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Direct Wind and Temperature Measurements in Venus Upper Atmosphere by Ground-based Infrared Heterodyne Spectroscopy

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Dynamics of the Venusian atmospheric transition zone between the sub-solar to anti-solar (SS-AS) flow dominated region above 120km and the superrotation dominated region below 90km is not yet fully understood. Temperatures in the same region are not very well constrained. Measurements are essential to gain a global understanding of the atmosphere and to validate global circulation models. Space based observations can provide temperatures but do not offer direct wind measurements at these altitudes and ground-based results lack in time coverage and spatial resolution. Hence measurements on various time scales and on different locations with sufficient spatial resolution on the planet are important.

The Tunable Infrared Heterodyne Spectrometer (THIS) was developed at the University of Cologne, I. Physikalisches Institut. The ground-based receiver is transportable and can be used at various telescopes. Beside high spectral resolution (R>107) this technique also guarantees high spatial resolution on the planet. Temperatures and winds in planetary atmospheres can be retrieved from detection of narrow non-LTE emission lines of CO2 at 10 mum. These emission lines are induced by solar radiation. Non-LTE emission can only occur within a narrow pressure/altitude region around 110km. Resolving the molecular features allow to retrieve temperatures and wind velocities. Temperatures with a precision of 5K can be calculated from the Doppler-width of emission lines and wind velocities can be determined from Doppler-shifts of emission lines with an precision up to 10 m/s.

We observed Venus at several characteristic orbital positions using the McMath-Pierce-Solar Telescope on Kitt Peak, Arizona, USA. Observations at maximum elongation in May and November 2007 and June 2009 and observations close to inferior conjunction in March and in April 2009 have been accomplished. These observing geometries allow investigations of wind velocities of different combinations of the superrotational component and the SS-AS flow component including investigations of temporal behavior on different time scales.

Keywords: Venus, atmosphere, heterodyne spectroscopy, dynamics, temperatures