Geoscientific
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Discussions

Interactive comment on "Forecasts covering one month using a cut cell model" *by* J. Steppeler et al.

Anonymous Referee #2

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General comments:

This paper demonstrates the impact of the use of the cut-cell vertical discretization for a set of five-day atmospheric forecasts. The model errors are investigated in an area influenced by strong orography, where improvements on forecasts are expected with the use of cut cells rather than the more common terrain-following coordinates. The authors show that the differences between the forecasts from the cut-cell model LMZ and the terrain-following version of the model LM are large, and that the corresponding observation data suggests that the LMZ is better especially in the forecasts of vertical velocities and precipitation. In addition, the comparison of the results to that from the up-to-date version of the terrain following model CLM is interesting and is a useful contribution to the atmospheric modelling community. I would recommend this paper for publication after the authors have addressed the following points.

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Specific comments:

1) Though the authors well describe the differences of the study from Steppeler et al. (2006), there is no mention of Steppeler et al. (2011) which also shares some features with this paper particularly in terms of the intention to "give a first indication of the impact of the cut cell discretisation" [p. 627, l. 23-24; in the last paragraph of the Section 1 of Steppeler et al. (2011)]. Therefore it is desirable that the authors should also cite Steppeler et al. (2011) in the Introduction and clarify the difference.

2) The authors mention that three methods are used to increase the size of the time step for cut cells and are already described in Steppeler et al. (2006): implicit treatment of the vertical coordinate, cell-merging technique and the thin wall approximation [p. 628, l. 14-18]. However, as far as I can see, no description of the cell-merging technique is found in Steppeler et al. (2006). If the paper does describe the technique, could the authors just show me in which part of the paper it is written? (I suppose that the description should be in Section 2 of Steepeler et al. (2006) where the other two methods are described, but I haven't found it on the cell merging.)

3) In Fig. 4, rather large differences are admitted between the Z and noZ forecasts even though the authors use filtered orography for both models [p. 628, l. 5] with the horizontal resolution of roughly 25 km [p. 629, l. 16]. Many studies have demonstrated problems with the terrain-following coordinates over steep hills [e.g., Sundqvist 1976, Janjić 1989], but at the same time, Satomura et al. (2003), for example, showed that the terrain-following coordinates still gave acceptable flow results over slopes of up to 45 degrees. In this regard, it would be good to mention the actual steepness of the model orography in this paper and discuss whether the huge errors in the terrain-following results are as expected from previous studies. For example, is it possible to add the information of the maximum slope angle of the model orography with filtering and the resolution used in Section 3? If it would be much smaller than 45 degrees, what do the authors think makes such huge errors in the terrain-following model?

4) In Section 4, the authors conclude that temperature is also improved in the cut-cell model [p. 633, l. 23] as well as precipitation and wind components [p. 633, l. 20-21]. However the improvement in temperature is not well discussed in the manuscript. The discussion of the temperature results in Fig. 2 is only one sentence: "the differences of the forecasts are rather large" [p. 631, l. 4-5]. The authors should explain why they think the temperature result in the cut-cell model is better in Fig. 2.

Technical corrections:

1) Section 4, p. 633: On line 15, "mayor" should perhaps be changed to ''major''.

References:

1) Janjić, Z. I., 1989: On the pressure gradient force error in σ-coordinate spectral models. Mon. Wea. Rev., 117, 2285–2292.

2) Satomura, T., Iwasaki, T., Saito, K., Muroi, C. and Tsuboki, K. 2003: Accuracy of terrain following coordinates over isolated mountain: Steep Mountain Model Inter-comparison Project (St-MIP). Annu. Disaster Res. Inst. Kyoto Univ., 46B, 337–346 [available online at http://www.dpri.kyoto-u.ac.jp/dat/nenpo/no46/46b0/a46b0t33.pdf].

3) Steppeler, J., Bitzer, H. W., Janjic, Z., Schättler, U., Prohl, P., Gjertsen, U., Torrisi, L., Parfinievicz, J., Avgoustoglou, E., and Damrath, U., 2006: Prediction of clouds and rain using a z-coordinate non-hydrostatic model. Mon. Wea. Rev., 134, 3625–3643.

4) Steppeler, J., Park, S.-H. and Dobler, A., 2011: A 5-day hindcast experiment using a cut cell z-coordinate model. Atoms. Sci. Let., 12, 340-344.

5) Sundqvist, H., 1976: On vertical interpolation and truncation in connection with use of sigma system models. Atmosphere, 14, 37–52.

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