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Interactive comment on “Dependence of particle nucleation and growth on high molecular weight gas phase products during ozonolysis of α -pinene” by J. Zhao et al.

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Received and published: 21 June 2013

The authors would like to thank the reviewer for valuable comments. The reviewer's comments are addressed point by point below.

1. p. 9325, Line 25: No attempt was made to scavenge OH radicals generated in the ozone-piene system. Can an estimate be made of the amount of OH generation?

A yield of about 76% for the OH radical from ozonolysis of α -pinene was previously measured (Forester and Wells, 2011). We did not measure the concentration of the OH radical, but it is likely that both OH and O₃ contributed to the measured reaction

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products. We agree that it will be important to determine the separate roles of OH and O₃, but that will be a subject of future studies. A recent study of ozonolysis of α -pinene shows that the produced OH radical can account for about one third of the secondary organic aerosol (SOA) formation and ozone accounts for the remaining two thirds (Qi et al., 2012). The following sentence was added on p. 9325-6: “A recent study has demonstrated an OH yield of about 76% during the ozonolysis of α -pinene (Forester and Wells, 2011), so both OH and ozone likely contributed to the formation of the reaction products detected in this study.”

2. p. 9326, Line 16: A little more justification would be useful of why experiment E1 is the focus of the paper. On page 9328, line 26, the 10-20 nm particles present in the background are described as “associated detectable Category I products.” What is the source of these particles? Residual products from prior experiments?

The source of background particles (point b in Figure 1b) is not clear. We did not observe such particles in every experiment, so it is possible that they are generated from the residual products of the prior experiment. However, the amount of aerosol present in the chamber when ozone was added was not significant compared to the levels of particles formed after ozone was added. We focused the discussion on E1 because it clearly shows the correlations between category I and II compounds and particle concentrations. We added several sentences on p. 9326, “The source of those background oxidized VOCs and particles is not known. It is possible that they were formed from the residual products of the prior experiment. However, the amount of aerosol formed after the ozone was added greatly exceeded the amount of aerosol present when the ozone was added (point b in Figure 1b).” We modified the sentence on p. 9328 “Also a sharp increase of 10–20 nm particle concentration was observed upon ozone addition” to “Also a sharp increase of 10–20 nm particle concentration was observed upon addition of ozone that clearly exceeded the concentration of any background particles (Fig. 1a).”

3. p. 9333, Line 9: What is the source of residual SO₂?

A zero air generator was used to produce the carrier gas. No additional precautions were taken to remove SO₂ before the house compressed air was sent to the generator. Hence there is a possibility that residual SO₂ was present in the zero air. We added a sentence on p. 9333, “Residual SO₂ was likely present in the zero air since the SO₂ was not scrubbed before the house compressed air was delivered to the zero air generator.”

4. p. 9336, Line 7-: The nitrate dimer ion was used as the reagent ion in the Cluster CIMS. Tests with the acetate dimer ion revealed a “much higher total steady state concentration of all products.” The choice of reagent ion is the single most important aspect of CIMS. One wonders how the conclusions of the study might have been affected if the acetate dimer had used a priori as the reagent ion. Would additional experiments be warranted with acetate?

We used nitrate dimer ion as the reagent ion for most of the experiments. Nitrate dimer ion is more selective than the acetate dimer ion, which aids in product detection. The background levels are also lower compared to those from the acetate dimer ion. In general, acetate dimer ion is less selective and more products are detected. On the other hand, background levels are higher and the spectra are more complicated when the acetate ion is used rather than the nitrate dimer ion. In addition, the ion chemistry of nitrate is better understood than that of acetate. Since our study focused on small particles (10–20 nm), within the measurement uncertainty, it is likely that Category I products contribute to the rapid growth of particles in the first hour after detection of 10 nm particles (p. 9335). In fact, we pointed out on p. 9335–6 in the paper that “The total steady state concentration of both Category I and II compounds is at least one order of magnitude lower than required for the observed particle growth rates of 28 nm h^{−1}, indicating that they are probably not the dominant species responsible for the growth of larger (> 20 nm) particles.” We added the following clarifying sentences on p. 9336, “It is likely that more oxidation products would be detected if acetate dimer ion were used as the reagent ion. Contributions of those products to the growth of larger (> 20 nm)

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particles will be studied in the future.”

References:

Forester, C.D. and J.R. Wells. Hydroxyl radical yields from reactions of terpene mixtures with ozone. *Indoor Air*, 21, 400–409. doi: 10.1111/j.1600-0668.2011.00718.x, 2011.

Qi, L., S. Nakao, and D. R. Cocker III. Aging of secondary organic aerosol from α -pinene ozonolysis: Roles of hydroxyl and nitrate radicals, *J. Air & Waste Manag. Assoc.*, 62, 1359-1369, 2012.

Interactive comment on *Atmos. Chem. Phys. Discuss.*, 13, 9319, 2013.

ACPD

13, C4004–C4007, 2013

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