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


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

\[ F₁₁(t) = 96.5 + 9.0 \times t \]
\[ F₁₂(t) = 162.7 + 15.3 \times t \]

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 × 10¹⁴ cm⁻² (see Fig. 1a) compared with an observed increase of 4 × 10¹⁴ cm⁻² (Zander et al., 1987a).

(b) In the same period the column abundance of HCl at 45°N increased by 9 × 10¹⁴ cm⁻² (See Fig. 1c), compared with an observed increase of 7 × 10¹⁴ cm⁻² (Zander et al., 1987b; Farmer, 1988 private communication).

(c) The corresponding increases in HF and HCl at 85°S are 1.4 x 10¹⁵ and 1.7 x 10¹⁵ cm⁻² respectively.

(d) The increase of free fluorine (Fₓ) and free chlorine (Clₓ) 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 due 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.