

Study on the Venusian atmospheric thermal structure: A comparative analysis between observations and models

Soumyaneal Banerjee^{*(1)}, R. K. Choudhary⁽¹⁾, K. R. Tripathi⁽²⁾, and Ambili K. M.⁽¹⁾

(1) Space Physics Laboratory, VSSC, Kerala, India

(2) Physical Research Laboratory, Gujarat, India

Abstract

We investigate the thermal structure of the Venusian middle atmosphere between 45 and 80 km using radio occultation (RO) measurements from Venus Express and Akatsuki spanning 2006–2024. Retrieved temperature profiles are compared with climatological predictions from the Venus-GRAM and the Venus Climate Database (VCD). Systematic deviations exceeding 10 K are observed between the RO temperatures and model climatologies, particularly at high latitudes in both hemispheres. The long-term dataset further reveals a possible decadal-scale temporal variability in temperatures across the low-to-mid latitude regions. This variability becomes less coherent at higher altitudes. A combination of post-stratification and bootstrap analysis on the temperature anomalies indicates that the observed temporal variability at low-to-mid and polar latitudes is not readily explained by the latitudinal sampling bias quantified using the adopted analysis, while the trends at mid-to-high latitudes are affected by sparse and uneven RO sounding. Sensitivity tests using modified cloud albedo inputs in VCD simulations show that adjusting cloud radiative forcing partially reconciles the discrepancies, especially at the lower altitudes, below 60 km. However, above the cloud top, at the lower latitudes, the divergence from the observations increases significantly, thereby failing to provide a general reconciliation between VCD and RO. These results highlight the need for updated empirical climatologies incorporating recent RO measurements and for improved physical parameterizations in Venus general circulation models to better capture the global variability in the planet's middle atmosphere.

References

1. Soumyaneal Banerjee, R.K. Choudhary, Keshav R. Tripathi, K.M. Ambili, J. Oschlisniok, Silvia Tellmann, T. Imamura, H. Ando, Study on the Venusian atmospheric thermal structure: A comparative analysis between VEX/Akatsuki and Venus-GRAM/VCD, *Icarus*, Volume 461, 2027, 117307, ISSN 0019-1035, <https://doi.org/10.1016/j.icarus.2026.117307>.