Reviewer's comments:

>Reviewer #1: ***The authors use Empirical Orthogonal Functions (EOFs) and Canonical Correlation Analysis (CCA) to explore patterns of variability and covariability mainly between sea surface temperatures and total cloud coverage. The results show coherent patterns of co-variability between SST and cloud patterns typical for Central and Eastern Pacific ENSO events, respectively. The manuscript also includes relationships of ENSO variability with other variables such as precipitation, mean sea level pressure, and winds. Lastly, CCA patterns obtained from temporally smoothed data are shown, which show some resemblance of the impact of Pacific Decadal Oscillation on clouds.***
There are some unclarities concerning the methodology (Are all involved fields deseasonalized and detrended? What kind of temporal smoothing is applied for the results presented in Figs 2-4? Is the CCA applied to the full spatial fields or to a set of PCs derived from the EOF analysis?), but the results look reasonable. However, I have two more major difficulties with this study: first, it presents a very limited set of diagnostics (3 out of 6 figures show the same diagnostic using different data sets). Second, and this is the biggest problem, the results are not novel at all. There is a huge body of literature documenting the response of various atmospheric fields (including clouds) to ENSO. While probably not many studies have applied CCA to this very specific question (how do SSTs and clouds co-vary?), the method does not reveal anything new.
One example for ENSO-related cloud variability is Wang et al (2015), which in fact includes more up-to-date obs-data (e.g. CERES) than the present manuscript. An example for PDO-related variability of atmospheric quantities is Chen et al. (2019) (using obs and models). A quick online search brought many more papers with similar topics. The authors do not claim that their results show much new beyond the state of the science, but scientific novelty is nevertheless a criterion for publication in ESD (see criterion 2 here: https://www.earth-system-dynamics.net/peer_review/review_criteria.html). I hence have to recommend to reject this manuscript.
I would like to mention that there are journals that only require soundness of methods for publication (e.g. Scientific Reports), which the authors may consider as an option.

We thank the reviewer for comments and suggestions. Please find below a detailed response to all the comments/suggestions made by the reviewer.

- All the analyzed fields were deseasonalized and detrended. Figs. 2-4 were obtained using annual detrended anomalies, without any temporal smoothing. The only smoothing (5yr running mean) was used in order to investigate the decadal SST-TCC coupled patterns (Fig.5).

- Observational cloud data have many retrieval artefacts. For example, ISPCC cloud data (also used by Wang et al. (2015) to compare and evaluate cloud cover simulated by CMIP5 models) have a systematic relationship between changes in reported cloud fraction and changes in geostationary satellite zenith angle and also difficulties to produce spatially coherent changes in cloud fraction at every location viewed by a satellite (Norris and Evan 2015). The CERES cloud data would not be suited to investigate decadal variations. In this study, we used the corrected version of the ISPCC and the PATMOS-x data, each corrected for specific artefacts, similar to the ones used in a study published in Nature by Norris et al. (2016).

- Cloud processes and, consequently, simulation, remains the main source of uncertainties in the CMIP6 models (IPCC 2021). Our aim was to check whether the same relationships are identified in more datasets: two different observational and one simulated. If similar results are identified in both observational data sets it increases our confidence that, on the one hand, the reported cloud changes are real (and not an artefact) and, on the other that the corrections made to the initial data are accurate. Comparison of these with the ERA5R cloud data offers an assessment of the quality of the cloud simulation in this reanalysis project.

- Global climate sensitivity is essentially linked to Pacific SST and clouds variations (Andrews and Webb 2018). By using CCA we were able to separate in the same analysis the impact of the two ENSO modes on the coupled global SST/TCC fields. This allowed us to properly compare the two modes in terms of the global

SST/TCC variance explained and also in terms of their induced feedbacks. For example, off the coast of Peru, TCC anomalies act as a positive feedback on CP-related SST anomalies locally, but those SST anomalies have opposite sign to those in the central equatorial Pacific. This is in contrast to the EP ENSO, where cloud cover anomalies also act as a positive feedback on SST anomalies locally off Peru, but those SST anomalies have the same sign as those in the central equatorial Pacific. Indeed, the conclusions of the manuscript are not new on the whole, but we are not aware of such comparisons and analysis to be made using more than one observational dataset covering a relative long period.

- Overall, we strongly believe that our study answers to three main questions: What are the differences between the EP and the CP ENSO as they relate to TCC? What is the quantitative relevance of each ENSO mode in relation to global cloud variability? What is the quality of the ERA5R simulations with regards to interanual and decadal global cloud variability? Although some of the results are expected and confirm previous studies, this work yields a much more detailed and comprehensive picture of the relationship between total cloud cover and the tropical Pacific climate variability. We feel that our findings add novel and useful information to previous published studies.

References

Andrews T, Webb MJ (2018) The dependence of global cloud and lapse rate feedbacks on the spatial structure of tropical pacific warming. J Clim 31:. https://doi.org/10.1175/JCLI-D-17-0087.1

IPCC, Masson-Delmotte V, Zhai P, et al (2021) Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change

Norris JR, Allen RJ, Evan AT, et al (2016) Evidence for climate change in the satellite cloud record. Nature. https://doi.org/10.1038/nature18273

Norris JR, Evan AT (2015) Empirical removal of artifacts from the ISCCP and PATMOS-x satellite cloud records. J Atmos Ocean Technol. https://doi.org/10.1175/JTECH-D-14-00058.1

Wang, H., and W. Su (2015), The ENSO effects on tropical clouds and top-of-atmosphere cloud radiative effects in CMIP5 models, J. Geophys. Res. Atmos., 120, 4443–4465, doi:10.1002/2014JD022337.