Anonymous Referee #1

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The authors use the CMIP5 sstClim, sstClimAerosol, and sstClimSulfate experiments to analyze the effect of anthropogenic aerosol emissions on cloud albedo in the marine stratocumulus regions.
The first major part of the paper is the temporal AOD variability on monthly scales in the CMIP5 models in these regions. The results (that the anthropogenic AOD perturbation is small compared to the temporal variability) are presented well and, in my opinion, should be published.

The second major part of the paper uses the cloud-fraction–scene-albedo technique to analyze aerosol perturbations to the cloud albedo. I agree with the authors that this formalism is well suited to the study of aerosol–cloud interactions. I also think that applying the formalism to these CMIP5 experiments is a worthwhile way to investigate the effect of different aerosol species in the participating models.
The major shortcoming of the study is the use of AOD as the aerosol variable. The authors cite Andreae et al. (2009) to justify this choice, but convincing evidence since then shows that AOD is a poor proxy for the aerosol properties that matter for aerosol–cloud interactions (CCN concentrations). As a consequence, the results are inconclusive and the discussion section becomes difficult to follow.
My suggestion to the authors is to avail themselves of the advantage that a modeling study affords them – that the CCN and CDNC fields are provided. Investigating the albedo response to the anthropogenic perturbations in these variables should provide much more easily interpretable results, including the results that the authors are after (relative influence of different species, monthly variability compared to the anthropogenic perturbation). The results based on AOD could still be retained; they would show what differences are to be expected when the CCN field is known versus when only the AOD is known.
In light of this fairly major suggested revision, I am not providing detailed comments now, but I would be happy to do so on the revised version.

We would like to thank the reviewer for his/her comments. We addressed all the major revision suggestions and added additional analysis for the cloud droplet number fields. The reviewer is right, that AOD is not the best indicator of aerosol properties that matter to aerosol-cloud interactions. CDNC (vertically resolved, or at cloud top) is not available for most models, but all models but one provide the column integrated cloud droplet number (unit 1/m2), and we have now investigated these fields closer.

Our motivation for using AOD was not clear in the manuscript, but has now been made more explicit. AOD is indeed an integral measure, including “CCN-active” aerosol, as well as other aerosol. Thereby, the AOD-relation to cloud albedo and scene albedo may be different in different regions, dominated by different aerosol types. This is also what previous work has shown to be the case when looking at observations, while models have seemed to have a less refined view of AOD overall being positively related to cloud albedo (Bender et al. 2016). Separating aerosol species in models as we do here is a way to search for some refinement in the models – is AOD still always positively related to cloud albedo, or can AOD be weakly or negatively related to cloud albedo, depending on dominating aerosol type?

CDNC in an albedo-cloud fraction diagram should always yield a positive gradient, and this is indeed the case, as indicated by the new Figure 3 in the revised manuscript.
That is to say that for a given cloud fraction, a cloud with more droplets has a higher reflectivity. The same can be said of LWP, which was also shown in Bender et al. (2016), for satellite observations and present-day model simulations (their Figures 6-7, respectively). The sstClim simulations studied here show the same LWP-pattern, as we now mention in the text.
The AOD-gradient on the other hand may vary, as the scene albedo for a given cloud fraction is dependent both on how the present aerosols act as CCN, how they affect the clear-sky albedo, and how different aerosol types are distributed in the vertical. If, for instance, models underestimate absorbing aerosol presence and/or reflectivity above clouds, then they may yield a positive relation between AOD and cloud albedo (a positive gradient in albedo- cloud fraction space), when a more realistic representation of absorbing aerosols should actually give a weak or reversed gradient.

We have made changes primarily to the Introduction of the paper to explain this. We have also taken care to better explain the albedo-cloud fraction technique used, rather than just referencing previous studies. We have also added analysis of CDN in relation to albedo and cloud fraction, as well as a more complete analysis of relations between AOD, CDN, LWP, sulfate loading, and cloud albedo (see new Figure 7), highlighting further model differences, but indicating which parameter changes have the greatest effect on cloud albedo changes between simulations.

Note: A new output version for the model CSIRO was provided on the ESGF data archive and was used for the analysis in the revised manuscript.