400,000 years millennial scale temperature and rainfall in East Asia deduced from paired Mg/Ca and oxygen isotope of planktic foraminifera from the East China Sea

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Abrupt millennial-scale climate changes during the late Quaternary were widely recognized in the East Asian monsoon region from deep-sea sediments in the Japan Sea and more recently from oxygen isotope ($\delta^{18}O$) variability in Chinese speleothems ($\delta^{18}O_{sp}$). The finely ^{230}Th-dating method on the speleothems enables comparison to climate records from other regions on millennial scale, and there is little doubt that the variability of these $\delta^{18}O_{sp}$ records is synchronized with climate perturbation in the North Atlantic high latitude, known as Heinrich events and with Dansgaard-Oeschger (D-O) oscillations in Greenland. However, mechanisms of the climate response in East Asia remain unclear due to the lack of fundamental agreement on what the $\delta^{18}O_{sp}$ climate signal represents. A primary impediment to interpreting the variability in $\delta^{18}O_{sp}$ is the lack of the means to decompose $\delta^{18}O_{sp}$ into constituent components. By contrast, the $\delta^{18}O$ of calcite planktic foraminifers ($\delta^{18}O_p$) from nearshore marine sediments can be quantitatively partitioned into sea surface temperature (SST) and $\delta^{18}O_w$ of seawater ($\delta^{18}O_w$), a function of sea surface salinity (SSS). In this study, millennial-scale climate variability in East Asia is investigated using 400,000-yr records of SST, $\delta^{18}O_p$, and $\delta^{18}O_w$ from the East China Sea (IODP Site U1429). $\delta^{18}O_w$ can be interpreted as reflecting SSS, hence rainfall, as the monsoonal runoff from the Yangtze River determines summer SSS in the northern East China Sea. As a result, SST and $\delta^{18}O_w$ variability accounts for 58% and 35% of the total variability of $\delta^{18}O_p$ and the rest (6%) is the ice volume component or noise; the primary contributor to $\delta^{18}O_p$ variations is SST, and the secondary is $\delta^{18}O_w$. Foraminiferal $\delta^{18}O_p$ shows the strongest similarly with Chinese $\delta^{18}O_{sp}$, indicating that $\delta^{18}O_{sp}$ is best interpreted as the combination of changes in surface temperature and monsoon rainfall; it is not indicative of summer monsoon rainfall alone. Partitioning of variance between temperature and rainfall does not change on glacial-interglacial timescales indicating that the hemispheric teleconnection mechanism between the Atlantic and East Asia does not depend on the global climate background status (CO_2, ice volume). In comparison with the millennial scale Greenland temperature, the East China Sea SST decreases and $\delta^{18}O_w$ increases (rainfall deceases) in most of the North Atlantic cold events (e.g., Heinrichs). However, SST and $\delta^{18}O_w$ exhibit overall poor coherence, revealing that these climate parameters fundamentally behave differently on the millennial scale, but tend to respond in the manner described above (decrease in temperature and rainfall) once a severe cold event occurs in the North Atlantic.

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