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Interactive comment on "African Easterly Waves in an Idealized General Circulation Model: Instability and Wavepacket Diagnostics" *by* Joshua White and Anantha Aiyyer

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We thank reviewer 3 for their time and effort.

1 Responses to comments

Please see below our responses to specific comments. The original reviewer comments are included.

Comment A: It seems to me that it would be instructive to have a quantitative measure for the limited zonal extent of the AEJ. The authors could then quantitatively compare its zonal extent with the amplification and longevity of the AEWs. In fact, dynamically, a comparison between the potential vorticity (PV) gradient and the longevity of the waves would be the most insightful. Say, for example, the meridional gradient of PV changes sign in a zonally limited section of the jet. How does the zonal length of the sign reversal region relate to the longevity of the waves? Perhaps the authors could comment on this.

Response We agree, a quantitative measure for the limited zonal the extent of the AEJ will be useful. We have now referred to both Molinari and Dickinson (2000) and Thorncroft et al.(2008) to make the point about the zonal extent of the AEJ. The former, in particular, clearly shows that the meridional gradient reversal of PV associated with the AEJ during July–October spans around 60–70^o longitudes. Assuming AEW wavelengths around 2000-4000 km, this corresponds to aboCharney and Stern's (1962) and Fjortoft's (1950) ut 2-3 wavelengths at most, consistent with Thorncroft et al.(2008).

We have not examined the relationship between the growth rate and the characteristics of the background environment beyond classifying all simulations into short, intermediate and long-lived categories. As the reviewer points out, one possible option is to compare the growth rates and metrics of the African easterly jet (AEJ) such as the zonal extent and the strength of the potential vorticity (PV) gradients. There are two main reasons.

First, the concern was to focus on the group dynamics that lead to these starkly different outcomes. The point that we make is that despite these different outcomes, nearly all AEW packets appear to be nearly stationary. The point that we make is that, since the packet is not swept out and damped rapidly, there is more likelihood of coupling with convection and dust radiative effects that could account for the existence of AEWs in nature.

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Second, Leroux and Hall (2009) attempted to relate wave growth to the strength of the AEJ and PV reversal. They did not find a clear signature of the impact of these parameters. On the other hand, they found that the surface area covered by these two parameters was a better indicator of wave growth. In light of this, as well as recognizing that any rigorous attempt at accounting for wave growth should include moist convection and dust radiative effects, we did not pursue this avenue of inquiry. We do plan to examine this issue using a model that can represent these additional diabatic effects.

Lines 45: The term "antifriction" is a bit unclear, although this term is commonly used in engineering when referring to lubricants in bearings, for example. I am unaware of it being used in an atmospheric context. Perhaps the subsection heading could be: The destabilizing influence of moist convection and dust aerosol loading.

Response Thanks for the suggestion. We have reworded the heading to: "Destabilization by moist convection and dust aerosol forcing."

Line 47: The first sentence of the paragraph states: "...two critical aspects of the dynamics are missing in their simulations." It might be clearer to start the next sentence as: "First, their model has no..." Then the next paragraph, line 55, could perhaps start with: The other aspect that was not considered in the simulations of Hall et al. (2006) and Hall (2009) were the feedbacks associated with aerosol loading...

Response Thanks for the suggestion. We have done that.

Line 153: Perhaps make this question a little clearer by writing: What mediates the vacillation of AEW activity?

Response Thanks for the suggestion. We have done that.

Lines 154-155: When the authors state the slowly varying background flow alternates aperiodically…" do they mean that it alternates aperiodically in time or space, or both. Also, how do the authors define "slowly varying?

Response We have clarified that it alternates aperiodically in time. The flow is also fully varying in space. The slow variation refers to the running 15-day average fields used for basic states. This ensures a slow, but steady change in the basic states. By considering 775 basic states constructed thus, we get a clearer picture of the AEW packet behavior as compared to one climatological basic state.

Comment B: For my eyes, the figures are too small. Perhaps they can be enlarged so that the axis notation and wind contours are more easily seen.

Response All figures have been enlarged.

Line 238: The authors state: "Importantly, as seen in observations, the AEW wavepacket…" It would be helpful if a couple of references could be provided regarding the observations. Also, "AEW wavepacket" should perhaps be "AEW packet", here and elsewhere.

Response We have now provided a reference to Fig. 1 in this paper and also external citations to Diaz and Aiyyer (2013a, 2015). We have also replaced all instances of AEW wavepacket with AEW packet.

Line 347: "...basic states considered here are associated with a reversal in potential vorticity gradients,..." Are the reversal in PV gradients over the entire zonal extent of the jet or only over a portion? In either case, what are the physical implications?

Response The reversal in basic state PV typically coincides with the AEJ. When averaged over several days, this appears as nearly continuous over the length of the AEJ. The climatological structure of the PV fields can be seen in Dickinson and Molinari (2000) and Russell and Aiyyer (2020). The reversal in PV gradient, along with the sign of the zonal flow over North/West Africa satisfies necessary conditions for hydrodynamic instability (Charney and Stern 1962; and Fjortoft 1950). This was first shown by Burpee (1972).

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