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Contribution of gravity waves to the universal vertical wavenumber (m^{-3}) spectra revealed by a gravity-wave permitting general circulation model

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Observations with high vertical resolution have shown that vertical wavenumber (m) power spectra of horizontal wind and temperature fluctuations have a universal shape with a steep slope that is roughly proportional to ~m^{-3}. Several theoretical models explaining the universal spectra were proposed based on the assumption of gravity wave (GW) saturation. However, it has not yet been sufficiently confirmed that such characteristic spectra are fully composed of GWs. Thus, in the present study, we examine whether the m^{-3} spectra are due to GWs, using a GW-permitting general circulation model with a high top in the lower thermosphere. The model-simulated spectra have steep spectral slopes, which is consistent with observations. GWs are extracted as fluctuations having total horizontal wavenumbers of 21–639. From the comparison between spectra of the GWs and those of all simulated fluctuations, it is shown that GWs are dominant only at high ms, while disturbances other than the GWs largely contribute to the spectra at low ms even in the m^{-3} range. In addition, we examine vertical and geographical distributions of the characteristic wavenumbers, slopes, and amplitudes of GW spectra. The slopes of GW spectra are particularly steep near the eastward and westward jets in the middle atmosphere. It is theoretically shown that strong vertical shear below the jets is responsible for the formation of steep GW spectral slopes.

Reference:

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