

Geosci. Model Dev. Discuss., author comment AC2
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Reply on RC2

Mike Bush et al.

Author comment on "The second Met Office Unified Model–JULES Regional Atmosphere and Land configuration, RAL2" by Mike Bush et al., Geosci. Model Dev. Discuss., <https://doi.org/10.5194/gmd-2022-209-AC2>, 2022

Thank you very much for your comments. Corrections have now been made to the manuscript. My replies to each of the specific comments are in **bold**.

Specific Comments

Where case studies and trials of the complete RAL2 configuration are described for the UK (Sec 3.3, 3.4, 3.5) these have been related back to the one or more of the individual changes (i.e. the performance described in Sec 3.2). However, the other cases are not so well linked. For example:

a) in the MCS case it is not clear whether the improvement in fractional coverage shown in Fig 12 is to be expected, nor which of the science changes might have caused this.

The increase in fractional coverage of cloud and rain in the MCS case is likely to be predominately a result of the introduction of the Leonard terms (ticket 27). This science change has the impact of reducing the number of small convective cells and heavy rain rates (Fig.6) and helps to produce better cloud cover, as indicated in Figure 5. However, to be able to quantify the contribution of each science change to the change in, for example cloud cover, would be require many more simulations that include both individual and combinations of changes, which is outside the scope of this study. Therefore we propose that the text remains unchanged as we don't have strong evidence to confidently address this comment.

b) in the South East Asia cases, what might be causing the degradation in FSS during spinup, or rather, why does RAL2-T take longer to spinup than RAL1-T. Is it due to the BL stochastic perturbations (Table 2) or was there no change in this from RAL1 to RAL2?

There was no change to the BL stochastic perturbations between RAL1 and RAL2. The change is likely to be predominately a result of the introduction of the Leonard terms (ticket 27). The spin-up with RAL2-T is more muted than with RAL1-T. The reduced rainfall amounts means that the absolute thresholds are worse (not significantly though), but the percentile thresholds are significantly better. We propose that the text remains unchanged as we don't have strong evidence to confidently address this comment.

c) for the Indian lightning cases, I assume the changes seen here are partly/mainly?? due to the liquid and ice phases in the cloud scheme (Sec 2.6).

The change to limit the overlap between the liquid water and ice phases was only applied to RAL2-M and is not applicable to RAL2-T.

There is mention of a reduction in graupel and ice water paths, but it's not obvious what is causing this. Also, I assume the results shown are after the reduction in GWP threshold was applied to the RAL2-M configuration; if so it would be helpful to see what the results from the 'standard' configuration looked like.

The GWP threshold reduction was not applied to RAL2-M. All experiments were performed using RAL2-T.

This threshold adjustment seems arbitrary, why tune RAL2 to RAL1 output? From Fig 14 & 15, it looks like both RAL1 and RAL2 are producing higher flash counts than the obs (albeit with lower spatial coverage) so its not clear why they should be increased.

The threshold adjustment to RAL2-T was made to increase the area coverage of the moderate lighting flash counts distribution which was for many cases even less than observations at many locations. By reducing the threshold, not only the area coverage, but the intensity also increases at some locations.

Agree that both RAL1-T and RAL2-T are producing higher flash counts compared to observations after the tuning of RAL2-T. Our strategy is to reduce the missing events at the cost of some false alarms. However, we have conducted experiments with many lightning events of light, moderate and extreme intensity, and the overall objective scores (Reply-to-reviewer Table, see attachment) are favouring RAL2-T compared to RAL1-T. Hence definitely there is an improvement over RAL1-T.

Reply-to-reviewer Table (see attachment) Objective scores of daily accumulated lightning for RA1T and RA2T (8-12 August 2019) over Indian domain (Root mean Square error, Correlation coefficient, Bias, Multiplicative bias, Mean forecast, Mean observation).

Technical Corrections

These have been made.

Please also note the supplement to this comment:

<https://gmd.copernicus.org/preprints/gmd-2022-209/gmd-2022-209-AC2-supplement.pdf>