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Quantifying India's HFC emissions from whole-air samples collected on the UK-India Monsoon campaign

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With a population exceeding 1 billion and a rapidly expanding economy, greenhouse gas (GHG) emissions from India are of global significance. As of 2010, India's anthropogenic GHG emissions accounted for 5.6% of the global total, with this share predicted to grow significantly in the coming decades. We focus here on hydrofluorocarbons (HFCs), a diverse range of potent GHGs, whose role as replacements for ozone-depleting CFCs and HCFCs in air-conditioning and refrigeration applications (among others) has led to rapid atmospheric accumulation. Recent efforts to reduce their consumption (and subsequent emission) culminated in an amendment to the Montreal Protocol; member states are now required to phase-down their use of HFCs, with the first cuts planned for 2019. Despite the potential climate implications, atmospheric measurements of HFCs in India, required for quantifying their emissions using top-down inverse methods, have not previously existed. Here we present the first Indian hydrofluorocarbon (HFC) observations, obtained during two months of low altitude (<2000 m) flights. Of the 176 whole air samples collected on board the UK's NERC-FAAM (Facility for Airborne Atmospheric Measurements) research aircraft, the majority were obtained above the Indo-Gangetic Plains of Northern India, where population density is greatest. Using a small subset of samples filled above the Arabian Sea, we derive compound specific baselines, to which the remaining samples are compared. Significant mole fraction enhancements are observed for all major HFCs, indicating the presence of regional emissions sources. Little enhancement is observed in the concentration of various HFC predecessors, including CFCs, suggesting India's success in phasing out the majority of ozone depleting substances. Using these atmospheric observations and the NAME (Numerical Atmospheric dispersion Modelling Environment) atmospheric transport model, we present the first regional HFC flux estimates for India.