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Eurasian cooling linked with Arctic warming: Insights from PV dynamics

Yongkun Xie, Guoxiong Wu, and Yimin Liu

LASG, Institute of Atmospheric Physics, Chinese Academy of Sciences, Beijing, China

The three-dimensional connections between Eurasian cooling and Arctic warming since 1979 were investigated using potential vorticity (PV) dynamics. We found that Eurasian cooling can be regulated by Arctic warming through PV adaptation and PV advection. Here, PV adaptation refers to the adaptation of PV to forcing and coherent dynamic/thermodynamic adaptation to PV change. In a PV perspective, first, the anticyclonic circulation change over the Arctic is produced by a negative PV change through PV adaptation, in which the change means the linear trend from 1979~2017. The negative PV change is directly regulated by Arctic warming because the vertical structure of Arctic warming is stronger at lower levels, which generates a negative PV change through the diabatic heating effect. Second, the circulation change produces a change in horizontal PV advection due to the existence of climatological PV gradients. Thus, as a balanced result, both the circulation change and PV change extend to mid-latitude through horizontal PV advection and PV adaptation. Eventually, Eurasian cooling at the surface and in the lower troposphere is dominated by PV changes at the surface through PV adaptation. Meanwhile, enhanced Eurasian cooling in the middle troposphere is dominated by top-down influences of upper-level PV change through PV adaptation. Nevertheless, the upper-level PV changes are still contributed by horizontal PV advection associated with Arctic warming. Overall, the general dynamics connecting Eurasian cooling with Arctic warming is demonstrated in a PV view.