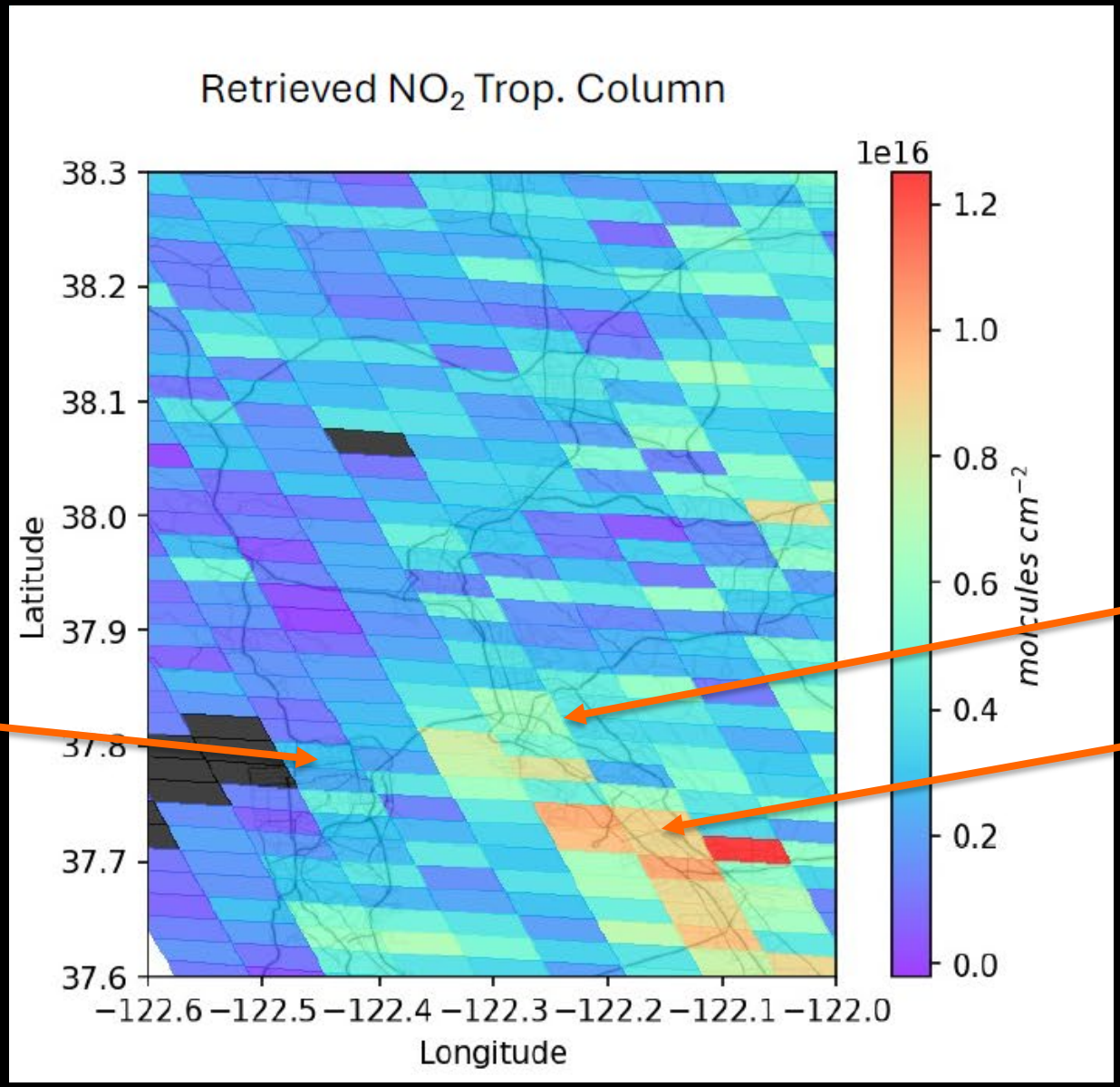
Space and time resolution enable new science with TEMPO

Ron C. Cohen, UC Berkeley

High spatial resolution

August 16, 2023 9:18AM PDT; San Francisco Bay region



San Francisco

Oakland

San Leandro

Many of our approaches to retrievals and analysis dampen the gradients that are fundamental to the science we are trying to do

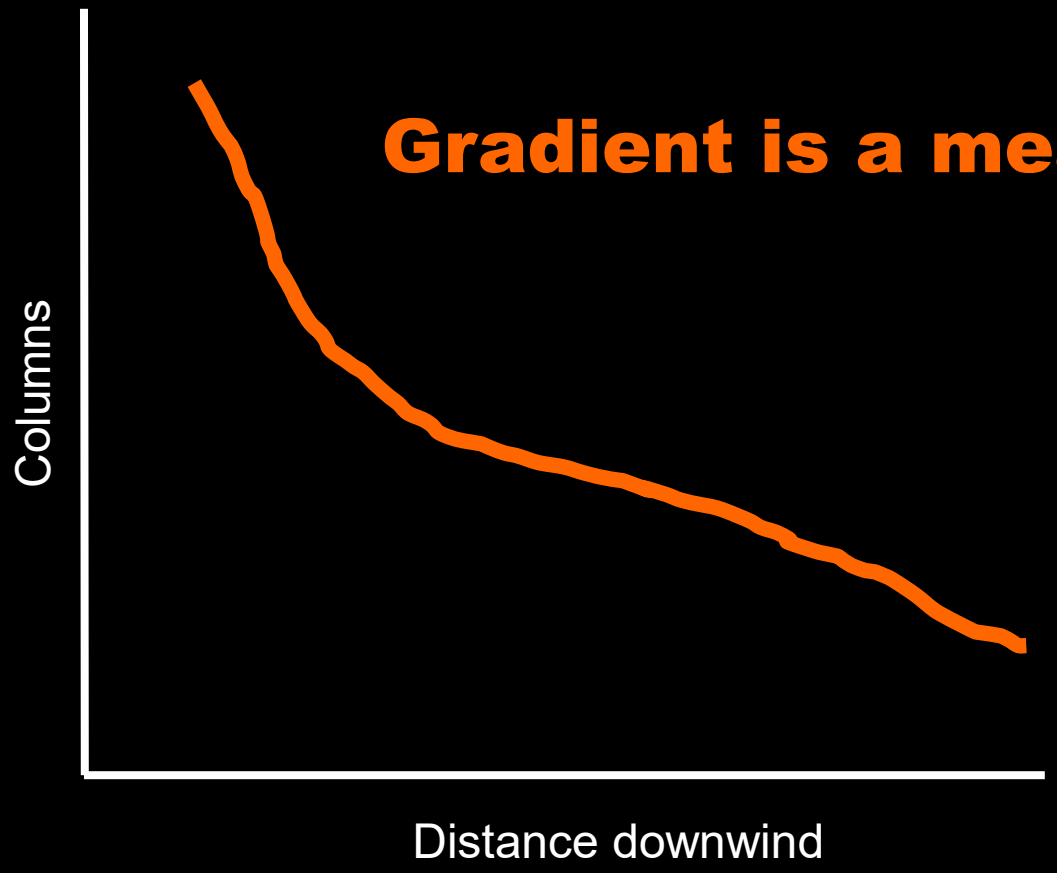
High spatial resolution

Averaging over time diminishes gradients that are measures of exposure inequity

Daily satellite observations of NO_2 air pollution inequality in NYC and Newark NJ: evaluation and application

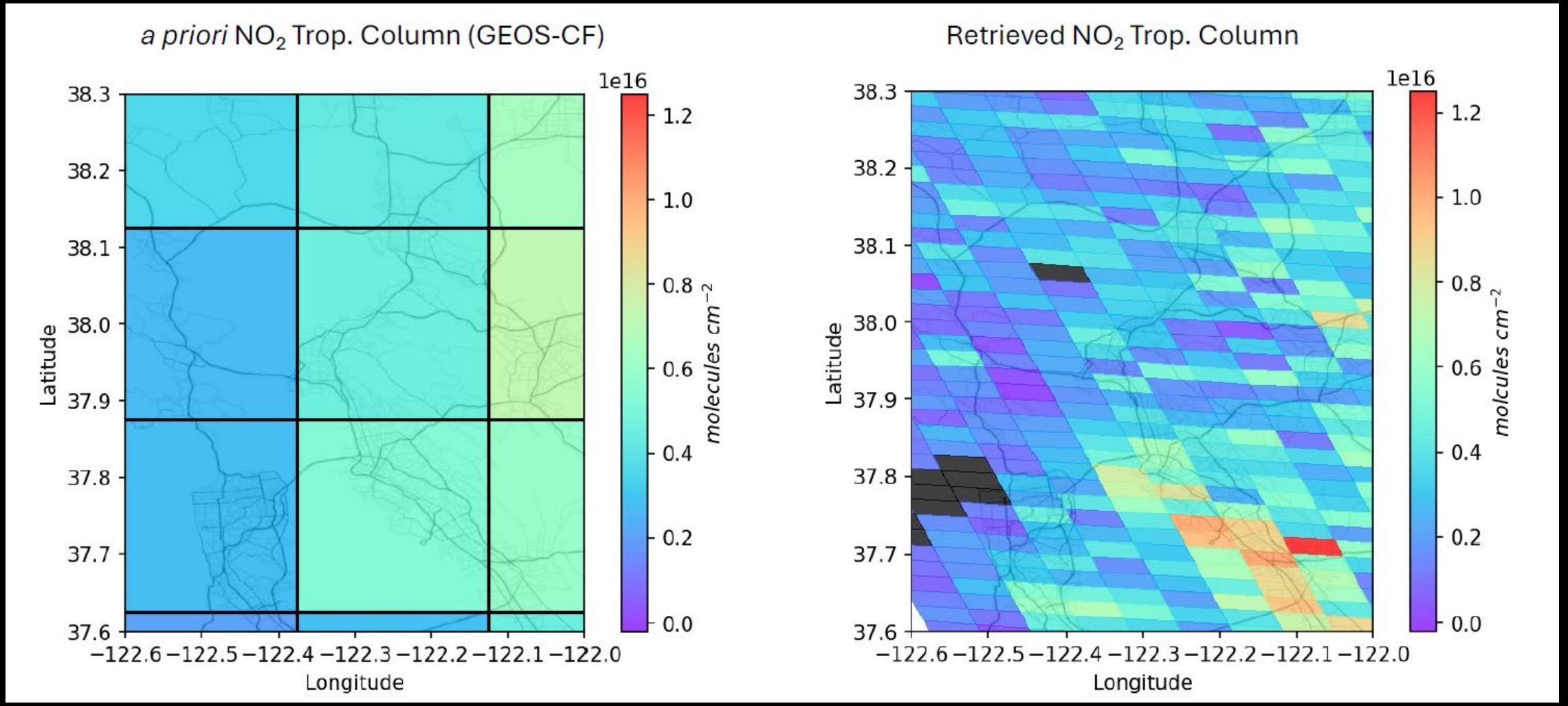
Dressel, Demetillo, Judd, Janz, Fields, Sun, Fiore, Mcdonald and Pusede, Env. Sci and Tech, 2022.

High spatial resolution

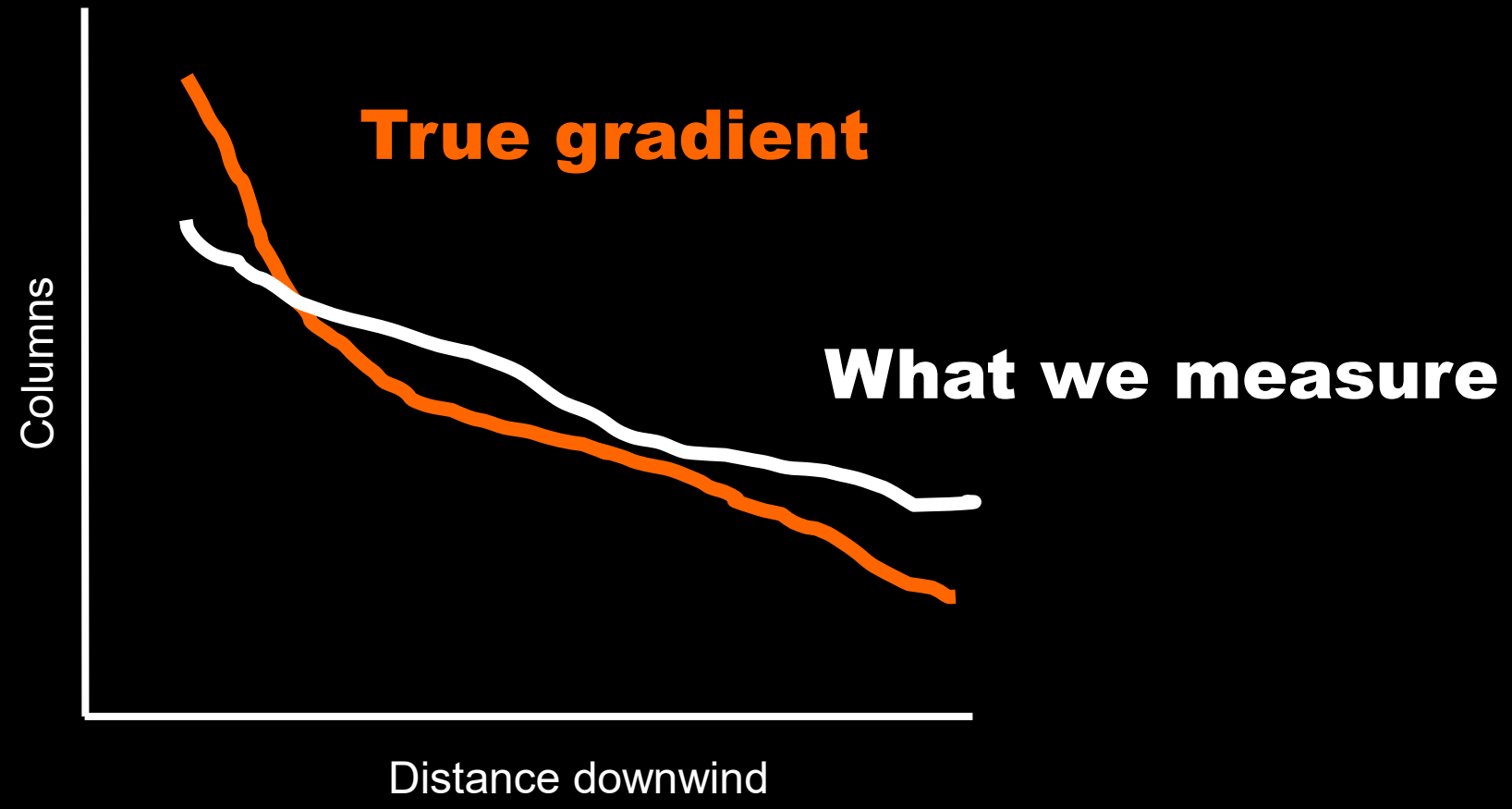


Gradient is a measure of lifetime and OH

Q. Zhu, J.L. Laughner, and R.C. Cohen, ***Estimate of OH Trends over One Decade in North American Cities***, Proc. Nat. Acad. Sci., 2022.


a priori NO_2 Trop. Column (GEOS-CF)
Retrieved NO_2 Trop. Column
1e16
1.2
1.0
0.8
0.6
0.4
0.2
0.0
molecules cm^{-2}
Latitude
38.3
38.2
38.1
38.0
37.9
37.8
37.7
37.6
Longitude
−122.6 −122.5 −122.4 −122.3 −122.2 −122.1 −122.0

High spatial resolution



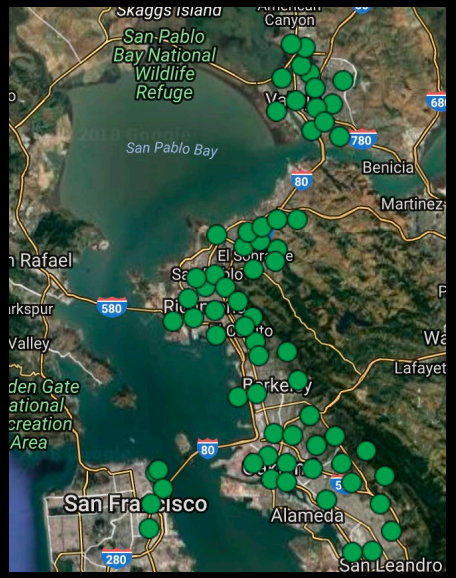
Anna Winter

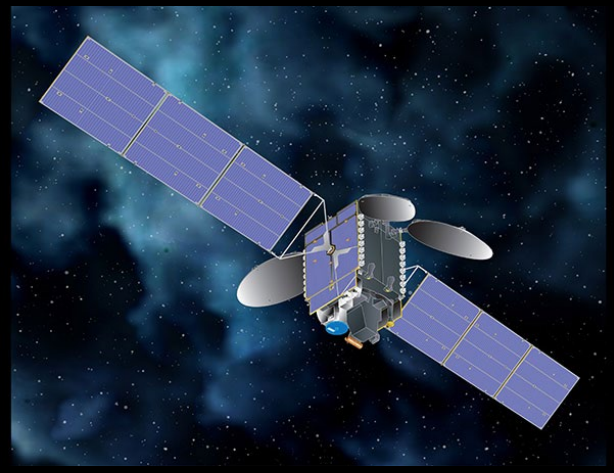
Yishu Zhu

Sam Beaudry

- **Evaluation of TEMPO NO_2**

and





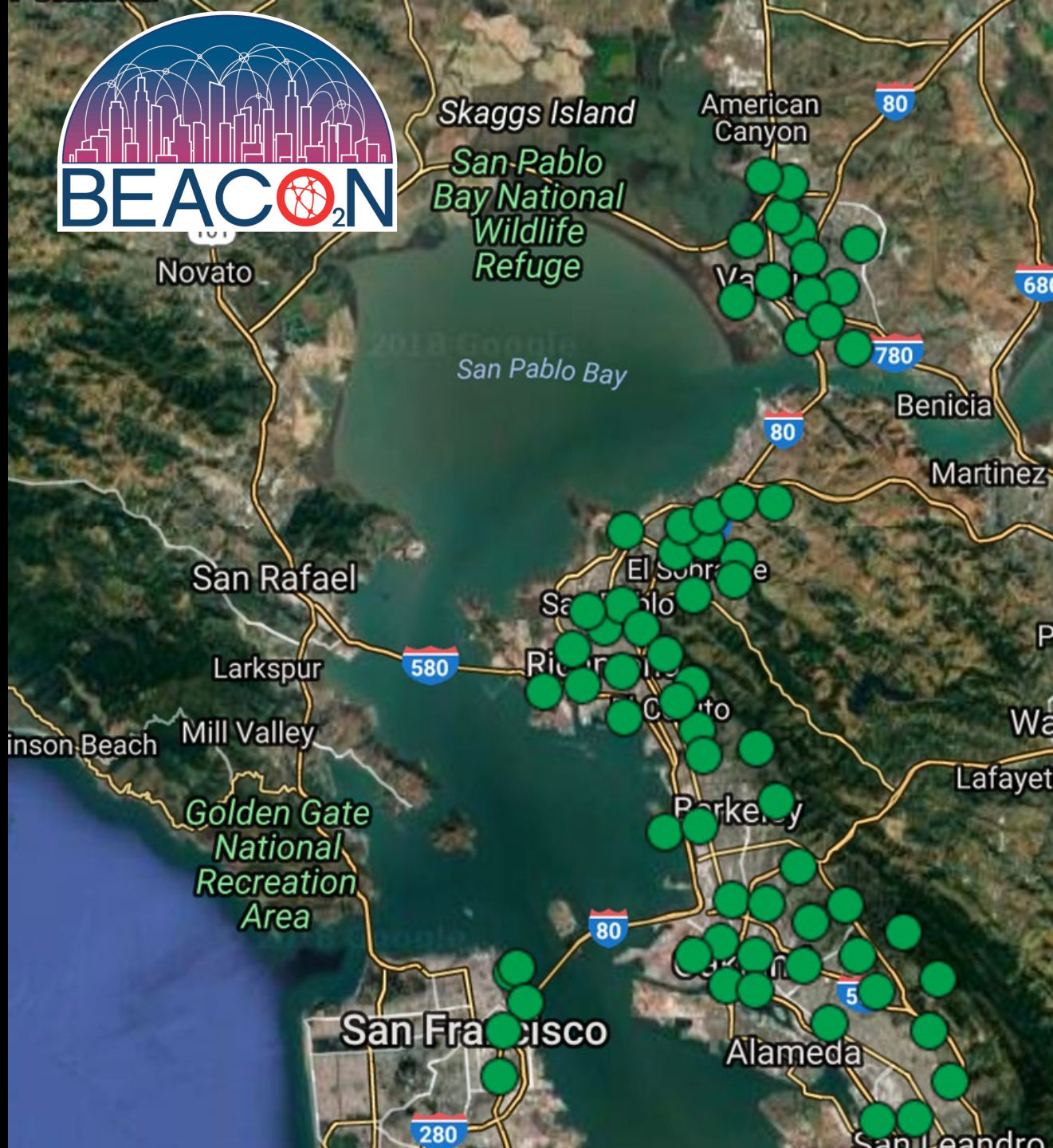
- **Design of a gradient preserving retrieval**

BEACON $_2$N

TEMPO

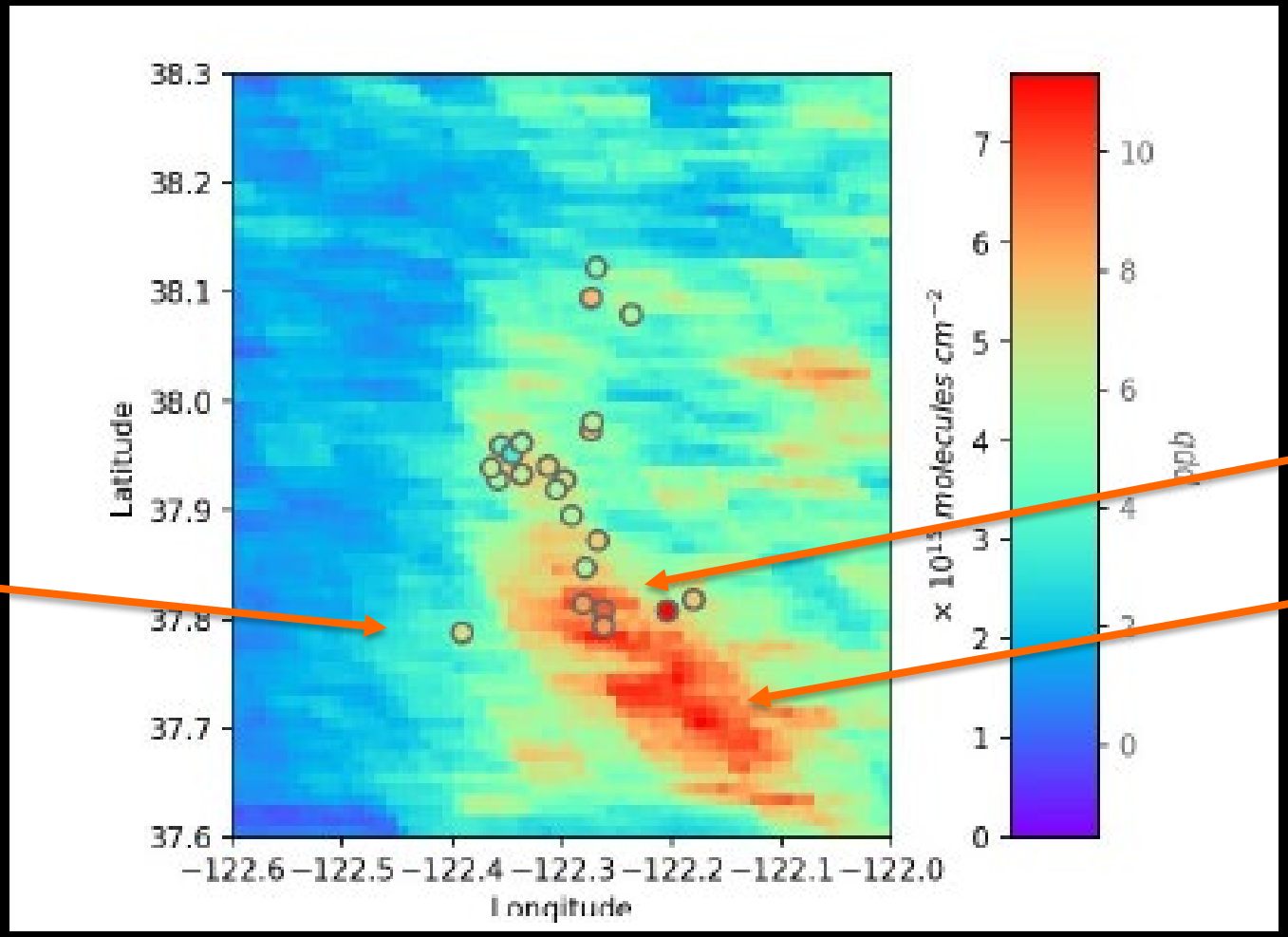
Berkeley
Environmental
Air Quality and
CO_2
Observation
Network

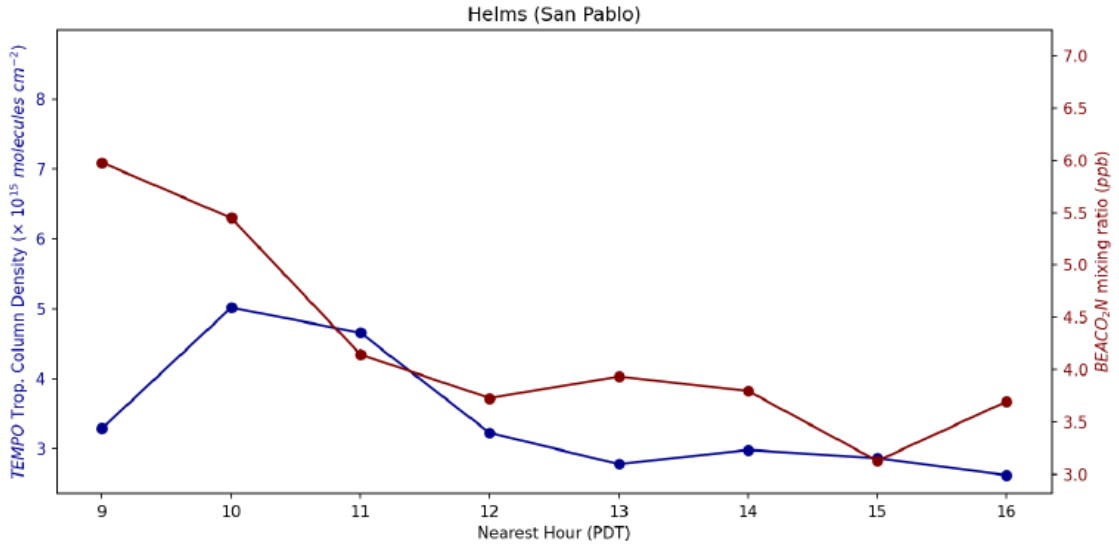
~2km spacing

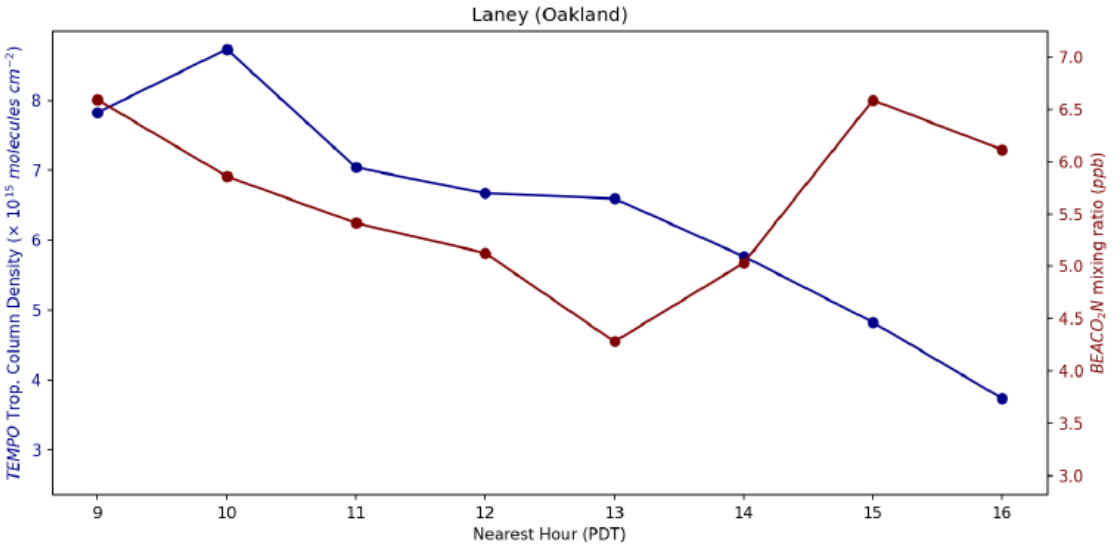


http://beacon.berkeley.edu

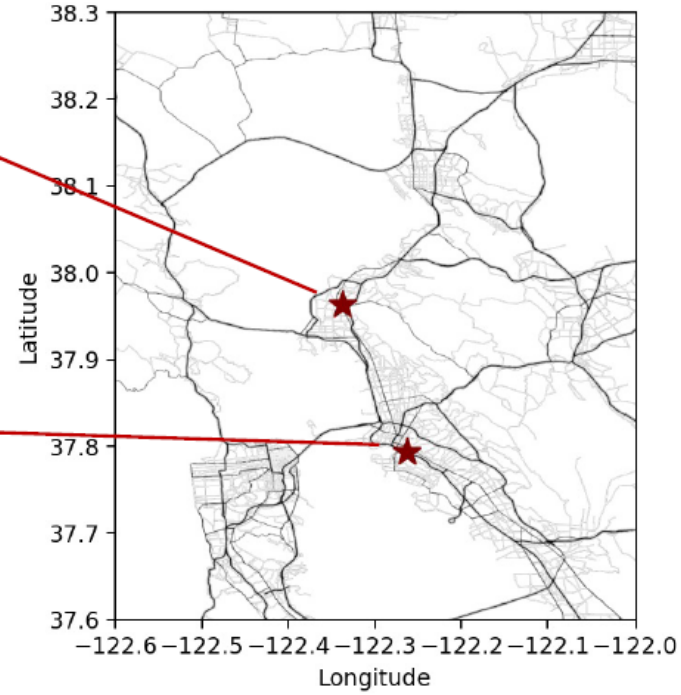
August 9:00AM average; San Francisco Bay region oversampled to 0.01^0 and averaged

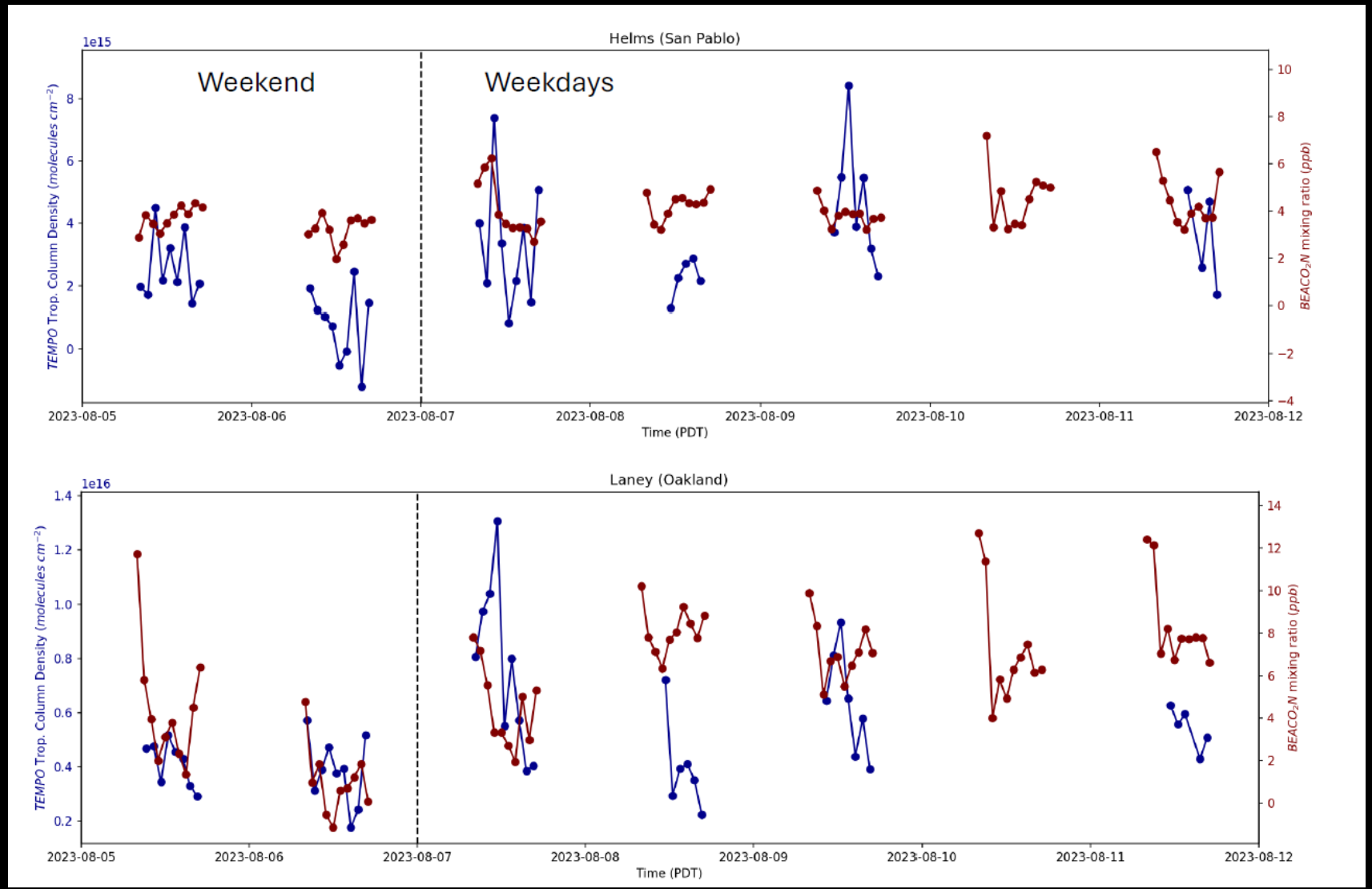






Hourly averages of TEMPO (0.01°) and $BEACO_2N$ measurements at two sites, August 2023 weekdays

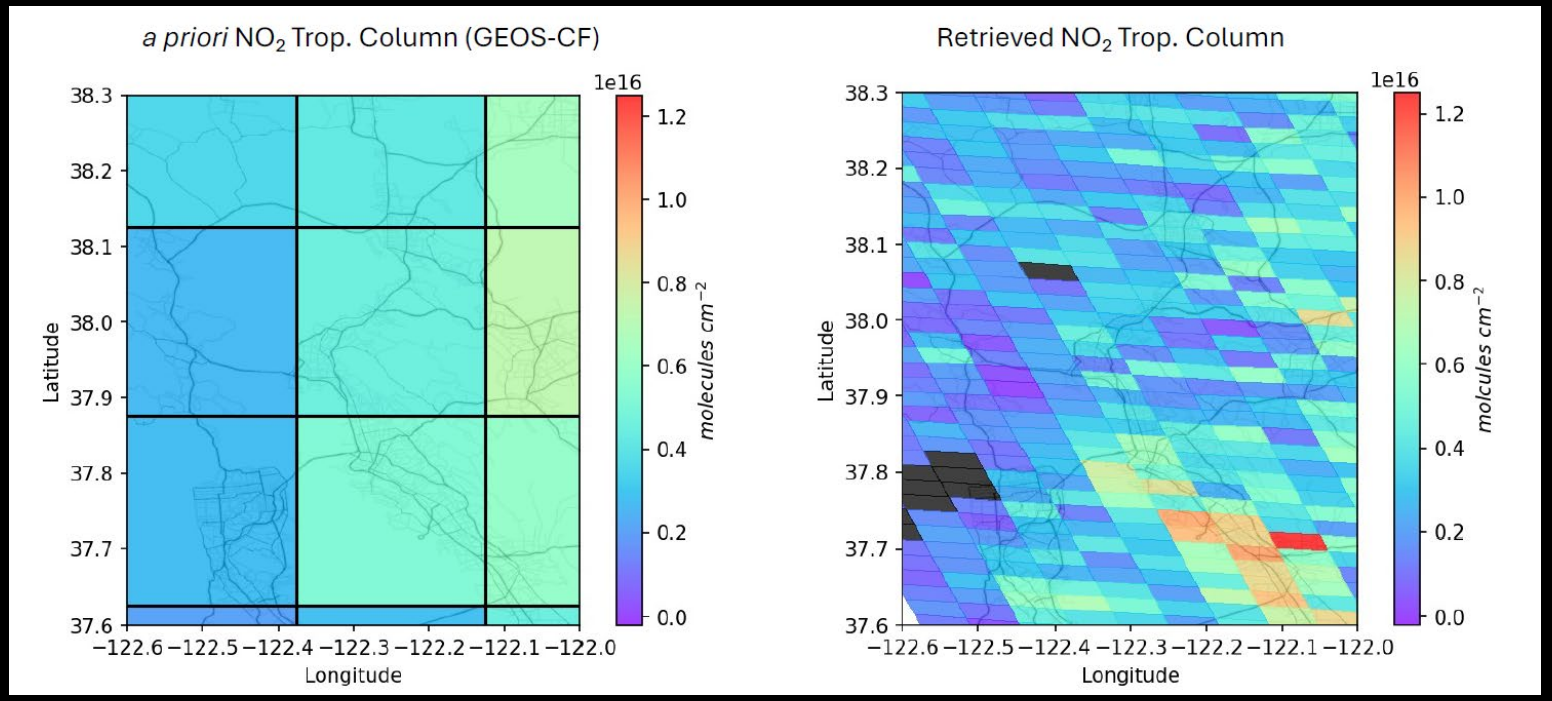




Blue TEMPO

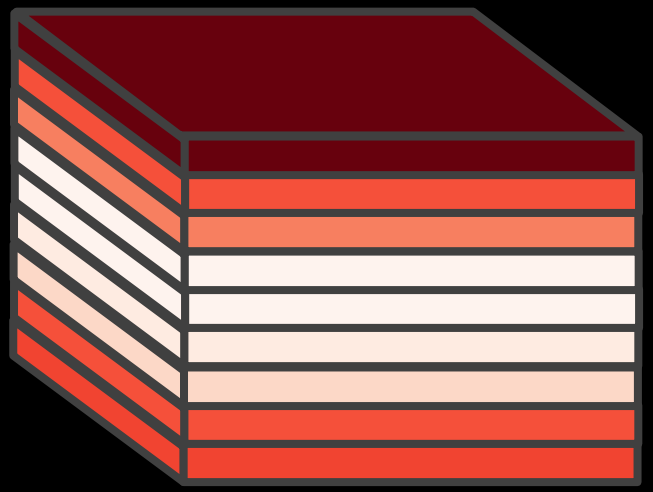
Red BEACO2N

Gradient preserving retrieval

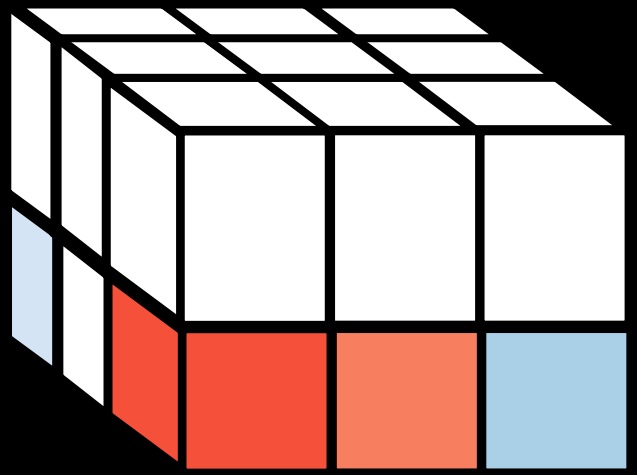


Reallocate boundary layer NO_x within GEOS-CF pixel according to slant column; preserve the GOES-CF total

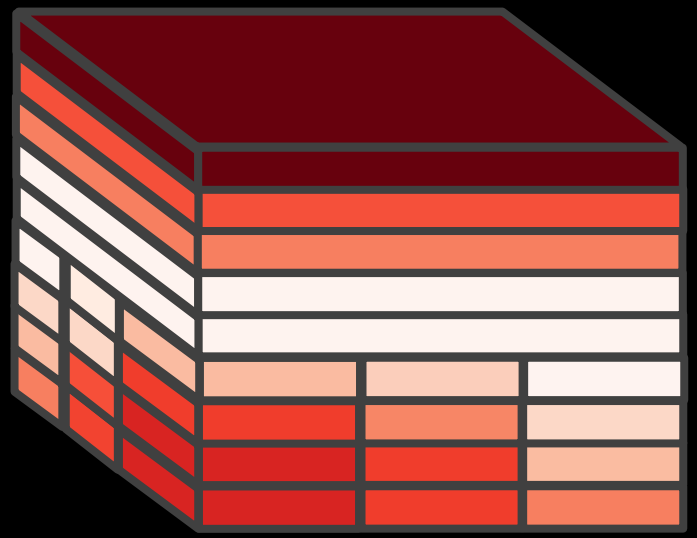
Gradient preserving retrieval



Original NO_2 profile (coarse)



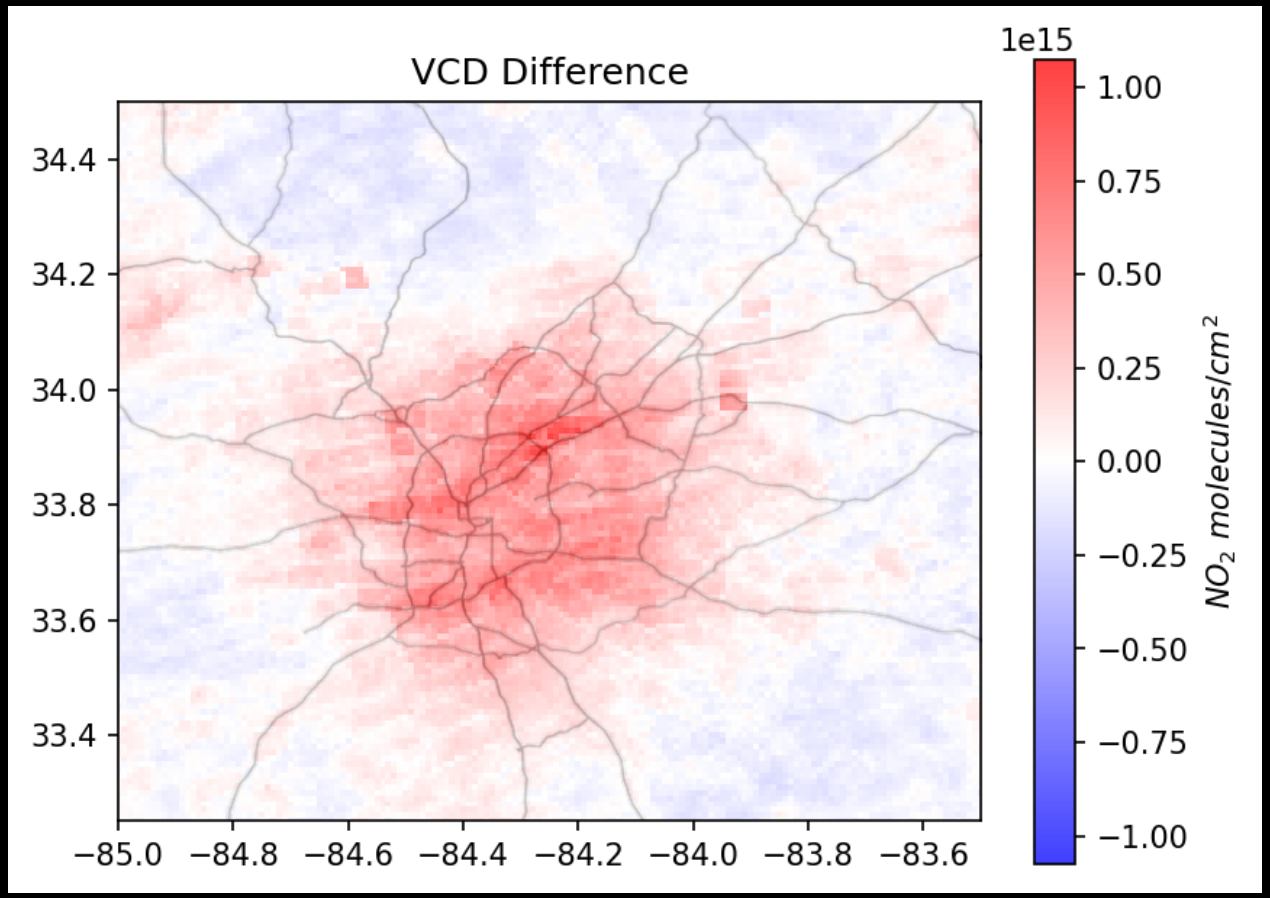
Deviations Resolved in space



Updated NO_2 profile

Reallocate boundary layer NO_x within GEOS-CF pixel according to slant column; preserve the GOES-CF total

Gradient preserving retrieval—TROPOMI Atlanta example



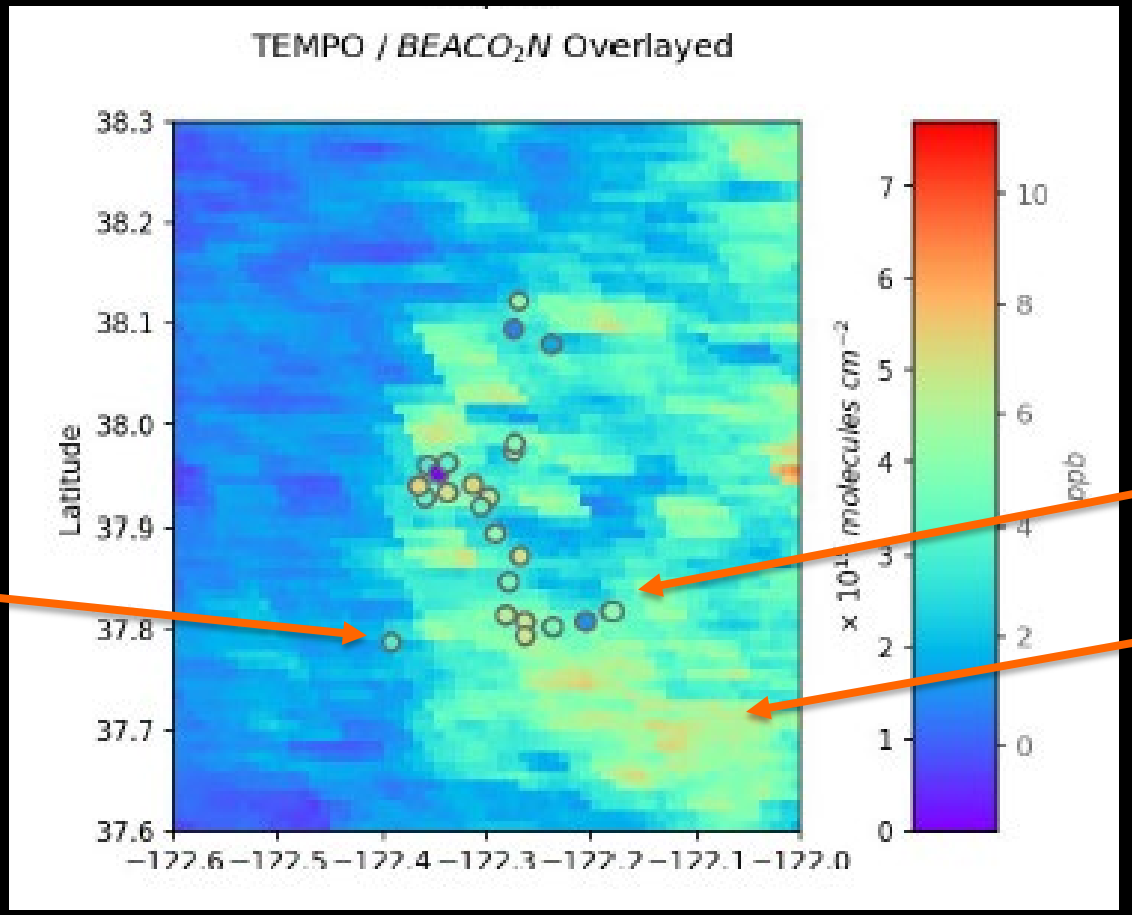
Substantial enhancements to peaks in downtown regions and other hot spots ~10%--higher emissions and shorter lifetimes.

Conclusions

New approaches to high spatial and temporal resolution evaluation of TEMPO and an emphasis on gradient preserving analyses are poised to open new science in areas including

- ***Environmental Justice***
- ***Emissions, lifetime, OH and PO_3 hourly info instead of once daily***
- ***Episodic events-soils, lightning***

August 4:00PM average; San Francisco Bay region oversampled to 0.01^0 and averaged



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