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Atmospheric Chemistry and Physics Discussions

Interactive comment on "The effects of timing and rate of marine cloud brightening aerosol injection on albedo changes during the diurnal cycle of marine stratocumulus clouds" *by* A. K. L. Jenkins et al.

Anonymous Referee #2

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General comments: In this manuscript, the authors used LES model simulations to quantify responses of marine stratocumulus clouds to sea salt aerosol injection in a weakly precipitating and a non-precipitating cloud regime. The sea salt particles are injected at different rates and times in the diurnal cycle to investigate the effect of injection rate and timing on cloud brightening (i.e., the increase of cloud albedo). They found that the effectiveness of aerosol injection is highly sensitive to diurnal injection time. For the weakly precipitating case, the optimal injection time for cloud brightening is in the early morning (3:00 local time in the model domain where sun rose at about

5:20), and the daytime (13:00) injection has the least impact on clouds because it's cloud-free in the simulations. However, the direct aerosol effect on all-sky albedo is more significant in the cloud-free daytime than the sum of direct effect and indirect effects in the evening (18:00). I find this study interesting to the community working on marine cloud brightening and the general aerosol-cloud-interaction topics. The paper is generally well written and organized with high-quality figures. However, I do have some concerns on the design of model simulations, results and some of the conclusions that need more explanations and clarifications. I recommend for publication after the following specific comments are fully addressed.

Specific comments:

1) It is emphasized in the manuscript that the sea salt particles are injected from a point source. There are some descriptions in section 3 on how the injection is done. It is unclear how the sea spray rate of 30 kg s-1 (Salter et al. 2008) was converted to the mass fluxes and number flux used in the model simulations. How large was the perturbation to aerosol number concentration in the model grid cell upon injection? The explanation on how the Salter's full emission rate causes simulation failure seems to be interesting but inadequate to justify the choice of inject rate. It needs more clarification. It also sounds odd to use the combination of CAM longwave radition scheme and RRTMG shortwave scheme. The latter is usually used for large-scale model simulations.

2) The domain size of 9 km x 9 km is rather small for simulating marine stratocumulus clouds, which usually have organized cloud structures with horizontal scale even larger than this domain size. Moreover, with such a small domain size, there is no way to characterize the mesoscale cloud dynamics and the interactions with cloud microphysical changes caused by the strong local aerosol perturbation. This raises the question of how representative the simulated clouds and their responses to the aerosol inject are for marine stratocumulus.

3) The total dissipation of clouds in the daytime makes the weakly precipitating case

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less representative. There are quite a few studies in the literature simulating the same DYCOMS II case using various LES models. None of them seems to have the cloud-free situation. It is unclear why this happened in the present study, which warrants more in-depth explanation than "due to the less turbulent conditions". In addition, the clouds are not totally recovered in any of the cases. If the simulations were extended to a second day, the model boundary layer would have collapsed completely. In other words, the simulated morning, daytime and evening clouds and their responses to aerosol perturbation very likely depend on when the model simulation is started.

4) The use of calculated clear-sky albedo as a measure of direct aerosol effect might be inappropriate. If cloudy columns are excluded from the calculation, should we see stronger direct effect when cloud fraction is lower? If you look at results in Fig 8, it doesn't seem to be the case.

5) Page 24206, line 13: domain or cloud "average"?

6) Page 24206, line 15: change "day" to "daytime" or more exactly "early afternoon". Same for a few other places in the main text.

7) Page 24206, lines 20-22: The sentence "penetration and accumulation of aerosols. . ...cloud albedo increases" seems to be out of context and incorrect. I suggest remove and clarify more.

8) Page 24208, line 22: This statement seems to be just applicable to some particular GCMs.

9) Page 24212, lines 5-7: how was the 800 nm sea water drops convert to 200 nm dry aerosol particle size.

10) Page 24216, lines 21: The defined all-sky planetary albedo might have accounted for ocean surface albedo as well.

11) Page 24222, lines 17-18: why are the non-absorbing sea salt particles typically not associated with SW attenuation?

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12) Page 24223, lines 25-27: why should the injection from a point source particularly lead to the penetration of aerosols above cloud top?

Interactive comment on Atmos. Chem. Phys. Discuss., 12, 24205, 2012.