Review: The impact of periodization methods on the kinetic energy spectra for limited-area numerical weather prediction models,

by

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Recommendation: *accept with minor revisions*

General comments:

First, studies of this type are lacking in the literature and the choices made in the applications are too much based on ad-hoc decisions about the geometries and the methods. For instance the properties of the smoother in the peridization has never been documented. Therefore, these type of papers are very relevant for the modeling community.

Secondly, I believe this study is useful for model development and the numerical schemes of the time-step integration (and not only for diagnostics of fields). The better spectrum with Boyd's method may have implications in the model dynamics (or said differently, this study corroborates the validation of Degrauwe et al. 2012); for instance in the semi-Langrangian scheme, the advection represents (hidden) non linear terms, that may contribute to the energy cascade, and one may get some spill over from the extension zone to the physical zone for long trajectories (long time steps) going outside of the pysical domain (this was studied in by Degrauwe et al 2012). Also he Helmholtz equation is solved after the Boyd relaxation in the whole domain including the extension zone.

So I recommend publication. I have a few suggestions for improvement of the paper.

Minor comments:

- p. 6492, line 17-18: replace AROME and HARMONIE by AROME and ALARO. HARMONIE is the common denominator for both model coinfigurations. These two are described in the following papers,
    - For AROME you can cite the paper: Seity, Y., P. Brousseau, S. Malardel, G. Hello, P. Bénard, F. Bouttier, C. Lac, and V. Masson, 2011: The AROMEFrance convective-scale operational model. Mon. Wea. Rev., 139, 976–991.
    - For ALARO, it is described in: De Troch, R., R. Hamdi, H. Van De Vyver, J.-F. Geleyn, P. Termonia 2013: Multiscale performance of the ALARO-0 model for simulating extreme summer precipitation climatology in Belgium, J. Climate , 26 , 8895-8915.
- Fig 1a: specifiy the powers of the dotted lines and mention it in the figure caption.
- p. 6496, line 13-14: cite Boyd 2005 and Termonia 2012, to be correct.
- Fig 4: Mention that the extension zone is included and draw it on the figure. It is clear for the HIRLAM and ALADIN and ALADIN smooth where the extension line is located from the fields, but not for the others.
- p. 6500, line 7, I do not agree with the statement that the method “favors” Boyd's method. In fact it depends on what your goal is. For instance, in a LBC relaxation you have the large-scale fields at the boundaries, so even inside you never have the true spectrum and there will be some errors in the scaling (in the scales smaller the the truncation of the large-scale coupling data). Nevertheless, your methodology is clean and you should certainly mention this issue. I propose you write: “Mind that for the Boyd method the grid-point values are obtained from the “true” spectrum with the correct theoretical scaling in the extension zone. This is not the case in the lateral-boundary couplings of real models where the goal is to nudge the solution to the one of the host model grid-point values as best as one can, obeying the spectrum of the host model.”
- Regarding the conclusions: I conclude you recommend the use a large extension zone for data

assimilation and together with the last bullet (p.6505, line 6), it is concluded that it should be done with either a detrending or Boyd's method. It might be useful to write this explicitly.

- You might add a sentence in the conclusion stating that the results in the present paper confirm the improvement of the Boyd method found by Degrauwe et al. (2012).