

Response to Editors and Reviewers

We appreciate the reviewers for their careful reading and their constructive comments on our manuscript. As detailed below, the reviewer's comments are shown as *italicized font*, our response to the comments are normal font. **New or modified text is in blue.**

All of the line numbers refer to Manuscript ID: acp-2021-886.

Reviewer #1

This work assesses the neglected uncertainty in steady state approximation for interpreting NO₃ and N₂O₅ based on in-situ observation data and explores the key influencing factors for the accuracies of equilibrium coefficient and heterogeneous uptake coefficient. The results highlight the large impacts of aerosol loading, NO₃ reactivity, and ambient temperature on the chemical reaction coefficients and provide a good solution for performing accurate steady state approximation in particular in high aerosol loading conditions. The manuscript is generally well written, with innovative methods, deep mechanism investigation, full discussion, and fluent language. It can be considered to accept after addressing the following minor comments.

1. *Line 27-28, can the “concentration ranges appropriate” be “appropriate concentration ranges”?*

The statement is modified as suggested.

2. *Line 130, removal the “0” before “1, 2, 3, 4” in the labels of the horizontal axis.*

The figure is modified as suggested.

3. *Line 222, specify the “plural emissions”, e.g., strong biogenic or vehicle emissions.*

Thank you for the suggestion. We modify the description as follows.

“It indicates that the region with plural emissions (e.g. strong biogenic or vehicular emission) might not be suited for steady state fit due to the high k_{NO_3} .”

4. *Line 231, suggest pointing out the meaning of the ϵ , e.g., the correction factor for $[N_2O_5]/([NO_2] \times [NO_3])$, when it appears for the first time in a new section.*

Thank you for the suggestion. We add the meaning of this parameter here for better clarification as follows.

“Almost 20000 simulations are displayed in the parallel plot of Figure 4, where each line connects 5 constraint parameters to the calculated steady state time and ϵ (the correction factor for Keq parameterization to match the exact ratio of $[N_2O_5]/([NO_2] \times [NO_3])$, detailed in Eq.6).”