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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 #1

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Review of "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, P. M. Forster, and L. S. Jackson

This manuscript describes some low resolution convection-permitting modeling of stratocumulus clouds to investigate the effects of seeding with large concentrations of sea-salt aerosols with a view to testing some aspects of marine cloud brightening geoengineering. One set of meteorological conditions (DYCOMS RF02 case) is used throughout, and changes to the background state are achieved by varying the aerosol prop-

erties. The diurnal cycle is included. A novel aspect of the research is the testing the impact of seeding at different times during the diurnal cycle. The results demonstrate that the albedo responses are sensitive to the background aerosol state and to the time of day that the seeding takes place.

There are some interesting results here, and the paper is well written. I believe the manuscript will be acceptable for publication given some revision. I have four substantial concerns and some other points:

1. Aerosol lifetime is longer than one day (typically it is 2+ days) in the MBL. Therefore, many of the particles injected at a particular time will still be present much later. So this renders testing the seeding time somewhat moot because real clouds would experience the high aerosol concentrations whatever the time of the seeding. Also, because the clouds are thinning over the course of the simulation, I am somewhat concerned that the results may not really be telling us much about the physical system but will mainly reflect the fact that there is less cloud to seed as time goes on. The authors should test this by comparing the results of seeding at 03hr on day 2 with seeding at 03hr on day 1. In other words, to comprehensively test their hypothesis, the authors would need to construct clouds that recover on the second night. I would suggest that the authors at least discuss this issue.

2. In the simulations practically all the simulated clouds essentially disappear in the middle of the day. Real subtropical stratocumulus clouds do not do this, but instead one sees a drop of perhaps 20-30% during the day, from close to zero at night (e.g. paper by Rozendaal et al. 1994, JCLI). Can the authors put their results in the context of real clouds?

3. The domain is very small given the low resolution. 30x30 points at 300 m resolution for stratocumulus is not really cloud resolving because stratocumulus large eddies are typically 100-1000 m in size. The simulations should be termed "convection permitting". The authors should perform a sensitivity test to demonstrate that their results are

robust. Otherwise, it's hard to believe their findings. What is the resolution near the MBL inversion? This needs to be better than 10 m and preferably 5 m to even begin to resolve entrainment 4. Is cloud droplet sedimentation included? If so, please say so. If not, then a major feedback that could be working here for the non-precipitating cases is being omitted. See Ackerman et al. (2009) and Bretherton et al. (2007) for details.

Other points:

If the wind is zero, then the surface fluxes are zero and there is no moisture transport into the cloud. This doesn't make much sense given that these cloud layers practically always have surface winds 5-10 m/s. What are the surface fluxes of LHF and SHF?

P24211, line 1: Fluxes have units of /m2/s. So is this a flux or an increased concentration? Is this consistent with what one would expect from DMS?

The addition of a table providing details of the unseeded aerosol state in these cases would be extremely helpful. Aerosol number concentrations, CCN concentrations and sizes should be included. Without this it is impossible for a reader to put the seeding in any kind of context.

Do any secondary circulations form, or does the aerosol become well-mixed within the domain after some time?

Can the authors explain the LWP changes? It is not obvious that there SHOULD be increases (see e.g. Ackerman et al. 2004, Wood 2007), so the authors need to do more to provide understanding.

It is not only the magnitude of the second indirect effect that is uncertain, but also the sign (Ackerman et al. 2004).

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