

Deuterated Methane and Ethane in the Atmosphere of Jupiter

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CH₃D and C₂H₅D are isotopic tracers in the deep Jovian atmosphere and susceptible to transport and chemical effects. It is expected that the tropospheric $([D]/[H])_{CH_4}$ ratios determined from the various observations made should be relatively invariable, yet previous determinations of this quantity for Jupiter have given results inconsistent with experimental error bars. This suggests that there may be a problem with the interpretation of some of the observations, or that the apparent CH₃D column abundance is variable. We report on the effects of varying important parameters over this pressure regime on the CH₃D and C₂H₅D mixing ratios, CH₃D and C₂H₅D fractionation, the $([D]/[H])_{CH_4}$, $([D]/[H])_{C_2H_6}$ and D/H ($= ([D]/[H])_{H_2}$) ratios and compare with the various CH₃D and HD observations.

Our results show that since the CH₃D and C₂H₅D mixing ratios are strongly dependent upon $K(z)$ in the region of interest where temporal or latitudinal variations in $K(z)$ could significantly impact the measured $([D]/[H])_{CH_4}$ ratio. The $K(z)$ adopted represents complex upward convection and downdraft mixing that occurs in the Jovian atmosphere as evidenced by recent observations (Gierasch et al., 2000; Ingersoll et al., 2000; Roos-Serote et al., 2000; Vincent et al., 2000). Using our technique allows for the

first time a way to explain the discrepancies in the $([D]/[H])_{CH_4}$ ratio observations by offering a plausible link between the CH_3D and C_2H_5D observations and upper tropospheric dynamical processes. In any case our calculations show how $([D]/[H])_{CH_4}$ and $([D]/[H])_{C_2H_6}$ can be used as a diagnostic tracer to constrain $K(z)$ and to better understand the dynamics of the atmosphere in this pressure regime.

Additionally, we have made calculations of the C_2H_5D in the thermosphere of Jupiter. The principal reactions determining the D abundance appear to be generation by reaction of H with vibrationally hot HD and loss by reaction of D with $H_2(v=0,1)$ and CH_3 . The H, CH_3D and C_2H_5D distributions have been calculated using the Caltech/JPL KINETICS 1-D photochemistry-diffusion model with the column H constrained using the H Lyman-alpha airglow. Reactions involving C_2H_5D are described by Parkinson (2002). Performing sensitivity studies, we have found an enhancement of greater than two orders of magnitude in C_2H_5D due to the vibrational chemistry, which is significantly larger than that for CH_3D enhancement reported by Parkinson et al (2003). This is of great interest and suggests that C_2H_5D should be detectable in the lower thermosphere: we propose that observations of this species should be made. Enhancement of deuterated hydrocarbons indicates that there may be exchange of these species between the stratosphere and troposphere and further show their usefulness as isotopic tracers in the Jovian atmosphere.

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