Levels of 'forever chemicals' reaching Antarctica have been increasing

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Taking a firn core sample. Credit: Dr Markus Frey, British Antarctic Survey

New evidence from Antarctica shows that toxic 'fluorinated forever chemicals' have increased markedly in the remote environment in recent decades and scientists believe CFC-replacements could be among likely

sources.

Known as forever chemicals because they do not break down naturally in the environment, chemicals such as perfluorocarboxylic acids (PFCAs) have a wide array of uses such as in making non-stick coatings for pans, water-repellents for clothing, and in fire-fighting foams. One of these chemicals, perfluorooctanoic acid (PFOA), bioaccumulates in foodwebs and is toxic to humans with links to impairment of the immune system and infertility.

In this new study, published by the journal *Environmental Science & Technology*, and led by scientists from Lancaster University along with researchers from the British Antarctic Survey and the Hereon Institute of Coastal Environmental Chemistry, Germany, firn (compacted snow) cores were taken from the extremely remote, high and icy Dronning Maud Land plateau of eastern Antarctica.

The cores, which provide a historic record between 1957 and 2017, provide evidence that levels of these chemical pollutants have shown a marked increase in the remote snowpack of Antarctica over the last few decades.

The most abundant chemical discovered by far was the shorter chain compound, perfluorobutanoic acid (PFBA). Concentrations of this chemical in the snow cores increased significantly from around the year 2000 until the core was taken in 2017.

Professor Crispin Halsall of Lancaster University, and who led the study, believes this increase can be partly explained by a switch by global chemicals manufacturers around 20 years ago from producing long-chain chemicals like PFOA to shorter-chain compounds, such as PFBA due to health concerns associated with human exposure to PFOA.

Dr. Jack Garnett who conducted the chemical analysis on the snow samples, added that "the large increase in PFBA observed from the core, particularly over the last decade, suggests there is an additional global source of this chemical other than polymer production. We do know that some of the chemicals replacing the older ozone-depleting substances like CFCs and HCFCs, such as the hydrofluoroethers, are produced globally in high quantities as refrigerants but can breakdown in the atmosphere to form PFBA."

"The Montreal Protocol certainly provided huge benefits and protection to the ozone, the climate and to us all. However, the wider environmental and toxicity impact of some of these replacement chemicals is still unknown."

PFOA shows an increase in the snow core from the mid-1980s onward, but with no evidence of a decline in more recent years to match the global industry phase out of this chemical. This indicates that production of PFOA was maintained or that volatile precursors to this chemical have remained high in the global atmosphere.

The researchers behind the study believe the chemicals are likely reaching Antarctica by the release of volatile 'precursor' chemicals into the atmosphere at industrial manufacturing sites. These precursors waft in the global atmosphere until they eventually degrade in the presence of sunlight to form the more persistent PFCAs.

Successive snowfall over the years has deposited these chemicals from the atmosphere resulting in a historical record of global contamination that is now trapped in the snow pack.

The results, which are consistent with modeled estimates of PFCA chemical emissions, further add to evidence that show increases in these forever chemicals in the Arctic and the Tibetan Plateau and helps

provide a global picture and further understanding of how chemicals such as these are transported in the atmosphere.

Dr. Anna Jones, Director of Science at the British Antarctic Survey, says that "these findings are a sobering reminder that our industrial activities have global consequences. Antarctica, so remote from industrial processes, holds this next signal of human activity arising from emissions thousands of miles away. The snow and ice of Antarctica are critical archives of our changing impact on our planet."

Dr. Markus Frey, scientist from the British Antarctic Survey and co-author of the report, says that "this is another example that despite its extreme remoteness man-made pollution does reach the Antarctic continent and is then archived in snow and ice, which allows us to establish a history of global atmospheric pollution and effectiveness of mitigation measures."

More information: Jack Garnett et al, Increasing Accumulation of Perfluorocarboxylate Contaminants Revealed in an Antarctic Firn Core (1958–2017), *Environmental Science & Technology* (2022). DOI: 10.1021/acs.est.2c02592

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