Meridional wind component and horizontal heat transport of equatorial Kelvin wave in the Venus atmosphere

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The equatorward heat fluxes of the equatorial Kelvin wave are seen in some atmospheric simulations of Venus (Yamamoto and Tanaka 1997; Yamamoto and Takahashi 2018). The eddy equatorial heating due to the heat flux induces the meridional circulation (Yamamoto and Tanaka 1997), which produces the zonal-wind deceleration balancing with the acceleration due to the Kelvin wave's momentum flux. However, these eddy heat fluxes have not fully been investigated. Unlike the Earth, the energy of equatorial Kevin wave is not strongly confined around the equator. On Venus, the e-folding latitude of the equatorial wave identified as an equatorial Kelvin wave is ~23° latitude at the cloud top (Del Genio and Rossow 1990). Although the theories based on the equatorial beta plane (Matsuno 1966) and their modifications have been applied to Venus' Kevin waves, the assumption of the equatorial beta plane may be not appropriate to Kelvin wave in the slowly rotating atmosphere below the upper clouds. In the present work, instead of the equatorial beta plane, the fluid on a rotating sphere was applied to Venus' Kelvin wave, based on Laplace's tidal equation. Longuet-Higgins (1968) found a mode corresponding to equatorial Kelvin wave from Laplace's tidal equation governing a thin layer of fluid on a rotating sphere. Although the meridional wind component is very small for the Kelvin wave mode in fast rotating planets like the Earth, it is not zero on the sphere, except for the equator. In contrast, as the Lamb parameter is relatively small in the superrotating atmosphere, we might need to consider the meridional wind component in the equatorial Kelvin wave. The present work applied the Kelvin wave solution on the rotating sphere to the Venus atmosphere and estimated the wave components and their eddy momentum and heat fluxes. The Kelvin wave with the upward eddy momentum flux has the equatorward heat flux in a rigid-body atmospheric rotation. These directions of the eddy fluxes are consistent with the numerical simulations of Yamamoto and Tanaka (1997) and Yamamoto and Takahashi (2018). In the presentation, the author will discuss whether we can detect the meridional wind component of the Kelvin wave, or not.

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