Persistent millennial-scale links between North Pacific intermediate-water ventilation and North Atlantic Climate during the deglaciation and last glaciation

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The deep ocean carbon cycle, especially carbon sequestration and outgassing, is one of the mechanisms to explain variations in atmospheric CO₂ concentrations on millennial and orbital timescales. However, the potential role of subtropical North Pacific subsurface waters in modulating atmospheric CO₂ levels on millennial timescales is poorly constrained. Here, we investigate a suite of geochemical proxies in a sediment core from the northern and middle Okinawa Trough to understand variations in intermediate-water ventilation of the subtropical North Pacific over the last 50,000 years (50 ka). Our results suggest that enhanced mid-depth western subtropical North Pacific (WSTNP) sedimentary oxygenation occurred during cold intervals during the last deglaciation and last glaciation, while oxygenation decreased during the Bölling-Alleröd (B/A) and warm interstadials. The enhanced oxygenation during cold spells is linked to the intensified North Pacific Intermediate Water (NPIW), while interglacial increase after 8.5 ka is linked to an intensification of the Kuroshio Current due to strengthened northeast trade winds over the tropics. The enhanced formation of NPIW during Heinrich Stadials was likely driven by the perturbation of sea ice formation and sea surface salinity oscillations in high-latitude North Pacific. The diminished sedimentary oxygenation during the B/A and interstadials due to decreased NPIW formation and enhanced export production, indicates an expansion of oxygen minimum zone in the North Pacific and enhanced CO₂ sequestration at mid-depth waters. We attribute the millennial-scale changes to intensified NPIW and enhanced abyss flushing during deglacial cold and warm intervals, respectively, closely related to variations in North Atlantic Deep Water formation. Our study extends the millennial-scale links between ventilation in the subtropical North Pacific Ocean and the Atlantic Climate into the last glaciations, highlighting the key roles of Atlantic Meridional Overturning Circulation in regulating the North Pacific environment at millennial timescales. Note: Financial support was provided by the National Program on Global Change and Air-Sea Interaction (GASI-GEOGE-04) and by the National Natural Science Foundation of China (Grant Nos.: 41876065, 41476056, and U1606401).