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Discussions**

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Interactive comment on "**Impacts of using spectral nudging on regional climate model RCA4 simulations of the Arctic**" *by* **P. Berg et al.**

R. Laprise (Referee)

laprise.rene@gmail.com

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Comments by identified reviewer René Laprise, ESCER/UQAM.

The authors have identified large biases in mean sea level pressure (MSLP) of the Rossby Centre regional atmospheric climate model RCA4, which lead to biases in the surface winds, which would lead to strong sea-ice biases in a system coupled with a regional ocean. An implementation of large-scale spectral nudging (SN) is applied to remedy the problems by constraining the large-scale components of the driving fields within the interior of the regional domain. It is found that the SN generally corrects for the MSLP and wind biases, while not significantly affecting other variables. The paper is well written and provides clear explanations of the motivation, methodology and results. It provides valuable information to the modelling community and deserves

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publication. Main comment Page 499, Paragraph 5: In the historical review, it should be noted that SN was initially introduced not for correcting systematic biases as applied here, but rather as a kind of "poor man data assimilation" to prevent "intermittent divergence in phase space", a phenomenon that has later been found to be associated with inter-member (internal) variability in ensembles of simulations with nested climate models (e.g. Alexandru et al. 2009, Šeparović et al. 2012, Laprise et al. 2012). It would be worth stressing that, while SN is also effective at correcting systematic model biases, this application is different from it initial purpose. In this respect, it would be interesting to present a figure analogous to Fig. 2, but for the domain average bias rather than RMSE. Below I wrote several comments and suggestions for considerations by the authors; these should by no means be interpreted as a criticism of the paper or cause for rejection. Other comments Page 496, Paragraph 25: "GCMs have shown problems with anomalously high MSLP values in summer, and with simulating the North Atlantic storm track route into the Arctic region in winter." Fig. 3 shows the RCA4 bias to be somewhat similar in summer, but rather different in winter. Do the authors have any potential explanations for this different behaviour? Page 500, Paragraph 10: The text refers to "longitude-latitude boxes Âż while it would rather appear from eq. 1-5 that the model uses some transformation to operate in an effective Cartesian grid. Page 507, Paragraph 25" "However, the method relies on the driving model to handle the large scale circulation well. For reanalysis data, this is a minor problem, but for free running GCMs it is not obvious that the circulation improves. There is ongoing work with analysing the effects of the method when applied to GCM downscalings directly, within the CORDEX framework." As shown by the cited reference to Chapman and Walsh, some major deficiencies in polar-region MSPL occur at fairly large scales. The alleged purpose of a high-resolution coupled RCM is to correct deficiencies of coarse-mesh AOGCM. Clearly SN will prevent this from occurring, as the RCM will inherit large-scale biases from the driving AOGCM. The paragraph should stress this point, and admit that the use of SN should be seen simply as an interim, pragmatic approach to allow the development of the

coupled version, but that the use of the coupled version will require fixing the regional model's components responsible for the noted biases, and eventually to get rid of SN. References Alexandru, A., R. de Elía, R. Laprise, L. Šeparović and S. Biner, 2009: Sensitivity Study of Regional Climate Model Simulations to Large-Scale Nudging Parameters. Mon. Wea. Rev. 137(5), 1666-1686. DOI: 10.1175/2008MWR2620.1 http://journals.ametsoc.org/doi/abs/10.1175/2008MWR2620.1 Šeparović, L., R. de Elía and R. Laprise, 2012: Impact of spectral nudging and domain size in studies of RCM response to parameter modification. Clim. Dyn. 38(7-8), 1325-1343, doi:10.1007/s00382-011-1072-7 http://link.springer.com/article/10.1007%2Fs00382-011-1072-7 Laprise, R., D. Kornic, M. Rapaić, L. Šeparović, M. Leduc, O. Nikiéma, A. Di Luca, E.P. Diaconescu, A. Alexandru, Ph. Lucas-Picher, R. de Elía, D. Caya and S. Biner, 2012: Considerations of domain size and large-scale driving for nested Regional Climate Models: Impact on internal variability and skill at developing small-scale details. In: Climate Change: Inferences from Paleoclimate and Regional Aspects, Proceedings of the Milutin Milankovitch 130th Anniversary Symposium. Belgrade, 22-25 September 2009. Springer, Editors: A. Berger, F. Mesinger and Dj. Sijacki, Part 4, 181-199, doi:10.1007/978-3-7091-0973-1_14, http://www.springerlink.com/content/n618577072623768/

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