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Simulated radiative forcing by molecules in Jupiter's stratosphere

KURODA, Takeshi[1*] ; MEDVEDEV, Alexander[2] ; HARTOGH, Paul[2]

[1]Tohoku Univ., [2]MPS

We present the radiative heating and cooling rates by molecules for Jupiter's upper troposphere and stratosphere (10^3 to 10^{-3} hPa) with a newly developed parameterization which is suitable for general circulation models. The scheme is a band model based on the correlated k-distribution approach, which accounts for the heating due to absorption of solar radiation by CH_4, and cooling in the infrared by C_2H_6, C_2H_2, CH_4 and collision-induced transitions of H_2-H_2 and H_2-He.

The band model achieved the accuracy of within 10% in comparison with the line-by-line calculations. We show the sensitivity of the heating/cooling rates due to variations of the mixing ratios of hydrocarbon molecules calculated with this scheme, in addition to the calculated radiative-convective equilibrium temperature which is in agreement with observations in the equatorial region. Our results suggest that the radiative forcing in the upper stratosphere is much stronger than it was thought before [Conrath et al., 1990]. In particular, the characteristic radiative relaxation time decreases exponentially with height from 10^8 s near the tropopause to 10^5 s in the upper stratosphere.

Keywords: Jupiter, atmospheric radiation, gas giants, JUICE