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Hydrology and Earth System Sciences Discussions

Interactive comment on "What do moisture recycling estimates tell? Lessons from an extreme global land-cover change model experiment" *by* H. F. Goessling and C. H. Reick

Anonymous Referee #3

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This manuscript investigates the role of continental evaporation in land climate. The authors compared the outcomes of two GCM simulations: one reference simulation representing the present-day climate and one controlled simulation cutting off continental evaporation. While this work is of much interest, the authors have reached some confusing conclusions.

1. The used terms of "recycled" and "recycling" have different meanings from the classical definitions of "precipitation recycling". It is necessary to address what they exactly mean in this paper. In the text, these terms are mostly used to describe evaporation

of continental origin. However, in section 7 (P3529:L24-25), the authors reached the conclusion "that moisture recycling estimates are of limited use to deduce hydrological impacts of land-cover change activities". If we understand the "moisture recycling estimates" as the estimated continental evaporation, this conclusion contradicts with the authors' data presentations. Apparently, the cutting off of continental evaporation has much impact on the moisture (Figure 2), precipitation (Figure 4), and temperature (Figure 4) responses in the DRY experiment. It is not clear "What do moisture recycling estimates tell".

2. The data analysis is rather simplified without considering the moisture transportation from oceans but dynamically "forced" by DRY land. In the extremely DRY experiment, the dry surface impacts (local) atmosphere by reduced evaporation. Meanwhile, the enhanced land-ocean thermal contrast may enhance large-scale circulations. This changes not only the amount but also the tracks of the moisture carried by atmosphere circulations. The authors have observed this phenomenon (section 4.4), but haven't sufficiently integrated it into their data interpretations. I suggest the data analyses in this manuscript are only valid on the incorrect assumption that the DRY land has no influence on large-scale circulations. Considering this DRY land forcing, it is not surprising to find the "mismatches" of VIM and precipitation responses. Principally this mechanism is expected to happen in the monsoon regimes, where the authors show indeed strongest "mismatches" to occur. It is very likely that the reduction of continental moisture due to suppressed evaporation is compensated for by the enhanced moisture transportation from oceans. I suggest the authors to check if this mechanism exists in their simulations; otherwise, exclude this possibility in the next version.

Instead, the authors have attributed the mismatches to the decreased precipitation owing to surface heating of atmosphere, reaching the major conclusion of this paper "Decreased precipitation rates compensate for the missing moisture input from evaporation, such that moisture content of an atmospheric column traveling over a continent may evolve similarly both with and without suppressed continental evaporation"

(P3523). While the mechanism, “surface heating -> precipitation decrease”, widely exists in nature, I am afraid the authors have overstated its consequence. The existence of this phenomenon can suggest nothing without knowing the magnitudes of its influences. Of more importance is “how much”. Only if the decreased precipitation, importantly, owing to temperature increase, compensates for nearly 100% of the decreased evaporation, this conclusion is correct. I advise the authors to provide this quantification. Something relevant is in Fig 5; however, we can not simply attribute a water balance problem to temperature increase.

3. I am not deep into dynamic meteorology, and probably have missed something in the manuscript. But I really confused by the claim “moisture content of an atmospheric column traveling over a continent may evolve similarly both with and without suppressed continental evaporation” (P3523), no matter how this conclusion has been reached. It suggests to me that the atmospheric moisture is self-organizing and nothing to do with the bottom surface, including land covers and oceans. So it is only a problem of external solar forcing, and thus latitude dependent. Is that real in nature? In section 4.1, the authors indeed have shown that the VIM is very sensitive to land cover and evaporation (Fig 2). They are contradictions.

4. The relative differences of VIM and precipitation are calculated using (DRY-REF)/max(DRY, REF). This strategy makes the outcome values fall into the interval [-1, 1]. However, the max(DRY, REF) is changing in these calculations. When REF>DRY, it becomes (DRY-REF)/REF; when DRY>REF, it becomes (DRY-REF)/DRY. The latter case is of no physical sense, although the obtained values are kind of beautified. This way, the quantities with different signs can not be compared with each other; thus they can not be plotted in one figure. There is no information how the relative difference of temperature is calculated; DRY-REF, I guess. I advise to uniform these calculations.

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