

Sample Abstract for analysis:

The Montreal Protocol was designed to protect the stratospheric ozone layer by enabling reductions in the abundance of ozone-depleting substances such as chlorofluorocarbons (CFCs) in the atmosphere. The reduction in the atmospheric concentration of trichlorofluoromethane (CFC-11) has made the second-largest contribution to the decline in the total atmospheric concentration of ozone-depleting chlorine since the 1990s. However, CFC-11 still contributes one-quarter of all chlorine reaching the stratosphere, and a timely recovery of the stratospheric ozone layer depends on a sustained decline in CFC-11 concentrations. Here we show that the rate of decline of atmospheric CFC-11 concentrations observed at remote measurement sites was constant from 2002 to 2012, and then slowed by about 50 per cent after 2012. The observed slowdown in the decline of CFC-11 concentration was concurrent with a 50 per cent increase in the mean concentration difference observed between the Northern and Southern Hemispheres, and also with the emergence of strong correlations at the Mauna Loa Observatory between concentrations of CFC-11 and other chemicals associated with anthropogenic emissions. A simple model analysis of our findings suggests an increase in CFC-11 emissions of 13 ± 5 gigagrams per year (25 ± 13 per cent) since 2012, despite reported production being close to zero since 2006. Our three-dimensional model simulations confirm the increase in CFC-11 emissions, but indicate that this increase may have been as much as 50 per cent smaller as a result of changes in stratospheric processes or dynamics. The increase in emission of CFC-11 appears unrelated to past production; this suggests unreported new production, which is inconsistent with the Montreal Protocol agreement to phase out global CFC production by 2010.