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Thermal structure of Venus atmosphere from Venus Express observations

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Abstract

The thermal structure of Venus atmosphere has been investigated since the early 1960s by several ground-based campaigns and spacecraft missions, such as Pioneer Venus (PV) orbiter [1], PV probes [2], Galileo flyby [3], Venera 15 and 16 [4]. Based on these early and sparse observations, a Venus International Reference Atmosphere (VIRA) model was published in 1983 [5]. The VIRA model splits the atmosphere into three different dynamical regions: (1) the lower atmosphere, from the surface to the upper cloud top (~ 70 km), (2) the middle atmosphere, extending between the cloud tops and 110 km, and (3) the upper atmosphere, above ~110 km. Vertical temperature profiles below 40 km of altitude are quite similar over the entire planet, with latitudinal and local time variations less than 5 K. On the other hand, the thermal structure of the middle and upper atmosphere shows a significant variability with latitude and local time. The VIRA model presents an atmosphere temperature that decreases from values of ~ 240 K at the cloud top to 170 K at ~ 90 ï 100 km altitudes on the dayside of the planet and reaching minimum values of less than 120 K during the nighttime in the upper atmosphere [5].

More recently, several experiments on board the European mission to Venus, Venus Express (VEx) [6], and ground-based campaigns [7,8,9] have extensively studied the thermal structure of Venus upper atmosphere over a long time scale revealing a far more complex situation. Three different methods are used to sound remotely atmospheric temperatures: (1) the VeRa radio occultation instrument studies the upper troposphere/mesosphere (40 ï 90 km) of both the north and south hemispheres with a vertical resolution of ~500 m [10,11]; (2) the nightside mesosphere (60 ï 90 km) is investigated also by VIRTIS thermal emission spectroscopy [12,13]; (3) finally, SPICAV-SOIR stellar/solar occultations sound Venus upper atmosphere (70 ï 150 km altitude) on the nightside and at the terminator [14,15,16].

Together, these three techniques sound Venus atmosphere in the altitude range from 40 km up to 150 km with different altitude coverage, resolution, temporal and spatial sampling. Observations acquired by these experiments will be compared and their differences and similarities will be analyzed with the main goal to improve and update the reference model of Venus atmosphere.

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