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Radiosonde observations of mid-latitude planetary waves in the lower atmosphere over America and China

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Planetary waves (PWs) are important atmospheric oscillations with periods from several days to several dozens of days, and their zonal wavelengths range from several thousand to ten thousand kilometers with zonal wave numbers between 1 and 5 in general. Therefore, they are called planetary waves, as their horizontal sizes are as large as global radius. PWs are mainly excited in the troposphere by topography and by diabatic heating associated with land and sea thermal contrast. In certain conditions, PWs will propagate to the middle atmosphere and play an important role in regulating middle atmosphere circulation and constituent distribution, such as ozone. PWs are usually observed with different oscillation periods mainly around 2, 5, 10, and 16 days. Quasi 2-day wave is a Rossby-gravity wave with period about 2-4 days, whereas quasi 5-, 10-, and 16-day waves are all Rossby waves whose periods are 4.5-6.2, 7.5-12, and 11-20 days, respectively.

The characteristics of mid-latitude PWs in the troposphere and lower stratosphere (TLS) are studied by both statistical and case studies with the data from radiosonde observations at three middle latitude stations (Miramar Nas, 32.9˚N, 117.2˚W; Santa Teresa, 31.9˚N, 106.7˚W; Fort Worth, 32.8˚N, 97.3˚W) in America and Wuhan (30.5˚N, 114.4˚E) in China. It is found that mid-latitude PWs exist in two regions. One is in the troposphere, and the other is in the stratosphere. The PW activities are rather intermittent, and their lifetimes are not longer than two months. In the troposphere, among three perturbation components in zonal and meridional winds and temperature, the temperature disturbance amplitude is the smallest, and the amplitude for the zonal and meridional wind components are comparable. The amplitudes of the mid-latitude PWs reach maximum round the center of the subtropical jet stream in winter, which indicates the subtropical jet stream may be one of the PW excitation sources. Around the subtropical jet stream, quasi 5, 10, and 16 -day PW activities can be observed simultaneously at three American stations. Among these PW components, the quasi 5-day and 10-day PW are the weakest and strongest, respectively. While at Wuhan station in China, quasi 5-day PW are much weaker than quasi 10-day and 16-day PWs.

However, in the stratosphere, the higher region, only quasi 10-day and 16-day PWs remain in winter, with the zonal component strongest, which amplitudes are smaller than those in the troposphere. By calculating the refractive index for PWs, it is found that there is a persistent reflection layer near tropopause, which is thick in summer and becomes thin or even disappears in winter, revealing that Low-frequency planetary waves are easier to propagate into the stratosphere through this reflection layer, and PWs in the stratosphere can only occur in winter.

PWs in the 2000/2001 winter at the four stations are analyzed in detail. It is found that for the focused observation duration, strong quasi 16-day waves exist both in the troposphere and stratosphere. The quasi 16-day wave in the troposphere is a standing wave in the vertical direction, with vertical wavelength larger than 26 km in the meridional component. Moreover, the tropospheric quasi 16-day wave propagates eastward with the zonal numbers between 5 and 8. Especially, the quasi 16-day wave in Wuhan around the subtropical jet stream is probable the same quasi 16-day wave at the three American stations, which steadily propagates around the latitude.The quasi 16-day wave in the stratosphere is also a quasi-standing wave in the vertical direction with vertical wavelength larger than 10 km in the zonal component. But it propagated westward with the zonal numbers between 1 and 2.