Supplementary Materials: Indices of Pacific Walker Circulation strength

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References

1. Clarke, A.J.; Lebedev, A. Long-Term Changes in the Equatorial Pacific Trade Winds. *Journal of Climate* **1996**, *9*, 1020–1029.
2. Wright, D.G.; Thompson, K.R. Time-Averaged Forms of the Nonlinear Stress Law. *Journal of Physical Oceanography* **1983**, *13*, 341 – 345. https://doi.org/10.1175/1520-0485(1983)013<0341:TAFOTN>2.0.CO;2.

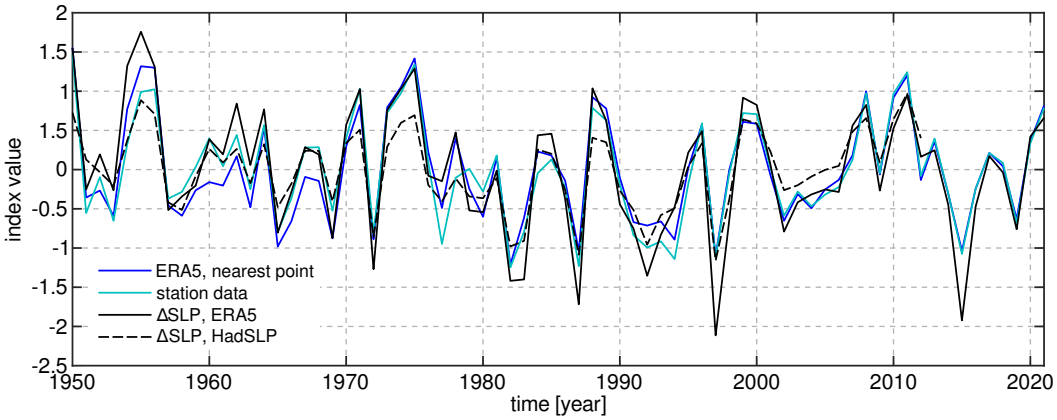

Figure S1. Time series of annual-mean Troup SOI (divided by 10), computed from ERA5 reanalysis using nearest gridpoints to Tahiti and Darwin stations, and NCAR Climate Data Guide station data time series. ΔSLP indices computed from ERA5 and HadSLP2com data are added for comparison. Nearest point method produces almost identical values as bilinear interpolation of surface pressure data to station locations (not shown). The difference decreases significantly in the recent period, most likely due to the steady improvement of reanalysis accuracy when more observations are assimilated. Note that ΔSLP from HadSLP2 is computed for 1950-2008 period.

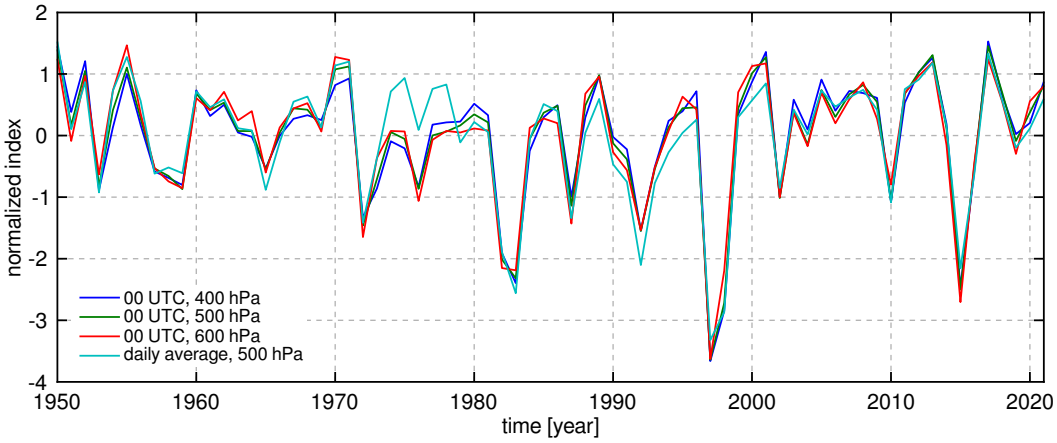

Figure S2. Time series of ω-indices of Pacific Walker circulation strength in ERA5 reanalysis between 1950 and 2021. Different ω-indices, computed from hourly data at 00 UTC or daily mean data at different pressure levels (400, 500, 600 hPa) are compared. Time series are normalized by their standard deviation. The indices are largely insensitive to the vertical level or to the data used (daily-mean data or 00 UTC) with their correlations higher than 0.95 for any pair of presented indices.

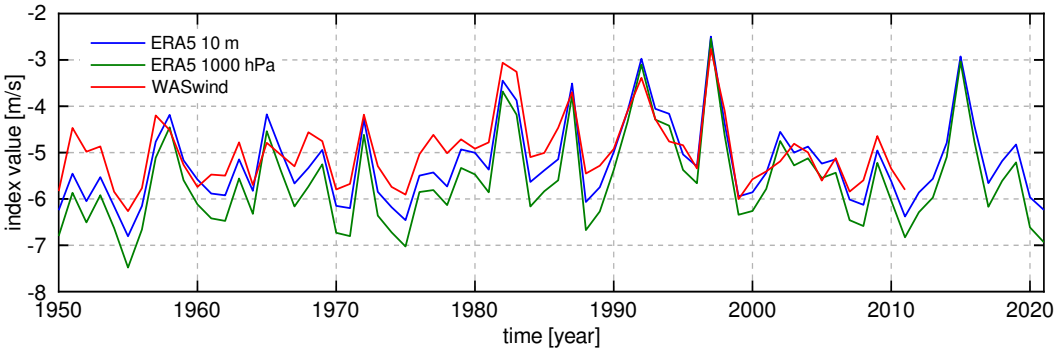

Figure S3. Time series of annual-mean U_{ave} index from ERA5 (at 10 m and at 1000 hPa) and from raw WASwind data.

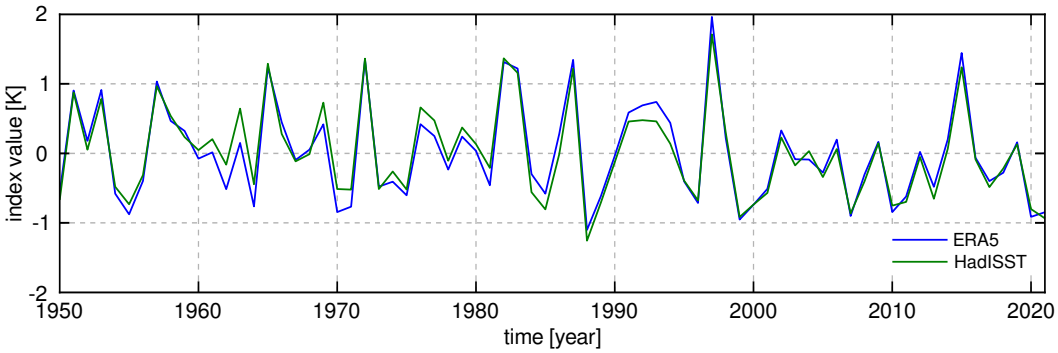

Figure S4. Time series of annual-mean SST index from ERA5 and from raw HadISST data.

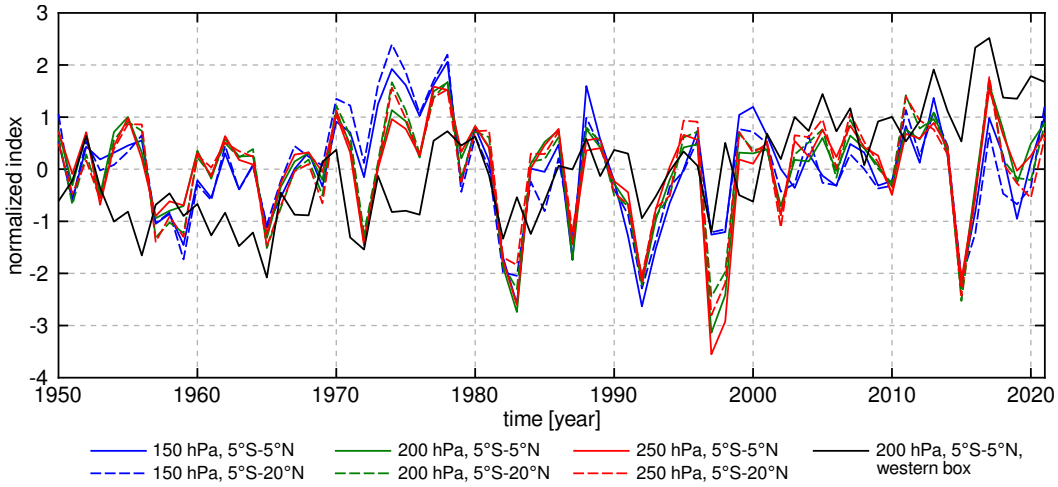

Figure S5. Time series of normalized annual mean values of Q index, calculated at different pressure levels, averaged over areas with different meridional extent. The index is largely insensitive to the change of meridional extent ($r > 0.94$ for any pair of indices). The same applies in the case of change in vertical level from 200 to 250 hPa ($r > 0.98$), whereas differences are larger in the case of change to 150 hPa ($r = 0.8$). Black line represent Q index computed from the western Pacific box only, without subtraction of values from the eastern Pacific box. The index does not distinguish circulation signal from the climate-change induced thermodynamic signal.

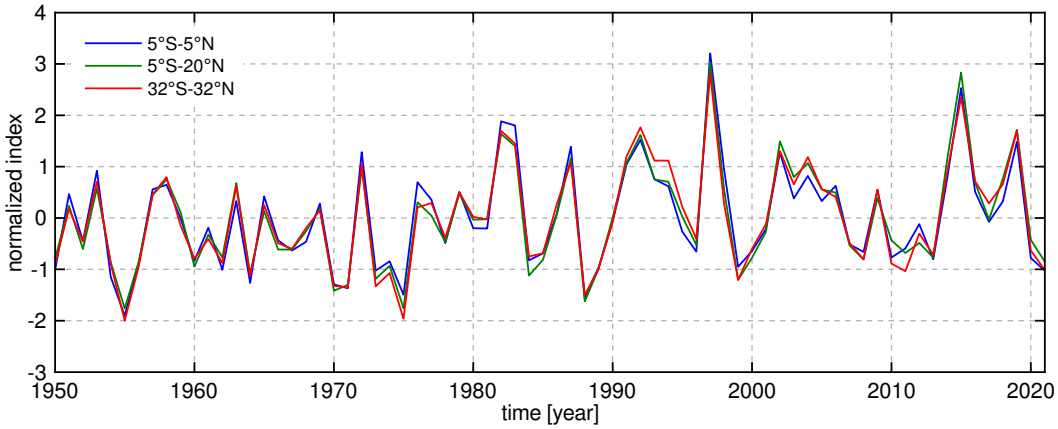

Figure S6. Time series of normalized annual means of V_e index computed for different meridional extent of horizontal areas: narrow tropical belt (5°S to 5°N) as in the main text; belt around ITCZ (5°S to 20°N), whole tropical belt (32°S to 32°N). Normalized V_e index show little sensitivity to change in meridional extent of area for computation of the index ($r > 0.97$).

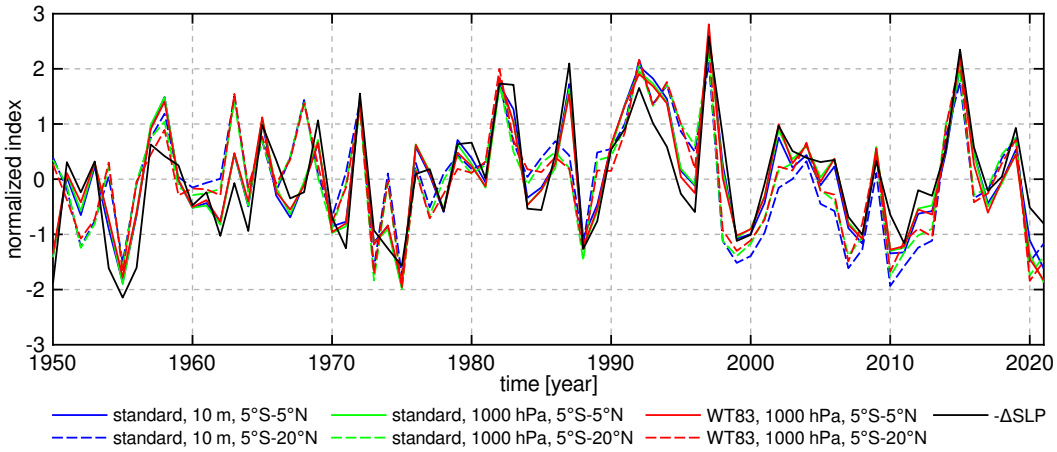

Figure S7. Time series of normalized annual mean values of L_τ index, computed from "standard" formula [1] at 10 m and 1000 hPa, and following Wright and Thompson [2] at 1000 hPa. For comparison, ΔSLP index multiplied by (-1) is added to the plot. Wind stress index is more sensitive to the change in meridional extent of horizontal area used for calculation of index than to the change in calculation of τ_x

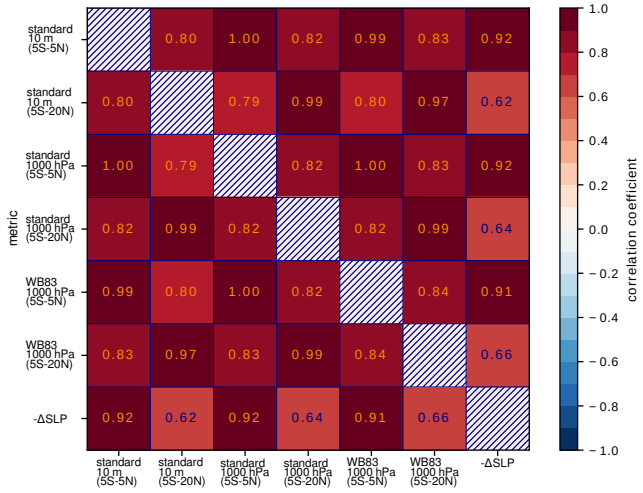

Figure S8. Correlation coefficients between different variations of L_τ index, and between different variations of L_τ index and ΔSLP index. High correlations with ΔSLP confirm the findings of Clarke and Lebedev [1] that the wind-stress index and surface pressure index may be used interchangeably when studying multidecadal variability.

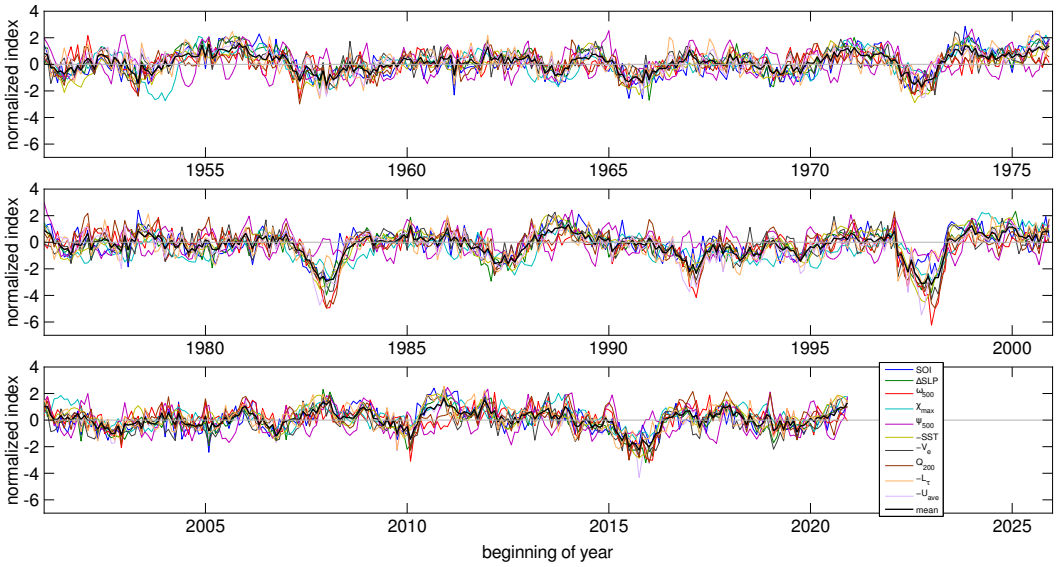

Figure S9. Time series of normalized indices and their mean. Monthly data.