Review of Richards et al. on "The development and duration of doldrums over the Great Barrier Reef"

This manuscript investigates the meteorological conditions associated with doldrum events over the Great Barrier Reef, which are periods of stagnant wind and clear skies that can trigger marine heatwaves and coral bleaching. The authors distinguish between brief and extended events. They show that prolonged doldrums are maintained by stalled Rossby wave packets and atmospheric blocking near New Zealand. The authors argue that extratropical dynamics interact with tropical phenomena like the Madden-Julian Oscillation and Equatorial Rossby waves to perturb the typical easterly trade wind flow. Furthermore, using Lagrangian trajectory analysis they reveal that these events are characterized by dry descending air (weak dry intrusions) originating from the mid-latitudes, which prevent ocean cooling by continuously supplying warm subsiding air, promoting stable conditions, limiting atmospheric convection and inhibiting upper ocean mixing. By identifying both tropical and extratropical drivers, the study provides a clear framework for understanding the atmospheric precursors to severe environmental stress on the Great Barrier Reef ecosystem.

It was a pleasure to read this very well written and clear paper. The only major general comment I have is related to the need for a clearer discussion of the nature and mechanisms leading to tropical-extratropical interactions as described in my comments 7 and 9 below. Otherwise, I have only minor comments listed below:

1) L. 39-40: it is interesting that the authors mention a reduction of surface fluxes due to weaker trade winds: in cases of extratropical dry intrusions investigated over the Noth Atlantic enhanced surface fluxes were found due to the supply of dry air (Aemisegger, et al. 2021, Villiger et al. 2022). Furthermore, Villiger et al. 2022 shows that extratropical dry intrusions provide a strong large-scale forcing for low-level cloud patterns and their related cloud radiative effects, which impacts the surface energy budget and the sea surface warming driven by the atmosphere. Depending on their interaction with the trailing cold front extratropical dry intrusions can arrive with a moist or dry anomaly in the western tropical North Atlantic.
2) L. 46: "the processes leading to their formation **and persistence?** are less clear"
3) Paragraph L.55-L65: De Vries 2021 would be an important reference in this context
4) L. 101: "influence on moisture **transport ?**»
5) L. 133 : add Wernli and Davies, 1997 as the pioneering publication for LAGRANTO
6) Section 2.4: Here the trajectory setup for investigating the relevance of dry intrusions could be optimised by running the trajectories backward **and forward** which may increase the number of identified dry intrusions especially considering that the dry intrusions are searched for throughout the troposphere.
7) L. 189: Here a reference to Fig. 5 would be needed otherwise the reader doesn't understand where the statement about the warm conveyor belt comes from. In general, to me this is the most critical point in the paper: the aspect related to the potential existence of a warm conveyor belt playing the role of a stabiliser for the downstream blocking is too vague and not well supported by explicit analyses done in the paper. I would suggest to explicitly phrase this as a hypothesis and matter of future exploration. Even though, I think the authors could easily run trajectories to check for potential WCBs as they did for DIs. This would also reinforce the discussion of tropical-extratropical interactions in a mechanistic way via Lagrangian analyses.
8) L. 194: cease → disappear?
9) L. 196-200: I think there is a break in narrative flow here leading over to 3.2 tropical dynamics. The statement "The longer doldrums also see larger dry, descending region forming over the GBR and north-eastern Australia…" gained from the Eulerian composites in Figs. 4 and 5 would call for the Lagrangian analysis that however comes only in 3.3.

I recommend switching the order of Sections 3.2 and 3.3. Since the Eulerian analysis in Section 3.1 identifies a significant dry, descending region, the manuscript should immediately follow with the Lagrangian analysis of those air parcels (currently 3.3) to maintain structural coherence. Following this, the authors should incorporate a transition that defines the tropical-extratropical coupling as an important driver of event persistence (?), thereby providing a clear rationale for the subsequent tropical wave analysis.

I understand that the suppressed phases of the MJO and ER wave must align with stalled Rossby wave packets to prevent the return of trade winds. But I am left hanging with respect to the nature of the mechanistic link between the tropical and extratropical dynamics. I think this aspect could be strengthened. Maybe my earlier comment about the missing explicit warm conveyor belt analysis could help.

10) L. 205: OLR as a measure for the strength of tropical convection?
11) L. 246: Given that this is a section on a Lagrangian analysis: please make clear that at this point in the text you are arguing based on a Eulerian perspective.
12) L. 328: This cooling and moistening of extratropical dry intrusions upon entry into the boundary layer has been previously noted in Fig. 15 in Aemisegger et al. 2021 (about 6 K in total) and Fig. 8 in Villiger et al. 2022 as being likely linked to cloud hydrometeor evaporation (and partly also radiative cooling induced just above the cloud layer). Please refer to these papers and add the magnitude of the strong cooling you find.
13) Section 5: in the conclusions I miss a discussion of the limitations of this study and an outlook into the need for future research, in particular with respect to the coupling between tropical and extratropical dynamics.

Typos:

- L. 21 Zzone → Zone
- Doldrum is sometimes used in singular sometimes in plural, is this on purpose? (e.g. L7 abstract doldrums formation? or doldrum formation
- L. 53: and cut-off low formation over eastern Australia (Richards et al., 2024) ~~)~~
- L. 104: one-sided t-test?
- L. 117 Missing word (method?): "The **Tibaldi et al. (1994)** was found to best capture southern hemisphere blocking"
- L. 133: "lagrangian" → Lagrangian throughout the manuscript
- L. 219 double is: The actual co-occurrence of the suppressed MJO and ER wave **is is** modest at day
- L. 299-300: repetition of "also"
- Fig. caption 7: composited using only the **days was** a suppressed wave over the GBR.. → **where there was?**

References:

Aemisegger, F., Vogel, R., Graf, P., Dahinden, F., Villiger, L., Jansen, F., Bony, S., Stevens, B., and Wernli, H.: How Rossby wave breaking modulates the water cycle in the North Atlantic trade wind region, *Weather Clim. Dynam.*, 2, 281–309, https://doi.org/10.5194/wcd-2-281-2021, 2021.

De Vries, A. J. A global climatological perspective on the importance of Rossby wave breaking and intense moisture transport for extreme precipitation events. *Weather Clim. Dyn.* 2, 129–161 (2021).

Villiger, L., Wernli, H., Boettcher, M., Hagen, M., and Aemisegger, F.: Lagrangian formation pathways of moist anomalies in the trade-wind region during the dry season: two case studies from EUREC^{4}A, *Weather Clim. Dynam.*, 3, 59–88, https://doi.org/10.5194/wcd-3-59-2022, 2022.

Wernli, H. and Davies, H.C. (1997), A Lagrangian-based analysis of extratropical cyclones. I: The method and some applications, *Q.J.R. Meteorol. Soc.*, 123: 467-489. https://doi.org/10.1002/qj.49712353811.