

Revision 2 author response

We appreciate the additional time and feedback given by the reviewer and editor on improving the manuscript. Please find below our point-by-point responses to the reviewers' comments and the corresponding changes made to the manuscript below.

Most of my recommendations have been implemented in a helpful way for the readership. I have two remaining requests:

1) Change warm conveyor belt track density -> warm conveyor belt air parcel density or something along these lines, because in the literature track density is rather used for weather systems such as cyclones or MCS and not Lagrangian air parcels.

We have changed warm conveyor belt track density to warm conveyor belt air parcel density in Figure 6.

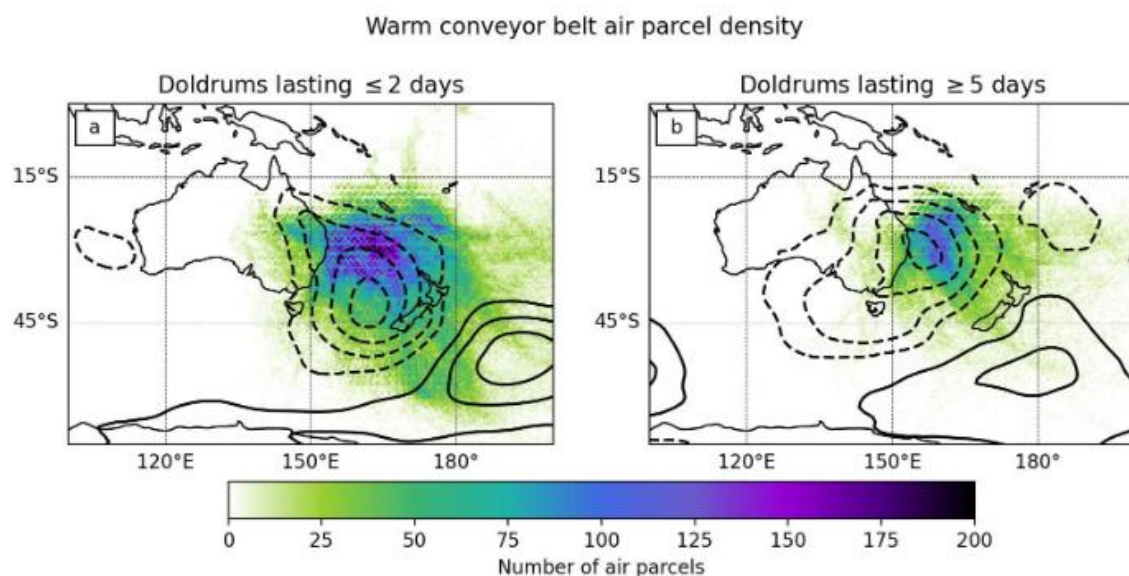


Figure 6. Warm conveyor belt air parcel density (shaded) for short (155 samples) and long (57 samples) doldrums cases showing only the first day of each event. The contours represent the MSLP anomalies (1 hPa intervals, 0 contour removed, dashed is negative, solid is positive)

2) I am disappointed by the reviewer's shallowness of their reply to my comment 1.10. I do think that they could go more into depth with respect to an explicit formulation of the mechanistic link between the tropical and extratropical dynamics and in terms of reader guidance. The transition between section 3.2 and 3.3 is very abrupt and 3.3. needs motivation and a better connection to what has been done in 3.1 and 3.2. Especially in light of their arguments concerning the novelty of their study compared to a previous one when answering the major reviewer comment 2.1. While I appreciate that the authors introduce the WCB analysis, phrasing the primary tropical-extratropical link simply as "moisture" is overly vague. Moisture is a thermodynamic state variable and

not a physical mechanism. How about helping the reader to connect what is done in Section 3.2 to Section 3.3 by adding just a few sentences. I appreciate that the overarching synthesis of tropical-extratropical interactions is reserved for Section 4. However, at the beginning of Section 3.3 on tropical dynamics, at L. 267 after the introductory sentence we need a connection to 3.2 on dry intrusions and 3.1 on extratropical dynamics, which could be something along the lines of: “Tropical wave activity could provide a critical thermodynamic and dynamical link to extratropical dynamics by supplying the tropical moisture that fuels poleward-ascending WCB airstreams. Diabatic latent heat release within these moist WCB airstreams modifies upper-tropospheric potential vorticity (Pfahl et al. 2015), which acts to reinforce downstream anticyclonic blocking over New Zealand and stall Rossby wave packets. Investigating tropical wave activity (MJO and ER waves) is therefore essential to clarify how tropical moisture availability and wave-induced circulation anomalies dynamically sustain the coupling between tropical and extratropical dynamics.”

Thank you for this helpful suggestion. We apologise that the original response did not fully address the point you raised. We have adjusted the opening paragraph of section 3.3 (L267-273) to provide a clearer transition from the extratropical circulation and dry-intrusion analyses to the subsequent examination of tropical wave activity. In particular, we have aimed to clarify the potential connection between the tropical and extratropical components without presenting the proposed mechanisms as established findings of this study. The revised text also provides a more natural lead-in to the mechanisms discussed later in the discussion.

“The extratropical circulation, blocking and WCB activity described above provide an important dynamical context for the development of persistent doldrums and drying over the GBR. Given its location at the interface between tropical and extratropical influences, the evolution of conditions over the GBR is closely linked to variability in tropical circulation, convection, and moisture distribution. Here, tropical wave activity could provide a critical thermodynamic and dynamical link to extratropical dynamics by modulating the circulation and moisture transport, including the supply of moisture that fuels poleward-ascending WCB air streams. We therefore next examine tropical wave activity, focusing on the slower-moving MJO (eastward propagating) and ER waves (westward propagating), exploring how tropical moisture availability and wave-induced circulation anomalies dynamically sustain the coupling between tropical and extratropical dynamics that produce the doldrums. ...”

Further explanation of the blocking and WCB connection is explained in the discussion lines 355-341

“In addition, when a Rossby wave packet moves over eastern Australia, amplifies, and subsequently breaks, it can advect moisture over the Coral Sea

from the active MJO towards the blocking anticyclone, along the WCBs identified in Fig. 6 (Pfahl et al., 2015). The upper anticyclone can then strengthen as the moist ascending air of the WCB releases latent heat as it condenses, warming the surrounding air and modifying the upper-tropospheric potential vorticity (Pfahl et al., 2015; Quinting and Reeder, 2017). As the strengthened block enhances easterlies on the equatorward side of the anticyclone together with the cyclonic circulation over eastern Australia would create a dipole forcing for the wave packet to stall (Masato et al., 2012; Barnes et al., 2023)”

And in the conclusion lines 408-414

“Concurrently, the tropics need to be primed to interact with the extratropical Rossby wave packet. During longer doldrums, the suppressed phases of the MJO and ER wave are more often located over the GBR region, with the active MJO in the Coral Sea. Moisture from the Coral Sea can then readily interact with the breaking Rossby wave as the cut-off low forms, promoting ascent and convection to the east of the low along the WCB. Here, both the impediment of the mid-latitude flow via the cyclonic RWB and diabatic latent heat release within the ascending WCB air streams may further reinforce downstream blocking over New Zealand and the stalling of the Rossby wave packet in line with previous findings (Pfahl et al., 2015). Overall, allowing the doldrums to persist for longer”