Three+ Decades of Continuous Monitoring of Long-lived Halocarbons

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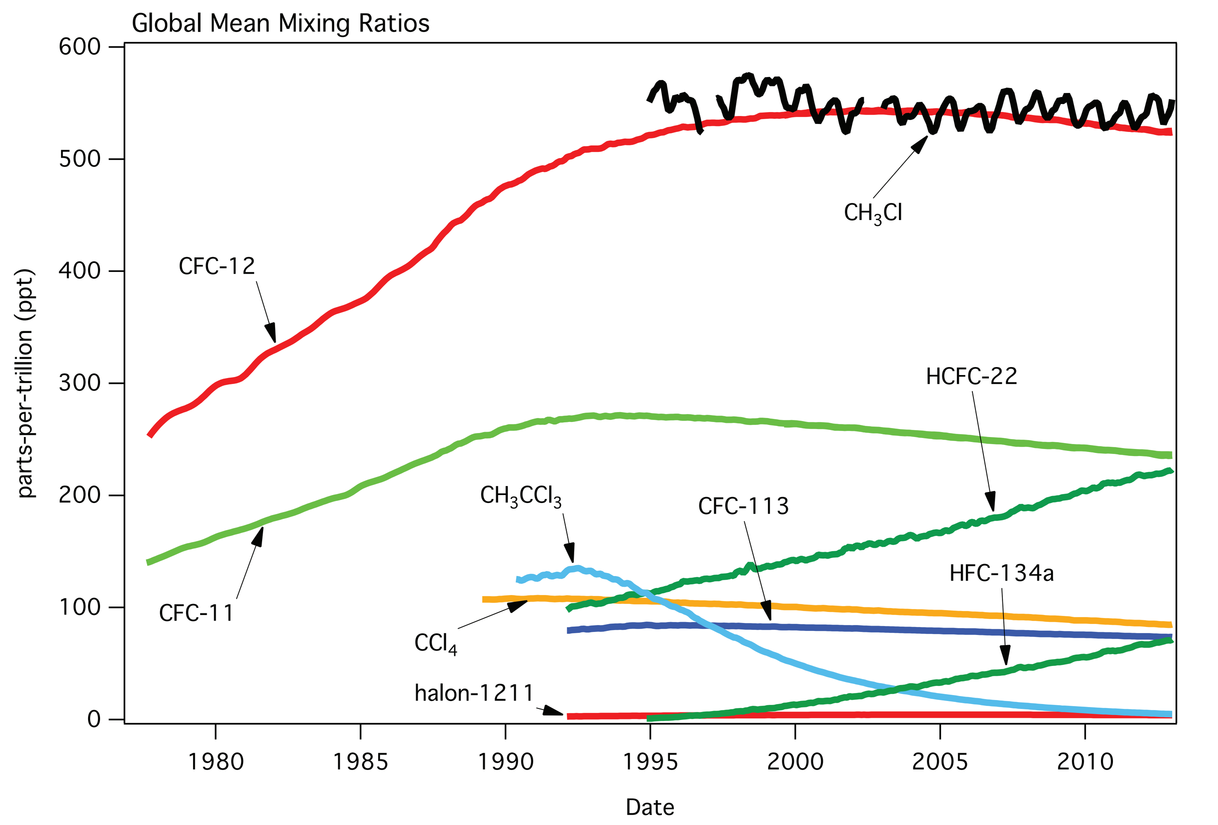
Intro

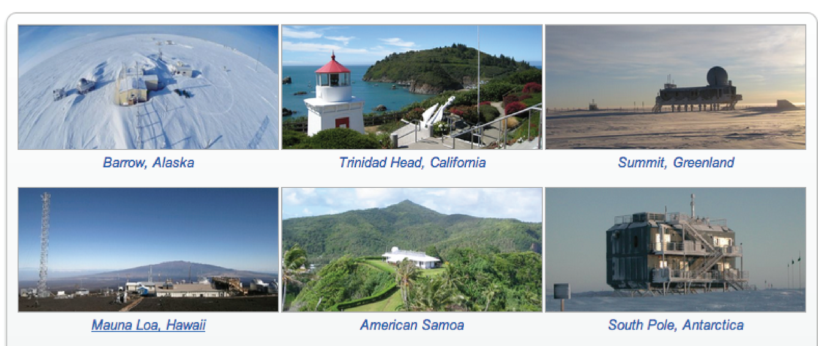
In the mid-1970s, the National Oceanic and Atmospheric Administration's (NOAA) Geophysical Monitoring for Climate Change (GMCC) program made a commitment to measure and monitor trace gases including carbon dioxide, nitrous oxide, and halocarbons including chlorofluorocarbons (CFCs). Over the next three decades GMCC grew into the Global Monitoring Division (GMD), and many trace gas measurement programs evolved into separate projects with different instrumentation. We present a statistical method developed to combine measurements from independent NOAA measurement programs to construct continuous long-term global records that are used to estimate global growth rates and top down emission estimates of these important gases.



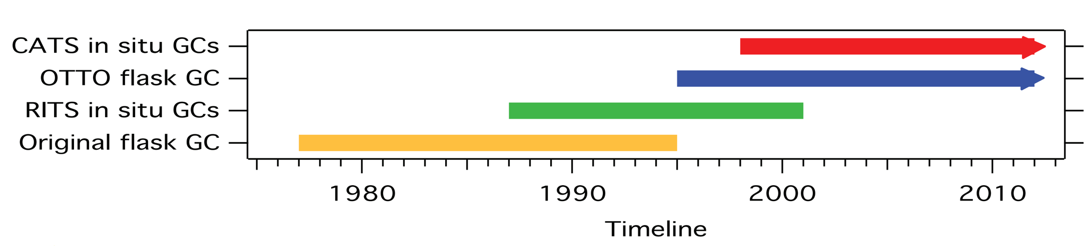
Global means of some of the halocarbons measured at GMD, where HCFCs and HFCs are replacement CFCs.

The Problem

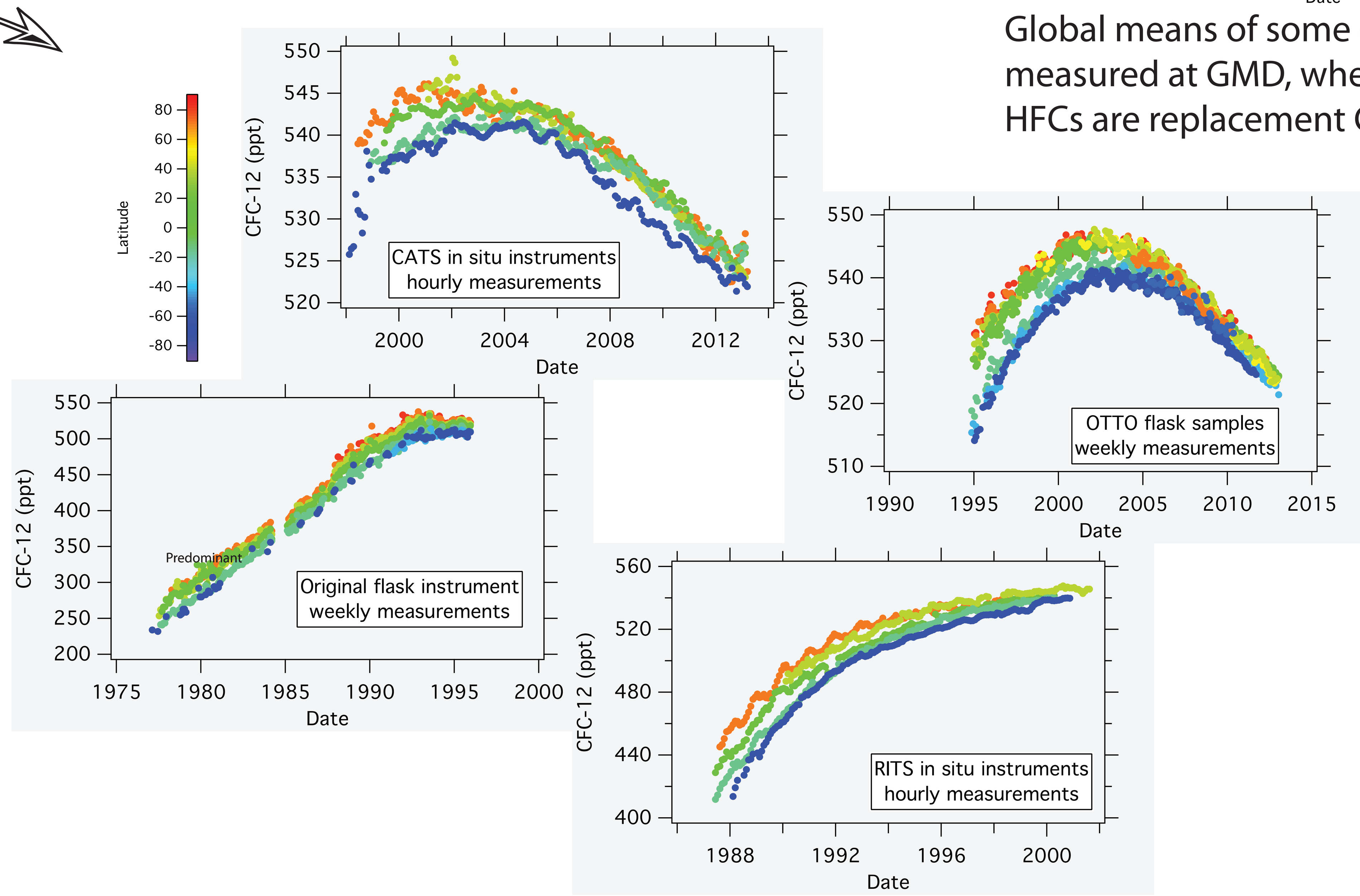
- Lots of data!
- From many locations



- At different times
- From different measurement programs
- Low (flask) and high (in situ) frequency measurements
- Potential scale issues



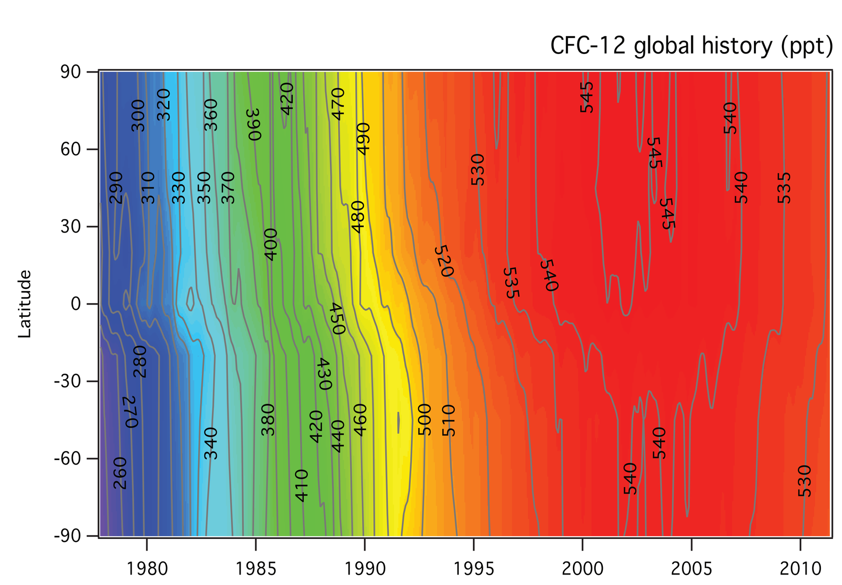
CFC-12 data from four GMD programs



Solution

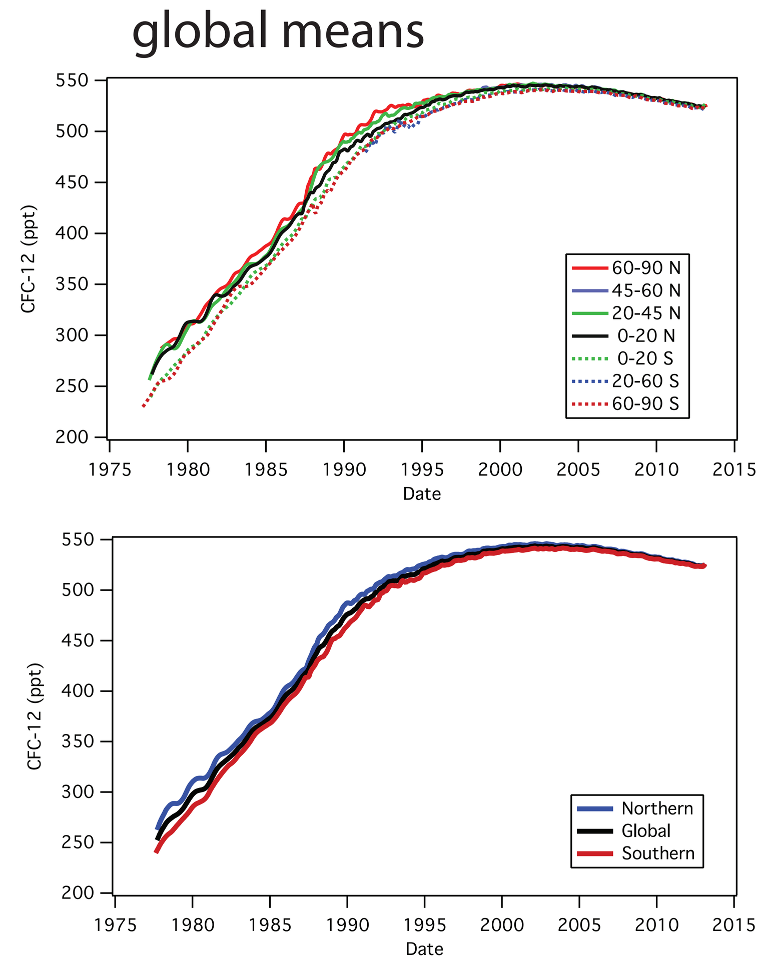
Developed a statistical method to combine co-located measurements into a global data set.

- Place all data sets on a common scale
- Linearly interpolate gaps for each program
- Weighted means based on instrumental precision
- Savitski-Golay smoothing applied at each location
- Robust algorithm (works on different data sets)
- Uncertainties are estimated at all locations

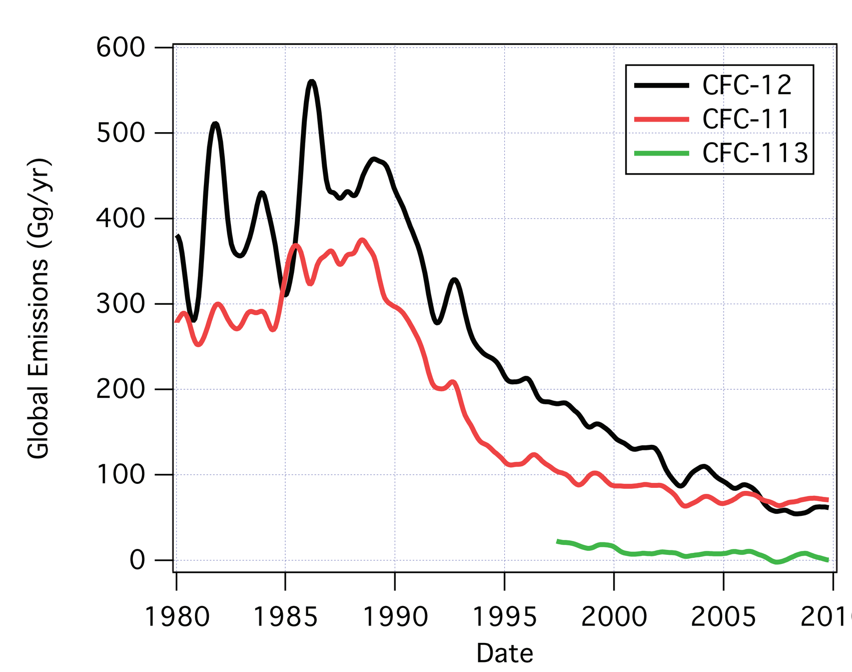


Contour map of CFC-12 global history shows the predominant sources in the northern hemisphere. Mixing ratios were in growth from the 1970s to 90s, where the southern hemisphere lagged behind the north. Growth rates of ozone depleting gases such as CFC-12 have declined as countries phased out production and use.

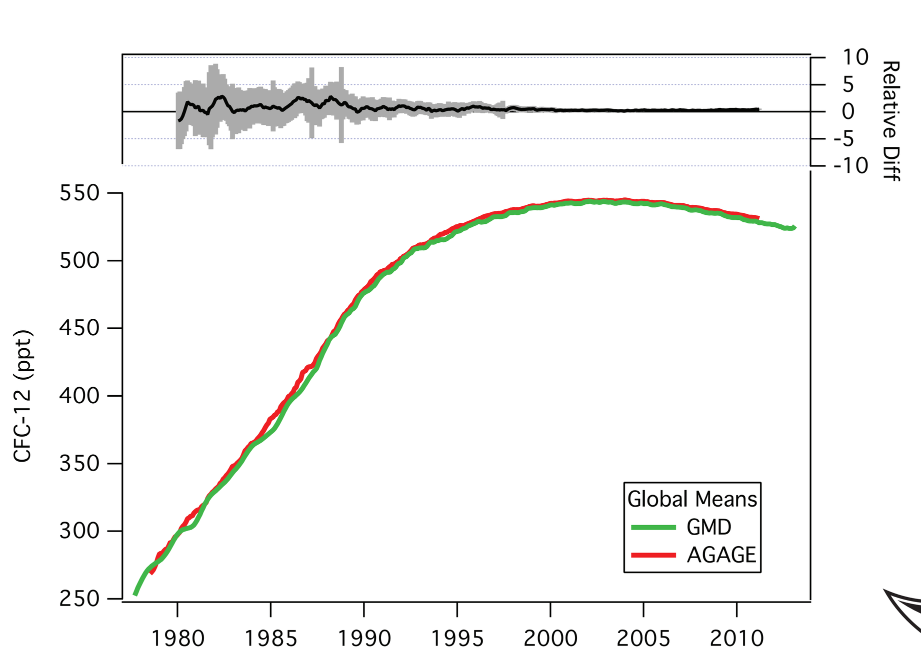
Zonal, hemispheric, and global means



Emissions and climate indices (AGGI and ODGI) are a couple of GMD results calculated with the combined data sets.



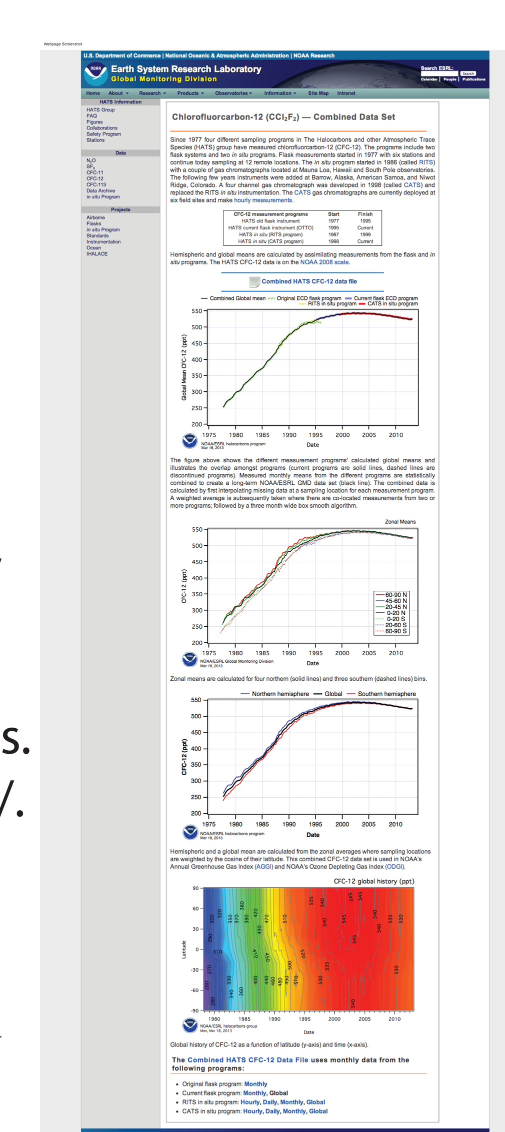
Global emissions of the three most abundant CFCs are calculated with a two-box model. The emissions record for CFC-12 and CFC-11 are veritable during the 80s, but show a significant increase followed by a decrease as countries responded to the Montreal Protocol. Recently CFC-11 and -12 emissions have leveled off and CFC-113 is nearly zero.



Comparison of GMD CFC-12 to an independent network, Advanced Global Atmospheric Gas Experiment (AGAGE). There is a mean difference (AGAGE-GMD) related to scale differences.

Web

The original and combined data sets for CFC-11, CFC-12, CFC-113, CH_3CCl_3, CCl_4, N_2O and SF_6 can be found on the NOAA/ESRL ftp and web sites. ftp://ftp.cmdl.noaa.gov/hats/.



Conclusion

- Combined data set benefits from multiple co-located measurements, flask and in situ.
- Independent calibration scale helps to resolve differences.
- Comparison with other independent networks is improved.

- Updated semi-annually at:

http://www.esrl.noaa.gov/gmd/hats/combined/X.html

where X equals CFC11, CFC12, CFC113, CH3CCl3, CCl4, N2O and SF6.