Simulation of generation of stratospheric gravity waves in upper-tropospheric jet stream accompanied with a cold vortex over Northeast China

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Abstract: The stratospheric gravity waves (GWs) activity accompanying an upper-tropospheric jet stream is simulated by using a meso-scale weather forecast model, i.e., the WRF-ARW. The simulation is conducted with a Northeast Cold Vortex, i.e., a cut-off low weather system, which develops over northeastern China in June, 2010. The simulation reproduces the key features of the development of the cold vortex, as well as the upper tropospheric jet stream evolving at around 9 km height. The results further reveal that pronounced stratospheric GWs are generated by the jet stream as they emerge from the exit region of jet stream. These GWs exhibit 2-D structure, and propagate preferentially in the upstream of the background winds which is just over the jet stream. Spatio-temporal spectral investigation results show that the predominant waves exhibit horizontal wavelength of ~700 km, period of 9-12 hrs, and vertical wavelength of 4-5 km. The presence of the jet stream results in strong vertical shear in background flow in the lower and middle stratospheric range over the jet stream. The shear further results in wave dissipation as the momentum flux of the GWs declines with height. Inhibition of GW propagation is disclosed by the great attenuation of GW momentum flux at around 18-20 km where the transition of easterlies and westerlies happens. It is anticipated that the upward propagating GWs may approach their critical level in the region thus deposit all their momentum fluxes there. Consequently, the bulk GWs drag on the mean flow in 11-20 km height range is estimated of around 0.86 m/s/day.

Key words: stratospheric gravity waves, upper-tropospheric jet stream, geostrophic adjustment, cold vortex over Northeast China