

Influences of tropical climate and weather on the variability of East Asian cold air outbreaks

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A recent study proposed an analysis method for estimating polar cold air mass (CAM) flux from its generation to disappearance [1]. Below a designated threshold potential temperature 280 K, two climatological equatorward streams were identified during boreal winter: East Asian stream and North American stream. These streams indicate two major pathways of intermittent cold air outbreak (CAO) events. An East Asian CAO index (CAOI) was defined as a longitudinal integration of equatorward CAM flux over East Asian stream region (90°-180°E) at 45°N [2]. This approach enables us to define a quantitative definition of East Asian CAO events. The CAO events often cause severe damages to human activities. It is characterized by strong equatorward wind and sudden drop of temperatures. CAOs are basically driven by extratropical internal dynamics. Nevertheless, its variation is also affected by remote forcing in the tropics. We present here the evidences of tropical impacts to the East Asian CAOs.

1) Interactions with El-Nino Southern Oscillation (ENSO)

Interannual variability of East Asian equatorward flow exhibits two major modes which are mentioned as western CAO and eastern CAO [3]. The western and eastern CAOs are closely associated with Siberian high and Aleutian low, respectively. In the tropics, their variations are affected by tropical climate anomalies associated with ENSO. The western and eastern CAOs are stronger than normal during La Nina and El Nino phases, respectively. The impacts of ENSO are delivered through Rossby wave trains triggered by convection anomalies over the Maritime Continent and central Pacific.

2) Interactions with Madden-Julian Oscillation (MJO)

We also investigated the interactions in intraseasonal time scale. Day-lagged regression analysis revealed that the intraseasonal western and eastern CAO events are preconditioned by large-scale tropical convection anomalies resembling particular phases of MJO. Western CAOs are triggered by MJO over the Maritime Continent, whereas eastern CAOs are triggered by MJO over the western Pacific. Observations and model experiments show the importance of Rossby wave trains in delivering the impact of MJO to the East Asian CAOs. Influence of MJO on the eastern CAO is relatively larger due to stronger Rossby wave trains induced by convection anomalies over the western Pacific and Indian Ocean.

Reference:

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