

Supplementary Information to the paper

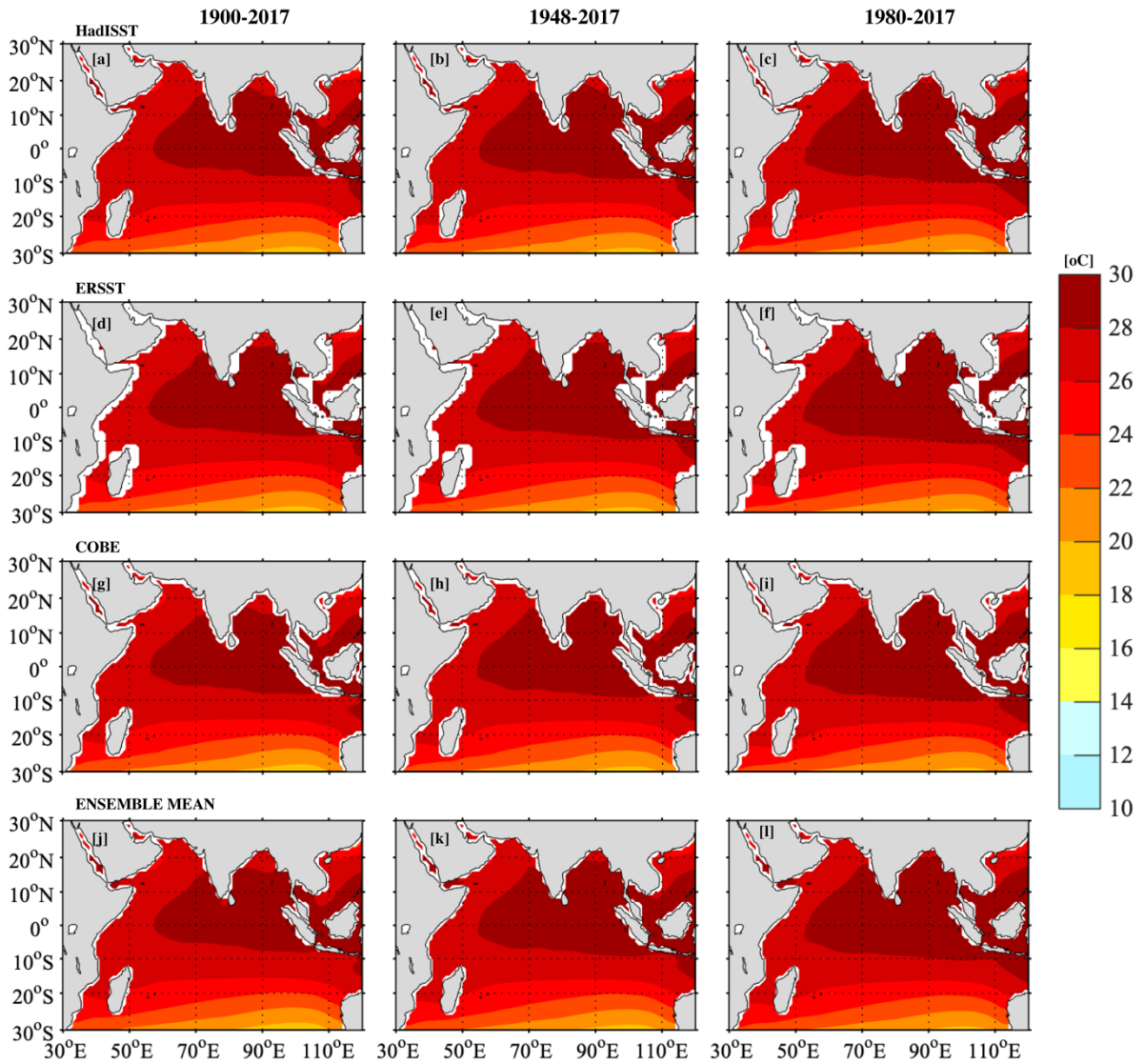
**Long-term variability of Sea Surface Temperature in the Tropical Indian Ocean in relation to climate change and variability**

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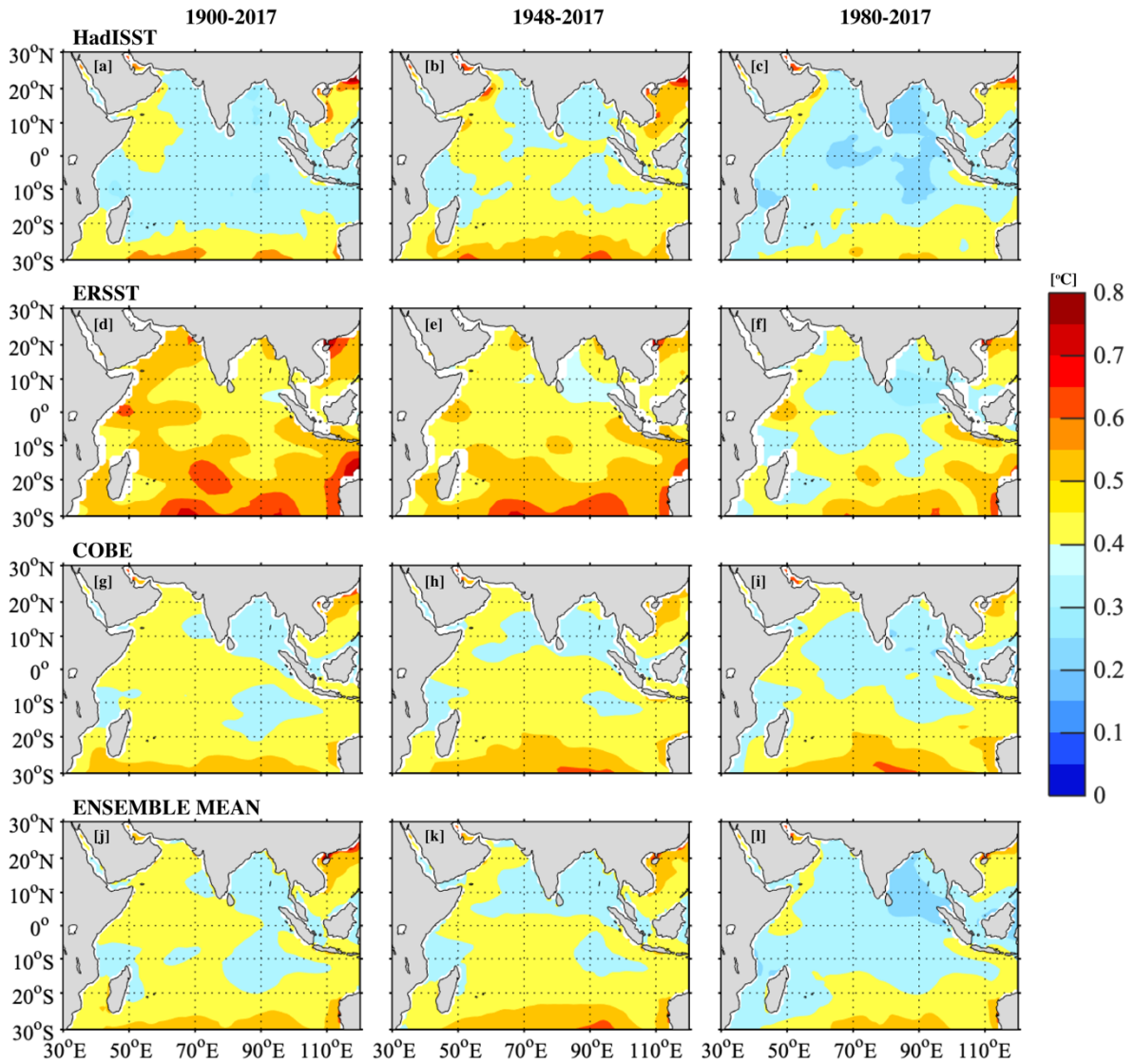
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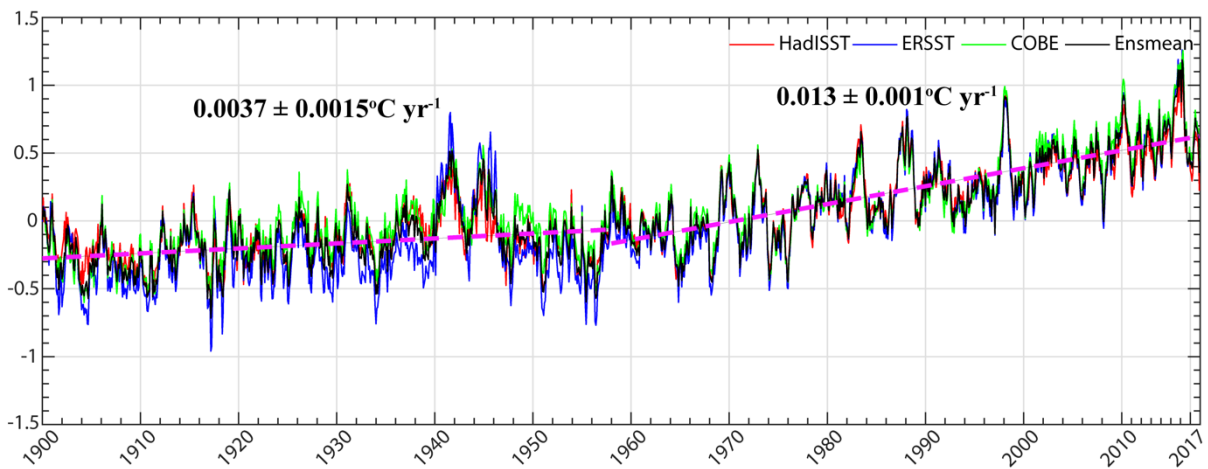
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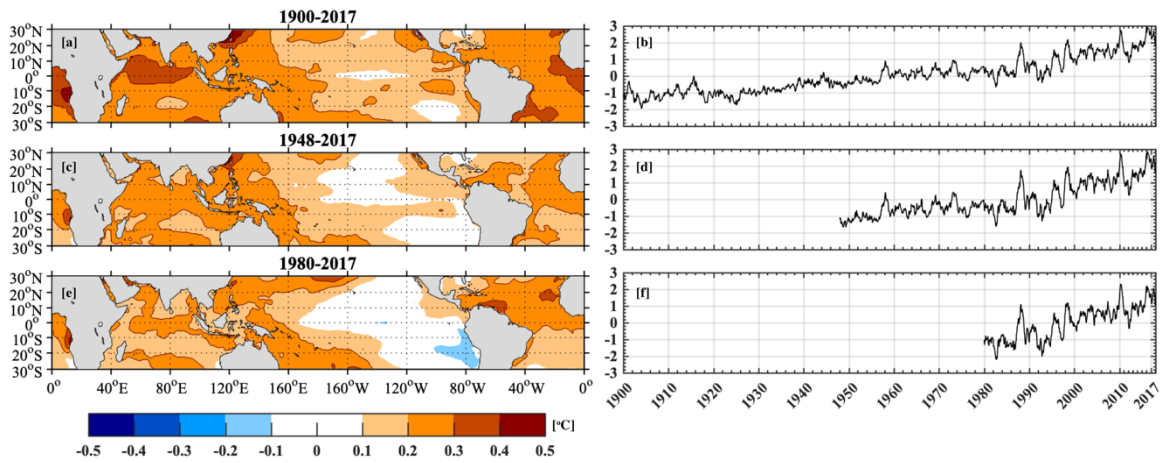
**Figure S1.** Climatology of SST in (a-c) HadISST, (d-f) ERSST, (g-i) COBE, and (j-l) their ensemble mean for the period 1900-2017 (left), 1948-2017 (middle), and 1980-2017 (right).



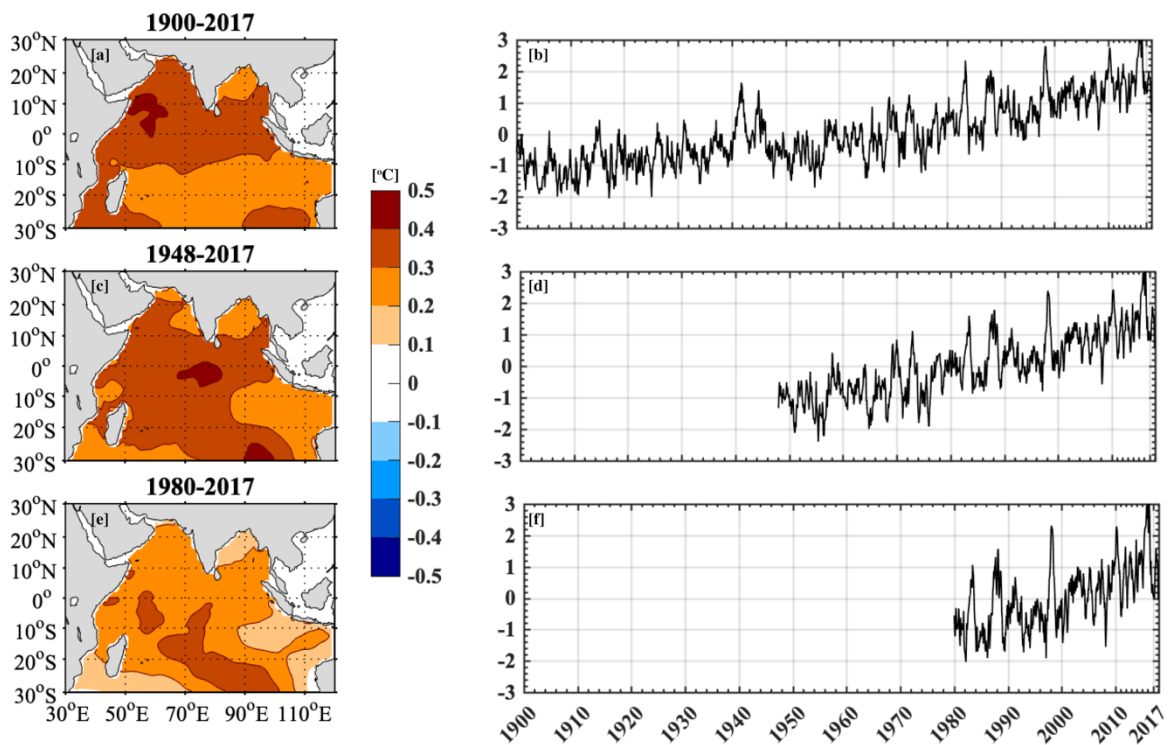
**Figure S2.** Same as Fig. S1, but for standard deviation.



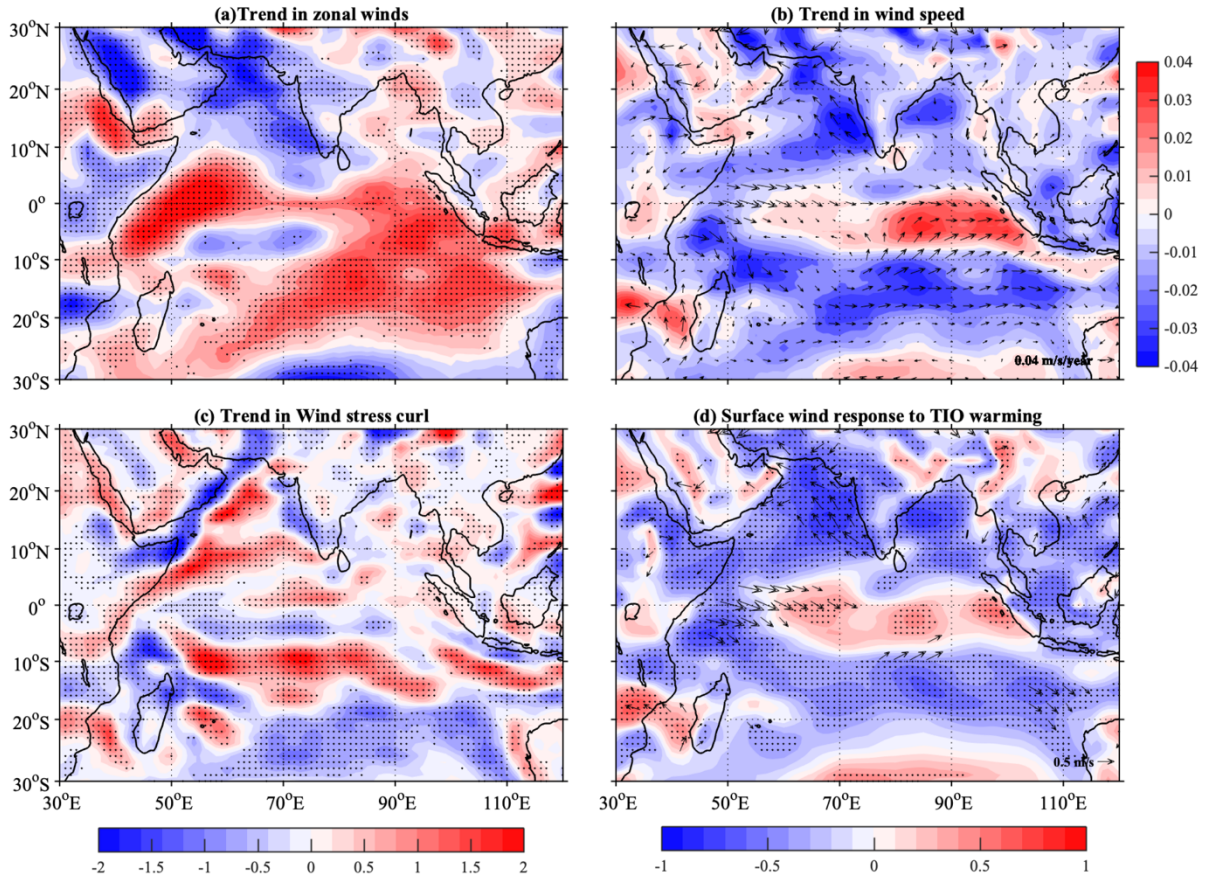
**Figure S3.** SST anomalies averaged over the TIO region for three reanalysis data sets and their ensemble mean. Linear trend of ensemble mean SST anomalies is shown for the periods 1900 to 1956 and 1957 to 2017.



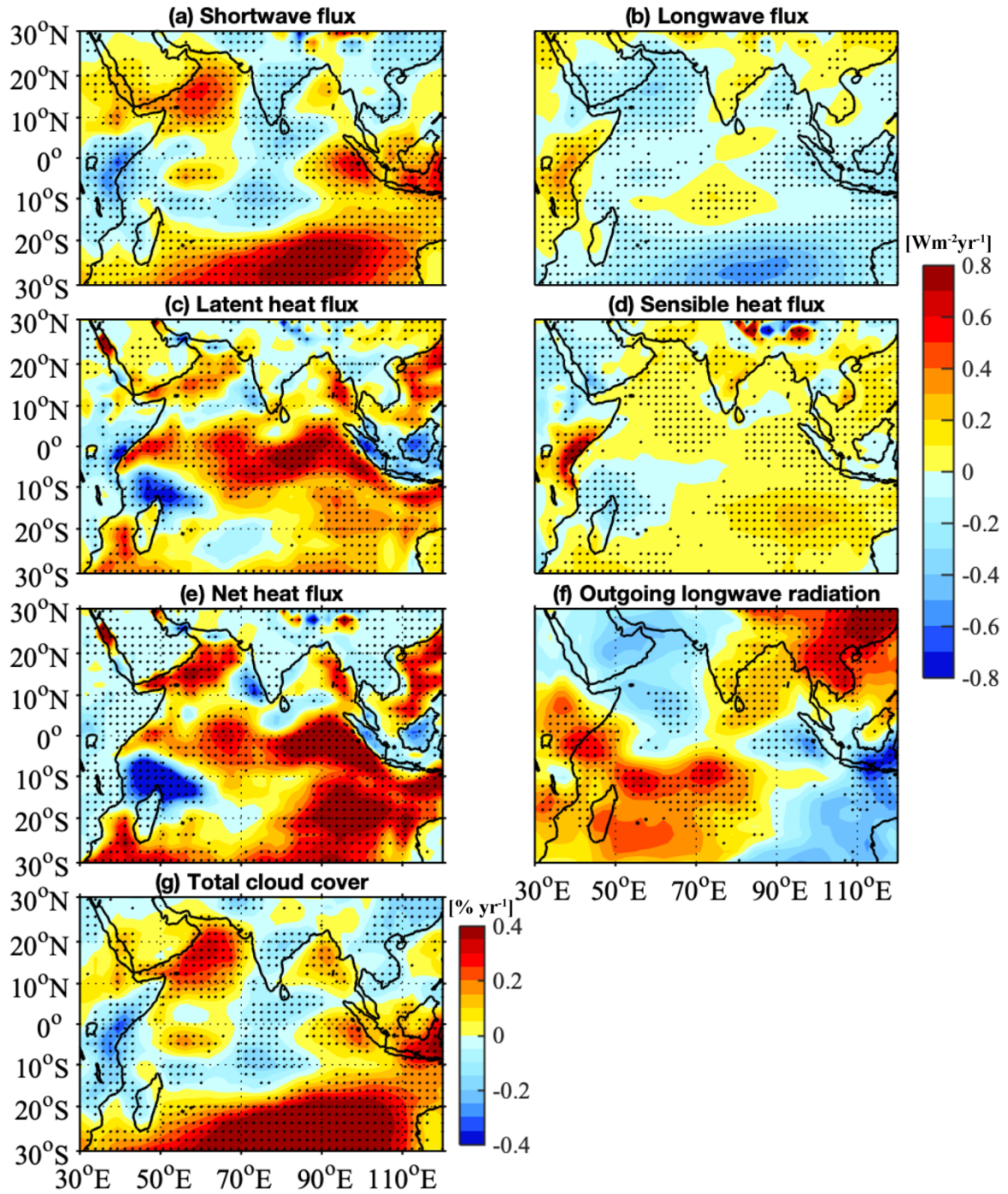
**Figure S4.** First mode of LFPs and LFCs computed for three different periods considered in the study.



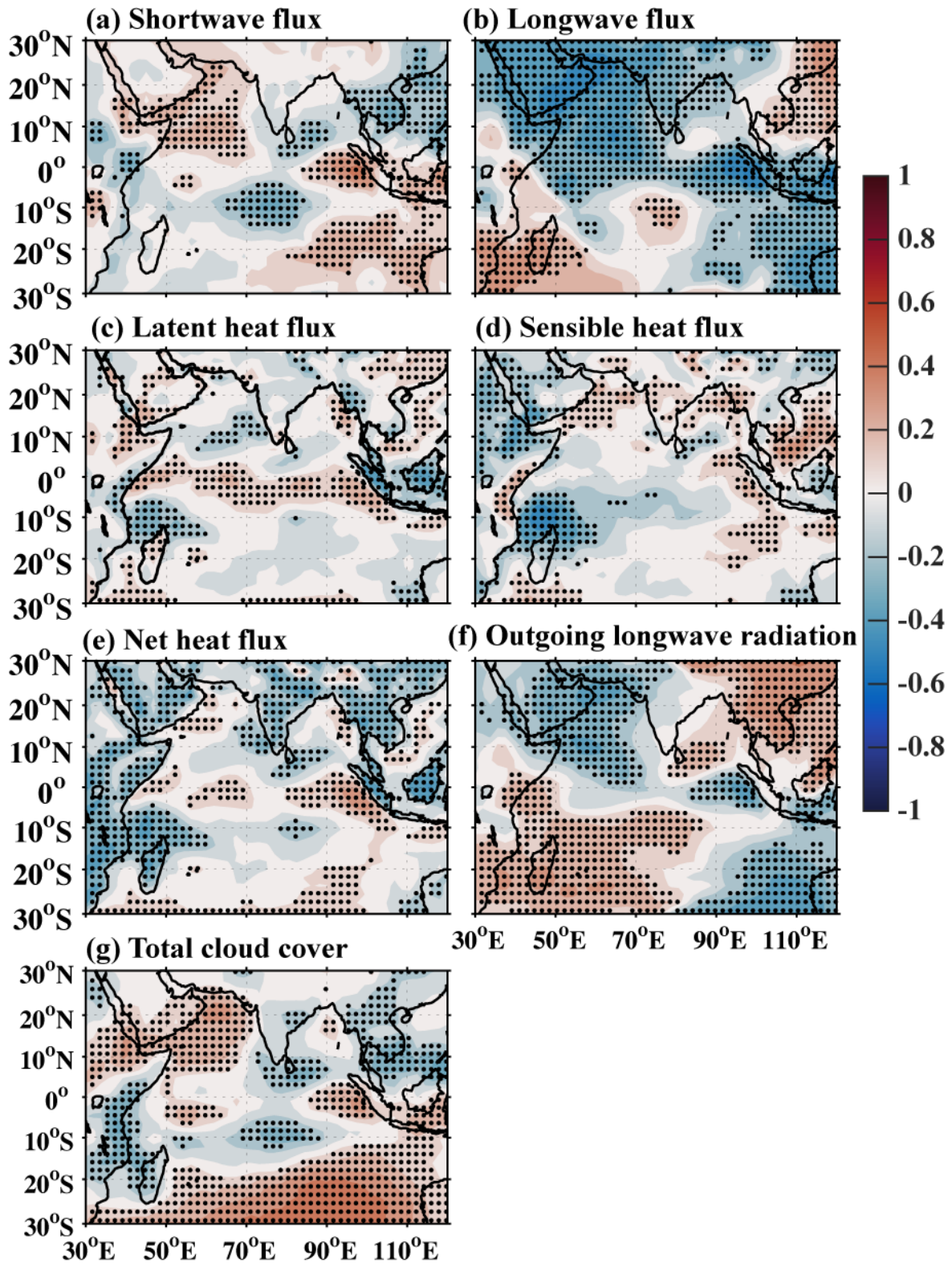
**Figure S5.** Same as Fig. S4, but for the TIO region.



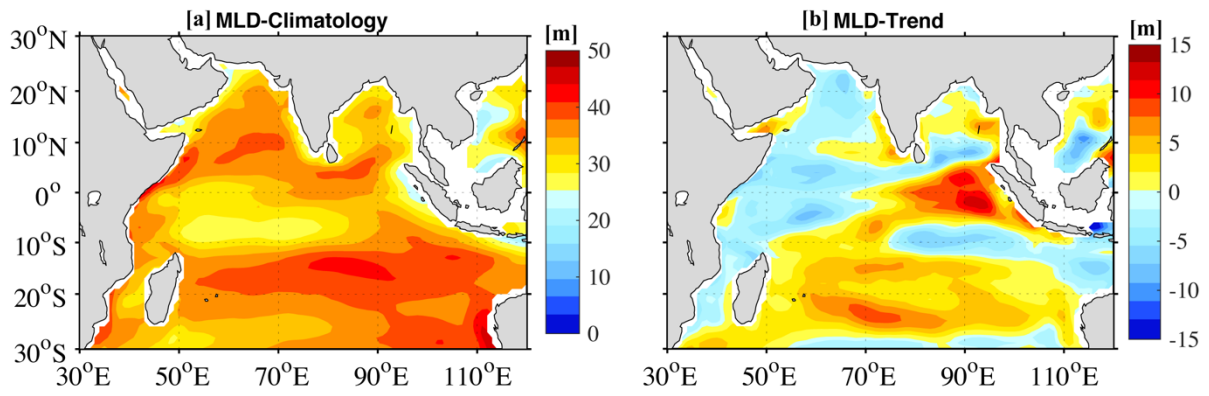
**Figure S6.** (a) Trend in surface zonal wind (NCEP, 1980–2017,  $\text{ms}^{-1}$ ). (b) Trend in surface wind speed and vectors ( $\text{ms}^{-1}$ ). (c) Trend in surface wind stress curl ( $10^{-9}\text{Nm}^{-3}$ ). Statistically significant trend values are highlighted by stippling. (d) Surface wind response ( $\text{ms}^{-1}$ ) to tropical Indian Ocean warming. Shade indicates the spatial correlation pattern of wind speed with Indian Ocean warming signal. Vectors are obtained by regressing Indian Ocean warming signal on zonal and meridional wind speed components. The vectors and stippling are shown over the regions where the regression and correlation coefficients respectively are statistically significant at 95% confidence level.



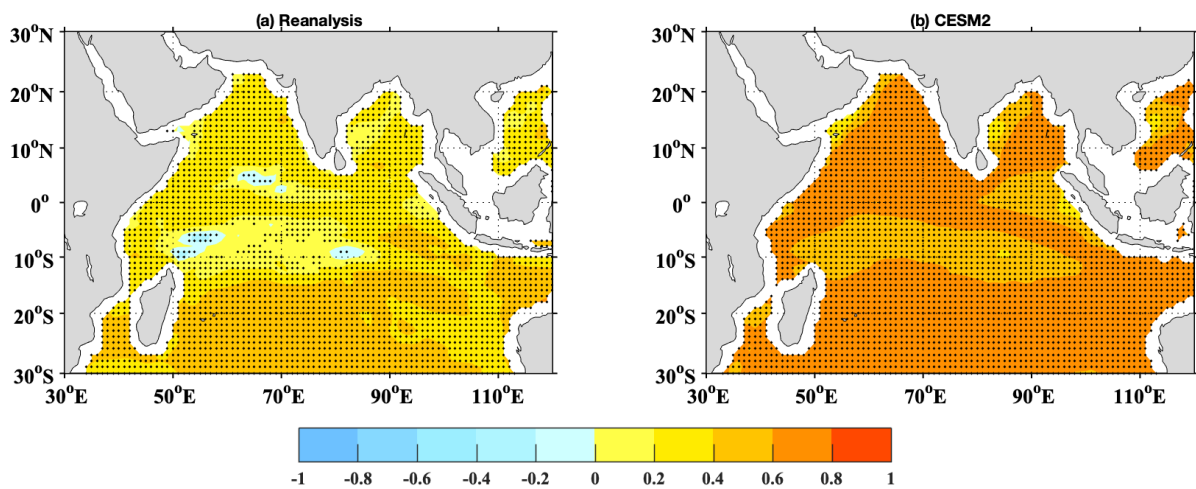
**Figure S7.** Trends in surface heat fluxes, OLR at the nominal top of the atmosphere and total cloud cover for the period 1980-2017. The sign conventions of shortwave flux and net heat flux are that the positive value indicates flux into the ocean and is reverse for other fluxes. Stipplings indicate the trends are statistically significant at 95% confidence level.



**Figure S8.** Correlation patterns of Indian Ocean warming signal and (a) net surface shortwave radiation flux, (b) net surface longwave radiation flux, (c) latent heat flux, (d) sensible heat flux, (e) net heat flux, (f) outgoing longwave radiation at the top of the atmosphere and (d) total cloud cover for the period 1980-2017. Black dots indicate the regions where correlation coefficients are statistically significant at 95% confidence level.

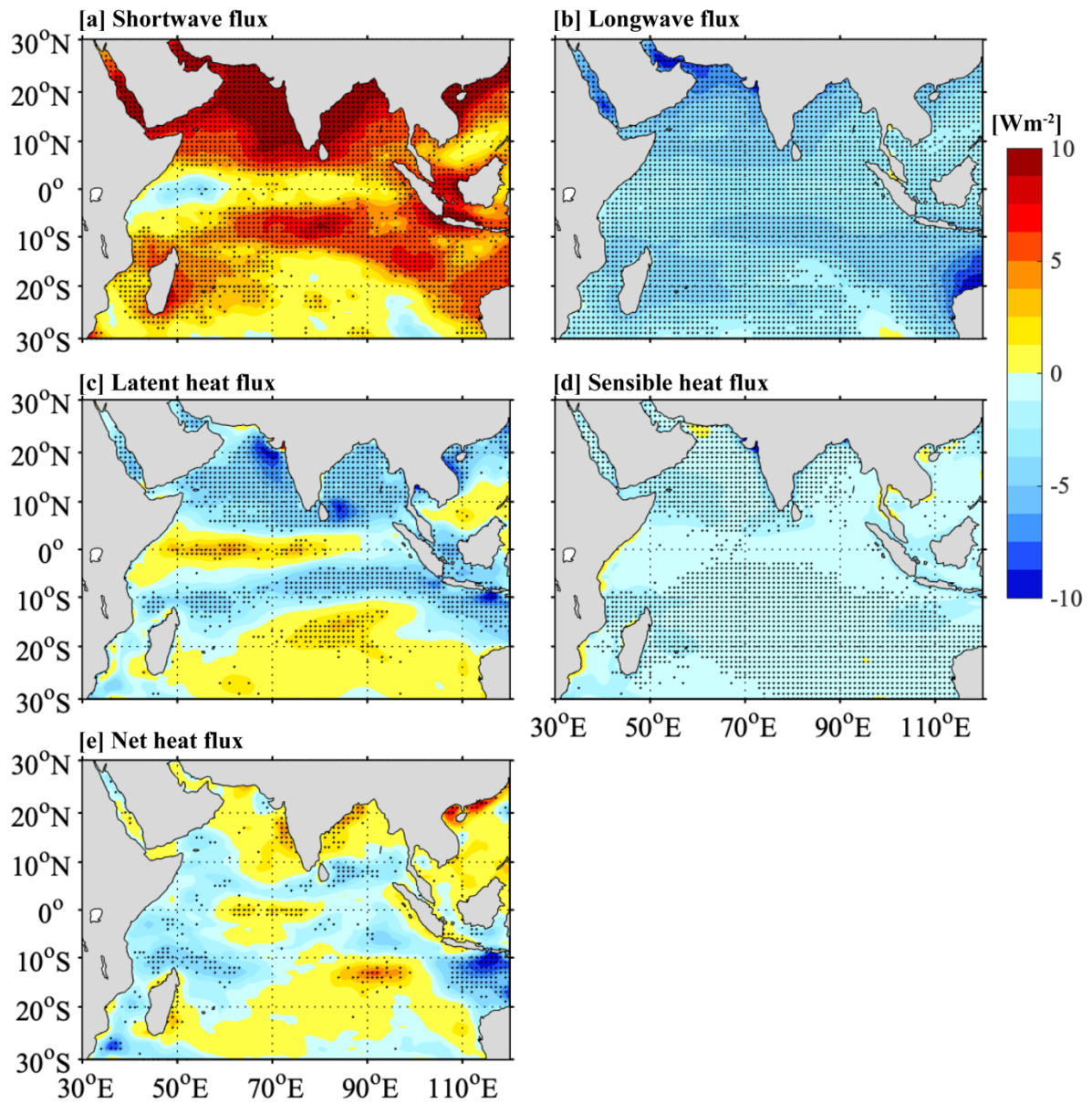


**Figure S9.** (a) Mixed layer climatology and trend for the period 1980-2017.



**Figure S10.** Pointwise correlation pattern of mixed layer temperature tendency anomalies with sum of heat budget terms in (a) reanalysis and (e) CESM2 historical simulation. Stipplings denote the statistically significant correlation values at 95% confidence level.





**Figure S11.** Long-term trend of surface heat flux components in CESM2 historical simulation for the period 1900-2014. (a) Shortwave flux, (b) longwave flux, (c) latent heat flux, (d) sensible heat flux, and (e) net heat flux trends for 115 years. The sign convention for fluxes is that the upward flux is positive. Stipplings indicate the trends are statistically significant at 95% confidence level.