Measurements of the Venusian mesospheric wind and temperature profiles using mid-IR heterodyne spectrometer MILAHI

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Mesospheres of terrestrial planets are the transition region between the lower and the upper atmosphere. Their altitudes are 50-90 km on Mars and 60-100 km on Venus, respectively. In Venus, It is also the transition region from the super-rotated upper cloud layer (altitude: 65-90 km, observed by JAXA Venus orbiter Akatsuki) to the thermospheric SS-AS (subsolar-antisolar) flow layer (altitude: 100-120 km). The observations of this region are not enough and disagree with the results of Venus International Reference Atmosphere (VIRA) [Sonnabend et al., 2010].
We have promoted the study of the wind velocity and temperature profiles in the Venusian mesosphere using MILAHI (Mid-Infrared LAser Heterodyne Instrument). It was developed in Tohoku University and installed to the Tohoku Univ. 60 cm telescope (T60) at Mt. Haleakala, Hawaii, and can achieve ~3.5 arcsec of spatial resolution and >~10^6 of spectral resolution. This talk mainly shows the result observed by this system, and compares the derived wind velocity and temperature profiles with the early observational results of Akatsuki, in order to investigate of the effects of the dynamics in the Venusian cloud layer to the mesosphere.
We observe CO_2 non-local thermodynamic equilibrium (non-LTE) emissions at a wavelength of 10 μm from the altitude of 100-120 km. Temperature and wind velocity along the line of sight can directly be derived from the Doppler width and shift of emission line, respectively. Although similar measurement can be accomplished by CO line in mm and submm from the altitude of 80-110 km [e.g., Clancy et al., 2008], its spatial resolution is up to ~14 arcsec in single dish observation. We can resolve the Venusian disk with higher resolution and get their constant and long-term variations. In nightside, wind velocity and temperature profiles in the altitude region 70-95 km also be observed by CO_2 absorption lines at 10μm. Those retrieval is done by Advanced Model for Atmospheric TeraHertz Radiation Analaysis and SimUlation (AMATERASU) [Baron et al., 2008] which performs forward (line-by-line radiative transfer and numerical modeling of instrumental characteristics) and inversion calculations.
We are now preparing the observation campaign in March 2016. Akatsuki will observe the atmospheric dynamics in the region between the surface and the altitude of 90 km. Our observation by MILAHI obtains the information at the region above them, and extend the vertical profiles above the cloud top toward the mesosphere. Akatsuki has several remote sensing instruments for those objectives; two imagers, LIR (wavelength range: 8-12μm) and UVI (wavelength: 283nm), with the radio occultation using USO. They will provide the temperature distribution near the cloud top (altitude: ~70 km) at nightside, the altitude of the cloud top and wind distribution near the cloud top (altitude: ~70 km) at dayside, and the vertical temperature profile at limb (altitude range: 35-90 km) twice in every orbital period, respectively. We will try to provide simultaneous and continuous ground-based observations.
In this study, we evaluate the vertically resolved profiles of Venusian atmosphere by the comparison between the temperature profile by MILAHI and the Akatsuki radio occultation. We also derive the daily variation of wind velocity profiles from cloud top to the mesosphere by UVI and

MLAHI in dayside, and evaluate the transition features between super-rotation and SS-AS flows. We also derive the daily variation of temperature profiles from the cloud top to the mesosphere by LIR and MILAHI in nightside.

Keywords: Venus, mesosphere, heterodyne, Akatsuki

