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Polar amplification: is signal from lower latitudes important?

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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 2xCO2 runs due to atmospheric heat transports and their interaction with surface conditions. The relative importance of atmospheric heat transport and surface albedo is assessed using a conceptual energy balance model. 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 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. We identify several scenarios in which the equilibrium response to uniform forcing by the model with fixed atmospheric heat transport is identical to that of the full model. 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.

Keywords: climate dynamics, atmospheric transport, albedo feedback