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Comment on wcd-2022-1

Anonymous Referee #2

Referee comment on "Recurrent Rossby waves and south-eastern Australian heatwaves" by S. Mubashshir Ali et al., Weather Clim. Dynam. Discuss., https://doi.org/10.5194/wcd-2022-1-RC2, 2022

Synopsis: Ali et al. analyse the relation of recurrent Rossby wave packets (RRWPs), quasi-resonant amplification (QRA), and atmospheric blocks in the Southern Hemisphere with an emphasis on southeastern Australian heat waves. Two case studies for the prominent heat waves in 2004 and 2009 motivate a climatological analysis. The authors find a significant relation between RRWPs and QRA and demonstrate that heat waves are two times more likely during QRA conditions. Overall, the study is well written and the results are clearly presented. However, I have three concerns which need to be addressed. Once these have been addressed in a suitable manner I am very happy to provide a detailed review of the manuscript.

Major:
1) According to the QRA concept, resonance can lead to high-amplitude quasi-stationary planetary waves if the combined orographic and thermal forcing pattern is sufficiently large. For the Southern Hemisphere, I assume the orographic forcing term to be of smaller magnitude than in the Northern Hemisphere and thus the thermal forcing term to dominate over the orographic forcing term. Accordingly, my interpretation is that the thermal forcing, which includes the zonal gradient of the azonal temperature at 300 hPa, becomes particularly strong during heat waves. The interpretation of the thermal forcing is therefore tricky as it could in principle be a result of the temperature anomalies rather than a forcing for large wave amplitudes. For these reasons I have doubts that the QRA concept is easily applicable during such periods and care must be taken when interpreting the results. At least a detailed discussion of this issue and how one can distinguish between forcing and results of the forcing should be included in the manuscript.

2) I very much appreciate that the authors decided to include two case studies. These nicely illustrate the approach that is later used from a climatological perspective. However, to my impression the discussion of the cases is not very goal oriented. This is perhaps also reflected in the abstract which does not include a clear outcome of the case study analyses. For example, SST anomalies are shown (Figs. 6f, 8f) but their relation to the RRWPs, blocking, or QRA is not discussed at all. If the purpose of the case studies is to explain the methodology used later on, my suggestion is to only present one case study.

If the purpose is to highlight certain dynamical processes, I think the discussions in Section 3.2.1 and 3.2.2 need to be revised in a sense that the main outcomes are immediately clear to the reader.

3) One main conclusion is that RRWPs exhibit a significant relation to the duration of heat waves. To my understanding this result is plausible since southeastern Australian heat extremes, for example, occur in a highly amplified flow. Accordingly, prolonged periods of high amplitude Rossby waves favour the occurrence of several heat extremes which then are identified as one long-lasting heat wave. What is less obvious but probably at least equally important is the relation of RRWPS and the heat wave magnitude. A possible scenario would be that a first upper-level ridge leads to a heat extreme which dries the soil and thus favours higher temperatures later on through enhanced sensible heating. Could the authors therefore comment on the relation of RRWPs and heat wave magnitude, and how this differs from "ordinary non-recurrent RWPs"? Such an analysis would be extremely insightful in an operational context.