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Hydrology and Earth System Sciences
Discussions

Interactive comment on "Revisiting global hydrological cycle: Is it intensifying?" *by* Demetris Koutsoyiannis

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Review of MS "Revisiting global hydrological cycling" by Demetris Koutsoyiannis

Recommendation: Reject, but encourage resubmission of a more focussed and substantiated manuscript

This manuscript makes the sweeping claim that current observations at ground stations, satellite observations, and reanalysis products do not support the notion that the hydrologic cycling intensifies with global warming. The author uses a number of data sources to look at trends in temperatures and different variables associated with hydrologic cycling, such as dewpoint temperatures, precipitation, vapor pressure, pre-

cipitable water, etc. He then plots the trends over the last decades, sometimes at the global scale, sometimes separated between ocean and land.

I found the manuscript hard to read and to review, with too many figures that partly include irrelevant material (like the seasonal cycle). Part of the difficulty for me is that it is unclear what the actual goal of the manuscript is, which could be stated quite clearly at the beginning as a hypothesis that is to be tested. But even if such a hypothesis existed, the analysis by the author is rather superficial, and I would expect that it would not be sufficient to substantiate that the hydrologic cycle operates differently to what is expected or predicted by climate models. Also, I find that the author goes on a lot of tangents in the manuscript that obscure what he actually tries to achieve. Given the rather wide claims the author tries to support, his analysis does not substantiate the claims.

Because of this, I think this manuscript needs to be rejected in its present form. In principle, I hesitate with such a strong recommendation, because I am generally open to new ways to look at things and to criticise the status quo. Yet, this needs to be done in a convincing and focussed way. So I can imagine that the author could take some of the analysis, focus on one or two aspects that can be formulated into concrete, testable hypotheses, test these more thoroughly with the datasets, and make a new, more focused manuscript out of this.

I also have a number of general comments that are hopefully of some use in developing the analysis further and for sharpening the focus:

- I recommend that the author takes a thorough look at the most recent IPCC report (AR4), specifically Section 2.5 of Working Group 1, which deals with changes in the hydrologic cycle in observed data sets (some of which are also used by the author) and describes to which extent these fit theoretical expectations. The IPCC chapter does so in a comprehensive way, using insights from various recent studies that looked at individual trends of hydrologic variables. If the author wants

to challenge some of the conclusions of the IPCC, then he would need to be more specific, and setting his results into the context of the studies that are synthesized by the IPCC chapter. But even then it is unclear whether the state described by the IPCC is to be challenged, because the data sets the author uses are all associated with rather large uncertainties as well.

- Note that the increase in saturation vapor pressure with temperature (the 6-7%/K that the author also alludes to in the text) does, in itself, not explain an intensification of the hydrologic cycle. It simply says that the atmosphere can hold more moisture, and probably is likely going to hold more. But holding more moisture does not imply that it rains more. The intensification actually comes mostly from a shift in the surface energy balance partitioning, specifically a shift from sensible to latent heat, with the equilibrium Bowen ratio decreasing because $s/(s+\gamma)$ increases with temperature (s: slope of the saturation vapor pressure curve, γ: psychrometric constant). This leads to the lower, expected increase of 2-3%/K in hydrologic fluxes (although this number is further modulated by radiative changes). Yet, this increase is only to be expected when the climate system equilibrated into a new climate state. The present, however, is largely dominated by a transient response, in which the ocean - as the main source of hydrologic cycling - still lags behind as it takes up heat and warms slowly than land. This transient response is known in the climate literature as "fast response", and this fast response deviates quite a bit from the equilibrium response (I can point you to Kleidon et al. (2015), GRL, doi://10.1002/2014GL062589 as a starting point, which includes some further references to this distinction). So not finding the anticipated equilibrium response in current observations does not imply that our understanding of the hydrologic cycle is wrong.

- Some statements in the manuscript like "without extreme floods and droughts, future climate threats may not be frightening enough" (line 35-36) I find have no place in a scientific paper!

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