

Research shows emissions of banned ozone-depleting substance are back on the decline

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An image of Gosan measurement station - part of the AGAGE monitoring network - on Jeju Island in South Korea. Measurements from this station were used in the study to quantify emissions from China. Credit: AGAGE

Global emissions of a potent substance notorious for depleting the Earth's ozone layer—the protective barrier which absorbs the Sun's harmful UV rays—have fallen rapidly and are now back on the decline, according to new research.

Two international studies published today in *Nature*, show emissions of CFC-11, one of the many chlorofluorocarbon (CFC) chemicals once widely used in refrigerators and insulating foams, are back on the decline less than two years after the exposure of their shock resurgence in the wake of suspected rogue production.

Dr. Luke Western, from the University of Bristol, a co-lead author of one of the studies, said: "The findings are very welcome news and hopefully mark an end to a disturbing period of apparent regulatory breaches. If the emissions had stayed at the significantly elevated levels we found, there could have been a delay, possibly of many years, in [ozone layer](#) recovery. On top of that, since CFC-11 is also a potent greenhouse gas, the new emissions were contributing to [climate change](#) at levels similar to the carbon dioxide emissions of a megacity."

The production of CFC-11 was banned globally in 2010 as part of the Montreal Protocol, a historic international treaty which mandated the phase-out of ozone-depleting substances. Thereafter, CFC-11 emissions should have steadily fallen.

But in 2018 some of the same scientists behind the recent more reassuring discovery found a jump in emissions had begun around 2013, prompting alarm at the time that production of the banned substance had resumed in an apparent violation of the Montreal Protocol.

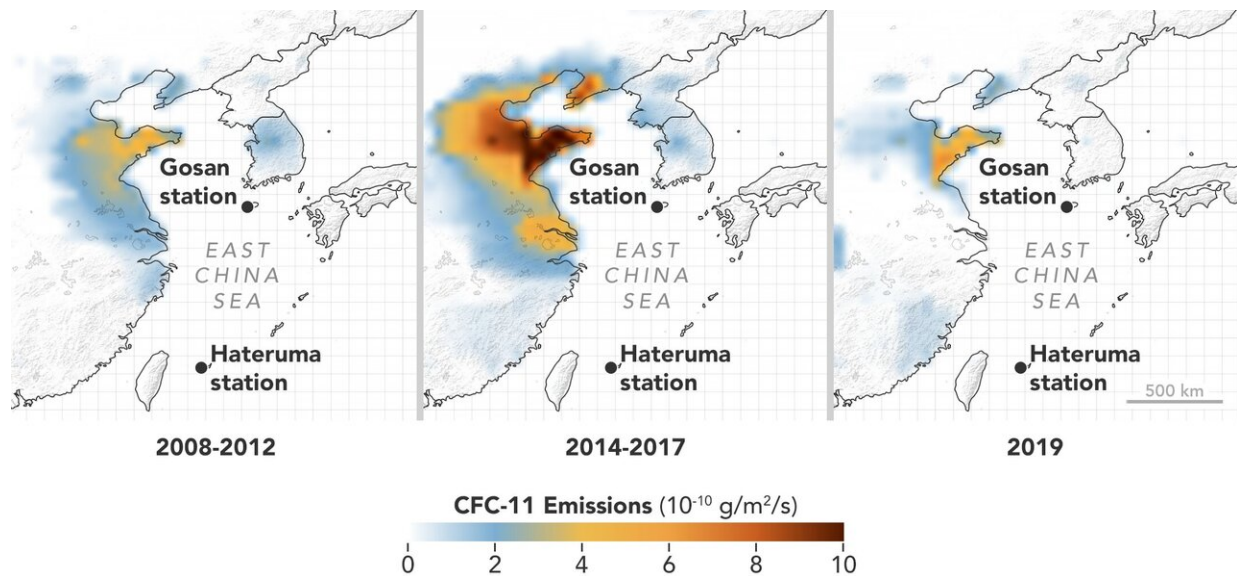
The first sign of something untoward was spotted by an international atmospheric monitoring team led by the National Oceanic and Atmospheric Administration (NOAA).

Dr. Steve Montzka from NOAA, lead author of the original research paper explained: "We noticed the concentration of CFC-11 had declined more slowly since 2013 than predicted, clearly indicating an upturn in emissions. The results suggested that some of the increase was from

eastern Asia."

These unexpected findings were confirmed by an independent global measurement network, the Advanced Global Atmospheric Gases Experiment (AGAGE).

Professor Ron Prinn from Massachusetts Institute of Technology (MIT), AGAGE principal investigator and co-author of both new papers, said: "The global data clearly suggested new emissions. The question was where exactly?"



Emissions of CFC-11 increased substantially in north-east China between 2008-2012 and 2014-2017, and fell back to these earlier levels in 2019. Emissions are concentrated in the Chinese provinces of Shandong and Hebei. Credit: AGAGE/NASA Earth Observatory, earthobservatory.nasa.gov/

"The answer lay in the measurements at AGAGE and affiliate

monitoring stations that detect polluted air from nearby regions. Using data from Korean and Japanese stations, it appeared around half of the increase in global emissions originated from parts of eastern China."

Further investigation by media and environmental campaigners exposed usage of CFC-11 in the manufacture of insulating foams in China. Chinese authorities took notice and at meetings of the Montreal Protocol in 2018 and 2019, they confirmed some banned ozone depleting substances were identified during factory inspections, but only in very small amounts relative to those inferred from the atmospheric data. According to their reports, arrests, material seizures, and the demolition of production facilities ensued.

The scientific teams have continued to closely monitor atmospheric levels, and the latest evidence, reported in the two papers on global CFC-11 emissions and eastern Chinese emissions, indicates that those efforts have likely contributed to dramatic [emission](#) declines.

Professor Matt Rigby, from the University of Bristol, co-author of both studies, explained: "To quantify how emissions have changed at regional scales, we compared the pollution enhancements observed in the Korean and Japanese measurement data to computer models simulating how CFC-11 is transported through the atmosphere. With the global data, we used another type of model that quantified the emissions change required to match the observed global CFC-11 concentration trends.

"At both scales, the findings were striking; emissions had dropped by thousands of tonnes per year between 2017 and 2019. In fact, we estimate this recent decline is comparable or even greater than the original increase, which is a remarkable turnaround."

Whilst the findings suggest the rapid action in eastern China and other regions of the world has likely prevented a substantial delay in ozone

layer recovery, any unreported production will have a lingering environmental impact.

Professor Rigby added: "Even if the new production associated with the emissions from eastern China, and other regions of the world, has now stopped, it is likely only part of the total CFC-11 that was made has been released to the atmosphere so far. The rest may still be sitting in foams in buildings and appliances and will seep out into the air over the coming decades."

Since the estimated eastern Chinese CFC-11 emissions could not fully account for the inferred global emissions, there are calls to enhance international efforts to track and trace any future emitting regions.

Professor Ray Weiss, from Scripps Institution of Oceanography, a Principal Investigator in AGAGE, said: "As a direct result of these findings, the Parties of the Montreal Protocol are now taking steps to identify, locate and quantify any future unexpected emissions of controlled substances by expanding the coverage of atmospheric measurements in key regions of the globe."

More information: A decline in emissions of CFC-11 and related chemicals from eastern China, *Nature* (2021). DOI:

[10.1038/s41586-021-03277-w](https://doi.org/10.1038/s41586-021-03277-w) ,
www.nature.com/articles/s41586-021-03277-w

A decline in global CFC-11 emissions during 2018–2019, *Nature* (2021). DOI: [10.1038/s41586-021-03260-5](https://doi.org/10.1038/s41586-021-03260-5) ,
www.nature.com/articles/s41586-021-03260-5

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