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Interactive comment on "The sensitivity of atmospheric blocking to changes in upstream latent heating – numerical experiments" *by* Daniel Steinfeld et al.

Oscar Martinez-Alvarado (Referee)

o.martinezalvarado@ncas.ac.uk

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General comments

Building upon recent findings related to the importance of tropospheric latent heating on the development of atmospheric blocking, this contribution investigates from a numerical modelling point of view, the extent to which latent heating influences the development of atmospheric blocking and the cause-and-effect relationship involved in this influence. Understanding these processes in the atmosphere is critical due to the important effects that blocking has at the surface and on human activities. Thus, these are without doubt relevant scientific questions within the scope of WCD. For this

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Discussion paper

investigation the researchers performed sensitivity analysis by varying latent heating in ad-hoc regions in numerical simulation of five cases, using the state-of-the-art ECMWF IFS and an advanced methodology based on atmospheric blocking tracking and trajectory analysis. Through their investigation they demonstrate in a convincing manner that atmospheric blocking features such as intensity, spatial extent and lifetime depend strongly on latent heating. However, they also showed that there is a large case-to-case variability. The paper is very well structured and written, and, in my opinion, the description of the methodology is sufficiently complete to allow their reproduction by fellow scientists. Therefore I recommend the article for publication in Weather and Climate Dynamics. I include a list of minor comments that could be considered by the authors to hopefully enhance the paper.

Specific comments

L66: How smooth are the physical temperature tendencies in the native resolution? If it is not a smooth field, is it properly represented after the interpolation to the 1-degree horizontal resolution?

L80-81: Please cite the previous studies that the methodology in this study is being contrasted against? In which way is the new methodology different to the one in previous studies? Did they dampened latent heating everywhere in their domain?

L105-106: How was the blocking event for which latent heating was reduced and increased chosen? Is the case representative in any way especially after considering that large case-to-case variability reported in this study?

L279-280: Is there any indication of the extent of the influence of initial conditions on the differences after 6 days? How would the differences found here compare to differences between members in an ensemble simulation? This is discussed to a certain extent in Maddison et al. (2020, doi:10.1002/qj.3739), which is in any case a relevant reference that you might want to cite.

L385-389: The Russia block is very interesting, and the discussion could be extended. If there is such a limited influence of latent heating in the evolution of the block, what is then the source of the big differences in the evolution of the blocks in the two simulations?

L411: I've got a bit confused with this description, in which the authors talk about a median heating of 3 K (dashed curves in Fig. 10a,b). What I can see is cooling in those curves? I'm sure I'm missing something. Can you clarify?

L435-436: Should the statement that the Thor onset and Cold spell block amplify without the contribution of LH be qualified? The LH was eliminated only between 900 - 500 hPa, and as the authors acknowledge in Section 2 there are diabatic processes active above that layer.

L464: Should the intensity of the upstream cyclone be included in the list of factors as is done in L432-433?

Technical corrections

L58-59: Delete 'exemplarily' or change it for 'as an example' after 'introduces'

L65: In addition to the number of vertical levels, give details on the top of the atmosphere and the typical separation between levels.

L115: Change 'quasi-stationary' for 'quasi-stationarity'

L123: Spatial extent is among the set of blocking characteristics calculated for each blocking event. Even though the method to identify blocking considers an atmosphere's layer rather than a single level, the extent referred to here is horizontal extent rather than a three-dimensional size. Is this so? It would be useful to add details on the layer considered for the blocking identification. Is it the 'upper-level' layer, i.e. 500 - 150 hPa? Is it possible to compute details on the vertical extent of the blocking region?

L230 and 241: There are references to Fig. 3e,g, but I cannot see those panels.

L220-221: Where are the trajectories emanating from in the vertical direction? Are they initially located between 500 hPa and 150 hPa? Or at a particular level?

L269: Are the divergent wind speeds quoted averages over a region? Please, specify.

L392: Add ‘simulations’ after ‘... NOLH (dashed lines)’.

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