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Interactive Comment

Interactive comment on "The Met Office Unified Model Global Atmosphere 4.0 and JULES Global Land 4.0 configurations" *by* D. N. Walters et al.

Anonymous Referee #2

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Review comments on: The Met Office Unified Model Global Atmosphere 4.0 and JULES Global Land 4.0 configurations by D. N. Walters , K. D. Williams , I. A. Boutle, et al.

In this paper, the authors document the development of version 4.0 of the Met Office Unified Model (MetUM) Global Atmosphere (GA4.0, hereafter) and JULES Global Land Model (GL4.0) configurations. This is an incremental model development based on a previous version of the model, GA3.0, which has been achieved through substantial updates of the various physics parameterization schemes. The paper is structured around the description of the model "dynamics" and "physics" (section 2), the new development since GA3.0 (section 3), and a preliminary assessment of the model performance against observations and GA3.0. Overall, the authors attempted to provide

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an adequate description of the updated parameterization schemes and their impact on the model performance in a structured way within the scope of the paper. The MetUM, with its GA4.0 configuration, is a sophisticated global climate model that incorporates the latest advances in our understanding of the atmospheric and land surface processes in parameterized form. Various versions of this model are used by a number of modeling and analysis groups worldwide for climate application and numerical weather prediction. Continuing development and documentation of the MetUM are therefore a worthwhile scientific endeavour. We recommend the publication of this paper, after the following issues are attended by the authors to improve the presentation and readability of the paper. We understand that the writing style has to be concise given the breadth and depth of the model components. The authors do follow a dense writing style, perhaps too dense at times. Much of this shortcoming may be improved by simply rewriting the sentences in a different form, without the need to add much additional text. We suggest that the paper should be thoroughly revised to make the text clearer, while being concise. Below, we provide some specific examples the authors should clarify for the convenience of the readers.

1. Section 2.6, 1st paragraph: "Momentum deposited when they break in the upper stratosphere and mesosphere drives a global circulation ..." doesn't quite make sense to me.

2. Section 2.7, 1st paragraph: Use of punctuations would improve the readability of this sentence: "For stable boundary layers and in the free troposphere a local Richardson number scheme (Smith, 1990) is used with the stable stability dependence given over the sea by the "sharp" function and over land by the "MES-tail" function ..."

3. Section 3.3, 2nd paragraph: I don't understand the description of Fig.1 "Figure 1 shows the impact of the particle size distribution change on the droplet size distribution." This figure shows the particle size distribution changes between GA3.0 and GA4.0 for different rainfall mixing ratios, as mentioned in the figure caption. Please clarify the text. Also, is it possible to draw a connection between this particle size distribution

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change and the slight worsening of the tropical-subtropical rainfall biases in GA4.0?

4. Section 3.4, 1st paragraph: "... Morcrette and Petch (2010) found a feedback in the model caused by ..." Was this feedback spurious? Please, explain.

5. Section 3.4, 2nd paragraph: "...assuming that the ice cloud fraction remains constant in the layer the ice is falling from." Shouldn't the cloud fraction be reduced because of the departing ice? Please, clarify.

6. Section 3.4, the 2nd last paragraph: "In GA4.0, the wind-shear term is calculated from the vertical shear of the model's horizontal wind and the potential increase in ice cloud fraction ..." This appears to be a significant improvement over the "constant shear" assumption in GA3.0. Is the impact of this improvement on weather/climate simulation known?

7. Section 4.1, Fig. 6: By the metric presented in Fig. 6, the performance of the GA4.0 appears to be slightly worse than the GA3.0 (more red coloured symbols than amber coloured symbols). This is contrary to the conclusion that both models perform comparably. Please, comment.

8. Section 4.1, the 2nd last paragraph: "A similar error (and hence a similar improvement) is not seen in the N96-AL clim GA3.0/GL3.0 control, which results in the Northern Hemisphere winter temperature bias structure now being very similar between N96-AOIL clim and N96-AL clim." This sentence doesn't make much sense to me; should be rewritten to clarify.

9. Section 4.4: The authors state that the reduction of a stratospheric warm bias in climate simulations cannot be attributed to a single change, but is the result of a combination of science changes. Yet, in the following sentences, a similar but bigger improvement in the NWP simulation is attributed to the updated ozone data. This comparison between the climate and NWP simulations involving the stratospheric warm bias reduction is therefore not a clean comparison. Also, note that Figs. 7 and 14 show

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results for two different seasons.

10. The dotted lines in Figs. 1 and 2 cannot be seen clearly.

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