

Comments to the authors

April 2026

The paper has some clear strengths. It asks a meaningful question, namely what DS instantaneous dimension is actually sensitive to and how it should be interpreted in tropical Pacific SSTA fields. The main result, especially the marked shift in DSID over Niño 3.4 and Niño 4 around 2007 and its weakening after low-pass filtering, is interesting and worth further investigation.

At the same time, I am not yet fully convinced by the paper in its current form. The attribution of the DSID shift mainly to high-frequency variability is plausible, but the evidence is still somewhat indirect. The choice of 2007 as a breakpoint feels rather empirical, the statistical testing is not fully convincing for autocorrelated time series, and the physical discussion remains limited. In addition, the manuscript also seems to overlook some highly relevant literature, which weakens its connection to the broader existing work on this topic. Please find more detailed comments below.

Detailed Comments:

1. There are two references that are highly relevant to this work are not cited by this manuscript. I believe adding some discussion about them could help this work better connect with existing work in the community. In [1], they explored dynamical properties of a similar region with exactly the same dynamical systems theory indices. Although the two study have different perspectives, I'm still quite surprised to see that their study did not find such shift in mean value of local dimension. I wonder if the authors could provide some comments on the link and differences with [1]. The second reference I would recommend is [2]. This paper also examines the sensitivity of instantaneous dimension, and in my view its objective overlaps with yours to some extent. At the same time, it includes some discussion about the caveats of this methodology that worth mentioning in your work.

2. I find the first half of the title a bit awkward. I would suggest something like: 'On the Sensitivity of the Instantaneous Dimension of Dynamical Systems ...'

3. For Figure 1, one could add a subfigure showing the bounding boxes of these regions to make it more clear for the readers. I would also suggest to add a time series of the El Nino index considering the strong modulation of El Nino to the dynamical properties of the studied region.

4. Line 59: The authors could consider to cite a more recent work on predictability: [3]. This reference [4] could also be added as it also works on tropical Pacific.

5. Line 130: If I understand correctly, the authors would like to perform a statistical test to see if there is an actual drop in the mean value. I would recommend bootstrapping than the surrogate data approach since it could be more clearly stated with a null hypothesis.

6. Line 155: It looks like a SDE instead of observational noise.

7. The explanation based on high-frequency variability is interesting, but I wonder whether the current evidence is still somewhat indirect. In particular, could the authors clarify more carefully why the change around 2007 should be interpreted primarily as a change in high-frequency variability, rather than a broader shift in the background state or low-frequency variability of the system?

References

- [1] Fabrizio Falasca and Annalisa Bracco. Exploring the tropical pacific manifold in models and observations. *Physical Review X*, 12(2):021054, 2022.
- [2] George Datseris, Inga Kottlarz, Anton P Braun, and Ulrich Parlitz. Estimating fractal dimensions: A comparative review and open source implementations. *Chaos: An Interdisciplinary Journal of Nonlinear Science*, 33(10), 2023.
- [3] Chenyu Dong, Davide Faranda, Adriano Gualandi, Valerio Lucarini, and Gianmarco Mengaldo. Time-lagged recurrence: A data-driven method to estimate the predictability of dynamical systems. *Proceedings of the National Academy of Sciences*, 122(20):e2420252122, 2025.

- [4] Davide Faranda, Yuzuru Sato, Chenyu Dong, Adriano Gualandi, Robin Noyelle, Tommaso Alberti, Berengere Dubrulle, Lucas Fery, Gabriele Messori, Mathieu Vrac, et al. El niño and droughts in southeast asia: A stochastic-chaotic modeling approach. *Physical Review E*, 111(6):064209, 2025.