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Reexamining the Relationship of La Niña and the East Asian Winter Monsoon

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The northern and the southern modes are two distinct principle modes that dominate the winter mean surface air temperature (Ts) variations over East Asia (EA). The cold southern mode is represented by a significant cooling south of 45°N and is linked to La Niña events. An objective criterion, which could distinguish the spatial distributions and the maximum center of sea surface temperature anomaly (SSTA), is used to classify the La Niña events into two categories: mega-La Niña and equatorial La Niña. Their impacts are inspected onto the Ts southern mode. The mega-La Niña, featured by a significant K-shape warming in the western Pacific with the maximum SSTA cooling centered in the tropical central Pacific. As a response, an anomalous barotropic high is generated over North Pacific (NP) implying a weak zonal gradient between ocean and the EA continent, which induces a neutral Ts southern mode. The equatorial La Niña characterizes a significant cooling in the tropical eastern Pacific with convective descending motions shifting eastward to the east of the dateline. The resultant low-level circulation anomalies show an anomalous subtropical NP low and a gigantic abnormal EA continent high. The strong zonal gradient results in significant northerly anomalies over EA from 55°N to southeastern China. Over the mid-upper troposphere, the anomalous subtropical NP low extends westward to the Korean Peninsula, leading to a strengthened and southward shifted EA trough. Such abnormal circulation patterns favor the intrusion of cold air to southern EA and correspond to a strong Ts southern mode. The numerical results well validate the above processes and physical mechanisms.