Review of HCFC-22: Metadata on Distributed Emissions

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Emission Functions

HCFC-22 ($CHClF_2$, chlorodifluoromethane) is used primarily within refrigeration and air conditioning systems as the working fluid. Some material is released into the atmosphere when these systems are first filled but the bulk of the losses occur subsequently during maintenance, or as the result of accidental damage or when the equipment is finally removed from service and scrapped. There are other minor uses in foam blowing and hermetically sealed systems.

As a consequence of the delay between first use and release, it is necessary to calculate emissions from time series of data on production and sales into three end-use categories having short, medium and long-term "banking times". The calculation method is described in Midgley and Fisher (1993).

Of the sales into "Short Banking Times" (mainly open cell foam), 83% are released in the year of manufacture and the remainder in the year following. Releases from "Medium Banking Times" (predominantly refrigeration) are distributed approximately normally about a 4.5 year mean following a 30% initial loss, so that all of the charge is expected to be lost within 10 years. Material in "Long Banking Times" applications is released at the rate of 2%/year. Emissions do not depend on the season of the year.

Basic Data on Sales

There is no single data set for global sales of any of the fluorocarbons. That compiled by industry (AFEAS, 2001) is compound specific and audited to ensure quality control, but has incomplete geographical coverage; production in China, India, Korea and Russia is not included. The data on production and consumption (the latter equating to sales) compiled by the United Nations Environment Programme to verify the application of the Montreal Protocol are neither compound specific nor audited although they do cover all parties to the Protocol (UNEP, 2002). UNEP data are reported as the aggregate total of all HCFCs in ODPtonnes (Ozone Depletion Potential multiplied by metric tonnes). Submissions by individual countries are incorporated into the UNEP database with no further checks and reported values have been revised, without explanation, several years after they were first submitted.

These data sets have been amalgamated to provide global consumption values with defined quality and uncertainty and the distributed emissions described here were based on Midgley and McCulloch (1997) and Aucott *et al.* (1999).

Geographical Distribution of Emissions

The calculated global emissions of HCFC-22 were distributed among countries using the distribution of CFC-12, calculated in McCulloch *et al.* (1994), as a surrogate. Within each country, emissions were distributed to individual gridsquares using the population distribution in Li (1996).

Results are presented here as the percentage distribution among gridsquares, with no cut-off at low values. Absolute emission from each gridsquare in 1990 should be calculated by multiplying global emission for 1990 in Table 1 by the gridsquare percentages in Table 2. For other years, the distribution in Table 2 should be applied to the global emission for the appropriate year. While global emissions change relatively rapidly, distribution is affected only by relative economic activity and population dynamics, which have slower rates of change with time. It is expected that the distribution can be applied to the years 1985 to 1995 without significantly increasing uncertainty but this has not been tested. It can be applied to years beyond this range only with caution and new distributions for more recent years are under development.

Time Series of Global Emissions

Taken from McCulloch et al., 2002 (itself compiled from AFEAS, 2001 and UNEP, 2002), the time series (1943 to 2000) of HCFC-22 emissions and their uncertainties is shown in Table 1 .

Future emissions will be governed by the controls required by the Montreal Protocol and by the quantity of material currently in the "bank" (that is: material which is in use but has not yet been emitted). A scenario for future releases of HCFC-22 was described in Madronich and Velders (1999). This scenario has been updated and will be published in Fraser and Montzka (2003).

Development

In view of the changes brought about by the Montreal Protocol, it is proposed to revise the distribution functions to provide gridded data for the year 2000.

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Table

Year	**Annual HCFC-22 emission, Mg**		
	Mean	**+ 2 SD**	**- 2 SD**

1947	0	0	0
1948	100	100	0
1949	100	200	100
1950	300	500	200
1951	500	700	300
1952	800	1100	500
1953	1200	1600	700
1954	1600	2200	1000
1955	2100	2900	1300
1956	3400	4500	2200
1957	3900	5400	2500
1958	4800	6500	3100
1959	6800	9100	4600
1960	8000	10700	5300
1961	8700	11500	5900
1962	10700	13900	7500
1963	13100	16700	9600
1964	16300	20500	12200
1965	19000	23900	14200
1966	23300	29000	17600
1967	27800	34700	20900
1968	33800	42200	25500
1969	41100	51400	30800
1970	44700	56000	33400
1971	49600	61400	37700
1972	54200	66500	42000

1973	62200	75100	49400
1974	70300	84400	56300
1975	71100	84500	57700
1976	80100	93800	66500
1977	89300	104100	74500
1978	97600	113300	81900
1979	104700	121500	87800
1980	113000	130600	95400
1981	119500	137700	101300
1982	121200	138000	104400
1983	133100	150100	116000
1984	142800	160500	125000
1985	148600	165800	131500
1986	157700	175300	140100
1987	166500	184200	148700
1988	185600	205400	165800
1989	210500	232800	188300
1990	217100	238600	195700
1991	226500	248200	204800
1992	235400	257300	213500
1993	236200	256500	215800
1994	241300	260500	222200
1995	247600	264800	230400
1996	263700	280900	246500
1997	257300	274300	240200
1998	256500	273500	239600

1999	266700	282700	250800
2000	267600	282400	252900

Table 1: Global Emissions of HCFC-22 (chlorodifluoromethane) from 1947 to 2000

Data in Mg (millions of grams or metric tonnes), SD=Standard Deviation
Compiled by A. McCulloch (archie@marbury.u-net.com)

Based on:
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