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Mesoscale Gravity Waves in the Mei-yu Front System

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High-resolution cloud-permitting simulations with the Weather Research and Forecast model (WRF) are performed to study the generation, structure and characteristics of mesoscale gravity waves in an idealized Mei-yu front system. Two classes of waves are generated successively during the control simulation. The first class of waves, which is typical of vertically propagating waves excited by the front itself, appears as the front develops before the generation of the prefrontal moist convection and has a coherent fan-like pattern from the troposphere to the lower stratosphere. The second class of waves, which is much stronger than the fan-like waves, appears accompanied by the generation of the moist convection. It is nearly vertically trapped in the troposphere, while propagates vertically upstream and downstream in the lower stratosphere. The source function analysis is introduced to demonstrate that the mechanical oscillator mechanism plays a dominant role in the generation of convective gravity waves in the lower stratosphere. The vertical motion induced by the deep convection develops upward in the troposphere, overshoots the LNB, and impinges on the tropopause. The net buoyancy forces the air parcels to oscillate about the LNB, thus initiating gravity waves in the lower stratosphere. Further spectral analysis shows that the upstream waves have more abundant wavenumber-frequency and phase speed space distributions than the downstream waves. And the former amplify with height while the latter weaken in general under the effect of background northerly wind. The power spectral densities of downstream waves concentrate on faster phase speed than those of upstream wave.