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Meridional trends in the radiative energy balance of the Venus mesosphere

Y. J. Lee (1), D. Titov (2), N. Ignatiev (3), S. Tellmann (4), M. Paetzold (4), and G. Piccioni (5)

(1) MPS, Katlenburg-Lindau, Germany (leeyj@mps.mpg.de), (2) ESA/ESTEC, Noordwijk, The Netherlands, (3) Space Research Institute (IKI), Moscow, Russia, (4) Rhenish Institute for Environmental Research, Universität zu Köln, Cologne, Germany, (5) IASF/INAF, Rome, Italy

The Venus clouds play an important role in the radiative energy balance. Thermal cooling to space occurs from the cloud tops. Also almost half of the solar energy received by Venus is deposited at about the same altitude by the unknown UV absorber. Observations revealed the latitudinal trend in the aerosol structure with cloud top altitude decreasing from ∼68 km in low latitudes to ∼62 km in polar region and aerosol scale height changing from ∼4 km to ∼1-2 km. This results in significant changes in the radiative energy balance at the cloud tops and the mesosphere as well as global energy balance of the planet. Here we present calculations of the thermal flux in the 0-99 km altitude range using the latitude dependent cloud top structure. Aerosol and temperature profiles are based on the radio science experiment (VeRa) and the thermal spectrometer (VIRTIS) onboard Venus Express [1]. We used radiative transfer model merged with a fast line-by-line routine to calculate thermal fluxes in the broad wavenumber range from 50 to 2590 cm^{-1} (=3.86-200.0 μm).

The cloud layers are responsible for thermal cooling below ∼70 km altitude. The meridional changes in the upper clouds result in cooling rate variation 6-10 K/day along the latitude. Contribution of the CO_2 emission to the outgoing flux becomes dominant above 70 km altitude. The outgoing flux shows maxima at equator (164 W/m^2) and pole (171 W/m^2) and a minimum (133 W/m^2) in the “cold collar” region (50-60°S). The earlier studies of the solar heating rate were used to derive a meridional trend of the radiative energy balance. The comparison shows dominant thermal cooling in high latitudes and strong solar heating at low latitudes suggesting radiative disequilibrium, that implies a need for another, possibly dynamical, mechanism to maintain the observed temperature and cloud structure [2,3].

References

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