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Polar amplification and atmospheric heat transport

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Surface albedo feedback is widely believed to be the principle contributor to polar amplification. However, a number of studies have shown that coupled ocean-atmosphere models without ice albedo feedbacks still produce significant polar amplification in $2xCO_2$ runs due to atmospheric heat transports and their interaction with surface conditions. In this article, the relative importance of atmospheric heat transport and surface albedo is assessed using a conceptual 2-box energy balance model in a variety of different model climates, from very cold to very warm. Running the model with prescribed ice area – and, therefore, no surface albedo feedback – always produces a significant polar amplification although smaller than that of the full model. Running the model with prescribed atmospheric heat transport and active surface albedo mechanism over a wide range of colder climates produces polar amplification similar to the one obtained in the full model. This could lead to the conclusion that atmospheric heat transport does not participate in forming the polar-amplified global warming response especially when the sea ice feedback plays a significant role. However, a detailed analysis suggests that although the temperature responses may be the same, the trajectories of reaching the final equilibrium as well as the underlying physics are quite different.