Urban greenhouse gas mole fraction in-situ measurements: Results from the Indianapolis Flux Experiment (INFLUX)

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Goals of the Indianapolis Flux Experiment (INFLUX)

- Develop and assess methods of quantifying greenhouse gas emissions at the urban scale, using Indianapolis as a test bed.
- In particular:
  - Determine whole-city emissions of CO₂ and CH₄.
  - Measure emissions of CO₂ and CH₄ at 1 km² spatial resolution and weekly temporal resolution across the city.
  - Distinguish biogenic vs. anthropogenic sources of CO₂.
  - Quantify and reduce uncertainty in urban emissions estimates.
  - Determine monitoring system requirements for achieving a given uncertainty threshold.

Questions:

- Are these methods viable for policy and management applications?
- What additional research is needed to make these methods useful for policy and management applications?

Methods and their characteristics:

- Atmospheric budgets:
  - All emissions are captured, but identifying individual sources is challenging.
  - Aircraft measurements: Cover space very well, poor spatial resolution, provide snapshots in time.
  - Tower-based measurements: Can provide continuous emissions estimates for years, spatial domain and resolution a function of the measurement network.
- "Bottom-up" inventories:
  - Economic data and emissions factors

Rich source of data regarding types of emissions and spatial distributions of emission. Prone to missing sources. Temporal resolution is limited.

Atmospheric measurement of greenhouse gas (GHG) emissions:

- Measure GHG concentrations upwind and downwind of a source.
- Measure atmospheric transport (wind, mixing depth).
- Estimate GHG emissions needed to explain the observed difference in GHG concentrations.

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Spatial Structure of Urban CO₂
Average [CO₂] Above Background Site

© Black: Site 01 larger than Site 09

• Model results using mesoscale atmospheric model and a "bottom-up" emissions estimate (Heida for 2002)
• Model results and observations are in agreement in terms of site ordering, indicating calculated footprints are reasonable
• Observations are 25% higher than modeled values, on average
• The discrepancy suggests an underestimate in the "bottom-up" emissions estimate

Atmospheric inverse flux estimate:

- Posterior emissions are 1541 ktC, whereas the prior emissions are 1371 ktC.
- Spatial structure of the model-data difference reveals the spatial pattern of emissions corrections.
- Corrections can be computed continuously in time, detecting changes in emissions over time.

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- http://influx.psu.edu