Laboratory Spectroscopy in Support of the Atmospheric Radiation Measurement Program

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There is considerable world-wide interest in the remote sensing of chlorofluorocarbons (CFCs), especially CFC-11 ($CFCl_3$) and CFC-12 (CF_2Cl_2); hydrochlorofluorocarbons (HCFCs), HCFC-22 ($CHFCl_2$) in particular; the fluorocarbon CF_4; the chlorocarbon CCl_4; and sulphur hexaflouride (SF_6). Laboratory measurements of the spectral absorption cross-sections are needed for the retrieval of the atmospheric vertical mixing ratios and column abundances of these molecules from observational data.

These molecules exhibit infrared absorption features that do not lend themselves readily to the conventional line-by-line analysis that is suitable for the spectra of CO, CO_2, N_2O, and CH_4. Therefore, our laboratory has developed a novel technique of measuring the absorption cross-section, k_ν (cm^2 $molecule^{-1}$), which is defined as $k_\nu = (-\ln \tau_\nu)/p\xi L$ in terms of the spectral transmittance τ_ν at the wavenumber ν, temperature T, and total pressure p along an optical path of length L through the absorbing chemical with a mixing ratio of ξ in N_2 (used in place of air without any measurable difference in the measured k_ν) directly.

At previous Science Team meetings, we have reported highly accurate k_ν in the thermal infrared bands of CFC-11 ($CFCl_3$), CFC-12 (CF_2Cl_2), HCFC-22 ($CHFCl_2$) and SF_6 at several *(T,p)* combinations representing atmospheric layers. We present now the significant enhancement that we have produced in the database on cross-sections by extending our earlier measurements to include additional chemicals such as CF_4 (CFC-14) and CCl_4 (Figures 1 and 2) and to conditions encountered in the atmosphere at Arctic and Antarctic latitudes.

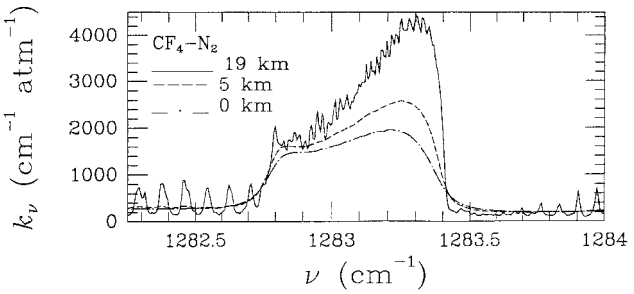

Figure 1. Spectral absorption cross-sections of CF_4 between 1281 and 1284 cm^{-1}. The experimental conditions correspond to the surface, 5-km, and 19-km levels of the U.S. Standard Atmosphere.

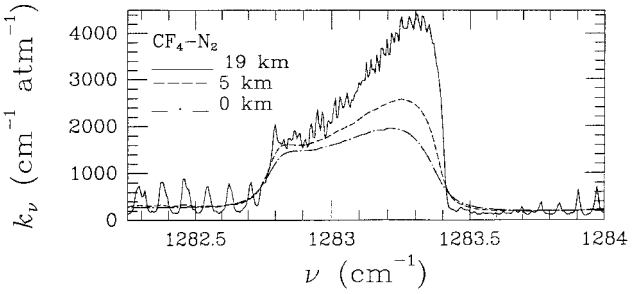

Figure 2. Spectral absorption cross-sections of CCl_4 between 755 and 810 cm^{-1}. The experimental conditions correspond to the surface, 5-km, and 19-km levels of the U.S. Standard Atmosphere.