

Review of “The effect of organic nucleation on the indirect radiative forcing with a semi-explicit chemical mechanism for highly oxygenated organic molecules (HOMs)” by Shao et al. [Research Article, egusphere-2024-4135]

This is an interesting study. The authors incorporated a HOMs-related chemistry and nucleation scheme into a climate model and explored the influence of the HOMs-derived NPF on CCN formation, along with the ensued changes in radiative forcings caused by ACI. Their results showed that including NPF mechanisms in the model can improve simulations of CCN number concentrations. With the new scheme, the authors found that significantly more CCN are generated from organic NPF in PI than PD, which greatly weakens the effective radiative forcing due to ACI. They argued that the weakened radiative forcings are not caused by altered nucleation rates as proposed by Gordon et al. (2016). Rather, it is primarily driven by the more enhanced sub-20 nm growth rate in PI compared to PD. I enjoyed reading this paper, which is very well organized and easy to follow. But there are a few grammatical errors that should be corrected. I have listed some below, but not exhaustive. This work demonstrates the important role of biogenic NPF in CCN formation especially in PI, which enhances our understanding of aerosol emissions and associated nucleation processes in radiative forcings and might help reduce the uncertainties of ACI among climate models in the future. Therefore, I believe this paper will be well-suited for publication in ACP if a few minor issues are addressed.

1. An important finding of this study is that the greater increase in CCN in PI than PD is attributed to organic condensational growth on sub-20 nm particles. I wonder whether the authors have examined the full CCN budget to rule out the impact of other contributing processes. For example, the sinks of CCN via precipitation scavenging might also play an important role.

2. To minimize the influence of meteorological fields on the results, the authors nudged T, winds, and others to MERRA2 reanalysis in the short-term simulations. But the methodology of the nudging experiment is not clearly described, such as what nudging time scale and temporal resolution of MERRA2 are used. A brief examination of simulated winds fields against MERRA2 would also be helpful to strength confidence in the nudging approach.

3. Since the primary goal of Figure 1 is to compare the bias errors of two simulation experiments against observations, rather than to examine correlations, I strongly recommend replacing the scatter plots with bar plots. The current scatter plots do not effectively convey the contrast between the two experiments. Instead, bar plots would allow a clearer demonstration of the simulation errors for each experiment across different regions. To enhance interpretability, the regions could be categorized into Marine, Urban, and Mountain environments, using distinct colors for each category. Additionally, to examine whether the improvement in CCN simulations by Inorg_Org is statistically significant, error bars should be added also.

Specific comments:

L30-32: The authors may consider removing the sentences “while the greater ... nucleation rates involving sulfuric acid and organics”. The current sentences look confusing here and disrupt the

reading flow. Alternatively, if the authors wish to retain these sentences, they need to rephrase these sentences to more clearly align with the argument proposed by Gordon et al. (2016).

L57: “are they” to “they are”

L59: “stringent” to “rigorous”

L171-172: It is difficult to discern the regional variation in bias from Figure 1.

L213: “simulated” to “found”

L215: “a low” to “the originally low”

L221: “in PI” to “in the PI”

L224: Add description for panels (c) and (d)

L229: CCN number concentration?

L230: But adding the NPF mechanism would increase aerosol burden, and thus change the direct radiative forcing, although the size distribution might not change.

L278: “in PI” to “in the PI”

L278: “leading” to “leads”

L281: “compared to PI” to “compared to the PI”

L284: “in PI” to “in the PI”

L295: remove “was neglected”

L312: Be specific about backgrounds

L315-320: To be clearer, the authors should first clarify how organic nucleation changes are responsible for greater enhancement in PI’s CCN burden in previous studies or Gordon et al. (2016). They can then highlight how their findings differ from those earlier results.

L320: add a period at the end of the sentence.

L328-330: Rephrase the sentences to emphasize “although our methods improve the simulations of CCN burdens”

L336: remove “the”

L340: remove the extra period