Statistical characterization of high-to-medium frequency gravity waves in vertical winds and temperatures in the MLT

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We present the first statistical study of the gravity waves with periods of 0.3-2.5 h in vertical winds and temperatures measured with the STAR Na Doppler lidar in Boulder, CO (40.1°N, 105.2°W). Due to the significant improvement of the receiver efficiency of the STAR lidar, the vertical winds can now be directly measured with high temporal and spatial resolutions, from which the most dominant wave signatures are those with periods of 0.3-2.5 h. We derive the probability density functions of wave amplitudes, amplitude ratios of temperature to vertical wind, phase differences between these two components, and vertical wavelengths of these GWs. The mean wave amplitudes in temperature and vertical wind are around 2.3 K and 0.7 m/s, with maximum values reaching ~7K and 2.4 m/s, respectively. There is a positive linear correlation between wave periods and the amplitudes ratios of temperature to vertical wind, i.e., longer-period waves tend to have larger amplitudes in temperature and smaller ones in vertical wind. The phase difference between temperature and vertical wind largely follows a Gaussian distribution centered at ~90º and with a standard deviation of 46º. Such a linear trend of the amplitude ratio versus period and the mean phase difference support the polarization relation of GWs without dissipation, while the standard deviations from the theoretical predictions may represent the dissipation effects. The intrinsic periods are also derived and found to be longer than the ground-based periods for about 30% waves, while those of the other 70% waves become smaller, which implies that the majority of waves propagate against the mean winds. The mean vertical wavelength is ~18 km with a standard deviation of ~7 km. The GWs studied in this paper likely fall into the mesoscale range horizontally, which can be resolved in the high-resolution GCMs. Therefore, the statistical characteristics of these high-to-medium frequency waves provide an invaluable observational validation for the fine-resolution GCMs and weather models.

Key words: high-to-medium frequency Gravity waves, dispersion and polarization relation, lidar, vertical wind and temperature

References (if needed)

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