Derivation of vertical profiles of sulfur dioxide in the Venus cloud layer by the Akatsuki radio occultation measurements

*Hinako Onuma[1], Katsuyuki Noguchi[1], Hiroki Ando[2], Takeshi Imamura[3], Hideo Sagawa[2]

1. Nara Women's University, 2. Kyoto Sangyo University, 3. Tokyo University

On Venus, clouds exist at the altitudes of 45 to 70 km, covering the entire planet. This thick cloud layer plays a key role in controlling the heat budget in Venus atmosphere. The vertical structure of cloud, including its microphysics, is still poorly understood. One of the missing information is the vertical distribution of the sulfur dioxide (SO2) which is the main chemical compound in forming the sulfuric acid clouds.
The previous observations of SO2 distribution above the cloud layer (above 65 km) has been conducted using ultraviolet and infrared spectroscopy such as by SOIR and SPICAV-UV in the Venus Express mission. They show the vertical distribution of the SO2 mixing ratio above 65 km and capture increasing it with increasing altitude. However, the observations of SO2 below 60 km have been limited to the in-situ measurements of the VEGA probes and the Venus Express radio occultation (RO) measurements. The former shows the vertical distribution of the SO2 mixing ratio from the surface to 60 km, but the number of observations is very small. In the latter, the mean SO2 mixing ratio at 51-54 km was derived from global data, mainly in the Arctic region.
In the present study, we estimated the SO2 vertical profiles near the cloud layer (50-55 km) using the data obtained by the RO measurements in the Japanese Venus climate orbiter mission, “Akatsuki”. In the analysis, using the attenuation of radio waves emitted from the spacecraft to Earth, we can obtain sulfuric acid vapor profiles. Provided that sulfuric acid vapor cannot be supersaturated in the cloud layer, we attributed any attenuations of radio waves that exceed the saturation curve of sulfuric acid vapor to the attenuations by SO2.
Using the Akatsuki RO measurements between 2016 and 2020, we obtained 32 vertical profiles of SO2 mainly at low latitudes (40˚N to 40˚S). The averaged profile showed the mixing ratio of was about 200 ppm at 50 km and decreasing with increasing altitude to about 50 ppm at 55 km. Our results are consistent with the previous results of the VEGA probes and Venus Express RO measurements.

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