

Atmos. Chem. Phys. Discuss., referee comment RC2
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Comment on acp-2022-817

Anonymous Referee #2

Referee comment on "Opposing trends of cloud coverage over land and ocean under global warming" by Huan Liu et al., Atmos. Chem. Phys. Discuss.,
<https://doi.org/10.5194/acp-2022-817-RC2>, 2023

Based on the use of a model cloud data set (ERA5) being treated as observations, I recommend a rejection (see detailed comments below). Overall, the authors may find it easy to either spin their paper towards a model only paper, or to substitute in a collection of different long-term observations (a suggested list is provided below).

Line 27: Zelinka 2020 doesn't look at trends.

Line 40 (or somewhere similar): you may be interested in (Andrew Manaster et al., 2017)

Line 60: Is the cloud cover in this study all based on ERA5? ERA5 is not giving observed cloud properties. ERA5 is just a global circulation model nudged to observations. The relevant properties that are nudged to observations, as state here, thermodynamic properties. These are used with a cloud scheme to generate cloud properties. See for instance <https://cds.climate.copernicus.eu/cdsapp#!/dataset/reanalysis-era5-pressure-levels?tab=overview> and the discussion of specific rain content. At least according to <https://wcd.copernicus.org/preprints/wcd-2020-26/wcd-2020-26-manuscript-version2.pdf> the scheme in question is (Tiedtke, 1993) with a few tweaks. If there is not an observed cloud data set, then this study presents an evaluation of the Tiedtke scheme as implemented by ECMWF in response to thermodynamic variability nudged towards observations.

Line 70: Why not just use 2m RH?

Because this study is using reanalysis clouds to try and say something about observed trends, I find it impossible to evaluate the rest of this paper. Their analysis seems of good quality and internally consistent, beyond the basic issue of using model output as

observations. I think that the authors have established a nice analysis framework and if they could utilize the many other long term cloud observations (ship observations, PATMOS-X, ISCCP, MAC-LWP, as in (Norris et al., 2016)) they will be able to have some nice, consistent results. As is, I recommend a reject with encouragement to resubmit when observed clouds are used.

Alternately, the authors can rewrite this as a model-only paper using ECMWF along with GCM output and contrast how GCM EOF patterns differ.

Andrew Manaster, Christopher W. O'Dell, & Gregory Elsaesser. (2017). Evaluation of Cloud Liquid Water Path Trends Using a Multidecadal Record of Passive Microwave Observations. *Journal of Climate*, 30(15), 5871–5884. <https://doi.org/10.1175/jcli-d-16-0399.1>

Norris, J. R., Allen, R. J., Evan, A. T., Zelinka, M. D., O'Dell, C. W., & Klein, S. A. (2016). Evidence for climate change in the satellite cloud record. *Nature*, 536(7614), 72–75. <https://doi.org/10.1038/nature18273>

Tiedtke, M. (1993). Representation of Clouds in Large-Scale Models. *Monthly Weather Review*, 121(11), 3040–3061. [https://doi.org/10.1175/1520-0493\(1993\)121<3040:ROCILS>2.0.CO;2](https://doi.org/10.1175/1520-0493(1993)121<3040:ROCILS>2.0.CO;2)