

Interactive comment on “A spectral nudging method for the ACCESS1.3 atmospheric model” by P. Uhe and M. Thatcher

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We thank the reviewer for taking the time to review our manuscript and for their valuable feedback. We have taken each comment into account and believe the revised manuscript will be much improved with these modifications. See below our response to each of the comments.

General Comments:

This paper describes the implementation of the spectral nudging method described in Thatcher McGregor (2009) to the ACCESS1.3 model (which uses the Met Office Unified Model vn7.3 as its atmospheric GCM). This development makes use of the code existing from the work by Telford et al (2008) which implemented a Newtonian relax-

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ation nudging method at an earlier Unified Model version. ERA-Interim reanalysis is used to drive the model. The experimental design is sound, and the technique, which allows for variations in the length scale of the nudging, is desirable in a model such as the UM. The paper is well written and has an appropriate number of references. The various methods of nudging (occasionally known as "specified dynamics") are also concisely explained and clear, and the reasoning for the use of a 1D filter to approximate a 2D filter is sound. However, the use of 500hPa air temperature as the only evaluation variable is not sufficient and the results section should be greatly expanded to present results from a number of variables. It is important that the variables include those which are directly affected by the nudging, and others (such as mean sea-level pressure or precipitation) which are not. Thatcher and McGregor presented analysis of 5 variables (surface pressure, mean sea-level pressure, zonal wind, meridional wind, and air temperature), mainly presented in tables or as a change in the variable with time. Telford et al examined 6 (potential temperature, zonal wind, vertical wind, surface pressure, precipitation, and specific humidity) presented these as a mixture of tables, column plots, lat/long plots, and zonal-mean plots. The model set up here is similar to Telford et al, where a set year-long integrations are performed. In Telford et al data was presented for October, January, and July, rather than as annual means. Given the similarity between this study and Telford et al (in terms of the model set up) I am surprised that a more detailed analysis similar to that presented in Telford et al was not performed. Major revisions to the analysis section are required before this paper is suitable for publication in GMD.

Response:

We thank the reviewer for their comments on the manuscript. Although our original aim was to focus on analysis that depicted the correct functioning of the scale-selective filter, we acknowledge that the manuscript could be improved by extending the analysis to other fields and other levels. To this end we have already analysed T, U and V at 850 hPa and 250 hPa, which depicts errors over land growing as we approach the surface,

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likely to arise due to the different parameterisations for the land-surface and differing topography between ERAI and ACCESS. We have also included unconstrained fields for precipitation and mean-sea-level-pressure as suggested by the reviewer. This has been useful advice as the precipitation errors help to distinguish the scale-selective filter and Newtonian nudging methods. We have elected to continue with the annual analysis as it provides a slightly different perspective to the Telford et work. Nevertheless, we certainly plan to extend the analysis significantly in the revised manuscript as advised by the reviewer.

Specific comments:

1.

p 6682, line 10/p. 6686, line 20: while the behaviour of α is defined for the lower part of the atmosphere (near the boundary layer), what is not defined is how α is changed near the top of the atmosphere. The top panel from Figure 1 of Telford et al (nudging cut-off at level 50) would not apply here as ACCESS1.3 is in a 38-level configuration. Does the nudging occur all the way to the top of the model.

We thank the reviewer for pointing out that we have not properly explained the behavior of α in the upper atmosphere. We have indeed applied the nudging all the way to the top of the model, although ramping down the nudging over the last three levels. We will improve this description in the revised manuscript.

2.

p 6682, line 19: As the model description section does come until 2.4, it is unclear why the reanalysis resolution has been changed to 1.875 degrees \times 1.25 degrees until we learn that.

The reviewer raises a valid point regarding the change in our reanalysis resolution compared to that used in Telford et. al. We chose this resolution to reflect the ACCESS GCM resolution submitted to CMIP5. It was an oversight not to discuss the resolution

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of the model in more detail and we intend to address this in the revised manuscript.

3.

p 6701, Figure 4: It is clear from this figure that there is a spin-up period of around 5-10 days or so. It is unclear if this spin-up period is also included in the other plots, which are all annual means. This could have an effect on these results. It would have been better to have performed a 13-month simulation and only used the final 12 months, or to take the approach of Telford et al and focus on specific months.

It was our original intention to keep the methodology simple in the original manuscript. However, we appreciate that the spin-up issue raises several questions regarding the results. To this end we have removed the first 10 days of the simulations from the analysis, to avoid the spin-up issue. We have not seen any significant change in the results or for the conclusions of the paper. We think this addresses the reviewer's concern, without complicating the description of the experimental design.

4.

p 6691, section 3.4 (Nudging period): I would suggest that this section should come before the preceding results sections, as it explains why the choice of 1-hour ("hard nudging") has been used throughout this paper (whereas e.g. Telford et al used 6-hour "soft nudging").

Thank you for making this point. We would like to clarify that section 3.4 explains the choice of 1 hourly application of the nudging correction (nudging period) as opposed to the 1 hour e-folding time ("hard nudging"). We will try to make this distinction as clear as possible in the revised manuscript.

With regards to the order of the sections, there are a number of parameters that need to be explained and we decided that it suited the purpose of our paper to justify the use of the spectral filter before the nudging period. We agree we do need to make the choice of parameters clear earlier in the manuscript and refer them to section 3.4 as to

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why we use nudging applied once an hour rather than every time-step (as per Telford et. al.).

With regards to the 1-hour e-folding time “hard nudging”, this was used in the paper as it is more consistent with the optimal configuration of the scale-selective filter identified later in the manuscript. Essentially we did not want to unfairly disadvantage the Newtonian nudging when comparing it with the scale-selective filter. Nevertheless, we acknowledge that this point should have been made more clearly in the manuscript and that the difference with the paper of Telford et al should have been clarified. These points will be discussed in detail in the revised manuscript.

Technical Corrections:

p. 6680, line 8: This should probably be "University of Cambridge, U.K."

Thanks for this advice. We will make the correction for the University of Cambridge in the revised manuscript.

Interactive comment on Geosci. Model Dev. Discuss., 7, 6677, 2014.