

Recent increases in global HFC-23 emissions

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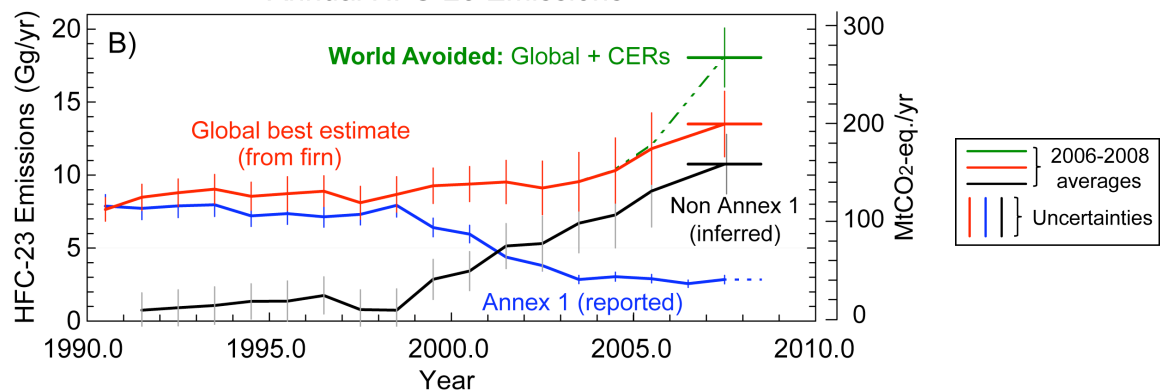
Global atmospheric concentrations and emissions of HFC-23 have continued to increase despite efforts in both developed and developing countries to reduce emissions of this potent greenhouse gas during the past decade.

• Observations: Recent HFC-23 emissions were derived from gas measurements made in ambient air and in the Antarctic snowpack (firn) three times between 2001 and 2009.

Background: HFC-23

Hydrofluorocarbon-23 (HFC-23) emissions arise primarily from over-fluorination of chloroform during HCFC-22 production.

Annual HFC-23 Emissions



Global annual HFC-23 emissions derived from atmospheric and firn air observations.

Global HFC-23 emissions have **increased** by 55% :

- 2006-2008 average: 13.5 ± 2 Gg/yr or 200 ± 30 Mt CO₂-eq.
- 1990-2000 average: 8.7 ± 1 Gg/yr or 129 ± 15 Mt CO₂-eq.

Developed country (Annex 1) annual HFC-23 emissions reported to UNFCCC.

- HFC-23 emissions have **decreased** in developed countries from 6 - 8 Gg/yr in the late 1990s to 2.8 Gg/yr in 2007.

Developing country (non-Annex 1) annual HFC-23 emissions. They are inferred here as the difference between derived global emissions and reported Annex-1 emissions. Non-Annex-1 HFC-23 emissions are not reported to the UNFCCC.

- HFC-23 emissions have **increased** steadily in developing countries from 1 - 3 Gg/yr in the 1990s to 11 ± 2 Gg/yr in 2006-2008 as a result of rapidly increasing HCFC-22 production.

World Avoided: Global annual HFC-23 emissions from atmospheric observations + **Certified Emission Reductions (CERs)** under the UNFCCC Clean Development Mechanism (CDM).

- Without CERs, HFC-23 global emissions would have **doubled** from approximately 9 to 18 Gg/yr between 2000-2002 and 2006-2008.
- Substantial amounts of HCFC-22 were produced but **not covered** by existing CDM projects (~57%) in 2007 and the HFC-23 associated with this production appears to be emitted to the atmosphere.

Background:

HFC-23 has a 100-yr global warming potential (GWP) of 14,800 (or 11,700 for UNFCCC CDM purposes).

1Gg HFC-23 = 14.8 Mt CO₂-eq

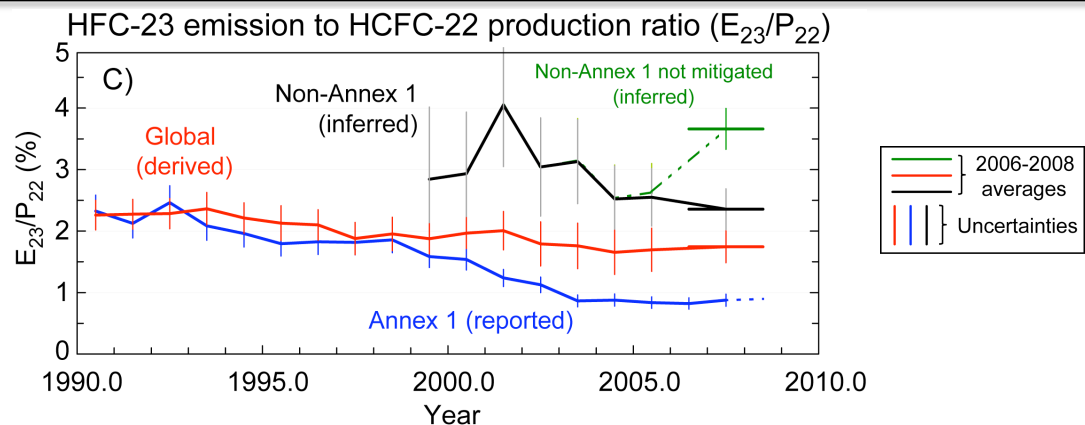
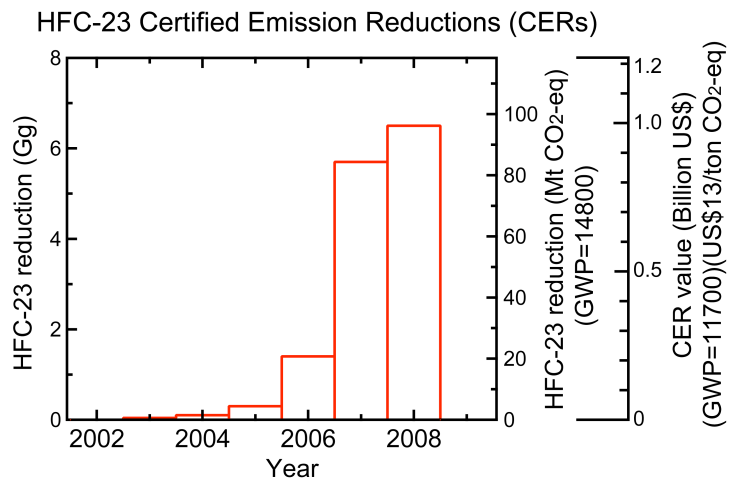
The GWP of HCFC-22 is 1,810.

Figure lines

- HFC-23 CERs through 2008 total 14 Gg which corresponds to **208 Mt CO₂-eq.** of climate protection.

- HFC-23 CO₂-eq. emissions in recent years have been about **1/3 as large** as HCFC-22 CO₂-eq. emissions despite only a 1.5 - 2.5% yield of HFC-23 during HCFC-22 production.

- The total value of CERs between 2003 and 2008 is **2.1 Billion US\$** assuming a HFC-23 GWP of 11700 and a US\$13/ton CO₂-eq market value.



Annual ratio of global HFC-23 emissions to global HCFC-22 production (E_{23}/P_{22})

- Global HFC-23 emissions as a percentage of total HCFC production have **decreased** since the mid 1990's to an average value of 1.7% in 2006-2008.

Developed country (Annex 1) annual E_{23}/P_{22} ratios from values reported to UNFCCC and UNEP.

- E_{23}/P_{22} values have steadily **decreased** in developed countries from approximately 2% in the 1990s to 0.9% during 2003-2007.

Developing country (non-Annex 1) annual E_{23}/P_{22} ratios from inferred HFC-23 emissions and reported HCFC-22 production.

- E_{23}/P_{22} values have **decreased** in developing countries since the early 2000's to reach $2.4 \pm 0.3\%$ for 2006-2008.

Developing country (non-Annex 1) annual E_{23}/P_{22} ratios from inferred HFC-23 emissions and HCFC-22 production not associated with CDM projects.

- E_{23}/P_{22} values in HCFC-22 production not associated with CDM projects are **high** ($3.7 \pm 0.3\%$) compared to values in the past obtained in either non-Annex-1 or Annex-1 countries.

Background:

Under the Montreal Protocol HCFC-22 production and consumption for non-feedstock uses will end in developed/developing countries in 2020/2030. The Montreal Protocol does not regulate feedstock production of HCFC-22.

Annual Total HCFC-22 Production *

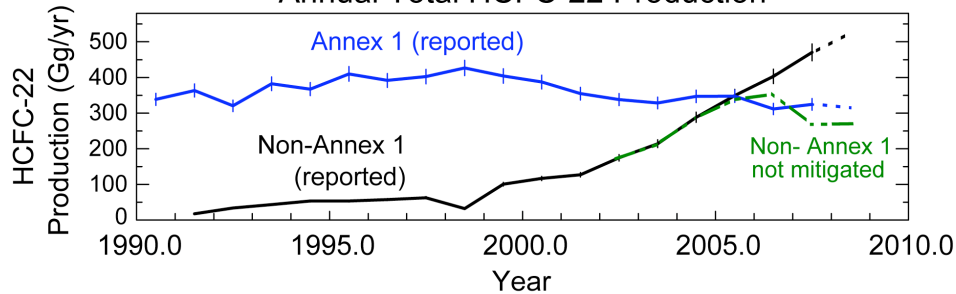


Figure lines

Developed country (Annex 1) annual HCFC-22 production as reported to UNEP.

- Developed country annual HCFC-22 production has **decreased** in the last decade.

Developing country (non-Annex 1) annual HCFC-22 production as reported to UNEP.

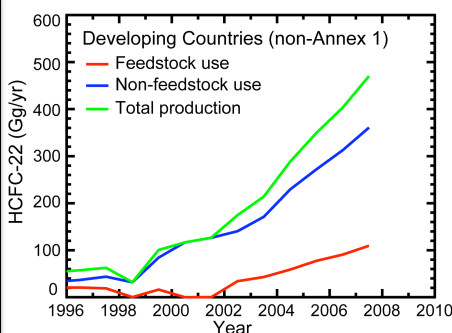
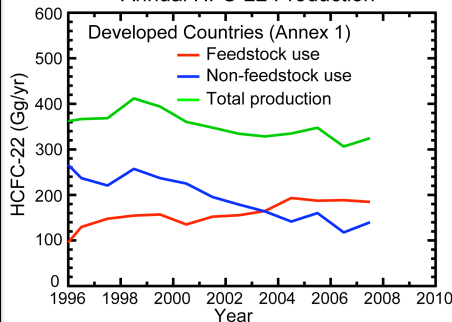
- Developing country annual HCFC-22 production has **increased** with a substantial growth rate in the last decade.

Developing country (non-Annex 1) annual HCFC-22 production not associated with CDM projects.

- A large fraction (57%) of developing country HCFC-22 production was not included in CDM projects in 2007 and hence is associated with **unmitigated** HCFC-22 production.

- Total HCFC-22 production = **feedstock** (fluoropolymers, e.g., *Teflon*, etc.) + **non-feedstock** (emissive uses, e.g., air conditioning and refrigeration).

Annual HFC-22 Production



** Data reported to the United Nations Environment Programme (UNEP). Data for years before 1996 are incomplete for feedstock and non-feedstock uses.

Annual HCFC-22 Feedstock and Non-feedstock Production **

- The Montreal Protocol does not control HCFC-22 feedstock production so when the HCFC-22 phaseout is complete in 2020/2030, HFC-23 will potentially still be emitted from continuing HCFC-22 feedstock production.

Total annual HCFC-22 production from feedstock and non-feedstock (emissive) uses.

Annual HCFC-22 production for feedstock use.

- Feedstock use of HCFC-22 since the mid 1990s has **increased** in both Annex-1 and non-Annex-1 countries and currently has a **large growth rate** in non-Annex-1 countries.

Annual HCFC-22 production for non-feedstock uses.

- Non-feedstock use has **fallen** steadily in developed countries in the last decade while it has **increased** strongly (25%/yr) in developing countries since 2002.

- Production of HCFC-22 for feedstock use worldwide accounted for **37%** (over a third) of total HCFC-22 production in 2007 and has been **increasing** at ~5% per year in recent years.