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Observing and interpreting urban CO_2 and other emissions using a dense network of low-cost, near-surface monitors

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Urban carbon dioxide comprises the largest fraction of anthropogenic greenhouse gas emissions but are also the most challenging to observe and enumerate, as multiple emission sources reside in close proximity within each topographically intricate urban setting. Similarly the gases NO, O_3, NO_2 and CO and aerosol each have sources and chemistry that vary in complex ways within a city. In attempting to better understand each individual source's contribution to the overall emission budget, there exists a large gap between activity-based emission inventories and observational constraints that are used on larger scales to create integrated, regional emission estimates. Here we leverage urban observations from the BErkeley Atmospheric CO_2 Observation Network ($BEACO_2N$) to enhance, rather than average across or cancel out, our sensitivity to hyperlocal emission sources. We utilize a method for isolating the local component of our signals that accentuates the observed intra-urban heterogeneity and thereby increases sensitivity to mobile emissions from specific highway segments. We demonstrate a multiple linear regression analysis technique that accounts for boundary layer and wind effects and allows for the detection of trends in vehicular emissions of CO_2 on scale with anticipated changes in fuel economy. The ability to represent trends of policy-relevant magnitudes with a low-cost sensor network has important implications for future applications of this approach, whether as a supplement to sparser existing reference networks or as a substitute in areas where fewer resources are available.