Characteristics of Gravity Waves Revealed in an Idealized Baroclinic Wave Simulation

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An idealized baroclinic instability case of Jablonowski and Williamson (2006) is simulated to investigate gravity waves generated in the jet-front system. The simulation is conducted using the global Weather Research and Forecasting (WRF) model with a horizontal resolution of ~0.09°, initialized with a small disturbance of zonal wavenumber 9. In the simulation, the baroclinic wave develops with a large amplitude in the lower troposphere. In the mature stage of the baroclinic wave, mesoscale gravity waves begin to appear east and west of the trough. These gravity waves (G1) are identified by three wave packets in the upper troposphere propagating eastward, southeastward, and northeastward, which are advected by the background westerly jet. They have horizontal wavelengths of 50–600 km at 8 km, with a pick of about 110 km, and have phase speeds ranging from 10 to 23 m s^{-1}. In the breaking stage of the baroclinic wave, the surface front in the southern part of the wave is occluded and a secondary cyclone is developed near the frontal region. Mesoscale gravity waves distinct from G1 appear (G2) above this secondary cyclone, which are quasi-stationary with a peak wavelength of about 360 km at 8 km. For both G1 and G2, the zonal momentum flux is negative, implying that upward-propagating mode is dominant. In the lower stratosphere, the magnitude of G1 decreases significantly due to filtering by the background westerly jet, whereas the quasi-stationary G2 propagates into the stratosphere with a substantial amplitude. The distribution of the residual of nonlinear balance equation suggests that both G1 and G2 are generated in the lower troposphere below around 3 km.

Key words: gravity wave, spontaneous imbalance, baroclinic instability, jet-front system

References

Jablonowski, C., and D. L. Williamson, 2006: *Q. J. R. Meteorol. Soc.*, **132**, 2943-2975.