Reconciling Estimates of SF_6 Emissions Using NOAA Observations

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The NOAA ESRL Carbon Cycle Group measures sulfur hexafluoride (SF_6) from discrete samples collected at ~60 sites globally. SF_6 is a strong absorber of terrestrial IR radiation, and it has a lifetime estimated at 3200 years. Taken together, these properties make SF_6 the strongest known greenhouse gas with a global warming potential of 22,800 over a 100 year time horizon. SF_6 sources include electricity distribution systems, magnesium production, manufacture of electronic circuit boards, automobile tires, and sneakers. SF_6 is inert in the lower atmosphere; its sinks are photolysis and reaction with electrons in the mesosphere.

SF_6 is the best known tracer for testing transport schemes used in atmospheric transport models. For example, Peters et al. [JGR, doi: 10.1029/2004JD005020, 2004] used an established emissions distribution in "Tracer Model 5" and found that the modeled latitudinal gradient was ~20% greater than the observations. To identify errors in transport, we need accurate estimates of the magnitude and distribution of SF_6 emissions globally.

Fortunately, we can assess the magnitude of emissions from observations, because the SF_6 lifetime is long enough, that all emissions remain in the atmosphere. SF_6 has increased from zero in pre-industrial times to more than 6 pmol mol^{-1} (ppt) in 2007. Since 1998, the average rate of increase in the global burden of SF_6 has been 0.21 ppt yr^{-1} (top panel), corresponding to 5.4 Gg SF_6 yr^{-1}. Our observations suggest that since the start of our measurements in 1997, SF_6 emissions have increased by ~15%. This increase in emissions has happened despite attempts to reduce SF_6 emissions under the Kyoto Protocol. Long-term measurements of SF_6 can be used to verify global emission inventories based on national statistics. SF_6 emissions calculated from the observed annual atmospheric increases (blue circles) are compared with emissions reported by Annex I countries (red triangles) to the United Nations Framework Convention on Climate Change (UNFCCC: http://unfccc.int). The large difference between the two estimates can be attributed to either a rapid increase in non-Annex I emissions or Annex I countries underestimating emissions reported to UNFCCC.

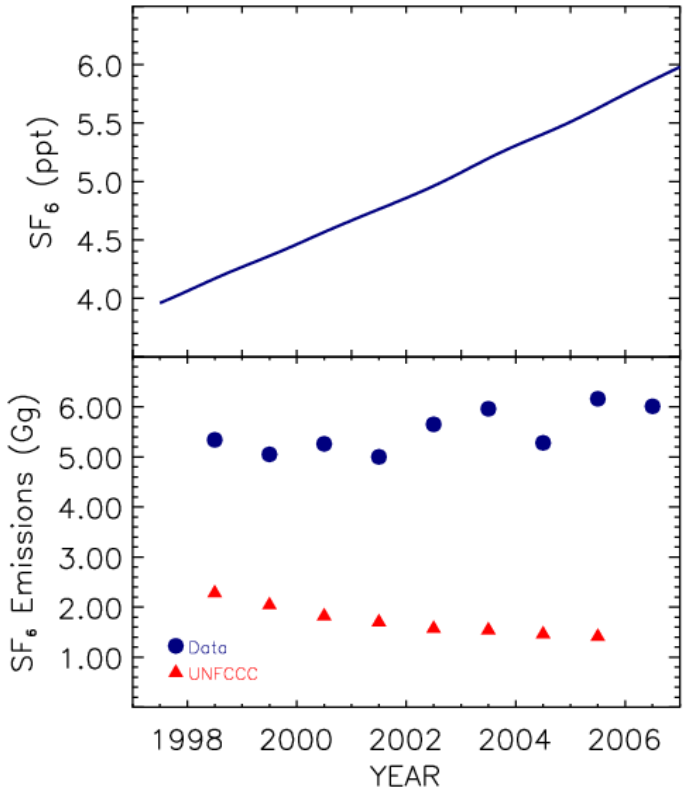

Figure 1. Globally averaged SF_6 trend from the NOAA ESRL global cooperative air sampling network (top). Global emissions of SF_6 calculated from annual increase (circles) and from emissions reported by Annex I countries to the UNFCCC (triangles). Annex I Parties include the industrialized countries that were members of the Organization for Economic Co-operation and Development (OECD) in 1992, plus countries with economies in transition (the EIT Parties), including the Russian Federation, the Baltic States, and several Central and Eastern European States.