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3.4 SEASONAL VARIATION OF THE TEMPORAL VARIANCE OF LONG-LIVED TRACE GASES MEASURED DURING MAP

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A series of balloon observations of long-lived trace gases has been performed in the midlatitude stratosphere during MAP. The temporal variance of the local mixing ratios of CH_4, N_2O, $CFCl_3$, and CF_2Cl_2 indicates a substantial annual variability. The concept of the equivalent displacement height (EDH) introduced by Ehhalt et al. [J. Atmos. Chem. 1, 27, 1983] is used to investigate some features of transport activity in the lower stratosphere. It appears that most of the temporal variance originates from strong transport effects during the periods of the spring and autumn turn-around of the stratospheric circulation. We found the dynamical process to be considerably reduced during October.

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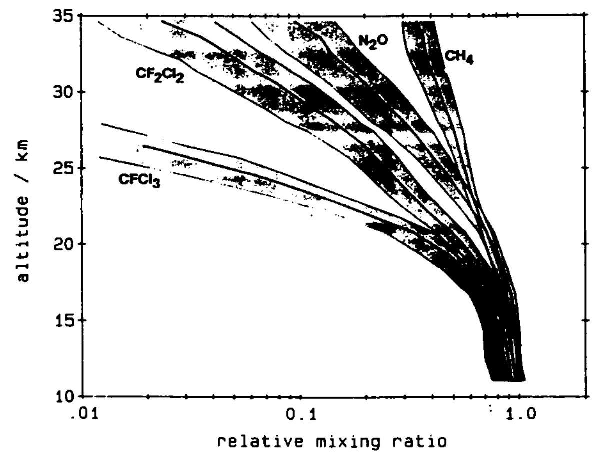

Figure 1. Vertical profiles of the volume mixing ratios of CH_4, N_2O, CF_2Cl_2, and $CFCl_3$, averaged over 19 balloon flights in Southern France (44°N). The local mixing ratios are given relative to a tropospheric value of 1. The shaded areas indicate the mean standard deviations of the data points. [Volz et al. Ber. Kernforschungsanlage Jülich, JÜL-1742, 1981; and Schmidt et al., Ber. Kernforschungsanlage Jülich, JÜL-Spez-375, 1986]. Running means and standard deviations are deduced from a regression line within a window of 5 km height with a step width of 1 km.

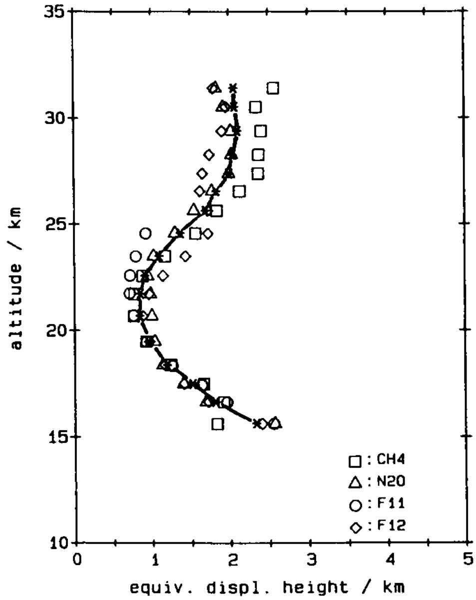

Figure 2. The vertical distribution of the equivalent displacement height for CH_4, N_2O, CF_2Cl_2, and $CFCl_3$ derived from the 19 balloon flights in Southern France displayed in Figure 1. The heavy line represents the EDH averaged at each level over the EDH of the individual source gases. The concentration of $CFCl_3$ becomes too low above 25 km for deducing a meaningful equivalent displacement height.

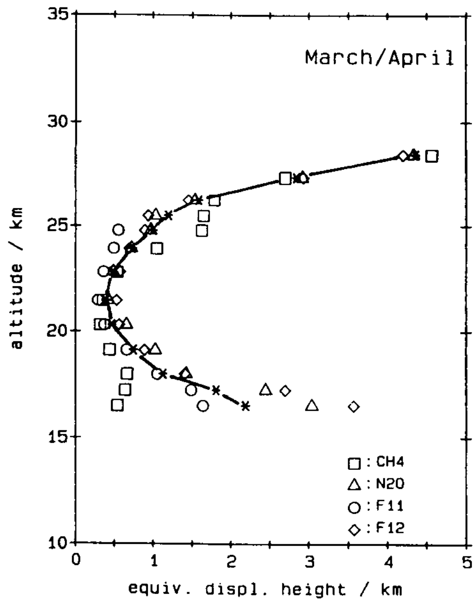

Figure 3. The vertical distribution of the equivalent displacement height, deduced from measurements of CH_4, N_2O, and $CFCl_3$, and CF_2Cl_2. The balloons were launched in spring (March 1983 and April 1984). The heavy line runs through the averages of the individual EDH. Values for $CFCl_3$ above 25 km were omitted.

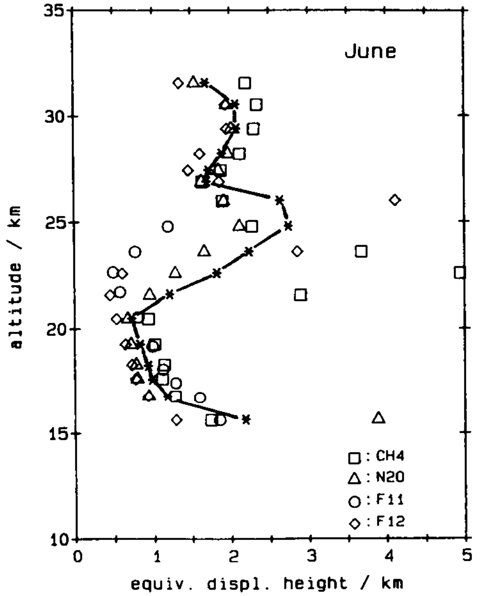

Figure 4. The vertical distribution of the equivalent displacement height, deduced from measurements of CH_4, N_2O, and $CFCl_3$, and CF_2Cl_2. The balloons were launched during June (1977-1979). The heavy line runs through averages of the individual EDH. Values for $CFCl_3$ above 25 km were omitted.

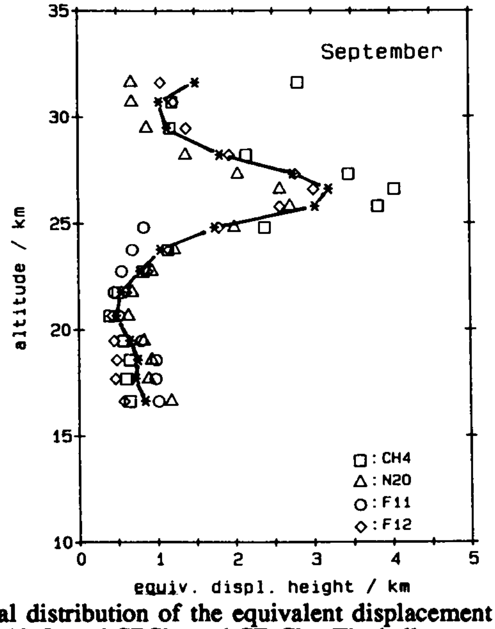

Figure 5. The vertical distribution of the equivalent displacement height, deduced from measurements of CH_4, N_2O, and $CFCl_3$, and CF_2Cl_2. The balloons were launched during the autumn turn-around period (September 1983-1987). The heavy line runs through the averages of the individual EDH. Values for $CFCl_3$ above 25 km were omitted.

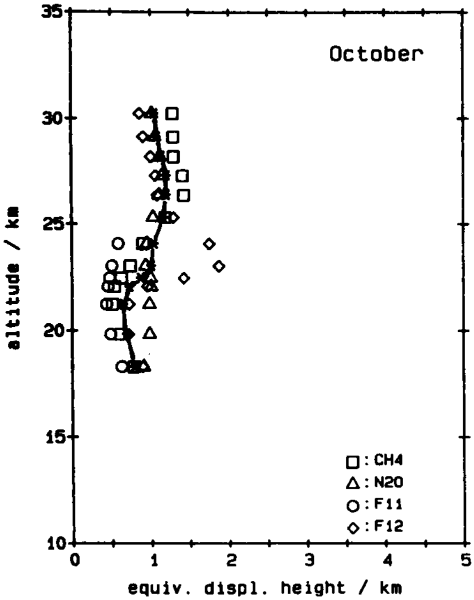

Figure 6. The vertical distribution of the equivalent displacement height, deduced from measurements of CH_4, N_2O, and $CFCl_3$, and CF_2Cl_2. The balloons were launched after the autumn turn-around period (October 1982-1986). The heavy line runs through the averages of the individual EDH. Values for $CFCl_3$ above 25 km were omitted.

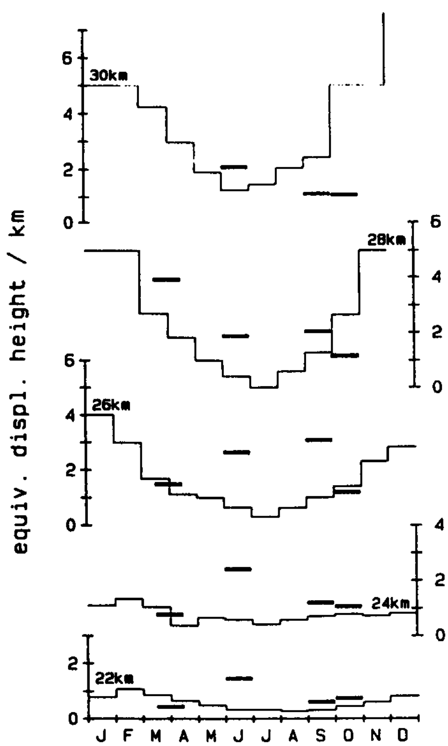

Figure 7. Comparison of the seasonal variation of the equivalent displacement height derived from long-lived tracer observations (heavy bars) and from balloon-borne ozone measurements (light line). The EDH of the long-lived tracers are the means shown in Figures 3 to 6, while the O_3 concentration profiles were published by Attmannspacher [Sonderbeobachtungen des Meteorol. Observatoriums Hohenpeisenberg, 1966-1985] and analyzed by Roth and Ehhalt (in Visconti and Garcia , editors, Transport Processes in the Middle Atmosphere, Reidel 1987, pp 137-152].