Geophysical Research Abstracts
Vol. 18, EGU2016-7870, 2016
EGU General Assembly 2016

Atmospheric observations for quantifying emissions of point-source synthetic greenhouse gases (CF_4, NF_3 and HFC-23)

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The fluorinated species carbon tetrafluoride (CF4; PFC-14), nitrogen trifluoride (NF3) and trifluoromethane (CHF3; HFC-23) are potent greenhouse gases with 100-year global warming potentials of 6,630, 16,100 and 12,400, respectively. Unlike the majority of CFC-replacement compounds that are emitted from fugitive and mobile emission sources, these gases are largely emitted from large single point sources – semiconductor manufacturing facilities (all three), aluminium smelting plants (CF4) and chlorodifluoromethane factories (HFC-23). In this work we show the potential for atmospheric measurements to understand regional sources of these gases and to highlight emission 'hotspots'. We target our analysis on measurements from two Advanced Global Atmospheric Gases Experiment (AGAGE) long term monitoring sites that are particularly sensitive to regional emissions of these gases: Gosan on Jeju Island in the Republic of Korea and Cape Grim on Tasmania in Australia. These sites measure CF4, NF3 and HFC-23 alongside a suite of greenhouse and stratospheric ozone depleting gases every two hours using automated in situ gas-chromatography mass-spectrometry instrumentation. We couple each measurement to an analysis of air history using the regional atmospheric transport model NAME (Numerical Atmospheric dispersion Modelling Environment) driven by 3D meteorology from the Met Office's Unified Model, and use a Bayesian inverse method (InTEM – Inversion Technique for Emission Modelling) to calculate yearly emission changes over a decade (2005-2015) at high spatial resolution. At present these gases make a small contribution to global radiative forcing, however, given that their impact could rise significantly and that point sources of such gases can be mitigated, atmospheric monitoring could be an important tool for aiding emissions reduction policy.