

## Frequent and abrupt cold episodes around 4.2 ka in the Yangtze delta: collapse of the earliest rice cultivating civilization

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Recently, investigations into Holocene climatic variability and its socioeconomic impacts are receiving attention with the aim of gaining insights necessary for predicting the future climatic changes and the evaluating of their impacts on human civilizations. In the estuary region of the Yangtze River, the oldest Neolithic civilizations based on paddy rice cultivation flourished in the mid-Holocene (7.5–4.2 cal. kyr BP). However, although it is known that this Yangtze civilization collapsed at around 4.2 cal. kyr BP, the reason behind it remains controversial. The purpose of this study is to reconstruct environment change behind the rise and fall of the Yangtze civilization.

We analyzed a sedimentary core (MD06-3040) recovered from the inner shelf mud belt of the East China Sea, off the coast of the Yangtze delta area. C37 alkenone unsaturation index ( $U_{37}^{k'}$ ) has provided an excellent opportunity to reconstruct the Holocene regional sea surface temperature (SST) with high time resolution. The monthly mean atmospheric temperature (AT) is correlated positively with the monthly mean SST in this area ( $[AT] = -10.8 + 1.35 \times [SST]$ ;  $r^2 = 0.90$ ,  $p < 0.001$ ), which allowed us to reconstruct AT near the Yangtze delta region quantitatively from SST. Our  $U_{37}^{k'}$ -SST fluctuation pattern resembled previous AT reconstructions in China, including Little Ice Age (0.3-0.1 cal. yr BP) which validates the reliability of our  $U_{37}^{k'}$  record as a temperature proxy. Extraordinarily severe and abrupt cold episodes (i.e., 3–4°C drop in SST, 3–5°C drop in AT) occurred frequently in the Yangtze delta region during 4.4–3.8 cal. kyr BP, which may be related to the global climatic transition known as the “4.2 ka event”. The causes of these environmental changes could be the changes in the seasonal progression of westerly jet, El Niño Southern Oscillation mode, and the strength of Kuroshio Current during this transition period. The abrupt and frequent cold episodes around 4.2 cal. kyr BP is a plausible explanation for the collapse of the Yangtze civilization, as it must have been sufficiently severe to damage rice cultivation.

Keywords: Holocene, 4.2 ka event, Yangtze civilization, rice cultivating culture

