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Double-plunge structure of the East Asian summer monsoon during Heinrich stadial 1 recorded in Xianyun Cave, southeastern China

WANYIN QIU[1,2], XIN ZHANG[1], XIUYANG JIANG[1], HSUN-MING HU[3], LE MA[1], HAIYAN XIAO[1], BINGGUI CAI[1] AND CHUAN-CHOU SHEN[3]

[1]Fujian Normal University

[2]Key Laboratory for Humid Subtropical Eco-geographical Processes of the Ministry of Education

[3]National Taiwan University

Presenting Author: 1628973640@qq.com

The interhemispheric anti-phase relationship of monsoon precipitation on the millennial timescale has been widely verified and is generally attributed to the migration of the mean position of the Intertropical Convergence Zone (ITCZ). However, previous high-resolution records showed that the interhemispheric monsoon climate could have been decoupled within Heinrich stadial 1 (HS1), creating a two-fold subdivision in the Asian summer monsoon and a double-plunge structure in the South American summer monsoon. In this study, we present a high-resolution and precisely dated composite stalagmite oxygen-isotope record exhibiting a clear double-plunge structure during HS1 from southeastern China, the frontal zone predominantly influenced by the East Asian summer monsoon (EASM). Our new record characterizes a weak EASM period corresponding to HS1, divided into two weak periods (HS1c, 17.89–17.01 ka B.P.; HS1a, 15.94–14.76 ka B.P.) by a relatively strong phase (HS1b, 17.01–15.94 ka B.P.). Comparisons with other records from global monsoon systems suggest the double-plunge structure of HS1 is widespread in the low latitudes of monsoon domains, and the interhemispheric anti-phase relationship of the monsoonal hydroclimate still holds on the sub-millennial timescale. This structure could be closely linked with two meltwater pulses in the North Atlantic, separated by a weak period and a brief rerouting of the main freshwater input produced by the Laurentide ice sheet from subpolar North Atlantic to the Gulf of Mexico. The change in the interhemispheric thermal gradient during HS1b likely pulled/pushed the ITCZ northward briefly and induced the synchronous and reverse change in the interhemispheric monsoon climate.

Fig.7

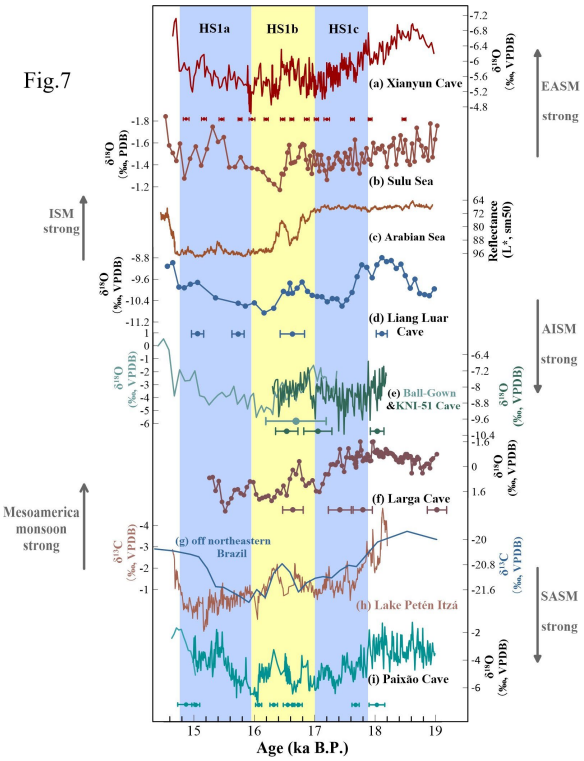

Fig.8