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Atmospheric wave propagation and wave-wave coupling in the Venusian mesosphere and thermosphere

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Atmospheric coupling between the lower atmosphere (<70 km) and the thermosphere (>110 km) through atmospheric waves in Venus is one of the important subjects for understanding the Venusian thermospheric dynamics. Past simulation studies suggested that small scale gravity waves would transport westward momentum from the Venusian cloud deck toward the thermosphere [e.g., Zhang et al., 1996]. In recent years, importance of planetary-scale waves on the general circulation of the Venusian atmosphere has been recognized. Forbes and Konopliv [2007] suggested the propagation of planetary-scale waves originated in the cloud deck into the upper atmosphere. However, characteristics of the propagation of planetary-scale waves in the mesosphere and thermosphere have not been investigated yet.
In this study, we have performed numerical simulations with a general circulation model (GCM), which includes the altitude region of 80-about 200 km in order to understand the characteristics of the atmospheric waves in the Venusian mesosphere and thermosphere. The planetary-scale waves (thermal tides, Kelvin wave, and Rosbby wave) are imposed at the lower boundary. The amplitudes and phase velocities of the waves are assumed from the study by Del Genio and Rossow [1990]. The simulation results show dominance of the Kelvin wave at about 80-120 km with a vertical wavelength of about 40-50 km. The amplitude of the zonal wind fluctuation caused by the Kelvin wave has a maximum value of about 9 m/s at about 95 km. The altitude of about 95 km is the emission region of the O2-1.27um nightglow. We estimate O2-1.27um emission intensity from an additional simulation including chemical processes, suggesting that the Kelvin wave would caused the temporal variation of the nightglow distribution with a period of 4 days. Other than the Kelvin wave, the wave with a period of about 2.4 days is seen in our simulation results. There is a possibility that the wave-wave coupling between the Kelvin wave with a period of 4 days and the Rossby wave with a period of 5 days would cause this wave.
In this presentation, we will show the details of our simulation results considering the planetary-scale waves. In addition, we will present the initial results of a simulation considering the small-scale gravity wave.

Keywords: Venus, thermosphere, mesosphere, atmospheric wave, wave