

Anonymous Referee #1 Received and published: 25 December 2020

GENERAL COMMENTS: In this manuscript the authors describe the design and evaluation of a portable chamber they have constructed primarily for studying aerosol growth under controlled conditions in outdoor air. It is 1 m³ and consists of a metal frame and Teflon film chamber that is permeable to gases but not particles so that particle growth can be studied under ambient conditions. The chamber walls are transparent to solar radiation, so that the ambient air photochemistry can be reproduced, and the chamber is slowly rotated to reduce losses of particles to the walls. The performance of the chamber was evaluated in a Texas field study by comparing measurements of ambient and chamber concentrations of various trace gases and VOCs with predictions of a box model, and in general the agreement is excellent. Particle growth rates were measured over a few months by periodically adding seed particles to the chamber and measuring changes size distributions with an SMPS. The results provide valuable new measurements of the magnitude of growth rates and their dependence on particle size, which can provide insight into the growth mechanism, and diurnal and seasonal variations. Overall, this is a very impressive new apparatus for studying gas and aerosol chemistry and particle growth under authentic atmospheric conditions. It is a major advance in the field and has applications beyond those described here. The manuscript is very clearly written and includes all the details and evaluation measurements one can hope for. I think it should be published in AMT after the following minor comments have been addressed.

SPECIFIC COMMENTS:

1. Lines 282-287: The agreement of the curves in Figures 7-9 is obviously very impressive, but do the authors have any idea why at a few times the ambient concentrations significantly exceed chamber concentrations?

We believe the question is regarding the spikes in ambient concentration rather than the periods when there is a difference that is explained by chemical loss (e.g., of isoprene) in the chamber. As is most clearly seen in the center satellite image in Figure 4, the site was in a forested area, but still close to a highway and only a few km from a major interstate. Emissions from those and other local sources are believed to be responsible for the spikes in NO and at least some other species. Those spikes are smoothed out in the chamber because of the ~30 min exchange time with the surrounding ambient air.

2. Lines 316-318: Are the ammonium sulfate seed particles in the chamber dry or deliquesced? Deliquesced ammonium sulfate particles will generally have very low pH (~1 or so) due to evaporation of ammonia. If the particles are deliquesced do the authors have any idea what ambient ammonia concentrations were? The pH could be estimated using E-AIM, for example. The nature of the seed could have a significant impact on SOA formation and growth via aqueous phase chemistry and acid catalysis. The authors might discuss this issue and offer suggestions on the best seeds to use, depending on measurement goals.

The seed particles were dried prior to injection. However, the ambient and chamber RH often exceeded the deliquescence RH of ammonium sulfate at night. Thus, the particles were sometimes dry and sometimes aqueous, and sometimes there was undoubtedly a mixture of dry and aqueous particles in the chamber at the same time. We appreciate the importance of aerosol composition, phase state, and

pH on particle phase chemistry and SOA formation. Some of our near-future experiments with the chambers are intended to examine the influence of seed particle composition and water content. For the experiments described in this manuscript we wanted to focus on variability with time-of-day and between days and, therefore, we tried to keep everything else unchanged, including the composition of the seed particles. Though it is not conclusive, some evidence that seed particle composition did not have a significant impact comes from the similarity in the growth rates of particles that formed from nucleation and those that were initially pure ammonium sulfate, as shown, for example, in Figure 12.

We added the following sentence to Section 5 immediately after stating that the seed particles were composed of ammonium sulfate.

“Future studies are planned to evaluate the sensitivity of particle growth to the composition of the seed particles.”

3. Line 388: Can the authors describe what steps were taken to minimize wall charging?

Following assembly of the chamber but prior to putting the acrylic sides on, concentrated bipolar ions were generated with a Po-210 source and directed towards the outside of the FEP as the chamber rotated. The acrylic sides were then installed, which prevented any further contact that could result in static charge. Some charge was likely removed at night when the RH inside and outside of the chamber was high. Towards the end of the campaign we also experimented with sliding a Po-210 source back and forth on a track underneath the chamber as it rotated. Since then we have stopped using Po-210 sources and rely instead on bipolar corona discharge ionizers, which are not quite as effective (or balanced), but obviously much easier to ship and use.

4. Are particle wall losses due mostly to diffusion?

We believe that diffusion is a large contributor to the loss of all but the supermicron particles. Unfortunately, it is difficult to determine the relative importance of diffusion and of electrostatic loss based on our results. The size range spanned by the tracked mode particles was not large enough to allow us to infer the dominant mechanism(s) based on any size-dependence of the loss. Furthermore, any attempt to quantify the size dependence would be complicated by time-of-day dependent variability in convective mixing (as is evident in Figure 15a) and day-of-experiment variability in things like static charge. Nevertheless, the observation that particle lifetime in these chambers is comparable to that in much larger ones, as summarized in Table 1, suggests that electrostatic loss is comparatively less important than in other Teflon chambers (making diffusion comparatively more important).

5. Line 417+: I suggest the authors provide some discussion of how gas-wall partitioning of VOC reaction products to the chamber walls can influence measurements of aerosol growth rates and products. It is now well established (e.g., Matsunaga and Ziemann, AST, 2010; Krechmer et al., EST, 2016) that this process has a significant impact on SOA formation and that equilibrium is reached in Teflon chambers on timescales of ~10 min and probably less in this small chamber.

We added the following brief discussion towards the end of Section 4:

“No attempt was made to account for gas-wall partitioning of VOC reaction products, despite recognition that such partitioning is significant and can complicate interpretation of results from Teflon chambers (Matsunaga and Ziemann, 2010; Krechmer et al., 2016). For species that partition reversibly to the walls, the impact may be only an increase in the ~30 min effective chamber-ambient exchange time by an amount comparable to the ~10 min time scale for reaching equilibrium for photochemically generated oxidation products as reported by Krechmer et al. (2016).”

TECHNICAL COMMENTS 1. Line 23: Should be “membrane is”.

We fixed this. Thank you.