

Geosci. Model Dev. Discuss., referee comment RC1
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Comment on gmd-2021-193

Anonymous Referee #1

Referee comment on "The Flexible Modelling Framework for the Met Office Unified Model (Flex-UM, using UM 12.0 release)" by Penelope Maher and Paul Earnshaw, Geosci. Model Dev. Discuss., <https://doi.org/10.5194/gmd-2021-193-RC1>, 2021

General comments:

The paper by Maher and Earnshaw describes a new flexible modelling framework for the UM model, Flex-UM, which is based on the same dynamical core as the Global Atmosphere configuration of the UM, GA7.0, but includes simplified physical parameterisations. The idea of Flex-UM is to provide a flexible modelling tool which allows for model set-ups of various complexity and intends to bridge the gap between simplified models and highly complex Earth system models.

The performance of Flex-UM is evaluated by two aquaplanet experiments, one with fixed SSTs and one with a slab ocean. The results are compared to Isca, an idealized model for the global circulation of terrestrial planetary atmospheres, which is built on the GFDL aquaplanet model, and to GA7.0 with sophisticated physical parameterisations.

Overall the paper is clearly written and the results are presented in a nice and concise way. My major point of criticism is related to the lack of discussion. At the moment the manuscript is limited to the pure presentation and description of the modelled climatology and the differences between the various model configurations. Even so this is a model description paper, I think it would benefit from some discussion of the underlying reasons for the differences between the models. I appreciate the authors as experienced modellers who know their model down to the smallest detail. I am convinced that they can easily come up with a few statements, e.g. on how the missing solar absorption in FlexUM impacts the simulated dynamics. After some minor modifications (for details see below) I recommend the manuscript for publication in GMD.

Specific comments:

- Introduction: As I understand FlexUM was designed to replicate the GFDL idealised model, which seems to be a benchmark for this model type. It is not quite clear to me what this exactly means? FlexUM has the same dynamical core as GA7.0, namely ENDGame, but simplified physical parameterisations. In which respect is it directly comparable to the GFDL aquaplanet model? And how is this comparability achieved?
- Model name and acronyms: I find the amount of used acronyms and model names for someone who is not familiar with the UM-family quite confusing (UM, UKESM1, GC3.0, GA7.0, HadGEM-GC3.0, ...). I know traceability of model versions/configurations is important to GMD, but I think it does not necessarily increase readability. Maybe the authors have a sketch at hand which gives an overview of the UM family and could be shown in the paper (as Appendix)?
- Sect. 3: I would suggest to add a table summarizing the performed model experiments and the key parameters of each model configuration, e.g. resolutions.
- Different resolutions: On page7, line 8-9 the authors state that "key differences in the climatologies are highly unlikely to be the result of resolution differences". Would it be possible to run FlexUM and GA7.0 at the same resolution to underpin this statement?
- P10, L15 onwards: I find this explanation too simplified and sketchy. How does the limited resolution impact the distribution of v and ω , and what integration artefacts are meant?
- Fig. 4a: FlexUM seems to show a kind of "wavy" structure in the precipitation climatology in the subtropics, which is not apparent in Isca (or not visible in Fig. 4b). Any explanation for that behaviour?
- P11/12, discussion of Fig. 4f: The authors rate the missing solar absorption in FlexUM as key difference to Isca. Are the shown differences in the climatologies consistent with the SWA of FlexUM being zero? How does the missing SWA impact the model performance in general? I would like see some discussion of the (potential) underlying reasons for the presented model differences, even if the authors can only speculate. This holds also for other sections. In the conclusions the authors state that including solar absorption might improve the atmospheric energy budget. It would be interesting to see which changes the authors expect from this modification. And if it will not help to close the energy budget, what would be the next steps.
Regarding the comparison with ERA5: I think it is clear that zonally symmetric aquaplanet models do not give the same results as ERA5, so what is the idea of comparing the idealized models to ERA5?
- Sect. 4.3: For the discussion of the differences between the fixedSST and slab ocean experiments it might be useful to show the difference in the surface temperatures. Can different surface temperature patterns be used to explain differences between the fixedSST and slab ocean experiments?

Technical comments:

- P6, L9: There are some closing parentheses ")" missing.
- P6, L28: "Interpolation is prone to[?] errors..."
- Fig. 1: Why are there no grey contours in the NH? Rocky Mountains, Tibetan Plateau,...? Is the masking done before or after zonal averaging?
- Fig. 2 and 3: It looks like the grey masking is not the same in the middle and right plots. Shouldn't it be identical?
- P11, L8: closing ")" missing: ... and in the LH of Fig. 4(e)).
- Fig. 4f: I think this plot shows Isca – FlexUM, and not FlexUM – Isca as written in the header. The SWA difference is $+59 \text{ W/m}^2$, but since the SWA of FlexUM is zero it

should be negative for the difference FlexUM – Isca.

- P13, L4: I think it must read "... at a lower altitude compared to GA7.0..."
- Fig. 7f: Same as Fig. 4f, GA7.0 – FlexUM
- Fig. 10f: Same as Fig. 7f, GA7.0 – FlexUM
- P15, L22: "It has also been shown that[?] the single ..."
- P15, L24: "... long standing problems[?]..."
- Caption Fig. 4, 7, 10: mmday-1, -1 should be superscript
- P18, L12: "However, there[?] are very few..."
- P18L14: "... by including[?] multiple new..."
- P19L2: citation: (Frierson et al., 2006) -> Frierson et al. (2006)
- P19L14: "it's configuration", it's -> its