

## ***Interactive comment on “Constraints on global aerosol number concentration, SO<sub>2</sub> and condensation sink in UKESM1 using ATOm measurements” by Ananth Ranjithkumar et al.***

### **Anonymous Referee #2**

Received and published: 24 December 2020

The authors present a comprehensive evaluation of the UKESM model against ATOm particle number concentration, SO<sub>2</sub> mixing ratio, and condensation sink data. The model includes state of the art aerosol microphysics packages and all the bells and whistles of CMIP6-era chemistry-climate modeling. The authors are quite thorough in their analysis, which makes for a satisfying, if rather long, paper. I especially like the various bar graphs and table which very clearly show which factors improve model bias. The paper is well written. Overall I think this is a solid paper that is worthy of publication subject to some minor revisions.

General comments:

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1. I am not sure a bug fix is worthy of such attention as given in this paper. It would be equally good, in this reviewer's opinion, to simply start the results with analysis of the 'baseline' simulation, and briefly describe the bug fix. Perhaps the 'default' (buggy) model simulation results could be put in the supplement.

2. I was looking for more detailed information on the simulation setup and could not seem to find it. It is mentioned that the model is sampled for the ATOm flight tracks and both the observations and model output are averaged up to (monthly?) means to beat down the noise. So how long was the model actually run for the baseline simulation and each of the many sensitivity simulations? Just the ATOm period? 2016-2018? Which years, since some analysis uses ATOm-4 only and others use ATOm 1-4. This becomes more important for the figures that show vertical profiles of model vs measured: what exact time periods are we looking for here? This should be mentioned in the caption at least. I could not find this information (apologies if it is somewhere else).

3. How does the use of ATOm-4 only for one evaluation metric versus all of ATOm 1-4 for other metrics impact the results? The authors should comment a bit on that.

Specific comments: P2L36: Unclear what "Analyzing the data with altitude" means here, since the previous sentence does exactly that. What's different?

P2L40: The perturbations could be well motivated but we don't know really what they are in the abstract. Of course we learn later in the main text. I think a sentence somewhere saying briefly what they are would be helpful.

P2L50: Is aerosol size strictly an "optical" property?

P4L116: Is the citation of Adams and Seinfeld (2002) correct here? That is a model description paper of TOMAS. The sentence as written is about how this paper evaluates the model.

P16: Seems to be a microsoft "paste" icon somehow in this figure

P20L385: We need a mathematical equation for how condensation sink is calculated

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P23L466: Consistent notation of numbers with exponents

P24L480: Odd to start discussing Figure 10 before discussing Figures 7-9.

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Interactive comment on Atmos. Chem. Phys. Discuss., <https://doi.org/10.5194/acp-2020-1071>, 2020.

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