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ITCZ and ENSO pacing on East Asian winter monsoon variation during the Holocene: Sedimentological evidence from the Okinawa Trough

Xufeng Zheng (1), Anchun Li (2), Shiming Wan (2), Shuhji Kao (3), and Gerhard Kuhn (4)

(1) Key Laboratory of Marginal Sea Geology, South China Sea Institute of Oceanology, Chinese Academy of Sciences, Guangzhou, 510301, China, (2) Key Laboratory of Marine Geology and Environment, Institute of Oceanology, Chinese Academy of Sciences (CAS) 7 Nanhai Road, Qingdao, 266071, China, (3) State Key Laboratory of Marine Environmental Science, Xiamen University, Xiamen, China, (4) Alfred-Wegener-Institut, Helmholtz-Zentrumfür Polar- und Meeresforschung, Am AltenHafen 26, 27568 Bremerhaven, Germany

Deep-sea fan sediments provide an excellent geological archive for paleoenvironment reconstruction. Grain size, clay mineral and elemental (Ti, Fe, Ca) compositions were measured for a core retrieved from a submarine fan in the Okinawa Trough. Varimax-rotated Principal Component Analysis (V-PCA) on time-evolution of grain size spectrum reveals that, since the Holocene, sediment was transported mainly by the benthic nepheloid layer (33%) and upper layers (33%) which is driven by the East Asian winter monsoon (EAWM). The intensification of the Kuroshio Current during the Holocene, masks the fluvial signal of the summer monsoon and obstructs clay minerals derived from the Yellow River, a major contributor prior to 12 ka BP. A new grain size index (GSI), which represents the EAWM well, exhibits a negative correlation with the δ18O record in Dongge Cave, China during the Holocene when sea level was relatively steady. This anticorrelation suggests the southward migration of the Intertropical Convergence Zone (ITCZ). The consistency among our records and rainfall records in Peru, Ti counts in the Cariaco Basin, monsoon records in Oman and the averaged summer insolation pattern at 30°N further support the ITCZ's impact on monsoon systems globally. Cross-Correlation Analyses for GSI and log(Ti/Ca) against δ18O record in Dongge Cave reveal a decoupling between the East Asian winter and summer monsoon during 5500–2500 cal yr BP, with greater complexity in the last 2500 years. This can be attributed to exacerbated ENSO mode fluctuations and possibly anthropogenic interference superimposed on insolation and ITCZ forcing.