Estimating Urban Carbon Dioxide Fluxes at High Spatial Resolution from *In Situ* Observations: First Results from the Berkeley Atmospheric CO_2 Observation Network

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Urban carbon dioxide (CO_2) sources are of growing relevance to the global carbon budget, yet have not traditionally been the subject of monitoring efforts. Recent attention to urban greenhouse gases has involved experiments using small handfuls of sparsely deployed, high-quality instruments. However, coherent plumes from urban roadways and other sources are thought to occur throughout the domain of any city, where they mix with other plumes, resulting in a generally elevated urban signal. The plumes have been observed to have e-folding scales of ~1 km, and so in order to observe emissions within the complex urban domain, we have constructed BEACO$_2$N (the Berkeley Atmospheric CO_2 Observation Network). BEACO$_2$N consists of approximately two-dozen sensor “nodes” dispersed at roughly 2-km intervals around the Bay Area. Each node contains instruments for measuring ambient CO_2 with modest precision, and we are in the process of adding instruments for observing particulate matter, carbon monoxide, nitric oxide, nitrogen dioxide, and ozone. Our goal is to leverage the network character of the instrument itself to: (1) provide novel internal cross-calibration, (2) enhance the long term accuracy of the measurements, (3) achieve a square-root of *n* improvement in the precision and accuracy of the overall network signal, and (4) create detailed maps of urban emissions and concentrations.

Here we present preliminary results from the first two years of CO_2 data collection, demonstrating the sensitivity of individual sensors to local scale emission events such as bridge closures, public transit hiatuses, and shipping activity at the Port of Oakland. We also offer outcomes from an initial implementation of network-wide BEACO$_2$N observations as constraints for an inverse model Coupled Weather Research and Forecasting/Stochastic Time-Inverted Lagrangian Transport (WRF-STILT), indicating the capacity of the network instrument to define locations that deviate from *a priori* emissions inventories on a daily or hourly basis.

Figure 1. Current BEACO$_2$N sensor locations.

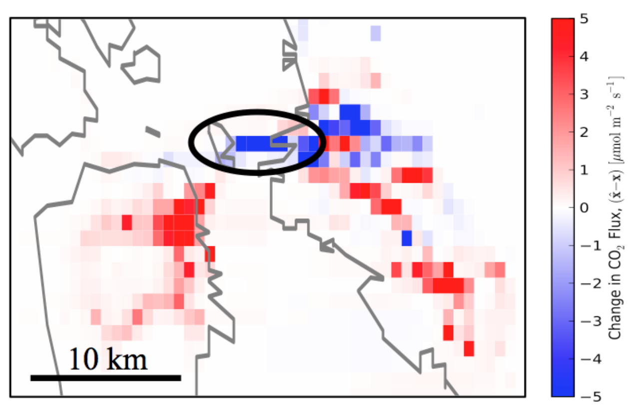

Figure 2. Calculated difference between annual bottom-up prior emissions inventory and posterior inventory informed by BEACO$_2$N observations on September 1, 2013. Highlighted discrepancy demonstrates the sensitivity of the network to reduced emissions over the Bay Bridge during its closure on that date.