



## Implications from the changes in the levels of halocarbons and the compliance with the Montreal Protocol

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An extensive air sampling made at 51 sites in metropolitan Taipei was conducted in 2012. The results were compared with the sampling made in 1998 using almost identical sampling approach. The goal is to investigate the changes in concentration levels and variability of ozone depleting substances (ODS) in urban atmosphere over the period of 14 years. Seven major halocarbons, i.e., CFC-11 ( $\text{CCl}_3\text{F}$ ), CFC-12 ( $\text{CCl}_2\text{F}_2$ ), CFC-113 ( $\text{CCl}_2\text{FCClF}_2$ ),  $\text{CH}_3\text{CCl}_3$ ,  $\text{CCl}_4$ ,  $\text{CHCl}=\text{CCl}_2$  and  $\text{CCl}_2=\text{CCl}_2$ , with the latter two being non-ODS but possible carcinogens, were analyzed to assess how successful the transition to an era of ceased emissions of ODS is. After 14 years, the concentrations of CFC-11, CFC-113 and  $\text{CCl}_4$  were found to be within the proximity of the background levels in the Northern Hemisphere. Moreover, we used concentration variability to imply emissions and usage of ODS. The variability of CFC-11 and  $\text{CCl}_4$  was less than 4% expressed as one standard deviation, indicating negligible usage for these two ODS in this city of five million residents. Surprisingly, a few samples showed high values for CFC-113, indicating that sporadic usage of CFC-113 still existed. The decline in concentration variability over the 14-year period was particularly dramatic for CFC-12 and  $\text{CH}_3\text{CCl}_3$ , which may be related to the fact that cars made after mid-1994 were required to use HFC-134a to replace CFC-12 as the air conditioning refrigerant, and other chlorine-free solvents largely replaced  $\text{CH}_3\text{CCl}_3$  in the past decade.