

Detection of Titan's mesosphere by infrared spectroscopy

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Titan's temperature profile is an indicator of the atmospheric energy transport, by radiation, convection and conduction. From the surface up to ~ 250 km altitude, the temperature profile was measured by the Voyager 1 radio occultations and infrared spectra. In the troposphere, the heating of the surface and low atmosphere by solar radiation absorption and cooling by emission to space are the dominant processes setting the temperature profile. The result are temperatures decreasing from ~ 94 K at the surface, to ~ 70 K at 200 km. Between 200 and 350 km, the atmosphere is close to a balance between radiation absorption and emission, thus with an approximately constant temperature. For the 250-500 km region, observations of stellar occultations reveal oscillations between 170 and 150 K. Atmospheric models predict the existence of a mesosphere, in the region 350-550 km, with the temperature decreasing by effect of emission by ethane and other hydrocarbons. In this work we observed emission lines of methane's ν_4 band ($8.1 \mu\text{m}$, 1230 cm^{-1}) with high resolution spectra. From the line profiles and using lines with different intensities, it was possible to determine the vertical temperature profile for the region 100-600 km, what was not possible with previously available data. We present the first infrared observation that can measure independently the temperatures for the regions 100-200 km, 200-400 km, and 400-600 km. These measurements show the existence of a mesosphere, with a temperature drop of at least 15 K from 380_{-100}^{+50} km altitude.