

Atmos. Chem. Phys. Discuss., referee comment RC1  
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## Comment on acp-2022-139

Anonymous Referee #1

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Referee comment on "Elucidating the critical oligomeric steps in secondary organic aerosol and brown carbon formation" by Yuemeng Ji et al., Atmos. Chem. Phys. Discuss., <https://doi.org/10.5194/acp-2022-139-RC1>, 2022

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This theoretical work conducted a comprehensive examination on the essential aqueous-phase oligomerization pathways of glyoxal without and with amine/ammonia and reveals their rate-limiting steps during isomeric processes. The detailed thermodynamic and kinetic characterization of the heterogeneous reactions of glyoxal in this study provided valuable insights into the formation mechanisms formation of secondary organic aerosol (SOA) and brown carbon (BrC) starting from small alpha-dicarbonyls in the atmosphere. The evidences are sufficient and the mechanisms are elucidated well.

There are minor issues with the manuscript:

Lines 277-278: A little confuse about the statement here: If  $\gamma_{GL}$  used was only suitable for urban condition, estimating other atmospheric conditions should be unreasonable, right? Also, does it mean that there are no available  $\gamma_{GL}$  values for remote and rural conditions from literatures like Liggio (2005)'s study? BTW, "are not" should be "is not".

Lines 294-303: Did the authors identify these primary reaction pathways based on their branching ratios?

Line 320: please also estimate the mean tau or its ranges for gas-phase processes.

Line 28: The full name of SOA is missed.

Line 30: "particle" -> "particles"

Line 34: "particle-phase and aqueous-phase" -> "particle- and aqueous-phase"

Figure 5: Please describe each circle ring in the caption.