

General comments

Study provides a very comprehensive analysis of how different aspects of nudging impact the representation of precipitation in CCAM in the context of downscaling ERA5. Overall, I found the analysis to be thorough, and the experiment design is systematic and well planned out in advance. The paper is well written and easy to follow, and the research aligns directly with the scope of the journal. The research makes an important contribution to the literature, and will no doubt provide important technical guidance for users of the model in future downscaling work. My comments below are relatively minor (mostly seeking clarification on methods/results), and I strongly support this important work being published.

Specific comments

-In the introduction section, when talking about nudging wavelength results (e.g. line 45-50), it would help to add detail around what model was being used in these studies. And note in the introduction what other regional models (e.g. WRF) have implemented spectral nudging approaches alongside CCAM.

-For the studies debating moisture nudging versus not (Line 51 onwards), were these in the context of downscaling reanalysis, or GCMs? Perhaps add some detail there, as that seems relevant to how well it performs?

-Table 1 is very helpful and well planned. However, I wasn't quite sure of the 'level' description in the caption and text earlier. Does level= 0.85 mean nudging from 850-hPa and higher? If that is the case, wouldn't it be simpler to just say "lowest nudging level" and then include pressure level/units. Apologies if I have misunderstood.

-Section 2.4. For the 'ctrl', what does 'no nudging' mean exactly? Clarify what 'no nudging' entails for the control simulation e.g., whether it is a raw ERA5 field or an SST-forced CCAM run, and reiterate this when interpreting results."

-Figure 2 caption, instead of 'bias between simulations' would be more clear to say 'bias relative to IMERG for each of the 16 simulations'. Caption should also specify what the different header colors mean.

-Figure 5, when referring to specific events (i.e. TCs) it would help to mark these out on the figure for readability.

-When interpreting Figure 5, I wonder if at times the peak of the precipitation in individual simulations for individual events may be missed more due to intrinsic internal variability (as we often see with deterministic weather forecasts vs ensemble forecasts for extremes). Sometimes this clearly isn't the case (i.e. if all simulations show clear underestimation), but other times the results might be more mixed. Suggest just adding a sentence or two when interpreting results related to individual events here.

-In Figure 8, the R3 specific humidity results are most notable, where for all experiments the correlation at around 900 to 850-hPa drops to between 0.15-0.4. Worth commenting on this a bit more in the context of physical processes, and possibly even adding the maps of this (i.e. selecting a certain specific humidity level) to supplementary material, for this specific

case/domain. And, when interpreting what this means, how much trust do we put in ERA5 (e.g. how constrained to obs is it for this region/level/variable).

-Lines 365 onwards, good to see that the limitations of IMERG are acknowledged. I think this can matter quite a bit, when interpreting small differences between the simulations relative to the likely uncertainty in IMERG. To this end, it would be helpful to expand on this in the discussion a bit more. Comparisons between IMERG and AGCD are helpful to estimate this uncertainty, and it would be useful to use these numbers a bit more directly in the text when interpreting apparent model biases vs observational uncertainty.

Minor

-L33 – “A central challenge for RCMs *is ensuring* that RCMs efficiently assimilate”

-Figure 6, include y-axis details/units in caption.

-Figure 8, these vertical profiles of correlation coefficients are a very nice way to present the evaluation, and the results very insightful. Caption should say “against ERA5”.