

## Relationship between early summer precipitation in Japan and the El Niño-Southern Oscillation over the past 400 years

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The El Niño-Southern Oscillation (ENSO) potentially influences East Asian Summer Monsoon (EASM) rainfall, but the relatively short instrumental rainfall record hinders the progress of a longer-term understanding of this relationship. To partially overcome this issue, we reconstruct precipitation from tree-ring oxygen isotopes ( $\delta^{18}\text{O}$ ) in central Japan from AD 1612 to 1935. Our results show that tree-ring cellulose  $\delta^{18}\text{O}$  is significantly correlated with May-June (MJ) rainfall in central Japan, allowing us to examine the relation between the EASM summer rainfall and ENSO during the past 400 years. Time- and frequency-domain comparison of the tree-ring  $\delta^{18}\text{O}$  record and recent ENSO reconstructions show a common high-frequency (3-8 year) variability that characterized the mid-17th, late 18th and late 19th centuries. Similar analyses of instrumental MJ precipitation and several ENSO indexes during the 20th century reveal that this high-frequency oscillation reappeared from AD 1980. Comparison of ENSO and Pacific Decadal Oscillation (PDO) indexes reveals that the ENSO-EASM relationship is strong when ENSO variance is high, and the PDO phase may modulate the ENSO-EASM relationship over the past four centuries.