

Atmos. Chem. Phys. Discuss., referee comment RC4  
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## Comment on acp-2022-86

Anonymous Referee #4

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Referee comment on "Reversible and irreversible gas-particle partitioning of dicarbonyl compounds observed in the real atmosphere" by Jingcheng Hu et al., Atmos. Chem. Phys. Discuss., <https://doi.org/10.5194/acp-2022-86-RC4>, 2022

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The article by Hu et al. titled "Reversible and irreversible gas-particle partitioning of dicarbonyl compounds observed in the real atmosphere" discusses the importance of reversible and irreversible gas-to-particle partitioning of glyoxal and methyl glyoxal. The authors present experimental and modeling results showing how irreversible gas-to-particle partitioning dominates the two partitioning pathways and also highlighted the other reaction processes that were not taken into account in the analysis of this study. The study is relevant for the atmospheric community and can be accepted to ACP after the comments have been addressed.

### Major corrections

1. Page 5, line 134: What are the other carbonyls that were measured in the gas and particle phases?
2. Based on what's written at the end of page 7 and later, the measured dicarbonyls in the particle phase are only ones that have formed products of the reversible pathways. It wasn't clear earlier when you talk about experimental partitioning coefficients that they only include reversible partitioning, point it out somewhere earlier to avoid confusion.
3. Page 8, line 210: How exactly are the proportions of hydrates and oligomers at different RH calculated? Table S2 gives the hydration rate constants as (pseudo) first order rate constants, so the amount of water should have no effect on the equilibrium, right? Or are the experiments used in these calculations somehow? Please specify in the text.

### Minor corrections

1. In the abstract "These two pathways of dicarbonyls jointly contributed to more than 25% of SOAs in the real atmosphere"
2. Page 1, line 27-28: "The  $\alpha$ -dicarbonyl functionality increases their water solubility and reactivity more than expected" would be better if you say something like "The  $\alpha$ -dicarbonyl functionality leads to higher water solubility and reactivity than expected." Otherwise, specify how the solubility and reactivity have increased (from what).
3. page 2, line 36-37: "however, there is still a missing sink for the two dicarbonyls" Do you mean that the known sinks listed before are not large enough to explain the loss of

the dicarbonyls from the gas phase? Or that there is a specific sink mentioned by Volkamer et al. that wasn't listed here? Please specify.

4. page 3, line 72: "among key regions with relatively higher PM2.5 concentrations" Do you mean that the the key regions have relatively higher PM2.5? Or Beijing has relative higher PM2.5 concentrations than the other key regions? Please specify.

5. Page 5, line 145: define GL and MG

6. Page 6, line 164: "lower temperature promoted the partitioning processes" do you mean gas-to-particle partitioning, or also particle-to-gas? It isn't clear by saying "partitioning processes".

7. Page 7, line 197: "which are more reactive than their counterparts" how do you determine "more reactive"? Aren't glyoxal and methylglyoxal also reactive, because they quickly react with water to become hydrates? Or are the reactions of the hydrates even faster than the non-hydrated glyoxals?

8. Page 7, line 199: "the most thermodynamically favored oligomer reactions for glyoxal and methylglyoxal" Specify that the reactions are for the hydrates, not (only) non-hydrated glyoxal and methylglyoxal.

9. Page 8, line 208-209: "The product distribution of the reversible formation could well explain this phenomenon." How?

10. Figure 2c: The two gray colors (estimated and theoretical values) are very similar, how about using some colors for them? Also, correct "porduct" to "product" in the title and add y-axis label to Figure 2b.

11. Page 8, line 223: "Combined with the vapor pressure of dominant products" where do you get the vapor pressures of the dominant products?

12. Figure 3: What are the lines in 3b? Also model like in 3c? Also, there are typos in the caption "(i) galyoxal and (ii) methylglyxoal"

13. Page 10, line 287: There are 2 figures in the Supplement labelled S7. In the second Fig. S7, what is the concentration unit for SNA in the ratios? Mass/mole/volume ratio?

14. Page 13, line 369: "Furthermore, we note that there may be other potential explanations for the increase in particulate concentrations and the uncertainty in the gas-particle partitioning process." Particulate concentrations of what? And which partitioning processes?

15. Page 13, line 371-372: "Other reversible pathways, like adducts formed from glyoxal with inorganic species, like sulfate and ammonia, could also promote the gas-particle partitioning process." I think you mean "such as", not "like". You used the the word "like" similarly also earlier in the manuscript so check those too.