

The Continued Slowdown in the Decline of Atmospheric CFC-11

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The atmospheric decline of CFC-11 since 2002 has been difficult to reconcile with reported global production being essentially zero since 2007. In the absence of production we would have expected the “bank” of CFC-11 (produced but not-yet-emitted chemical) to have diminished, a slow decline in global emissions, an accelerating decline in global mean mole fraction, and a north-to-south mole fraction approaching zero. Instead, measurements from multiple instruments at GMD from 2002 to 2012 show that the atmospheric CFC-11 decline did not accelerate over this period but remained steady at -2.2 ± 0.2 ppt/yr in both hemispheres, implying unchanging global emissions throughout that decade. Conceivably these results could be explained by a slowly changing emission rate of CFC-11 from in-use applications (the bank), but this cannot readily explain the striking 50% slowdown in the atmospheric decline of CFC-11 observed since 2012 to -1.1 ppt/yr. This slowdown was also coincident with a 50% increase in the measured hemispheric mole fraction difference (north – south). These observations imply a substantial increase in the flux of CFC-11 in the northern hemisphere, although the underlying cause of these changes remains unclear. Here we consider the observations with multiple 3-D model simulations (CESM1-WACCM) using dynamics specified by MERRA, MERRA2 or GEOS5 to diagnose the observations to investigate if they reflect substantial changes in broad-scale atmospheric mixing process, an increase in emissions nearly a decade after reported global production ceased, or a combination of both influences.

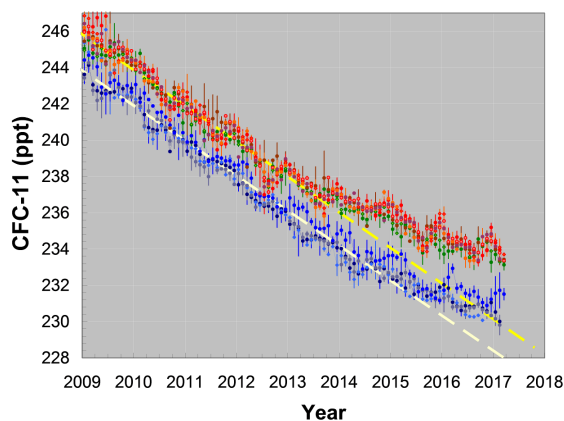


Figure 1. Monthly mean mole fractions of CFC-11 at northern hemispheric sites (red and green points) and southern hemispheric sites (blue points) since 2009 as measured from flasks by gas chromatography with mass spectrometry detection. Dashed lines are fits to northern (yellow) and southern (white) hemispheric means during 2004 to 2013.

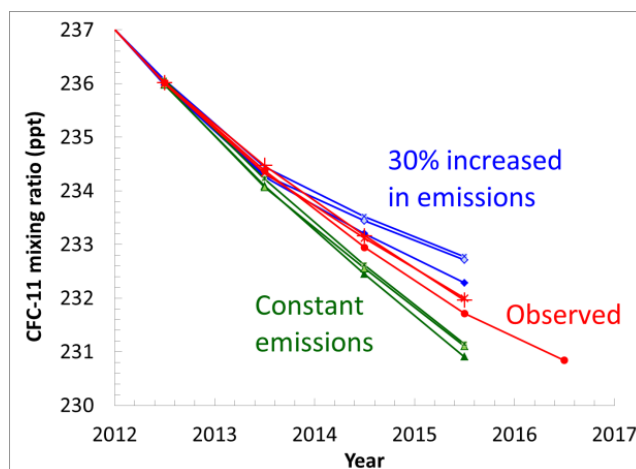


Figure 2. Observed and simulated annual mean mole fractions of CFC-11 in recent years. Results from three different measurement systems at NOAA (red) are compared to 3-D simulations using the CESM1-WACCM model and three different representations of reanalyzed meteorology (MERRA, MERRA2, and GEOS5) with constant emissions after 2012 (green lines) and a 30% increase in emissions in 2014 and 2015 compared to the 2002-2012 mean (blue lines).