Author Replies

We are grateful to both reviewers for the time they took to review and for their thoughtful comments which helped to improve this work. We have replied inline to the comments.

Reviewer 1

This study employs reanalysis data to explore the role of recurrent Rossby wave packets (RRWPs) and blocks in the persistence of southeastern Australia (SEA) heat waves using a combination of statistical analyses and case studies. As is the case with any observational study of a limited set of unique extreme events, understanding and quantifying the role of an individual Earth system component (the atmospheric flow in this case) is a challenging but important research effort. With this in mind, the authors have managed to illuminate aspects of SEA heat waves and provide new evidence on the role of the upper-tropospheric circulation. I have listed below my comments on the presented material - some of which could be deemed as "major issues" - as well as a few suggestions and corrections toward a revised version of the manuscript.

Comments/Issues

1. Lines 96-99 are not that clear. The 1.3 PVU threshold is an upper limit, lower limit, or what? Given the multiplication with -1, anticyclonic anomalies correspond to negative PV anomalies in the SH, right? What does it mean that with a 1.0 PVU threshold there are no blocks found over SEA? Is this a stricter or softer threshold? Is this sentence used to imply that blocking detection is too sensitive to the threshold used? Why is the blocking count over SEA used as an indication for the sensitivity?

The -1.0 PVU threshold in vertically averaged PV fields is a less stringent threshold than -1.3 PVU. We have added more information in the text to make this clearer.
The blocking over SEA is used to check whether the blocking algorithm, with a less stringent threshold, can identify the ridges over SEA as blocks or not for the two case studies.

Please note that the PV fields are multiplied with -1 for the rest of the analysis except for calculating blocks. This is also updated in the Method section as below:

"*PV fields are used as it is for calculating the blocking fields. However, for rest of the analysis, the PV fields are multiplied by minus one, which implies that negative (positive) PV anomalies represent anticyclones (cyclones) similar to the NH.* "

We have also added more details on the blocking algorithm:

“Atmospheric blocking data is computed following the methodology of Schwierz et al. (2004) as in Rohrer et al. (2020) and Lenggenhager and Martius (2019). The detection scheme identifies persistent anticyclonic PV anomalies vertically averaged (VAPV) between 500 hPa and 150 hPa vertical levels. First, the VAPV anomaly is computed from the 30-day running mean climatology of the corresponding time step of the year for the years 1979–2018. An additional 2-day running mean filter is applied to smooth out high frequency transients. Then the algorithm identifies areas with VAPV ≥ 1.3 PVU in the SH. The identified areas having a persistence criterion of 5 days, and a minimum overlap of 0.7 between consecutive time steps are classified as blocks. Blocking fields identified with this algorithm are available at 6 hourly temporal resolution and 1° × 1° spatial resolution. We tested the blocking fields with a less stringent threshold of VAPV ≥ 1.0 PVU for the two case studies and did not find blocking directly over SEA. The code used to calculate blocks is available on GitHub (See Code and data availability).”

2.Figures 4, 6 are not introduced anywhere in the text. There are just references to them and the information contained in their captions. An introductory sentence about the aim of these figures would be good. Furthermore, it is worth noting in the text that these Hovmöller diagrams do not contain information of the flow right over Australia (averaging is done between 35°-65°S). It is also worth mentioning that warm air advection from the desert and semi-arid parts of the continent toward SEA can be rather significant even with weak (lower- and/or upper-level) winds. These two aspects are relevant e.g. when considering the fact that the 2004 heat wave seems to start prior to the passage of strong RWPs over the Australian longitudinal range (Fig. 4).

As per the reviewer’s suggestion, we have added an introductory paragraph to introduce the two figures. We have also mentioned now that the latitudinal bands for the Hovmöller diagram are chosen such that to capture the jet and the synoptic-scale Rossby waves. The 35°S to 65°S is an appropriate choice consistent with Röthlisberger et al. (2019).

“Figure 4 shows the flow conditions prior to and during the heatwave and the corresponding T2m anomalies over SEA. The Hovmöller diagram (Fig. 4b) uses the 35° S – 65° S latitudinal-band for averaging V250 fields. The choice of the latitudinal band is motivated by the position of the jet suited to identify RWPs. Figure 5 shows the upper-level flow at different time steps prior to and during the heatwave. We used the two figures (Fig. 4 and Fig. 5) to study the role of transient RWPs and blocks during the heatwaves and present that next.”

We have highlighted the role of warm air advection from the continental Australia in the lines 212–214 and added the sentence suggested by the reviewer as shown below:

“The surface flow associated with anticyclonic anomalies may also advect warm continental air due to the north westerly flow at lower levels (e.g., Parker et. al. 2014b). The warm advection associated with the surface flow can be significant even with weak upper or level winds. “

On the reviewers point of 2004 heatwave starting prior to the passage of strong RWPs: Yes, we agree that even with weak upper-level flow there may be significant warm advection at lower level, contributing to the heatwave. However, for this case specifically, we observe an upper-level wave breaking over SEA around 4 February (Fig. 1), which could have helped the lower-level advection (Parker et. al. 2014b). Whereas, in the presentation of the results, we have only focused on the role of RRWPs rather than discussing all the possible factors responsible for the heatwave.

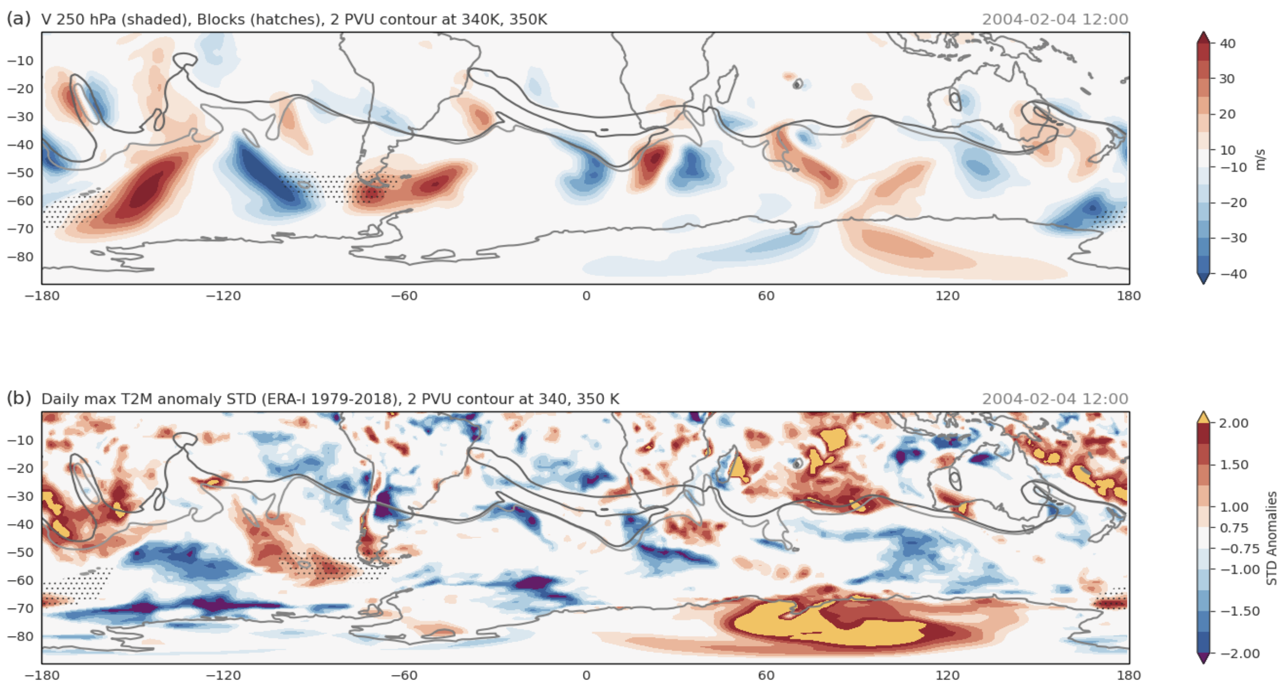


Figure 1: Synoptic chart at 2004-02-04 12:00 (a) shows meridional wind at 250 hPa and (b) shows standardized 2-m Temperature (T2M) anomalies of daily maximum T2M. Hatches in (a) and (b) show blocks and grey-coloured solid lines show 2 PVU contour at 340 and 350 K isentropes.

3.Lines 230-236, 364: The description of the synoptic evolution of these days suggests that RWPs and blocks are independent entities of the flow and that the blocks appear to "initiate" the RWPs. Is this really justified/proved by Figs. 4 and 5? The identified blocks are not really isolated features and waves of certain amplitude do exist upstream and downstream. In addition, it is claimed - I guess unintentionally - that RWP P3 is initiated by both B3 and B4.

Thank you for pointing it out. It is not our intention to say that RRWPs and blocks are independent entities of the flow, rather the opposite that the two features are closely related. RRWPs (i.e., eddies) upstream of a block can sustain the block (e.g., Shutts 1983; Hoskins et al. 1983). And RRWPs can form downstream of blocks because of the near constant phase of the wavebreaking (trough) on the downstream flank of blocks (Röthlisberger et al., 2018; Barton et al., 2016). Indeed, Barton et al., (2016) and Röthlisberger et al., (2018) show that blocks can initiate RWP downstream. We have now mentioned it in lines 40–45. However, here, we agree with the Reviewer's comment that the cause and effect for the block B3 initiating P3 and P4 is difficult to conclude just by Figs 4 and 5. Therefore, we have modified the text as (Lines 247–248):

"Another set of RWPs (P3 and P4 in Fig. 4b) are associated with a block over the Pacific Ocean (B3 in Fig. 4b, 5d)"

Thank you for spotting the mistake of RWP P3, we have corrected that.

4.Section 3.3 investigates the relation between RRWPs and SEA heatwaves. One aspect of the statistical analysis (Lines 272-275, Table C1) - that the authors do acknowledge - is that the list of high R_SEA days contains all days with strong cyclonic PV anomalies over SEA as well. Considering the fact that ridges/blocks are associated with lower R values than troughs (Lines 405-410, Figure D1), it is plausible that the days exceeding the 90th percentile in SEA R are predominantly associated with cyclonic PV anomalies. This creates an undesirable bias in the high R_SEA sample, that can easilly be eliminated in my opinion. The authors could just discard the DJF days when the average PV anomaly over SEA is above 0 (i.e., cyclonic), that is 50% of the days and calculate the 90th percentile in R based on the remaining (ridge) days. We will then have a more homogeneous sample of 176 high R_SEA days, X% of which co-occur with SEA HD. It would be interesting to see the new results in the last row of Table C1. What is the HD frequency increase when the ridge over SEA is associated with an RRWP rather than an individual RWP?

The reviewer mentions that ridges/blocks are associated with lower R values than troughs citing lines 405-410 (in the previous submission) and Figure D1; however, Figure D1 (now Fig. E1) shows high *R* values both upstream and downstream of the centroid of the block. Even at the centroid of the block, the *R* values are higher than the background (i.e., away from the block).

The reviewer suggested to filter out all the days in DJF containing a cyclonic PV anomaly over SEA. This filters out almost 50% of the days in DJF leaving 1641 days. The high *R* days computed from this sample gives 164 days, 57 of which co-occur with SEA HD. This increases the conditional probability to 0.34 as the reviewer hypothesized. This result has been added to Table C1 and also stated in lines 290–294. We thank the reviewer for this suggestion. However, we would like to clarify that we have not optimized the high *R* threshold chosen for the highest co-occurrence ratio with SEA heatwaves as this is not the aim of the study

On the last question, *what is the HD frequency increase when the ridge over SEA is associated with an RRWP rather than individual RWP*?
This is an intriguing question. However, it is quite challenging to define an individual RWP. Here, we use the RWP dataset from Frougdoulis et al. (2020) and are grateful to them for sharing their dataset. They calculate a 2-D RWP amplitude for each time step. Hence, to compare the RWP with R-metric, we average the RWP data between 30S–65S and then average it over SEA longitude, let's call this E. Next, we categorize high E days representing amplified RWP activity over SEA by taking 90th percentile of E for DJF, same way as we define high R days over SEA. Please note that this is a quick preliminary analysis as to we did not check which threshold is best for RWP amplitude. Therefore, the results below should be carefully interpreted are not optimized to the best hit rate for each metric.

We obtain 352 days with high E of which 40 overlap with SEA HD. Out of these 40 days, only 8 days include high *R* days. Whereas 67 high *R* days overlap with SEA HD. In the DJF climatology, we find that 63 days categorized as high E days overlap with high R days.
It is possible to have high *R* day but not high E day as the high R days have an additional condition for recurrence in the same phase.

Fragkoulidis, G., & Wirth, V. (2020). Local Rossby Wave Packet Amplitude, Phase Speed, and Group Velocity: Seasonal Variability and Their Role in Temperature Extremes, Journal of Climate, 33(20), 8767-8787.
https://journals.ametsoc.org/view/journals/clim/33/20/jcliD190377.xml

5.Lines 286-292: The lack of preferred PV anomaly phase on days that do not feature a SEA heatwave is not that surprising. What is a bit strange is the predominantly negative PV anomalies throughout the hemisphere on these days (Fig. 8b). What causes this? Is it perhaps because years 2011-2018 do not contribute to the mean climatology and PV anomalies in these warmer years are standardized based on a "cooler" DJF distribution?

The PV climatology is calculated using 1979–2018 as mentioned in the caption of Figure 8. We have removed the climatology period in the Method to avoid confusion (L69 in previous version). We found a mistake in the code when calculating PV anomalies. The Figs. 8a and 8b have been updated and we do not see predominantly negative anomalies in Fig 8b as before. The Section 3.3 is updated as per the changes in Figs. 8 and 9.

6.Figure 9: First, the contour values of the kernel density are missing. The preferred phasing in SEA heatwave days is clear and, as mentioned before, not too surprising. It is interesting though that this only occurs in wavenumber 4. Besides, what can be said about the wavenumber 4 amplitude between HD and non-HD? It seems that the mean distance from the complex plane origin (which, if I'm not mistaken, corresponds to the amplitude) is similar in the 2 sets of days. Is there perhaps an increase in the amplitude of larger wavenumbers during SEA heatwave days?

We have updated Fig 9 with contour values and added distribution for the climatology as well. We have additionally added wavenumber 5 because we also see a wavenumber 5 pattern in the updated Fig 8a. The WN4 and WN5 amplitude (distance from the origin) is expected to be higher than climatology for high R days. This is also what we observed in the Fig. 8 (a, b, d, e).

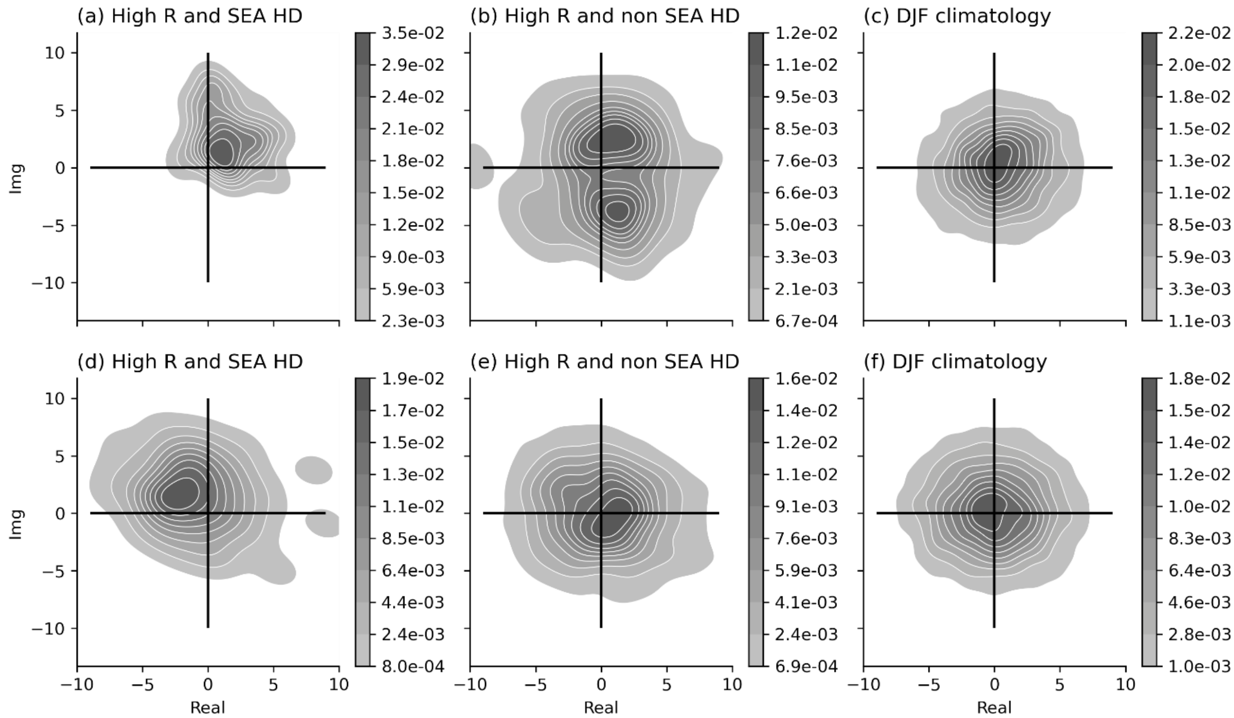
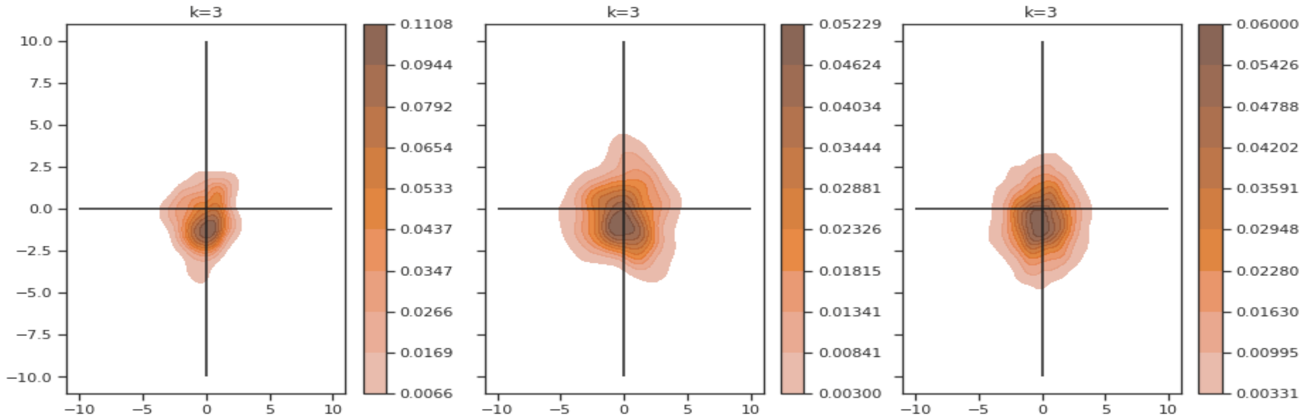


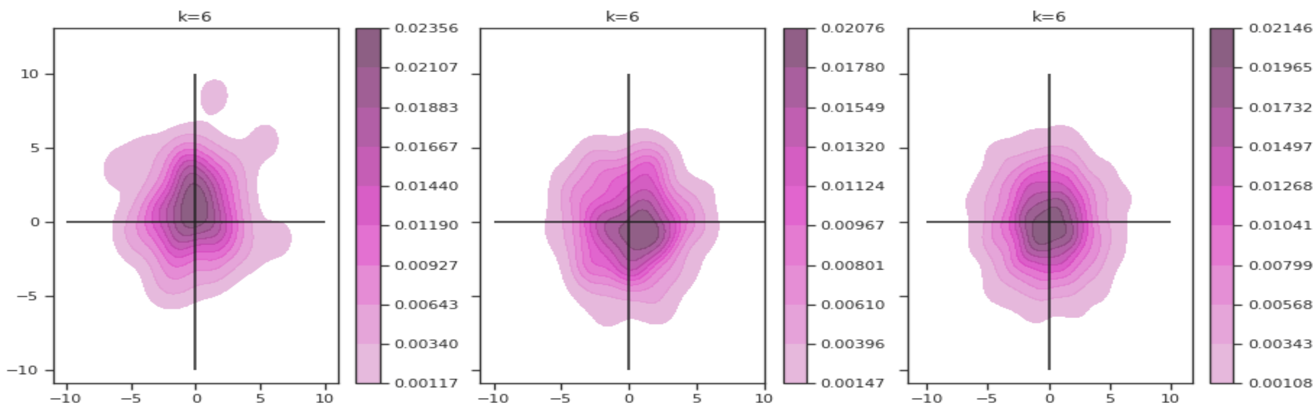
Figure 2. Bivariate kernel density estimate using Gaussian kernels in the complex plane of the Fourier decomposed meridional wind at 250 hPa averaged between 35°S and 65°S. Only zonal WN4 (top) and WN5 (bottom) are shown for days belonging to (a, d) high RSEA and SEA HD, (b, e) high RSEA and non-SEA HD, and (c, f) DJF climatology.

As mentioned in the updated text, the wavenumbers shown in Figure 9 are motivated from the WN4 and WN5 patterns observed in Fig 8a, and the difference in phase and amplitude distribution of other wavenumbers shown below (Fig. 3) is relatively smaller.

(a) k=3



(a) k=6



(b) k=7

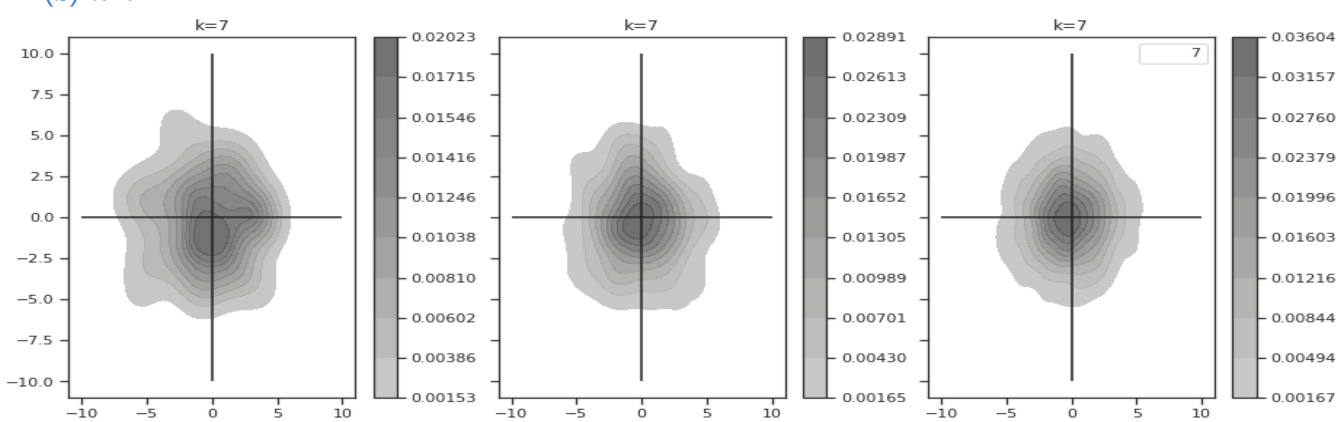


Figure 3: Same as Figure 2 but for WNs, k=5, 6, 7.

7.Appendix A: It is indeed interesting that Southern Hemisphere R is higher in summer than winter. I wonder whether this is associated with the fact that SH storm tracks are spiralling in winter but remain rather circular in summer (e.g., Hoskins and Hodges 2005; https://doi.org/10.1175/JCLI3570.1). In any case, the fact that SH summer provides a favorable stage for RRWPs is an aspect worth mentioning in a more prominent part of the text. On a technical note, it is not clear how are the R anomalies in Fig. A1 computed and how can we compare the typical R values in the two hemispheres, if the two Hovmöller diagrams (most probably) refer to different mean climatologies.

R anomalies for each day of year at each longitude are calculated from the mean of the day of the year mean. Therefore, the R anomalies at each longitude show variation with the mean of the day of year mean and have a seasonal pattern. The magnitude of the anomalies shows that there is larger variation in the values for the NH than the SH. We have updated the description Lines 410 onwards to make it clearer. As the reviewer rightly points out, R is higher in austral summer than winter.
This is indeed an interesting result. However, we did not include in the main text because:
a. More analysis is needed to explain the difference observed between the Southern and Northern Hemisphere.
b. Comparing NH R-metric with SH R-metric does not quite fit with the storyline of the paper. Hence, we have included it in the Appendix. Thank you for also sharing Hoskins and Hodges (2005) reference.

Minor issues

We thank the reviewer for spotting the minor issues.

1. Line 17: ERA-I is also an observation-based dataset. Use instead, e.g., "weather station observations" or similar.
Thank you, we have implemented this suggestion.

2. Line 30: "extratropics"
Thank you, we have corrected that.

3. Line 45: "part of a synoptic-scale"
Thank you, we have corrected that.

4. Line 53: "the persistence of"
Thank you, we have corrected that.

5. Line 56: This sentence is not really contradicting the previous. So, "however" is not fitting here.
Thank you, we have implemented this suggestion.

6. Lines 66-67: Is SST and horizontal (I suppose "zonal" was meant here) velocity still used in the revised version of the paper? In addition, Figs. 4, 6, and B1 make use of a "daily maximum 2m temperature". Is this another field from ERA-I that should be mentioned here, or estimated somehow from the 6-hourly 2m temperature?
Yes, daily maximum 2m temperature is derived from the 6 hourly 2m Temperature. We have removed zonal velocity updated the Data section accordingly.

7. Line 69: Is this reference period (1980-2010) also used for the blocking feature Detection?
Blocking detection uses 1980-2018 period. We have updated the description in the Methods section (Lines 107-109).

We have also clarified the period used in the anomaly calculation where necessary (e.g., caption of Figure 8).

8. Line 71: "used to quantify the recurrence"
Thank you, we have corrected that.
9. Line 90: "the wave packet envelope"
Thank you, we have corrected that.
10. Line 91 and elsewhere in the text: "complex plane" (not plain)
Thank you, we have corrected that.
11. Line 92: Specify the section in which this phase-amplitude distribution is used.
Thank you, we have corrected that.
12. Line 94: "between the 500 hPa and"
Thank you, we have corrected that.
13. Line 102: "QRA conditions" should be removed
Thank you, we have corrected that.

14. Line 106: What does "high-quality" mean? Has there been a study that evaluates the quality of BoM's monitoring network against others?

The weather stations in this dataset are selected for their quality and length of the available temperature data. From the website of the ACORN-SAT dataset, "*The Bureau's methods have been extensively peer-reviewed and found to be among the best in the world. This is crucial, as it means the community can have confidence the Bureau is providing an accurate estimate of Australia's true temperature trend.* "

More details about the quality checks are provided here:
http://www.bom.gov.au/research/publications/researchreports/BRR-032.pdf

15. Line 108: 2019 is not used in the other fields.
Thank you for spotting this. We initially used ACORN-SAT till 2019 but later used it only until 2018 due to the availability of other datasets. We have corrected the time period as 1979–2018.

16. Line 111: "were on average"
Thank you, we have corrected that.

17. Line 114: "a day that is part", "SEA heatwave day (HD)"
Thank you, we have corrected that.

18. Line 116: "averaged between 130°E and 153°E, which corresponds to the SEA longitudinal range" ...since "over SEA" is not correct (R is computed over a latitudinal band that lies to the south of Australia).
Thank you, we have corrected that.

19. Line 117: "A sensitivity test"
Thank you, we have corrected that.

20. Line 124: "1-degree horizontal resolution"
We think that it is also correct to use "spatial resolution".

21. Line 133: "Higher numbers of"
We have modified the sentence as:
"Over land, many hot spells are seen over parts of SEA, South Africa, and South America, having 350 or more spells."

22. Line 161: "rejecting the null"
Thank you, we have corrected that.

23. Lines 165-171: All the information here is also included in the previous paragraph.
Yes, we have re-structure this part.

24. Line 232: "(B3 in Fig. 5d)"
Thank you, we have corrected that.

25. Line 243: "windy conditions fueled many catastrophic fires"
Thank you, we have corrected that.

26. Line 247: "Several RWPs"
Thank you, we have corrected that.

27. Line 248: "The RWPs prior to"
Thank you, we have corrected that.

28. Line 259: "moving block" sounds strange. Moving ridge perhaps?
Removed "moving". We haven't used "ridge" because it is classified as a block by the detection algorithm, a ridge would be more general.

29. Line 272: A verb would make this sentence more formal.
We have modified the sentence as the following:
"First, we note the co-occurrence of high R_{SEA} days and SEA heatwave days (SEA HD) as defined in section 2.3."

30. Line 276: "explore why some"
Thank you, we have corrected that.

31. Line 328: "presents the relationship"
Thank you, we have corrected that.

32. Line 338: "zonal wavenumber of meridional wind in the complex"
Thank you, we have corrected that.

33. Figure D1: The x-axis label should be corrected ("pseudo"). In addition, the time axis direction could be the same as in the other Hovmöller diagrams of the study for consistency. In addition, the domain limits in the caption are different from the ones mentioned in Lines 401-402.
Thank you, we have corrected the spelling.

34. Lines 406, 411: The figure references need correction (D1 instead of C1)
Thank you, we have corrected that.

35. Line 411: "where DJF blocks show R"
Thank you, we have corrected that.

Reviewer 2

The authors have addressed my comments of a previous review in a suitable manner. By removing the QRA analysis, a critical aspect that would have required further consideration and analysis is taken out of the manuscript. Nevertheless, the manuscript is an important step towards understanding the atmospheric precursors of heat waves in southeastern Australia. Numerous minor inaccuracies have made it difficult to read. Once these are corrected, I recommend the manuscript for publication in WCD.

Major comment:
1) The R metric is calculated at the 250 hPa level. The 350-K isentropic level which is commonly used to diagnose upper-level anticyclones associated with heat waves lies at a higher isobaric level (approx 200 hPa climatological DJF mean). If you determined the R metric at the 350-K isentropic level instead, would you then find an even stronger link between high R_SEA days and SEA HDs? This would be somewhat expected as the high tropopause in such

case would correspond to high thickness and accordingly to a higher troposphere-mean temperature.

Figure 4 below shows R-metric at 200 hPa compared with 250 hPa for January 2004. The major patterns are captured well at both the pressure levels. There are only minor changes in magnitude and those changes will affect the whole distribution of R-metric. Thus, we do not expect a substantial difference in the high R days as they were selected based on a percentile from that distribution.

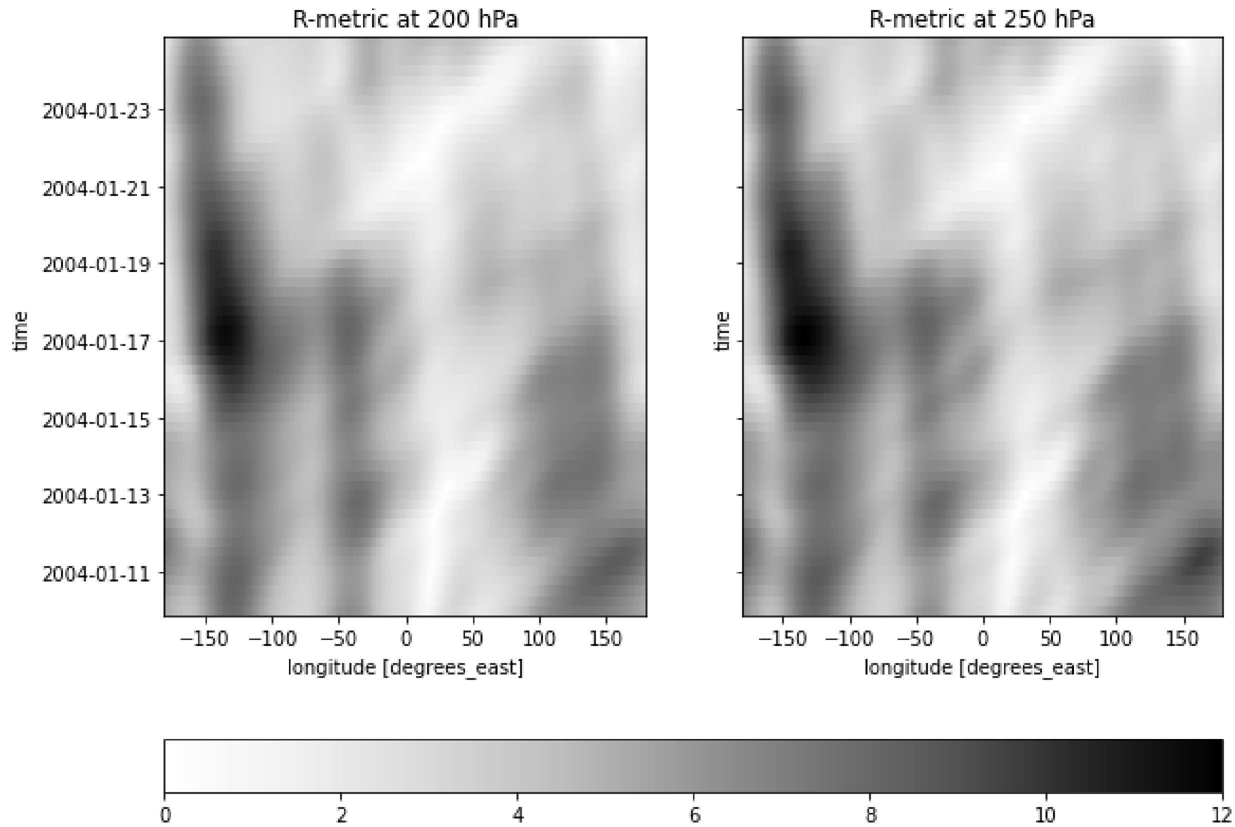


Figure 4: Comparison of R-metric at two pressure levels: 200 hPa and 250 hPa

We think that both 200 and 250 hPa levels are well suited to capture the jet. The figure 5 showing zonal mean zonal wind for DJF climatology from the ERA-40 Atlas also supports our point. Hence, we stick with 250 hPa as also used in Röthlisberger et al. (2019).

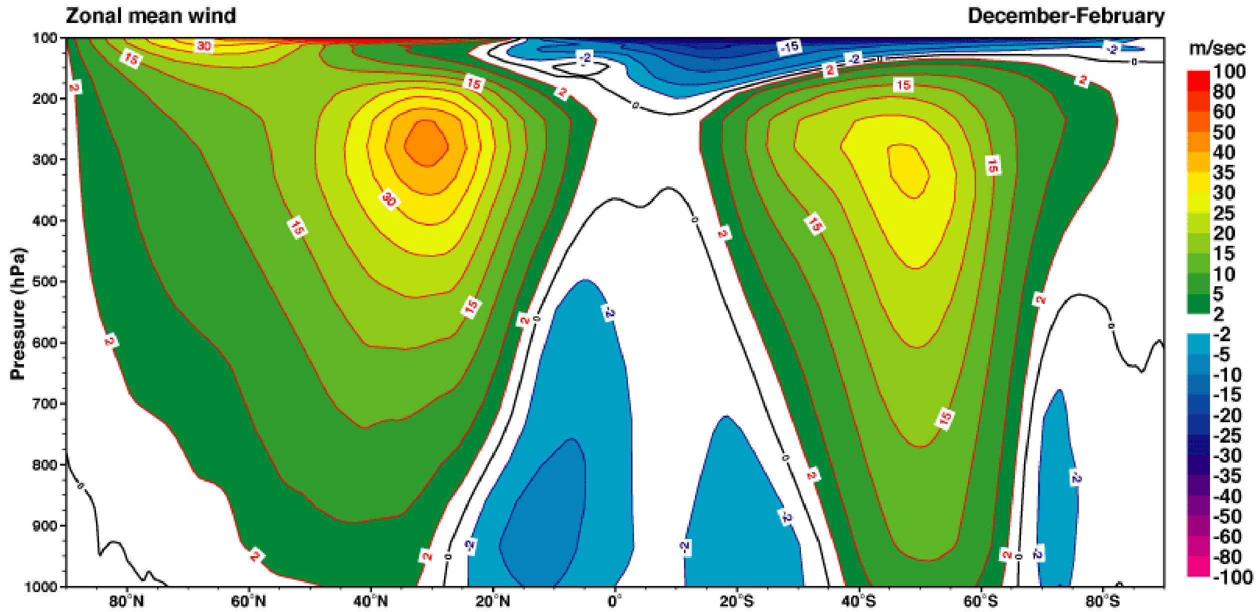


Figure 5. Zonal mean zonal wind for DJF climatology from the ERA-40 Atlas. Source: https://sites.ecmwf.int/era/40-atlas/images/full/D25_XS_SON.gif

Minor comments:

l. 32/33: Here the authors use the terms "Rossby wave patterns" and "recurrent Rossby wave patterns". Are these any different from Rossby wave packets? If not, please consider to use consistent terminology.

Thank you for this suggestion. Here, both imply the same. We have changed it to Rossby wave packets instead of patterns and did so in the other instances.

l. 36: Perhaps remove "short" as it is a relative term or replace it with "on medium-range to sub-seasonal time scales"?

Thank you for this suggestion. We have modified it to be more specific about the time scale: *"RRWPs can be considered as a subset of amplified Rossby waves with a condition that the transient eddies recur spatially in the same phase on a short time scale of days to weeks."*

l. 37: See comment on lines 32/33.

Please see reply to Minor point 1.

l. 45: "Rossby wave packets" instead of "Rossby wave packet"?

Thanks for the suggestion. We have modified the sense as: "These anticyclonic PV anomalies can form as part of a synoptic-scale Rossby wave packet (RWP)."

l. 47: "RWPs...break over SEA as anticyclonic equatorward (LC1-type) Rossby wave breaking" is awkward as "breaking" is redundant. Perhaps simply write "...and eventually break anticyclonically over SEA".
Thank you, we have corrected that.

l. 65: I assume you are using 6-hourly data!? Perhaps provide this information so that it becomes immediately clear later on why you are using 14.25 day running means later on.
Yes, thank you, we have added that.

l. 69: Please clarify, are you considering seasonal means, running means or something different?
We have clarified the climatology calculation where used, e.g., caption of Fig. 8 which uses seasonal means and in the Method section for T2M anomalies.

l. 70: I guess it has to be "2.2 Recurrent Rossby Waves".
Thank you, we have corrected that.

l. 99: So I guess with both thresholds 1.3 PVU and 1.0 PVU you did not find blocking directly over SEA? Please write this explicitly in the text.
Thanks for this suggestion. We have mentioned it explicitly in lines 112–113:
"We tested the blocking fields with a less stringent threshold of VAPV ≥ 1.0 PVU for the two case studies and did not find blocking directly over SEA."

l. 102: I guess this needs to be updated as QRA is not included any more in the manuscript.
Thank you, we have corrected that.

l. 115: I assume "HD" refers to heat day? Please introduce the acronym.
Thank you, we have corrected that.

l. 117: For TMAX, the 90th percentile is calculated for each station for each month in DJF. So, the 90th percentile for R is not entirely consistent as this is defined based on the daily mean, right? Please clarify.
Yes, the TMAX scheme is on the lines of one used in Quinting and Reeder (2017). The 90th percentile of R, based on the daily mean R, aims to identify days with R towards the extreme end of the distribution and hence serves our purpose of comparing RRWP conditions during SEA heatwaves.

l. 131: Better write "hot surface weather"? This would be consistent with the terminology "hot spell".
Agreed, thanks for the suggestion, we have changed it.

l. 147: The value of R is averaged from 35 to 65°S. The hot spells, however, are defined between 20 to 70°S. How do you treat hot spell grid points, e.g., between 20 to 35°S that are remote from the region over which R is averaged?

Although the metric R is computed from 35°S to 65°S meridional wind at 250 hPa, it only has longitude information as shown in lines 154–160.
Hence, the value of covariate R will be the same for all the spells at the same longitude. And based on that, we did not find substantial significant areas North of 30°S, implying that R does not play a significant role for most of the hot spells North of 30°S. However, the ones we get significant around the 30°S band, e.g., over SEA can be explained by the process discussed in the case studies i.e., RRWPs helping to form recurrent ridges over SEA.

Furthermore, we also checked sensitivity of the R-metric to latitudinal averaging by using 20°S to 80° S meridional wind vs 35° S to 65° S (Figure 5). We did not find differences in the seasonal anomalies of R between the two.

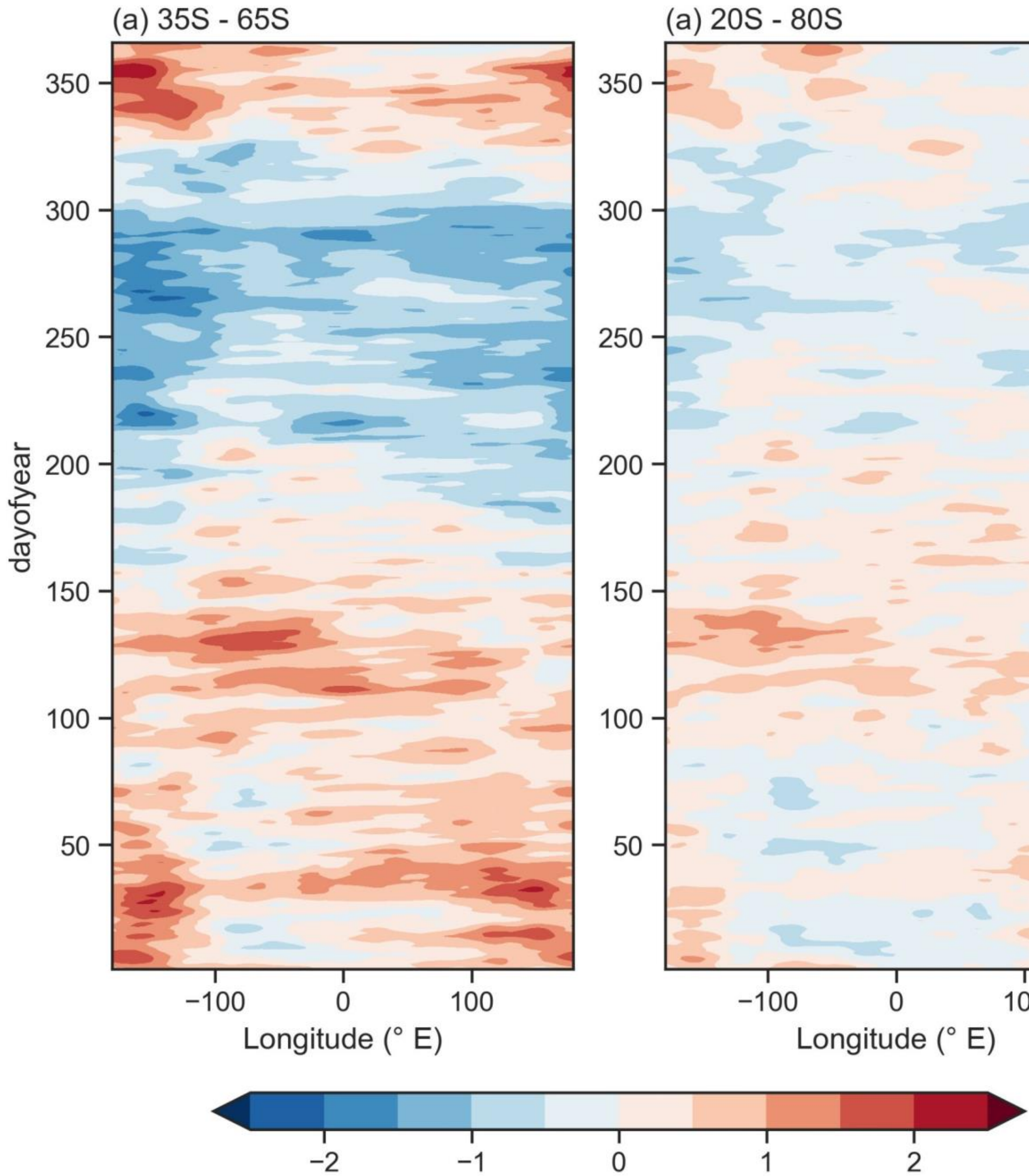


Figure 5: Day of year R anomalies computed for each longitude and each day of year with respect to the mean of day of year means.

l. 153: Are May and September considered at all?
No, only NDJFMA months are considered for the Weibull analysis.

l. 166-171: These lines are nearly the same as in the previous paragraph and can presumably be removed from the manuscript.
Thank you, we have corrected that.

l. 193: The heading needs to be adapted as QRA is not included in the manuscript any longer.

Thank you, we have corrected that.

l. 209 and elsewhere: Please use notation m\,s^{-1} instead of m/s.
Thank you, we have changed the notation.

l. 226: R is already at high levels from 7-12 February (grey contours in Fig. 4b). However, the shading does not indicate high values of the meridional wind. Is this due to the averaging between 35-65°N where positive and negative values in v may cancel out? A short explanation would help to avoid a potential confusion.

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250°E.

This is due to the approximately 15-day running mean filter that the R-metric uses. We can see the small wind velocity pulses around 8–9 February are in-phase with the amplified wave packet P1 later (around 12 February).

l. 228: I guess you mean the labeling in Fig. 4b!? Only B1 but not P1 is labelled in Fig. 5b.
Thanks for spotting, it is corrected now.

l. 228: 2x downstream: Consider to specify the location of the block as "central Pacific" instead of "downstream of Australia" which is quite unspecific.

l. 229: The block in Fig. 5a south of Australia is this the same block as B1 in Fig. 5b? If so, please label the block also in Fig. 5a.
Yes, it is the same block, thanks for spotting it.

l. 232: The text and the labels in the Figures do not match. There is no B3 in Fig. 5b. Please carefully revise this paragraph to ensure that the labels are correct.
Thank you for spotting, it is corrected now.

l. 233: Also here, B4 is south of South Africa but not of South America. Please correct.
Thank you for spotting it.

l. 235: I guess you mean four RWPs instead of three.
Thank you for spotting it.

l. 250: Remove "forming" before "over Australia".
Thank you for spotting it.

l. 258: I guess you mean P2, P4.
Yes, thank you.

l. 259: Is it better to use the term absorption here than injection? This would be, for example, consistent with the terminology used by Yamazaki and Itoh (2009).

Thank you, we have changed it to absorption.

l. 270: Should be "Same as in Fig. 5", I assume.
Yes, thank you.

l. 308: To my impression the PV anomalies in Fig. 8e occur unexpectedly close to the equator (especially compared to where PV anomalies are found during SEA heat waves). Do the authors have any explanation for this?

Please note that we have updated Fig. 8d, 8e to have the WN4 and WN5 components for the mean PV for SEA HD and high R days.

However, in the version of the figure 8 in the last revision to which this comment refers to, Fig. 8d and 8e showed climatological PV values and not the PV during the heatwaves. When comparing the PV climatology composite for the zonal wavenumber 4 in Fig. 8e, with Fig. 8d, the location of the zonal wavenumber 4 component matches with where the amplified ridges are located (Fig. 8d). So, we do not think that this is unexpected. Also, in the case studies, the location of the 2PVU contour at 350 K varies considerably depending on the time step.

l. 313: I assume it should be non SEA HD.
Yes, thank you.

l. 327: "which suggests" instead of "and suggests"?
Yes, thank you.

l. 361: "persistent ridges" may also be referred to as blocking, but I think this is not what you would like to say as blocks were not directly observed over SEA. Please reconsider the wording.
Yes, precisely why we did not refer to “persistent ridge” as blocking. It is also arguable in the scientific community whether a subtropical ridge should be referred to as a “block”.

l. 368: Although the MJO is probably known among the WCD readership, please introduce the acronym here.
That’s true, we have corrected that.

l. 373: Also as a prognostic metric? This could be relevant towards sub-seasonal forecasts of heat waves/hot spells.
Thank you for this suggestion. We have added that.

References

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