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Venusian atmospheric turbulence evaluated from cloud brightness distribution in VEX UV images

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In the Venusian atmosphere, there are turbulences in various scales. In order to evaluate the energy transportation between them in the Venusian atmosphere, we derived the power spectra of the cloud brightness distribution at the cloud top (altitude ~65 km) using the UV images obtained by Venus Monitoring Camera (VMC) onboard Venus Express. VMC provides the first uniform long-term data set of Venusian UV images with high spatial resolution, which covers over 4 years with the resolution of 25-45 km/px.

According to the classical turbulence theory, power spectral intensity at the wavenumber k is expressed by $P(k)=C_k k^{-n}$, where the index $-n$ corresponds to the slope of the spectrum in the logarithmic plot. In this study, we derived this parameter from 44 images of Venus full disc image obtained from May 2006 to Jan. 2010. The power spectra of 0.0001 - 0.01 /km in the latitude from 20S to 70S enabled us the comparison with the similar characteristics in the terrestrial atmosphere. The result also compared with the theoretical values (n = -3 in energy cascade case and n = -5/3 in enstrophy cascade case). This study suggested following points:

(1) The power spectra mostly contained the inflection. The slope at lower wavenumbers was steeper than that at higher wavenumbers. Such a feature agrees with the characteristics in the kinetic energy spectra shon Earth (*Nastrom et al.*, 1984; *Nastrom and Gage*, 1985).

(2) The slopes at planetary wavenumbers K < 50 (0.001 /km at the latitude of 20S) had intermediate value between the theoretical ones, -3 and -5/3. It agrees well with the previous Venusian studies (e.g. *Peralta et al.*, 2007). This feature was common over three years.

(3) We first derived the slope at higher wavenumbers, 0.002 - 0.01 /km, which was due to the high spatial resolution of VMC. However, it was sometimes close to 0, which might be affected by instrumental noise. We are doing further checks.

(4) We found some temporal and spatial changes of the slopes in short interval as several hours. This result also suggests that the PSD slope has a large variability in the individual latitude.

(5) The wavenumbers at the inflection point were 0.001 - 0.003 /km. *Kitamura and Matsuda* (2006) suggested that the inflection point at 330 - 1000km can be a border between 2D and 3D turbulences. Our result indicates a possibility to have enstrophy forward cascade in 2D turbulence at lower wavenumbers and the energy forward cascade in 3D turbulence at higher wavenumbers.

At the moment, due to the limitation of the maximum longitudinal coverage in single image, we do not confirm the injection at synoptic-scale (*Tung and Orlando*, 2003). Baroclinic instability wave and thermal tides are possible driving mechanisms of injection. By the full-disc image with a composite of multiple images, we will expand the longitudinal coverage. Furthermore, recent results using the same instrument successfully performed cloud wind tracking, which shows the highly variability of the Venusian dynamics (*Moissl et al.*, 2009). The comparison of the cloud brightness spectra with the kinetic energy spectra derived from wind velocity would be the next target.