Japan Geoscience Union Meeting 2012
(May 20-25 2012 at Makuhari, Chiba, Japan)


PCG33-P05 Room:Convention Hall Time:May 25 15:30-17:00

# Westward acceleration of the mesospheric and thermospheric atmosphere in Venus caused by gravity waves

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We present the numerical simulations for the investigation of the effects from gravity waves to the Venusian mesosphere and thermosphere dynamics. The results reproduced the fast westward wind acceleration above 90 km in altitude. The result first showed that westward acceleration at 110km occurs mainly in the nightside.

Momentum transport from the cloud layer (50-70km) toward the upper atmosphere by gravity waves is essential to understand the 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.

We use the parameterizations which can consider the wave-wave interaction and the attenuation of gravity waves caused by molecular viscosity. We introduced these physical processes by using the new gravity wave parameterization developed by Medvedev et al. [2000] (Medvedev scheme) into our GCM calculation, which enabled us to investigate the 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. For the former, it is set to be 500 km [Kasprzak et al. 1988] in this calculation. For the latter, we assume the Desaubies spectrum, which is the familiar spectrum shape of the terrestrial gravity waves, at the lower boundary. In this calculation, the wind velocity distribution at the lower boundary (80 km) is the solid body rotation with the equatorial wind velocity of 40 m/s.

The result shows that gravity waves, which transport the westward momentum upward, drive the RZW above about 90 km. The strength of the RZW becomes stronger with height in the 90-125 km region. The maximum RZW velocity is about 120 m/s at about 125 km. The RZW velocity is weaker with the height in the 125-140 km region and becomes constant (about 60 m/s) above about 140 km. The vertical change of the RZW strength is interpreted as the result of the wave filtering caused by the background wind.

We also first showed that in the horizontal wind velocity distribution at about 110 km, where wind velocity is observed with the CO and CO2 absorption/emission lines, the westward acceleration caused by gravity waves occurs mainly in the nightside. On the other hand, the subsolar-to-antisolar flow is dominant in the dayside in spite of the existence of the RZW.

(This paper will be submitted to J. Geophys. Res.)

Keywords: Venus, GCM, mesosphere and thermosphere, wind velocity field, gravity wave