Data Assimilation of the Venus Atmosphere to Reproduce Planetary-scale Wave

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Planetary scale waves with about a 4-day period, which are considered to be “Kelvin waves”, have been observed in the equatorial region at the cloud top of the Venus atmosphere[1,2]. It is pointed out that these Kelvin waves could contribute to generate and maintain the atmospheric “super rotation”: the zonal wind circulating Venus 60 times faster than the solid part of Venus[3]. However, the Kelvin waves have not been simulated so far in any Venusian Atmospheric General Circulation Model (AGCM) in the world.

We have developed a Venusian GCM (AFES-Venus), and the Venus AFES LETKF Data Assimilation System (VALEDAS) based on the Local Ensemble Transform Kalman Filter (LETKF) for the first time[4,5]. Using VALEDAS, we have examined the reproducibility of a unique atmospheric structure so-called “cold collar”, a cold latitudinal band encircling the warm polar vortex at about 60–70 km altitudes, in order to elucidate the effects of temperature observations by multiple small satellites[6].

In this study, we prepared an idealized horizontal wind observation that was expected to be obtained from cameras with various wavelengths, and examined the reproducibility of Kelvin wave by varying conditions such as observation altitude, observation area, and time interval. The idealized observation data are created from CCSR/NIES Venus AGCM[7], in which the Kelvin wave was reproduced by forcing it at a lower level.

Fig (a) shows result of a free run forecast (without observation), and (b) shows assimilated result of horizontal wind observation at the altitude of 30 km with 24 hourly. By the data assimilation, the upper propagation of waves with a period of about 5 days at the equator was reproduced. We will also discuss how the observation and this kind of study would be helpful to design the future mission for understanding of Venus.

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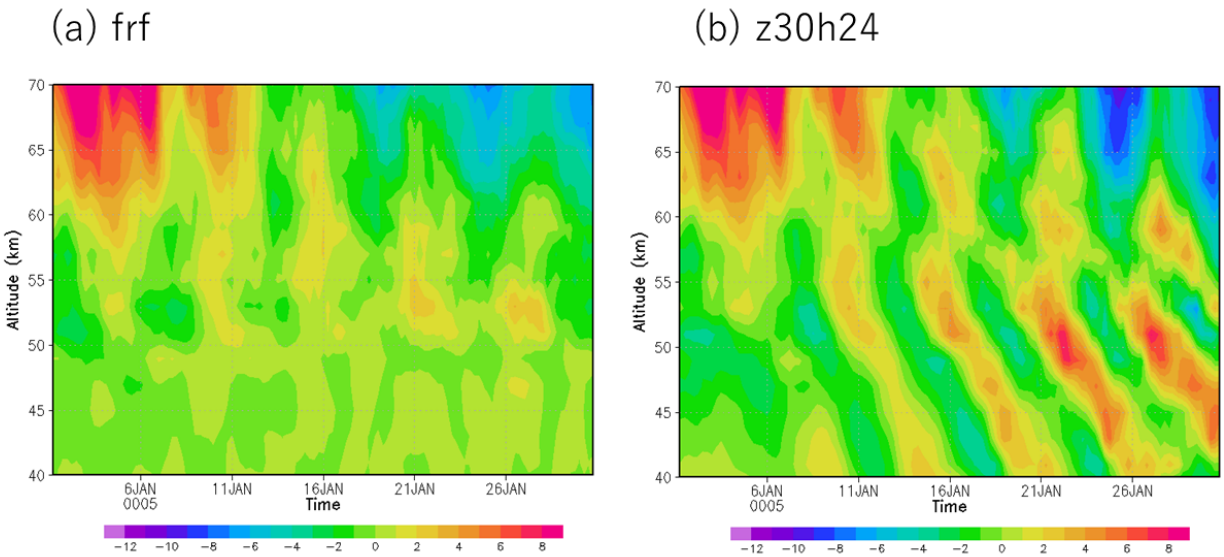

Fig: Time-height cross sections of the zonal wind at the equator.

