Simulation of the Transport of Halogen Species from the Equatorial and Mid-Latitude Stratosphere to the Polar Stratosphere in a Two-Dimensional Model

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The bulk of O3 destruction in the Antarctic stratosphere takes place in the lower stratosphere between 15 and 25 km. Both O3 and the halogen reservoir species have their origins in the higher altitude region (20-30 km) in the equatorial and mid-latitude stratosphere. Using the Caltech-JPL two-dimensional residual circulation model, we investigate the growth of stratospheric halogen due to the increase of CFC13 and CF2Cl2.

The model has 18 latitudes (pole to pole) and 40 vertical layers (0 to 80 km). It was run from 1972 to 1988, with CFC13 and CF2Cl2 specified at the lower boundary

\[
F_{11}(t) = 96.5 + 9.0 \times t, \\
F_{12}(t) = 162.7 + 15.3 \times t, \\
\]

where the mixing ratio is given in pptv and \( t \) is in years since 1972.

Preliminary conclusions are:

(a) Between 1976 and 1987 the column abundance of HF at 45°N increased by \( 6 \times 10^{14}\text{cm}^{-2} \) (see Fig. 1a) compared with an observed increase of \( 4 \times 10^{14}\text{cm}^{-2} \) (Zander et al., 1987a).

(b) In the same period the column abundance of HCl at 45°N increased by \( 9 \times 10^{14}\text{cm}^{-2} \) (see Fig. 1c), compared with an observed increase of \( 7 \times 10^{14}\text{cm}^{-2} \) (Zander et al., 1987b; Farmer, 1988 private communication).

(c) The corresponding increases in HF and HCl at 85°S are \( 1.4 \times 10^{15} \) and \( 1.7 \times 10^{15} \text{cm}^{-2} \) respectively.

(d) The increase of free fluorine (\( F_x \)) and free chlorine (\( Cl_x \)) occurs above 25 km at midlatitudes, but occurs much deeper in the atmosphere at 85°S (see Fig. 2).

References:


Figure Caption:

Fig. 1a. Column abundance of HF at 45 N cue to increase of CFCI₃ and CF₂Cl₂ in the atmosphere.
Fig. 1b. Same as Fig. 1a, for 85 S.
Fig. 1c,d. Same as Fig. 1a,b for HCl.
Fig. 2a. Vertical profile of Fₓ at 45 N and 85 S in Jan 1987 derived from CFCI₃ and CF₂Cl₂.
Fig. 2b. Same as Fig. 2a, for October 1987.
Fig. 2c, d. Same as Fig 2a,b for Clₓ.