Trifluoromethyl Sulfur Pentafluoride (SF_5CF_3) and Sulfur Hexafluoride (SF_6) from Dome Concordia

Graphics Digital Data

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Period of Record

1965-1999

Methods

The sampling and analytical methods are described more fully in Sturges et al. (2000). In summary, air samples were pumped from consolidated deep snow (firn) at Dome Concordia (eastern Antarctica) in December 1998 and January 1999, from the surface to a depth of approximately 100 m. Air samples were analyzed with a gas chromatograph - mass spectrometer, with a detection limit of about 0.001 parts per trillion (ppt). A diffusive transport model was used to calculate the age of samples as a function of depth. Measurements of SF_6 were used to determine the mean age of the firn air by comparison with extrapolated measurements from Cape Grim, Tasmania combined with estimates from industrial emissions (Maiss and Brenninkmeijer 1998, adapted by Sturges et al. 2000). Dates for SF_5CF_3 are different than for SF_6 due to the lower diffusivity of SF_5CF_3: the SF_6 ages were multiplied by the ratio of the free-air diffusion coefficient of SF_5CF_3 to that of SF_6 (1.18). Free-air diffusion coefficients were determined by a semi-empirical formula based on molecular volumes (Fuller et al. 1966). Note that mean ages represent a very wide distribution of probable ages spanning many years, with an increasing spread of ages at increasing depth.

Trends

The measured concentration of SF_5CF_3 increased from zero in 1965-1966 to about 0.12 ppt in 1999, with a current growth rate of about 0.008 ppt per year (about 6% per year). Given the similarity of the growth curves of SF_5CF_3 and SF_6 (which increased from 0.18 ppt in 1970 to 4.0 ppt in 1999), Sturges et al. (2000) speculate that the former may originate as a breakdown product of the latter in high-voltage equipment. While the current radiative forcing of SF_5CF_3 may be minor, the high growth rate and long atmospheric residence time suggest that the greenhouse significance of this gas could increase markedly in the future. Conversely, SF_5CF_3 appears not to have any natural sources, so control might be feasible, once the sources are identified.

References

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A new method for prediction of binary gas-phase diffusion coefficients. *Industrial Engineering and Chemistry* 58:19- 27.

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CITE AS: Sturges, W.T., T. J. Wallington, M. D. Hurley, K. P. Shine, K. Sihra, A. Engel, D. E. Oram, S. A. Penkett, R. Mulvaney, and C. A. M. Brenninkmeijer. 2000. Trifluoromethyl Sulfur Pentafluoride (SF_5CF_3) and Sulfur Hexafluoride (SF_6) from Dome Concordia. In Trends: A Compendium of Data on Global Change. Carbon Dioxide Information Analysis Center, Oak Ridge National Laboratory, U.S. Department of Energy, Oak Ridge, Tenn., U.S.A.

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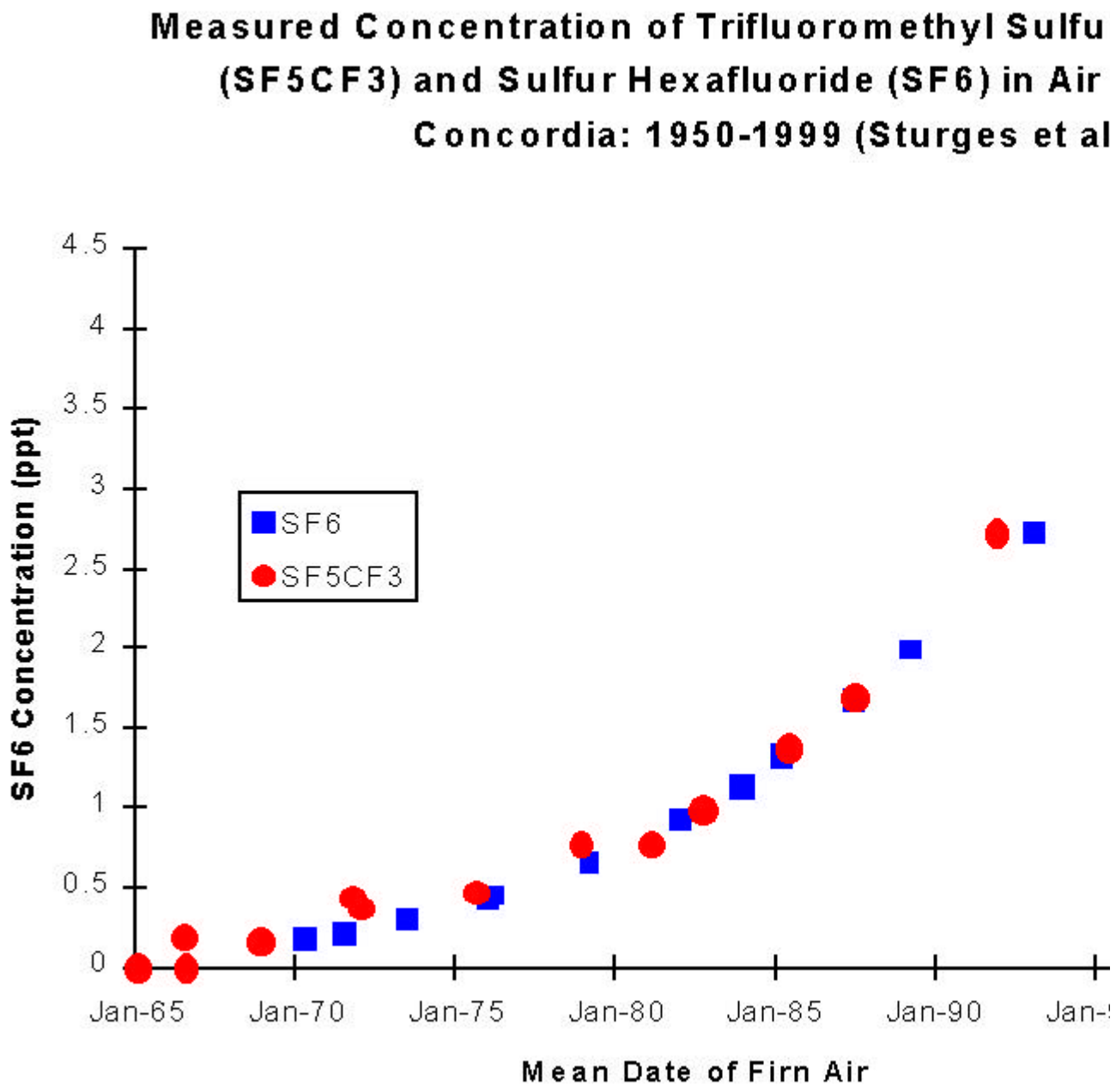
Measured Concentration of Trifluoromethyl Sulfu
(SF5CF3) and Sulfur Hexafluoride (SF6) in Air
Concordia: 1950-1999 (Sturges et al
SF6 Concentration (ppt)
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
SF6
SF5CF3
Jan-65
Jan-70
Jan-75
Jan-80
Jan-85
Jan-90
Mean Date of Firn Air

Trifluoromethyl Sulfur Pentafluoride (SF5CF3) and
Sulfur Hexafluoride (SF6) from Dome Concordia


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*** Last revision - October 2000                                      ***
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Date	SF6 concentration (ppt)	SF5CF3 concentration (ppt)
February 10, 1965		0.0000
August 1, 1966		0.0053
September 7, 1966		0.0000
December 10, 1968		0.0051
April 1, 1970	0.18	
July 1, 1971	0.21	
August 1, 1971	0.21	
November 22, 1971		0.0130
February 1, 1972		0.0111
July 1, 1973	0.29	
September 20, 1975		0.0143
January 1, 1976	0.42	
March 1, 1976	0.43	
January 24, 1979		0.0235
April 1, 1979	0.64	
March 21, 1981		0.0237
February 1, 1982	0.92	
September 10, 1982		0.0307
December 1, 1983	1.14	
March 1, 1985	1.32	
June 10, 1985		0.0426
July 1, 1987	1.67	
July 4, 1987		0.0523
April 1, 1989	1.97	
January 12, 1992		0.0845
February 1, 1993	2.72	
October 27, 1997		0.1147
January 1, 1998	3.88	
January 1, 1999	4.03	
January 1, 1999	3.97	

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January 1, 1999                                    0.1218
January 1, 1999                                    0.1220
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Other Atmospheric Trace Gases

In addition to carbon dioxide (CO_2), several other atmospheric trace gases are radiatively active, and thereby can contribute to a greenhouse warming of the lower atmosphere. Some of these other greenhouse gases include methane (CH_4), nitrous oxide (N_2), ozone (O_3), and halocarbons. The combined radiative forcing from these other trace gases is approximately equal to that of CO_2 (Prather et al. 1996).

A recent paper by Sturges et al. identified trifluoromethyl sulfur pentafluoride (SF_5CF_3) as a previously unreported gas that is long-lived (an atmospheric residence of several hundred to several thousand years) and with significant global warming potential (perhaps 18,000 times that of CO_2 on a unit-mass basis). The database included here quantifies atmospheric concentrations of SF_5CF_3 and sulfur hexafluoride (SF_6), another greenhouse gas, from 1965 through 1999, based on samples obtained from firn (deep consolidated snow) at Dome Concordia (eastern Antarctica).

References

Prather, M., R. Derwent, D. Ehhalt, P. Fraser, E. Sanhueza, and X. Zhou. 1996. Radiative forcing of climate change: Other trace gases and atmospheric chemistry. pp. 86-103 In J.T. Houghton, L.G. Meira Filho, B.A. Callender, N. Harris, A. Kattenberg, and K. Maskell (eds.). *Climate Change 1995: The Science of Climate Change*. Cambridge University Press, Cambridge, U.K.

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