Analysis of CFC-11 observations

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Introduction

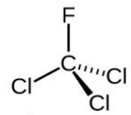
Research question:

Can we identify CFC-11 pollution events at Mace Head (Ireland)?

Fig. 1. Mace Head Atmospheric Research Station

Background:

- CFC-11 (CCl_3F)



  - A chlorofluorocarbon that was used extensively in refrigeration and as a foam blowing agent
  - However, it is a strong greenhouse gas and has a large ozone depleting potential. It stays in the atmosphere for hundreds of years
  - Production was phased out after the Montreal Protocol in 1987, but sources remain.

AGAGE Advanced Global Atmospheric Gases Experiment
Sponsored by NASA's Atmospheric Composition Focus Area in Earth Science

- The Advanced Global Atmospheric Gases Experiment (AGAGE) started in 1994
- It is a follow-up to the earlier GAGE and Atmospheric Lifetime Experiment (ALE), started in 1978.
- Measures almost all long lifetime non-CO_2 greenhouse gases and ozone depleting substances.

Methods

Interval Selection

Select the day of interest with a 120 period around it.

Establish Background

The background is a 2nd order polynomial fit to the daily minima of the 121-day period.

Identify Pollution Events

A day is marked as pollution event if it is 3σ above the median of the remaining signal.

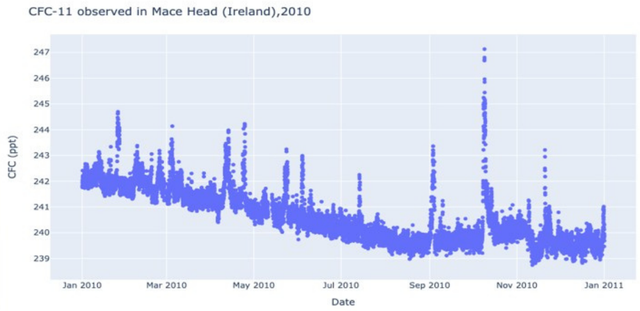


Fig. 2. Raw AGAGE CFC-11 dataset 2010

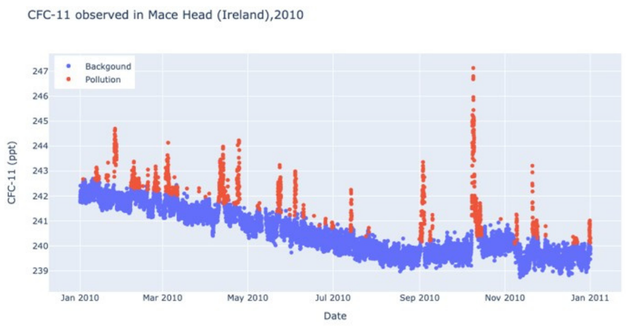


Fig. 3. Separation of pollution events from background

Results

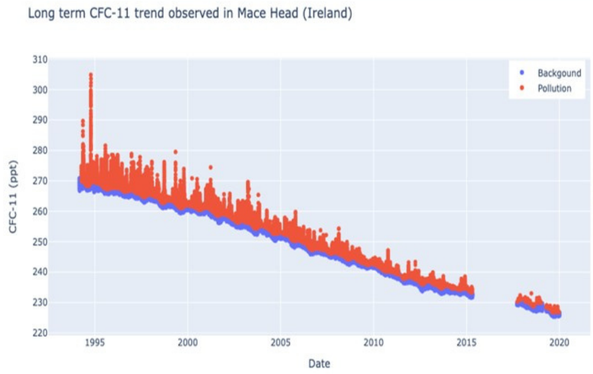


Fig. 4. CFC-11 background trend and pollution events

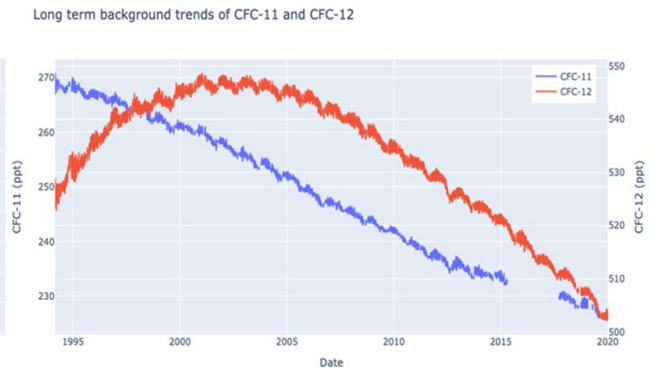


Fig. 5. CFC-11 and CFC-12 background trend

Background trend and pollution

- "Spikes" above the background measured at the Mace Head site decreased quickly, suggesting emissions from North-Western Europe had fallen.
- Occasional pollution events are still detected at Mace Head.

Compare CFC-11 with CFC-12

- Correlation coefficient: 0.85
- Emissions of CFC-12 (co-produced with CFC-11) have declined since 2000s
- Degrading ratio of CFC 11 to CFC 12 means better air quality

Discussion

Summary:

- The background concentration is derived using a statistic method
- The results are consistent with other data
- Next steps:
  - Investigate the quantitative relations between the variables
  - Build a model to study the sources of pollution

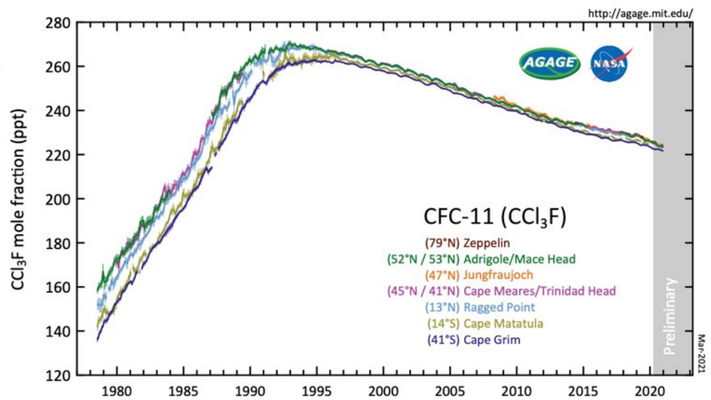


Fig. 6. Official data for verification

Conclusion:

- The CFC-11 background trend and pollution events in Mace Head are declining consistently.
- CFC-12 concentrations are increasing first and then declining faster than CFC-11 over the period. Its trend is correlated with CFC-11