

Interactive comment on “Factors controlling marine aerosol size distributions and their climate effects over the Northwest Atlantic Ocean region” by Betty Croft et al.

Anonymous Referee #2

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The paper by Croft et al. provides an assessment of size distributions and its controls over the Northwest Atlantic Ocean. Climate effects of selected processes are included as forcings, both direct and 1st indirect effect. The work is very valuable: marine aerosol background, especially aerosol size distribution, is not well constrained in climate models. While the analysis in the manuscript is rather standard, the paper is generally well written and results are presented in a clear way. Below are detailed comments on selected issues with the research itself. Some issues listed below should become more clear in the revised manuscript.

The study applies activation-type nucleation (l. 265) with linear function of sulfuric acid

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concentrations. The empirical activation nucleation coefficient ($A=2 \times 10^6 \text{ s}^{-1}$) is retrieved in continental environments, and is known to include high variability even over land. As discussed in the same paragraph (l. 275), the role of marine organic compounds in nucleation remains unclear, which also has implications in using continental empirical coefficient A in marine environment. This might be very essential for the study, especially since ABLNUC seems to produce a significant AIE (Fig. 8).

Also, is the activation-type nucleation really active only between MBL-top and 2 km altitude (l. 265)? Why not through all levels in MBL? Although large-scale models have typically limited a separate nucleation mechanisms, such as activation-type nucleation to the BL, it seems even more unphysical to limit a mechanism to only a few (not well defined?) regions of the model system. Perhaps another mechanism/parameterization could better account for different regimes in the surface/BL/BL-top/2-km/free troposphere system.

The choice and reasoning behind MSOA emission parameters remains non-conclusive. Five sets of two parameters for MSOA source are simulated, and size distributions are used in constraining the best possible parameter set (e.g. Fig. S1). I do not see that the information compiled in Figs. S1-S4, or even the statistics in Table S1, would convince the chosen source parameters as the best plausible set. Considering the amount of additional assumptions for MSOA, e.g. volatility and chemical processing (l. 321) as well as dismissing the effect on NPF, the uncertainty in simulated MSOA and conclusions on the respective aerosol-cloud effects remains non-satisfactory.

One key factor when analyzing the role of nucleation or early growth is to constrain the background aerosol, in this case sea spray aerosol, to have e.g. realistic sink described for NPF. According to l. 298, sea salt emissions are simulated according to Jaeglé et al. (2011). Jaeglé et al. (2011) compares several formulations of sea spray emission. Assuming this refers to the flux as a function of SST, Jaeglé et al. (2011) shows that this decreases global emissions from 5200 to 4600 Tg/yr when compared to Gong (2003), with clear reduction over study area. However, e.g. Regayre et al. (2020) used

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a massive amount of observations was to constrain a global model with Gong (2003) sea spray flux, and the process indicated that simulated sea spray flux was even a factor of 3 too low. Perhaps this result is not applicable to the study region used here, but some discussion on potential biases could be discussed in model description or in conclusions.

The simulations are using a very coarse horizontal resolution, 4x5 degrees. Even while the observation/model comparison is using hourly output, there is no discussion on potential biases or sampling issues with large grid-scale. Is there any horizontal interpolation performed when sampling the model data against flight/ship data?

References:

Regayre, L. A., Schmale, J., Johnson, J. S., Tatzelt, C., Baccarini, A., Henning, S., Yoshioka, M., Stratmann, F., Gysel-Beer, M., Grosvenor, D. P., and Carslaw, K. S.: The value of remote marine aerosol measurements for constraining radiative forcing uncertainty, *Atmos. Chem. Phys.*, 20, 10063–10072, <https://doi.org/10.5194/acp-20-10063-2020>, 2020.

Interactive comment on *Atmos. Chem. Phys. Discuss.*, <https://doi.org/10.5194/acp-2020-811>, 2020.

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