EGU24-5122, updated on 20 May 2024
https://doi.org/10.5194/egusphere-egu24-5122
EGU General Assembly 2024

The mechanism of multi-year La Niña events and their impact on spring precipitation over southern China

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By diagnosing and analyzing the frequent occurrence of multi-year La Niña events in recent years, this study reveals the process and mechanism of the Southeast Pacific subsurface cold water triggering multi-year La Niña events. Revealing for the first time the propagation channels and physical processes of multi-year La Niña events triggered by subsurface cold water. In late spring and early summer, the anomalous eastward wind strengthens in the central equatorial Pacific, while abnormal wind stress divergence occurs in the eastern Pacific, which strengthens and spreads westward over time. The weak negative sea surface temperature anomaly in the eastern equatorial Pacific is accompanied by upwelling, providing a source of cold water for the surface. As the season progresses, the weakened equatorial undercurrent and the enhanced southern equatorial current cause cold water to spread westward and accumulate in the central Pacific, thereby extending upwards to expose the sea surface. The exposed cold water causes a cooling of the sea surface and triggers local sea atmosphere interactions, leading to abnormal development of sea atmosphere and ultimately forming a multi-year La Niña events. Composite analyses were performed in this study to reveal the differences in spring precipitation over southern China during multiyear La Niña events from 1901-2015. It was found that there is significantly below normal precipitation in the first boreal spring, but above normal in the second year. The differences in spring precipitation over southern China are correlative to the changes in anomalous atmospheric circulations over the northwest Pacific, which can in turn be attributed to different anomalous sea surface temperatures (SSTs) over the tropical Pacific. During multiyear La Niña events, anomalous SSTs were stronger in the first spring than those in the second spring. As a result, the intensity of abnormal cyclones (WNPC) in the western North Pacific Ocean (WNP) in the first year is stronger, which is more likely to reduce moisture transport, leading to prolonged precipitation deficits over southern China. In contrast, the tropical SST signal is too weak to induce appreciable changes in the WNPC and precipitation over South China in the second year. The difference in SST signals in two consecutive springs leads to different spatial patterns of precipitation in southern China by causing different WNPC.