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14:45～15:00

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Characteristics of Venusian gravity waves inferred from thermal infrared cloud images

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Although Venus is a terrestrial planet sharing similar size and mass with the Earth, the atmospheric circulation of Venus is yet to be fully understood. Above the surface, the sulfuric acid clouds are located at about 48-70 km altitudes, covering the entire surface. At the cloud-top level, the global zonal wind shows predominantly westward with a maximum speed of about 100 m s^{-1}, namely superrotation, which is about 60 times faster than the rotation of Venus. Gravity waves are thought to play crucial roles in the momentum balance of the superrotation.

However, the details of the gravity waves on Venus remain unknown. In this study, we are developing an algorithm to retrieve the amplitude of gravity waves based on the observation from the Longwave Infrared Camera (LIR) on board Akatsuki. Infrared radiation and other physical quantities will be characterized in the presence of gravity waves. Comparing to the analysis of short-vertical wavelength gravity waves using radio occultation data, we anticipate providing a new perspective for studying the gravity waves with longer vertical wavelengths.

In this study, the infrared radiance was calculated based on line-by-line radiative transfer codes following Sato et al.[1]. We adopted temperature and pressure profiles for equatorial regions ($<30^o$) from The International Venus Reference Atmosphere[2] and the cloud particle density model from Haus et al.[3]. The extinction cross-section of cloud particles was calculated by the Mie Scattering model with parameters corresponding to 75% H_2SO_4 aerosol particles. Gaseous absorption includes H_2O, CO_2, CO, SO_2, HF, and OCS. Their vertical profiles were taken from Marcq et al.[4], and spectral line data was taken from the HITRAN2020 database[5].

Responses of the atmosphere to gravity waves were described by the linear theory [6]. The influence of gravity waves on the infrared radiance includes perturbations of temperature and particle density. Given the equatorial regions being studied, perturbations of temperature and particle density were calculated following the linear theory in the absence of the Coriolis force.

LIR observation data containing large-scale stationary waves on Aug. 3rd, 2016, was analyzed. We applied high-pass filtering to the brightness temperature data to highlight the horizontal structure of stationary waves. Using our model, we managed to retrieve the amplitude of the gravity wave and derive the perturbation of other physical quantities associated with the gravity waves.

However, this model still needs to be polished. More precise models simulating processes including radiative damping, eddy diffusion, etc. are needed. The 3D gravity wave structure should be constructed to estimate the meridional energy propagation of gravity waves. Eventually, we aim to estimate the angular moment transported by gravity waves and evaluate the contribution of gravity waves to the global circulation.

Reference:
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