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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Manipulating marine stratocumulus cloud amount and albedo: a process-modelling study of aerosol-cloud-precipitation interactions in response to injection of cloud condensation nuclei" *by* H. Wang et al.

Anonymous Referee #2

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Review of "Manipulating marine stratocumulus cloud amount and albedo: a process-modelling study of aerosol-cloud-precipitation interactions in response to injection of cloud condensation nuclei" by Wang et al.

General comments

This manuscript presents cloud resolving model simulations that are designed to test the efficacy of a proposed geoengineering solution, which aims to use surface based

sprayers to modulate cloud albedo through the injection of sea-salt aerosol into marine stratocumulus. Sensitivity studies are performed with different sprayer configurations, background aerosol concentrations and meteorological regimes. The results illustrate that significant changes to the cloud albedo only occur under certain conditions, namely in weakly precipitating boundary layers where the injection of additional cloud condensation nuclei (CCN) aerosol are able to reduce drizzle production in the cloud, and in CCN limited environments (for example after washout from heavy precipitation), where additional CCN are required to sustain the cloud layer.

The paper is interesting, well structured and certainly addresses scientific questions that are relevant to the journal. I would therefore recommend publication in ACP once the authors have considered the following comments.

Specific comments

1. In the introduction can the authors highlight the key differences (advances) between the aims of this study and the ship-track simulations of Wang and Feingold (2009b).

2. Additional information on the model set-up would be useful in section 2. Mean thermodynamic and wind profiles would be of interest for example. I noted that the sprayer tracks don't look like they are advected with the wind in the simulations (Fig. 1). Is this because the domain is orientated with the wind direction or that the boundary layer winds are too weak to advect the aerosol? It is also worth mentioning that the diurnal cycle of solar radiation is included in the simulations - I didn't realise this until I got to section 3.2.

3. It is mentioned that the injection rate of particles from the single surface based sprayer is 10 times lower than that proposed by Salter et al. (2008). The justification for this is that the model domain is a factor of 10 times smaller than the horizontal scales that Salter et al. (2008) propose a single sprayer would target. Does this have any implications for the aerosol transport into cloud i.e. if the modelled surface based sprayers had a much higher injection rate, how different would the results of the sim-

ulations be, particularly for the precipitating cases? Would the change in albedo be much larger for example?

4. How do you assign a “wet” and “dry” definition to each simulation? For example, the W200 series is non-precipitating but is assigned as “wet”.

5. When introducing the simulations in section 3 it would be useful if you can refer to tables 1 and 2.

6. The vertical distribution of injected particles in the W50-P3 case looks less uniformly mixed than in the W50-P1 case close to the sprayers (0-20 km in the x direction if Fig 1 c). This is presumably driven by the complex mesoscale circulations that exist between the plumes. Does this have implications for the optimum separation distance between sprayers?

7. Is figure 2 representative of one point in the x-direction or averaged over all grid points in the x-direction?

8. In the caption for Fig. 3 I suggest changing “in-cloud CCN number” to “in-cloud unactivated CCN number”.

9. The importance of the diurnal cycle is discussed in section 3.2. Does the time of the simulations correspond to local time, such that the simulations begin at night-time when a more well-mixed sub-cloud layer and higher cloud LWP and precipitation rate would be expected? Would there be any significant changes to the simulations if the sprayers were instead initiated in the day-time?

10. In the control simulations e.g. green line in Fig. 5 there is a rapid decrease in cloud fraction and LWP in the first 6h of the simulation. Is this because the simulations are not in equilibrium? Note that the cloud cover and LWP does not recover the following night in the control run. Does this have any implications for the results and would it have been better to initiate the sprayers after this initial period?

11. The boundary layer depth in the simulations is shallower than that observed in

some other marine Sc regions (see observations in Abel et al. (2010) and Bretherton et al. (2010) in the ACP VOCALS-REx special issue for example). Do the authors expect a deeper marine boundary layer to impact the efficiency of surface based sprayers?

Interactive comment on Atmos. Chem. Phys. Discuss., 11, 885, 2011.