Inverse Modeling Working Group

Participants: Sharon Gourdji, Israel Lopez-Coto, Subhomoy Ghosh, Kuldeep Prasad, Tom Oda, Thomas Lauvaux, Yuyan Cui, Mathias Falk, Vineet Yadav, Maryanne Sargent, Liza Diaz, Thomas Nerhkorn, Eric Kort, Ben Fasoli*, Ariel Stein*

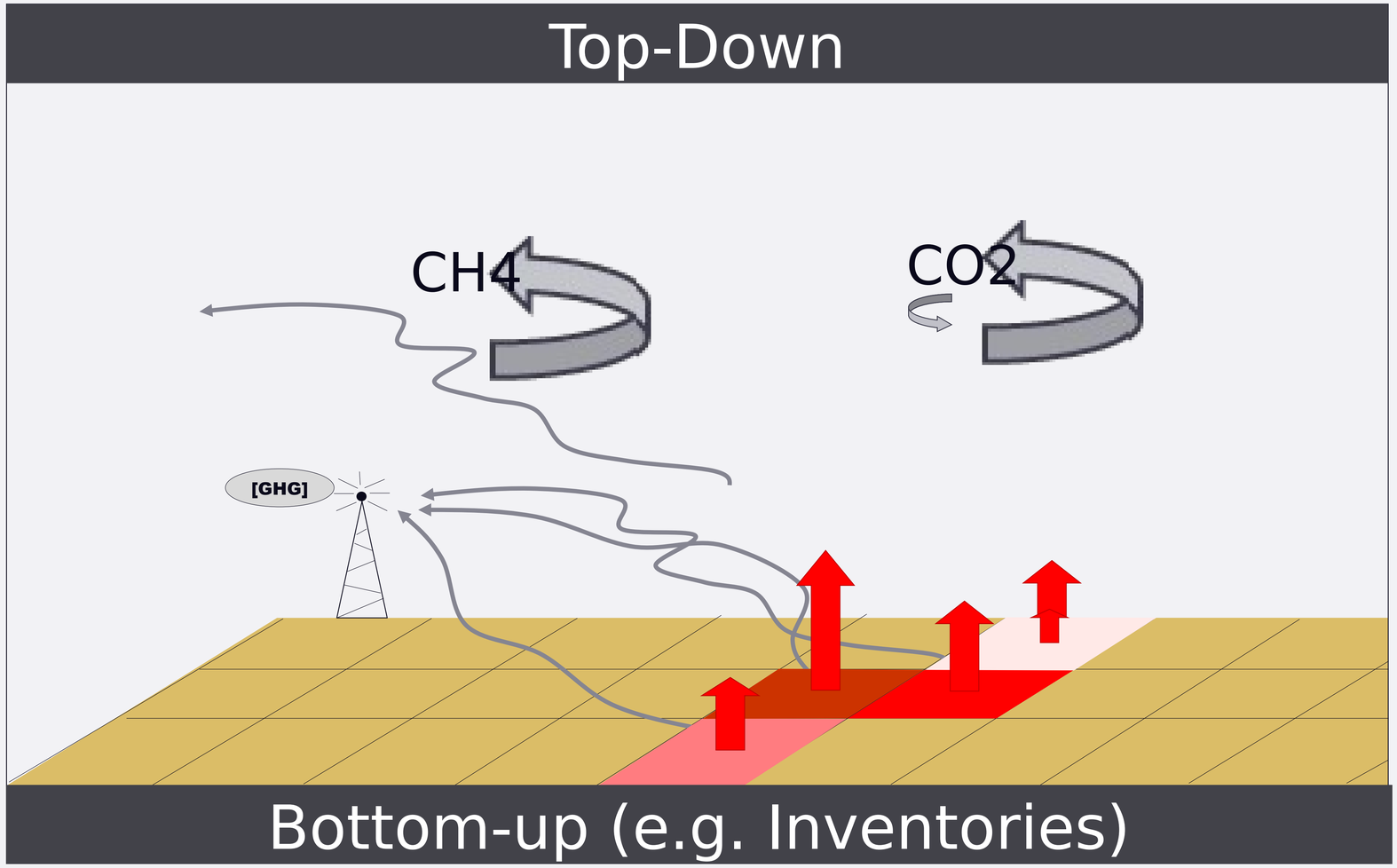
10/25/2018

Greenhouse Gas Measurements Program,
Special Programs Office

National Institute of Standards and Technology

Top Down

ex. atmospheric inversions



Why observations so important: “**observations generally tied to a standard so that CO2 measured in New Zealand can be compared to a CO2 measurement in Europe**”

Felix Vogel

Why?

Inverse modeling working group

the *chicken* versus the *egg* dilemma

<u>Questions</u>:

What answers can inverse models help inform both now and in the future given the state of research?

Methods

<u>Output</u>:

So called “ipad phenomenom”, aka sometimes a number starts a conversation (*L. Sugar*)

Inverse modeling working group

the *chicken* versus the *egg* dilemma

<u>Questions</u>:
What answers can inverse models help inform both now and in the future given the state of research?

Methods

<u>Output</u>:
So called “apple approach”, aka sometimes a number starts a conversation (*L. Sugar*)

How do/could urban emissions inform city-scale needs?

(1) How much GHG has the city emitted over the course of the year;
(2) What are the sector's (e.g. traffic, industry, etc.) contribution to the emissions produced within a city?
(3) How do these emissions vary in time?
(4) What are the spatial patterns of emissions within a city and where are GHG hot-spots including, unpredictable failures such as leaking infrastructure, located?
(5) Can a mitigation activity (either by an industry or a city-wide initiative) be detected?

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Baltimore City Boundaries

LL Crane Power Plant

Herbert Wagner Power Plant

Brandon Shores Power Plant

Inventories:

Purple Rectangles = 10km2 Vulcan 2002
Blue Dots = 1km2 ACES centroids 2013/2014
Black Points = 200m2 Hestia centroids 2010-2014
City of Balimore CAP (2010)

hourly

annual

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ex

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Baltimore City

Redo with ACES

LL Crane Power Plant

Herbert Wagner Power Plant

Brandon Shores Power Plant

**Many "back of the envelop" assumptions
Not exactly apples to apples comparison

**Hestia:
Compliments of Gurney Lab
DRAFT – Not for redistribution or publication**

Categories are based on "sectors"

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Are atmospheric observations consistent with what we "think" we know?

Baltimore City

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Categories are based on "sectors"

How do urban emissions translate into national totals?

Production Numbers

ONLY CONUS!
Could be different with more updated Vulcan product

ex. question for urban inverse modelers

https://www.epa.gov/ghgemissions/sources-greenhouse-gas-emissions

Gurney, K.R., D. Mendoza, Y. Zhou, B. Seib, M Fischer, S. de la Rue du Can, S. Geethakumar, C. Miller (2009) The Vulcan Project: High resolution fossil fuel combustion CO2 emissions fluxes for the United States

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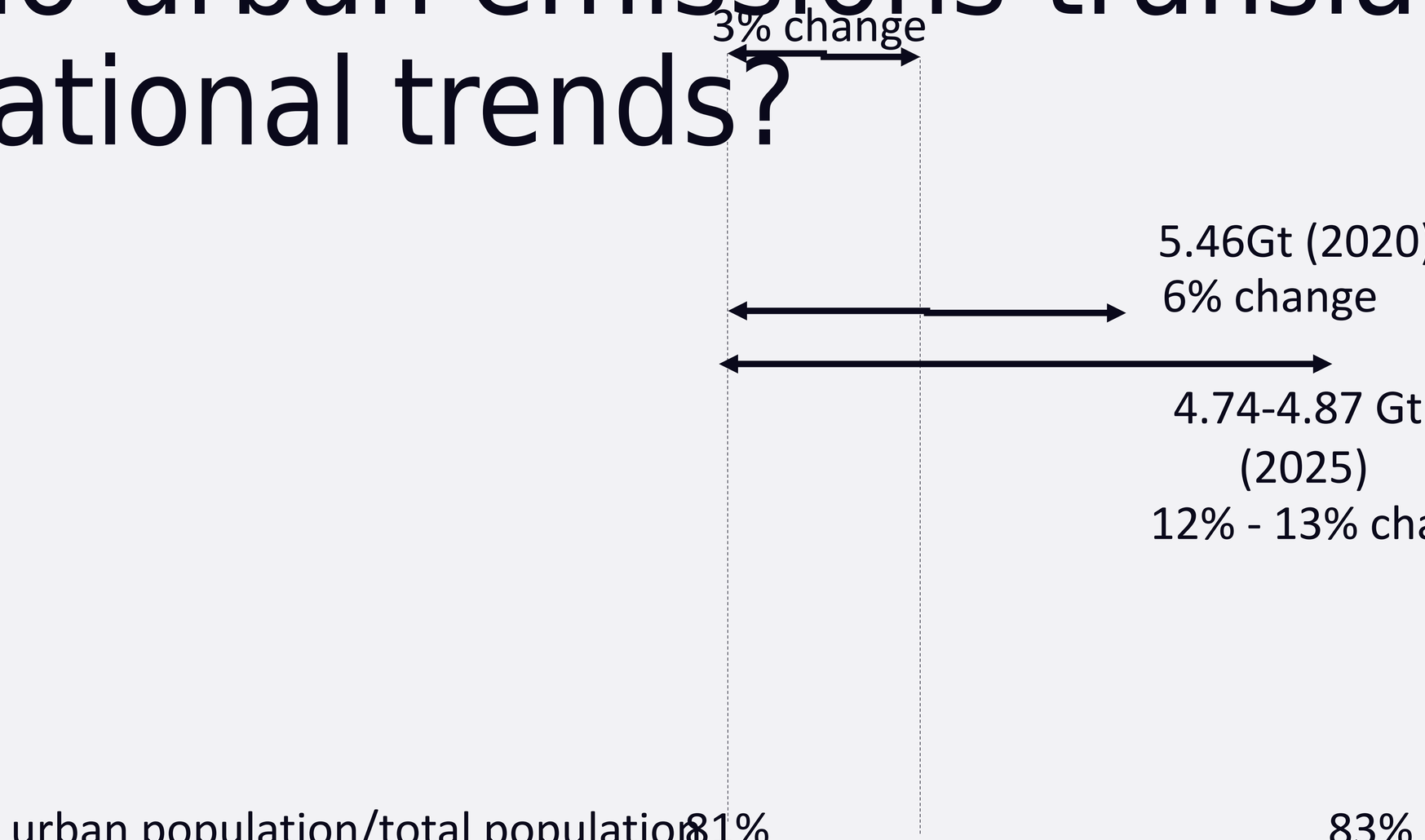
How do urban emissions translate into national trends?

e.x.



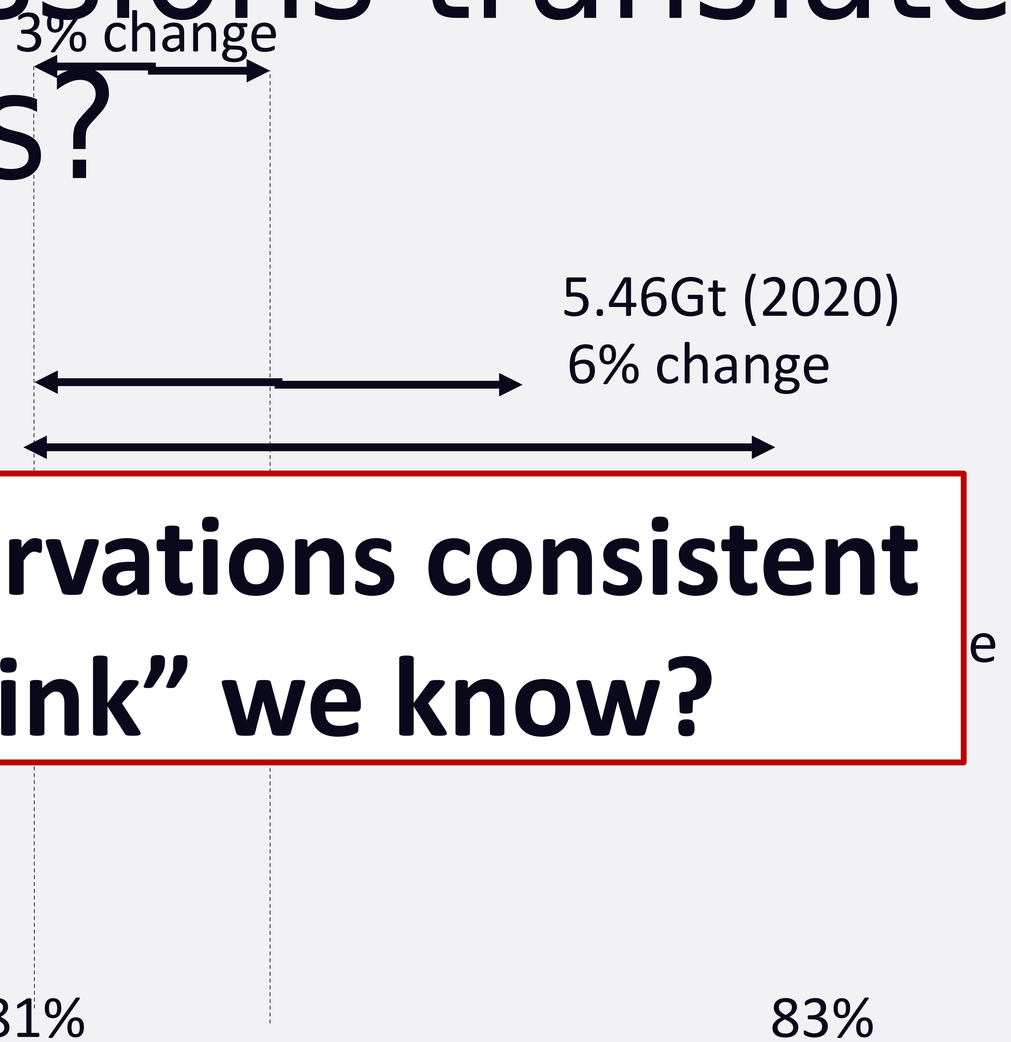
https://www.climatewatchdata.org/countries/USA

IPCC Categories

How much of trend **driven** by urban emissions?

How do urban emissions translate into national trends?

e.x.



Are atmospheric observations consistent with what we “think” we know?

urban population/total population 81% 83%

https://www.climatewatchdata.org/countries/USA

IPCC Categories

Challenges to estimating emissions at urban scale

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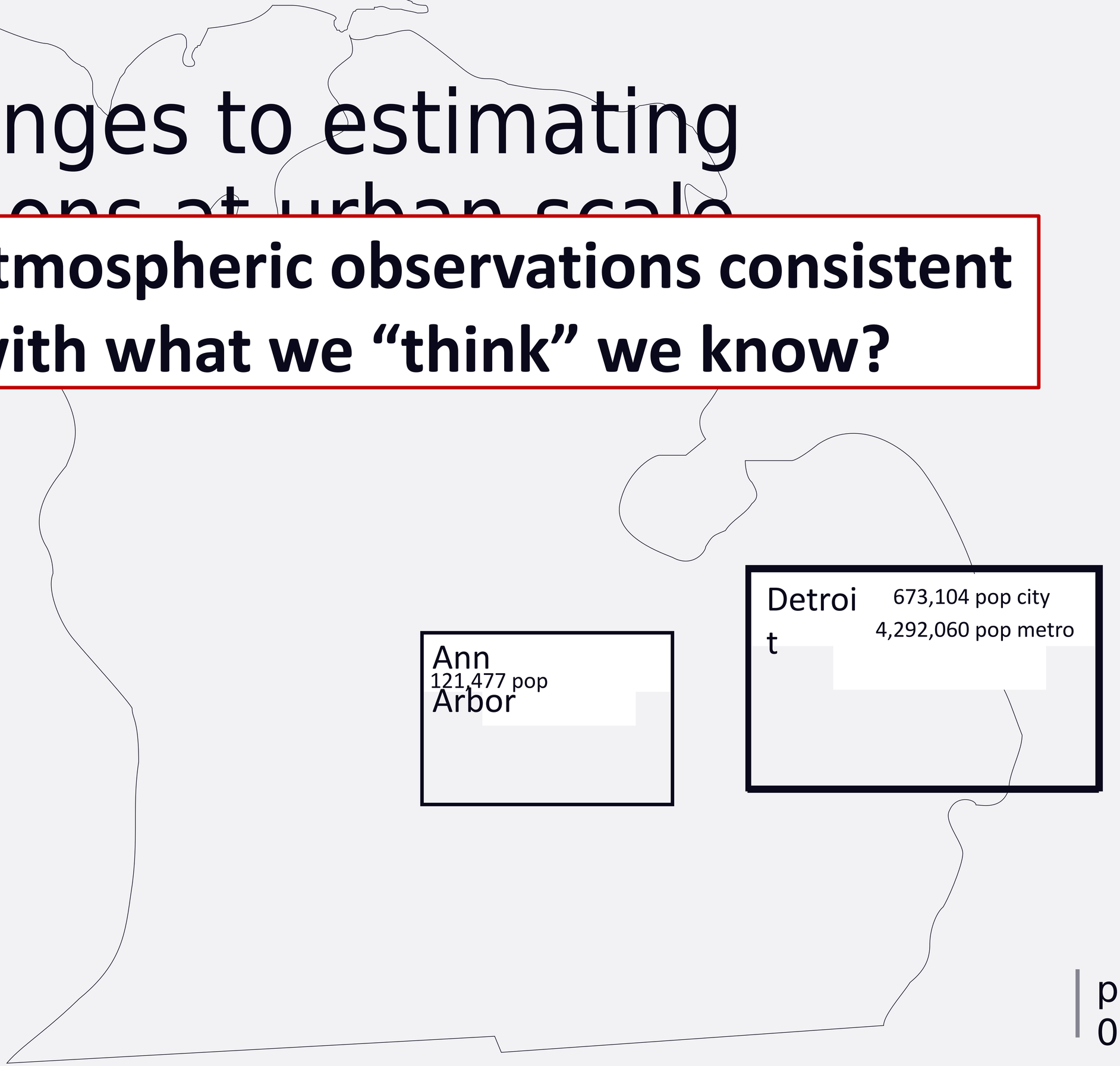
Are atmospheric observations consistent with what we “think” we know?

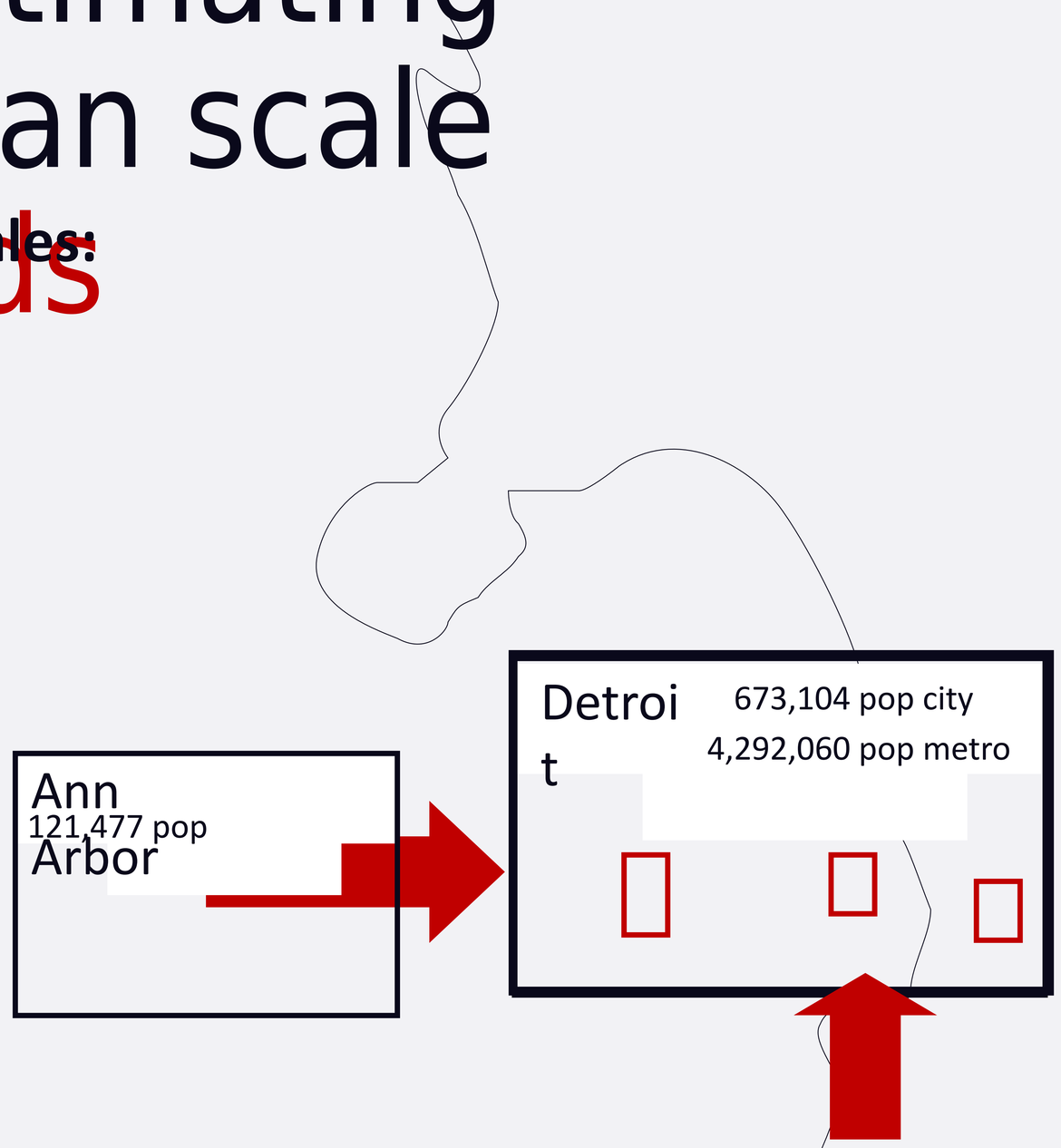


Challenges to estimating emissions at urban scale

Inverse Modeling Challenges @ city-scales:

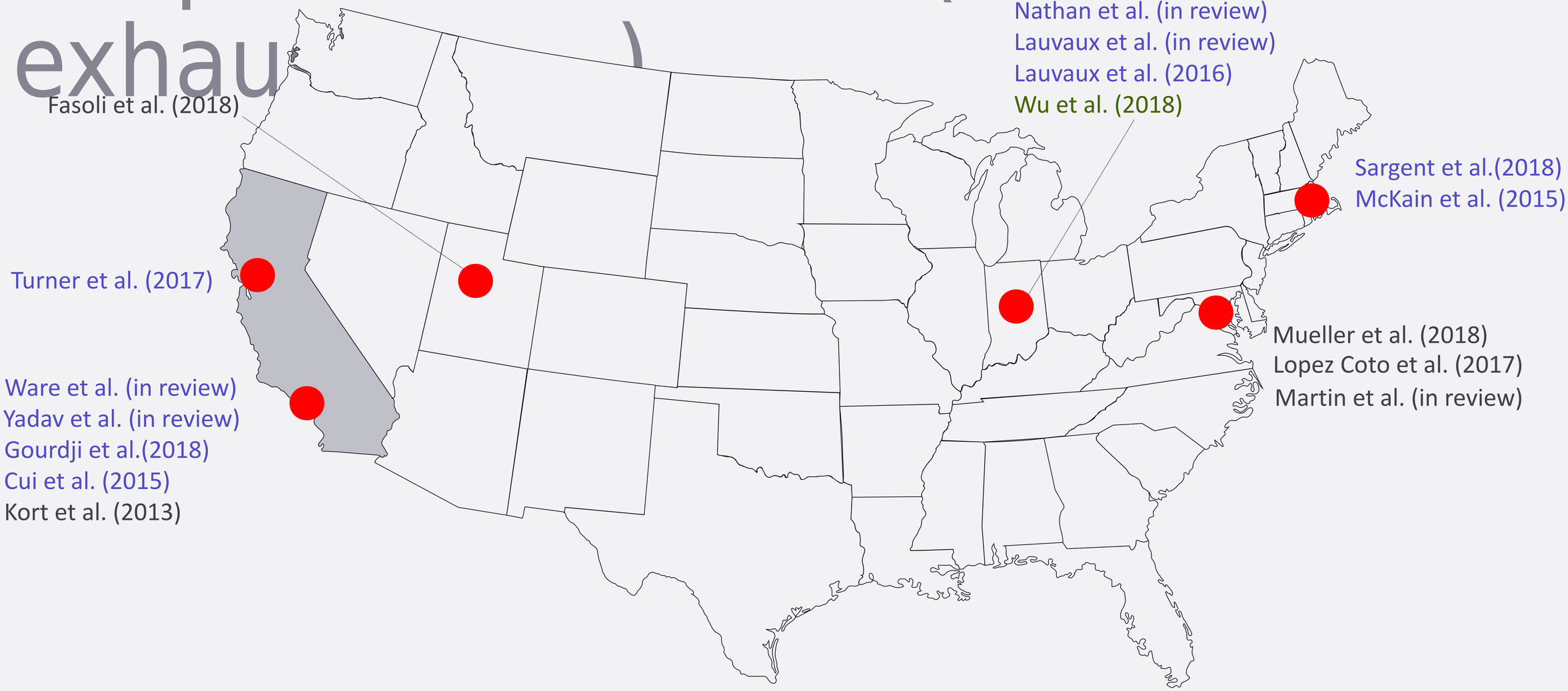
Inversion Methods

1. Incoming air (aka background)
2. Disentanglement of cities
3. Transport and dispersion modeling
4. High-frequency measurements
5. Observational coverage time/space
6. Observational integration
7. Model representations
8. Metrics
9. Consistency
10. Transparency



Urban inverse modeling

ex. published works (not exhaus)



Real Data (emission estimates) **Synthetic Experiment** **Method Component**

Not exclusive

Urban inverse modeling
ex. Discussion topics

Partially informed

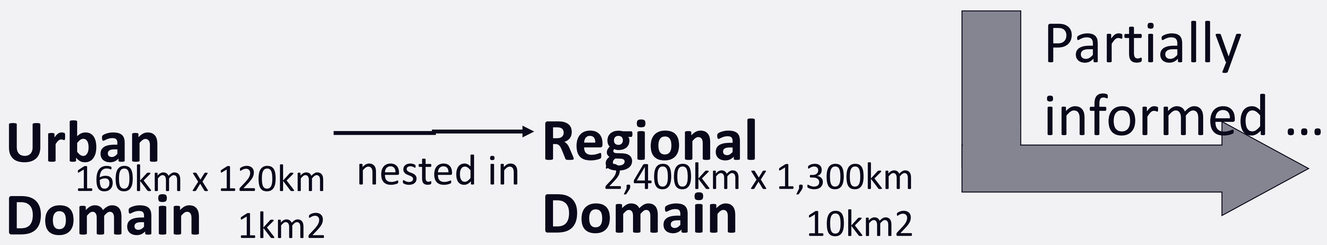
…

Inversions in the Washington DC/Baltimore area using FLAGG-MD data

5 Flight campaigns Feb 2016/ 2 aircrafts

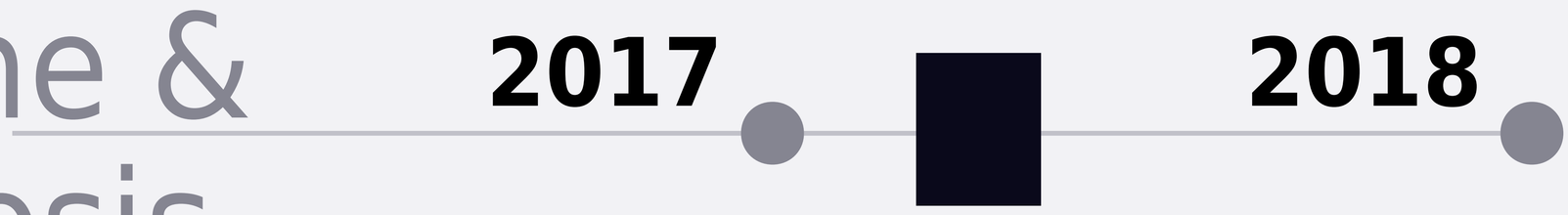
Lopez Coto et al., “GHG flux inversions in the Washington DC / Baltimore metropolitan area: FLAGG-MD 2016 flight campaign”, in prep. (and poster)

Urban inverse modeling
ex. Discussion topics



The north-east corridor: Baltimore / Washington
urban greenhouse gas measurements project
Lightning talk (A. Karion)

Inverse Modeling Workshop timeline & Diagnosis



Why didn’t succeed

- Small number of practioners;
- Not many practioners are engaged in this process;
- Dedicated facilitator;
- Unique platform; and,
- Funding?

Overcoming Challenges

How do we bring our research/knowledge to various stakeholders who represent a variety of spatiotemporal scales?

Overcoming Challenges

MPO's

City with climate pledge

Counties

States with Climate Action Plans

How do we bring our research/knowledge to various stakeholders who represent a variety of scales?

Inversion estimation domain

49% of 300 most populated cities in CONUS have emission reduction targets

BUT median size of city with climate pledge is approx. 100K people!