Atmospheric Chemistry and Physics Discussions

Atmos. Chem. Phys. Discuss., referee comment RC2
https://doi.org/10.5194/acp-2022-203-RC2, 2022

Comment on acp-2022-203

Anonymous Referee #2

Referee comment on "Long-term variability in immersion-mode marine ice-nucleating particles from climate model simulations and observations" by Aishwarya Raman et al., Atmos. Chem. Phys. Discuss., https://doi.org/10.5194/acp-2022-203-RC2, 2022

Review of "Long-term Variability in immersion-mode Marine Ice Nucleating Particles from Climate Model Simulations and Observations"

Raman et al. (2022)

The authors present a detailed comparison of observed and modeled immersion-mode marine INP using a number of observational datasets in the Southern Ocean region, measurements from aircraft, global coastal sites, and output/diagnostic variables from E3SMv1. With limited aerosol information, the authors find that E3SMv1 underpredicts the INP concentration by 1 – 2 orders of magnitude at all sites compared due to inadequate treatment of dust immersion freezing in the model INP parametrizations. Secondarily, it is found that biases in modeled and observed INP concentrations at coastal and open ocean sites in the Southern Ocean are likely due to processes (chemical, biological, physical) interacting near an island source of INP, with recommendations provided to the scientific community to better understand and model the process.

Overall, I think the paper is written well and the results describing the MICRE dataset and its comparisons with model estimates are important to report to the scientific community. Therefore, this paper is worthy of publication in ACP after addressing the following comments/concerns.

Comments:

Line 264: Can a reference please be provided for ATom PALMS instrumentation and measurement?

Figure 2: Please format the ordinate axis in panel(e) to that of the other panels.

Figure 2 caption: Can you please clarify "Also shown are the E3SM simulated sea salt climatology at the Macquarie Island and time series of dust concentrations from AWARE field campaign with co-located E3SM model simulations"? I am only seeing the observed and simulated dust climatologies in this figure, not sea salt.

Line 285: Which figure is being referenced here? Is it Figure S2? (authors have left "??").

Line 285: This line reads a bit awkwardly; please proof read. A "the" might need to be added following the comma after "stations".

Line 290: change "budget" to "budgets"

Line 303-305: Please clarify, "dust concentrations do not vary much below 400 hPa in E3SM simulations and ATom measurements". Do the authors mean the difference in values between the model and observations are not very different? Or, are the authors discussing a statistical metric of variability in the average values below 400 hPa; no model variability is shown in Figure 4.

Line 303-305: The authors note that the lack of vertical variability in dust concentration for ATom and E3SM is "consistent with the lack of local emissions from the underlying ocean surface". Do the authors not consider advection of dust from continental regions above the surface that may impact variability?

Figure 4: Do the horizontal line extensions (error bars) on each vertical point represent the range of values or variability in the ATom measurements? Please clarify this in the caption. Why is this not shown for the averaged model output as well?

Line 311: Please clarify "good agreement in model vertical gradient". Is this assessed visually or statistically?

Line 312: A source of literature here would provide support for this claim of

microphysical/optical implication.

Figure 6: The caption for this figure does not clarify what the acronym “FGE” means.

Figure 7: What are the values represented in the brackets of the legend? Are these values discussed in the text? This needs to be clarified in the caption.

Line 378-379: With very close visual inspection of Figure 7b, one could potentially see that CNT “agrees well with INP measurements”, though it is a bit challenging due to the number of data points and numerous colors. Are the authors able to provide a statistical metric of agreement between the MICRE observed INP concentrations and those of the model values?

Line 410-415: Ship stack exhaust has been mentioned as a significant influence on aerosol and particle measurements during the MARCUS campaign (Humphries et al., 2021). Can the authors please provide a discussion on how this influence was removed from the dataset or how ship stack exhaust may influence/bias the MARCUS INP dataset?

Line 425-429: Are the authors able to point to literature that supports the claims of potential biases between MICRE INP and the model from island processes described in this passage?

References

Humphries, R., Keywood, M., Gribben, S., McRobert, I., Ward, J., Selleck, P., Taylor, S., Harnwell, J., Flynn, C., Kulkarni, G., Mace, G., Protat, A., Alexander, S., and McFarquhar, G.: Southern Ocean latitudinal gradients of cloud condensation nuclei, Atmospheric Chemistry and Physics, 21, 12757-12782, 10.5194/acp-21-12757-2021, 2021.