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# *Interactive comment on* "The Met Office Unified Model Global Atmosphere 7.0/7.1 and JULES Global Land 7.0 configurations" *by* David Walters et al.

**Anonymous Referee #2**

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The paper provides a lucid description of the development of the most recent versions of the Met Office global atmosphere and land models. The structure, an overview of changes from earlier versions with motivations, followed by implementation details, is an effective means of organizing this complex discussion. The inclusion of both climate and prediction characteristics presents a comprehensive view of model behavior. The discussion is naturally in the context of earlier Met Office models, a knowledge of which will increase readers' appreciation of the material greatly, but sufficient information is generally available (though note the issues raised in RC1) to get the gist of the scientific developments for readers with less background in earlier model versions. Specific



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points for revision or consideration follow.

1. Given that GA7.1 will be be the UK contribution to CMIP6, ideally GA7.1 would have been the model described with changes required to reduce the magnitude of the aerosol effective radiative forcing (ERF) integrated into the main deveopment sequence. The point when it was realized the GA7.0 ERF was inconsistent with observed climate change may have not made this practical, and the authors note that many of the GA7.0 results presented change either little or are improved in GA7.1. Still, if this is so, it would have been better to have seen the GA7.1 results consistently through the paper.

2. Section 5 omits some very important information which is essential, and its inclusion is recommended as a major revision:

(a) The paper reports ERFs for GA7.0 but not GA7.1. It is the latter values that are critically important to understanding GA7.1. The GA7.1 aerosol and total ERFs must be reported.

(b) Provide references to justify the 70% increase in marine DMS emissions (p. 60, l. 5).

(c) Provide some indication of the relative importance of the changes designed to reduce the magnitude of the aerosol ERF (p. 60) in doing so.

3. Even if the changes discussed on p. 60, which can be viewed as ERF tunings, are empirically and physically justified, an important point emerges. Even a skillfully designed model like GA7.0 can produce a manifestly unrealistic behavior (global cooling,

instead of warming, during the 20th century). It is not the only model for which this is an issue. Four of the six U.S. climate models discussed in Schmidt et al. (2017) use aerosol indirect effect in their tuning. To this reviewer, this should impel research to understand more robustly the magnitude of the aerosol ERF. Further comments on the implications of the need to develop GA7.1 distinctly from GA7.0 should be included in the paper.

4. Section 3.11 (p. 42, ll. 6-8) notes the importance of tuning with principles for selection of parameters based on observations, other models, and constraints based on theory or observations. Yet, some parameterizations seem designed primarily to reduce model bias with structural designs difficult to justify otherwise. The particular example here is the parameterization for cirrus spreading (p. 23). The parameterization form (4) is not evidently related to the physics of shear-generated fall streaks but rather to preventing unrealistic cloud fractions in the model.

5. Figs. 7, 13, 14, 15, 16, 17, 18, 24, and 25: Include summary statistics (mean bias, RMSE, correlation coefficient) to compare model fields with observations.

6. p. 7, ll. 5-10: Indicate the number of moments in the microphysics parameterization.

7. p. 12, ll. 7-8: Nudging toward climatology presumably does not take place with interactive vegetation. This is somewhat unclear.

8. p. 16, ll. 23-26: Quantify the magnitude of the radiation improvements.

9. Numerous important references are described as in preparation. Unless these have at least reached the submitted stage when the final version of this manuscript is ready,





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I suggest removing them.

p. 32, l. 22-23: N50 concentrations are described as in reasonable agreement with modeled results, but modeled concentrations are as much as an order of magnitude lower than observed as observed N50 approaches 10,000 $cm^{-3}$.

p. 45, ll. 5-10: Tunings to improve the coupled simulation are described. How much do these tunings change the global, annual-mean top-of-atmosphere OLR, SW, and net radiative fluxes if imposed in the uncoupled model?

p. 8, l. 3: Cores do not detrain into *variables.*

p. 22, l. 20: “Whilst" $->$ “whilst"

p. 23, l. 6: Should “GA4" be “GA6"?

p. 35, l. 16: “$m^{-2}$" $->$ “$m^{-3}$"

p. 43, l. 12: “describe" $->$ “described"



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