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Title:
Planetary-scale waves and their dynamical roles in the Venus atmosphere

Abstract:
Venus observations have revealed that planetary-scale atmospheric waves such as the thermal tides and the 4-day and 5-day waves exist in and above the cloud layer (about 45-70 km altitudes). These waves are expected to play important roles in the formation of atmospheric general circulation, especially in maintaining the superrotation (SR). In order to investigate the dynamical properties of these waves, we carried out numerical simulations of the Venus atmosphere using a general circulation model (GCM). The structure of the thermal tide obtained in the GCM is consistent with recent Akatsuki UVI observations, suggesting that it could contribute to the SR in low latitudes near the cloud top. However, the meridional-altitude distribution of the acceleration/deceleration of SR induced by the thermal tide is quite complex. The net effect on the SR remains unclear. The 4-day and 5-day waves were also reproduced in the GCM. These waves could be excited by the Rossby-Kelvin instability, which induces the equatorward angular momentum flux to contribute to the SR. The Rossby mode of 5-day wave has a baroclinic structure with significant poleward heat flux. The 5-day and 7-day waves could produce the quasi-periodic variation of the equatorial jet in the lower cloud layer, consistent with Akatsuki IR2 observations. The 7-day wave, newly found in our GCM study, is a planetary-scale wave antisymmetric about the equator, although it has not yet been observed. We need further observations over a wide altitude range to understand the dynamics of the Venus atmosphere.