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Evaluating Arctic Warming Mechanisms in CMIP5 Models

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Arctic warming is one of the most striking signals of global warming. The Arctic is one of the fastest warming regions and constitutes, thus, a good test bed to evaluate the ability of climate models to reproduce the physics and dynamics involved in Arctic warming. Different physical and dynamical mechanisms have been proposed to explain Arctic Amplification. These include the surface albedo feedback,an increased poleward heat flux, the winter convective cloud feedback mechanism and dynamic warming, the so-called Tropically Excited Arctic warming Mechanism (TEAM).

Here we show that while the current generation of climate models all reproduce Arctic warming, the inter-model variability is large with respect to geographical distribution and magnitude of the temperature increase. Furthermore, we find that there are two groups of CMIP5 models: one with large correlations with the Arctic temperature trend and the surface heat flux trend; these are consistent with the albedo-temperature feedback. The other group appears to be more closely related to the large-scale circulation. In this group the models have relatively high correlations between downward IR and 500-hPa geopotential height consistent with TEAM. Both groups are consistent with a water vapor feedback. While the former have a warm or weak bias, the latter have large cold biases in the Arctic. These results suggests that the surface flux tunings are not appropriate in the CMIP5 models likely because the heat flux coefficients are too large in the second group.