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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Observed Trends of Clouds and Precipitation (1983–2009): Implications for Their Cause(s)" *by* Xiang Zhong et al.

Anonymous Referee #1

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Summary

This is a relatively straightforward paper that reassess changes in both cloud cover and precipitation, and the possible causes of these changes. Which is an important endeavor. Using global satellite data (e.g., corrected ISCCP data and GPCP data), the authors first show similar changes in cloud cover and precipitation, particularly over the Maritime continent, and suggest these changes are largely consistent with widening of the tropical belt (and the moisture-convection-latent heat feedback). They go on to associate a significant percentage of these changes mainly to global warming, but also the AMO. These results are based on correlation/regression analysis alone. In a

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Discussion paper

somewhat disconnected Part 2 of the paper, the authors focus on China, and investigate clouds and precipitation trends from nearly 500 surface stations over a longer time period. Here, the authors argue the decrease in cloud cover and overall shift toward higher precipitation intensity is due to global warming, and the moisture-convection-latent heat feedback.

Comments

In terms of the indices that are looked at to understand the cloud and precipitation changes, the authors focus on global mean temperature, as well as the PDO, ENSO (Nino3.4 SST) and AMO. However, Norris et al. (2016) also argued for the importance of volcanic aerosol in explaining the cloud changes (as described in the Introduction). To some extent, this volcanic aerosol signal should appear in the global mean surface temperature. Any thoughts on how to disentangle this? Any thoughts on the possible importance of volcanic aerosol, and recovery from their cooling? Or is this not important, based on the authors analysis?

The conclusion that the PDO is not very important to the cloud and precipitation changes (which the authors argue are primarily due to tropical widening) is inconsistent with several studies that have argued the PDO is associated with tropical widening/contraction. For example:

Allen, R., Norris, J. & Kovilakam, M. Influence of anthropogenic aerosols and the Pacific Decadal Oscillation on tropical belt width. Nature Geosci 7, 270–274 (2014). https://doi.org/10.1038/ngeo2091

And more generally, others have argued for the importance of natural variability in driving recent tropical expansion (as opposed to global warming, at least over the relatively short time period considered). For example:

Allen, R. J., and M. Kovilakam, 2017: The Role of Natural Climate Variability in Recent Tropical Expansion. J. Climate, 30, 6329–6350

Mantsis, D. F., Sherwood, S., Allen, R., and Shi, L. (2017), Natural variations of tropical width and recent trends, Geophys. Res. Lett., 44, 3825– 3832,

Grise, K. M., and Coauthors, 2019: Recent Tropical Expansion: Natural Variability or Forced Response?. J. Climate, 32, 1551–1571

Can these pointsâĂŤparticularly the prior conclusion related to the importance of natural variabilityâĂŤbe commented on and incorporated into the paper?

The conclusion that the cloud and precipitation changes are consistent with tropical widening is a bit “hand-wavy”. Can the authors better quantify this, with an actual analysis of the data, in the context of tropical edge displacements?

It is also unclear how the authors associate tropical widening to the moisture-convection-latent heat feedback. This feedback in largely a thermodynamic feedback, related to global warming and CC scaling. And it seems to largely explain why we would expect less light/moderate precipitation, but more heavy precipitation, under warming. So how does it also explain tropical widening? Is dynamics not important here? Several dynamical mechanisms have been proposed.

L179 “Direct effect of anthropogenic aerosols on clouds and precipitation in the tropical zone is expected to be small as the majority of aerosol emissions are at northern hemisphere mid–latitudes.” Is this true? Aren’t there quite a lot of tropical aerosol emissions, for example biomass burning?

I suggest including the time series of the climate indices used here (perhaps in the Supplement). The AMO that the authors use is said to have the global warming signal removed. It would be nice to see what this looks like (as well as the other indices, e.g., PDO).

Can the authors better connect part 1 (global analysis) and part 2 (China analysis) of this paper? At the least, the authors can add a statement to the abstract that indicates they extend the global analysis by similarly investigating connections between clouds

and precipitation in China, which has a large number of long-running, high-quality surface weather stations, etc. Or something similar, etc.

The abstract also seems to contradict itself. The global analysis largely attributes cloud and precipitation changes to global warming and the AMO. But then the China analysis says the cloud and precipitation changes are largely due to global warming and the PDO, with AMO (and ENSO) playing an insignificant role, consistent with the global analysis. The only thing consistent is the dominance of global warming, right? AMO is important for the global analysis, but is not important for the China analysis.

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