Supplement for

Responses of the Hadley Circulation to regional sea surface temperature changes

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Introduction

The text in this Supporting Information discusses the mechanism of how HC width is affected by SST warming patterns.

Figure S1-3 show differences between conjugate experiments in illustrative subtropical patches in DJF.

Figures S4-7 show the sensitivity of seasonal HC to regional warmings in each grid.

Figure S8 show the HC changes in AMIP and AMIPFF simulations.

Figures S9-11 show the seasonal HC changes in AMIPFF simulations and that reconstructed by the Green’s function approach.
Figure S1. Differences between conjugate experiments in an illustrative subtropical patch in DJF. (a) Surface temperature. (b) Vertical velocity at 500hPa. (c) Diabatic heating rate. (d) Zonal mean temperature. (e) Meridional air temperature at 850 hPa. The red and blue lines are for warm patch experiment and cooling patch experiment, respectively. (f) Zonal mean zonal wind. (g) Zonal mean meridional wind. (h) Meridional wind at the edge of NH HC (31N) as a function of longitude and pressure. (i) MMS. The shadings denote differences between conjugate experiments, and contours denote climatological values. Solid black lines denote positive and zero contours, and dashed black lines denote negative contours.
Figure S2. Same as Fig. S1, except for an illustrative patch in the tropical Pacific Ocean.
Figure S3. Same as Fig. S1, except for an illustrative patch in the tropical Indian Ocean.
Figure S4. Response of MAM HC width and strength to warming in each grid box, calculated using equation (2). The unit for (a-b) is degree latitude/K, and the unit for (c-d) is kg/s/K.
Figure S5. Same as Fig. S2, except for JJA.
Figure S6. Same as Fig. S2, except for SON.
Figure S7. Same as Fig. S2, except for DJF.
Figure S8. Variations of annual HC width and strength in AMIP and AMIPFF simulations. The thin lines denote values from individual runs, and thick lines denote ensemble mean values. The HC width and strength in AMIP and AMIPFF simulations are generally consistent with each other, indicating that the interannual variations of HC is primarily driven by SST.
Figure S9. Same as Fig. 9 in the main text, except for MAM (March, April and May). The Green’s function approach is not doing a well job in reconstructing the NH HC variations during MAM. The NH HC location variations in MAM is correlated with that in DJF ($r=0.8$), indicating that the NH HC in MAM might be largely affected by the DJF SST, but the Green’s function reconstruct HC changes uses SST in MAM only, so the delayed SST effects might partially explain the inconsistency between Green’s function reconstructed and actual poleward shift of NH HC edge.
Figure S10. Same as Fig. 9 in the main text, except for JJA (June, July and August). The NH HC in JJA is affected by subtropical waves significantly, so the NH HC time series in individual runs are not well correlated with each other. As a result, the signal-to-noise ratio of NH HC in JJA is much smaller than that in DJF, so the NH HC reconstructed by the Green’s function approach is not well correlated with the model simulated values.
Figure S11. Same as Fig. 9 in the main text, except for SON (September, October, and November).