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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Occurrence of lower cloud albedo in ship tracks" *by* Y.-C. Chen et al.

Anonymous Referee #2

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The paper presents an interesting observational study of the influence of aerosol from ship plumes on stratocumulus cloud in a range of conditions. The paper shows that whilst the additional aerosol reduces the droplet size and increases the droplet number on some occasions the reduction in optical depth of the cloud is sufficient to produce a lowering of cloud albedo (which seems to be most likely with higher cloud tops and when the air above cloud top is particularly dry). The paper is thus an interesting study of the complexities of the aerosol indirect effect in marine stratocumulus. It is well presented, succinct and well written with appropriate diagrams. I recommend publication after minor revision.

My specific comments are:

1. The paper discusses the results in terms of their implications for the marine cloud brightening geo-engineering scheme. The results from this study are most certainly

relevant but there are some key differences. The plume from a ship stack is highly buoyant and so will reach the cloud even if the boundary layer is stably stratified. The surface generation of sea-salt aerosol will lead to a plume which is if anything slightly negatively buoyant so may well not reach the cloud level in conditions where a reduction in cloud albedo is likely. This point needs to be discussed. This study does have considerable interest for the general topic of cloud aerosol interaction extending beyond any geo-engineering application a point which needs to be made.

2. The physical explanations of the key processes responsible for the range of effects seemed to be clear but somewhat brief. Quantitatively the key to the paper is equation 3 and the explanation of this was less clear. The assumptions in deriving this equation need to be carefully explained along with the limitations in their use. The clouds are clearly not always adiabatic e.g. the effects of entrainment and precipitation are discussed in the paper; but there should be some discussion of how significant this is and whether the assumptions that are made still hold in these cases. The units of each of the quantities need to be stated, since some are stated while others are not

I do not intend to pick up on all the minor text changes or typos (there are a few but these may change/re-appear after revision anyway). However, as stated above, I would like to see some additional explanation of terms in equations – particularly Eq. 3, with better provision of units for most terms since the few given are not the same and are mixed together.

The definition of cloud drops and drizzle drops seems to be somewhat arbitrary, e.g. P13556, line 14: cloud drops 1.77μm (e.g. why was this value chosen?) P13556, line 17: the size limit used in the definition of drizzle (20μm) is somewhat low in comparison to what is often used – but it is defined clearly so at least the reader has been made aware of this.

This leads on to the issue that there is little discussion about measurement details e.g. with respect to the probes used (CIP is said to be used for drizzle but never described

at all wrt its size range or type – I assume a CIP-25 is used as part of CAPS - providing the larger end particle size measurements up to 1.6mm from CAPS); how well they were working (e.g. what calibration checks or maintenance checks were undertaken and how well did the probes perform - to inform the reader about how "good" or trustworthy the data are); or how well similar measurements (by different probes) compared (e.g. particle size distributions) particularly at crossover points in that comparison too. Leading on from this, there is no discussion as to what fraction of which instruments data set comprised the final data set presented (or used). Although I suspect this will not affect the main arguments presented in this paper, there should be some discussion or summary of these instrumentation/data set details so that the reader can have confidence in the data presented (for those that are not measurement experts, and also to allay the concerns of those readers who may be measurement experts!). Basically this is a request to provide an estimate of uncertainty in the measurements used. I suspect the data presented on occasions come from a single probe and that definitions of "cloud drop" and "drizzle drops" are also somewhat tied into the size ranges of the different instruments. There should be some statement also that the range of probes used was capable of capturing the full size range of the particles present – e.g. that the CIP probe did not miss a number of larger precipitation sized particles for example.

A similar statement(s) should be made about the quality/limitations of the remote sensing data too (P13558)

P13559, line 22 and Fig, 2: the Reff axes in Fig.2(a) and (b) are not labelled (or described in the legend)

P13564, line 25 Conclusion: change "led" to "leads"

P13565, line 4: change "deeper" to "higher"

P13565 "Conclusions" and Fig. 8: I do not find the "conceptual figure" provided to be particularly illuminating, especially since it needs the long description in the figure legend to be present (repeating what is shown graphically above) to make sense of it.

This long description should be in the main body of text rather than the legend. Then the requirement for the figure is debateable, so the continued presence of this figure should be justified or it should be removed

Table 2 (and text P13558): The significance of values and changes in "k" (the droplet spectral shape parameter) are not really discussed anywhere in any useful sense. This is true of many parameters introduced into the main body of text (e.g. dispersion). Please justify their inclusion.

Fig 1: there is no indication of ambient wind - is it low and hence unimportant – then say so (quantitatively)

Fig 2: (as above) – label effective radius axes

Fig. 7: the 5K and 200m described are: "5K wide bins" and "200m wide bins"

Fig. 8: Move long explanation in legend to main body of text – justify the need for the figure.

Interactive comment on Atmos. Chem. Phys. Discuss., 12, 13553, 2012.