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Atmospheric Chemistry and Physics Discussions



# *Interactive comment on* "Impact of resolution and air temperature on Large Eddy Simulation of mid-latitude summer time convection" *by* Christopher Moseley et al.

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Thank you for your comments and suggestions for improving the manuscript. Before the open discussion phase ends, we here provide preliminary replies to your comments.

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1. In the analysis of the 36-day simulations, the authors separated the cases into warm and cool days to compare the impact of surface air temperature on convection activity as seen in simulations and in observation.One of the motivations for doing this seems



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to be that the authors are concerned with the ability of the cloud-resolving models to correctly simulate the response of atmospheric convection in a warming climate, which they hinted at in the introduction. But it is not obvious to me that the contrast in the large-scale environment between the warm and cool days chosen in this study is comparable to the contrast in typical large-scale environment of middle-latitude convection activity between the current and future warmer climate. If the authors think they are comparable, they should make the claim more explicitly. If the authors just want to compare the sensitivity of the simulated convection to different environmental conditions as characterized by the surface air temperature the analysis is completely valid in my opinion given the importance of surface condition for summertime convection over mid-latitude land.

Reply: You are correct that our study is not able to predict changes in convective precipitation under climate change. Thank you for drawing our attention to this possible misunderstanding. The practice to investigate the sensitivity of heavy precipitation to temperature by conditioning high percentiles of precipitation intensity on daily mean temperatures has been originally proposed by Lenderink and van Meijgaard (2008), and has been adopted by several subsequent (mainly observational) studies. Many of these studies refer to climate change as a motivation, reasoning that warmer temperatures in the future are likely to produce higher precipitation extremes. In our manuscript, we also follow this approach based on the 35 simulation days that we have available. Of course, changes in large-scale circulation and variability also have to be taken into account when making statements about climate change, but they are not considered here. We will reformulate the Introduction section in the revised manuscript to make this clear.

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2. I wonder what criterion the authors used for selecting cases to perform higher-resolution simulations and why the authors did not choose those cases so that they could also investigate the contrast between warm and cool days at higher resolu-

tions(even just with 2 or 4 cases).

Reply: Given the high computational costs of such simulations, especially the high resolution simulations with 3 nests, we had to constrain our analysis to the simulated days that were available. We chose the given 35 days period as there was convection in a large part of the domain in almost all of these days, but due to the available computing time and storage space we could only run it on the 625 m nest. 3-nest simulations were performed for pre-selected days within the German joint project "HD(CP)2 High deïňĄnition clouds and precipitation for advancing climate prediction" (mentioned in the Acknowledgement) of which our study was part of, and out of 4 available high resolved model days within this period, we chose 3 for our analysis. As can be seen in Table A1, only one of these days (June 6) falls inside the "warm" category. None of the available 3 nest days are within the "cool" category. This is insufficient for an analysis of the temperature sensitivity for the higher resolutions, unfortunately. Therefore we decided to present the results of the resolution impact (based on the three high resolved days), and of the temperature sensitivity (based on the 35-day simulation with 625 m) separately, and stated in the Discussion (p. 20, l. 9 ff.):

"Our study also leaves the question open if higher resolution will lead to an improved simulation of the sensitivity of heavy rainfall and convective organization to temperature, as only three model days are available on the higher resolved nests. Given that the magnitude of the intensiïňĄcation of heavy rainfall with temperature has both a thermodynamic (based on the CC argument) and a dynamic aspect, and that thermodynamic processes can be expected to be rather independent of resolution, we can assume that it is mainly an insufiňĄcient representation of the dynamics within the convection cells that causes an underestimated intensiïňĄcation at 625 m grid spacing."

As our results show that convective life cycles and convective organization are better represented at the 100 m scale, we may speculate that also the sensitivity of heavy precipitation to temperature will be better simulated.

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