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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Recent advances in understanding the Arctic climate system state and change from a sea ice perspective: a review" *by* R. Döscher et al.

F. Pithan

felix.pithan@zmaw.de

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I have a few comments and suggestions regarding the description of atmospheric processes and climate feedbacks in the review paper.

1. Role of different feedback processes in causing Arctic amplification

The authors mention a number of studies that have looked at the role of single feedback mechanisms in causing Arctic amplification, but largely overlook the literature that attempts to quantify and compare the contribution of different mechanisms. The latter includes both arguments in favor of a dominant role of surface albedo feedback (eg

Crook et al, 2011 Taylor et al. 2013) and studies concluding that atmospheric longwave feedbacks are dominant (Winton 2006, Pithan and Mauritsen 2014). The latter studies might also call into question the claim that "The Arctic sea ice is the central and essential component of the Arctic climate system" - in my view, that claim could be made more specific or better explained.

2. The lapse-rate feedback

The explanation of the lapse-rate feedback and its contrast between low latitudes and the Arctic (mostly p. 10935) could be improved: The lapse-rate feedback is negative in the tropics (which dominate the global mean) not just because of mixing, but because moist convection keeps the tropical atmosphere close to a moist adiabat. As the climate warms, the moist adiabat becomes steeper, leading to stronger warming in the upper troposphere than at the surface. I also believe that a clear definition of the lapse-rate feedback as the change in TOA radiation caused by warming that deviates from the vertically uniform reference response (the Planck feedback) is missing in the manuscript.

3.The planck feedback

The contribution of the Planck feedback to Arctic amplification , i.e. the weaker increase in blackbody radiation per unit warming at colder temperatures is not mentioned in the review. That contribution is smaller than that of the lapse-rate feedback, but still important enough to be mentioned (cf fig. 2a: http://www.nature.com/ngeo/journal/v7/n3/full/ngeo2071.html)

4. changes in atmospheric moisture

At several instances in the text, the authors discuss changes in atmospheric moisture as a result of changes in evaporation. However, changes in moisture largely follow temperature changes at constant RH, both in the Arctic and globally (nicely explained by Isaac Held: http://www.gfdl.noaa.gov/blog/isaac-held/2011/06/29/13-the-strength-

of-the-hydrological-cycle/). If the Authors refer to changes in RH, this should be made more explicit in the text.

Specific comments:

5. p 10932, ll 11ff: Manabe and Wetherald also mentioned the role of the vertical structure of warming, i.e. the lapse-rate feedback

6. p 10936, l 15: water vapour feedback is indeed stronger in the Tropics than the Arctic and does not lead to AA, “even” and “likely” could be omitted here (see figure from comment 3)

7. p 10936, ll 21 ff: The referenced papers do not show that cloud feedbacks alone can cause Arctic amplification, since they disable the surface albedo feedback but not the lapse-rate feedback, planck feedback or changes in atmospheric heat transport.

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