Geosci. Model Dev. Discuss.,
https://doi.org/10.5194/gmd-2018-257-AC2, 2019

Geoscientific Model Development Discussions
Open Access

Interactive comment on "Use an idealized protocol to assess the nesting procedure in regional climate modelling" *by* Shan Li et al.

Shan Li et al.

shan.li@lmd.jussieu.fr

Received and published: 22 January 2019

Referee Comment: The manuscript presents an original approach in the evaluation of the so-called nesting technique used in regional climate modelling. The perfect model framework allows to perfectly isolate the detrimental impact of imposing lateral conditions to a limited area model. However the framework is somewhat different from the traditional RCMs: the forcing area is not a narrow band, but the rest of the globe. The paper is short and avoids non-essential descriptions, because some details might depend on the model and on the approach. This study deserves publication after a few clarifications and minor corrections listed below:

Authors Response: Thank you for your constructive comments. We take into account

Printer-friendly version

Discussion paper

all your remarks in the new manuscript.

Referee Comment: 1. page 1 line 34: do not forget to mention here statistical downscaling

Authors Response: It is mentioned now.

Referee Comment: 2. page 1 line 35: "impact" an impact model and an RCM are two different things

Authors Response: Yes. We agree. We removed the word "impact" to avoid confusion.

Referee Comment: 3. page 2 line 2: The climate of an RCM is generally better because of the higher horizontal resolution, but also because the empirical adjustments of the parameterizations are specific to its domain

Authors Response: Yes, we agree. We added a phrase in this sense.

Referee Comment: 4. page 2 line 4: "boundary", the relaxation area is not a boundary here, as the RCM has a global integration domain, and thus no boundaries

Authors Response: In our case, the Newtonian relaxation is applied only outside the RCM's domain. The buffer zone is indeed the whole globe outside the RCM's effective domain. We use the term "boundary" to respect the traditional concept for limited-area models.

Referee Comment: 5. page 4 line 17: how do 90 min compare with the model time step and the frequency of updating the relaxation conditions? The authors should mention that in an actual RCM the relaxation time generally varies between these two times from the inner to the outer relaxation zone.

Authors Response: The lateral boundary conditions from GCM are renewed every two hours. For the relaxation time scale controlling the relaxation strength, we used a binary solution: 90 minutes outside the domain and infinity inside (1.0e+25). We didn't employ any transition between the two. In fact, our configuration inherited from a two-way nesting methodology in which the two models should be spatially complementary from each other and there is no recovering between them.

Referee Comment: 6. page 5 line 38: what is the difference between “idealized” and “ideal”? Do the authors oppose “simplified” to “accurate”?

Authors Response: We would like to maintain the use of “idealized” versus “ideal” (to make some humor for our writing), although we agree that an “idealized” protocol is a “simplified” one, but not necessarily an inaccurate one.

Referee Comment: 7. page 6 line 2 and further in the text: “autonomy” does not fit in the case of DS300-to-300 (it might be more suitable in the case of DS300-to-100). Indeed the day-by-day solutions of the RCM and GCM should be identical. The difference appears because of the numerical inadequacy of the driving, amplified by the non-linearity of the equations (similar to the butterfly effect in GCMs). If the forcing were perfectly adequate, the differences between the two models should be minimal, irrespective of the “autonomy” of the RCM.

Authors Response: We think the word “autonomy” is an appropriate description of RCM behaviors, although we agree completely that the butterfly effect is a fundamental cause to diverge the two models (RCM versus GCM). But there are two other explanations. First, the relaxation time is an e-folding time scale, relaxed variables can never reach the true relaxing values. Second, GCM provides driving conditions only every two hours, not every time step (half an hour in our model). These practices, together with the atmospheric nature of butterfly effect, ultimately give certain autonomy to RCM. In our idealized protocol of DS-300-to-300 (GCM and RCM identical, including spatial resolution), GCM and RCM would produce strictly identical results if the GCM updating frequency was the same as the model time step, and if the relaxation was replaced by a simple assignment (= in Fortran).

Referee Comment: 8. page 7 lines 1-5: please discuss further this feature wrt lateral forcing (e.g. is T2M subject to horizontal advection?)

Authors Response: We recognize that we don't fully understand this behavior. We think that the RCM autonomy is certainly amplified by the interaction with the surface. This may explain why the divergence between GCM and RCM is larger for T2m than for Z500.

Referee Comment: 9. page 7 line 20: "first ten"; this error is found further in several instances.

Authors Response: That's done. Thanks.

Referee Comment: 10. page 8 lines 29-34: the decreasing trend in the correlation is certainly significant. This is not necessarily the case of the fluctuations (e.g. EOF3 vs EOF4). To make the assessment clearer, the authors should calculate the correlation at each grid point. After a proper spatial filtering, they could observe a correlation minimum in the center of the domain. Then, an EOF with its maximum weights in the centre is expected to have a lower correlation.

Authors Response: We put our largest effort here in re-calculating the correlation coefficients between GCM and RCM for each spatial grid. This was done for three emblematic variables: geopotential height at 500 hPa, 2-m surface air temperature and surface precipitation. Results are shown in Figure R2-1, together with RMSE on the right column. We can see that the intuition of Referee is partly true: larger correlation coefficients are generally found at borders and lower values inside. But it is also clear that there are many exceptions, the concept based on spatial structures, as what we want to emphasize in our manuscript, would be more appropriate. The intuition would be totally true if the atmosphere was motionless and the diffusion was the only process controlling the signal propagation in the atmosphere. The real atmosphere (hopefully also in a GCM) has plenty of dynamical motions: advection, convection and dynamical waves. They can easily break down the intuitive image.

Referee Comment: 11. page 9 line 16: reference? (e.g. Michelangeli and Vautard)

Authors Response: That's done. We added two references: Michelangeli and Vautard, 1995, and Vautard, 1990.

Referee Comment: 12. page 12 line 3: stronger

Authors Response: That's done.

Referee Comment: 13. page 12 line 11: comes **Authors Response**: That's done.

Figure R2-1: Correlation coefficients (left column) and Root-Mean-Squared Error (RMSE, right column) between GCM and RCM. The calculation was performed for the synoptic variability only and for the whole 80 years. Upper panels for geopotential height (m) at 500 hPa, middle panels precipitation (mm/s) and lower panels 2-m surface air temperature (°C).

Interactive comment on Geosci. Model Dev. Discuss., https://doi.org/10.5194/gmd-2018-257, 2018.

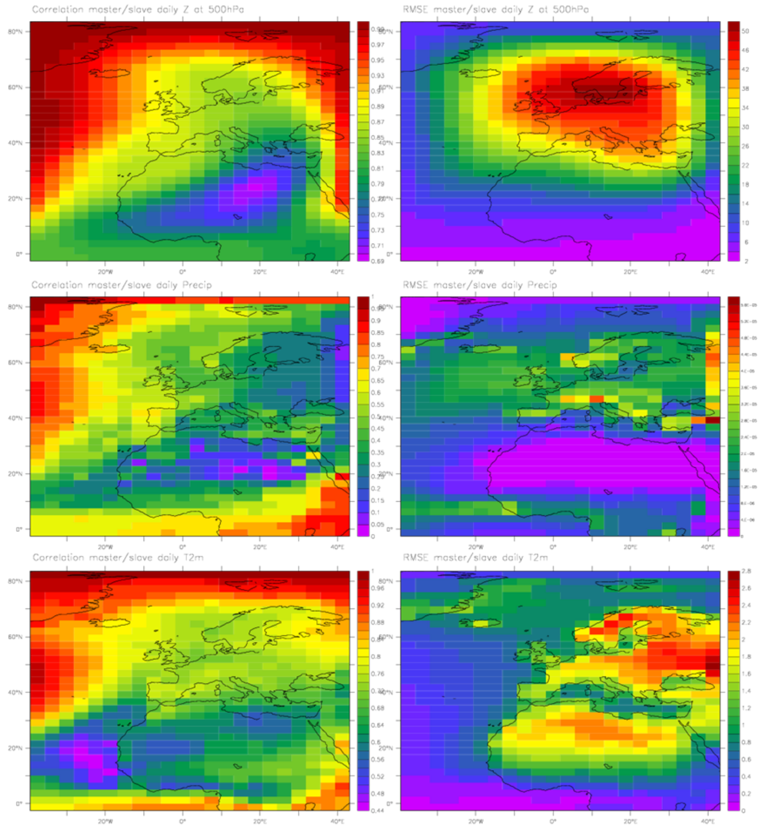

Fig. 1. Figure R2-1

Printer-friendly version

Discussion paper