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Effects of gravity waves on the wind velocity in the Venusian mesosphere and thermosphere

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Momentum transport from the cloud layer (50-70km) toward the upper atmosphere by gravity waves is essential to understand the general circulation in the Venusian mesosphere (70-110km) and thermosphere (>110km) (e.g. Bougher et al. [2006]). Zhang et al. [1996] performed simulations with a gravity wave parameterization and showed that the momentum transport by gravity waves drove the retrograde zonal wind (RZW) as fast as 15 ? 30 m/s above about 140 km. They also showed the westward shift of the O2-1.27um nightglow emission region because of the RZW. However, parameterizations used in previous simulations could not consider the wave-wave interaction and the attenuation of gravity waves caused by molecular viscosity. In our simulations, we considered these physical processes by using the new gravity wave parameterization developed by Medvedev et al. [2000] (Medvedev scheme) in our GCM calculation and investigated effects of gravity waves on the Venusian mesosphere and thermosphere.

In the Medvedev scheme, the characteristic horizontal wavelength and the spectrum of the vertical wavelength at the lower boundary are the adjustable parameters. The information is referred from the recent gravity wave observations with Venus Express (VEX) [Peralta et al., 2008]. We performed the numerical simulations with two lower boundary conditions: the wind velocity at the lower boundary is (1) 0 m/s and (2) 80 m/s. In the calculation of case (1), we compared the wind velocity distribution between the results with Medvedev scheme and Rayleigh friction, which was the gravity wave parameterization used in previous studies. We discussed the influence of gravity waves on the RZW in the case (2).

Our result of case (1) shows the dominance of the subsolar-to-antisolar(SS-AS) flow with the maximum value of about 290 m/s in the thermosphere. The amplitude of the SS-AS flow is about 50 m/s bigger than that calculated with the Rayleigh friction. There is a possibility that wave drag of Medvedev scheme become smaller than that of Rayleigh friction above 140 km because of the gravity wave attenuation caused by the molecular viscosity. In the case (2), the gravity wave transports the westward momentum upward and drives the RZW with the amplitude of about 70 m/s above about 120 km. The amplitude of the RZW is almost 0 m/s at about 100 km and becomes bigger with altitude. The vertical gradient of the RZW amplitude is consistent with previous ground-based observations [Sandor et al., 2009]. Our result also shows that the RZW causes the shift of the nightglow emission region from 00:00 LT to 02:30 LT.

Keywords: Venus, mesosphere, thermosphere, gravity wave