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Latitudinal cloud characteristics in the Venusian northern high-latitude region evaluated from VEX/VIRTIS observations

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This paper presents the characteristics of Venusian northern high-latitude clouds, i.e, its opacity, cloud top temperature and altitude, evaluated from Venus Express (VEX) observation, and tries to interpret it with the possible atmospheric circulation around the polar vortex structure.

Venusian clouds mainly consist of sulphuric acid droplets in the altitude of 40-70 km. Recent long-term observations by Venus Monitoring Camera (VMC) and Visible and Infrared Thermal Imaging Spectrometer - M channel (VIRTIS-M) aboard VEX have investigated the polar vortex in the southern hemisphere. There is a bright 'dipole' feature surrounded by a cold 'collar' [Piccioni et al., 2007]. It is also found that the cloud top altitude is located at 74 ± 1 km in low and middle latitudes, and it decreases poleward and reaches 63–69 km in the polar region [Ignatiev et al., 2008].

Based on these results, we try to compare the characteristics in the northern polar region with previous southern studies since the past observations by Galileo Near-Infrared Mapping Spectrometer indicated that cloud mean particle size in the Northern hemisphere is more than that in the Southern [Carson et al., 1993]. We pay attention to confirm whether differences between the both hemispheres are evident or not in other aspects.

Firstly, we investigated the latitudinal variations of cloud opacity, cloud top temperature and altitude in the northern hemisphere by the data observed by VIRTIS - High spectral resolution channel (VIRTIS-H), which can get the information of northern hemisphere that has not been well reported.

(A) In the 2.3um thermal radiation in the night side, we could not find enough flux from lower altitude regions more than 70degN in latitude. With the combination of a radiation transfer analysis based on standard aerosol models, we conclude that the cloud optical thickness in high latitude region is constantly about twice of that in lower latitudes.

(B) We retrieved the cloud top temperature from 5um radiation and the dayside cloud top altitude by 2.2um CO_2 absorption band. The averaged cloud top temperature increased from 220K at 70degN (cold collar region) to 260K at 85degN (bright dipole region). On the other hand, the averaged cloud top altitude at 80degN (65.4±0.7 km) was lower than that at 50 degN (69.3±0.5km). These are consistent with the characteristics in the southern hemisphere [Ignatiev et al., 2008]. In an event study, it was also shown that the cloud top altitude in the cold collar regions surrounding the hot polar dipole is nearly 1km higher than at

60degN.

(C) We compared the averaged latitudinal distributions of cloud opacity (from A), cloud top temperature and altitude (from B) from 15 orbits nadir observations, with the resolution of 1 deg. in latitude. Although there was a negative correlation between the cloud top temperature and its altitude (from B), there were no remarkable characteristics between other two. It suggests the temperature of the Venusian polar structure (bright ‘dipole’ and cold “collar’) is affected by cloud top altitude.

Secondly, we investigated the carbon monoxide distributions under the cloud layer and its relationship with brightness temperature of the cloud-top range in the northern hemisphere using VIRTIS-M nadir observation data. Since CO can be used as an atmospheric dynamical tracer [Tsang et al., 2008], we investigated the correlation of the atmospheric circulation with the structure of polar vortex shown as a temperature structure. We used the ‘Band Ratio Technique’ [cf. Tsang et al., 2009] to derive the CO distributions. As a result, the mixing ratio increased from 14±3ppm at equator regions to 25±5ppm at 65degN. Furthermore, we confirmed that there was a negative correlation between the CO distributions and brightness temperature of the cloud-top range, and the peak of CO abundance was located in the cold collar regions (Lat = 65 to 70degN) and its abundance decreased toward bright dipole region. 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 are now trying to evaluate this suggestion with a GCM modeling result. In the paper, we will also report the results including their interpretations.