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Weather and Climate Dynamics Discussions

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Interactive comment on "Atmospheric convergence zones stemming from large-scale mixing" *by* Gabriel M. P. Perez et al.

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article

Reply to anonymous Reviewer 1

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1 Response to general comments

We appreciate the Reviewer's insightful comments and suggestions. The Reviewer pointed out the following general issues:

1 - Connection between sections: We have added transition paragraphs at the end of each section to motivate the next. The text now reads more seamlessly.

2 - Motivation for going to a climatological study: We have now made it more explicit in the introduction the need for running the LCS detection algorithm in a climatology. We have incorporated the Reviewer's suggestion to motivate it through the need of investigating the impact of LCSs in moisture and rainfall at different scales.

3 - Conclusion improvements: We have expanded the conclusion section adding more on the potential applications of the methodology for convergence zones in other regions as well as forecast applications.

Other issues pointed in the Reviewer's general comment are addressed in the original submission. For example, the reviewer questions about the period employed in the

climatological analysis. The period is stated in Line 161 of the original submission. Similarly, the Reviewer questions about how the methodology was applied in the entire climatology. This is expressed in the methodology diagram in Figure 3: the method is repeated in sliding time windows of 2 days separated by 6 hour intervals.

2 Response to specific comments

2.0.1 Line 22

We appreciate the Reviewer's suggestion to use "coherent winds" instead of "coherent trajectories". However, trajectories are used to highlight the Lagrangian nature of historical definitions of the ITCZ: it was considered to be and interface of air parcels originated from both hemispheres; thus the use of "coherent trajectories".

2.0.2 Line 23

We thank the Reviewer for the question. We consider that previous studies were focused on both quantitative and qualitative analyses. However, the automated methodologies employed by them required previous knowledge of the phenomena, such as the typical shape and intensity of the SACZ cloud band. Thus, heuristic rules were developed to identify SACZ events that attended their existing expectations.

2.0.3 Line 130

We thank the Reviewer for this suggestion. The formulation of the Cauchy-Green tensor was done in 3D Cartesian space by transforming the lat-lon departure points in x, y, z coordinates. We have added this information in the revised version.

2.0.4 Line 169

: We thank the Reviewer for this suggestion. We have performed sensitivity tests to identify the smallest relaxation angle able to still capture LCSs associated with convergence zones attempting to preserve properties of Shadden's (2005) LCSs. Peikert and Sadlo (2008) suggest 45°, but we found that 15° sufficed for our case. We have included this brief explanation in the revised manuscript. We haven't performed further analysis regarding shear regions along the Andes, but we plan to do so in future studies.

2.0.5 Line 176

: No, the +-20% sensitivity tests refer only to the intensity and length filters. We thank the r for this suggestion and included a short table summarising the parameters employed in the methodology.

2.0.6 Figure 6

: As suggested by the Reviewer, we have now included a definition of "frequency of occurrence" in the manuscript.

2.0.7 Line 202

: We appreciate the Reviewer's suggestion and have rephrased the definition of LCS accordingly.

2.0.8 Line 210-214

: We agree with the Reviewer that LCSs in the neighborhood of the Andes can be shear LCSs. However, we do not believe this to be the case of the structure labeled as “1” in Figure 5. This structure originates around a cyclonic circulation feature in South Atlantic and progresses with the confluence of the front associated with the cyclone. Furthermore, this event, as described in Line 191 of the original submission, was classified by Brazilian meteorology agencies to be an event of South Atlantic Convergence Zone.

We think that the source of confusion is that we positioned the label “1” in Figure 5 at an unfortunate location. We have replaced it to make it clear that we refer to the attractive LCS described by the Reviewer and we have attempted to clarify its interpretation in the text.

2.0.9 Line 241

: We thank the Reviewer for this comment and provide relevant citations as requested. However, we disagree with the Reviewer’s comment about the relationship between FTLE and mixing. The backwards FTLE at a given time is an integrated measure of the attraction of trajectories arriving in a neighborhood. Thus, ridges of the backwards FTLE can diagnose high mixing efficiency because arriving air parcels underwent substantial stretching. This is consistent with the concept of mixing proposed by Ottino (1989): “Mixing is stretching and folding”.

3 Technical comments

We appreciate the Reviewer’s suggestions about Figures 8 and 4. We have improved these figures accordingly as well as provided an improved color palette in Figure 1.

4 References

1. Ottino, Julio M., and J. M. Ottino. The kinematics of mixing: stretching, chaos, and transport. Vol. 3. Cambridge university press, 1989.

2. Peikert, Ronald, and Filip Sadlo. "Height ridge computation and filtering for visualization." 2008 IEEE Pacific Visualization Symposium. IEEE, 2008.

3. Shadden, Shawn C., Francois Lekien, and Jerrold E. Marsden. "Definition and properties of Lagrangian coherent structures from finite-time Lyapunov exponents in two-dimensional aperiodic flows." Physica D: Nonlinear Phenomena 212.3-4 (2005): 271-304.