ESTIMATING CO_2 EMISSIONS USING REAL AND SIMULATED TOTAL COLUMN XCO_2 OBSERVATIONS

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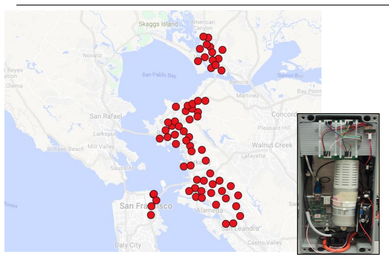
BACKGROUND AND MOTIVATION

Rising atmospheric CO_2 concentrations necessitate deeper understanding of urban sources and sinks. Various sensor technologies and data assimilation strategies can be used to determine short- and long-term atmospheric trends. We seek to find the optimal synthesis of various measurement types in order to characterizing different types of sources in an urban environment.

SURFACE MEASUREMENTS



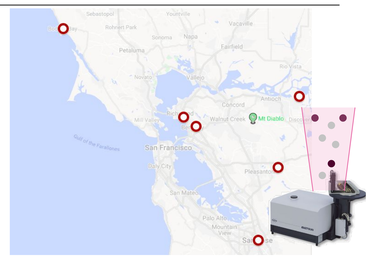
BEACO2N Sensor Network
CO_2, CO, PM, O_3, NO_2, NO

Hypothesized to be sensitive to:
- Boundary Layer Height
- Shallow circulations
- Local traffic emissions

75+ sites **Extensive**

$6,000/node **Operationally Simple**

COLUMN MEASUREMENTS



Berkeley-Harvard 2016 Field Campaign
EM27/SUN FTIR Spectrometers - CO_2

Hypothesized to be sensitive to:
- Regional-scale meteorology
- Mean wind speeds
- Emissions integrated through large area

4 instruments **Sparse**

$27,000/node **Operationally Complex**

METHODS

1. Select 3 study areas to assess surface, column measurements for understanding point emissions sources in a city, using WRF-CHEM modeled data from June 2013 at 1 km resolution.

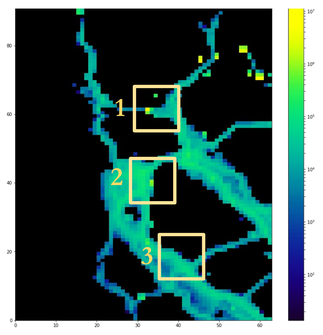


Figure 1. Total Daily Emissions over SF Bay Area (Log Scale)

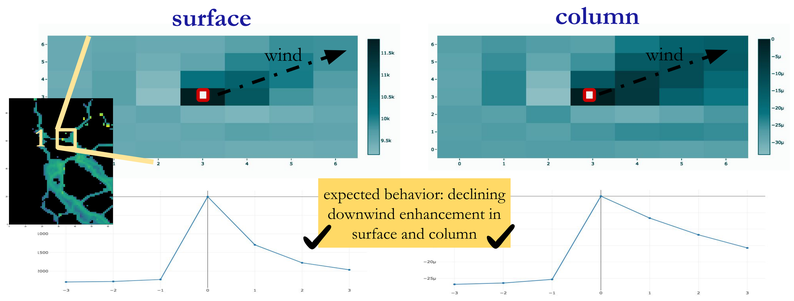
[1] Refineries, Richmond, CA
46x larger than surroundings
[2] Power Plant, Upper SF Peninsula
9x larger than surroundings
[3] Power Plant, Lower SF Peninsula
2x larger than surroundings

POINT SOURCES

2. Integrate the difference of each model box diurnal cycle from the diurnal cycle of the source model box and evaluate downwind patterns.

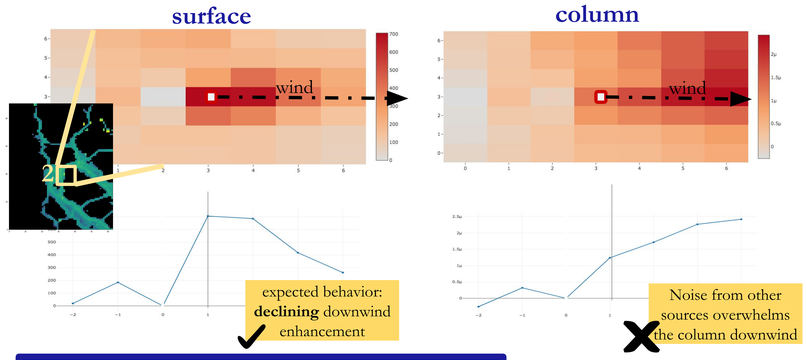
Source 1: Large Refinery

46x larger than surrounding emissions



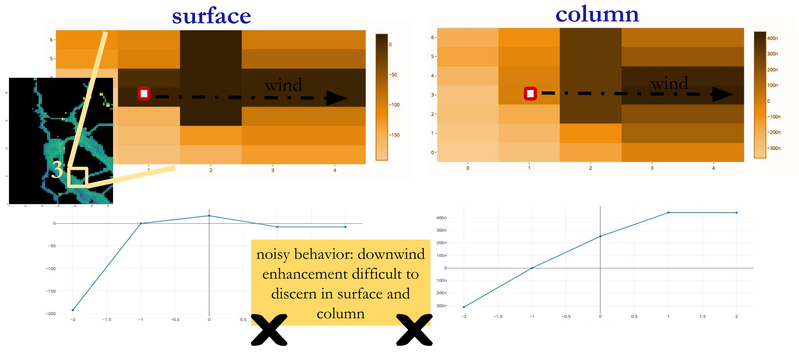
Source 2: Large Power Plant

9x larger than surrounding emissions



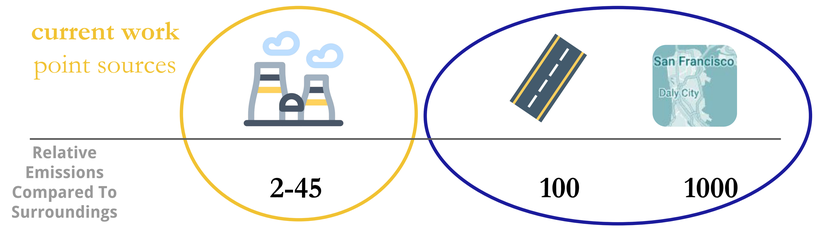
Source 3: Small Power Plant

2x larger than surrounding emissions



CONCLUSIONS AND FUTURE WORK

- Larger sources show clear declining enhancement pattern downwind of emissions and can be detected with both approaches
- Smaller magnitude sources are overwhelmed by other emissions, with column measurements failing at intermediate levels and both methods failing at the lowest emissions tested



APPLICATIONS

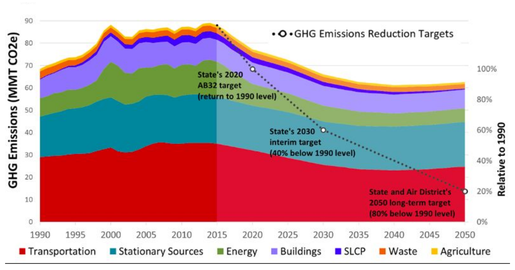


Figure 2. AB32 California Climate Action Plan: Greenhouse Gas Emissions and Reduction Targets for 2050

- AB32 California Climate Action Plan Goal: reduce emissions to 1990 levels by Year 2020 & further reductions by 2030 and 2050
- Assessment of greenhouse gas emissions reductions will need atmospherically measured validation
- Surface and XCO_2 measurements need to be synthesized to find the optimum method for assessing total reductions and sector-wise reductions in emissions