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Momentum flux of convective gravity waves derived from an off-line gravity wave parameterization: Spatiotemporal variations at source level

Min-Jee Kang (1), Hye-Yeong Chun (1), and Young-Ha Kim (2)

(1) Department of Atmospheric Sciences, Yonsei University, South Korea, (2) Department of Atmospheric Science and Engineering, Ewha Womans University, South Korea

Spatiotemporal variations in momentum flux spectra of convective gravity waves (CGWs) at the source level (cloud top), including nonlinear forcing effects, are examined using an off-line version of CGW parameterization and global reanalysis data. We used 1-hourly NCEP Climate Forecast System Reanalysis (CFSR) forecast data for a period of 32 years (1979-2010), with a horizontal resolution of 1° x1°. The cloud-top momentum flux (CTMF) is not solely proportional to the convective heating rate but is affected by the wave-filtering and resonance factor (WFRF), background stability and temperature underlying the convection. Consequently, the primary peak of CTMF is in the winter hemisphere midlatitude in association with storm-track region where secondary peak of convective heating exists, whereas the secondary peak of CTMF appears in the summer hemisphere tropics and intertropical convergence zone (ITCZ), where primary peak of convective heating exists. The magnitude of CTMF fluctuates largely with 1 year and 1 day periods, commonly in major CTMF regions. At low latitudes and Pacific storm track region, a 6-month period is also significant, and the decadal cycle appears in the Asian summer monsoon region and the Andes Mountains. The equatorial eastern Pacific region exhibits substantial inter-annual to decadal scale of variability with decreasing trend that is described as statistically significant. Interestingly, the correlation between convective heating and the CTMF is relatively lower in the equatorial region than in other regions. The CTMF spectra in the large-CTMF regions reveal that the spectrum shape and width changes with season and location, along with anisotropic shape of the CTMF spectrum, caused by changes in wind speed at the cloud top and the moving speed of convection. The CTMF in the 10°N to 10°S during the period of February to May 2010, when the PreConcordiasi campaign held, approximately follows a lognormal distribution but with a slight underestimation in the tail of the probability density function.