Dynamics of equatorial Kelvin wave and ultraviolet contrast of Venusian atmosphere

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The influence of the Hadley-like meridional circulation on the Venusian Kelvin wave, which propagates in the super-rotating stratosphere, is investigated, using an equatorial beta-plane primitive equation model. The Kelvin wave has been observed in ultraviolet cloud images as a planetary-scale distinct albedo feature. The meridional circulation has also been observed in cloud images: clouds drift poleward at a speed of 1-10 m/s in the mid-latitude in both hemispheres. Such a fast meridional circulation should influence the Venusian Kelvin wave, since the wave has a deformation radius of 2000 km and extends to the mid-latitude.

The model result shows that the wave is modified to have a non-zero meridional wind disturbance, which is absent when the background atmosphere is at rest. The combination of the meridional and zonal winds induces a meridional flux of zonal momentum in the upstream direction of the background north-south flow. In the upper branch of the Hadley circulation, the wave transports zonal momentum equatorward.

The predicted momentum redistribution should contribute to the maintenance of the super-rotation, since a direct cell transports angular momentum upward whenever equatorial regions of the atmosphere have an angular momentum surplus relative to high-latitude regions. It is also suggested that the deformation of the Kelvin wave in the meridional circulation may explain the shape of the albedo feature which is called the horizontal Y.