Response to referees' comments on "A Climatology of Tropical Wind Shear Produced by Clustering Wind Profiles from the Met Office Unified Model (GA7.0)"

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Response to Mitchell Moncrieff – Referee 1

Many thanks for your comments on our paper – we have sought to clarify and improve it in response to them.

1. We have replaced the citations to Rotunno et al. (1988) and Thorpe et al. (1982) with a citation to Moncrieff and Miller (1976) to make the point about shear being important from theory, and added a short summation of why. We have left in one citation to Rotunno et al. (1988) in Sect. 2.2, with the caveat that its applicability in the tropics is disputed because of weaker tropical cold pools, citing Grant et al. (2018) and Grant et al. (2020). We have removed the second citation to Thorpe et al. (1982) in Sect. 2.2.

2. It is our intention to eventually provide supporting information for schemes such as Moncrieff et al. (2017), and the sentence you highlighted does not reflect this properly. We have amended it to: "could provide supporting information for "shear-aware" CPSs such as Moncrieff et al. (2017) that aim to represent some aspects of shear-induced organization. In particular, the continuation of the work here could be used to provide information about the strength of the response in terms of the low-level shear, as represented by their α parameters.". We have also added a citation to Chen et al. (2021), and stated that the continuation of our work may provide an alternative basis for setting the tunable shear-triggering parameter.

3. This is a good point. We have added a short note to this effect at the end of Sect. 3.2, and linked it to known biases of the UM. In discussion of this point, it got us thinking about how our method could be used more generally in climate models to investigate the link between (lack of) vertical shear and the representation of the MJO and Kelvin waves. This is similar to what you said about the value of the approach for diagnosis in your introductory remarks, and we have added an extra sentence to the abstract and Sect. 4.5 (Extensions) to reflect this perspective.

4. We agreed with these comments, and have added a sentence to this effect in Sect. 4.2.

5. We have added an extra sentence to the first paragraph of the introduction, trying to summarize the salient points for our study.

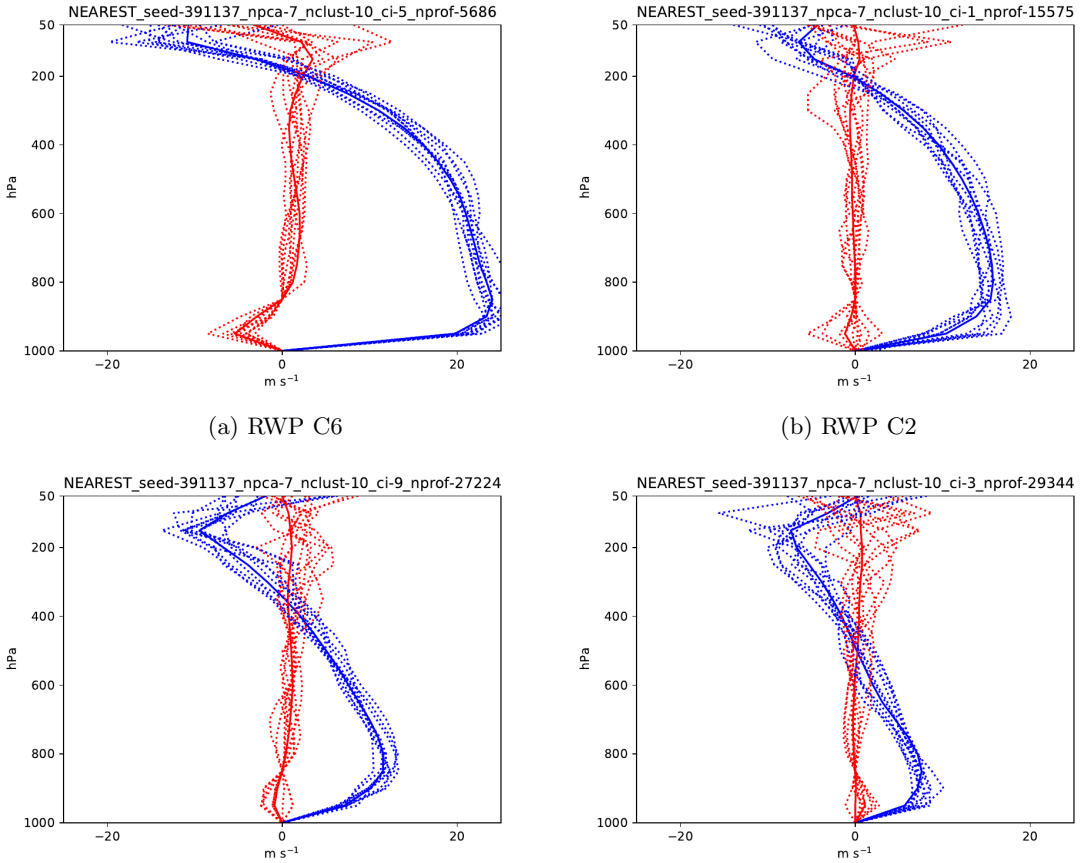
6. When discussing the relative role of lower- and upper-level shear in Sect. 2.2, we included two sentences making the point you raised here and relating it to our work.

Response to Anonymous Referee 2

Thank you for your comments and suggestions for modifications. We reread the paper with your comments in mind, and have streamlined a couple of the sections where our description of the methods was unnecessarily detailed (Sects. 2.5 and 2.6). In describing the arbitrary aspects of our paper, we were trying to not just detail what we did, but why we did it, as we believe this is important for a novel method and we find this useful when reading such papers. However, I (Mark) take your point that some sections were overly detailed, and will endeavour to improve my writing style going forward.

Regarding the abstract, your version is a good template for how to condense it whilst retaining most of the salient points. We have used it to rewrite the abstract in our own words, and shorten it (428 to 354 words). We have kept the final short paragraph on a potential extension, as this was motivation for our paper and we believe it should be there. Additionally, we have minorly extended it in light of Referee 1's comments.

Regarding the "representative" hodographs we used the median as the RWP because it is less prone to outliers than other summary measures. We looked at specific wind profiles that were closest to the given RWPs, as per your suggestion, and it was possible to find several that matched each RWP very closely (Fig. 1), even for one of the RWPs with less shear (C4). The overall spread of the 10 closest profiles is small, apart from higher in the atmosphere due to the reduced weighting at those levels. The filtering and normalization should preserve *relative* shears between different levels, and this is what we wanted to obtain from the space of all wind profiles in the clustering algorithm. Some evidence for the success of this is provided by looking at the RWPs and their spread, which clearly still represent strong shear in certain cases (RWPs C2, C6 and C10).



(a) RWP C6

(b) RWP C2

(c) RWP C10

(d) RWP C4

Figure 1: Four RWPs discussed at length in the paper and their 10 closest wind profiles, in order of maximum to minimum low-level shear (a – d). Shows u' (blue) and v' (red) for each RWP (solid) and for the 10 closest wind profiles (dotted).

Response to Editor Astrid Kerkweg

We have included the name and version number of the climate model in the title, and have added it to the revised abstract. In the abstract, we have made it clear that the UM is being used as a climate model.

References

Chen, C. C., Richter, J. H., Liu, C., Moncrieff, M. W., Tang, Q., Lin, W., Xie, S., and Rasch, P. J.: Effects of organized mesoscale heating on the MJO and precipitation in E3SMv1, Journal of Advances in Modeling Earth Systems (in review), 2021.

Grant, L. D., Lane, T. P., and van den Heever, S. C.: The role of cold pools in tropical oceanic convective systems, Journal of the Atmospheric Sciences, 75, 2615–2634, https://doi.org/10.1175/JAS-D-17-0352.1, 2018.

Grant, L. D., Moncrieff, M. W., Lane, T. P., and van den Heever, S. C.: Shear-parallel tropical convective systems: Importance of cold pools and wind shear, Geophysical Research Letters, 47, e2020GL087 720, https://doi.org/10.1029/2020GL087720, 2020.

Moncrieff, M. W. and Miller, M. J.: The dynamics and simulation of tropical cumulonimbus and squall lines, Quarterly Journal of the Royal Meteorological Society, 102, 373–394, https://doi.org/10.1002/qj.49710243208, 1976.

Moncrieff, M. W., Liu, C., and Bogenschutz, P.: Simulation, modeling, and dynamically based parameterization of organized tropical convection for global climate models, Journal of the Atmospheric Sciences, 74, 1363–1380, https://doi.org/10.1175/JAS-D-16-0166.1, 2017.

Rotunno, R., Klemp, J. B., and Weisman, M. L.: A Theory for Strong, Long-Lived Squall Lines, Journal of the Atmospheric Sciences, 45, 463–485, https://doi.org/10.1175/1520-0469(1988)045⟨0463:ATFSLL⟩2.0.CO;2, 1988.

Thorpe, A. J., Miller, M. J., and Moncrieff, M. W.: Two-dimensional convection in non-constant shear: A model of mid-latitude squall lines, Quarterly Journal of the Royal Meteorological Society, 108, 739–762, https://doi.org/10.1002/qj.49710845802, 1982.