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Directional Absorption of Parameterized Mountain Waves and Its Influence on the Wave Momentum Transport in the Northern Hemisphere

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The directional absorption of mountain waves in the Northern Hemisphere is assessed by examination of horizontal wind rotation using the 2.5°×2.5° European Centre for Medium-Range Weather Forecasts ERA-Interim reanalysis between 2011-2016. In the deep layer of troposphere and stratosphere, the horizontal wind rotates by more than 120 degrees all over the Northern Hemisphere primary mountainous areas, with the rotation mainly occurred in the troposphere (stratosphere) of lower (middle to high) latitudes. The rotation of tropospheric wind increases markedly in summer over the Tibetan Plateau and Iranian Plateau, due to the influence of Asian summer monsoonal circulation. The influence of directional absorption of mountain waves on the mountain wave momentum transport is also studied using a new parameterization scheme of orographic gravity wave drag (OGWD) which accounts for the effect of directional wind shear. Owing to the directional absorption, the wave momentum flux is attenuated by more than 50% in the troposphere of lower latitudes, producing considerable orographic gravity wave lift (OGWL) which is normal to the mean wind. Compared with the OGWD produced in traditional schemes assuming a unidirectional wind profile, the OGWD in the new scheme is suppressed in the lower stratosphere but enhanced in the upper stratosphere and lower mesosphere. This is because the directional absorption of mountain waves in the troposphere reduces the wave amplitude in the stratosphere. Consequently, mountain waves are prone to break at higher altitudes, which favors the production of stronger OGWD given the decrease of air density with height.