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Comment on amt-2022-167

Anonymous Referee #1

Referee comment on "Direct measurement of N_2O_5 heterogeneous uptake coefficients on ambient aerosols via an aerosol flow tube system: design, characterization and performance" by Xiaorui Chen et al., Atmos. Meas. Tech. Discuss., https://doi.org/10.5194/amt-2022-167-RC2, 2022

Wang et al describe an aerosol flow reactor for the measurement of the reactive uptake of N_2O_5 to ambient aerosol particles. This approach has already been reported in the literature and the approach taken by the authors is very similar to that previously reported. I suggest that the authors focus the paper on the specific aspects of the flow reactor system that are new and less on the aspects that are replication of prior work. In 2009, Bertram et al reported on the development of a flow reactor for measurement of the reactivity of ambient aerosol that is strikingly similar to this. In 2018, Wang et al reported on the use of an iterative box-model coupled to the flow reactor to improve the retrieval of the reactive uptake coefficients for N_2O_5 to ambient aerosol, which again is very similar to that used here. It is not clear what is new with this approach that would warrant a new publication. The authors need to make the case for what technological advancement has been made. It is also not clear that the uncertainty associated with the measurements have been reduced.

The authors do note that "simultaneous N_2O_5 measurement at both end of the flow tube" is a unique feature of this reactor. I find this statement to be misleading: 1) The measurement is NOT simultaneous. In this technique the top and the bottom of the flow tube are sampled sequentially within one duty cycle. 2) Sampling of the N_2O_5 concentration at the top and the bottom of the flow tube was also done in Bertram et al to retrieve daily wall loss terms (see section 3.2 of Bertram et al). The authors would need to argue that measuring the wall loss more frequently leads to a reduced uncertainty in the retrieved uptake coefficients if this is the primary technical advance of the paper.

There are a few aspects of the reported work and new directions that the authors could take this work that are (or would be) interesting:

- The residence time modeling in the flow tube was interesting, especially the conclusion that there are two flow paths. I think there is room for advancement in this technique if the distribution of reaction times was narrowed, while still preserving a long interaction

time. Alternatively, it would also be interesting to try to use the RTD that is modeled within the framework of the N2O5 retrieval as it is not clear to me that an average residence time is appropriate with this type of RTD.

- While there were some nice calculations of the uncertainty in the retrieved N2O5 uptake coefficient, actual measurements are most important. I would like to see systematic evaluation of the approach in the laboratory. Some example experiments that would be extremely informative might include: i) measurement of g(N2O5) as a function of surface area for a model compound at constant RH and NO. ii) Modulation of NO (and RH above the deliquescent point) at the inlet while flowing a constant surface area concentration of a known aerosol composition. These experiments would confirm whether the modeled uncertainty holds for experimental conditions.