Geophysical Research Letters

Supporting Information for

The sensitivity of the El Niño- Indian monsoon teleconnection to Maritime Continent cold SST anomalies

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Text S1

The developing years of composites of EP are 1951, 1969, 1972, 1976, 1982, 1987, 1997, 2006 and the CP are 1953, 1957, 1963, 1965, 1968, 1977, 1991, 1994, 2002, 2004, 2009 and the positive IOD years are 1961, 1963, 1972, 1982, 1983, 1994, 1997, 2006, 2012, 2015 respectively. The Pacific anomalies for the developing phase of an El Niño year (0) are derived by compositing SST anomalies from November of year (-1) to October of year (0). October-November is chosen as the best month to transition between year 0 and year -1 to minimise the impact of any shock on the monsoon season. The developing ENSO period typically has SST anomalies during the Indian Monsoon season in JJAS of year (0), which have a strong influence on concurrent ISM rainfall and circulation (e.g., Wang et al., 2003; Jang and Straus, 2012).

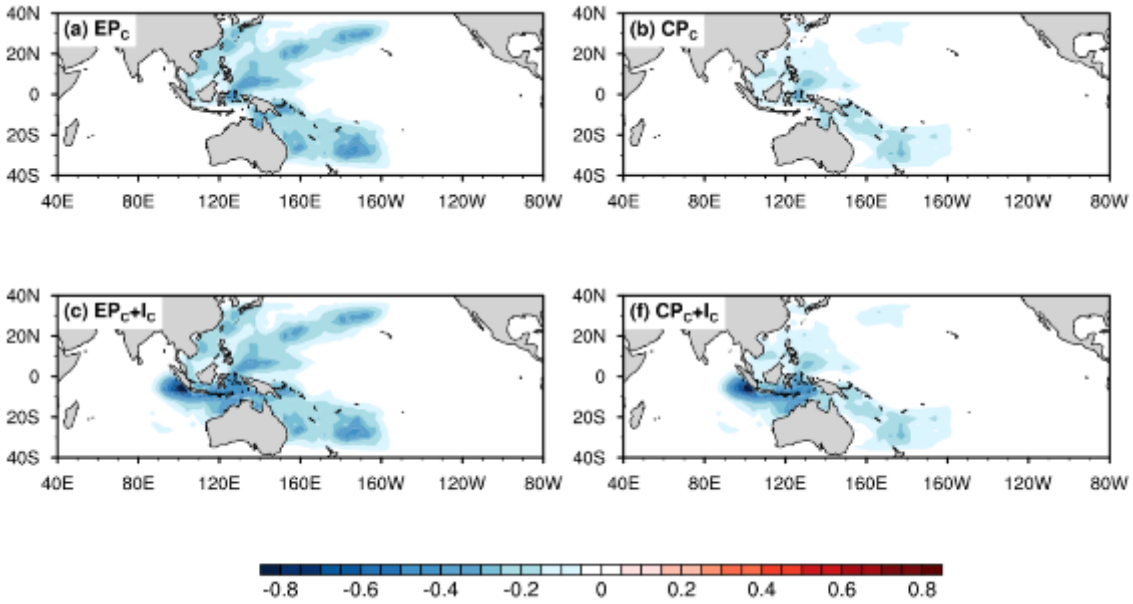

Figure S1. The JJAS mean composites of SST anomalies overlaid with SST climatology to provide surface forcing in IGCM model experiments for EP, CP. In our naming convention, EP and CP suggest whole Pacific-basin SST anomalies, while W and C subscripts indicate experiments in which only the warm or cold SST anomalies are retained (respectively) for El Niño (over Pacific Ocean) and IOD (over Indian Ocean) events.

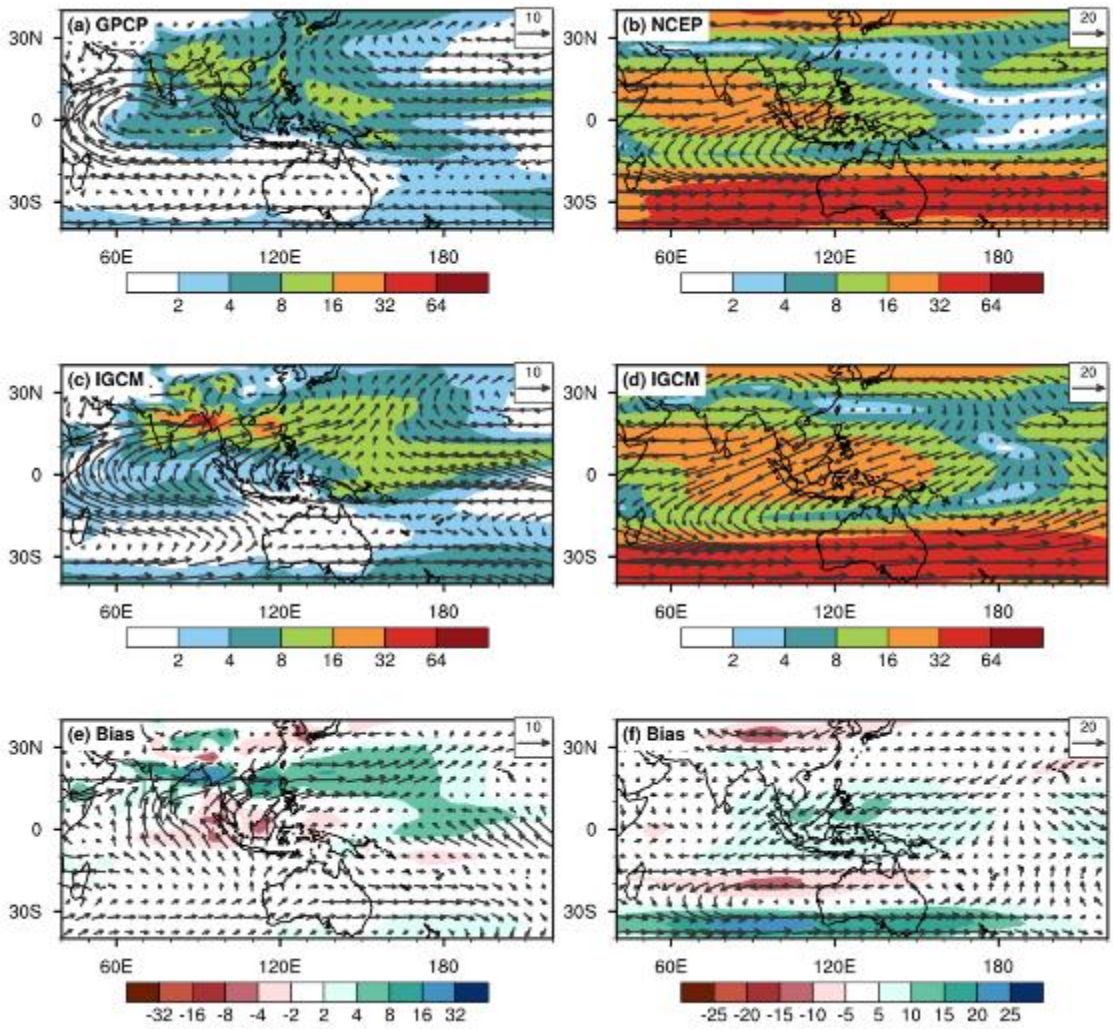

Figure S2. Observed (reanalysis) and IGCM-simulated climatology of JJAS rainfall (mm d^{-1}) and the circulation (wind vector, m s^{-1}). **(a)** GPCP rainfall (contours) overlaid with 850 hPa winds (NCEP), **(b)** 200 hPa windspeed (shaded) overlaid with wind vectors. **(c & d)** represents the IGCM-simulated rainfall and circulation, and **(e & f)** indicate the model biases. The climatology in reanalysis is based on the period 1979-2008, while the IGCM climatology is based on the years after the model spin up (in this case 30 years)

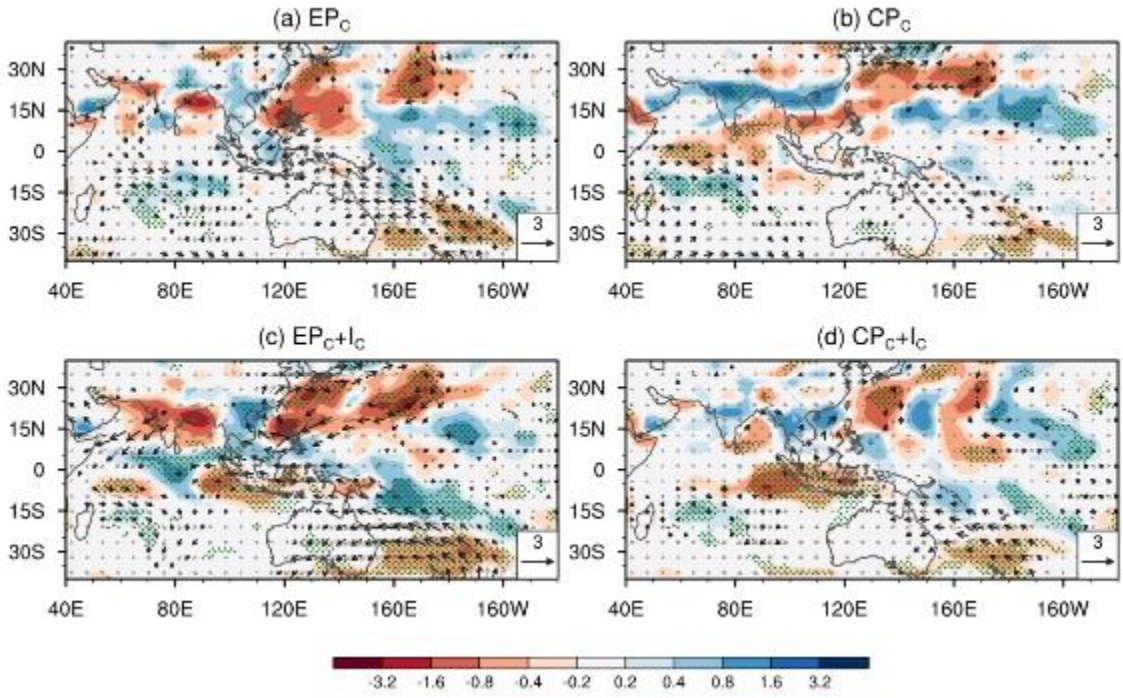

Figure S3. IGCM responses in JJAS rainfall (shaded, mm d^{-1}) and circulation (850 hPa wind vectors; m s^{-1}) over the ISM domain for the 4 model experiments shown in Figure 1. (**a-b**) the model response to Pacific cold SST forcing only (EP_C, CP_C); **(c-d)** model response to Pacific cold SSTs combined with cold Indian Ocean SST anomalies (I_C). The wind vectors (black) and the precipitation (hatched) represent statistical significance at the 90% confidence level based on a student's t-test.

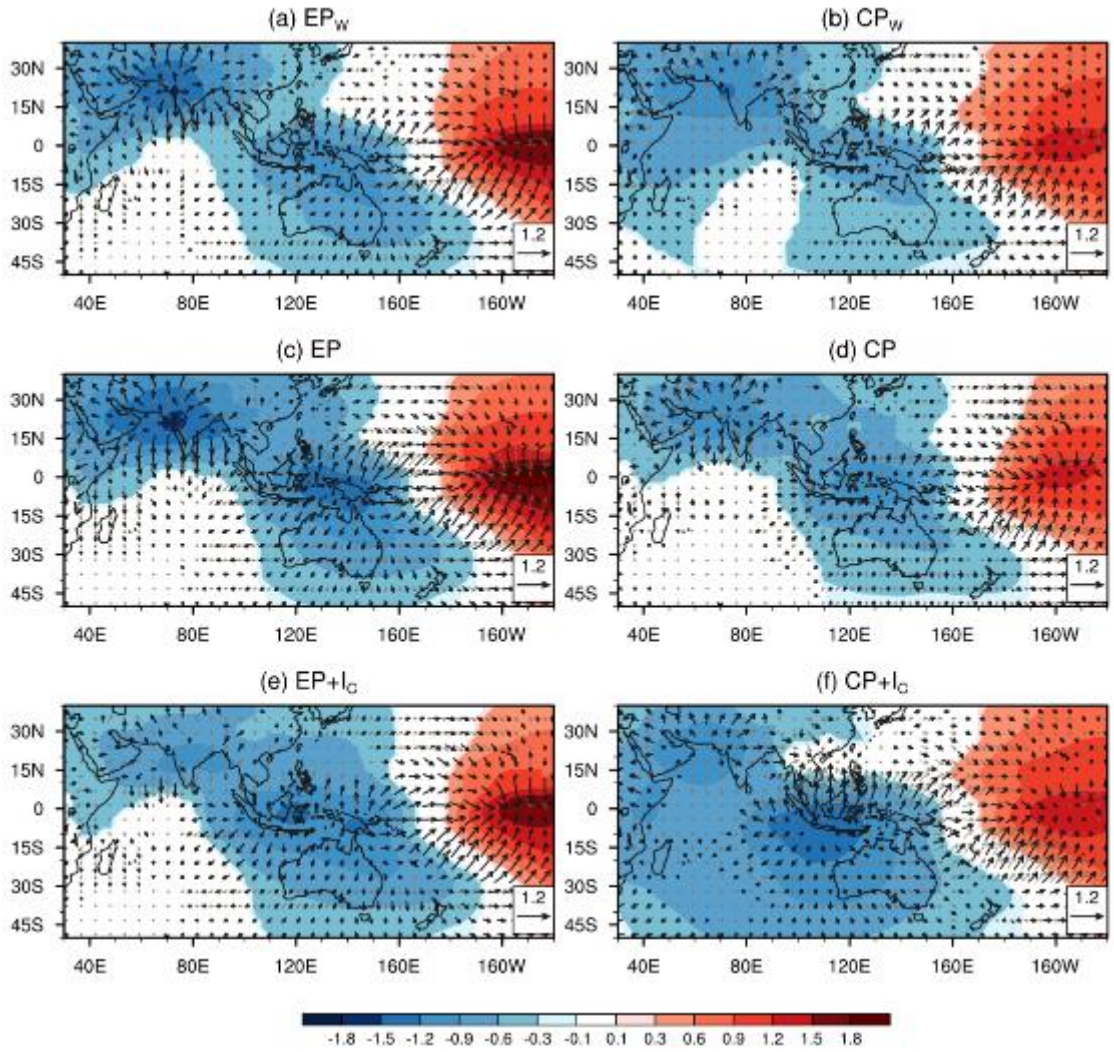

Figure S4. Same as Figure 2, but for lower level (850 hPa) velocity potential (shaded; 10^{-6}, $m^2\ s^{-1}$) overlaid with divergent wind anomalies (vectors). Only signals of velocity potential significant at the 90% level are shown (shaded), while divergent winds are shaded grey (black) below (above) this level.

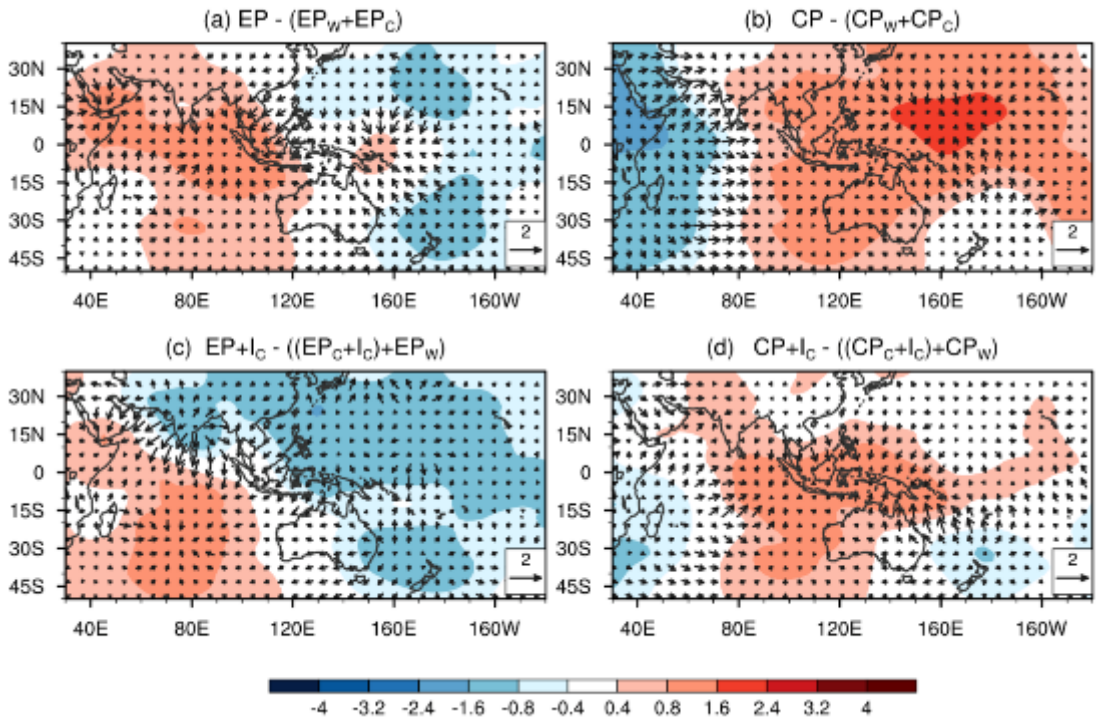

Figure S5. Non-linearity in IGCM responses to SST forcing during JJAS, (a-b) upper-level (200 hPa) velocity potential (shaded; 10^{-6}, $m^2\ s^{-1}$) overlaid with divergent wind anomalies (vectors) between EP (CP) and the sum of responses to EP_W and EP_C (CP_W and CP_C), (c-d) between EP+I_C (CP+I_C) and the sum of responses to EP_W and EP_C+I_C (CP_W and CP_C+I_C).

Tables

Table S1: Additional model experiments. In our naming convention, EP and CP suggest whole Pacific basin SST anomalies, while W and C subscripts indicate experiments where only the warm or cold SST anomalies are retained (respectively) for El Niño (over Pacific Ocean) and IOD (over Indian Ocean) events.

Experiments	**SST forcing**
EP_C, CP_C	Ctrl + Pacific cold SST anomalies
EP_C+I_C, CP_C+I_C	Ctrl + Pacific cold + IOD cold SST anomalies