Weather Clim. Dynam. Discuss.,
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Interactive comment on "A Lagrangian analysis of upper-tropospheric anticyclones associated with heat waves in Europe" *by* Philipp Zschenderlein et al.

Anonymous Referee #2

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Summary

This study follows Pfahl et al. (2015) and Steinfeld and Pfahl (2019) - most of the tools are used there – but this study targets heat-wave-associated upper-tropospheric anticyclones, which often can be weaker summertime continental anticyclones. Such target allows this study to find two heating branches: western (Atlantic, related to warm conveyor belt, stratiform precipitation) and eastern (continental, related to ML CAPE, convective precipitation, orographic lifting). The latter is not known in previous studies, potentially because analyses in previous studies (including the above two) might tend to be dominated by stronger oceanic blocking.

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Discussion paper

I find this study scientifically significant and methodologically sound. It may be well suited for publication if the presentation quality can be further improved and a couple of scientific comments below are addressed.

Major comments

1. (Line 281): As mentioned in line 358, trajectories do not resolve sub-grid scale convective processes. So, how is the eastern branch heated? Is it heated by the weaker stratiform precipitation?

2. I view the physical difference between the two heating branches is more about the heating mechanisms, less about where they are 3 days ago. Would it be cleaner to define the two branches based on their "locations of maximum diabatic heating", instead of where they are 3 days ago?

3. The novelty of this study against related work is not explicitly emphasized enough. In introduction, readers might want to know the deficiencies in related works that you will be solving, and in what way you might expect your results to differ from theirs.

As mentioned in my summary: I view this study is novel in targeting heat-wave-associated upper-tropospheric anticyclones. These anticyclones often collocate with heat waves [Roethlisberger et al. 2016, https://doi.org/10.1002/2016GL070944; Brunner et al. 2018, https://doi.org/10.1029/2018GL077837; Chan et al. 2019, https://doi.org/10.1029/2019GL083307], and are therefore continental anticyclones.

Line 57: Instead of throwing out all the key words, you can emphasize on heat wave anticyclone, saying that they often can be weaker summertime continental anticyclones and therefore may differ from global studies like Pfahl et al. (2015) and Steinfeld and Pfahl (2019), analyses in which might be dominated by more frequent oceanic blocking.

Line 60: Do you expect this study to be different and better than Quinting and Reeder (2017)? If so, please explicitly tell the difference.

Line 145: Again, lack of detailed studies of continental blocking could be the reason

why this eastern branch is not known before. Could emphasize on that.

Minor comments

You don't have to, but I personally find the naming of western/eastern branch not intuitive enough. Is there a better alternative?

The separation line of 30W is not repeatedly mentioned enough. Line 217: You might want to repeatedly remind readers that eastern means east of 30W and western means west of 30W, in this line and many other lines. Line 327: You might want to repeat in conclusions that 30W divides the two branches.

Line 9: "located southwest of the anticyclone" and "above western North Atlantic" are not mutually exclusive, consider saying "is located *over Africa/Europe* to the southwest. . ."

Line 22: Warming being "not spatially uniform" doesn't seem to connect well with the idea of changes in "regional circulation patterns".

Line 26: This paragraph can start with a better topic sentence, saying that heat waves are associated with either an upper-tropospheric ridge or a blocking flow pattern.

Line 27-28: In introduction, probably you don't need to include the fine details of methods in previous research.

Line 82: Would be good to exemplify upfront that for Central Europe, 72? heat waves lasted for at least 3 days are identified.

Line 87: You might want to explicitly mention that your definition of upper-tropospheric anticyclone requires no temporal persistence (this is implied in line 122).

Line 109: Might be good to be slightly clearer about the difference in method to Steinfeld and Pfahl (2019).

Line 233: Might be useful to show the figure for the pressure of maximum diabatic

heating.

Line 270: Is the idea of Quinting and Reeder (2017) more like warm conveyor belts in the western branch? Or more like the eastern branch? Could be more explicit.

Figure captions: Proofreading or copy-editing is needed. (Plurals, Capital letters, spaces, etc.)

Figure 7b caption line 6: Please note in caption that orange shading in 7b is not visible.

Figure 8 caption: Please note in caption that WCB is not visible.

Figure 8 purple hatching: Do you require total precipitation >= 2 mm/d? You might also want to remind readers that purple hatching in Fig. 8 is opposite to that in Fig. 7.

Technical corrections

Line 162: is found east of the *western* heating branch.

Line 224: over the *European* continent. . .

Line 236: *42* to 54 h

Line 296: “About 70” -> “72”?

Line 297: a duration of *at least* three days

Line 332: Are there *three* source regions instead of two?

Line 376: Do you mean Rossby wave *packets*?

Figure 3 caption line 4: boxes represents -> boxes represent

Figure 6 caption line 3: ... and Greece/ Italy (GI).

Figure 7 caption line 6: warm conveyor belts *(red)* frequency

Figure 8 caption line 2: grey shading -> purple hatching?

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