Polar Vortex Influence on Broadscale Cold Extremes Associated With Arctic Oscillation

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Despite the global climate is clearly warming, many regions experienced extremely cold weather in recent years. The cold events were often attributed to the negative Arctic Oscillation (AO) and the wobbled polar vortex. Because AO and polar vortex are global-scale phenomena, we are curious about how the broadscale cold extremes are influenced by their variability? We first analyzed the correlation of the AO index and the 300-hPa mean zonal wind and found high correlation in 50° N to 65° N. Then we separated the 40° N to 50° N belt to three broad regions and found that only over the Europe-Asia region the cold extremes are modulated by the AO, where 67% of the cold extremes occurred when AO is in negative phase. After checking the vertical cross section from 1000 hPa to 50 hPa of the geopotential height averaged from 60° N to 90° N, we classified 54 negative AO associated extreme cases into two types. Type I showed positive geopotential height anomalies from 300 hPa to 50 hPa and Type II did not show large anomalies above 300 hPa. The horizontal maps suggest that for Type I the polar vortex tended to split in two, while for Type II the polar vortex was weak or shifted. The Europe-Asia extreme cold events were observed with intensified ridges near Aleutian and Greenland that resulted in deep low pressure (cyclonic) anomalies over the Eurasian continent. Regarding the extremity of surface temperature we did not find clear difference between two types. The most interesting finding is the relationship between the Europe-Asia regional cold extremes and the AO and polar vortex variation. We suspect the regional difference may be due to some geographical patterns of the planetary wave amplification or breaking that we do not understand yet. Much more studies are needed.

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