Review of "Impacts of marine organic emissions on low level stratiform clouds – a large eddy simulator study" by Prank et al. (acp-2022-265)

The manuscript addresses how aerosol particles formed from sea spray or marine gas-phase emissions affect the colloidal stability of stratocumulus clouds using large-eddy simulations. The authors compare different parameterizations of the aforementioned aerosol sources, showing that their effects on stratocumulus stability can vary substantially based on the type of parameterization applied in their simulations. While I generally appreciate the authors' efforts and agree with most results, I have substantial concerns about how well the effects of giant cloud condensation nuclei (GCCN) on the collision/coalescence process are represented by the applied cloud microphysics scheme. As the effects of GCCN constitute one pillar on which the study is based, I cannot support the publication of this study in its current form. Please note that my review focuses on cloud microphysical processes and their modeling, as my expertise does not cover the chemical details addressed in other parts of the study.

Major Comments

Description of the cloud microphysical model. While the authors spend several lines on how the different chemical species and types of aerosol are considered in their model (ll. 118 – 181), I miss a similarly detailed explanation on the applied cloud microphysical model. There are some hints on how cloud microphysics are represented in Sec. 2.2, but I miss a more concise description. The most important questions are: How is the aerosol hygroscopicity considered in the condensational growth of droplets? Is condensational growth explicitly represented or treated by a saturation adjustment scheme, as often done in simpler cloud microphysical models? Do the authors account for supersaturation changes on a sub-timestep level (e.g., Clark 1973)? How does Seifert and Beheng (2001) autoconversion scheme consider GCCN? These questions are crucial because the way these processes are represented in the cloud microphysical model affect the simulated cloud and its behavior.

The effect of GCCN (ll. 270 – 273). As outlined above, I doubt that the applied collision/coalescence scheme can adequately represent the effect of GCCN, as it is only based on the number and mass of cloud and rain drops, without considering the GCCN explicitly. While I might miss a detail here, the relatively minuscule effects of the GCCN shown in Fig. 3c (blue and gray lines) do not indicate a substantial effect. While it is known that precipitating clouds are not very susceptible to the addition of GCCN, the results agree with my expectation, but this behavior might also be caused by an insufficiently represented GCCN effect on collisional growth.

Minor Comments

L. 27: Define SOA.

Ll. 8 – 29: The abstract is too long. Consider shortening it.

L. 12: A large-eddy simulation model is used to simulate dynamics, not aerosol particles, cloud droplets, or rain drops. A cloud microphysical model does this.

Ll. 17 ff.: The concept of a lifetime for stratocumulus clouds is odd. I would rather refer to the transitioning timescale between closed and open cells.

Ll. 38 – 39: The role of longwave radiative cooling in causing and sustaining a cloud, especially a stratocumulus cloud, should not be understated.

L. 40: The aerosol size distribution contains information on the aerosol number concentration. I would rather write about aerosol number concentration and aerosol size as the controlling factors.

Ll. 124 ff.: Here and other places: Do these values refer to particle radius or diameter?

Ll. 191 – 192: Open stratocumulus cells can be much larger than 10 km (e.g., Kazil et al. 2017).

Ll. 255 – 258: How is the droplet size calculated? From the number concentration and mass of the droplets?

Fig. 11: Is it possible to show the aerosol and droplet size distributions not as a bar graph? It is very hard to decern differences between the simulated cases.

Technical Comments

Please indent the first line of a new paragraph, as it is done in almost all publications. Without this optical help, it is very hard to read the text.

If aerosol particles are addressed, please write “aerosol particles” and not “aerosols”, as the latter may also refer to different species of aerosol.

L. 61: Citation style.

L. 84: “volatile VOCs” is tautological.

References

Kazil, J., Yamaguchi, T. and Feingold, G., 2017. Mesoscale organization, entrainment, and the properties of a closed-cell stratocumulus cloud. *Journal of Advances in Modeling Earth Systems, 9*(5), pp.2214-2229.

Clark, T.L., 1973. Numerical modeling of the dynamics and microphysics of warm cumulus convection. *Journal of the Atmospheric Sciences*, *30*(5), pp.857-878.

Seifert, A. and Beheng, K.D., 2001. A double-moment parameterization for simulating autoconversion, accretion and selfcollection. *Atmospheric research*, *59*, pp.265-281.