Vertical momentum transports associated with moist convection and gravity waves in a minimal model of QBO-like oscillation

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The internal oscillation dynamically analogous to the equatorial quasi-biennial oscillation (QBO) is obtained as a radiative-convective quasi-equilibrium state in a highly-idealized two-dimensional regional model with explicit moist convections under a periodic lateral boundary condition without Coriolis effects. The obtained oscillation has a clear signal both in the stratosphere and troposphere, including the modulation of precipitation patterns. In this study, the momentum budget of the QBO-like oscillation is examined by taking account of these organized motions.

The momentum flux is objectively separated into three contributions that involve convective momentum transport (CMT) and momentum transports by upward and downward-propagating gravity waves (upward and downward GWMTs). The separation method is based on linear theory of group velocity to separate upward and non-upward-propagating contributions, and used the spectra of the total cloud (ice plus cloud water) mixing ratio to identify the CMT contribution. The upward GWMT occurs in both the troposphere and stratosphere, and dissipates near critical levels located in the shear zones there. The CMT and downward GWMT are confined to the troposphere, and the spectral features of them are changed in accordance with the precipitation patterns. The most important factor to accelerate the zonal mean zonal wind is the convergence of upward GWMT in the stratosphere, and that of CMT in the troposphere. The method introduced here is useful to qualitatively evaluate the space–time variations of each contribution. The results also show the importance of the dynamical coupling between the stratosphere and troposphere through the modulation of precipitation patterns associated with the oscillation of the zonal mean zonal wind.

Key words: middle atmosphere, stratosphere-troposphere coupled system, gravity wave, wave-mean flow interaction