Cloud top structure from the analysis of the VeRa and VIRTIS observations

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Vertical structure of the Venus clouds is important for understanding of the radiative energy balance and the atmospheric dynamics. The structure of the cloud tops (75-65 km) is especially poorly investigated since it falls between the altitude ranges sounded by solar/ stellar occultation and that studied by descent probes. In this work we analyze the data from the radio occultation experiment VeRa and Visible and Infrared Thermal Imaging Spectrometer (VIRTIS) onboard Venus Express to constrain aerosol structure at the cloud top. The radio sounding is insensitive to the clouds and provides "true" temperature structure, while thermal IR spectra depend on both temperature and aerosol distribution. Thus the joint analysis allows one to retrieve vertical structure of aerosol at the cloud tops and its latitudinal variations. Using VeRa temperature profiles we fit VIRTIS spectra in the wavelength range of 4.4 - 5 μm by tuning two parameters in the exponential model of aerosol vertical distribution: the altitude of unit opacity and the scale height (H) ~~H~~. We found that the cloud top altitude decreased from 68-70 km in tropics to 62-64 km in high latitudes (see Figure). The scale height ranges from 1 km to 4 km with a trend to decrease with latitude. In the middle and high latitudes the retrievals result in two possible solutions: 1). low cloud with very sharp top boundary~~top~~ (H < 1 km) and 2). high cloud with gradual top boundary (H ~ 5 km). The first case tend to better reproduce characteristic spectral inversions in the wings of 4.3 μm CO_2 band. We also find that in the middle and high latitudes the cloud top coincides with temperature inversions at the tropopause.

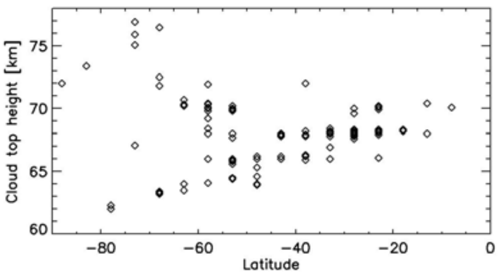

Figure. Cloud top altitudes from equator to the South Pole.