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Interactive comment on "A simple explanation for the sensitivity of the hydrologic cycle to global climate change" *by* A. Kleidon and M. Renner

Anonymous Referee #1

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This is an interesting and relevant paper, focused on the specific question: what are the individual contributions of change in solar radiation and surface temperature on the hydrological cycle in a globally warming climate? In this context, it makes a case for caution regarding research on climate engineering. While in principally well written and well done, I recommend some clarifications, as listed in the following.

Discussion: I am not an expert on atmospheric physics, but I feel that it would be helpful if you reflected a bit more on whether any of the global assumptions you make does influence the result (i.e. the stated sensitivities of the hydrological cycle?) For example, neglect of atmospheric dynamics and spatial patterns, open water and E_opt assumptions. Can any differential effect of the two processes on the spatial climate pattern be expected (perhaps important for the precipitation projections in a geo-engineered

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climate)?

Pages 863 and 864 are difficult to follow, not least because it uses long sentences and a long list of process interactions. Can you provide some curve graph(s) showing what is told here, i.e. illustrating how the different sensitivities diverge under different assumptions (perhaps as a function of global mean temperature rise or using as example a stylized simple geo-engineering scenario)?

Minor comments:

Title could reflect the two disparate processes under consideration here – that is, would you like to convey the main message that there is "a simple explanation for the sensitivity" (as suggested by the present title), or the (additional) message that there is sensitivity to both surface warming and altered solar radiative forcing.

Abstract: you mention two sensitivities, 2.2 and 3.2%/K; what is the combined sensitivity?

Introduction: You may want to reflect this paper, which appears to derive a sensitivity of about 1%/K over land, though with a high standard deviation among GCMs (p. 3552, and Fig. 5 for spatial pattern): Heinke et al. 2012: A new dataset for systematic assessments of climate change impacts as a function of global warming. Geosci. Model Dev. Discuss. 5, 3533–3572.

Introduction should explain in some more detail the two separated effects, as is done now in the first paragraph of section 3 (could partly be moved).

Introduction page 856: line 19: did Bala et al. consider both effects? line 5: what is "maximum power"? Page 858 line 22: what is "Carnot limit"? line 19: which "key characteristics"? Page 859 line 8: more than 70% of the strength of the hydrological cycle: what does "strength" mean here (at the beginning you should define what you mean with hydrological cycle and its strength).

Results/Discussion, p. 864 line 20: what is meant by "reduced" hydrological cycle,

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reduced global precipitation? Can you point to your relevant equations here, from which one might deduct the 6.4% and 5.8% change? It is not absolutely clear how these numbers relate to a 2% strengthening per K warming stated in other studies (see also above comment on abstract).

Conclusions: Is it possible to add something on the applicability of this simple model for specific research questions (maybe on geo-engineering)?

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