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Latitudinal cloud structure in the Venusian northern hemisphere evaluated from VEX/VIRTIS with GCM

Morihiro Kuroda[1], Takeshi Kuroda[1], Yasumasa Kasaba[1*], P. Drossart[2], G. Piccioni[3], Kohei Ikeda[4], Masaaki Takahashi[5]

[1]Tohoku Univ., [2]Observatoire de Paris, [3]INAF-IAPS, [4]JAMSTEC, [5]Univ. Tokyo

The latitudinal characteristics of Venusian northern cloud, i.e, opacity, top temperature and top altitude are evaluated from the Venus Express/VIRTIS observations. The cloud optical thickness in the polar region (˜65 degN) is ˜1.5 times larger than in middle latitudes. It suggested that in the polar region the amount of cloud particles is larger or the properties of cloud particles are different. The averaged cloud top temperature is uniform in 0 - 40 degN (232+-2 K), gradually decreases north to 70degNN (223+-5 K), and increases again to north pole (233+-6 K). On the other hand, the averaged cloud top altitude is monotonously decreasing from equator (68.2+-1.6 km) to north pole (58.3+-1.0 km). Since the cloud top altitude sharply decreases beyond the polar region (˜65 degN), the structure of Venusian polar vortex is affected by the decreasing of cloud top. The abundance of carbon monoxide under the cloud layer was measured using Band Ratio Technique constructed by Tsang et al. (2009). As a result, the mixing ratio increases from 16+-3 ppm at equator regions to 24+-5ppm at 70 degN, and it decreases to 19+-5 ppm at 80 degN. Furthermore, there is a negative correlation between the CO abundance and cloud top temperature, and the peak of CO abundance is located in the cold collar regions (˜70 degN). Since CO under the cloud is transported from the upper layer, the CO enhancement in the cold collar can be interpreted the down-welling region of planetary-scale circulations, i.e., the Hadley-Circulation. We tried to evaluate the suggestion with a Venusian General Circulation Model (GCM). As a result, the cloud top altitude is monotonously decreasing from equator (67.3 km) to north pole (59.3 km) and the cloud top temperature is almost same from equator to 40o N (234 K), and gradually decreasing to 70 degN (228 K), and increasing toward north pole (242 K) again. In addition, the mean meridional stream-function indicates the existence of down-welling of Hadley-Circulation at the cloud top regions around 70 degN. It can be interpreted that the Venusian polar vortex structures (polar dipole and cold collar) seen from infrared wavelength are created from decreasing of cloud top due to the Hadley-Circulation.

Keywords: Venus, Cloud, altitude, latitude, Venus Express, GCM