



An annually laminated stalagmite record of precipitation in spring persistent rains region over SE China and its relationship to ENSO and PDO

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The spring persistent rains (SPR) over Jiangnan area in southeastern China are a unique synoptic and climatic phenomenon, it is another rainy period besides East Asian tropical summer monsoon over East Asia. Studies show that the annual to decadal variability of precipitation in SPR region mainly influenced by the summer monsoon is correlated with El Niño/Southern Oscillation (ENSO) and the Pacific Decadal Oscillation (PDO). We present a 190 year, seasonally resolved stalagmite $\delta^{18}\text{O}$ record from E'mei cave in southeastern China that exhibits a significant correlation with ENSO, PDO, and western Pacific subtropical high (WPSH) variability. In SPR region, spring (March-May) rainfall amount accounts for about 40% of annual rainfall amount, which is roughly equivalent to summer (June-September) rainfall amount, but the $\delta^{18}\text{O}$ value of spring rainfall is more positive than that of summer rainfall. Accordingly, we suggest that $\delta^{18}\text{O}$ of stalagmite in SPR region is mainly influenced by the ratio of summer monsoon amount/non-summer monsoon amount at annual to decadal scale. Comparisons between $\delta^{18}\text{O}$ series and ENSO, PDO, and WPSH index show that, during El Niño phase or positive PDO phase, the WPSH becomes strong, and subsequently extend southwestward, the summer monsoon rainfall in SPR region decreases but non-summer monsoon rainfall increases, which results in the heavier oxygen isotope in annual precipitation, and subsequently in the stalagmite; and vice versa. However, this relation has weakened during the past two decades.