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On the role of temperature feedbacks for Arctic amplification

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The amplification of global climate changes at the poles is a well-known feature of the climate system mentioned already by Arrhenius (1896). It has been linked to the surface-albedo feedback, changes in atmospheric and oceanic heat convergence, water vapour and cloud feedbacks and the albedo effect of black carbon on snow (Serreze and Barry, 2011).

We here focus on the role of temperature feedbacks, which have received rather little attention in recent debates. The basic temperature feedback is the Planck feedback or the increase in the Earth's blackbody radiation due to a uniform temperature increase. Since the blackbody radiation scales with the fourth power of temperature, stronger warming is necessary in cold regions to balance a globally uniform radiative forcing.

The second temperature feedback is caused by changes in the vertical atmospheric temperature structure: In the Tropics, deep convection leads to warming aloft being larger than at the surface, which causes a greater increase in outgoing longwave radiation compared a vertically uniform forcing and thus constitutes a negative feedback mechanism. In the Arctic, where warming is amplified at the surface, the lapse-rate feedback is positive (Wetherald and Manabe, 1975). We use CMIP5 model output and radiative Kernels to investigate the zonal distribution of temperature feedbacks.

Arrhenius, S. (1896). On the influence of carbonic acid in the air upon the temperature of the ground Philos. Mag. J. Sci., 5, pp. 237–276

Serreze, M.C. and Barry, R.G. (2011) . Processes and impacts of Arctic amplification: A research synthesis, Global and Planetary Change, 77(1–2), pp. 85-96
Wetherald, R. and Manabe, S. (1975). The effects of changing the solar constant on the climate of a general circulation model. J. Atmos. Sci., 23 pp 2044-2059