Supplementary Information (SI) for

[Unraveling El Niño’s Impact on the East Asian Monsoon and Yangtze River Summer Flooding]

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### Table S1. Definitions of different SST anomaly (SSTA) indices used in this study.

<table>
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<th>Index Name</th>
<th>Definition</th>
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<td><strong>El Niño Modoki index (EMI)</strong></td>
<td>( EMI = \left[ \text{SSTA}_C \right] - 0.5 \left[ \text{SSTA}_E \right] - 0.5 \left[ \text{SSTA}_W \right] ), where the brackets represent the area-averaged SSTA over the regions C (10°S–10°N, 165°E–140°W), E (15°S–5°N, 110°W–70°W), and W (10°S–20°N, 125°E–145°E)</td>
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<td><strong>C-index</strong></td>
<td>( C-index = \left( \text{PC1} + \text{PC2} \right)/\sqrt{2} ), where the PCs (normalized and 1-2-1 filter applied) correspond to the EOFs of the SST anomalies over the tropical Pacific (10°S–10°N, 110°E–60°W)</td>
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<tr>
<td><strong>Trans-Niño index (TNI)</strong></td>
<td>Difference between normalized SSTA over regions Niño4 (5°S–5°N, 160°E–150°W) and Niño1+2 (0°–10°S, 80°–90°W)</td>
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<td><strong>Indian Ocean Dipole (IOD)</strong></td>
<td>SSTA difference between the western (50°E–70°E, 10°S–10°N) and southeastern (90°E–110°E, 10°S–0°) tropical Indian Ocean</td>
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<td><strong>Indian Ocean Basin Mode (IOBM)</strong></td>
<td>SSTA over the tropical Indian Ocean (20°S–20°N, 40°–100°E)</td>
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<td><strong>SSTA dipole pattern between the Indian Ocean and the WNP (IO_WNP)</strong></td>
<td>SSTA difference between the IO (10°S–10°N, 50°E–110°E) and the WNP (0°–15°N, 120°E–160°E)</td>
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</table>

### References for definitions of different SST A indices

Figure S1. Spatial and temporal patterns associated with the Niño-A index and SST anomaly time series \( T \) forced by the second principal component (PC2)-associated surface wind anomalies based on the equation \( dT/dt + \lambda T = \beta(\text{PC2})_N \) (see Methods section). (a and b) Regressed SST anomalies (contour; °C) with respect to Niño-A (a) and \( T \) (b). Shading indicates the correlation coefficient with SST anomalies. The contour interval is 0.1 °C. (c) Normalized Niño-A (same plot as Fig. 2d) and \( T \) time series.
Figure S2. Lead/lag correlation between the Niño-A index and PC2, Niño3.4, EMI (reversed sign), TNI, IOD, and IOBM indices over the period of 1979–2015. Negative lags (months) means that Niño-A is leading the other indices.
Figure S3. (a and b) Spatial SST anomaly patterns (contour, °C) for the EMI (a) and TNI (b). Shading indicates the correlation coefficient with SST anomalies. (c-e) Power spectra of Niño-A (c), EMI (d), and TNI (e) over the period of 1979-2012. The dashed line represents the 95% confidence interval of a $\chi^2$ test against AR(1).
Figure S4. (a) Composite evolution of two strong El Niño events (1982/83 and 1997/98) for the normalized PC2, Niño3.4, Niño-A, and IO_WNP indices. The El Niño developing year and the decaying year are designated as 0 and 1, respectively. (b) Scatter diagram of boreal summer (JJA) Niño-A (normalized) and WPSH indices (m) during El Niño years (1982/83, 1986/87, 1991/92, 1994/95, 1997/98, 2002/03, 2004/05, 2006/07, 2009/10). Yellow and red colors represent the developing and decaying summers, respectively. (c and d) Composite geopotential height anomalies (contour, m) at 850 hPa during El Niño developing (c) and decaying (d) summers. Shading indicates significance at the 95% confidence level.
Figure S5. (a) Scatter diagram of the Niño3.4 and Niño-A indices (°C) during the ENSO mature phase averaged from November (0) to April (1). (b and c) Composite SST anomalies (contour and shading, °C) for the high (b, red dots in a) and low (c, green dots in a) Niño-A values during El Niño mature phase. Only values above the 95% confidence level are shown.
Figure S6. (a) Seasonal (3-month running mean) correlations for an East Asia monsoon index (WPSH) with Niño3.4, Niño-A, and their combination. (b) Same as (a) but for other indices (Table S1).
Figure S7. Observed and reconstructed precipitation anomalies (shading in mm/d and contour interval 1 mm/d) during boreal spring (MAM) of 2016 (left column) and the average of MAM 1983 and MAM 1998 (right column). The reconstruction uses the linear regression with the Niño3.4 and Niño-A indices.