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ATMOSPHERIC DISTRIBUTIONS AND CHANGING TRENDS OF CFCS AND HALONS IN THE NORTHERN AND SOUTHERN HEMISPHERES (ABSTRACT)

Yoshihiro MAKIDE[1] and Takeshi TOMINAGA[2]

[1]*Radioisotope Center, The University of Tokyo, 11–16, Yayoi 2-chome, Bunkyo-ku, Tokyo 113*
[2]*School of Science, The University of Tokyo, 3–1, Hongo 7-chome, Bunkyo-ku, Tokyo 113*

Chlorofluorocarbons (CFCs), chlorocarbons, and bromofluorocarbons (Halons) with extremely long lifetimes are responsible not only for stratospheric ozone depletion but also for global warming. We have been accurately measuring atmospheric concentrations of those halocarbons (CFC-11, CFC-12, CFC-113, CFC-114, CH_3CCl_3, CCl_4, Halon-1301, Halon-1211, etc.) in the Southern Hemisphere (S.H.) as well as in the Northern Hemisphere (N.H.) in order to clarify the behaviors of these compounds in the atmosphere and to estimate the future trends of concentrations and their effects on the earth's environment.

Surface level samples in Antarctica have been collected (since 1982) at 500–1000 m NE (upwind direction) of Syowa Station (69°S) into all-stainless steel sample canisters which had been prepared in extremely clean conditions and evacuated for grab-sampling. All the Antarctic samples have been analyzed after 3–15 months at The University of Tokyo by ECD gas chromatography. Averaged concentrations in the mid-latitude N.H. have been obtained (since 1979) by analyzing the samples collected in Hokkaido (43–45°N) every summer and winter. Most samples collected in Antarctica have been stored in the laboratory for later measurement of new species and for checking the stability of calibration standards.

Over the decade up to 1990, the averaged tropospheric concentrations of CFC-12 and CFC-11 observed in Antarctica were 9–10% lower than those observed in Hokkaido in accordance with the predominant emission of these CFCs in the N.H. and their delayed diffusion into the S.H. across the ITCZ, and the globally averaged concentrations of CFC-12 and CFC-11 increased almost linearly by about 4% a year. The concentration of CFC-113 in the S.H. was 20–30% lower than that in the N.H. and increased by 10–20% a year.

However, since 1990, the increasing trends of major CFCs (CFC-12, CFC-11 and CFC-113) in the N.H. have changed drastically, slowing down to 0–3% a year. Their increasing trends in the S.H., on the other hand, have only slightly changed and the differences between the N.H. and the S.H. are becoming small. The distributions in both hemispheres and the recent trends of globally averaged concentrations are reasonably in accordance with the international regulation of emissions of CFCs according to the 1987 original Montreal Protocol on Substances that Deplete the Ozone Layer and the following revisions.

The concentration of CH_3CCl_3 which is decomposed mainly in the troposphere with OH radicals has shown larger differences (such as 30%) between the two hemispheres and a smaller rate of increase corresponding to its short atmospheric lifetime.

The measurement of CFC-114 concentration is strongly disturbed by its isomer CFC-114a, and reliable CFC-114 atmospheric concentration was obtained for the first time. The precisely observed concentrations of Halons with better gas chromatographic separation have recently shown much larger increasing trends than those of major CFCs.

The total Cl concentration in the troposphere controls the Cl amount introduced into the stratosphere and the Cl concentration (including Br as equivalent amount) is anticipated to reach a maximum in several years with substantial depletion of stratospheric ozone. It will take 50–60 years for the Cl concentration to return to the level before the Antarctic Ozone Hole appeared.

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