Anonymous Referee #2

This manuscript runs a mesoscale model to look at aerosols in shallow maritime cumulus clouds. The subject matter is sutiable for ACP. The results try to classify factors that affect simulated outgoing longwave radiation. The results need to be far more quantitative and the methodology and simulations explained better. I am not sure of what the benefit is in using the mesoscale model set up, and how dependent the results are on heavily parameterized parts of the problem (such as vertical velocity). It is hard for example to tell if they are using a convective parameterization with their 3km resolution. The resolution seems awkward. Also the time period is limited, it would be nice to use more than one flight from the RICO experiment and try to run several cases. The conclusions are not quantitative enough, and little significance is shown. This work needs to be made more robust if it is to be publishable in ACP. This paper may be suitable for publication in ACP subject to major revisions to address these general issues, and the specific points below.

We have made the results more quantitative and attempted to explain the methodology and simulations better. We address the advantages of our chosen mesoscale model and discuss the vertical velocity. We have included a sentence to clarify that we are not using a convective parameterization scheme. Each sensitivity simulation requires one month of computing time with our resources; it is not feasible to simulate multiple flight measurement days. We have made the conclusions more quantitative and show sensitivity simulation significance in Figures 2, 6-8.

P27638: Abstract: The abstract is a bit long and awkward.

We have shortened and attempted to improve the abstract.

P27638,L15: 1/10 as important as what? This section of the abstract is awakward. 1/10th as important as something 2/3 as important as something 2/3 as important of the 'predominant' effect. Please quantify all this in the abstract and paper.

This was a confusing formulation and we have removed it from the paper.

P27639, L13: "more evaporation from the earth's surface": Only if they warm the surface. Aerosols don't change the energy balance except by reflecting radiation.

Rewritten: "...for example by reducing incoming radiation which leads to less evaporation from the earth's surface".

P27640,L23: "To summarize, we are looking for if in clean, non-precipitating maritime air, can different aerosols, through their influences on cloud droplet properties, change the concentration of atmospheric water vapor sufficiently to change the top of atmosphere radiation budget?" Awkward. Please rephrase.

Rewritten: "To summarize, we are investigating the possibility that aerosols in clean, non-precipitating maritime air, through their influences on cloud droplet properties, can change the concentration of atmospheric water vapor sufficiently to change the TOA radiation budget."

P27641, L0: Maybe I misunderstood something, but essentially you are stepping back from LES modeling and using parametrized convection in a mesoscale model To try to represent the interactions. 'Complexity' comes in what aspects of the model? The Aerosols? How is the convection treated and the aerosols in convection?

Rewritten: " Previous research on these
interactions has been performed with Large Eddy Simulation
models, while we are utilizing the coarser, yet still detailed,
high-resolution WRF-Chem model. Some advantages
of utilizing this regional scale model are that it includes the
feedback of aerosols onto meteorological processes and that
many properties important to our analyses, including cloud
droplet number concentration, aerosol composition, atmospheric
heating rates, and water vapor condensation are calculated
explicitly and not prescribed."

"At this resolution no convective parameterization is utilized."

Methods:
P27641,L14: What about other RICO flights? If I understand correctly you are extrapolating from 3.5 hours of data? That doesn't seem right.

We are not extrapolating from 3.5 hours of data; that is the data we are using to compare with the Reference simulation. This day was chosen for our simulations because there was no precipitation during this flight. Incorporating more flight days is beyond the scope of this study.

P27641,L20: "high spatial resolution approaching cloud resolving models": 3km is not approaching cloud resolving models.

Rewritten:" Because WRF-Chem is nonhydrostatic,
it can be run at at so-called "cloud-permitting"
spatial resolution."

P27641,L25: References for the Lin, CBM-Z and MOZAIC8 schemes?

We are not including the references for the established parts of the model, rather we include the references for Gustafson et al (2007) and Chapman et al (2009) as we are using the same setup of WRF-Chem described in these two papers.

P27642,L11: "vertical velocities": this seems a bit like an Awkward solution. Is this linked to the convective parmeterization? I assume you are using a convective parameterization at 3km? If not that would be really awkward. You should test the sensitivity to these assumptions about vertical velocities.

"At this resolution no convective parameterization is utilized."

The vertical velocity distribution function is discussed in the response to Anonymous

Referee #1.

P27643, L1: On Figure 1, show the domain.
Figure 1 changed to show the domain.

P27643, L20: Sea Salt emission: what does it depend on? Please provide a sentence of explantation

" The emission of sea salt is calculated online using the parameterization
of Gong (2003) as described in Blechschmidt
et al. (2012)."
We don't include more details because then we would need to include a lot more details for dust, the anthropogenic emissions, etc. and all the sea salt details can be found in the two cited papers.

Results:
P27644,L15: I really do not like that you are quoting the gray literature for model evaluation. I think you need to download the data and plot it yourself in this case, or quote a published figure.

We don't use gray literature for model evaluation, all of our comparisons of model results with measurements are done with downloaded original measurement data.

P27644, L20:"These concentrations were calculated by subtracting the concentration of the species in the experiment excluding the local aerosol source of interest from the Reference simulation." : I am not sure these would be linear to subtract. Also: need to show variability, not just an average. Also show for aircraft observations. Also: what is the reference simulation?

The influences an emission source of interest has on a simulation are calculated by subtracting a sensitivity simulation which excludes it from a Reference simulation which includes it. We show variability for influences where it is important to see how they vary with time: H2O(v), OLR, and OSR. The temporal variability of the concentration of the emissions is not important during the measurement flight as there is sufficient spin-up time for the relationship between the emission sources to have achieved an equilibrium, and it is more important to show the vertical variation rather than the temporal variation. The aircraft measurements do not show the relative contributions of the different emission sources- an advantage of a modeling study is that this is possible.

"The Reference simulation included all emission sources."

P27645,L10: "here the Reference simulation was subtracted from the "1000 anthropogenic" simulation." Can you be sure this is linear? Not sure that removing one source yields the same answer: think about an autocoversion rate non linear in number, if you remove 20% of the number and fall below that you get a very different answer.

The effects of the different emission sources are not linear- the model is very complex and includes many non-linear processes. This method of comparing sensitivity simulations with a Reference simulation is a standard modeling tool to study complex, non-linear interactions.

P27646,L19: "dry conditions: when the effect of H2O(v) is excluded (denoted as Dry);" What is a 'dry' atmosphere? Is this relevant (the atmosphere is never really 'dry').

"By utilizing the radiation schemes off-line, it is further possible to make radiation calculations excluding individual forcings. The so-called "Clear sky" condition is when the effect of clouds is excluded from the radiation calculation, the so-called "Clean sky" condition is when the direct aerosol effect is excluded, and the so-called "Dry sky" condition is when the effect of $H_2O(v)$ is excluded. Radiation calculations which exclude the forcing of one component permit the relative importance of each component to be determined for each sensitivity experiment. This helps us to understand how the different aerosol sources influence each component of the radiative forcing."

P27647,L10: Need to show variance and thus significance for these statements about increases and decreses.

We show when the sensitivity simulations are significantly different from the Reference simulation with regard to CDNC in Figure 2, with regard to $H_2O(v)$ in Figure 6, with regard to OLR in Figure 7, and with regard to OSR in Figure 8. We show where the Clean sky, Clear sky, and Dry sky radiation calculations are significantly different from the All Sky radiation calculations in Figures 7 and 8. Where and when results are significant has been added to the text.

P27648,L10:"In the longwave, the effect of H2O(v) is much greater than that of clouds...." As noted with the abstact, better discussion is needed here just give quantitative values and/or percentages instead of '»'

This part of the paper has been extensively replotted and rewritten to improve the discussion and give quantitative values and percentages.

P27648, L18: "changes they make to the direct aerosol effect being about 2/3 of that due to changes to the clouds, and in turn the importance of the H2O(v) is about 2/3 of that of the direct effect" Are all these changes above the noise? Show variance and significance as well as quantify these statements.

These changes are above noise, temporal variation and statistical significance are now shown in Figures 7 and 8.

P27650,L18: But the effect of H2O here is not significant? You are not talking about deep clouds here.

Figure 6 shows when the effect on $H_2O(v)$ is significant. We are talking about shallow clouds. This paragraph discusses future work.

"Future work will address the aerosol-cloudwater

vapor interactions in and above mixed-phase Arctic clouds. This study focuses on shallow warm clouds, where there is a lot of water vapor in the air, so adding a small amount of $H_2O(v)$ has only a small impact on its atmospheric concentration. In the cold, dry upper atmosphere, however, a small increase in $H_2O(v)$ can produce a much greater radiative effect."

Conclusions
P27651,L1: Again: just quote percentages or magnitudes here.

Rewritten to remove confusing formulation.