Interaction between the thermosphere and the cloud-level atmosphere of Venus studied with simultaneous observations by Hisaki and Akatsuki

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In the thermosphere of Venus, the flow directing from sub-solar to anti-solar (SS-AS) is dominant driven by large temperature gradient associated with a long Venusian solar day which is ~117 Earth days. According to a numerical study by Mayr et al. (1985), the SS-AS flow without drag would exceed 300 m s^{-1} at the maximum.
It is believed that the drag force generated by gravity waves breaking effectively decelerates the thermospheric wind speed. Zalcucha et al. (2013) developed a Venus Thermosphere General Circulation Model in the presence of the gravity wave-drag, which accelerates the atmosphere when the gravity waves are broken. The model showed the SS-AS flow speed of 100-200 m s^{-1}.
The periodical variation that indicates the atmospheric waves in the thermosphere was observed by Masunaga et al. (2017). They analyzed OI dayglow variation using data obtained by the Extreme Ultraviolet Spectroscope for Exospheric Dynamics (EXCEED) on-board the Hisaki spacecraft and detected the periodicity of ~4 days only on the dawn side. They pointed out planetary-scale waves in the middle atmosphere which are expected to be exist in Venus might responsible for the variations in the thermosphere, while the existence of the planetary-scale waves at that time was not confirmed.
In this study, we investigated the vertical coupling between cloud-level atmosphere and the thermosphere of Venus, focusing on the role of atmospheric waves. To find the evidence for the wave propagation, we used data that are obtained simultaneously by Hisaki and Akatsuki spacecraft on the dawn side of Venus in June 2017.
Analyzing the time series of the atomic O dayglow emissions measured by the EXCEED and the UV images which reflect the spatial distribution of unidentified absorbers at the cloud top (~70 km) obtained by the Ultraviolet Imager (UVI), we identified characteristic periodicities of 3.5 days in both data. The wind velocity deduced with cloud tracking from UV images suggests that the 3.5-day periodicity can be associated with Kelvin waves at the cloud top; however, Kelvin waves should decay with height through radiative damping and will not reach the thermosphere. We propose an indirect process in which the Kelvin waves change the wind field periodically and examine how the vertically propagating small-scale gravity waves influence the thermospheric dayglow with a simplified numerical model.

キーワード：金星、熱圏、雲層、上下結合、重力波
Keywords: Venus, Thermosphere, Cloud level, Vertical coupling, Gravity waves