Atmospheric structure of Venus revealed by Akatsuki radio occultation measurements

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Venus orbiter Akatsuki was launched by (JAXA) in 2010 and started to orbit Venus in 2015. Radio occultation measurements have been conducted since 2016 [1,2], and more than 60 temperature profiles have been obtained so far. The radio occultation measurements have provided knowledges of the thermal structure of the atmosphere especially in the low latitude because of the equatorial orbit. The vertical structures of the thermal tides which are thought to propagate upward from the cloud layer were clarified through the comparison between the radio occultation measurements and the Venus general circulation model named AFES-Venus [3]. We found that the zonal-mean wind speed around 75–85 km is significantly slower than that at the cloud top by applying the dispersion relation to the observed wave structure. Currently the downward propagation of thermal tides from the cloud layer is under investigation; the angular momentum exchange between the cloud-level atmosphere and the near-surface layer by the thermal tides might be essential to the maintenance of the super-rotation [4]. We also found that the depth of neutral stability layer in the cloud tends to be deeper on the nightside than on the dayside [2]. This is consistent with a model prediction that the diurnal variation of the solar heating of the upper cloud layer regulates convective activity [6]. Radio holographic analysis was applied to the open-loop data of the radio occultation to improve the vertical resolution and revealed the presence of short-vertical scale gravity waves and thin near-neutral layers [7]. The frequent occurrence of a sharp temperature minimum near the cloud top was also found with this method and interpreted as the evidence of penetrative convection. Spectral analyses of the temperature fluctuation and the signal intensity scintillation suggested that those structures were caused by small-vertical scale gravity waves. The decrease of the amplitudes of temperature fluctuation with altitude above the cloud layer seems to be attributed to radiative damping. However, large amplitudes of temperature fluctuation appeared even above 80 km altitude, which could be due to shear instability caused by an abrupt vertical gradient of the zonal wind speed.

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