DECOUPLING OF NW PACIFIC FROM GLOBAL CLIMATE EVOLUTION LINKED TO THE MID-PLEISTOCENE TRANSITION AND MID-BRUNHES EVENT

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The Quaternary is a period with major changes in Earth´s climate, including the build-up of stable northern hemisphere ice caps. The Mid-Pleistocene Transition (MPT; 1.2-0.7 Myr) marks the last of these substantial changes and was characterized by global cooling, intensification and lengthening of glacial phases from ~40 kyr to ~100 kyr, and abrupt ice sheet growth after ~900 kyr (Rohling et al., 2014). The mechanisms leading to the climate changes during the MPT remain still unresolved, but dust-borne iron fertilization of the Southern Ocean (Chalk et al., 2018) or the expansion and increased production of North Pacific Intermediate Water (NPIW) (Kender et al., 2018) have been suggested as amplifiers for the glacial drawdown of atmospheric CO_2 during the MPT. In order to decipher the effects of the climate changes during the last 1000 kyr in the mid-latitude NW Pacific, we reconstructed paleoceanographic and paleoenvironmental changes by studying water temperature evolution based on the $U^{K´}_{37}$ (unsaturated ketone index) and TEX^{H}_{86} (tetraether index of tetraethers consisting of 86 carbon atoms), sedimentary long-chain *n*-alcohol concentrations as East Asian Winter Monsoon (EAWM) dust flux indicator, and Ba/Al ratios as productivity proxy. Deep-sea sediments used for this study were obtained from Site U1437 drilled during IODP Expedition 350 in the Izu rear-arc (SE of Japan).
$U^{K´}_{37}$- and TEX^{H}_{86}-based water temperatures at Site U1437 were at a constant level of ~25 °C and ~23.5 °C, respectively, throughout the intra-MPT warm phase (1000-900 kyr) and subsequently decreased. Glacial-interglacial temperature amplitudes increased after the 900 kyr cooling event, with highest TEX^{H}_{86}-based water temperatures during MIS 19, 11, and 5 and maximum $U^{K´}_{37}$-SSTs during MIS 15, 13, 7, and 5. Lowest temperatures were reached during MIS 2 (TEX^{H}_{86}) and MPT-glacial MIS 20 ($U^{K´}_{37}$). Average post-MPT glacials were by 0.7 °C colder than during the MPT, whereas post-MPT interglacials were on average by up to 0.9 °C warmer than those during the MPT. Pulsed fluxes of wax lipids of land plants as seen in peak *n*-alcohol concentrations were confined to glacials prior to the Mid-Brunhes Event (MBE; ~430-375 kyr) and mimicked the dust accumulation in the Southern Ocean during this time interval (Fig. 1). Elevated concentrations of wax lipids may have been a result of a stronger EAWM associated with the build-up of large ice sheets in the northern hemisphere, which resulted in increased meridional temperature gradients and a stronger Siberian High. After the MBE, sedimentary abundances of wax lipids significantly decreased and seem unrelated to Southern Ocean dust accumulation, indicating a decoupling of northern and southern hemisphere atmospheric dust transport mechanisms. A possible explanation may be a process called “Arctic amplification” that is amplified warming in the Arctic region, with temperature rises that exceed those in any other region, thereby likely affecting the Siberian High and thus EAWM strength. The Arctic amplification enhanced after the MBE (Cronin et al., 2017) and was accompanied by extensive sea ice loss, which may have decreased NPIW formation and expansion in the Subarctic Pacific and Bering Sea. NPIW is also present at intermediate water depth at Site U1437. Lower MPT and pre-MBE Ba/Al ratios (average of 0.47±0.3) at Site U1437 may reflect a greater expansion of nutrient-poor

NPIW at the site, whereas a higher overall productivity after the MBE (average Ba/Al ratio of 0.64 ± 0.4) may indicate a decreased influence of NPIW. Similarly, the bulk sediment $\delta^{15}N$ record shows a pattern similar to the global $\delta^{18}O$ curve of benthic foraminifera during most of the glacial and interglacial periods from ~1000 - 350 kyr. In contrast, larger offsets during glacials of the past 350 kyr suggest a decoupling of nitrate utilization in the mid-latitudinal NW Pacific and global climate post-MBE.

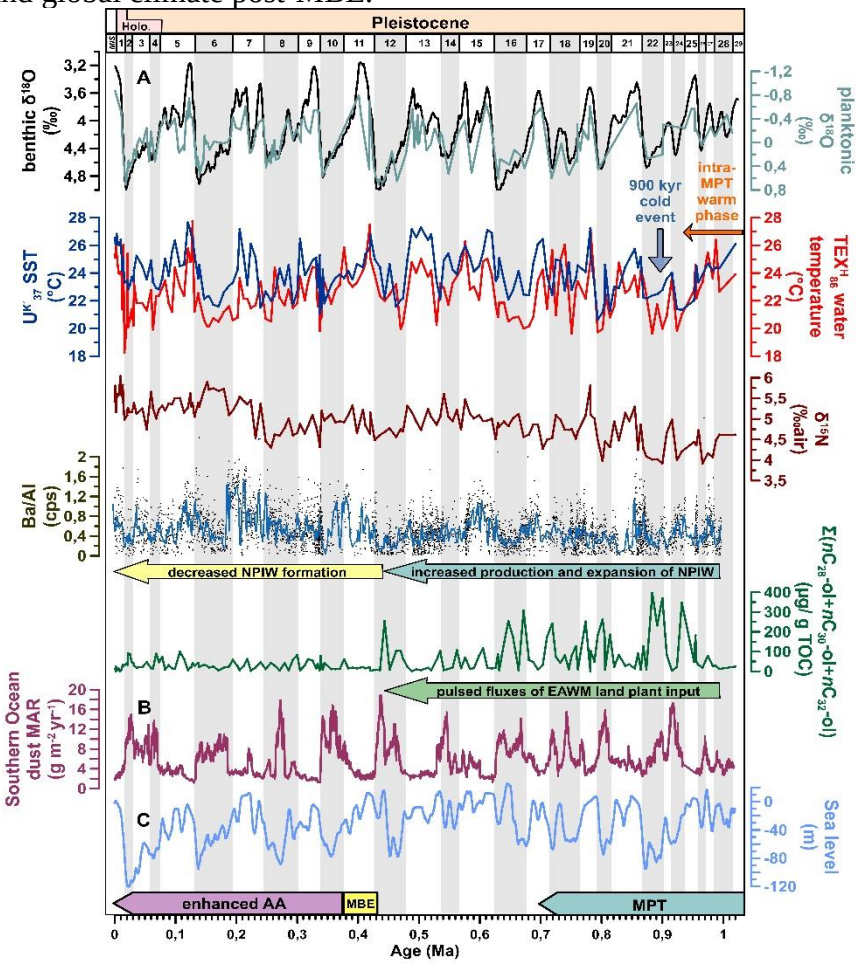

Figure 1 *Site U1437 paleoenvironment and paleoclimate proxies in comparison with A: black = Lisiecki and Raymo, 2005, light green = Kars et al., 2017; B: Martínez-Garcia et al., 2011; C: Rohling et al., 2014. Abbreviations: MPT = Mid Pleistocene Transition; MBE = Mid- Brunhes Event; EAWM = East Asian Winter Monsoon; AA = Arctic Amplification; NPIW = North Pacific Intermediate Water*

References

Chalk, T. B. et al., 2017. Causes of ice age intensification across the Mid-Pleistocene Transition. PNAS 114(50), 13114-13119.

Cronin, T. M. et al., 2017. Enhanced Arctic Amplification Began at the Mid-Brunhes Event ~400,000 years ago. Nature Scientific Reports 7:14475.

Kars, M. A. C. et al., 2017. Impact of climate change on the magnetic mineral assemblage in marine sediments from Izu rear arc, NW Pacific Ocean, over the last 1 Myr. Palaeogeography, Palaeoclimatology, Palaeoecology 480, 53-69.

Kender, S. et al., 2018. Closure of the Bering Strait caused Mid-Pleistocene Transition cooling. Nature Communications 9:5386.

Lisiecki, L.E., Raymo, M.E.A., 2005. Pliocene-Pleistocene stack of 57 globally distributed benthic δ18O records. Paleoceanography 20, PA1003.

Martínez-Garcia, A. et al., 2011. Southern Ocean dust-climate coupling over the past four million years. Nature 476, 312-315.

Rohling, E. J. et al., 2014. Sea-level and deep-sea-temperature variability over the past 5.3 million years. Nature 508, 477-482.