Earth System Dynamics Discussions

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Comment on esd-2021-75

Anonymous Referee #2

Referee comment on "Consistent coupled total cloud cover – sea surface temperature footprints linked to Pacific climate modes" by Petru Vaideanu et al., Earth Syst. Dynam. Discuss., https://doi.org/10.5194/esd-2021-75-RC2, 2022

Review of "Dominant influence of Pacific climate modes on global observed and reanalysis cloud cover fields" by Vaideanu et al.

This paper studies the dominant modes of variability in total cloud cover. The Principal Component Analysis (PCA) is used to decompose the observed total cloud cover into dominant modes and the Canonical Correlation Analysis (CCA) is used to identify the physical linkage with known atmospheric-ocean variabilities. The authors show that the dominant modes are the Central Pacific ENSO and the ENSO modoki in the tropical Pacific region.

The PCA and CCA analyses used in this study are well established in the scientific community and have been commonly used in climate studies. However, I am concerned about the physical interpretation of the results.

As the authors discussed in Section 1, cloud is a highly uncertain variable in climate prediction because of its spatial variability in both vertical and horizontal and because of the fact that cloud at different altitudes induces very different and sometimes opposite climate forcings. Therefore, I am a little hesitant to study the total cloud variability instead of studying high and low clouds separately. The authors should explain more clearly why studying the total cloud cover is important.

The principal modes in the total cloud cover, the CP ENSO and ENSO Modoki, have already been known in a previous study which studies high cloud fraction [Li et al. (2016), An Analysis of High Cloud Variability: Imprints from the El Niño-Southern Oscillation, Climate Dynamics, 10.1007/s00382-016-3086-7]. Therefore, the principal modes found in this study are not new and are primarily due to the high clouds instead of the total cloud cover, as is also explained by the authors in their Section 3.5. It also goes back to my comment above that why should we study the total cloud cover?

A critical issue with the authors' interpretation of the principal modes is that they ignore the second mode of ERA5R total cloud cover because "[t]he second EOF derived using the ERA5R TCC data (Supp. Fig. 1) is not of interest for our study due to its temporal characteristics." The PCA is a pure mathematical decomposition of any given matrix, random or not, where the principal modes are forced to be mutually orthogonal singular vectors and no physical constraints are applied in the construction of the singular vectors. Therefore, one must be extremely careful when trying to attribute physical meanings to the principal modes. The fact that the phenomenon of the authors' interests has shifted from the second mode to the third in ERA5R TCC means that the second and third modes are likely degenerated because the eigenvalues of these modes are statistically indistinguishable. A serious problem associated with degenerated modes is mode-mixing, which makes the physical interpretation of the degnerated modes difficult. As the authors are trying to compare ERA5R modes with those obtained from ISCCP and PATMOS-x, simply ignoring the second mode without considering possible mode-mixing in ERA5R TTC could potentially lead to inaccurate conclusion about the quality of the ERA5R assimilations. The authors may check whether there are also mode-mixing in the second and third modes in ISCCP and PATMOS-x TCC. For more details on mode-mixing, see Quadrelli et al. (2005), On Sampling Errors in Empirical Orthogonal Functions, Journal of Climate, 10.1175/JCLI3500.1.

A minor comment is that the authors mentioned in abstract and in the text a few times the ISCCP and PATMOS-x "each corrected for specific errors". I first thought that the authors corrected these data themselves but the authors actually downloaded the corrected data directly from the web. The discussion about the correction by Norris et al. in Section 2.1 is reasonable, but can the authors elaborate more on why they want to emphasize the correction in various places?