

# Review replies for the manuscript entitled “Representing improved tropospheric ozone distribution over the Northern Hemisphere by including lightning NO<sub>x</sub> emissions in CHIMERE” (egusphere-2024-3087) by Sanhita Ghosh et al.

We sincerely thank the editor and the reviewer for their valuable time and insightful feedback on our manuscript. Below, we address each comment in detail and outline the corresponding revisions made to improve the manuscript.

## Reviewer 1

1. L300-304: “which is not enough to differentiate land and ocean flashes” I don’t understand the above sentence. If the ICEFLUX scheme underestimates oceanic flashes wouldn’t that indicate that it is overestimating the land-ocean difference as opposed to being unable to differentiate the difference.

**Reply:** The reviewer is right. We have modified the sentence to avoid confusion.

According to Finney et al. (2014), the ICEFLUX scheme underestimates oceanic flash rates primarily due to weaker updraft strength in oceanic storms. This leads to less efficient charge separation, which in turn results in fewer lightning flashes. The ICEFLUX scheme explicitly relates lightning flash rates to the upward ice flux and since oceanic storms generally have weaker convection compared to land storms, the scheme naturally predicts lower flash rates over the ocean.

On the other hand, CTH scheme relies on cloud-top height as a proxy for lightning activity, which may not fully account for differences in updraft strength and charge separation efficiency over different surfaces, causing the estimation of relatively higher oceanic flash rates.

**Changes in the manuscript:** Please see the modified lines 298–300 in the manuscript, “The ICEFLUX scheme explicitly relates lightning flash rates to the upward ice flux; therefore, the weaker updraft strength in oceanic storms leads to less efficient charge separation, resulting in fewer lightning flashes over the ocean (Finney et al., 2014).”

2. L545-547: “The simulations also identify a secondary maximum in NO<sub>2</sub> column density at 35°–45°N, which aligns with satellite observations over the mid-latitudes, however, shows an underestimation from simulations.” I don’t understand what you mean here. Please rephrase.

**Reply:** We have modified the sentence for clarity.

**Changes in the manuscript:** Please see the modified lines 522–523 in the manuscript, “A secondary maximum in NO<sub>2</sub> column density is identified between 35°–45°N from simulations as well as from satellite observations. However, the simulated NO<sub>2</sub> column density is underestimated at mid-latitudes by 20%–40%.”

## References

Finney, D. L., Doherty, R. M., Wild, O., Huntrieser, H., Pumphrey, H. C., and Blyth, A. M.: Using cloud ice flux to parametrise large-scale lightning, *Atmospheric Chemistry and Physics*, 14, 12 665–12 682, <https://doi.org/10.5194/acp-14-12665-2014>, 2014.