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Measurements of Carbon Dioxide, Methane, and Other Related Tracers at High Spatial and Temporal Resolution in an Urban Environment

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The ability to quantify sources and sinks of carbon dioxide and methane on the urban scale is essential for understanding the atmospheric drivers to global climate change. In the 'top-down' approach, overall carbon fluxes are determined by combining remote measurements of carbon dioxide concentrations with complex atmospheric transport models, and these emissions measurements are compared to 'bottom-up' predictions based on detailed inventories of the sources and sinks of carbon, both anthropogenic and biogenic in nature. This approach, which has proven to be effective at continental scales, becomes challenging to implement at urban scales, due to poorly understood atmospheric transport models and high variability of the emissions sources in space (e.g., factories, highways, green spaces) and time (rush hours, factory shifts and shutdowns, and diurnal and seasonal variation in residential energy use). New measurement and analysis techniques are required to make sense of the carbon dioxide signal in cities. Here we present detailed, high spatial- and temporal- resolution greenhouse gas measurements made by multiple Picarro-CRDS analyzers in Silicon Valley in California. Real-time carbon dioxide data from a 20-month period are combined with real-time carbon monoxide, methane, and acetylene to partition the observed carbon dioxide concentrations between different anthropogenic sectors (e.g., transport, residential) and biogenic sources. Real-time wind rose data are also combined with real-time methane data to help identify the direction of local emissions of methane. High resolution WRF models are also included to better understand the dynamics of the boundary layer. The ratio between carbon dioxide and carbon monoxide is shown to vary over more than a factor of two from season to season or even from day to night, indicating rapid but frequent shifts in the balance between different carbon dioxide sources. Additional information is given by acetylene, a fossil fuel combustion tracer that provides complimentary information to carbon monoxide. In spring and summer, the combined signal of the urban center and the surrounding biosphere and urban green space is explored. These methods show great promise for identifying, quantifying, and partitioning urban-ecological (carbon) emissions.