Next-generation greenhouse gas emissions estimation using AI, big data and atmospheric measurements

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Based in Imperial's department of Physics with lead supervisor Heather Graven and co-supervisors Fangxin Fang (Earth Sciences and Engineering) and Carole Helfter (Centre for Ecology and Hydrology)

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Description:
Urban regions are responsible for >70% of the world's greenhouse gas emissions driving climate change. Some urban regions are also leading in the implementation of climate change mitigation policies, for example, London has an ambition for its greenhouse gas emissions to become net zero by 2030. However, information on urban greenhouse gas emissions is currently lacking, inconsistent, and uninformed by new, big data resources. Typically, greenhouse gas emissions are computed on national scales with a 2-year lag period, which does not address the spatial and temporal needs for cities, especially those enacting mitigation policies. For cities that do calculate and report their own emissions, our research and others have found that cities under-report their greenhouse gas (GHG) emissions, leading to poor understanding of emissions and ineffective policies for mitigation.

There is presently a huge opportunity to use AI, big data and atmospheric measurements to create detailed, refined and near-real-time emissions estimates, which could help governments, companies and organisations develop, deploy and evaluate effective policies for mitigation. Some exciting emissions estimation using AI and big data has been happening at national and global scales, particularly by ClimateTrace (climatetrace.org). However, these methods have generally not yet been developed for city-scale GHG estimation. Cities in both developed and developing regions need these methods, whilst having different opportunities and constraints on applying them.

In this project, we will develop and apply AI and big data to produce detailed, sectoral, spatially and temporally-resolved emissions estimates in London and at least one other city, which will be selected from the Global South. The methods will be developed in a way that allows them to be applied to any other city, accounting for specific characteristics and data resources of a city. We will also incorporate measurements from established atmospheric observation sites in London to understand and evaluate greenhouse gas emissions in London. The sites include the BT Tower and the Huxley building at Imperial in South Kensington. The observations include eddy flux measurements of greenhouse gas fluxes and continuous measurements of greenhouse gas concentrations and other trace species that can help distinguish the sources of greenhouse gases.

The outcomes of this project will improve understanding of greenhouse gas emissions in London and their reduction in relation to net zero policies. The student will gain knowledge and experience in AI and machine learning, atmospheric observation and atmospheric modelling. The student will be based at Imperial with supervision from Prof Heather Graven in Imperial Physics, Dr Fangxin Fang in Imperial Earth Sciences and Engineering and Dr Carole Helfter at the Centre for Ecology and Hydrology. In addition to the co-supervisors, the

student will collaborate with other observational scientist and modellers, and they will correspond with local authorities and emission inventory scientists.

Relevant literature and websites:
https://nap.nationalacademies.org/catalog/26641/greenhouse-gas-emissions-information-for-decision-making-a-framework-going
https://agupubs.onlinelibrary.wiley.com/doi/full/10.1029/2023GL103834
https://acp.copernicus.org/articles/22/3595/2022/
https://acp.copernicus.org/articles/16/10543/2016/
https://climatetrace.org/
https://cities.carbonmonitor.org/