Review for:

Dependence of CCN Closure Relationship with Organic Fraction from Two Airborne Field Campaigns over Mid-Latitude Land and Ocean

Overall comments:

This manuscript addresses how aerosol composition, specifically organic fraction, can influence CCN closure results. The authors obtain aerosol composition and CCNC measurements from aircraft observations in different field campaigns, ACE-ENA and HI-SCALE. The sites differ in their environments, resulting in differing composition and changes in CCNC observations and closure. The results highlight the importance of understanding regional aerosol sources in order to reduce the gap between observed CCNC results and model results. The paper can be a great asset for future studies bridging the gap between modeled and observational CCN. I do have a few questions/a comment:

Specific comments:

Page 5, Lines 121 – 125: I would suggest putting the supersaturation levels and kappa values used here; it was confusing to have this mentioned and then not find the values until later

Page 7, Line 159-160: I understand the kappa values were pulled from Liu et al., but why not prescribe kappa values for each species as opposed to lumping non organics under a singular value? For example, Kulkarni et al assigned a range of kappa values of soluble organic, and kappa of 0.7 for nitrates and sulfates. These values are higher than the assigned kappa inorg of 0.507– would this not affect the closure results? Does the kappa inorg value also include elemental carbon (kappa of 0) by chance?

Citation: Kulkarni, G., Mei, F., Shilling, J. E., Wang, J., Reveggino, R. P., Flynn, C., Zelenyuk, A., & Fast, J. (2023). Cloud Condensation Nuclei Closure Study Using Airborne Measurements Over the Southern Great Plains. *Journal of Geophysical Research: Atmospheres*, *128*(5), e2022JD037964. https://doi.org/https://doi.org/10.1029/2022JD037964

Figure 3(d): How are the error bars for CCN number determined?

Page 13, Line 292: With internal mixing contributing to gaps in the CCN closure, would you consider other kappa hygroscopicity frameworks or incorporating other models? For example, using PartMC (Riemer et al 2009) to assume external, internal mixing, and phase separated morphology? What about calculating kappa using frameworks that assume phase separation (Malek et al 2023)? The future work

Citations:

Riemer, N., West, M., Zaveri, R. A., and Easter, R. C. (2009). Simulating the Evolution of Soot Mixing State with a Particle-Resolved Aerosol Model. *J. Geophy. Res.*, 114:D09202. DOI:10.1029/2008JD011073.

Malek, K., Gohil, K., Olonimoyo, E. A., Ferdousi-Rokib, N., Huang, Q., Pitta, K. R., Nandy, L., Voss, K. A., Raymond, T. M., Dutcher, D. D., Freedman, M. A., & Asa-Awuku, A. (2023). Liquid–Liquid Phase Separation Can Drive Aerosol Droplet Growth in Supersaturated Regimes. *ACS Environmental Au*, *3*(6), 348–360. https://doi.org/10.1021/acsenvironau.3c00015