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Response of atmospheric blocks to the Arctic Amplification in idealized model experiments

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Atmospheric block is the abnormal quasi-stationary system which obstructs the weather system flow in the mid-latitude. Because of its importance on extreme weather, its long-term trend in response to the Arctic amplification has been extensively examined. While several studies have documented a hint of increasing blocking frequency due to the Arctic amplification, others have shown essentially no evidence of such change. The present study re-visits this issue by performing a series of idealized model experiments. A primitive equation model is integrated using Held and Suarez (1994) temperature forcing. Specifically, the equator-to-pole temperature difference (ΔT) is systematically reduced from 100K to 60K with a 10-K interval by mimicking Arctic amplification. Blocks are then identified by applying the hybrid blocking index, which incorporates blocking anomaly and absolute gradient reversal, to 500-hPa geopotential height fields.

With decreasing ΔT (e.g., Arctic-amplification-like state), westerly jet becomes weaker and moves equatorward. Likewise, both high- and low-frequency eddies get weaker and shift equatorward along the jet. Blocks, which primarily form on the poleward flank of the jet, also shift equatorward. Atmospheric block, which is quasi-stationary system, tends to occur more frequently as weather systems move slowly. However, blocked area becomes smaller, indicating that less frequent blocks tend to have a larger spatial scale. In the presence of wavenumber-1 topography, this relationship breaks down. Both number and area of blocks tend to decrease with decreasing ΔT. This result indicates that stationary wave plays an important in modulating blocks. More importantly, it supports the previous studies that documented no evidence of block change in response to the Arctic amplification.