4.2. RESULTS IN URBAN AREA

(1) Results of Automatic Measurements

Monthly and annual medians, means, 20% values, 80% values, maximum values, and numbers of the valid data for CFC-11, CFC-12, HCFC-22, HCFC-141b, HCFC-142b, methyl bromide, and HFC-134a calculated from the results of the measurements achieved by the use of the automatic measuring apparatus obtained during March 2007-February 2008 are shown in **Table 4.6.1-Table 4.6.7**. The "median" is a value of the ”0.5 x N”th result of the N results arranged in order of size. The "20% value" is a value of the ”0.2 x N”th result and "80% value" is a value of the “0.8 x N”th results of the N results arranged in ascending order, respectively.

(A) CFC-11

The annual median, mean, and number of valid results for CFC-11 were 0.31 ppbv, 0.31 ppbv, and 1,474, respectively. The annual maximum value was 2.1 ppbv. The annual 20% value was 0.28 ppbv. The annual median and the 20% value did not differ largely from those of the previous fiscal year. The annual median and the 20% value approached the background level and this indicates that emissions of this substance into the air decreased as a whole. However, the annual 80% value was 0.33 ppbv, and this value is still large. Although not frequently, concentrations that reached several times the background level were detected. This indicates that emissions of this substance still continue.

(B) CFC-12

The annual median, mean, and number of valid results of CFC-12 was 0.59 ppbv, 0.60 ppbv, and 1,477, respectively. High concentrations which reached several ppbv were sometimes detected. This indicates that isolated emission of this substance still continues.

(C) HCFC-22

The annual median, mean, and number of valid results for HCFC-22 were 0.68 ppbv, 2.5 ppbv, and 1,477, respectively. The annual median exceeded three times the background level (= 0.2 ppbv). The annual 20% value was several times the background level. Extremely high concentrations were frequently detected. This indicates that a large amount of this substance is being discharged in the urban area.

(D) HCFC-141b

The annual median, mean, and number of valid results for HCFC-141b were 0.077 ppbv, 0.113 ppbv, and 1,474, respectively. The annual median closed to four times the background level (= 0.02 ppbv). The annual 20% value exceeded twice the background level. This indicates that a considerable amount of this substance is being discharged in the urban area.

(E) HCFC-142b

The annual median, mean, and number of valid results for HCFC-142b were 0.030 ppbv, 0.034 ppbv, and 1,477, respectively. The annual 20% value was close to the background level (= 0.02 ppbv). This indicates that this substance is being discharged in the urban area, although the amount of the emissions is little.

(F) Methyl Bromide

The annual median, mean, and number of valid results for methyl bromide were 0.013 ppbv, 0.026

ppbv, and 1,452, respectively. The annual 20% value was closed to the background level (= 0.009 ppbv). This indicates that this substance is being discharged in the urban area, although the amount of the emissions is little.

(G) HFC-134a

The annual median, mean, and number of valid results for HFC-134a were 0.14 ppbv, 0.33 ppbv, and 1,477, respectively. The annual median closed to three times the background level (= 0.05 ppbv). This indicates that a large amount of this substance is being discharged in the urban area.

Table 4.6.1. Statistical summaries of concentrations of the measured substances in air of urban area obtained through the automatic measurements (CFC-11) (Unit : ppbv)

Period of Calculation	Median	Mean	20%Valuue	80%Value	Maximum	n
March 2007	0.29	0.29	0.26	0.32	0.33	16
April 2007	0.29	0.29	0.28	0.30	0.34	132
May 2007	0.30	0.31	0.29	0.32	0.55	118
June 2007	0.31	0.34	0.29	0.34	0.56	100
July 2007	0.32	0.34	0.29	0.34	2.1	126
August 2007	0.32	0.35	0.29	0.36	0.90	149
September 2007	0.34	0.30	0.32	0.38	0.72	129
October 2007	0.29	0.32	0.27	0.32	0.44	142
November 2007	0.32	0.29	0.30	0.35	0.42	143
December 2007	0.28	0.28	0.26	0.31	1.7	133
January 2008	0.27	0.32	0.26	0.28	0.86	149
February 2008	0.32	0.32	0.30	0.32	0.41	137
March 2007-February 2008	0.31	0.31	0.28	0.33	2.1	1,474

Note 1) "Median" is a value of the “0.5 x N”th result of the N results arranged in order of size. The "20% value" is a value of the “0.2 x N”th result and the "80% value" is a value of the”0.8 x N”th results of the N results arranged in ascending order, respectively. (Hereafter the same.)

Note 2) "n" is the number of valid results.

Table 4.6.2. Statistical summaries of concentrations of the measured substances in air of urban area obtained through the automatic measurements (CFC-12) (Unit : ppbv)

Period of Calculation	Median	Mean	20%Value	80%Value	Maximum	n
March 2007	0.56	0.55	0.52	0.57	0.62	16
April 2007	0.56	0.56	0.54	0.57	0.60	132
May 2007	0.58	0.58	0.56	0.60	0.82	118
June 2007	0.58	0.57	0.55	0.60	0.64	91
July 2007	0.61	0.61	0.58	0.63	0.84	126
August 2007	0.59	0.60	0.58	0.61	0.77	149
September 2007	0.64	0.64	0.61	0.67	0.86	129
October 2007	0.58	0.59	0.56	0.61	0.73	142
November 2007	0.58	0.59	0.56	0.60	0.89	143
December 2007	0.58	0.59	0.56	0.61	2.2	135
January 2008	0.58	0.59	0.57	0.60	0.71	149
February 2008	0.65	0.67	0.63	0.68	1.4	137
March 2007-February 2008	0.59	0.60	0.56	0.63	2.2	1,467

Table 4.6.3. Statistical summaries of concentrations of the measured substances in air of urban area obtained through the automatic measurements (HCFC-22) (Unit : ppbv)

Period of Calculation	Median	Mean	20%Value	80%Value	Maximum	n
March 2007	0.58	0.69	0.46	0.85	1.1	16
April 2007	0.80	0.88	0.62	1.1	4.2	132
May 2007	0.72	0.86	0.47	1.1	3.7	118
June 2007	0.48	0.54	0.35	0.71	1.1	101
July 2007	0.60	0.70	0.42	0.83	4.6	126
August 2007	0.44	0.56	0.34	0.73	2.5	149
September 2007	0.51	0.67	0.35	0.80	5.5	129
October 2007	0.63	0.80	0.46	0.94	3.8	142
November 2007	2.8	2.9	2.0	3.6	7.0	143
December 2007	0.62	0.99	0.42	1.3	4.9	135
January 2008	0.54	0.68	0.41	0.83	3.3	149
February 2008	19.2	17.4	1.0	29	47	137
March 2007-February 2008	0.68	2.5	0.42	1.6	47	1,477

Table 4.6.4. Statistical summaries of concentrations of the measured substances in air of urban area obtained through the automatic measurements (HCFC-141b) (Unit : ppbv)

Period of Calculation	Median	Mean	20%Value	80%Value	Maximum	n
March 2007	0.043	0.052	0.037	0.061	0.10	16
April 2007	0.055	0.066	0.042	0.078	0.31	132
May 2007	0.066	0.091	0.046	0.105	0.81	118
June 2007	0.062	0.075	0.039	0.094	0.68	100
July 2007	0.077	0.105	0.052	0.143	0.87	126
August 2007	0.055	0.078	0.037	0.100	0.43	149
September 2007	0.071	0.100	0.044	0.114	0.89	129
October 2007	0.088	0.157	0.061	0.189	2.2	142
November 2007	0.263	0.266	0.184	0.34	0.70	143
December 2007	0.090	0.117	0.039	0.173	0.77	133
January 2008	0.050	0.067	0.031	0.096	0.29	149
February 2008	0.107	0.108	0.051	0.141	0.33	137
March 2007-February 2008	0.077	0.113	0.044	0.158	2.2	1,474

Table 4.6.5. Statistical summaries of the concentrations of the measured substances in air of urban area obtained through the automatic measurements (HCFC-142b) (Unit : ppbv)

Period of Calculation	Median	Mean	20%Value	80%Value	Maximum	n
March 2007	0.023	0.026	0.021	0.028	0.046	16
April 2007	0.024	0.025	0.022	0.027	0.051	132
May 2007	0.028	0.031	0.025	0.034	0.074	118
June 2007	0.027	0.031	0.024	0.035	0.080	101
July 2007	0.032	0.036	0.026	0.042	0.27	126
August 2007	0.031	0.036	0.026	0.043	0.111	149
September 2007	0.031	0.036	0.027	0.041	0.101	129
October 2007	0.031	0.035	0.027	0.042	0.077	142
November 2007	0.039	0.043	0.032	0.051	0.084	143
December 2007	0.033	0.035	0.024	0.043	0.134	135
January 2008	0.026	0.030	0.023	0.035	0.079	149
February 2008	0.032	0.033	0.029	0.037	0.063	137
March 2007-February 2008	0.030	0.034	0.025	0.040	0.27	1,477

Table 4.6.6. Statistical summaries of concentrations of the measured substances in air of the urban area obtained through the automatic measurements (Methyl bromide) (Unit : ppbv)

Period of Calculation	Median	Mean	20%Value	80%Value	Maximum	n
March 2007	0.017	0.025	0.012	0.024	0.096	16
April 2007	0.013	0.018	0.012	0.017	0.166	119
May 2007	0.014	0.017	0.012	0.019	0.057	118
June 2007	0.013	0.021	0.011	0.016	0.58	101
July 2007	0.015	0.066	0.012	0.022	5.8	126
August 2007	0.014	0.016	0.011	0.018	0.093	149
September 2007	0.014	0.018	0.012	0.020	0.075	129
October 2007	0.013	0.017	0.011	0.017	0.36	142
November 2007	0.014	0.018	0.011	0.018	0.46	143
December 2007	0.014	0.071	0.011	0.020	6.7	123
January 2008	0.011	0.013	0.010	0.014	0.056	149
February 2008	0.012	0.015	0.011	0.015	0.132	137
March 2007-February 2008	0.013	0.026	0.011	0.018	6.7	1,452

Table 4.6.7. Statistical summaries of concentrations of the measured substances in air of urban area obtained through the automatic measurements (HFC-134a) (Unit : ppbv)

Period of Calculation	Median	Mean	20%Value	80%Value	Maximum	n
March 2007	0.136	0.171	0.085	0.173	0.66	16
April 2007	0.111	0.47	0.079	0.26	24	132
May 2007	0.105	0.39	0.077	0.20	28	118
June 2007	0.106	0.170	0.069	0.161	3.7	101
July 2007	0.136	0.23	0.091	0.28	2.6	126
August 2007	0.130	0.184	0.081	0.25	1.12	149
September 2007	0.131	0.36	0.093	0.25	11.0	129
October 2007	0.131	0.22	0.093	0.22	4.6	142
November 2007	0.23	0.70	0.149	0.44	38	143
December 2007	0.177	0.30	0.084	0.35	3.8	135
January 2008	0.110	0.192	0.073	0.20	4.3	149
February 2008	0.154	0.40	0.100	0.36	8.3	137
March 2007-February 2008	0.136	0.33	0.086	0.28	38	1,477

(2) Changes in Concentrations of Measured Substances in Urban Area

The summarized annual results of the concentrations of measured substances in the urban area from March 1991 to February 2007 measured using an automatic measuring apparatus are shown in **Table 4.7.1 - 4.7.2**. The results shown in these tables are calculated from the measured concentrations obtained in the period of a fiscal year from March 2006 to the following February. The plots of the monthly statistics on the concentrations of CFC-11 and CFC-12 in the period mentioned above are shown in **Figure 4.4**. Among the statistical results shown in **Table 4.7.1 - 4.7.2**, the medians of CFC-11 and CFC-12 obtained in recent years approach the background levels and have been almost stable since 1993. Since other substances have been observed from the previous year, their behavior in terms of variation in the concentrations is not well known. The medians of concentrations of almost all these substances are about twice the background level.

Table 4.7.1. Annual summaries of concentrations of the measured substances in air of urban area obtained through the automatic measurements (CFC-11 and CFC-12) (Unit : ppbv)

Period	CFC-11				CFC-12			
	Median	80% Value	20% Value	n	Median	80% Value	20% Value	n
Mar 1991 - Feb 1992	0.42	0.57	0.35	3,880	0.72	1.0	0.59	3,905
Mar 1992 - Feb 1993	0.37	0.51	0.30	4,194	0.65	0.88	0.55	4,195
Mar 1993 - Feb 1994	0.32	0.39	0.29	4,297	0.56	0.76	0.54	4,296
Mar 1994 - Feb 1995	0.30	0.38	0.27	4,101	0.61	0.78	0.55	4,100
Mar 1995 - Feb 1996	0.30	0.37	0.27	4,024	0.59	0.67	0.55	4,015
Mar 1996 - Feb 1997	0.28	0.32	0.26	4,065	0.57	0.65	0.54	4,064
Mar 1997 - Feb 1998	0.28	0.30	0.26	3,718	0.60	0.72	0.54	3,727
Mar 1998 - Feb 1999	0.28	0.32	0.26	3,023	0.63	0.76	0.54	3,020
Mar 1999 - Feb 2000	0.29	0.32	0.27	4,159	0.60	0.70	0.57	4,159
Mar 2000 - Feb 2001	0.30	0.33	0.28	3,812	0.58	0.64	0.56	3,809
Mar 2001 - Feb 2002	0.29	0.33	0.28	4,220	0.62	0.68	0.58	4,219
Mar 2002 - Feb 2003	0.29	0.32	0.28	4,162	0.59	0.63	0.57	4,159
Mar 2003 - Feb 2004	0.28	0.31	0.27	4,304	0.58	0.61	0.56	4,304
Mar 2004 - Feb 2005	0.28	0.31	0.27	4,195	0.57	0.60	0.56	4,193
Mar 2005 - Feb 2006	0.28	0.30	0.27	4,012	0.57	0.59	0.55	4,009
Mar 2006 - Feb 2007	0.29	0.36	0.27	1,519	0.57	0.61	0.53	1,516
Mar 2007 - Feb 2008	0.31	0.33	0.28	1,474	0.59	0.63	0.56	1,467

Note 1) The "median" is a value of the “0.5 x N”th result of the N results arranged in order of size. The "20% value" is a value of the “0.2 x N”th result and "80% value" is a value of the ”0.8 x N”th results of the N results arranged in ascending order, respectively. (Hereafter the same.)

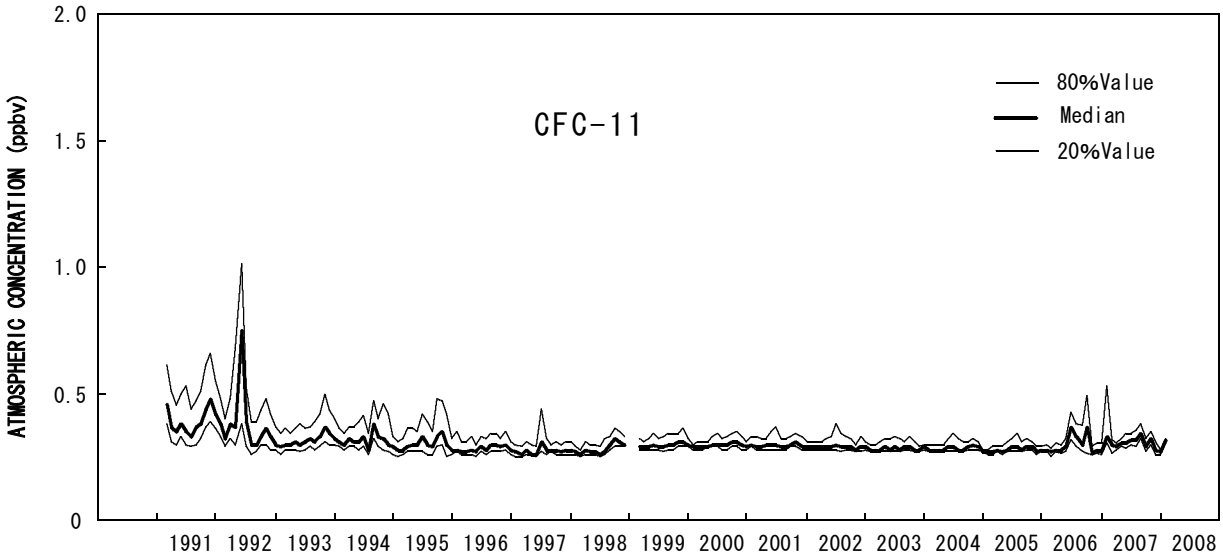
Note 2) The "n" is the number of valid results.

Table 4.7.2. Annual summaries of concentrations of the measured substances in air of urban area obtained through the automatic measurements
(HCFC-22, HCFC-141b, HCFC-142b, methyl bromide, and HFC-134a) (Unit : ppbv)

Period	HCFC-22				HCFC-141b			
	Median	80% Value	20% Value	n	Median	80% Value	20% Value	n
Mar 2006 - Feb 2007	0.65	1.1	0.42	1,519	0.075	0.14	0.047	1,519
Mar 2007 - Feb 2008	0.68	1.6	0.42	1,477	0.077	0.16	0.044	1,474

Period	HCFC-142b				Methyl bromide			
	Median	80% Value	20% Value	n	Median	80% Value	20% Value	n
Mar 2006 - Feb 2007	0.028	0.037	0.022	1,519	0.022	0.035	0.015	1,519
Mar 2007 - Feb 2008	0.030	0.040	0.025	1,477	0.013	0.018	0.011	1,452

Period	HFC-134a			
	Median	80% Value	20% Value	n
Mar 2006 - Feb 2007	0.090	0.28	0.042	1,519
Mar 2007 - Feb 2008	0.136	0.28	0.086	1,477



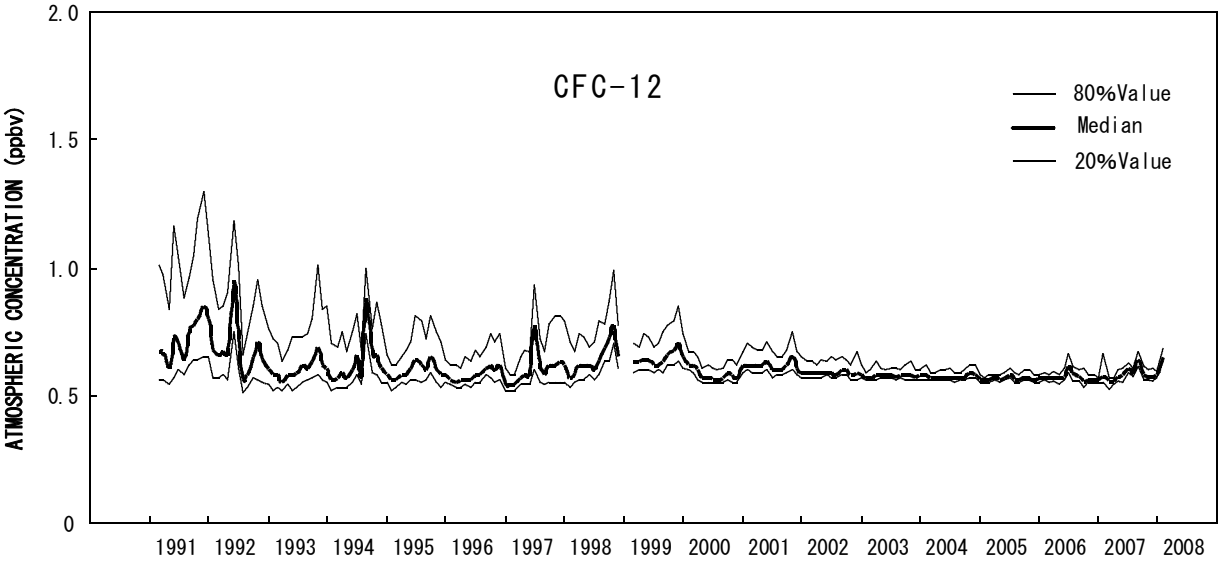


Figure 4.4.1 Monthly concentrations of CFC-11 and CFC-12 in urban air (Kawasaki) March 1991-February 2008. Solid thick line represents median, the upper and lower solid thin lines represent 60% ranges.

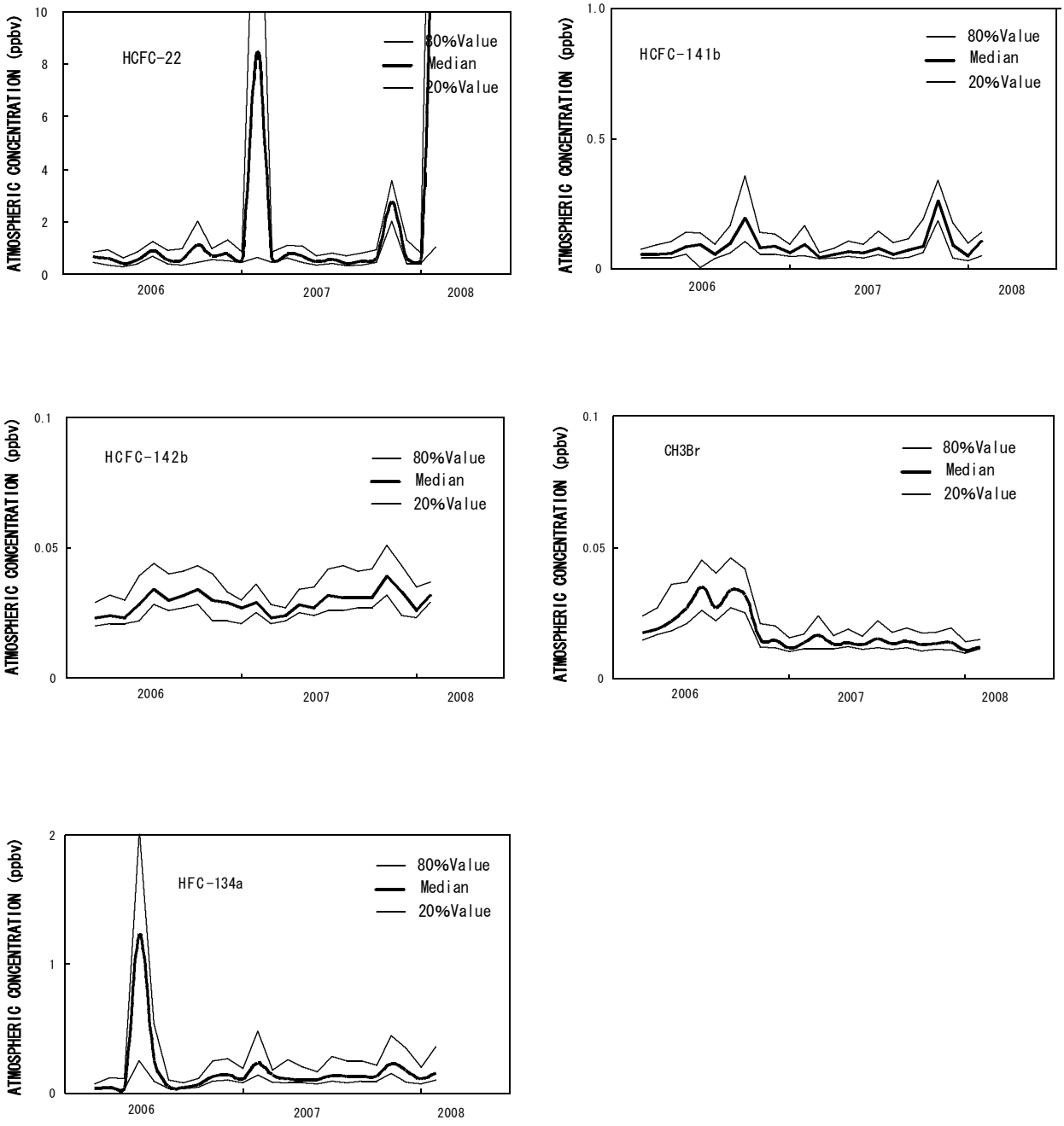


Figure 4.4.2. Monthly concentrations of HCFC-22, HCFC-141b, HCFC-142b, methyl bromide, and HFC-134a in urban air (Kawasaki)

March 2006 - February 2008. Solid thick line represents median, the upper and lower solid thin lines represent 60% ranges.

(3) Relationship between the concentrations and wind direction in urban area

To examine the relationship between the atmospheric concentrations of the measured substances and the wind direction, mean concentrations according to wind direction were calculated from the one year of measurements obtained from March 2007 to February 2008 using the automatic measurement equipment. The results are plotted on the 16-point wind directions in Figure 4.5. The averages are used in the analysis because; 1) averages were used in similar analyses in the previous reports, 2) averages emphasize the differences in the variations in the concentrations more than the medians do.

The following are the results of this analysis described according to the respective substances. The concentration values described here mean the averages of the results of the measurements according to the wind direction (a typical sample number is about 100).

(CFC-11)

The figure of the concentration-wind rose for CFC-11 is almost round. This indicates that there is no significant emission source in a specific direction. The concentrations are close to the background level in any wind direction.

(CFC-12)

The figure of the concentration-wind rose for CFC-12 is almost round. This indicates that there is no significant emission source in a specific direction. The concentrations are close to the background level in any wind direction.

(HCFC-22)

The figure of the concentration-wind rose for HCFC-22 is not round. The concentrations rise higher in the northwest ～ north and southwest directions. The highest concentration exceeds 30 times the background level. In the southwest direction, the concentration is the lowest, however it is still three times the background level.

(HCFC-141b)

The figure of the concentration-wind rose for HCFC-141b is not round. The concentrations rise higher in the west ～ north and northeast ～ east directions. In the southwest direction, the concentration is the lowest, however, it is still three times the background level.

(HCFC-142b)

The atmospheric concentrations of HCFC-142b slightly rise in west ～ northwest direction. The concentrations are stable in the other directions and they are close to the background level.

(Methyl bromide)

The figure of the concentration-wind rose for methyl bromide is not round. It has a sharp and high peak in the south-southeast direction. It also has some small peaks in the south-southwest ～ west-northwest direction. The concentrations are close to the background level in the other directions.

(HFC-134a)

The figure of the concentration-wind rose for HFC-134a is not round. It has sharp peaks in the east, west-southwest, and northwest directions. No significant peak is found in other directions, however, the concentrations are obviously higher than the background level.

To examine the relationship between the concentrations of the measured substances and the wind direction, the mean concentrations were calculated from the one year of measurements according to wind direction and analyzed. Almost no variation was found in the atmospheric concentrations of CFC-11 and CFC-12 depending upon the wind direction. This indicates that there is no significant emission source of these substances in this area and few emission sources that are gathered in a specific direction. The analysis

assumed that the amount of HCFC-142b being emitted in the area is not so large, but that large amounts of HCFC-22, HCFC-141b, and HFC-134a are being emitted in the area while a not so large amount of methyl bromide is being emitted from a specific and small area.

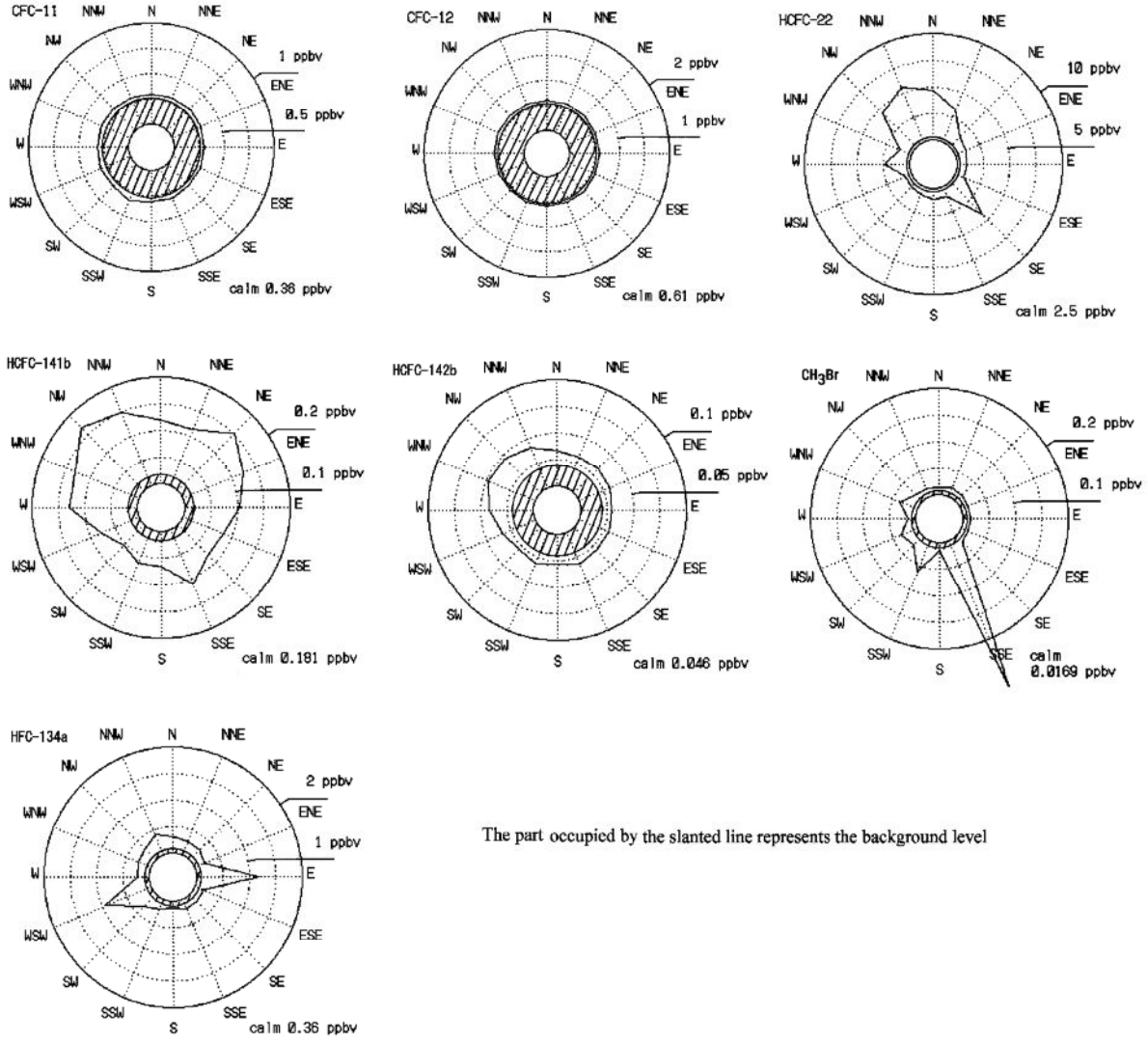


Figure 4.5. The atmospheric concentration-distributions of the measured substances in the urban area according to wind direction (mean values, March 2007-February 2008)

(4) Relationship between the concentrations and time of day in urban area

To examine the relationship between the atmospheric concentrations of the measured substances and the time of day, the medians of the concentrations according to the hour of the day were calculated from the one year of measurements obtained from March 2007 to February 2008 using the automatic measurement equipment. The results are illustrated in Figure 4.6.

The following are the results of this analysis described according to the respective substances. The concentration values described here mean the medians of the results of the measurements according to the hour of the day（a typical sample number is about 65）.

（CFC-11）

The atmospheric concentrations of CFC-11 vary slightly according to the hour of the day. The concentrations slightly decreased in the afternoons in the daytime.

（CFC-12）

No significant diurnal variation is found in the atmospheric concentrations of CFC-12.

（HCFC-22）

The atmospheric concentrations of HCFC-22 increased before noon in the daytime and decreased between the afternoons of the daytime and the nighttime.

（HCFC-141b）

Diurnal variations are found in the atmospheric concentrations of HCFC-141b. The tendency of the variation is similar to that of HCFC-22.

（HCFC-142b）

Diurnal variations are found in the atmospheric concentrations of HCFC-142b. The tendency of the variation is similar to that of HCFC-22 and of HCFC-141b as well.

（Methyl bromide）

No significant diurnal variation is found in the atmospheric concentrations of methyl bromide.

（HFC-134a）

The atmospheric concentrations of HFC-134a increased in the daytime and decreased in the nighttime. The concentrations of HCFCs showed a difference between before noon of the daytime and the afternoon of the daytime, but this substance showed no tendency like this.

To examine the relationship between the concentrations and the time of day, the medians of the concentrations according to the hour were calculated from the one year of measurements and analyzed.

The diurnal variations in the atmospheric concentrations of CFC-11 and CFC-12 are small because the amounts from the emission of these substances are expected to be small in this area. The diurnal variation in the atmospheric concentrations of methyl bromide is small as well. The atmospheric concentrations of HCFCs and HFC-134a varied depending upon the hour of the day. They increased in the daytime hours and decreased in the nighttime hours. The differences in the concentrations between the daytime and nighttime hours are smaller than expected. These results must be understood as involving; 1）differences in the amounts of emissions between the daytime and nighttime hours, 2）delays in the variation of the concentrations that are described in the next section, 3）differences in meteorological conditions. The atmospheric concentrations of HCFCs showed a tendency to decrease in the afternoon of the daytimes.

Since these simple hourly statistical calculations will be affected by differences in the meteorological conditions between the daytime and the nighttime, these results must be considered as involving both the emissions and the meteorological conditions.

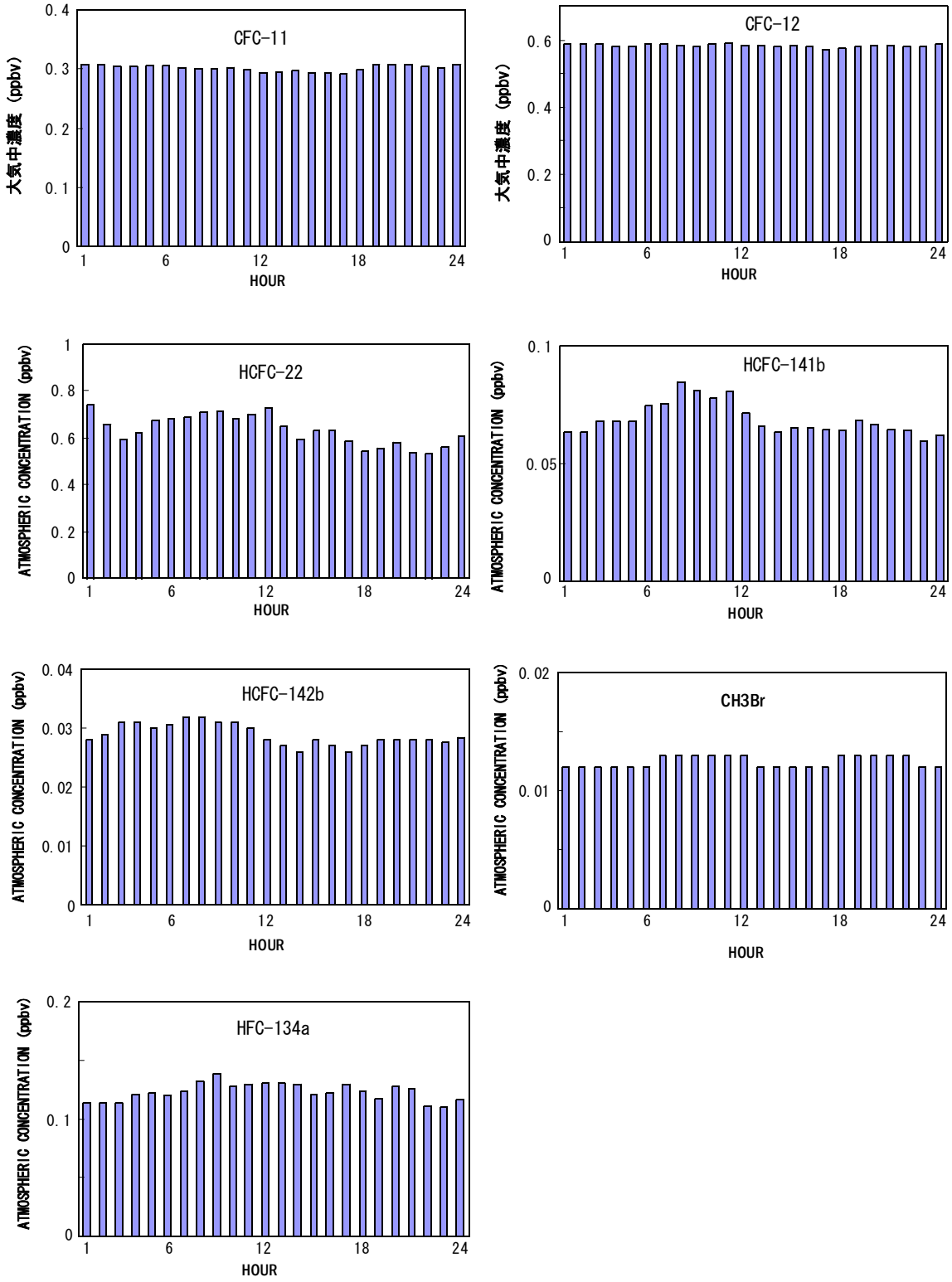


Figure 4.6. Diurnal variations of the atmospheric concentrations of the measured substances in the urban area (medians, March 2007-February 2008)

(5) Relationship between the concentrations and the days of the week in urban area

To examine the relationship between the atmospheric concentrations of the measured substances and the days of the week, the medians of the concentrations according to each day of the week are calculated from the one year of measurements obtained from March 2007 to February 2008 using the automatic measurement equipment. The results are illustrated in Figure 4.7.

The following are the results of this analysis described according to the respective substances. The concentration values described here mean the medians of the results of the measurements according to the day of the week（the typical sample number is about 220）.

（CFC-11）

The atmospheric concentrations of CFC-11 slightly decreased from Sundays to Mondays, but the tendency of the variations is not obvious.

（CFC-12）

No significant variation is found in the atmospheric concentrations of CFC-12 from Sundays to Mondays.

（HCFC-22）

The atmospheric concentrations of HCFC-22 obviously decreased on Sundays.

（HCFC-141b）

The atmospheric concentrations of HCFC-141b vary over Sundays to Mondays. The tendency of the variation is similar but much more obvious compared to that of HCFC-22.

（HCFC-142b）

The atmospheric concentrations of HCFC-142b only slightly decreased from Sundays to Mondays, but the tendency of the variations is not obvious.

（Methyl bromide）

The atmospheric concentrations of methyl bromide slightly decreased from Saturdays to Mondays.

（HFC-134a）

The atmospheric concentrations of HFC-134a obviously decreased from Saturdays to Mondays.

To examine the relationship between the concentrations and the day of the week, the medians of the concentrations according to the day of the week are calculated from the one year of measurements and analyzed.

Results from the statistical calculations according to the day of the week are expected to not be affected by the meteorological conditions. It is therefore expected that the human activities in this urban area directly resulted in the variations in the atmospheric concentrations calculated according to the day of the week. The variations in the atmospheric concentrations of CFC-11 and CFC-12 from Sundays to Mondays were small. Large amounts of these substances are no longer emitted in this area, thus the results are comprehensible. The atmospheric concentrations of HCFCs, methyl bromide, and HFC-134a vary depending upon the days of the week. They have a tendency to decrease from the weekends to Mondays. These are the results of the variations in emissions according to human activities in this urban area.

The atmospheric concentrations of almost all the substances are obviously lower on Mondays than on the days from Tuesday to Friday, but are rather similar to that on Sundays. Since it is possible to presume that human activities in this urban area are constant from Mondays through to Fridays, these results show that the increased emissions on Mondays raised the concentrations to certain levels with a lag of about one day.

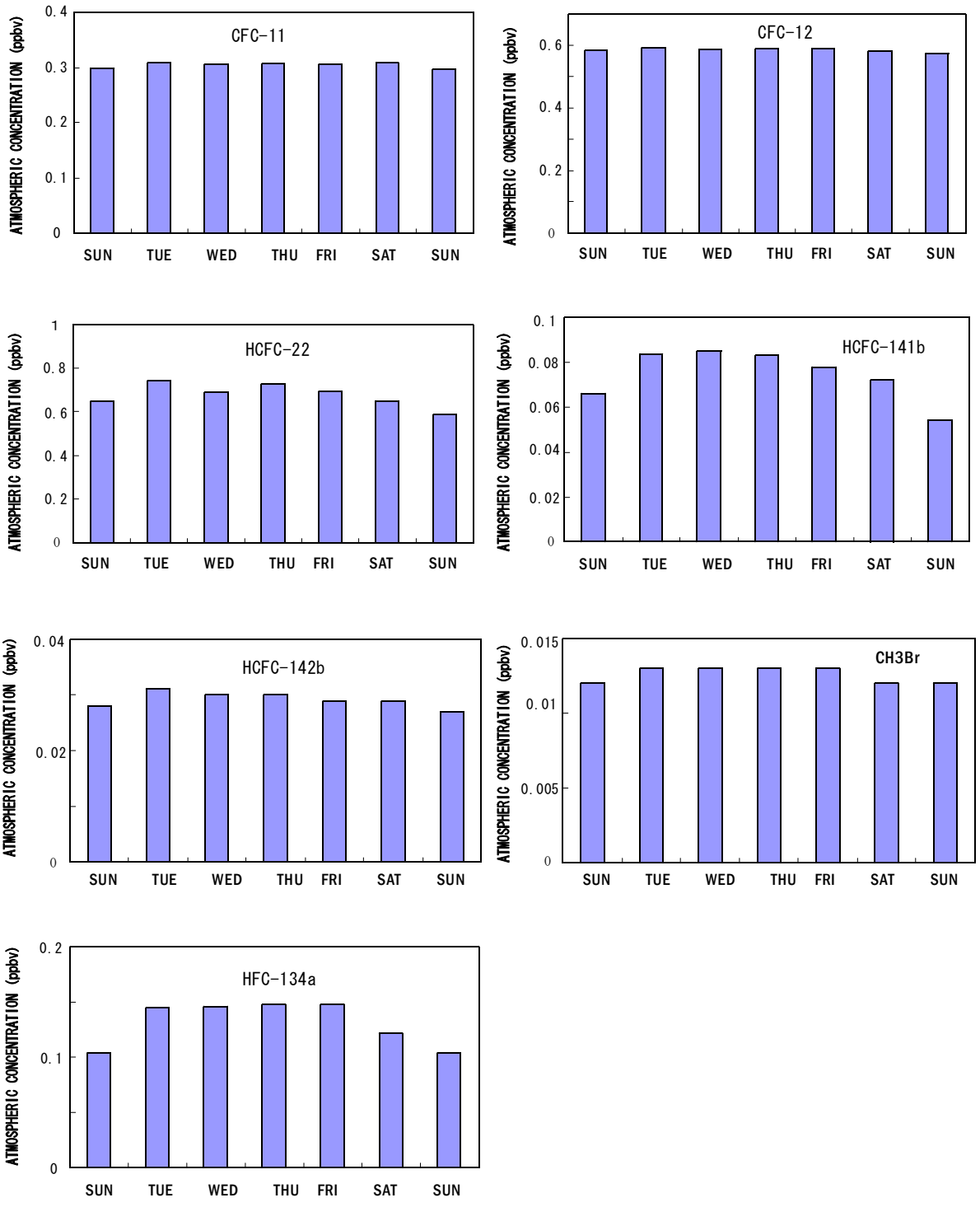


Figure 4.7. Variations of the atmospheric concentrations of the measured substances in the urban area according to the days of the week (medians, March 2007-February 2008)