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A review of Aleutian Low variability for the last 7,500 years using pan-Pacific delta 18O records

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The North Pacific Ocean is the largest geographic feature in the Northern Hemisphere and its interactions with the overlying atmosphere drives critical components of the global climate system. The Aleutian Low (AL), the semi-permanent atmospheric low-pressure system centered near the Aleutian Islands, is dynamically linked to environmental change in the North Pacific and surrounding continental areas. However, the multi-centennial and longer time-scale history of the AL during the Holocene is poorly understood.

In this study, AL variability since 7.5 ka was examined by applying principal component analysis (PCA) to published $\delta^{18}O$ data of sedimentary calcite, peat, and speleothem deposits (n = 7) from western North America. Extracted Principal Component 1 (PC1) is characterized by multi-centennial to millennial-scale oscillations, with a spatial loading pattern that suggests PC1 reflects intensification and westward shifts of the AL during ca. 7.3–7.1, 6.3–5.2, 3.6–3.3, 2.9–2.7, 2.6–2.1, 1.8–1.2 and 0.5–0.3 ka. The timing of these shifts are coeval to periods characterized by large meanderings of the Westerly Jet (WJ) Stream over East Asia and solar activity minima, which together suggest that AL variability is related to declines in solar irradiance through its interactions with the WJ. In contrast, PC2 represents a dramatic change between the middle and late Holocene, and appears to reflect long-term intensified AL conditions related to orbitally-driven El Niño–Southern Oscillation intensification between the middle to late Holocene at ~4.5 ka. These findings are critically important for understanding background natural climate variability during the Holocene.