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Title: Climate Feedbacks and their Implications for Poleward Energy Flux Changes in a Warming Climate

Authors: Mark D. Zelinka[1,2] and Dennis L. Hartmann[2]

1. Program for Climate Model Diagnosis and Intercomparison, Lawrence Livermore National Laboratory, Livermore, CA, USA
2. Department of Atmospheric Sciences, University of Washington, Seattle, WA, USA

Feedbacks determine the efficiency with which the climate system comes back into equilibrium in response to a radiative perturbation. Although feedbacks are integrated quantities, the processes from which they arise have rich spatial structures that alter the distribution of top of atmosphere (TOA) net radiation. Here we investigate the implications of the structure of climate feedbacks for the change in poleward energy transport as the planet warms over the 21st Century in a suite of GCMs. Using radiative kernels that describe the TOA radiative response to small perturbations in temperature, water vapor, and surface albedo, we partition the change in poleward energy flux into the individual feedbacks that cause it.

We find that latitudinal gradients in the sum of climate feedbacks reinforce the preexisting latitudinal gradient in TOA net radiation, requiring that the climate system transport more energy to the poles on a warming planet. This is primarily due to structure of the water vapor and cloud feedbacks, which are strongly positive at low latitudes and decrease dramatically with increasing latitude. Using the change in surface fluxes, we partition the anomalous poleward energy flux between the atmosphere and ocean, and find that reduced heat flux from the high latitude ocean further amplifies the equator-to-pole gradient in atmospheric energy loss. This implied reduction in oceanic poleward energy flux requires the atmosphere to increase its share of the total poleward energy transport. As is the case for climate sensitivity, the largest source of uncertainty in the change in poleward energy transport in these models can be attributed to the SW cloud feedback.