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Investigation of vertical extension of Venus main cloud layer based on analysis of VEX/VIRTIS 1.74-um data

Takehiko Satoh[1]; Takeshi Imamura[1]; Kazuaki Mitsuyama[2]; Satoko Sorahana[3]; George L. Hashimoto[4]

[1] ISAS/JAXA; [2] Earth and Planetary Sci., Univ. of Tokyo; [3] Dept. Earth and Planetary Sci., Univ. Tokyo; [4] Kobe Univ.

Observations of the night-side (un-illuminated) disk of Venus in so-called atmospheric windows (wavelengths of relatively weaker CO_2 absorption in 1-2.5 micron region) opened a new era to study the physical and chemical conditions within and below the enormous cloud of Venus. ESA's Venus Express (VEX), orbiting Venus since April 2006, is the first orbiter which fully utilizes the capabilities of such windows. VIRTIS (Visible, Infrared and Thermal Imaging Spectrograph) is one of VEX instruments and its medium-resolution infrared sensor (VIRTIS-M-IR) provides us dramatic views of Venus middle-to-low atmosphere with unprecedented quality. VIRTIS-M-IR takes a series of 2-D spectra (one spatial dimension along the slit and another in the direction of dispersion with 10-nm spectral resolution) with the slit moving across Venus disk. This yields a data cube of multi-wavelength images (one complete scan requires approximately 20 minutes so that the resultant image is by nature not a simple snapshot). We analyze VIRTIS-M-IR data acquired during Orbit 344 (29 March 2007) to investigate the spatial and temporal variability of Venus main cloud layer.

From a VIRTIS-M-IR data cube, images at 1.74 micron (center of a window) and at 1.71 micron (near the wing of the window) were reconstructed with standard corrections applied. Then, the latter is divided by the former to evaluate the ratios of 1.71-micron flux (F1.71) to 1.74-micron flux (F1.74) for individual image pixels. Such ratios are the measure of the degree of multiple light scattering within cloud layer: the ratio becomes smaller (or, F1.71 rapidly decreases) if cloud particles are sparsely distributed (or, increase of path length during multiple scattering is greater). By examining the distribution of (F1.71 / F1.74) ratio, we have found that there exist two distinctive regions.

Analysis have been performed with a radiative transfer code (layer adding and doubling algorithm) and a rather simplified model (a single layer of Mode-2 cloud particles). We have found, for the first time with remote sensing, spatial variation of physical thickness of Venus main cloud deck: The region of larger (F1.71 / F1.74) ratio is found to have approximately 40% thinner cloud layer compared to the region of smaller ratio. More data from different orbits are being analyzed to study where and how cloud thickening or thinning occurs. Such information is expected to reflect vertical motion within the middle atmosphere of Venus, essential to study global circulation of Venus atmosphere.