Poleward Heat Transport by a 5-Day Rossby Wave at the Venus Cloud Top

*Masataka Imai[1,2], Toru Kouyama[3], Takeshi Horinouchi[4], Makoto Taguchi[5]

1. UTokyo, 2. Present affiliation: Kogakuin Univ., 3. AIST, 4. Hokkaido Univ., 5. Rikkyo Univ.

The atmosphere of Venus exhibits super-rotation (SR), with zonal winds reaching ~100 m s^{-1} near the cloud top (~70 km). Planetary-scale waves, including a quasi-periodic ~5-day Rossby wave with zonal wavenumber 1, are frequently observed in wind and temperature fields. Recent GCM studies (e.g., Takagi et al., 2022; Lai et al., 2024) suggest that these waves contribute to meridional angular momentum (AM) and heat transport. In the TEM framework, meridional eddy heat flux drives a residual circulation that redistributes AM, highlighting the importance of observational constraints on both AM and heat transport.

From June to October 2017, a quasi-periodic 5-day Rossby-like wave with zonal wavenumber 1 and near-equatorial symmetry was identified from cloud-tracking winds derived from ultraviolet images taken by Akatsuki/UVI. Concurrent planetary-scale temperature perturbations were reconstructed from Akatsuki/LIR brightness temperatures. Using these data, we estimated the associated eddy AM and meridional heat fluxes. The eddy AM flux was smaller than that of thermal tides, whereas a clear poleward heat transport (~3 K m s^{-1}) was detected. Assuming quasi-geostrophic Rossby-wave dynamics, the observed heat flux is consistent with upward propagation. The vertical wavelength estimated from the dispersion relation (~20 km) is shorter than that inferred from the observed heat flux (~60 km), likely due to vertical smoothing by the LIR contribution function. A simple forward calculation assuming a vertical wavelength of 20 km shows that the apparent temperature amplitude is reduced by a factor of ~2–3 when the LIR weighting function is applied, thereby reconciling the two estimates.

These results indicate that the 5-day Rossby wave at the cloud top contributes significantly to meridional heat transport, while its direct eddy AM transport is comparatively small. The resulting heat transport may influence wave–mean flow interaction, although quantitative assessment of zonal acceleration requires comparison with GCM simulations.

Keywords: Venus, Akatsuki, Rossby wave

