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Comment on acp-2022-316

Anonymous Referee #2

Referee comment on "Record-breaking statistics detect islands of cooling in a sea of warming" by Elisa T. Sena et al., Atmos. Chem. Phys. Discuss., https://doi.org/10.5194/acp-2022-316-RC2, 2022

The authors explore the SST trends over the last 75 years and discuss the spatial characteristics. They use a trend-free random variable technique along with standard methods to test statistical significance. The number of high records clearly outweighs the number of low records, with the majority of the SST grid points showing a warming trend. While I consider the paper sound from a methodological point of view, I'm not sure whether ACP is the ideal outlet given its statistical nature. The results do merit publication, but in order to make it work for ACP I would suggest incorporating CMIP6 models to add more analytical (i.e. physical) content to the discussion of the observed trend or their differences for that matter. I therefore suggest major revisions to make it fit for ACP.

Overall, I have three suggestions which may help to improve the manuscript:

1 Use CMIP6 pre-industrial control runs (random 75 year chunks) in order to compare the results when applying the TFRV technique. In order to obtain meaningful results (or learn something), I suggest selecting a dedicated CMIP6 subsample with a transient climate response (TCR) similar to observations, i.e. 1.3-1.8K. This way models with unrealistically high internal variability and/or too rapid southern ocean warming are likely omitted, which helps to confine the 'true' range of low-frequency internal variability. Taking all CMIP6 at face value without subsampling won't help us to distill the magnitude of the unforced trends.

2 I suggest expanding the analysis to other SST datasets such as HadSST4, Kadow et al. 2020 (https://www.nature.com/articles/s41561-020-0582-5.pdf) or the (preliminary) version of HadISST2. They do tend to have small difference even after 1946 (between 1950-1980 in particular), hence it would be insightful to test them separately with the same method. It will certainly increase the robustness of the results. Expanding the analysis further by using the same subsample of CMIP6 SSP2-4.5 simulations between

1946-2020 would have the potential to add further insight into the forced nature of the signal and the physical reasons for missing warming trends in some ocean regions.

3 It might be worthwhile applying an ENSO correction to the data. The method provided in Foster and Rahmstorf 2011 (https://iopscience.iop.org/article/10.1088/1748-9326/6/4/044022/pdf) using multiple regression to filter out all natural factors (volcanoes, solar variability and ENSO), could offer some more interesting insights, both as far as trends as well as high and low record statistics at grid point level are concerned.