6. Halocarbons (CFCs, HCFCs, CCl_4, CH_3CCl_3)

Halocarbons are carbon compounds containing fluorine, chlorine, bromine or iodine. Halocarbons containing chlorine, e.g., chlorofluorocarbons (CFCs), hydrochlorofluorocarbons (HCFCs), carbon tetrachloride (CCl_4), and methyl chloroform (CH_3CCl_3), and halocarbons containing bromine, i.e. halons, bring about depletion of the ozone layer. A decrease in ozone in the stratosphere leads to the cooling of the lower stratosphere. However, the increase in halocarbons has a positive net radiative forcing for global warming because of the larger direct radiative forcing of halocarbons than the negative indirect radiative forcing through ozone depletion (WMO, 1999a).

CFCs are dissociated mainly by photolysis with ultraviolet radiation in the stratosphere, and their life times are generally long (e.g., about 50 years for CFC-11). However, HCFCs and CH_3CCl_3, which contain hydrogen in the molecules, react with hydroxyl radicals (OH) in the troposphere and thus, have relatively short life times (e.g., about 5 years for CH_3CCl_3).

The Montreal Protocol and its Adjustments and Amendments regulate the production of ozone-depleting compounds. As a result, global concentrations of CFC-11, CCl_4 and CH_3CCl_3 have started to drop; CFC-113 had stopped growing by 1996, and the global growth of CFC-12 has largely slowed down (WMO, 1999a).

Figure 6.1 shows the time series of the monthly mean concentrations of CFC-11, CFC-12 and CFC-113. Figure 6.2 shows that of HCFCs, and Figure 6.3 shows that of CCl_4 and CH_3CCl_3. The absolute values of concentrations differ significantly from station to station, probably because of the different standard gases in use. Therefore, all the data from each station are plotted with the same marks to highlight only the long-term trends for each hemisphere.

Long-term trends in the 1990s for each compound are almost the same for each hemisphere. The features for each compound are described as follows:

- CFC-11: Concentrations were at a maximum around 1993 and then started decreasing.
- CFC-12: Concentrations were slowly increasing, but recently the growth rates have declined to nearly zero.
- CFC-113: Concentrations had slightly increased by the early 1990s, but growth has almost stopped now.
- HCFC-141b: Concentrations are linearly increasing.
- HCFC-142b: Concentrations are linearly increasing.
- CCl_4: Concentrations are slowly decreasing.
- CH_3CCl_3: Concentrations were at a maximum around 1992 and then started an obvious decrease.

The increase in the concentration of HCFCs is a result of the continuation of earlier use and of their use as substitutes for the CFCs.

Table 6.A Measurement sites and their measurement compounds

	Site	Country / Territory	CFC -11	CFC -12	CFC -113	HCFC -141b	HCFC -142b	CCl_4	CH_3CCl_3
Northern Hemisphere	Kosan	Rep. of Korea	○	○					
	Ryori	Japan	○	○	○			○	○
	Alert	Canada	○	○					
	Barrow	U.S.A.	○	○			○	○	○
	Cape Meares	U.S.A.	○	○	○			○	○
	Niwot Ridge	U.S.A.	○	○			○	○	○
	Ragged Point	Barbados	○	○	○			○	○
	Trinidad Head	U.S.A.	○	○	○			○	○
	Cape Kumukahi	U.S.A.	○	○					
	Mauna Loa	U.S.A.	○	○			○	○	○
	Lampedusa	Italy	○	○					
	Mace Head	Ireland	○	○	○	○	○	○	○
	Zeppelinfjellet	Norway	○	○	○			○	○
Southern Hemisphere	Cape Grim	Australia	○	○	○	○	○	○	○
	Cape Matatula	U.S.A.	○	○	○			○	○
	Tutuila	U.S.A.	○	○	○		○	○	○
	South Pole	U.S.A.	○	○			○	○	○