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Reconstructing the intensity and location of Northern Hemisphere westerlies during the Plio-Pleistocene using marine sediments

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The warm Pliocene serves as an analogue for predicted warming over the next century. However, large uncertainties exist for atmospheric circulation and land surface conditions during the Pliocene. Dust transported by wind to locations of accumulation (terrestrial or marine) can provide a record of wind intensity and/or direction. Few dust flux records spanning the Plio-Pleistocene exist. As such, there is ample opportunity to use marine sediments to reconstruct changes in atmospheric conditions during a warmer-than-present world, as well as across the onset/intensification of Northern Hemisphere Glaciation (NHG). During this time, East Asia's interior, the second largest source of mineral dust today, experienced aridification, occurring alongside a major reorganization of the subarctic North Pacific circulation which led to stratification of the surface ocean. Here, we present two North Pacific marine sediment records of extraterrestrial (ET) ^{3}He-derived terrigenous dust flux proxies ($^{4}He_{Terr}$ and Th), along with a record of multiple paleoproductivity proxies (Ba_{xs}, Opal, and C^{37}_{Total}) for the period spanning ~2.5-4.5 Ma. Our results show that dust flux to the western North Pacific was relatively low and constant through the Pliocene up until ~2.7 Ma, with minor peaks during cooler phases from ~2.9-3.1 Ma. At ~2.7 Ma, concurrent with the intensification of NHG and formation of a permanent halocline cap in the subarctic North Pacific, dust fluxes increase dramatically. The central North Pacific record shows a less drastic shift in dust, but generally displays higher fluxes after ~3 Ma. Dust fluxes in East Asia and the North Pacific are consistent during this time interval, as are global dust fluxes from the North Atlantic, South Atlantic and North Pacific. Western North Pacific dust, SST, and paleoproductivity records point to northward-shifted and weakened Northern Hemisphere westerlies during the warm Pliocene, with evidence for strengthening and southward movement of the westerlies during glacials after ~2.7 Ma. Changes in both winds and dust production mechanisms are likely working in tandem to produce the coherent global dust signals.