

On the Uneven Decline of Atmospheric CFC-11: Bumps in the Road to Ozone Recovery or Variations in Atmospheric Transport and/or Loss?

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Atmospheric mole fractions of the ozone-depleting and greenhouse gas CFC-11 have declined since 1995 owing to global controls on production associated with the fully adjusted and amended Montreal Protocol on Substances that Deplete the Ozone Layer. From 2002 to 2012, CFC-11 mole fractions decreased at a near-constant rate of 2.2 ± 0.2 ppt/yr in both the northern and southern hemisphere. Since 2012, however, a substantial slow-down in the atmospheric decline of CFC-11 has been observed by three quasi-independent techniques at NOAA/GMD (the 2013 to 2015 rate was -1.3 ± 0.1 ppt/yr), with the slow-down being most prominent in the northern hemisphere. Given that global production of CFC-11 has been essentially zero since 2007, it seems improbable that this anomaly is due to increased emissions. Here we will explore this possibility, as well as the possibility that variations in transport (or in loss rates as captured by surface observations) might explain the slower decline. Preliminary analyses with an idealized model suggest that the mass flux of CFC-11 from the stratosphere to the troposphere was anomalously low during 2014. Does this transport-related anomaly explain the anomalous rates in 2014 and does it persist through 2015? Or, do the observations provide irrefutable evidence of a significant increase in global CFC-11 emissions since 2013?

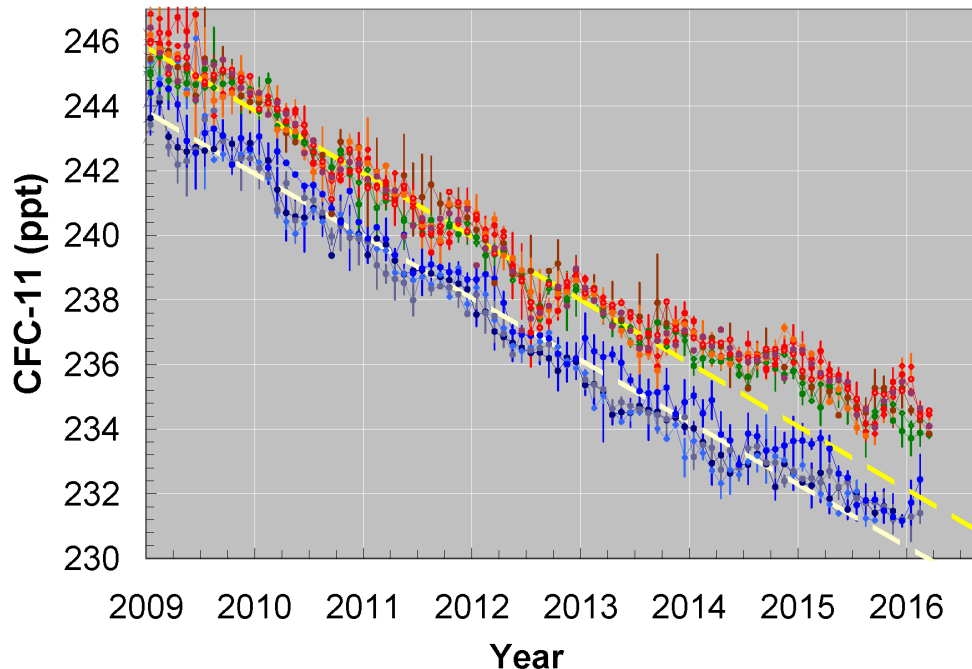


Figure 1. Monthly mean mole fractions of CFC-11 at northern hemispheric sites (red and green points) and southern hemispheric sites (blue points) since 2009 as measured from flasks by gas chromatography with mass spectrometry detection. Bold dashed lines are fits to hemispheric means from decade between 2004 and 2013 (yellow dashed line for northern and white dashed line for southern hemispheres) and are extrapolated through 2016.