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LONG-TERM TRENDS OF ATMOSPHERIC CONCENTRATIONS OF TRACE HALOCARBONS IN THE SOUTHERN AND NORTHERN HEMISPHERES (ABSTRACT)

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An extremely large ozone hole in Antarctica and record-breaking low levels of global scale ozone have been observed even after the effect caused by aerosols from the Mount Pinatubo eruption in 1991 decreased. These stratospheric ozone depletions have been considered to be caused by still increasing atmospheric halocarbons. 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 behavior 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 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 samples collected in Hokkaido (43–45°N). Most samples collected in Antarctica and Hokkaido 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 globally averaged concentrations of CFC-12 and CFC-11 increased almost linearly by about 4% a year and that of CFC-113 increased by 10–20% a year. However, since 1990, the increasing trends of 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 their globally averaged concentrations are still increasing.

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 total concentration of Cl present in halocarbons is anticipated to reach a maximum in a few years in the troposphere and 4–5 years later in the stratosphere, with substantial depletion of stratospheric ozone.

The concentration of CH_3CCl_3, which is decomposed mainly in the troposphere by OH radicals, has shown change in its increasing trends since 1992 reflecting the late start of the regulation of emission and its shorter life time (5–6 years) in the troposphere. Its atmospheric concentration has started decreasing even in the Southern Hemisphere, and the globally averaged concentration has already been decreasing.

The atmospheric concentration of HCFC-22 ($CHClF_2$), which is a typical CFC substitute, was newly and precisely measured by gas chromatographic separation followed by the newly developed detection method with O_2 doped and sensitized ECD (electron capture detector). The observed concentration of HCFC-22 showed a larger increasing trend than CFCs in the last two decades and much larger recently: accelerating the increasing trend since 1988 reflecting the international regulation of the use of CFCs by the Montreal Protocol adopted in 1987.

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