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Semiconductor and aluminium industries underestimate greenhouse gas emissions

Emissions of the greenhouse gases (GHGs) tetrafluoromethane (TFM) and hexafluoroethane (HFE) reported by industry accounted for only around half actual levels measured in the atmosphere between 2002 and 2010, new research reveals. The semiconductor and aluminium production industries, the two main sources of these gases, have reported success in their voluntary efforts to control these emissions. However, this does not match 'top-down' atmospheric monitoring, the researchers say.

TFM and HFE are among the longest lived GHGs. HFE has an atmospheric lifetime of around 50 000 years and TFM 10 000 years. Over a period of 100 years, TFM and HFE can trap 6 630 and 11 000 times as much heat as an equivalent amount of CO_2, respectively.

TFM and HFC are both regulated under the Kyoto protocol of the United National Framework Convention on Climate Change. The two main sources of these gases are the semiconductor and aluminium production industries, both of which have launched voluntary efforts to control these emissions and have reported success in meeting their goals.

However, despite this, a discrepancy remains between the 'top-down' atmospheric measurements of TFM and HFE and the 'bottom-up' emission values reported by industry, calculated from figures for production and mitigation technologies as well as levels of production. Top-down measurements are consistently greater than bottom-up calculation would suggest.

This new study has developed a method to account for these discrepancies. The researchers used data from a global network of atmospheric GHG monitoring stations (AGAGE) to compare the ratios of TFM and HFE in regions where one or the other industry dominates: Australia for aluminium and South Korea for semiconductors.

These data were used to identify and allocate the emissions to either industry. This allowed a 'top-down' measurement of emissions from each industry to be directly compared to the bottom-up figure generated by the industry.

Across both industries, between 1990 and 2000, around a third of the measured global, top-down emissions of TFM (34%) and HFE (35%) were unaccounted for in industry bottom-up figures. This discrepancy increased to 50% for TFM and 48% for HFE of emissions between 2002 and 2010.

Averaged over 1990 to 2010, semiconductor industry bottom-up emissions were around 30% of their top-down values for TFM, and around 42% for HFE. The discrepancy in semiconductor industry emissions was largest in 2002, after which the gap began to narrow. This, the authors say, could be due to improvements in manufacturing technologies which significantly reduce overall emissions.

The authors also highlight two areas of uncertainty which may explain gaps between top-down and bottom-up values. Firstly, standardised calculations may not wholly apply to the wide range of manufacturing conditions in the semiconductor industry. Secondly, the efficiencies of different technologies used to reduce these kinds of emissions may vary from the assumed 90% efficiency used in estimates.

Top-down and bottom-up emissions figures were generally in agreement with one another for the aluminium industry. However, after 2001 top-down values gradually increased leading to a growing difference with bottom-up global emissions.

Between 2001 and 2010, aluminium production in China grew from 11% to 39% of global production. Comparisons between top-down and bottom-up emissions suggests that the bottom-up calculations used for China are significantly underestimated.

The study shows that a more accurate understanding of the sources of GHGs can highlight areas of concern that need to be addressed, which in turn can help inform future policymaking.