Response to Reviewer 2 (Dr. Alex Gonzalez)

We wish to thank Reviewer 2 for your encouraging comments and very detailed corrections in the annotated supplement. In this revision, we have followed your suggestions and made all necessary changes. Below please find a list of the changes that we have made in response to your comments/suggestions in the annotated PDF.

This paper revisits the well-known topic of the ITCZ breaking down due to barotropic instability into individual vortices that can be seeds for tropical cyclones. This paper provides a new and unique perspective on the topic, showing extensive mathematical derivations about the zonal wavenumber that first becomes unstable in ITCZ breakdown and how this zonal wavenumber sets constraints on the size and total number of tropical cyclones on the globe at one time. Overall, the paper is well-written and the mathematical derivations appear to be accurate. The only concerns I have are about presentation quality. There are issues with the authors being too vague about the nomenclature in their derivations, which made it difficult to check all of the math. Additionally, the authors are not consistent in physically interpreting many of the parameters, which if fixed, would help more general audiences follow the entire paper. My concerns seem like they can be addressed relatively quickly, thus I am recommending acceptance of the paper after minor revisions.

Page 1, tile: Modified as suggested.

Page 1, line 5-6: Reworded as suggested.

Page 4, line 3: Yes, this is the trade wind. The phrase has been changed to directly indicate this.

Page 4, line 15: Thank you. The definition of the Laplacian operator has been added.

Page 4. This is the total derivative, as it contains the horizontal advection component as well, i.e., $\frac{d\Delta\psi}{dt} \equiv \frac{\partial(\Delta\psi)}{\partial t} - \frac{\partial\psi}{\partial y}\frac{\partial(\Delta\psi)}{\partial x} + \frac{\partial\psi}{\partial x}\frac{\partial(\Delta\psi)}{\partial y}$ The existence of such horizontal advection is required such that the effects of background vorticity gradient can be properly taken into account as you commented (see the term that accounts for the background vorticity gradient in Eq. (8) for the contribution from the background $\widetilde{\psi_s}$.)

Page 5, table 1: Yes, the ITCZ latitude can be extended from 1500 km to 2000 km with little changes in our analyses or conclusion. This is because the meridional scale is still much less than the zonal scale, which is the circumference of the Earth (i.e., $2\pi R \sim 40{,}000\ km \gg 2000\ km$). Our choice of the ITCZ latitude around 12-15^0 is simply based on the typical latitude of the ITCZ during the peak TC season.

Page 5. The unit of Horizontal eddy viscosity coefficient should be “m^2 s^-1” has been corrected.

Page 5, line 6: The phrase has been added as suggested.

Page 5, line 11, 12: changed as suggested.

Page 6, line 12: Thank you. The typos related to the domain size has been now corrected.

Page 6, line 17: we have added the definition of the non-dimensional parameter γ_1 here. You are right, this is the ratio of the vorticity forcing and vorticity response.

Page 6, line 18: reworded as suggested.

Page 6, line 23: deleted as suggested.

Page 7, line 6: You are correct. R is physically a ratio between the external forcing and the sum of the viscous and linear damping terms. This physical meaning has been now included in this revision.

Page 7, line 8: the typo has been corrected.

Page 7, line 12: Thank you. This is out typo. It should be no v-wind component, not u-wind component for the boundary condition here. This has been corrected.

Page 7, line 13: delete as suggested.

Page 7, line 15: delete as suggested.

Page 7, line 16: The physical meaning of three differential operators have been now added.

Page 7, line 22: Our typo here. It should be partial derivative here after expanding all of the terms.

Page 7, line 22: this is our typo. It should be minus sign here.

Page 8, line 16: reworded as suggested.

Page 8, line 17: The way we choose the zonal wave number m is very similar to the way one solves, e.g., an oscillating string held fixed between two walls. Basically, the boundary condition dictates the possible values of the eigenstates. Given the periodic boundary condition in the zonal direction, the eigenvectors include therefore all possible eigenmodes $m, \forall m \in Z^+$. So, this differs from the Fourier expansion for which there exists a pair of dual amplitudes.

Page 8, line 18: Yes, m represents zonal wavenumber or meridional mode. This has now been stated clearly here.

Page 8, line 19: reworded as suggested.

Page 8, line 21: reworded as suggested.

Page 9, line 1: reworded as suggested.

Page 9, line 2: n represents the order of derivative w.r.t to y direction. This has been now clearly indicated.

Page 9, line 9: We have moved the definition of $\phi_{m,n}$ to the above line to make it clearer.

Page 9, line 13: reworded as suggested.

Page 9, line 17: reworded as suggested.

Page 10, equation (34): Definition of the real part operator has been now included.

Page 10, line 18: deleted as suggested.

Page 10, line 19: modified as suggested.

Page 11, line 3: corrected.

Page 11, line 5: corrected.

Page 11, line 10: reworded as suggested.

Page 11, line 14: A separated equation has been added here. Note that different value of m for different value of L_y is what Fig 3 is about (the value of L_y is encoded in the parameter a), and so we don't provide a separate table for this equation.

Page 11, line 17: Per your suggestion. we have now added some comment about the result in Neito Ferreira and Schubert (1997) of the most unstable zonal wavenumber being wavenumber 13 here.

Page 11, line 22: changed as suggested.

Page 11, line 23: reworded as suggested.

Page 11, line 25, 26: This is out typo. It should be 3000 km, not 3x3000 km. This has been fixed.

Page 11, line 27: Is there a citation to back up this statement? "that has been long observed but not fully explained so far."

Page 12, line 3: the Rayleigh and/or Fjørtoft necessary conditions for instability has been now explicitly mentioned in this revision.

Page 12, line 3: reworded as suggested.

Page 13, line 10: reworded as suggested.

Page 14, line 7: reworded as suggested.

Page 14, line 13: Thank you for commenting on this. Because $\nu\pi^4 \ll \alpha L^2\pi^2$ in our calculation of R (see Eq 9), use of $\nu = 100, or\ 1000$ $m^2\ s^{-1}$ would not change much our estimation of the critical number . We have now mentioned this explicitly in this work.

Page 14, line 28: turn "this new state" to "the disturbances in this new state".

Page 14, line 31: Thank you. The follow vectors have been added in this revision.

Page 15, line 8: changed to "feedbacks".

Page 15, line 11: changed to "discussed hereinafter".

Page 15, line 14: delete "," after (TCs).

Page 15, line 15: corrected as suggested.

Page 15, line 17: reworded as suggested.

Page 15, line 19: reworded as suggested.

Page 15, line 21: reference might help here "Using the Principle of Exchange of Stabilities condition for the ITCZ model"

Page 15, line 24: typo, add "." after generate.

Page 15, line 25: "k~12" = (the word estimation already implies an approximation).

Page 16, line 10: reworded as suggested.

Page 17, line 5: fixed.

Page 19, line 1: fixed.

Figure 3, 4: $m = 13$ has been added. The label axis has been also fixed.

Figure 5: Fixed.