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Supplement of

Process-based evaluation of ENSO simulation sensitivity to horizontal resolution in the Chinese Academy of Sciences FGOALS-f3 Climate System Model

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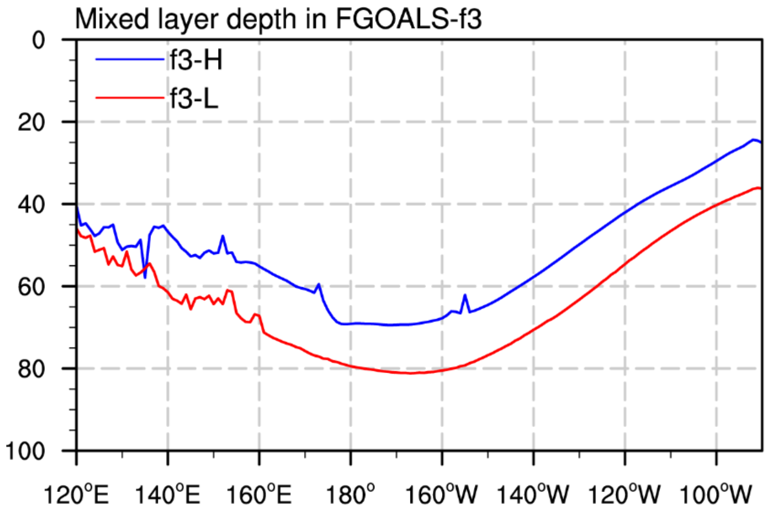

Figure S1. The longitudinally varying climatological mixed layer depth (unit: m) averaged over the equatorial Pacific (5°S–5°N) in f3-L (red line) and f3-H (blue line).

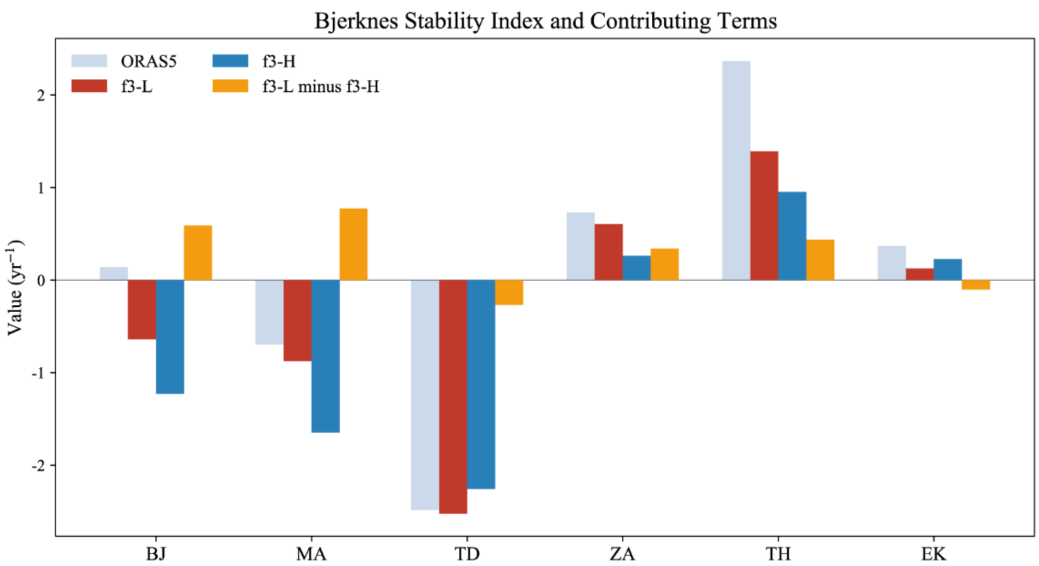

Figure S2. BJ index and the corresponding main contributing terms for the reanalysis (grey bars; ORAS-5), f3-L (red bars), f3-H (blue bars) and their difference (f3-L minus f3-H, orange bars). The BJ index is calculated using longitude-varying MLD (shown in Fig. S1). The five contributing terms include dynamic damping by mean advection (MA), thermodynamic damping feedback (TD), zonal advection feedback (ZA), thermocline feedback (TH) and Ekman feedback (EK).

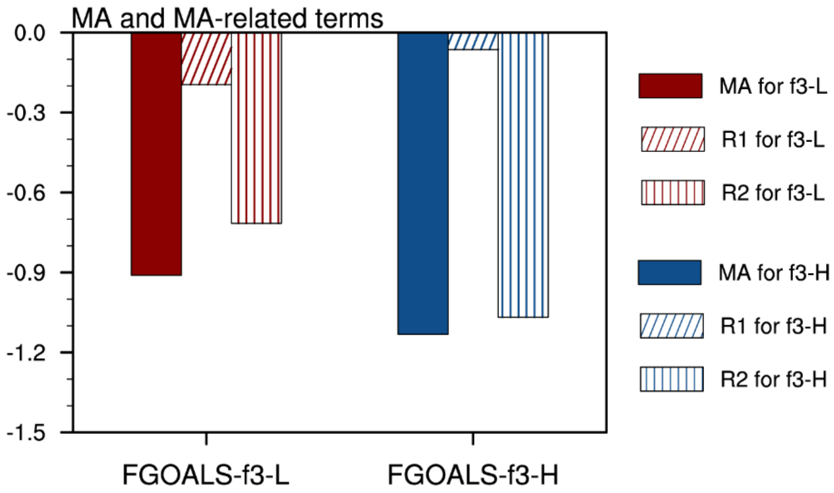

Figure S3. The MA term and its two components: dynamic damping by mean zonal current (R1 = $-a_1\frac{\langle\Delta\bar{u}\rangle_E}{L_x}$) and dynamic damping by mean meridional current (R2 = $-a_2\frac{\langle\Delta\bar{v}\rangle_E}{L_y}$), for f3-L (red) and f3-H (blue).

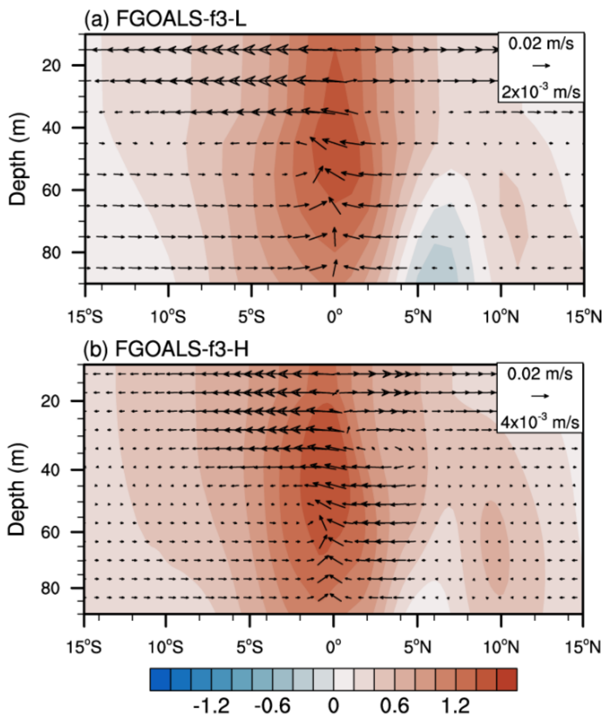

Figure S4. Oceanic mean currents (vectors, units: m s^{-1}) and ENSO-related ocean temperature anomalies (contours, units: °C) averaged over 150°W–90°W for (a) f3-L and (b) f3-H. Here the ENSO-related ocean temperature anomalies are obtained by regressing the ocean temperature anomaly field onto the Niño3.4 index.

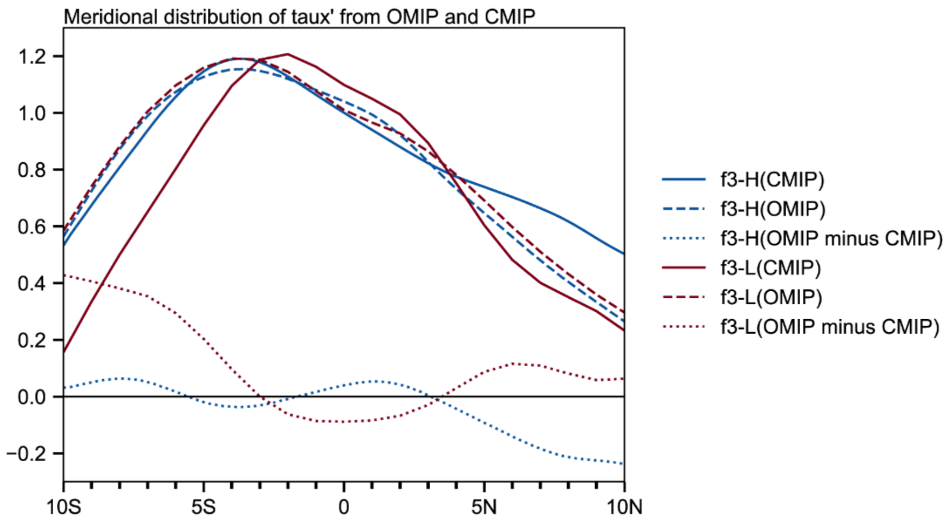

Figure S5. Meridional structure of normalized zonal wind stress anomalies [units: N m^{-2} (N m^{-2})$^{-1}$] averaged over 160°E–150°W for f3-L in CMIP (red solid line), f3-L in OMIP (red dashed line), and their difference (red dotted line, OMIP minus CMIP); f3-H in CMIP (blue solid line), f3-H in OMIP (blue dashed line), and their difference (blue dotted line, OMIP minus CMIP). The normalized zonal wind stress anomalies are obtained by regressing the zonal wind stress anomaly field onto the Niño4 region (5°S–5°N, 160°E–150°W) averaged zonal wind stress anomalies and then averaged over the Nino4 longitude range (160°E–150°W).

Section S1. Interpretation of the MA difference between f3-H and f3-L (results from the Longitude-varying MLD strategy)

Under Strategy 2, the MA term exhibits a considerably larger difference between f3-L and f3-H than under Strategy 1. To understand this, we further decomposed the MA term into its two components: the damping by mean zonal current (R1 = $-a_1 \frac{\langle \Delta \bar{u} \rangle_E}{L_x}$) and the damping by mean meridional current (R2 = $-a_2 \frac{\langle \Delta \bar{v} \rangle_E}{L_y}$). As shown in Figure S3, the MA term difference primarily arises from the meridional component (R2).

This meridional damping component is closely related to the mean subtropical cell (STC) circulation in the central-eastern equatorial Pacific. Figure S4 shows the latitude–depth distribution of the mean ocean currents and ENSO-related ocean temperature anomalies averaged over 150°W–90°W. The ENSO-related temperature anomalies are centered at the equator from the surface down to approximately 100 m, and are advected poleward by the mean meridional currents, constituting a dynamical damping effect. In both models, the mean meridional flow associated with the STC is directed poleward above approximately 40 m but equatorward below 40 m. Consequently, the advection of temperature anomalies by the mean meridional current reverses sign at approximately 40 m, so that the contributions from the upper and lower portions partially cancel each other. When a constant MLD of 65 m is used for vertical averaging, this cancellation occurs similarly in both models, yielding comparable MA terms. However, under the longitude-varying MLD strategy, the shallower MLD in f3-H means that the vertical averaging captures a thinner layer in which the poleward (damping) branch dominates, resulting in a more negative MA term in f3-H compared to f3-L. This MLD sensitivity of the MA term partially explains why the BJ index in f3-H becomes even more negative under Strategy 2.