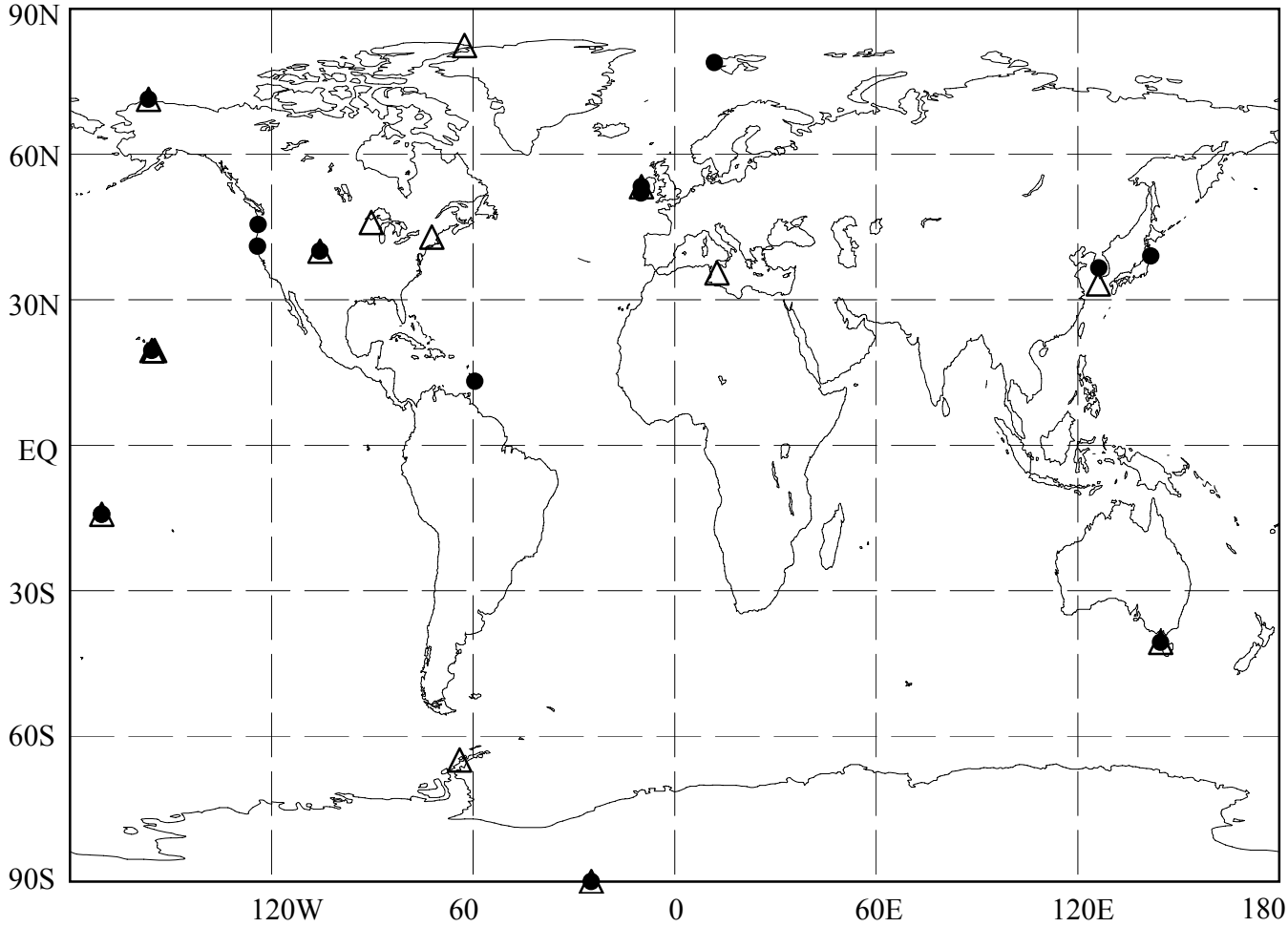
6.
HALOCARBONS

● :*IN SITU* STATION
△ :FLASK STATION



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). Because the reaction with OH in the troposphere is a major sink for CH_3CCl_3, global measurements of CH_3CCl_3 provide an accurate method for estimating the global concentration of OH (Prinn *et al.*, 2001).

The Montreal Protocol on Substances that Deplete the Ozone Layer 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. All the monthly data from each station are plotted in these figures. The absolute values of concentrations differ significantly from station to station, probably because of the different standard gases in use.

It can be seen from these figures that concentrations for each compound except HCFCs increased largely in the 1980s in both hemispheres. Long-term trends since around 1990 for each compound are described as follows:

- CFC-11: Concentrations were at a maximum around 1992 in the Northern Hemisphere and about one year later in the Southern Hemisphere. Then they are slowly decreasing now.
- CFC-12: The growth rates have declined since around 1990 and are now nearly zero in both hemispheres.
- CFC-113: Concentrations were at a maximum around 1992 in the Northern Hemisphere and around 1994 in the Southern Hemisphere. Now concentrations are almost constant or slowly decreasing in both hemispheres.
- HCFC-141b: Concentrations are linearly increasing.
- HCFC-142b: Concentrations are linearly increasing.

CCl_4: Concentrations were at a maximum around 1991 in both hemispheres. After then, they are slowly decreasing now.

CH_3CCl_3: Concentrations were at a maximum around 1992 in the Northern Hemisphere and around 1993 in the Southern Hemisphere. Then they started an exponential decrease.

Comparing the stations using the same standard gases, the differences of the concentrations for each compound except HCFCs between both hemispheres were large in the 1980s. But after the peak of concentrations, their differences are becoming smaller.

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.