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Future atmospheric abundances and climate forcings from HFC scenarios

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Abstract

HFCs are used as substitutes for ozone-depleting substances. They do not deplete ozone, but are potent greenhouse gases. New global scenarios show that HFC baseline emissions may equal 9 – 29% of the increase in annual business-as-usual CO_2 emissions from 2015 to 2050. Regulations to limit HFC use have already been adopted in the EU, Japan and USA, and proposals have been submitted to amend the Montreal Protocol to reduce growth in HFC use. Baseline emissions are reduced by 90% in 2050 by implementing the North America amendment proposal. Global adoption of technologies required to meet national regulations would be sufficient to reduce 2050 baseline HFC emissions by more than 50% of that achieved with the North America proposal for most countries.

Baseline HFC scenarios

The new baseline (or business-as-usual) scenarios are formulated for 10 HFC compounds, 11 geographic regions, and 13 use categories. The scenarios rely on detailed data reported by countries to the United Nations; projections of gross domestic product and population; recent observations of HFC atmospheric abundances; and saturation of HFC consumption in developing countries at levels found in developed countries. HFC baseline emissions reach 4.0 – 5.3 $GtCO_2$-eq yr^{-1} in 2050, which is 9 – 29% of the increase in annual business-as-usual CO_2 emissions from 2015 to 2050 (Figure 1). In the scenarios, by 2050 China (31%), India and the rest of Asia (23%), Middle East and northern Africa (11%), and USA (10%) are the principal source regions for HFC emissions; and refrigeration (40-58%) and stationary air conditioning (21-40%) are the major use sectors.

Montreal Protocol amendment proposals

Proposals have been submitted in 2015 and 2016 by North American countries, the EU, India, and 8 Pacific Island states to amend the Montreal Protocol to include controls on HFCs and significantly limit their future use. All proposals give HFC emission reductions for developed countries of 80% or more compared to baseline emissions in 2050 (Figure 2). The estimated reductions for developing countries show a range depending on the different base levels and reduction schedules in the proposals.

Radiative forcing reductions

In the baseline scenario, global HFC radiative forcing in 2050 is projected to be 0.22 – 0.25 W m^{-2}. This is equivalent to 6 – 9% of global CO_2 radiative forcing in business-as-usual scenarios or 12 – 24% of the increase in CO_2 radiative forcing from 2015 to 2050. Global HFC radiative forcing is projected to decrease after 2035 in most Montreal Protocol amendment proposals (Figure 2C). Differences in emission reductions translate into differences in the estimated reductions in radiative forcing. All the new national regulations reduce HFC emissions in 2050, and most amendment proposals are projected to reduce radiative forcing as well.

National regulations

Regulations have been adopted in the EU, USA and Japan in 2014/2015 that are projected to reduce the HFC emissions in these regions. It is likely that this will drive global technological developments and thereby also reduce emissions in other regions. Global adoption of technologies required to meet these national regulations are estimated to reduce HFC emissions by 50% or more compared to the North American proposal (Figure 3).

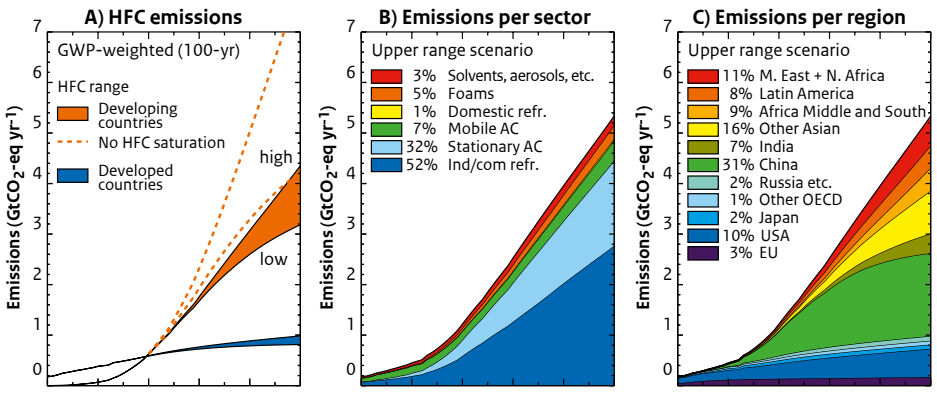

Figure 1. Emissions of the upper and lower range baseline scenarios for developed and developing countries (A) and contributions of use sectors (B) and regions (C) in the upper range scenario. The percentages refer to the relative contributions of the GWP-weighted emissions in 2050. Ignoring saturation (A) of HFC consumption in developing countries increases 2050 emissions from 3.2 – 4.4 to 4.2-7.9 $GtCO_2$-eq yr^{-1}. HFC-23 is not included in the scenarios, since it is emitted almost completely as a byproduct of HCFC-22 production.

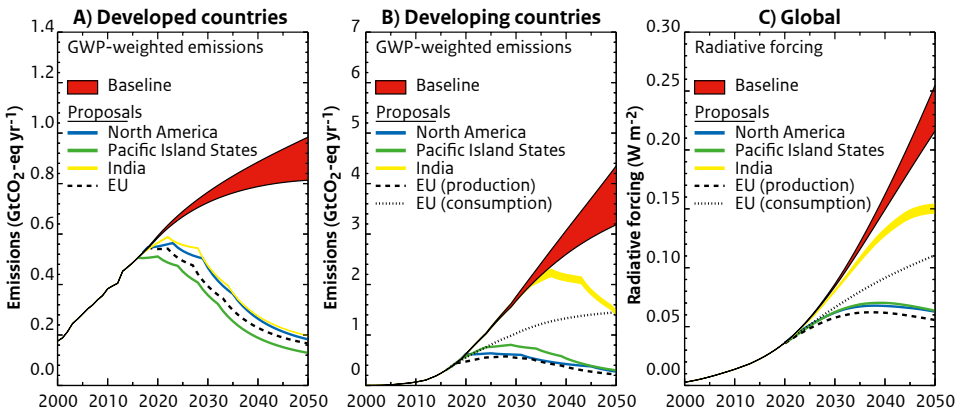

Figure 2. Response of HFC emissions in the baseline scenario for developed (A) and developing (B) countries to implementation of Montreal Protocol amendment proposals to regulate HFC use, and the response of global radiative forcing (C).

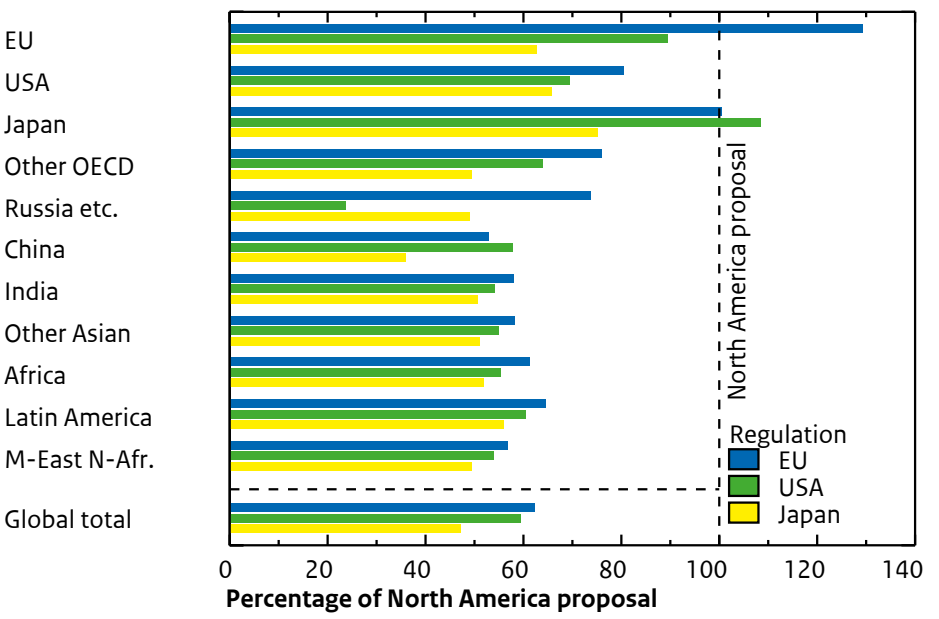

Figure 3. Projected reductions in cumulative (2015-2050) HFC emissions in the baseline scenario relative to that projected by implementing the North America proposal to amend the Montreal Protocol. The reductions are those that result from implementing the EU, USA or Japanese national regulations in that region, with a five-year delay for developing countries. A reduction of 100% means that the reduction in emissions is equal in magnitude to the reduction from the HFC phasedown of the North America proposal.

Reference

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