A numerical simulation of the large-scale stationary gravity waves in the Venus atmosphere

Takeru Yamada[1]; Takeshi Imamura[2]; Tetsuya Fukuhara[3]; Makoto Taguchi[4]
[1] Physics, Rikkyo Univ.; [2] The University of Tokyo; [3] Rikkyo Univ.; [4] Rikkyo Univ.

The Longwave Infrared Camera onboard Akatsuki observed a bow-shaped stationary temperature feature on December 7, 2015 [Fukuhara et al., 2017]. It extended from the northern polar region to the southern polar region across the equator, and stayed near the evening terminator for four earth days at least in contrast to the background wind speed of about 100 m s^{-1} at the cloud-top level. The prominent feature disappears in the different local time. A simple numerical simulation suggested that the stationary feature may be caused by a gravity wave propagated from near the surface. However, conditions the wave propagation is permitted are still unknown. Hence, we attempted to reproduce the wave propagation in the numerical simulation, and investigated a contribution of the Venus cloud layer at the altitude of 45 - 55 km where the static stability is relatively low.

A nonlinear primitive equation model in spherical geometry was used based on Imamura [2006]. The vertical log pressure level was divided to 100 sections from 5 km (66.65 x 10^{5} Pa) to 109 km (66.65 x 10^{-1} Pa). The grids of longitude and latitude are 3 degrees. The basic zonal wind, which increases monotonically from 1.3 m s^{-1} at 5 km to 94 m s^{-1} at 69 km, was given based on the Schubert and Walterscheid [1984]. Radiative transfer was represented by time constant with Newtonian cooling based on Crisp. [1989]. We gave a forced temperature disturbance of 2 K on the bottom boundary with a Gaussian-shaped function with a half width of about 6 degree on the equator. Thus, the bow-shaped stationary temperature feature at the cloud-top layer was reproduced in the simulation. When the static stability at the cloud layer decreased to nearly zero from the nominal value, the amplitude of the temperature at the bow shape decreased. The static stability at the cloud layer may be one of the conditions of the bow-shaped structure appearing at the cloud top.