global distribution molar ratio of totNH₃ (sum of NH₄⁺ and NH₃) to totSO₄ (sum of SO₄²⁻ and HSO₄⁻). (b) global distribution molar ratio of free NH₃ (totNH₃ minus double totSO₄) to totNO₃ (sum of NO₃⁻ and HNO₃), both (a) and (b) are based on SNA molar concentrations in PM₁₀ with a threshold of $\geq 1 \mu\text{g m}^{-3}$.

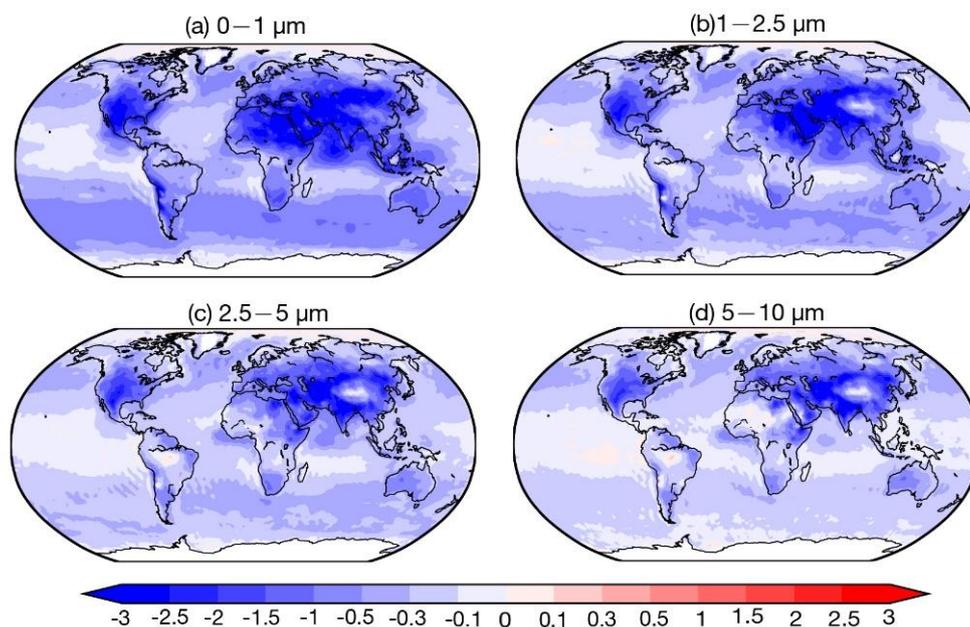


Figure S4. Global distribution maps of pH value absolute difference between Meta case and base case in the size ranges of 0 – 1 μm, 1 – 2.5 μm, 2.5 – 5 μm, and 5 – 10 μm, averaged from 2010 to 2012.

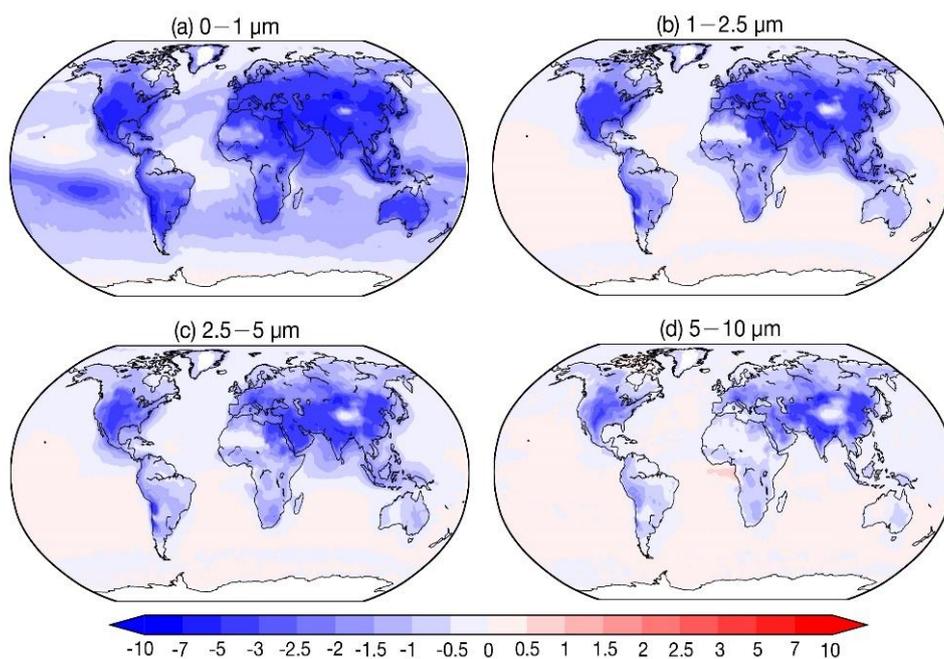


Figure S5. Global distribution maps of pH value absolute difference between noNH₃ case and base case in the size ranges of 0 – 1 μm, 1 – 2.5 μm, 2.5 – 5 μm, and 5 – 10 μm, averaged from 2010 to 2012.

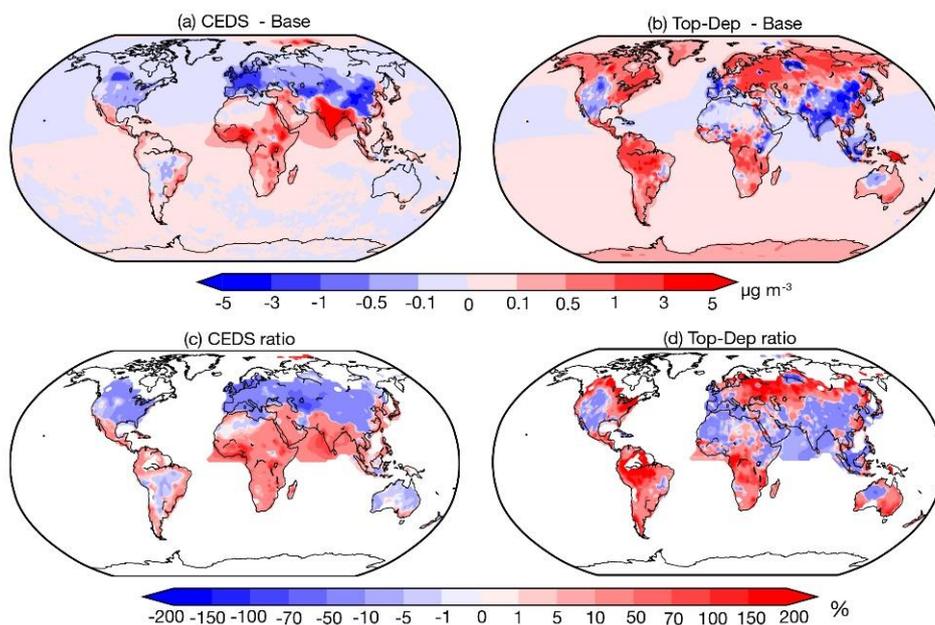


Figure S6. Global distribution maps of surface NH₃ mass concentration absolute difference between CEDS case (a) and Top-Dep case (b) and base case; change ratio (absolute difference/Base case) between CEDS case (c) and Top-Dep case (d) and base case, averaged from 2010 to 2012. The calculation of change ratio is based on the mask of 0.3 μg m⁻³.

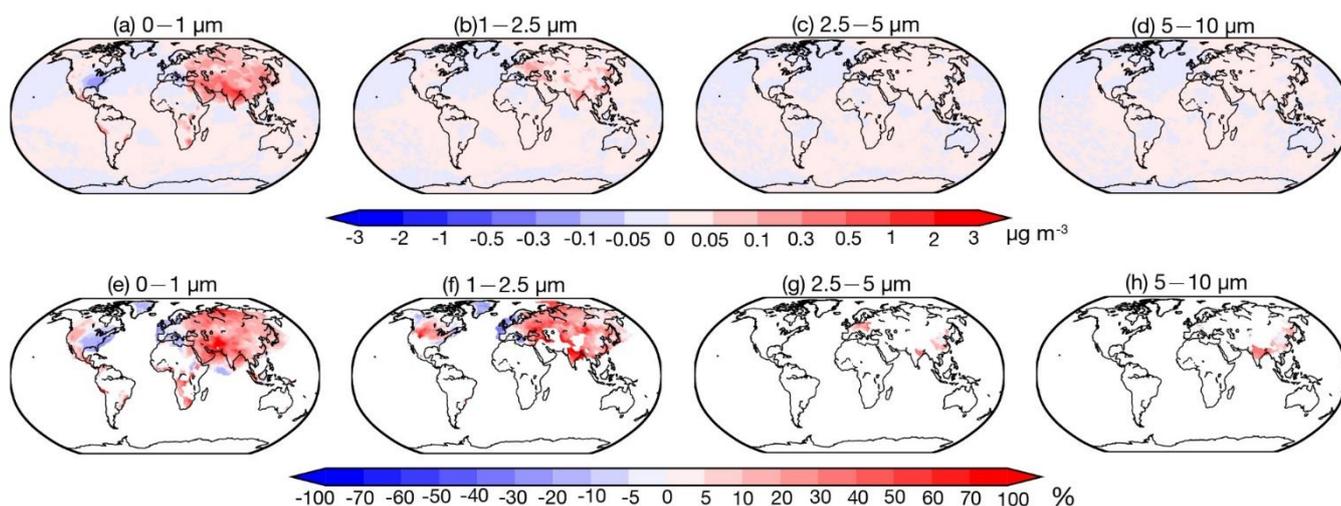


Figure S7. Global distribution maps of surface NH_4^+ mass concentration absolute difference between CEDS case and base case in 0–1 μm (a), 1–2.5 μm (b), 2.5–5 μm (c), 5–10 μm (d); change ratio (absolute difference/base case) between CEDS case and base case in 0–1 μm (e), 1–2.5 μm (f), 2.5–5 μm (g), 5–10 μm (h), averaged from 2010 to 2012. The calculation of change ratio in full size and 0–1 μm is based on the mask of $0.1 \mu\text{g m}^{-3}$, in 1–2.5 μm , 2.5–5 μm and 5–10 μm is based on the mask of $0.05 \mu\text{g m}^{-3}$.

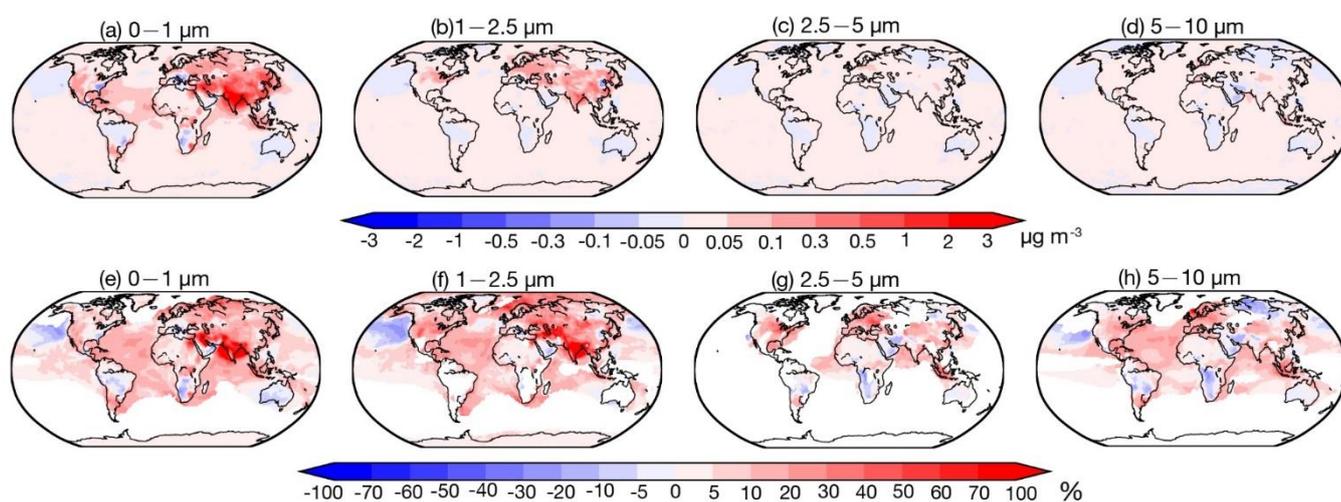


Figure S8. Global distribution maps of surface NO_3^- mass concentration absolute difference between CEDS case and base case in 0–1 μm (a), 1–2.5 μm (b), 2.5–5 μm (c), 5–10 μm (d); change ratio (absolute difference/base case) between CEDS case and base case in 0–1 μm (e), 1–2.5 μm (f), 2.5–5 μm (g), 5–10 μm (h), averaged from 2010 to 2012. The calculation of change ratio in full size and 0–1 μm is based on the mask of $0.1 \mu\text{g m}^{-3}$, in 1–2.5 μm , 2.5–5 μm and 5–10 μm is based on the mask of $0.05 \mu\text{g m}^{-3}$.

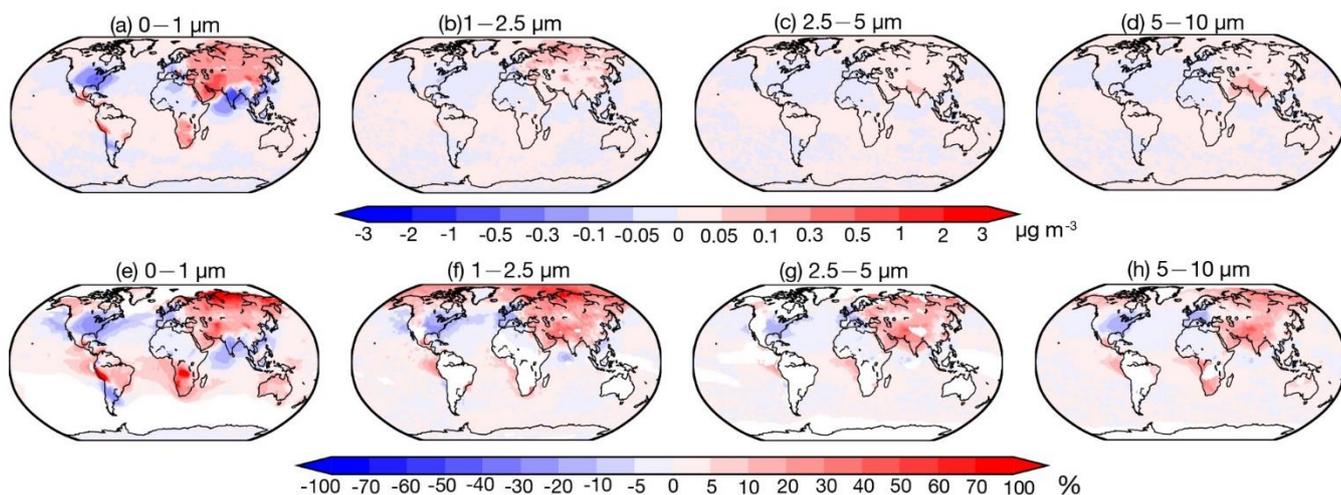


Figure S9. Global distribution maps of surface SO_4^{2-} mass concentration absolute difference between CEDS case and base case in 0–1 μm (a), 1–2.5 μm (b), 2.5–5 μm (c), 5–10 μm (d); change ratio (absolute difference/base case) between CEDS case and base case in 0–1 μm (e), 1–2.5 μm (f), 2.5–5 μm (g), 5–10 μm (h), averaged from 2010 to 2012. The calculation of change ratio in full size and 0–1 μm is based on the mask of $0.1 \mu\text{g m}^{-3}$, in 1–2.5 μm , 2.5–5 μm and 5–10 μm is based on the mask of $0.05 \mu\text{g m}^{-3}$.

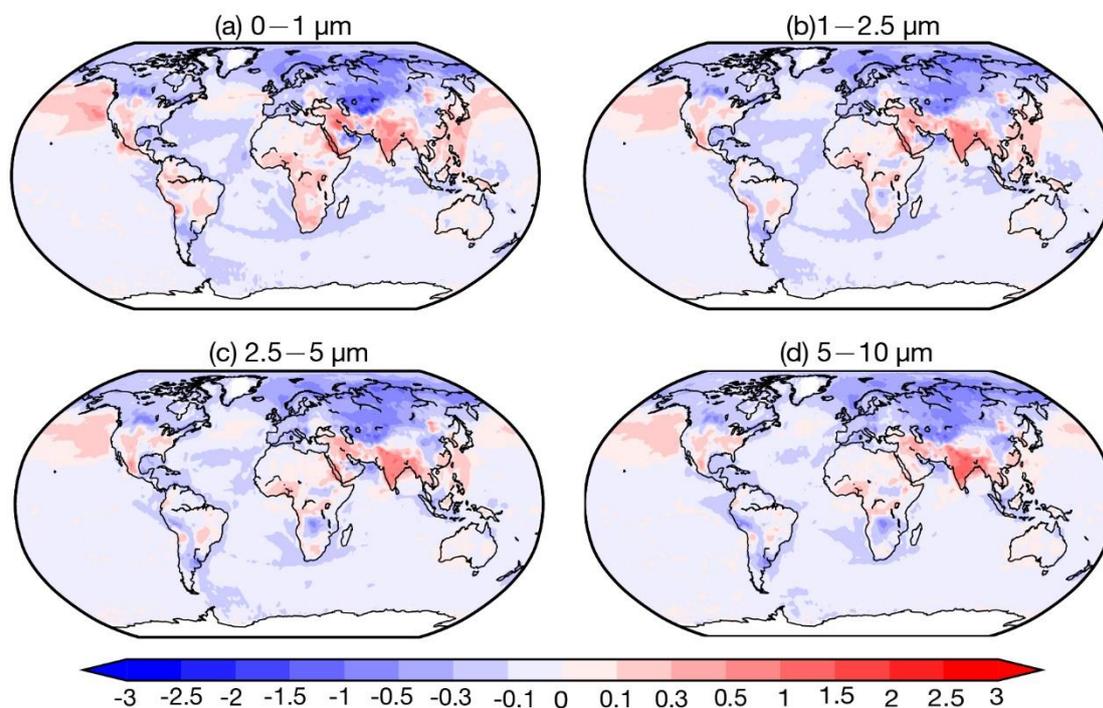


Figure S10. Global distribution maps of pH value absolute difference between CEDS case and base case in the size ranges of 0–1 μm , 1–2.5 μm , 2.5–5 μm , and 5–10 μm , averaged from 2010 to 2012.

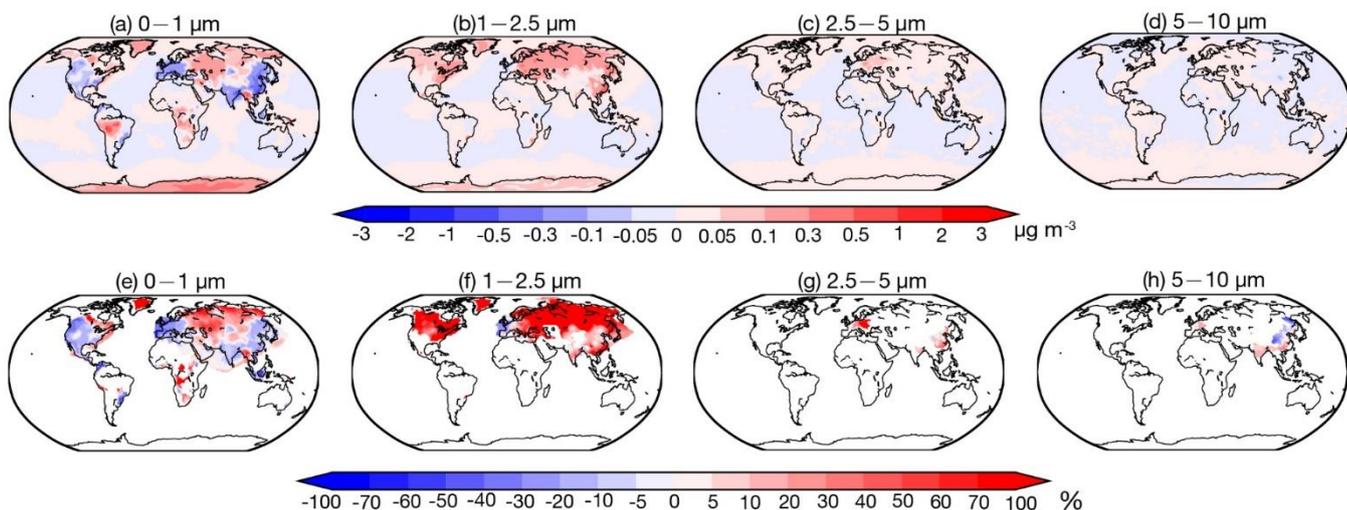


Figure S11. Global distribution maps of surface NH_4^+ mass concentration absolute difference between Top-Dep case and base case in 0–1 μm (a), 1–2.5 μm (b), 2.5–5 μm (c), 5–10 μm (d); change ratio (absolute difference/base case) between Top-Dep case and base case in 0–1 μm (e), 1–2.5 μm (f), 2.5–5 μm (g), 5–10 μm (h), averaged from 2010 to 2012. The calculation of change ratio in full size and 0–1 μm is based on the mask of $0.1 \mu\text{g m}^{-3}$, in 1–2.5 μm , 2.5–5 μm and 5–10 μm is based on the mask of $0.05 \mu\text{g m}^{-3}$.

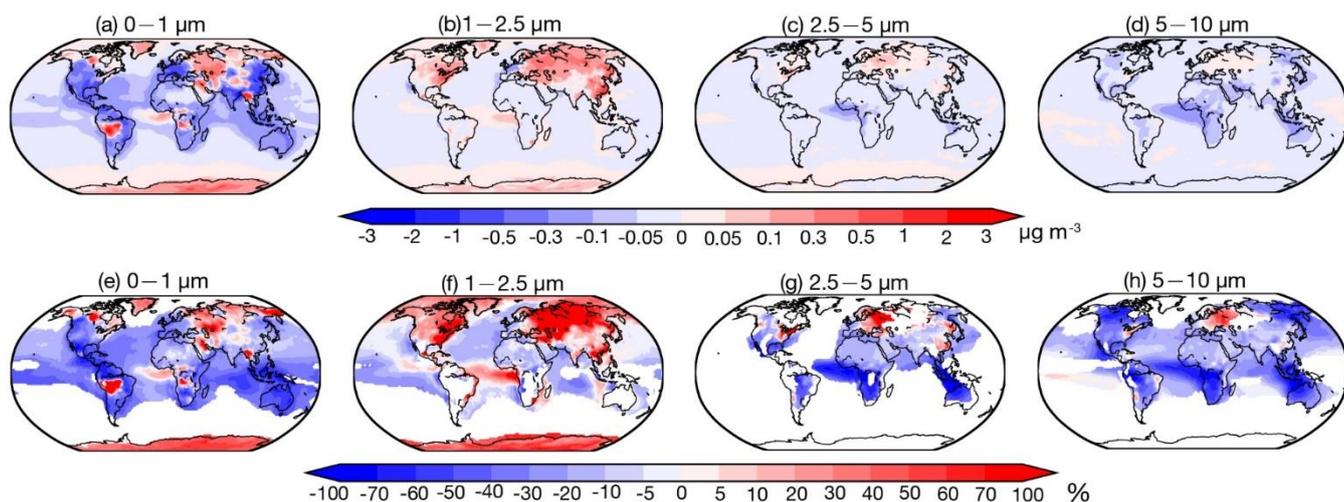


Figure S12. Global distribution maps of surface NO_3^- mass concentration absolute difference between Top-Dep case and base case in 0–1 μm (a), 1–2.5 μm (b), 2.5–5 μm (c), 5–10 μm (d); change ratio (absolute difference/base case) between Top-Dep case and base case in 0–1 μm (e), 1–2.5 μm (f), 2.5–5 μm (g), 5–10 μm (h), averaged from 2010 to 2012. The calculation of change ratio in full size and 0–1 μm is based on the mask of $0.1 \mu\text{g m}^{-3}$, in 1–2.5 μm , 2.5–5 μm and 5–10 μm is based on the mask of $0.05 \mu\text{g m}^{-3}$.

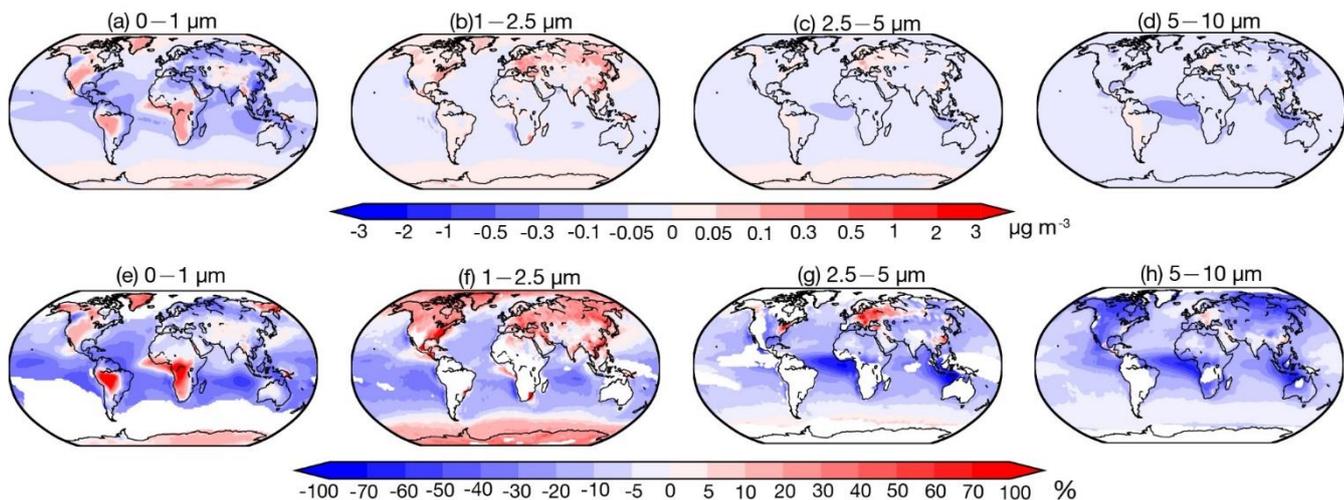


Figure S13. Global distribution maps of surface SO_4^{2-} mass concentration absolute difference between Top-Dep case and base case in 0–1 μm (a), 1–2.5 μm (b), 2.5–5 μm (c), 5–10 μm (d); change ratio (absolute difference/base case) between Top-Dep case and base case in 0–1 μm (e), 1–2.5 μm (f), 2.5–5 μm (g), 5–10 μm (h), averaged from 2010 to 2012. The calculation of change ratio in full size and 0–1 μm is based on the mask of $0.1 \mu\text{g m}^{-3}$, in 1–2.5 μm , 2.5–5 μm and 5–10 μm is based on the mask of $0.05 \mu\text{g m}^{-3}$.

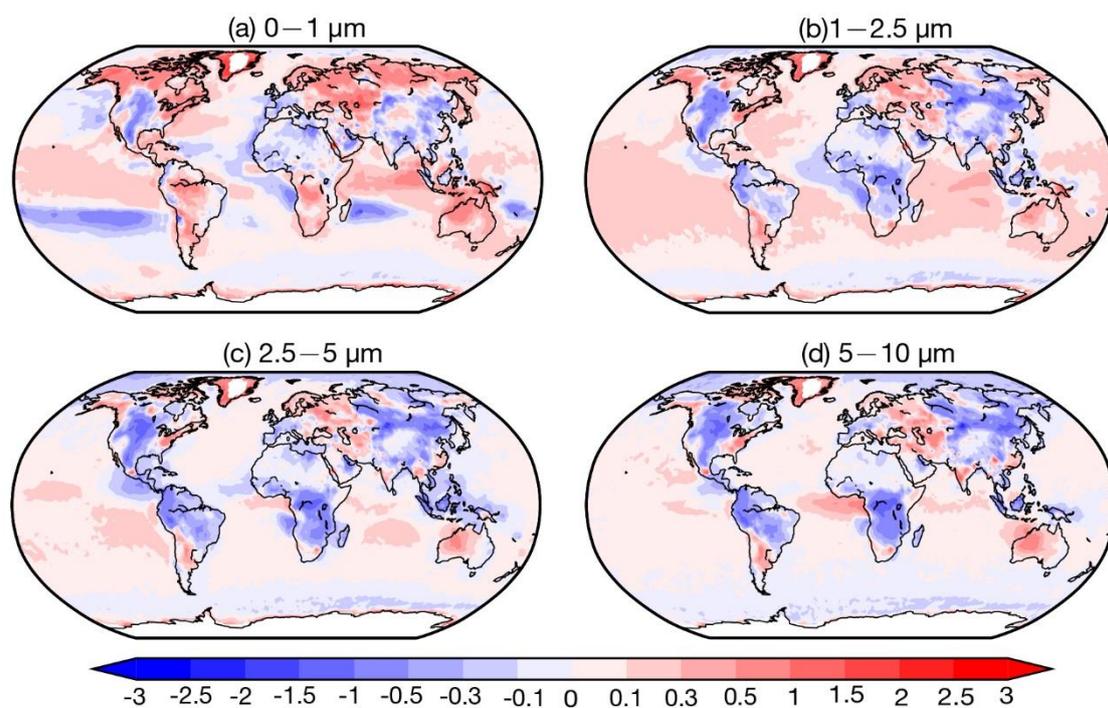


Figure S14. Global distribution maps of pH value absolute difference between Top-Dep case and base case in the size ranges of 0 – 1 μm , 1–2.5 μm , 2.5–5 μm , and 5 – 10 μm , averaged from 2010 to 2012.

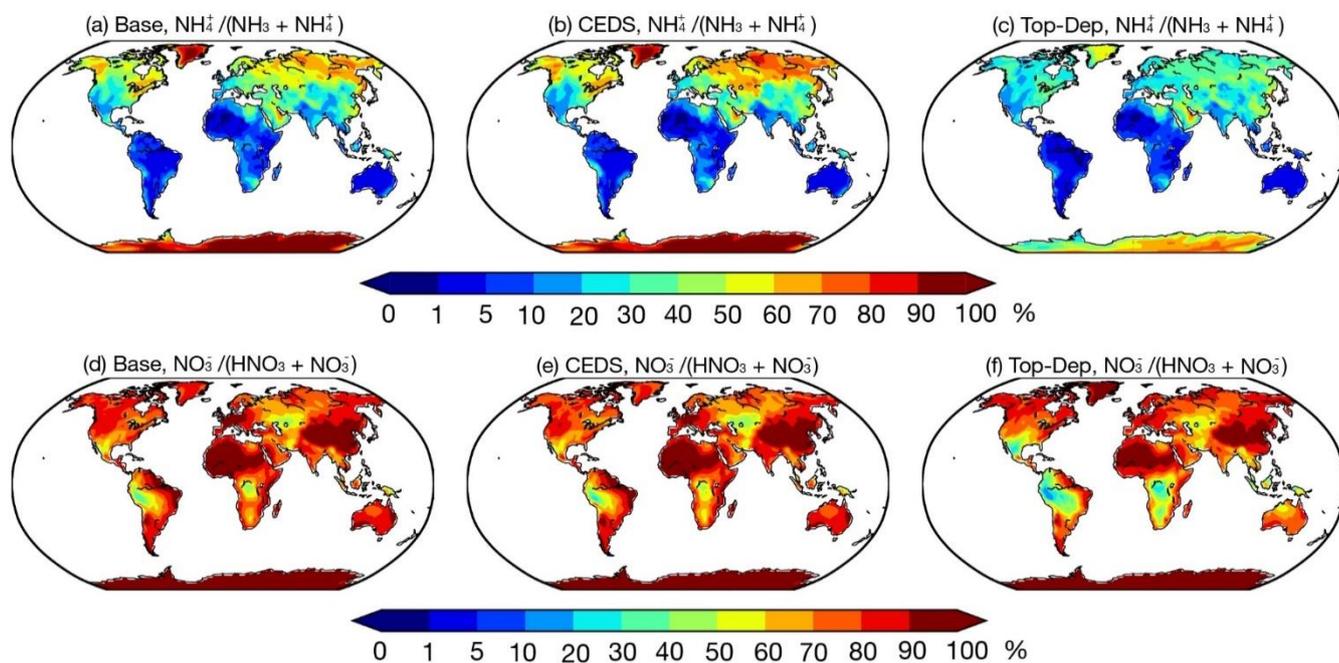


Figure S15. Global distribution maps of gas-particle partitioning molar ratio of $\text{NH}_3/\text{NH}_4^+$ and $\text{NO}_3^-/\text{HNO}_3$ from simulation results, averaged from 2010 to 2012.

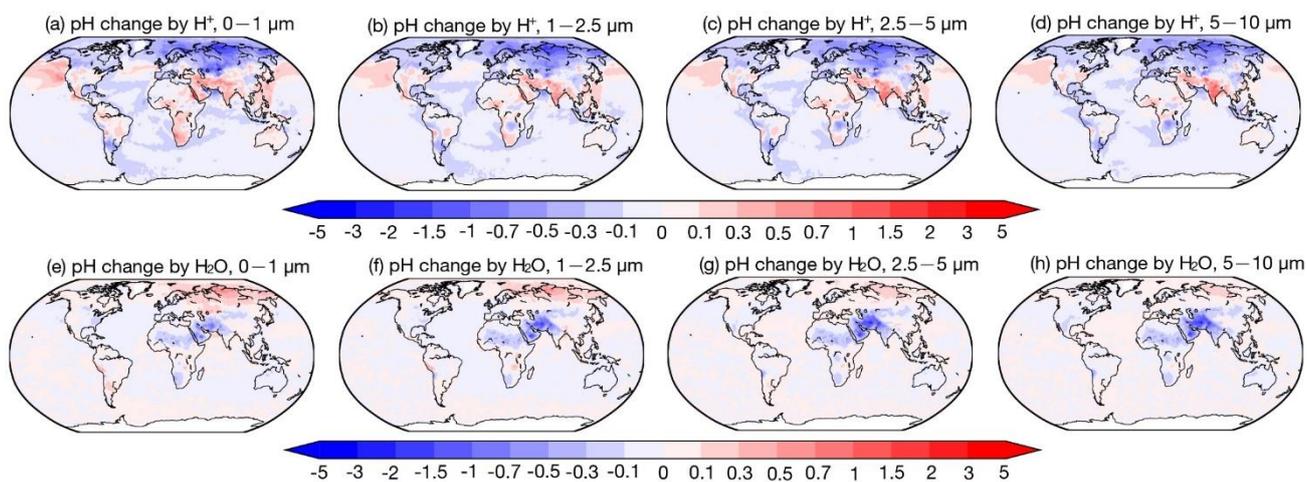


Figure S16. Global distribution of pH value changes derived by H^+ concentration change from CEDS case in the size range of 0 – 1 μm (a), 1– 2.5 μm (b), 2.5– 5 μm (c), and 5 – 10 μm (d); pH value changes derived by H_2O concentration change in the size range of 0– 1 μm (e), 1– 2.5 μm (f), 2.5– 5 μm (g), and 5 – 10 μm (h), averaged from 2010 to 2012.

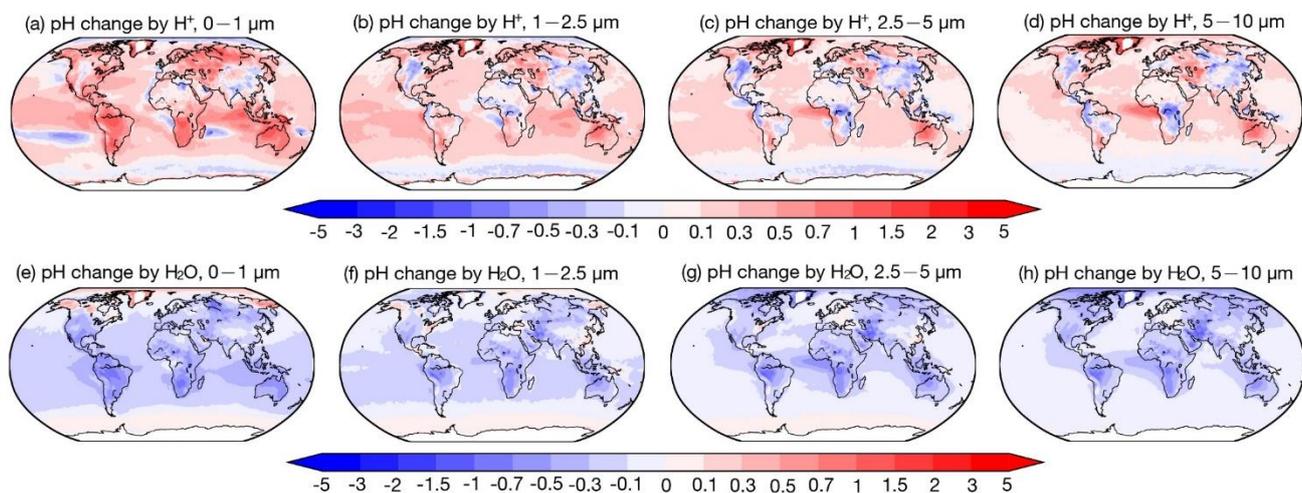


Figure S17. Global distribution of pH value changes derived by H^+ concentration change from Top-Dep case in the size range of 0 – 1 μm (a), 1– 2.5 μm (b), 2.5– 5 μm (c), and 5 – 10 μm (d); pH value changes derived by H_2O concentration change in the size range of 0– 1 μm (e), 1– 2.5 μm (f), 2.5– 5 μm (g), and 5 – 10 μm (h), averaged from 2010 to 2012.

Table S1. Regional NO_x and SO₂ emission amount (Tg yr⁻¹) comparison between CAMS and CEDS_GBD.

	NO _x			SO ₂		
	CAMS	CEDS_GBD	Relative difference	CAMS_GBD	CEDS_GBD	Relative difference
Land	75.89	86.19	14%	101.33	104.45	3.1%
North America	8.62	9.18	6.5%	9.56	6.87	-28%
South America	5.43	5.55	2.3%	4.80	5.80	21%
Europe	6.17	7.05	14%	7.9	8.08	2.2%
Middle East	3.33	3.43	3.2%	5.21	5.98	15%
South Asia	6.27	7.03	12%	9.88	9.56	-3.3%
East Asia	17.16	18.96	11%	27.95	29.08	4.0%