

## Arctic midlatitude linkage modulated by the QBO

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We examined an observed relationship between the BKS sea ice variability and the midlatitudes cold anomaly and found that this relationship is highly dependent on the QBO phase, easterly (QBO-E) or westerly (QBO-W). For the QBO-E winters midlatitude cold (warm) anomalies appear significantly under the low (high) sea ice condition. On the other hand, such a relationship is not found in the QBO-W winters. This dependence is a robust feature. Atmospheric circulation anomalies related to the high and low sea ice conditions are also different between the two QBO phases. In the troposphere, stationary Rossby wave propagation from the BKS region and the negative NAO appear in QBO-E, along with weakened stratospheric polar vortex and downward propagation of the signals. For QBO-W, such tropospheric and stratospheric signals are mainly absent. Our results may provide an explanation for why some simulations suggest the presence of Arctic sea ice impacts on midlatitude surface temperature while others do not. The most important implication is that in the Arctic-midlatitudes climate linkage tropics also plays a key role.

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