

I thank the authors for their revisions to the manuscript. The structure of the summary, discussion, and outlook sections have strongly improved. Moreover, the added total atmospheric heat transport and vertical structure of the response in the supplement make this study an even richer resource for future research. Only one important aspect of my previous comments has remained unaddressed by the authors. Please find my two final follow-up comments below.

In one of my previous comments, I criticized the framing that the increased NH OLR as a response to OHT corresponds to an increased deficit that necessitates an increase in overall meridional heat transport (revised version in lines L353-356 and L490-493). For the LSC, I agree with the framing that OLR is driving heat transport changes because adding land directly affects OLR via the surface heat capacity (cooler surface in the extratropics means less OLR at these latitudes, which implies an enhanced equator-to-pole gradient in longwave cooling, which gets closer to compensating the invariant equator-to-pole gradient in solar heating, i.e. less transport needed). For LSC, less total atmospheric heat transport (AHT) is realized in MiMA as shown by cyan bars in Fig. 9a5,8. Importantly, this decrease in total AHT is also found for the OHT only experiment. From my perspective, if you specify an increased OHT you warm the extratropics such that either AHT has to decrease or more heat has to be lost via OLR to reach equilibrium (in MiMA, both happens, and the decrease in TE MSE transport is consistent). The increased OHT should thus be considered the reason for the increased deficit and the increased OLR together with decreased AHT a response to that. Arguing that increased OLR necessitates more transport neglects that you already imposed increased transport within the ocean. Therefore, I strongly suggest revising the two paragraphs indicated above.

The point we are trying to make is that the change in OLR in response to OHT is a direct consequence of the warming extratropics (correlations in MiMA of 0.99), and so we don't think this change in OLR can be separated in any meaningful way from the change in OHT itself, and so it isn't a response to the energetic deficit per se but rather a direct consequence of a warming extratropical surface.

But we agree that the language in these two locations could be refined. It now reads:

Line 353-355 "For example, adding OHT to an aquaplanet leads to an increase in extratropical NH TOA OLR, which subsequently increases the NH extratropical energy deficit and thus partially mitigates the reduced TE that is needed in response to increased OHT (Figure 9a6, Figure 4c)."

Line 490-493 "OHT preferentially warms the NH which leads to more longwave cooling to space; this increase in NH longwave increases the energy deficit in the NH extratropics and thus partially mitigates the reduction in NH TE that would otherwise be required (Figure 9a3,b3)"

Moreover, I don't think that the current version of Fig. 4c helps illustrating this response as it suggests a paradoxical behavior (reduced TE transport despite an increased deficit), which is actually expected (L470).

We considered dropping this panel, but we still think it helps a reader less familiar with energetic arguments. For now we have left it in, but if the editor or reviewer feels strongly we can just drop it entirely.

Minor follow-up:

The cyan bars in Fig. 9a1,2 and 9a7,8 confirm the invariance of total AHT when adding or removing topography found in White et al. 2021 and Cox et al. 2022. This could be mentioned to further motivate showing the cyan bars.

We have added to the Discussion section “While such a compensation framework may be valid in other modeling frameworks or in response to other perturbations (Donohoe et al 2020, Cox et al 2022), a two-way compensation framework is not valid here, and instead changes in TOA radiative fluxes play a crucial role. Indeed, we find that a compensation framework is more applicable to topographic perturbations than to OHT or LSC perturbations, and Cox et al 2022 and White et al 2021 focus on topographic perturbations only when they find strong compensation”

We think this belongs in the Discussion section more than in the Results section

References:

- Cox, T., Donohoe, A., Roe, G. H., Armour, K. C., and Frierson, D. M. W.: Near Invariance of Poleward Atmospheric Heat Transport in Response to Midlatitude Orography, *Journal of Climate*, 35, 4099–4113, <https://doi.org/10.1175/JCLI-D-21-0888.1>, 2022.
- White, R. H., Wallace J. M., and Battisti, D.: Revisiting the role of mountains in the Northern Hemisphere winter atmospheric circulation. *J. Atmos. Sci.*, 78, 2221–2235, <https://doi.org/10.1175/JAS-D-20-0300.1>, 2021.