Reply on referee #4

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

All the line numbers refer to original version of Manuscript ID: **amt-2022-167**.

It is critical to developing in-situ γ(N2O5) measuring system with high accuracy since direct measurement of γ(N2O5) on ambient aerosols is still very scarce. Chen et al describe an aerosol flow reactor system combined with a box model to determine γ(N2O5) on ambient aerosols. As far as I know, this is the third direct measurement system of ambient γ(N2O5) which was successfully applied to field measurement. The system was built on two previous works (Bertram et al, AMT, 2009 and Wang et al., AMT, 2019) and has some similarities. The authors have made efforts to reduce the measurement uncertainty and improve the performance of the instrument, such as using periodical measurements of N2O5 source concentration at the entrance of the flow tube by using a well-designed tubing connection. N2O5 is very sensitive to NO, relative humidity, and temperature, which biases the entrance N2O5 concentration even within a short time period, and thus the γ(N2O5) results. The authors ran a detailed box model with the constraint of NO, NO2 and O3 at 'time zero' to retrieve N2O5 loss rate. These improvements can largely reduce the uncertainty of γ(N2O5) retrieval from varying ambient air mass and expand its adaptability and application scope. This work is a small step forward in the direct measurement of N2O5 uptake and can really contribute to the community. Overall, this paper is well written with detailed and comprehensive lab characterization and shows the feasibility of the performance in field applications. I recommend this manuscript published after attention to the following comment and minor mistakes.

1. To underscore the reduced uncertainty made by this instrument and further improve the readability, it is suggested that the authors refine the results of laboratory characterizations in sections 2 & 4 and compare the uncertainty and detection limit of this approach, if it is possible, with previous works.

Thanks for the valuable suggestions. We try our best to refine the description of flow tube system and its laboratory characterization tests in sections 2 & 4 according to reviewer's suggestion. There is no reported $\gamma(N_2O_5)$ detection limit in previous ambient flow tube studies. Thus, we only add the comparison of uncertainty with previous studies in section 5 as follows.

“To directly compare with previous studies, at 0.03 $\gamma(N_2O_5)$ with 1000 μm^2 cm^{-3} Sa, the uncertainty is calculated to be 19% which is lower than that ~24% in Bertram et al (2009) and that ranging 37%~40% in Wang et al (2018).”

2. Line 138: delete ‘to’.

We revise the sentence according to the reviewer’s suggestion.

3. Line 144: What is the advantage of using a static mixer? Please clarify its effect.

We clarify the advantages and effects of using a static mixer in front of the entrance as follows.

“A 10 cm long stainless-steel static mixer is mounted inside the Y-tee in order to swirl the flow and therefore facilitate the mixing between sampling stream and N_2O_5 source in a relatively short distance. The presence of static mixer ahead the inlet also help to improve the flow expansion after entering the flow tube by minimizing recirculation zone, which decreases the wall loss of N_2O_5 and particles (Huang et al., 2017).”

4. Line 301-302: Change to ‘be fully drained out of the flow tube’.

We revise the sentence according to the reviewer’s suggestion.

5. Line 367-369: Please clarify the temperature, RH, and the range of NO2 and O3 used in these tests.

We thank this suggestion and clarify the conditions of these tests according to the reviewer’s suggestion as follows.

“The levels of PNO_3 was adjusted by NO_2 and O_3 concentrations (O_3 ranging from 10 to 80 ppbv and NO_2 ranging from 50 to 160 ppbv) under the temperature of 283 K and RH of 30%.”