Responses to Referee #3

Wyant et al. 2014, Global and Regional modeling…: the VOCA Intercomparison, ACPD

Thank you for your helpful comments.

General Comments:

However I think the conclusions section needs further work, as I didn't really come away with a clear sense of how this latest intercomparison has advanced our understanding, particularly when compared against the previous multi-model assessment, pre-VOCA.

VOCALS is the first extended study to compare marine aerosols in situ througout the boundary layer using aircraft observations. So VOCA is novel as compared with Pre-VOCA as it compares models to a MBL dataset for an extended period with in situ data and compares aerosols. This difference from Pre-VOCA is already noted in the introduction. The start of the conclusion has been revised and expanded to better make these points.

On page 6542, lines 15-20, a number of questions are listed that provide the motivation for the paper, although there doesn't seem to be a clear attempt to come back to these questions towards the end of the manuscript. I suggest the conclusions section be restructured to directly tackle the questions raised at the start of the paper on page 6542, and where possible, to be more quantitative.

In revisiting these introductory questions, we have revised the second question to better match the direction of the paper: "How well do the geographical and vertical concentrations of aerosols agree?". In the revised conclusion each of our introductory questions is now addressed.

The authors reference the work of Yang et al 2011 on page 6542, line 1. Yang et al use WRF-CHEM to show that an explicit treatment of aerosols leads to a better simulation with respect to the observations, compared to simulations performed with a passive treatment of aerosols. However in general, the results from VOCA when compared to pre-VOCA do not necessarily seem to support this conclusion. Is this because there are too many other differences between models to allow for a fair comparison to be made? If so, I think it is important to say this.

While this study is a follow-on to Pre-VOCA, the two studies focus on different things, and involve different sets of models or versions of models. The experimental setup of the various models in this study was not controlled enough to provide specific guidance on the merits of explicit treatment of aerosols, or to refute or confirm these conclusions of Yang et al. 2011. The following statement was added in the conclusions to help clarify our position on the issue: "For many models in VOCA, the representation of aerosol processes is a relatively new feature, and at this stage of model development, we do not

expect, nor generally find, that their inclusion necessarily improves model performance relative to Pre-VOCA."

Maybe a good way to strengthen the conclusions section would be to suggest ways that future intercomparisons could be designed/improved to make it easier to gleam insight. For instance, do we need a more standardised model setup to really be able to home in on the questions we want to answer? Would it be better in future to concentrate efforts around one or two common dynamical models, where the physics options, aerosol treatment, resolution etc can be varied systematically (possibly using factor separation methods) to help identify which specific aspects of a model are most important in terms of improving the agreement with the observations?

A paragraph was added to the conclusions to suggest future directions for a follow-on study.

Specific comments:

Page 6541, line 10-11: "Most of these models had no representation of aerosol-cloud interactions". Is this because the majority of models in pre-VOCA did not include an explicit treatment of aerosols? Or is it because the microphysics in the pre-VOCA models was too simplistic (i.e. single moment)?

The text has been revised to make the meaning clearer: "Most of these models had no explicit representation of aerosols."

Page 6542 line 7 – 'reported a large aerosol lifetime effect'. I wasn't sure what the authors meant by 'aerosol lifetime effect' here – do the authors mean that the emissions had a large impact on cloud lifetime?

This is referring to the feedback of reduced precipitation due to increased aerosol concentrations, which further maintains elevated aerosol concentrations. The statement was rephrased to make the meaning clearer: 'Their follow-up modeling study (Q. Yang et al. 2012)...reported a large feedback of aerosol concentration on precipitation and aerosol lifetime over the clean ocean environment."

Page 6543, lines 9-10: "Each model submitted data on its native vertical levels". Do the authors think this could have been important in explaining some of the differences between models?

The main purpose for having models submit data on native vertical levels is to preserve details of boundary layer vertical structure in the analysis, so the text was edited slightly:

"Each model submitted data on its native vertical levels to preserve vertical structure for analysis."

Vertical resolution does have an impact on model performance, and this is already a component of several discussions later in the text.