Geophysical Research Abstracts
Vol. 20, EGU2018-13765, 2018
EGU General Assembly 2018

The impact of tropical sea surface temperatures on recent circulation trends over north Canada and Greenland

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Identifying the key drivers of Arctic climate is essential for understanding the recent rapid changes in its climate. Remote changes in sea surface temperatures (SSTs) have been identified as a potential driver of Arctic climate, particularly connections of tropical SSTs to recently observed increases in upper level geopotential height (Z200) and surface temperature over north Canada and Greenland (NCG) through a poleward propagating Rossby wave train emanating from the tropical Pacific.

This work investigates the Tropics-Arctic teleconnection using reanalysis data and targeted climate model experiments to determine the circulation response in the Arctic to tropical SST forcing. Trends in Z200 from 1979-2012 in ERA-Interim and two model datasets with prescribed observed transient SSTs (UPSCALE and AMIP) are compared to a number of time slice sensitivity experiments conducted using the Met Office HadGEM3 model. These experiments are forced by observed changes in SSTs between the periods 1979-1988 and 2003-2012 imposed separately for; [i] the entire tropics, [ii] the tropical Pacific Ocean, [iii] the tropical Atlantic Ocean and [iv] the tropical Indian Ocean.

The ERA-Interim, UPSCALE and AMIP datasets all show an increase in eddy Z200 over NCG in agreement with the results of Ding et al. (2014). In contrast, the HadGEM3 sensitivity experiments show negative eddy Z200 anomalies over NCG in boreal winter in response to SST forcing in all ocean basins. This response is most strongly influenced by SST anomalies in the tropical Atlantic Ocean, highlighting a key role for the Atlantic in driving atmospheric circulation over NCG. The changes in circulation over NCG from all model experiments, in contrast to results found in previous studies, cannot be directly explained by anomalous wave forcing from the tropics, as based on wave activity flux analysis, thus suggesting that other mechanisms are responsible. Increases in the temperature gradient between the Arctic ocean and north Canada, however, may have generated the large negative Z200 anomaly through deepening the climatological stationary wave pattern over NCG relative to the control model experiment. These results highlight that, in contrast to recently published work, atmospheric circulation trends over NCG may not be the direct result of recent changes in tropical SSTs, and that the influence of tropical SST forcing on Arctic climate is still not well understood.