Momentum flux of convective gravity waves derived from an offline gravity wave parameterization: Impacts on the large-scale flow including the QBO

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The characteristics of small-scale convective gravity waves (CGWs) (horizontal wavelengths<100 km) and their contributions to the large-scale flow in the stratosphere, including the quasi-biennial oscillation (QBO), are investigated using an offline calculation of a source-dependent, physically-based CGW parameterization by Kang et al. (2017) with global reanalysis data from 1979 to 2010. The CGW momentum flux (CGWMF) and CGW drag (CGWD) are calculated from the cloud top (source level) to the upper stratosphere using a Lindzen-type wave propagation scheme, and the magnitude of the CGWMF is constrained by GW observation by super-pressure balloons in the tropical region. The CGWMF has two peaks in the stratosphere: one in the summer hemisphere tropics and another at mid-latitude regions in the winter hemisphere. The CGWD is the most prominent in the upper stratosphere in tropical regions and at mid-latitude regions in the wintertime in both January and July. The CGWD in the tropical upper stratosphere may contribute to the driving of the SAO with a magnitude of 0.5-1 m s^{-1} day^{-1} above ~40 km. The stratospheric jet (~60°) in the winter hemisphere is decelerated by the CGWD, but it is accelerated at the equatorward flank of the jet. In the tropics, the momentum forcing by CGWs at 30 hPa associated with the QBO in the westerly shear zone is 3.5-6 m s^{-1} $month^{-1}$, which is smaller than that by Kelvin waves, while that by CGWs in the easterly shear zone (3.1-6 m s^{-1} $month^{-1}$) is greater than that by any other equatorial planetary waves or inertio-GWs. Composite analyses of the easterly (EQBO) and westerly QBO (WQBO) phases reveal that the zonal CGWMF is concentrated near 10°N and that the negative (positive) CGWD extends latitudinally to ±20° (±10°) at 30 hPa. The strongest (weakest) negative CGWD is in March-April-May (September-October-November) during the EQBO, and the strongest (weakest) positive CGWD is in June-July-August (March-April-May) during the WQBO. The CGWMF and CGWD are generally stronger during El Niño than during La Niña in the equatorial region, and this is caused by not only a larger magnitude of the zonal CGWMF but also a strong wind shear during El Niño.

Key words: convective gravity waves, stratospheric circulation, quasi-biennial oscillation, parameterization

References

Kang, M.-J., H.-Y. Chun, and Y.-H. Kim, 2017: Momentum flux of convective gravity waves derived from an offline gravity wave parameterization. Part I: Spatiotemporal variations at source level. *J. Atmos. Sci.,* **74,** 3167–3189.