Trends of halocarbons observed in Ny-Ålesund

Ann Mari Fjæraa[1], Frode Stordal[1,2], Ove Hermansen[1], Chris Lunder[1],
Norbert Schmidbauer[1], Cathrine Lund Myhre[1]

1 Norwegian Institute for Air Research (NILU), P.B. 100 N-2027 Kjeller, Norway
2 Department of Geosciences, UiO, P.B. 1022 Blindern N-0315 Oslo, Norway

Introduction

Continuous measurements of halogenated greenhouse gases in the Norwegian Arctic were initiated in 2000 at Mt. Zeppelin observatory (78°54' N, 11°54' E, 474 masl.) A wide range of halogenated greenhouse gases are measured in situ at this background station. Measurements are performed at high frequency by the use of an automated gas chromatograph with a mass spectrometry detector (GCMS).

This poster presents a summary of observations from 2001 – 2006, which are analyzed for trends and seasonal cycles.

Fig. 1

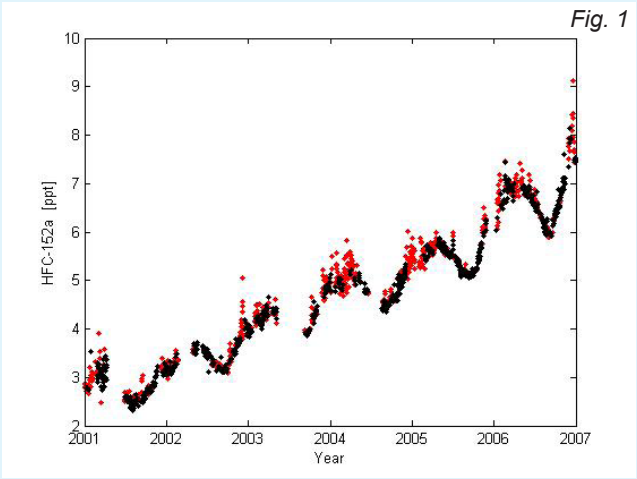
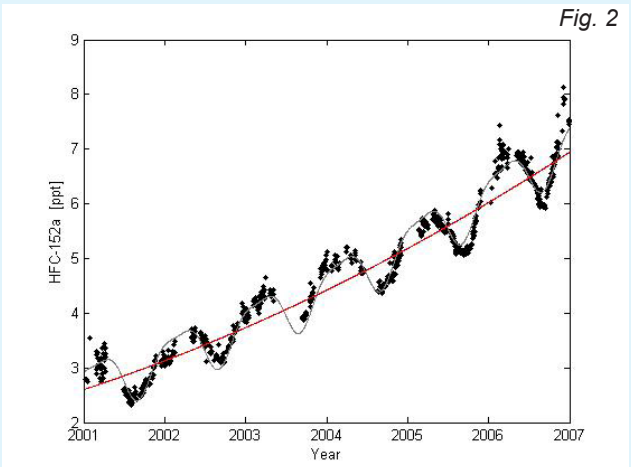


Fig. 2



Methods and observations

Long term monotonic trends and seasonal cycles are studied in this work. Based on the daily mean concentrations, an algorithm is selected to identify observations representing clean background air. Back trajectories arriving at the Zeppelin observatory have been used for this purpose. They were calculated for 7 days based on winds from the ECMWF. If at least 75% of the trajectories within +/- 12 h of the sampling day are coming from Atlantic or Artic sectors, we label them as baseline cases. The remaining trajectories from European, Russian or North-American sector represent polluted events.

Figure 1 shows daily means of HFC-152a (ppt) at Mt.Zeppelin, Svalbard (2001-2006), with baseline data shown in black and pollution events indicated in red. Most of the spikes, i.e. assumed polluted events, are removed during the filtering.

To calculate trends and seasonal cycles in the baseline concentrations, the observations have been fit by a function of Legendre polynomials in combination with annual and semi-annual harmonic terms as given in Equation 1. Figure 2 shows the background data in terms of this function (grey line) for HFC-152a, as well as individual daily average data. The red line is the trend line of 2nd degree (three first terms in Equation 1). Trends for the period 2001 – 2006 were calculated for all measured compounds at Mt. Zeppelin. For HFC-152a, the numbers that describe the mean, trend and growth in the trend are: a) 4.54 ppt, b) 0.72 ppt/year, and d) 0.08 ppt/year2.

Eq. 1

$$x(t) = a + b(N/12)*P1(t/N - 1) + 1/3d(N/12)2 *P_2(t/N - 1) + c_1*cos(2\pi*t) + s_1*sin(2\pi*t) + c_2*cos(4\pi*t) + s_2*sin(4\pi*t)$$

The observed f can be expressed as functions of time measures from the 2N-months interval of interest. The coefficient a defines the average mole fraction, b defines the trend in the mole fraction and d defines the acceleration in the trend. The c and s define the annua cycle in mole fraction. N is the mid point of the period of investigation."

Main findings

- The main findings for some selected components are listed in Table 1.
- Positive trends in the background concentrations were observed for substances which are used as CFC-substitutes (hydrofluorcarbons, hydrochlorofluorcarbons). Background concentrations in the HFCs at Ny-Alesund increased from January
- 2001 to December 2006 as follows: HFC-134a from 21.43 ppt to 45.13 with an average growth rate of 4.74 ppb/year, HFC-152a from 2.90 ppt to 6.63 with a major growth rate of 0.72 ppb/year and HCFC-142b from14.99 ppt to 18.74 ppt.
- All peak concentrations of the measured gases were significantly lower at Ny-Alesund than at other measurement sites in the SOGE network, due to the station's remote location and the amplitudes of polluted events are small and the episodes are rare.
- While the CFCs are about to level out or in case of CFC-11 decreasing, the HCFCs are showing moderate increase rates. The HFC concentrations in the atmosphere are still showing substantial yearly increase.
- HFC-134a and HFC-152a were estimated to have the greatest increase in the mixing ratios at Mt.Zeppelin in the 2001- 2006 period, which is consistent with their high European emissions. HFC-152a had an increase of more than 220% in the 6 years of investigation.

Component	*2001*	*2002*	*2003*	*2004*	*2005*	*2006*	*a) Mean 2001-2006*	*b) Trend*	*d) Growth in trend*	*s1) Sin1*	*c1) Cos1*	*s2) Sin2*	*c2) Cos2*
CFC-11	263.44	263.35	262.60	261.18	259.08	256.32	260.99	-1.42	-0.67	0.39	0.44	-0.47	0.56
CFC-115	8.33	8.49	8.59	8.63	8.61	8.54	8.53	0.04	-0.06	-0.01	0.03	0.00	0.05
HFC-134a	21.42	26.35	31.18	35.92	40.57	45.13	33.43	4.74	-0.09	-0.01	0.60	-0.08	-0.08
HFC-152a	2.90	3.45	4.10	4.84	5.69	6.63	4.60	0.75	0.10	0.41	0.20	-0.11	0.05
HCFC-142b	14.99	15.59	16.26	17.01	17.83	18.74	16.74	0.75	0.08	-0.02	0.18	-0.08	0.07