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A Numerical Study on Gravity Waves Generated by Typhoon Rusa

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Momentum transport by convective gravity waves plays an important role in the middle atmospheric large-scale circulation. Among various convective sources, typhoon is most well-organized and vigorous convective system. In this study, we simulate Typhoon Rusa, which passed through the Korean peninsula in 2002, using a three-dimensional mesoscale model (MM5), and examine the characteristics of gravity waves generated by convection associated with typhoon. Wave propagation mechanism is also examined by comparing the convective source with induced gravity wave spectra. Simulation is conducted with 27 km horizontal grid spacing and 71 vertical levels from surface to 10 hPa. We found that convection in the cloud bands generated by typhoon is the major source of gravity waves. In the stratosphere, waves with large amplitude appear in the northwestern part of typhoon and propagate northwestward according to the convective bands propagating in same direction, although typhoon itself moves north-northeastward. In the southeastern region, large amplitude of waves with small horizontal scales appears due to small-scale convective cells within the southeastern branch of cloud bands. In the two regions, vertical wind and potential temperature perturbations show a nearly 90-degree phase difference. For spectral analysis, we extract the gravity waves components from variables that satisfy the vertical propagation condition of inertio-gravity waves (IGWs). The IGWs in the stratosphere generated by Rusa have a dominant horizontal wavelength of 300-600 km, a period of 6-11 hrs, and a vertical wavelength of 3-11 km. Power spectrum of vertical velocity in the troposphere shows a Gaussian-type forcing spectrum with a spectral peak at zero phase speed. However, induced gravity wave spectrum in the stratosphere is asymmetric, because a large fraction of IGWs is filtered out in the upper troposphere and stratosphere mainly due to critical level filtering process. In the non-filtered region, decreasing of wave momentum flux with height is likely due to the damping process, and wave breaking that can occur exclusively near the critical-level phase speeds.