

# European Emissions of the Powerful Greenhouse Gases Hydrofluorocarbons Inferred from Atmospheric Measurements and Their Comparison with Annual National Reports to UNFCCC

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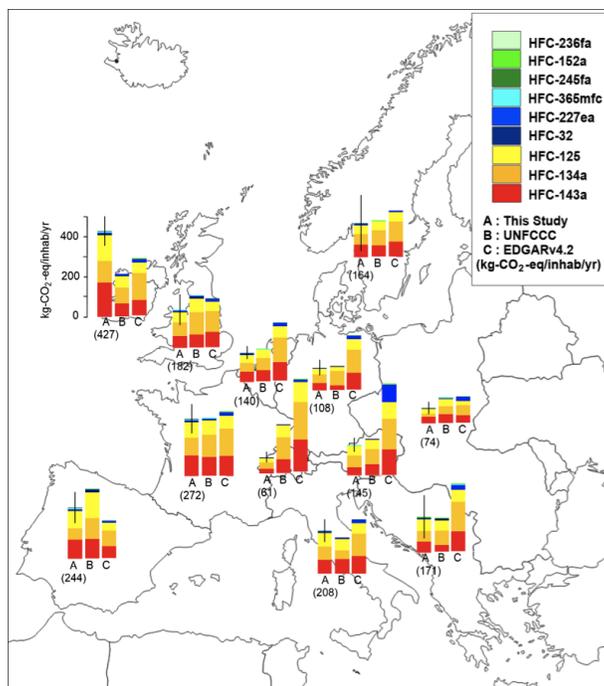
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Hydrofluorocarbons (HFCs) are powerful greenhouse gases (GHG) introduced after the phase-out of the ozone depleting chlorinated gases required by the Montreal Protocol (MP). The climate benefit of reducing the emissions of HFCs led to the Kigali amendment to the MP calling for developed countries to start to phase-down HFCs by 2019 and for developing countries to freeze between 2024 and 2028, to avoid half a degree Celsius of warming by the end of the century. HFCs are also controlled under the Kyoto Protocol of the United Nations Framework Convention on Climate Change (UNFCCC). Annex I parties to the Convention submit annual national GHG inventories based on a bottom-up approach. Top-down methodologies based on atmospheric measurements can be used in support to the inventory compilation. We used atmospheric data from four European sites combined with the FLEXPART dispersion model and a Bayesian inversion method, to derive emissions of nine HFCs from the European Geographic Domain and from twelve regions within it, then comparing our results with the annual reports of European countries to the UNFCCC, as well as with the EDGAR database. Despite some discrepancies when considering the single compounds and countries, an overall agreement is found when comparing aggregated data, which between 2008 and 2014 are on average 84.2 against the 95.1 Tg-CO<sub>2</sub>-eq.yr<sup>-1</sup> reported to UNFCCC. In agreement with other studies, the gap at the global level between bottom-up estimates of Annex I countries and total global top-down emissions should be essentially due to emissions from non-reporting countries (non-Annex I).



**Figure 1.** Per-capita emissions from twelve macro-areas in the European Geographic Domain. Emissions, given in kg-CO<sub>2</sub>-eq.y<sup>-1</sup>.inhabitants<sup>-1</sup>, are averaged over 2008-2014 for the inversion results (columns A) and the IPCC country reports (columns B). EDGAR data (columns C) are averaged over 2008-2010.