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Suppressed migrating diurnal tides in the mesosphere and lower thermosphere region during El Niño in northern winter and its possible mechanism

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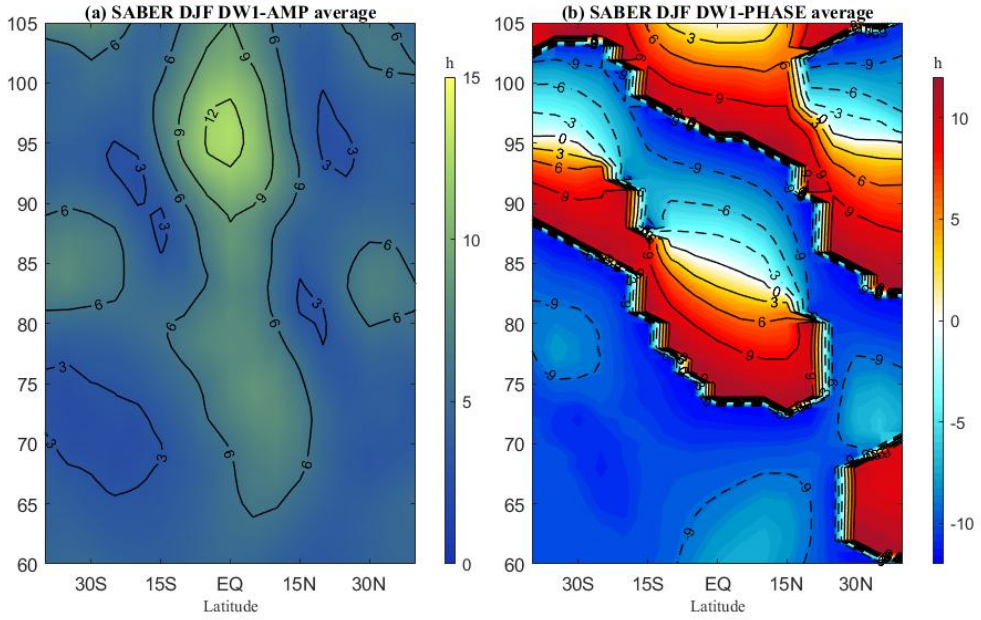

Figure S1. (a) The average DW1 temperature amplitude of SABER observation during 2002-2020 winter (DJF, Dec-Jan-Feb). (b) the same as (a), but for phase.

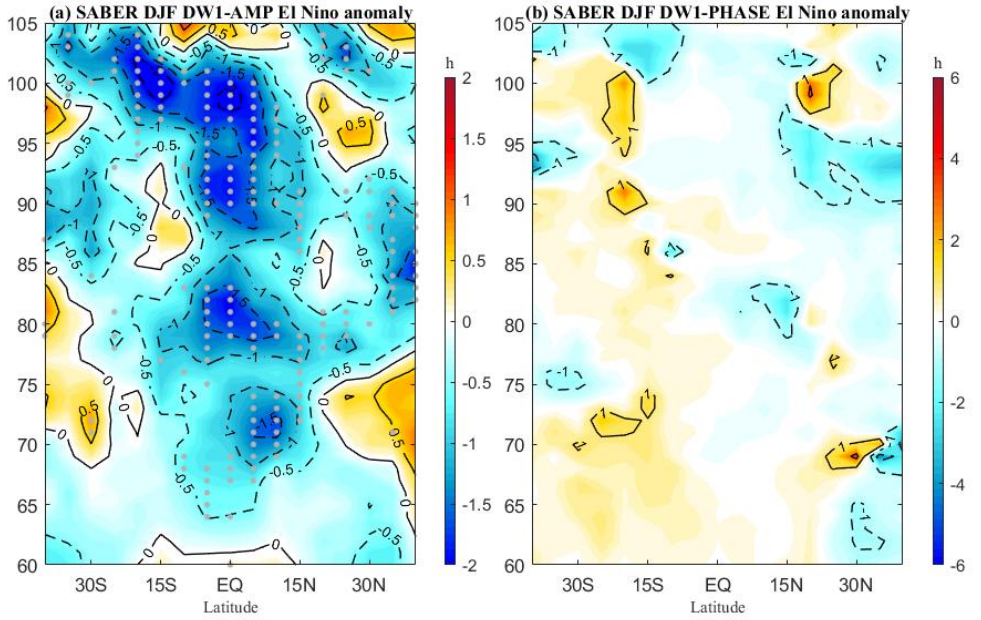

Figure S2. Dec-Jan-Feb mean of the SABER DW1-T (a) amplitude and (b) phase anomaly during El Niño years. Stippling indicates statistical significance at the 95% level using Student's T test.

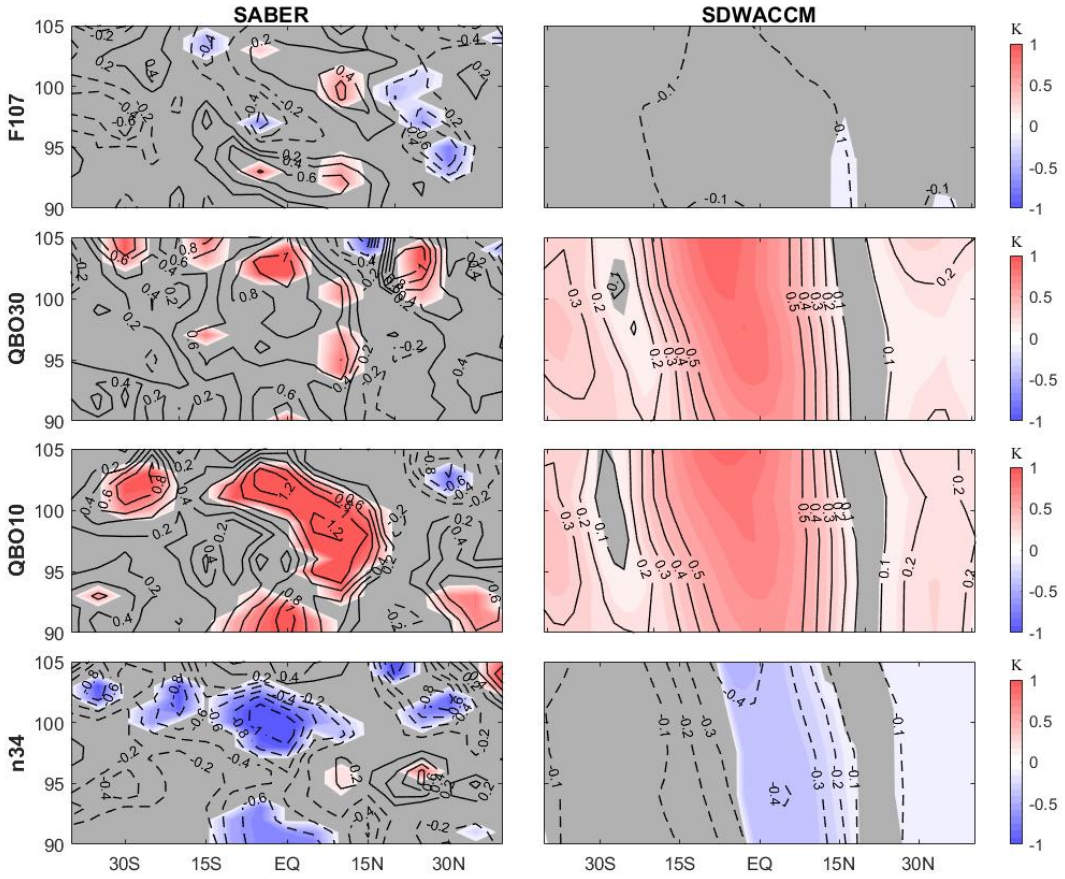

Figure S3. The DJF linear regression coefficient of DW1 responses F107, QBO10, QBO30, NIÑO 3.4 in SABER (the left column) and SD-WACCM (the right column). Red represents positive response and blue represents negative; the gray regions denote confidence levels below 95% for F-test.

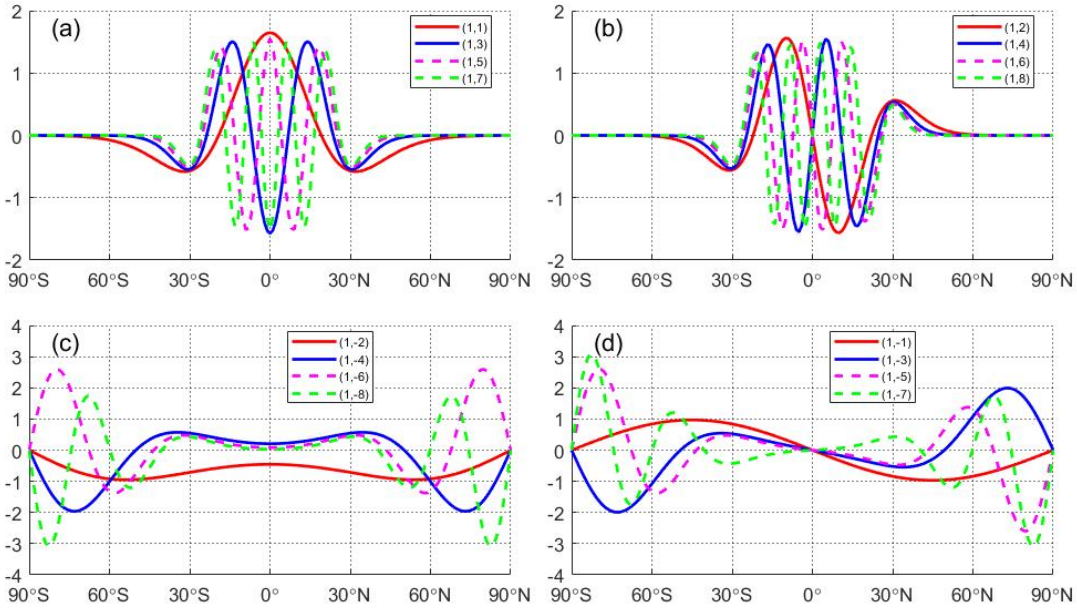

Figure S4. The latitudinal structure of 16 sets of normalized Hough functions for diurnal tides. Figures a and b are Propagating modes, and Figures c and d are trapped modes. Figures a and c are symmetric modes, and Figures b and d are antisymmetric modes.

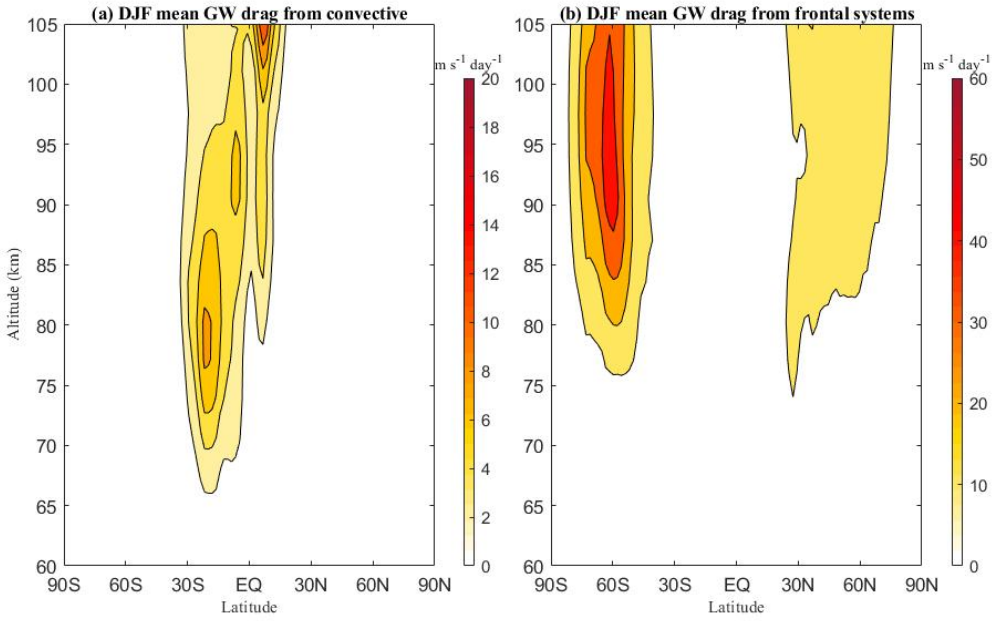

Figure S5. The zonal mean GW drag average in winter due to convective (a) and the frontal systems (b) in SDWACCM.

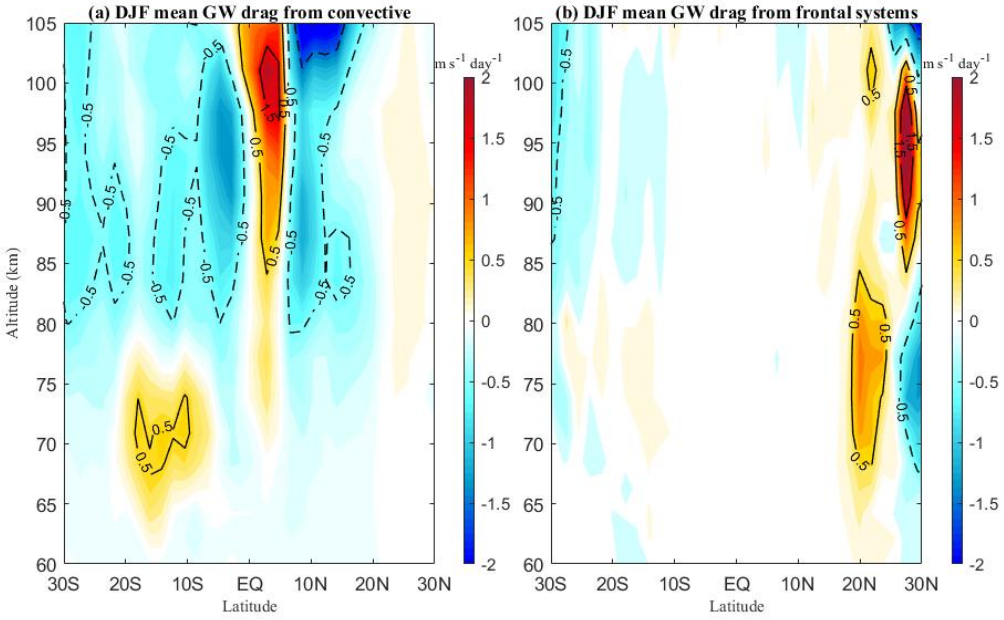

Figure S6. The zonal mean GW drag anomaly during El Nino winter due to convective (a) and the frontal systems (b) in SDWACCM.

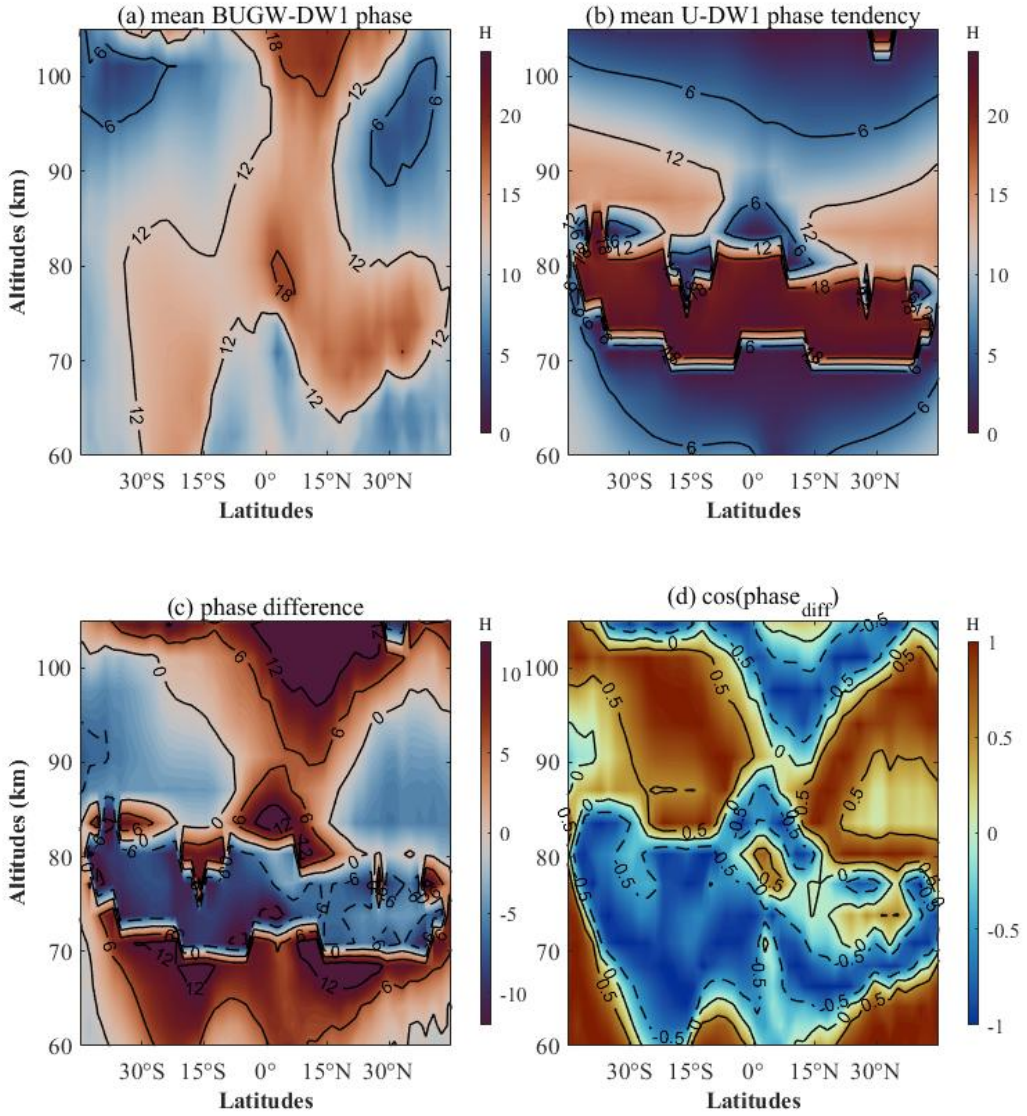

Figure S7. (a) Mean Gravity Wave (GW) drag due to convection on the phase of DW1 tidal U during the winter (DJF). (b) The mean time tendency of the zonal wind DW1 tidal phase during the winter (DJF). (c) The phase difference between (a) and (b). (d) cos value of phase difference.

Table S1. Comparison of vertical wavelengths at different heights in climatological mean winters and El Nino winters.

Saber height	88-92 km	93-97 km	98-102 km
Climatological mean vertical wavelength (km)	20.8	25.2	20.2
El Nino year vertical wavelength (km)	18.5	26.6	18.2