Lessons Learned from LISTOS and SUNVEx – Organic Gases and Urban Atmospheric Chemistry

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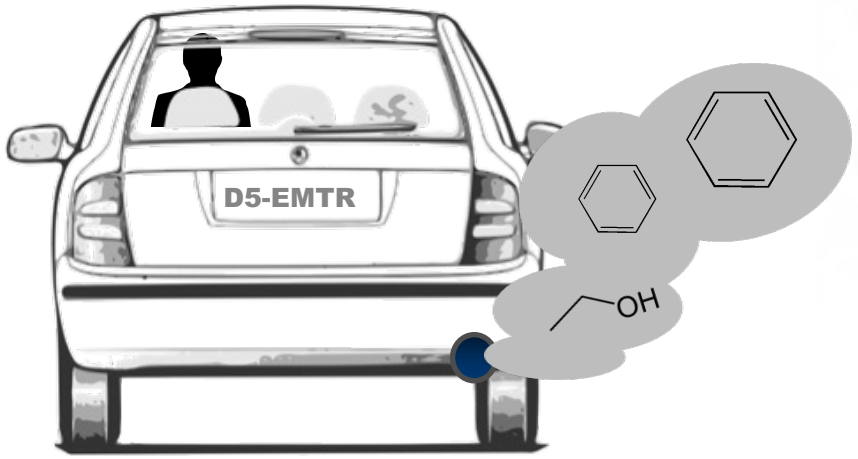
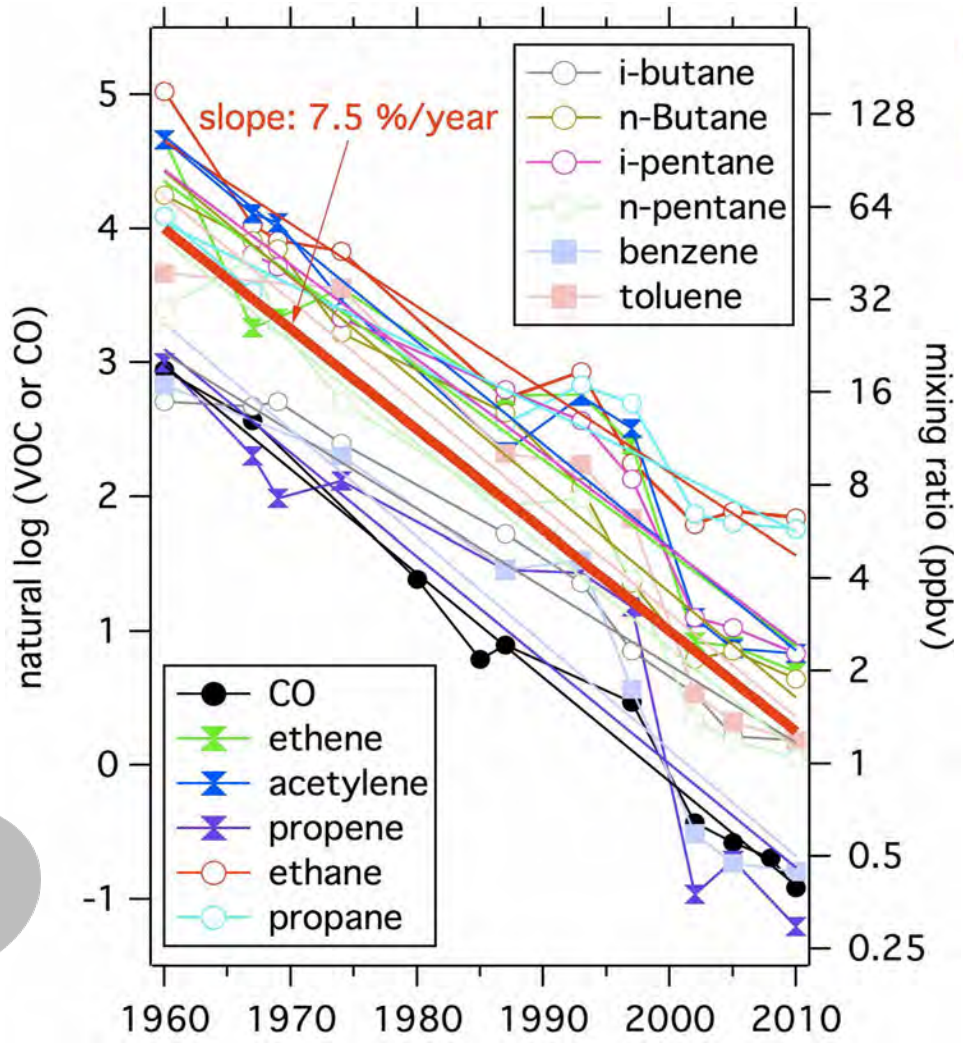
The Past...

Latimes.com

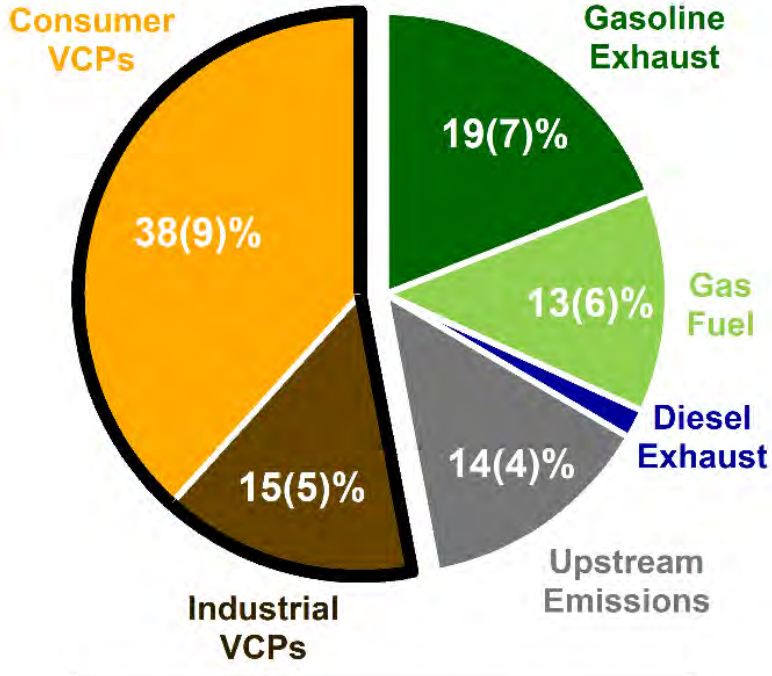


The Transition...



Warneke et al. (JGR 2012)

The Present...



Solvent emissions from Volatile Chemical Products (VCPs) now as important as fossil fuel emissions

McDonald et al. (Science 2018)

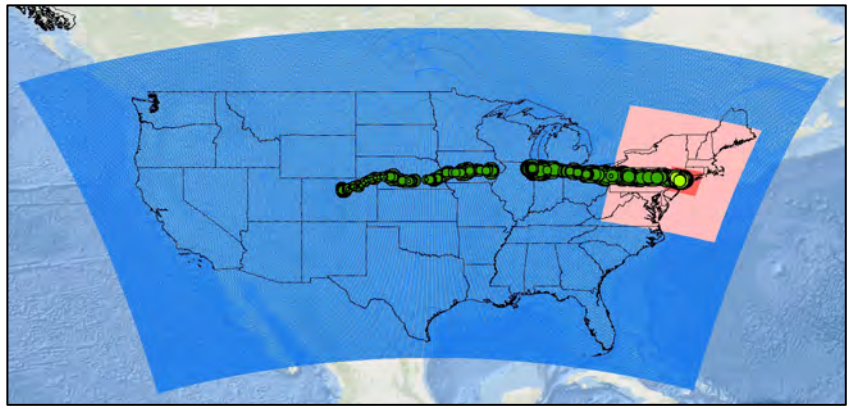
NY-ICE, LISTOS, and SUNVEx

NY-ICE / LISTOS - 2018

SUNVEx - 2021

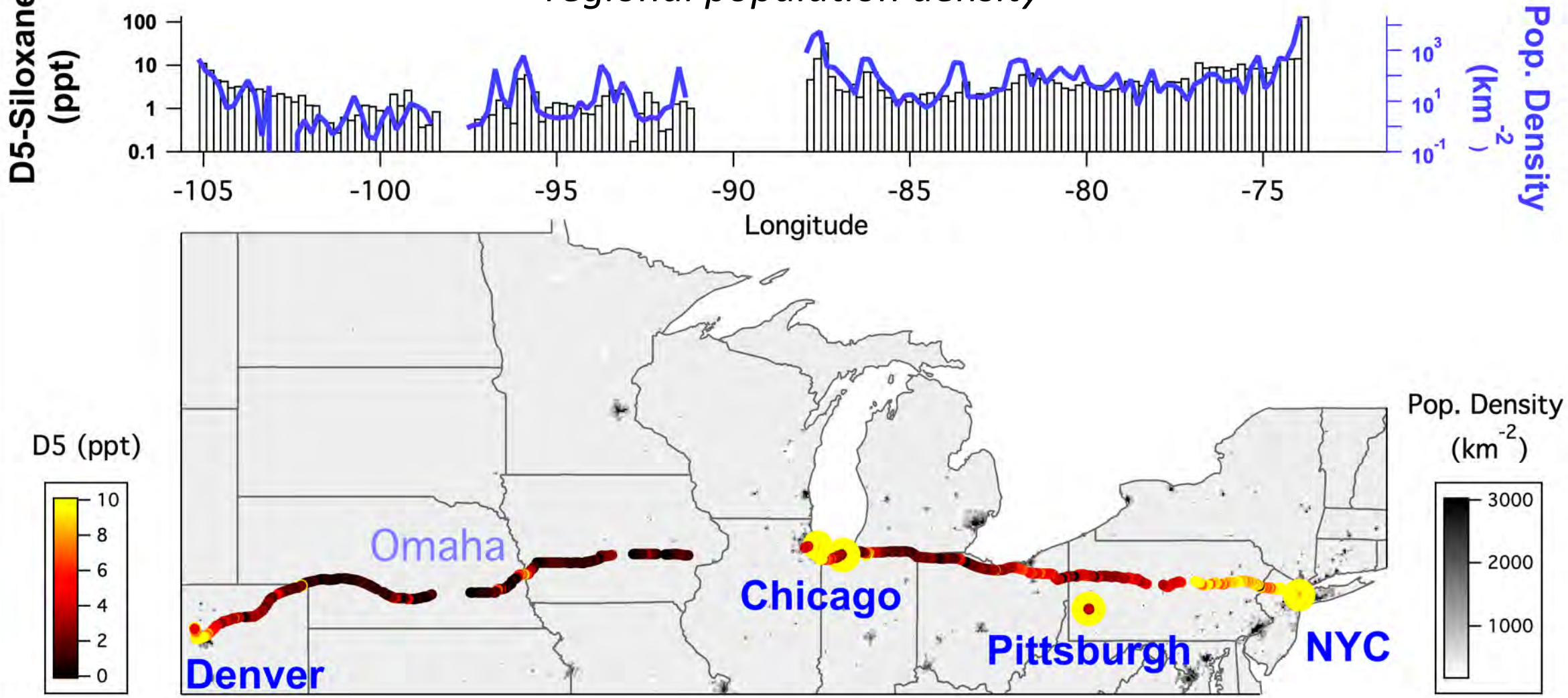
VOC measurements to determine emissions

Modeling to determine impacts



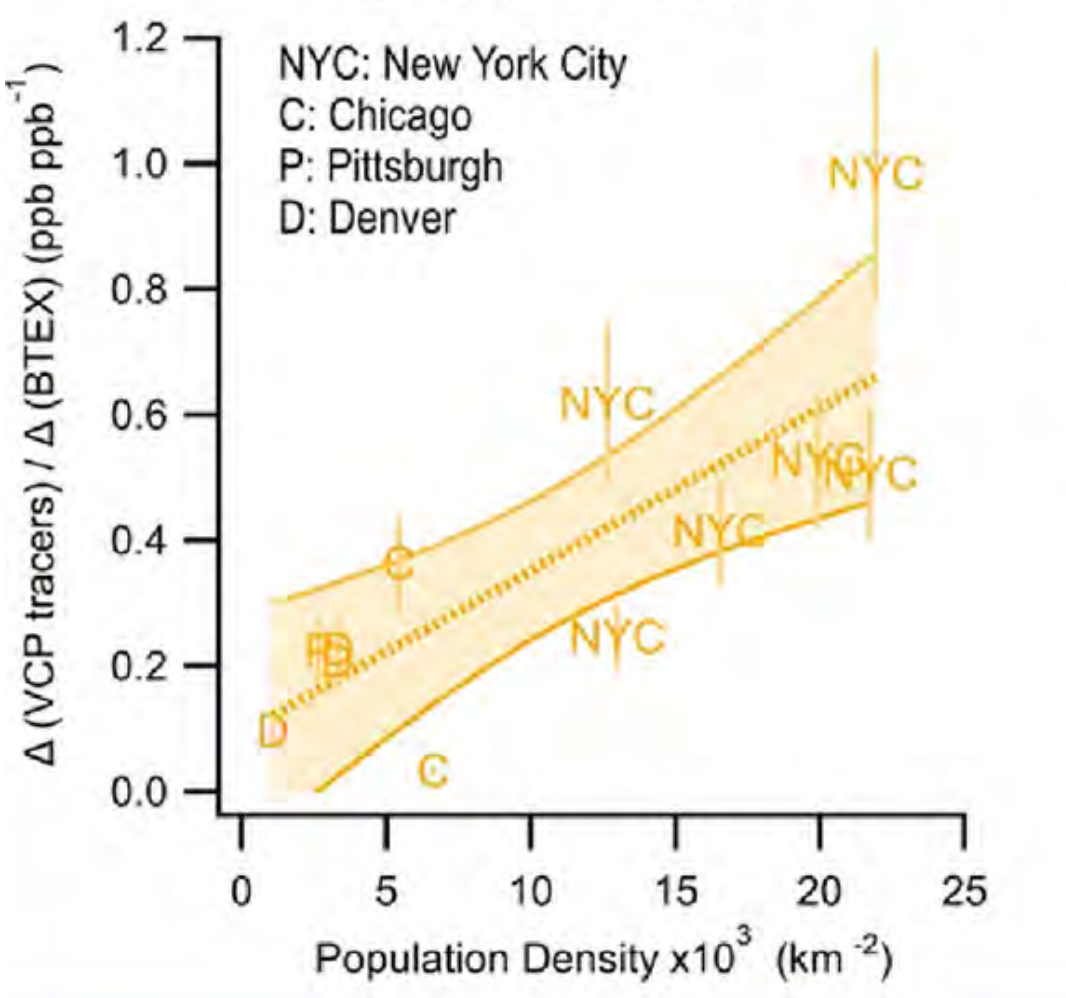
VCPs vary by population density

A strong relationship exists between the concentration of D5 and regional population density



Coggon et al. (PNAS, 2021)

Emission mixtures reliant on population density size

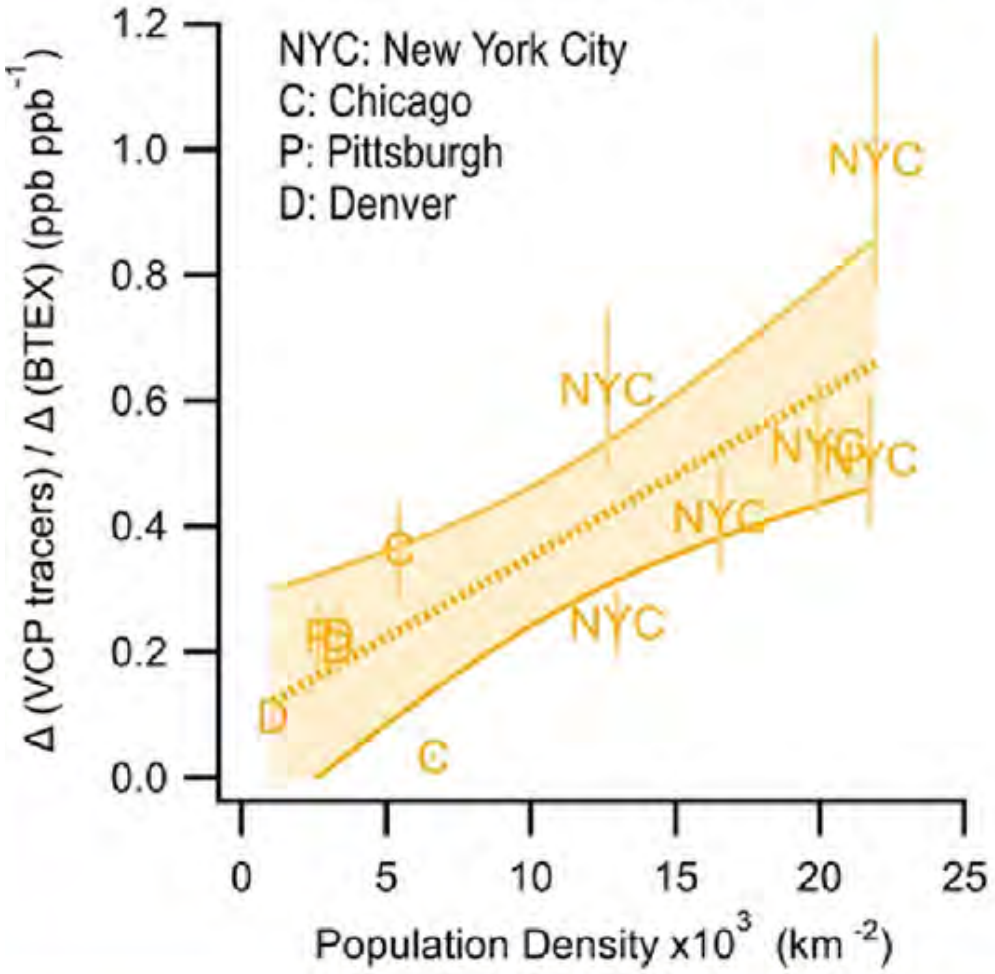


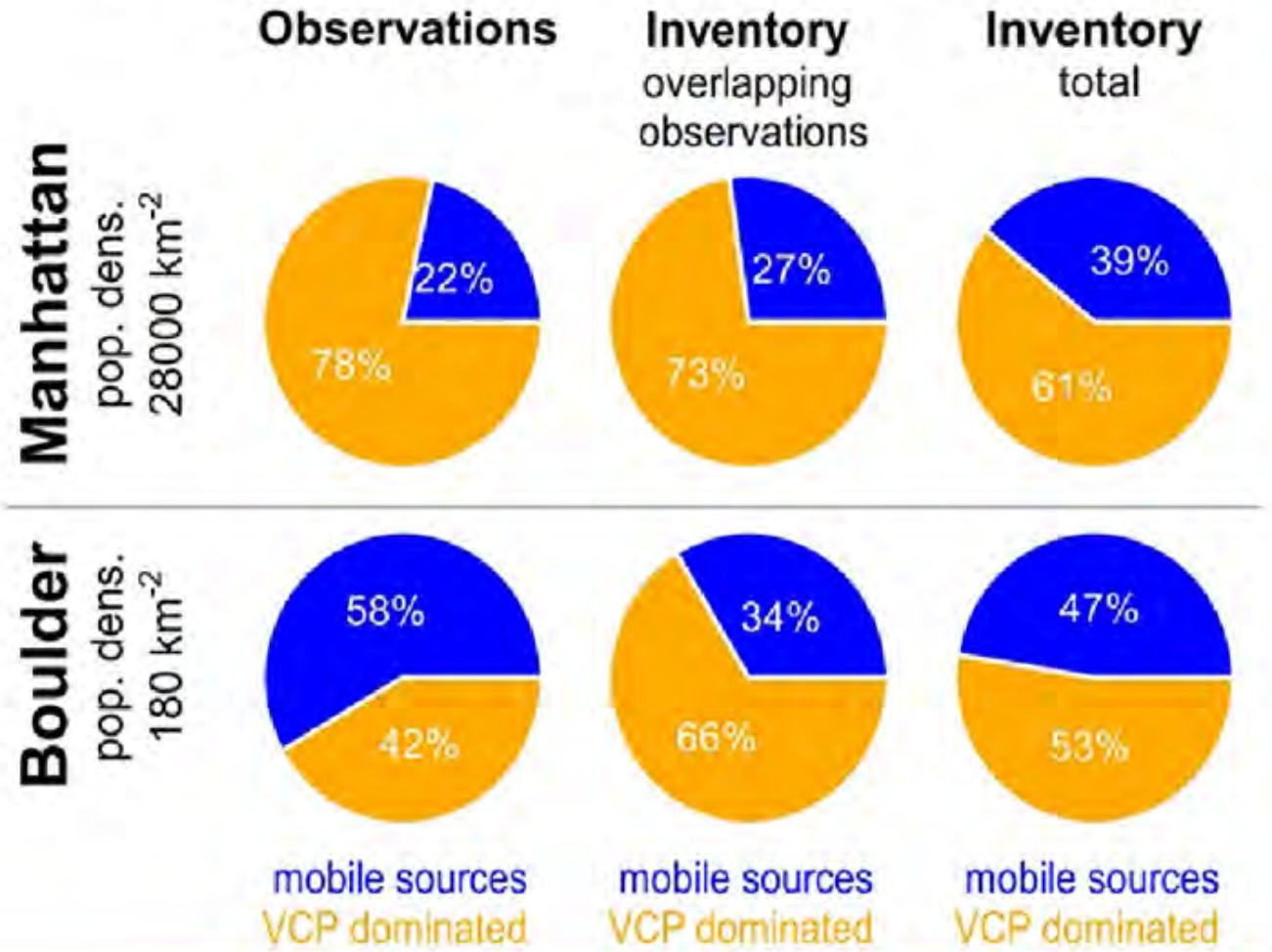
Relative emissions of VCPs / fossil fuels varies based on population density

Gkatzelis (ES&T, 2021)

Emission mixtures reliant on population density size

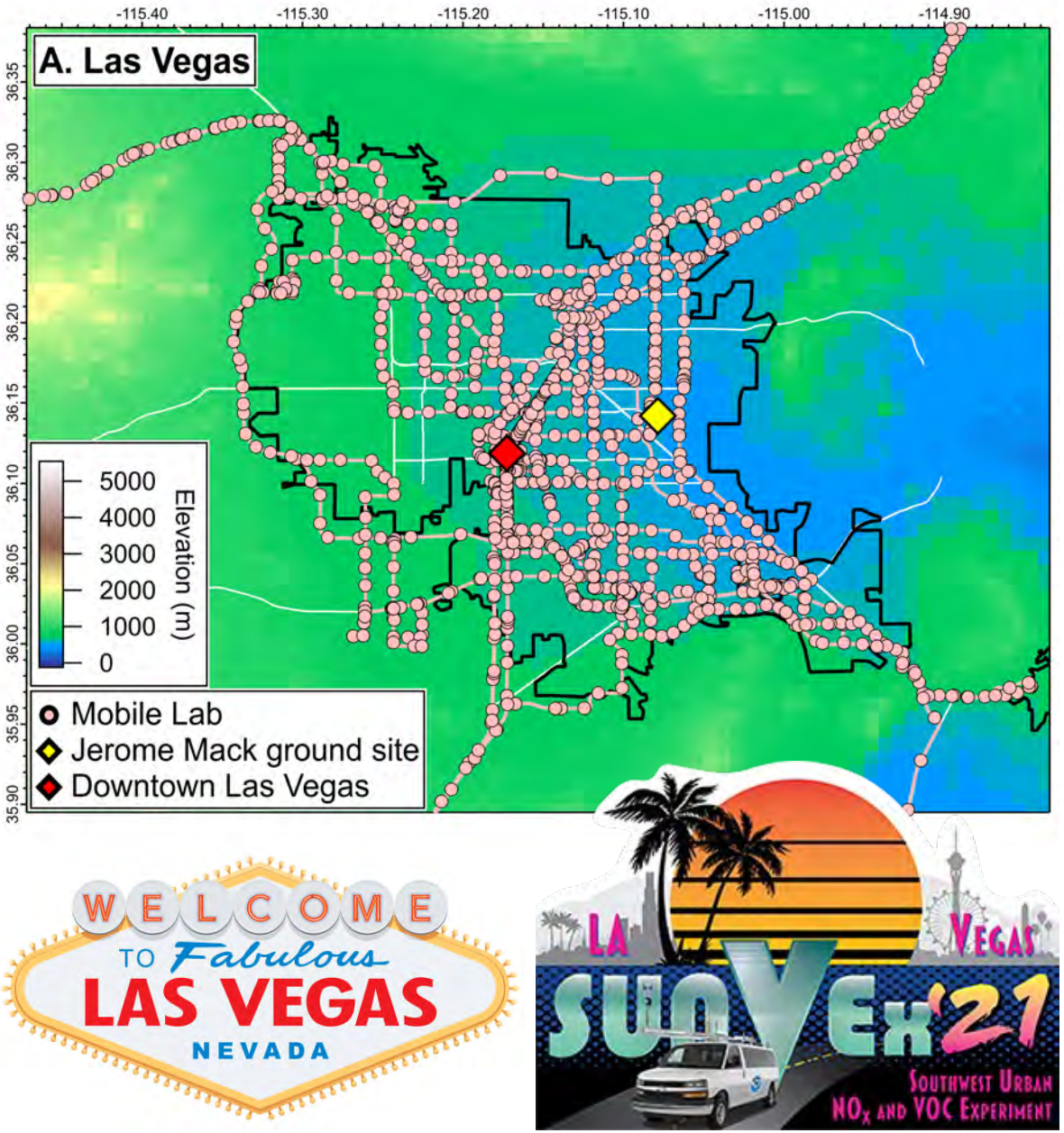
Bottom-up Inventories can explain relative distribution of VCP and fossil fuel emissions



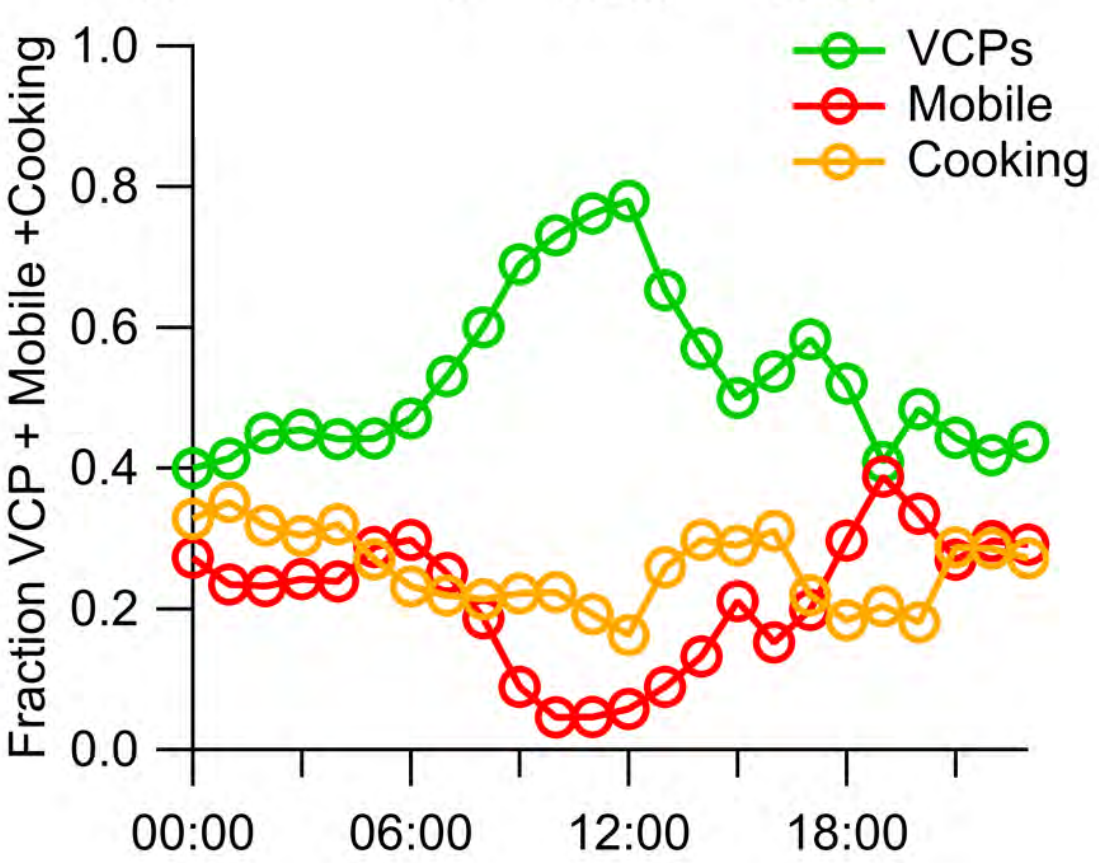


Gkatzelis (ES&T, 2021)

Other understudied sources matter!



PMF analysis in Las Vegas shows that VCPs *and* cooking compete with mobile source emissions



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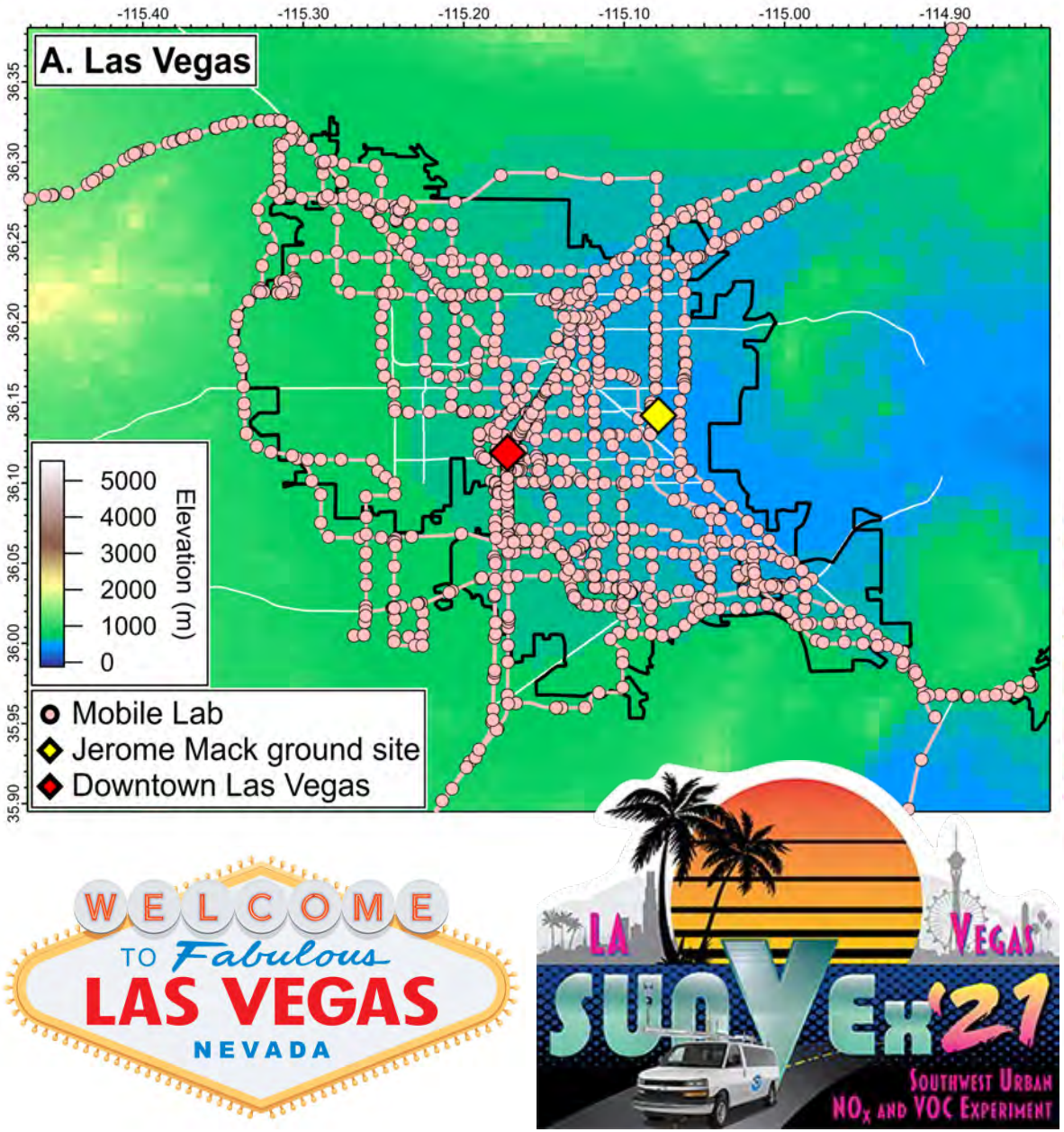
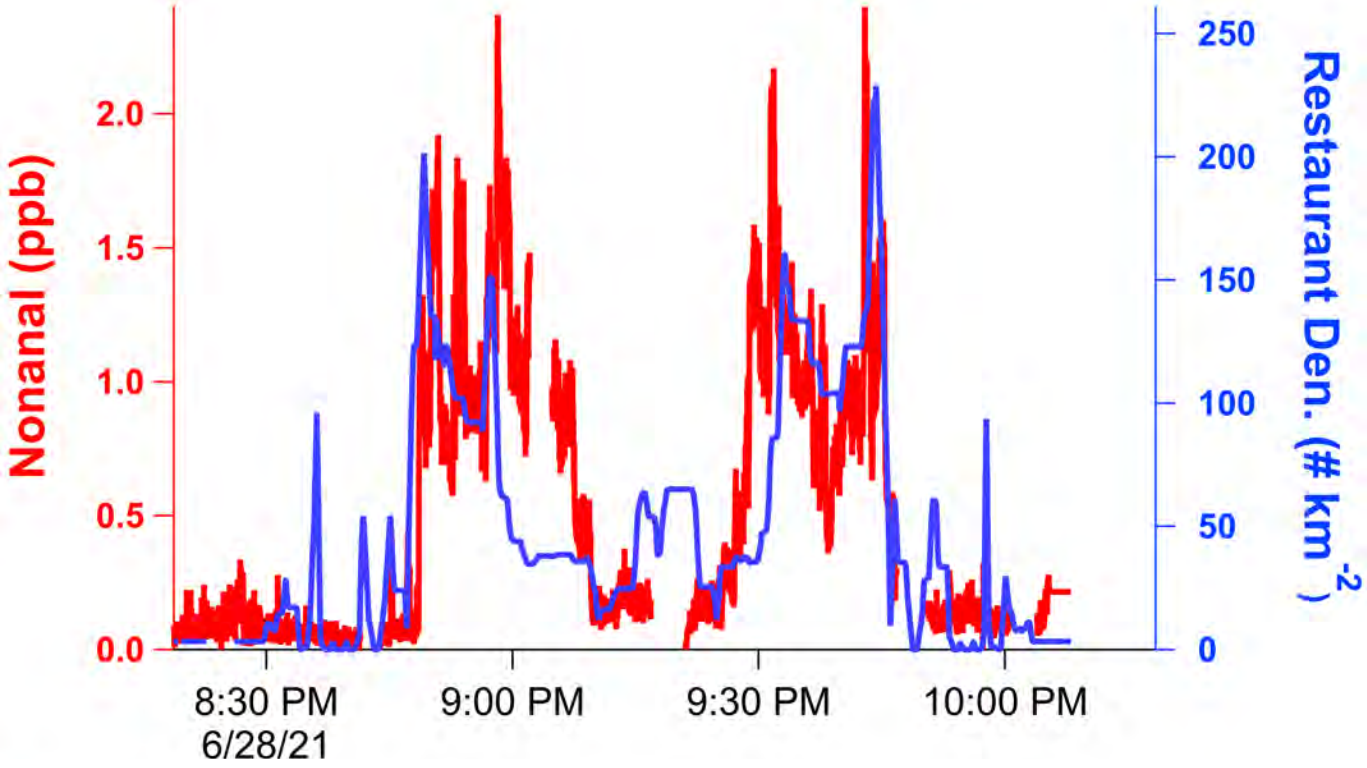
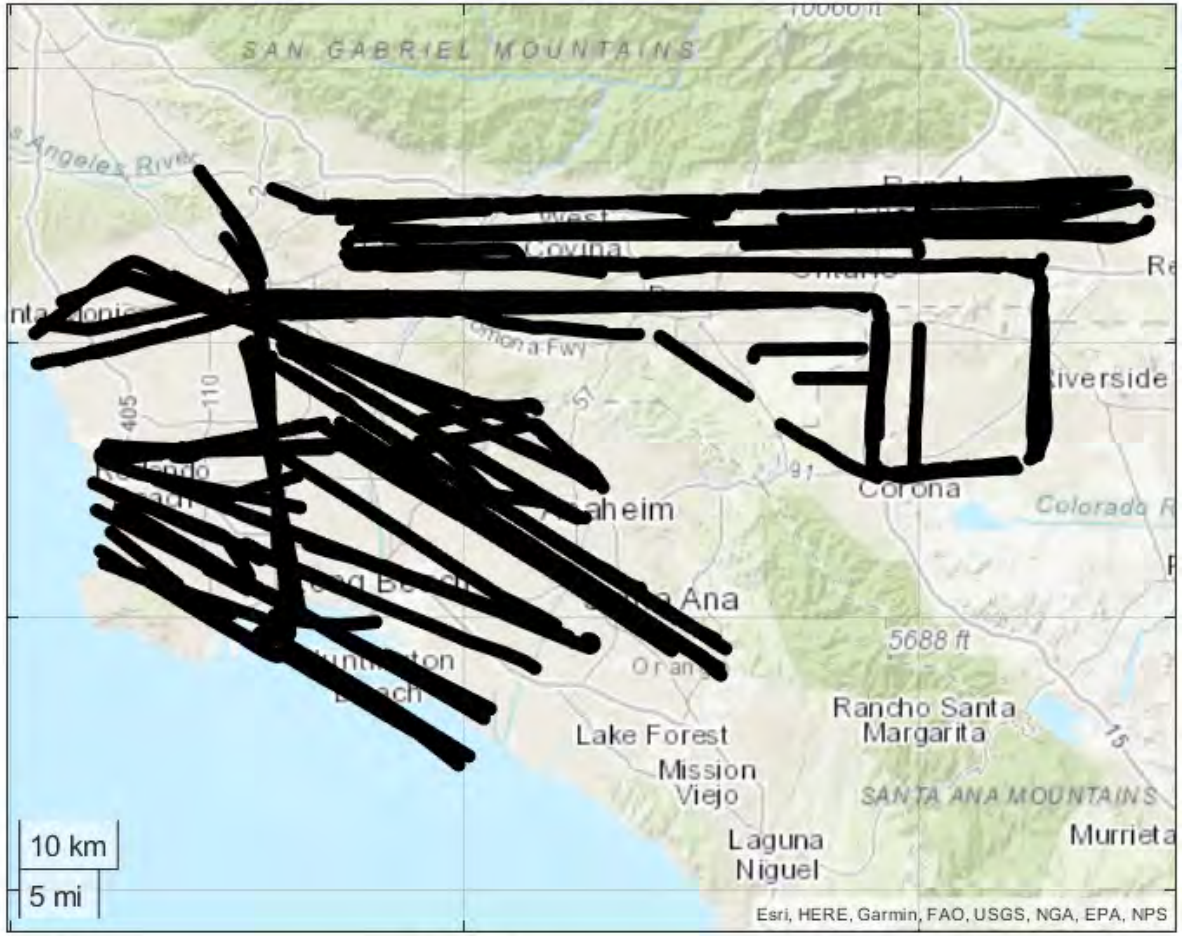


Molecular tracers, such as nonanal and octanal, may help to constrain cooking emissions

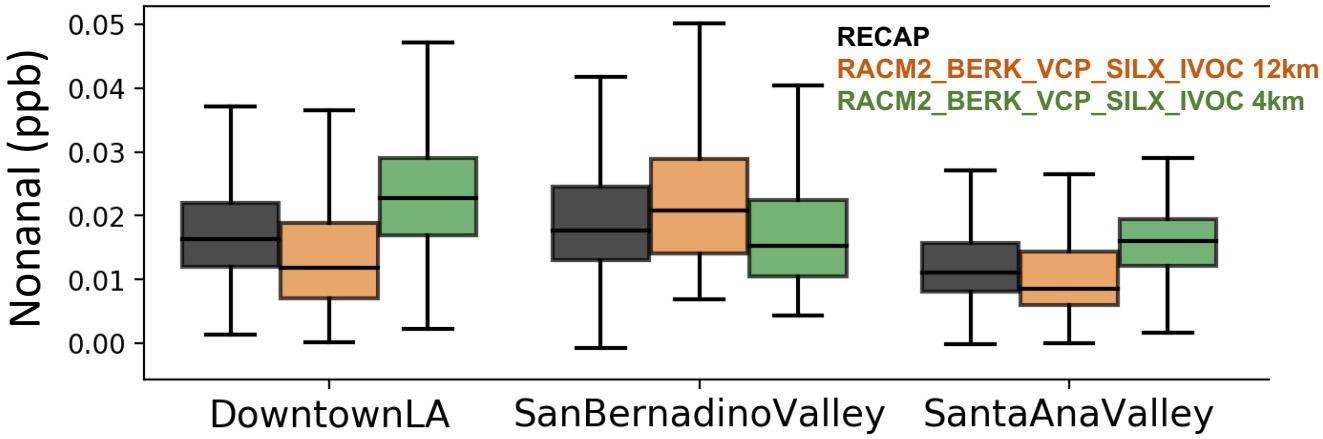


Other understudied sources matter!

Twin Otter Flights over the LA Basin during SUNVEx / RECAP



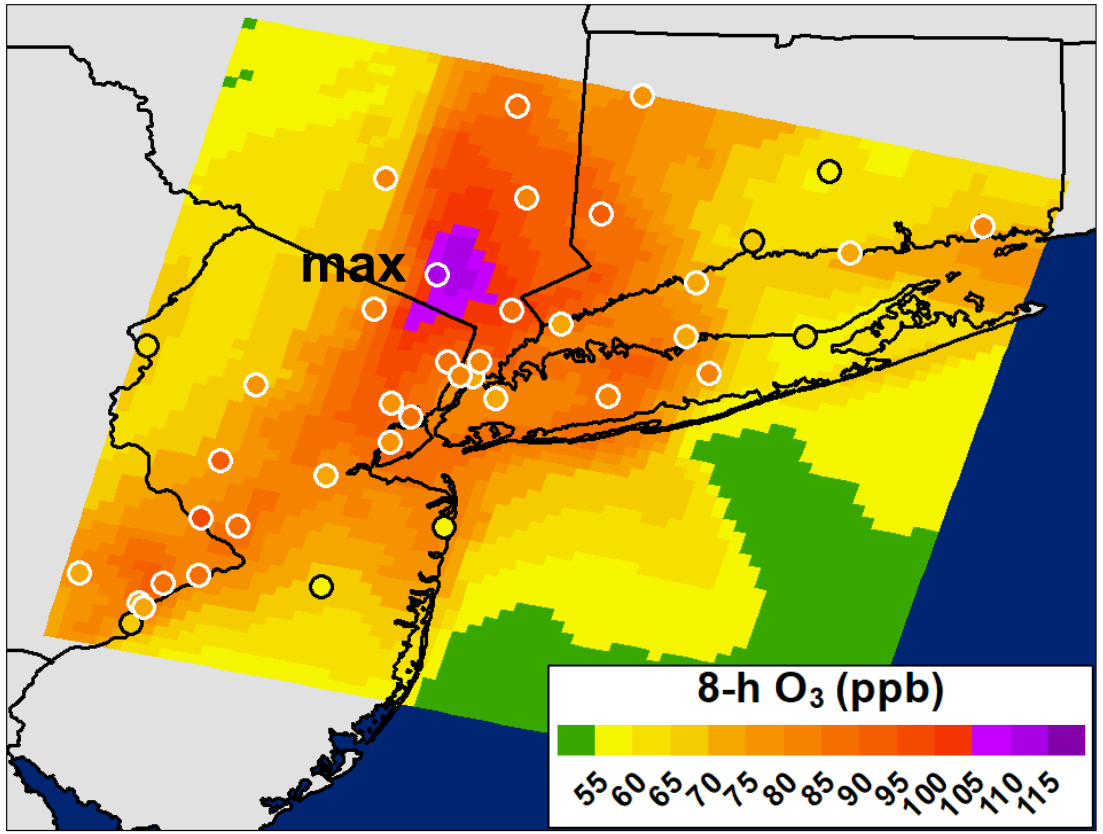
Top-down estimate of cooking emissions can be derived by comparing WRF-Chem output to nonanal measurements by aircraft. *Implications TBD!*



Courtesy of Qindan Zhu and Rebecca Schwantes

Urban Cores Exhibit VOC Sensitivity

Ozone during heatwave, July 2, 2018



AQI and population impacted

Good	Moderate	Unhealthy for sensitive groups	Unhealthy	Very Unhealthy
400	3.3 million	13.5 million	10.3 million	0.4 million

Coggon et al. (PNAS, 2021)

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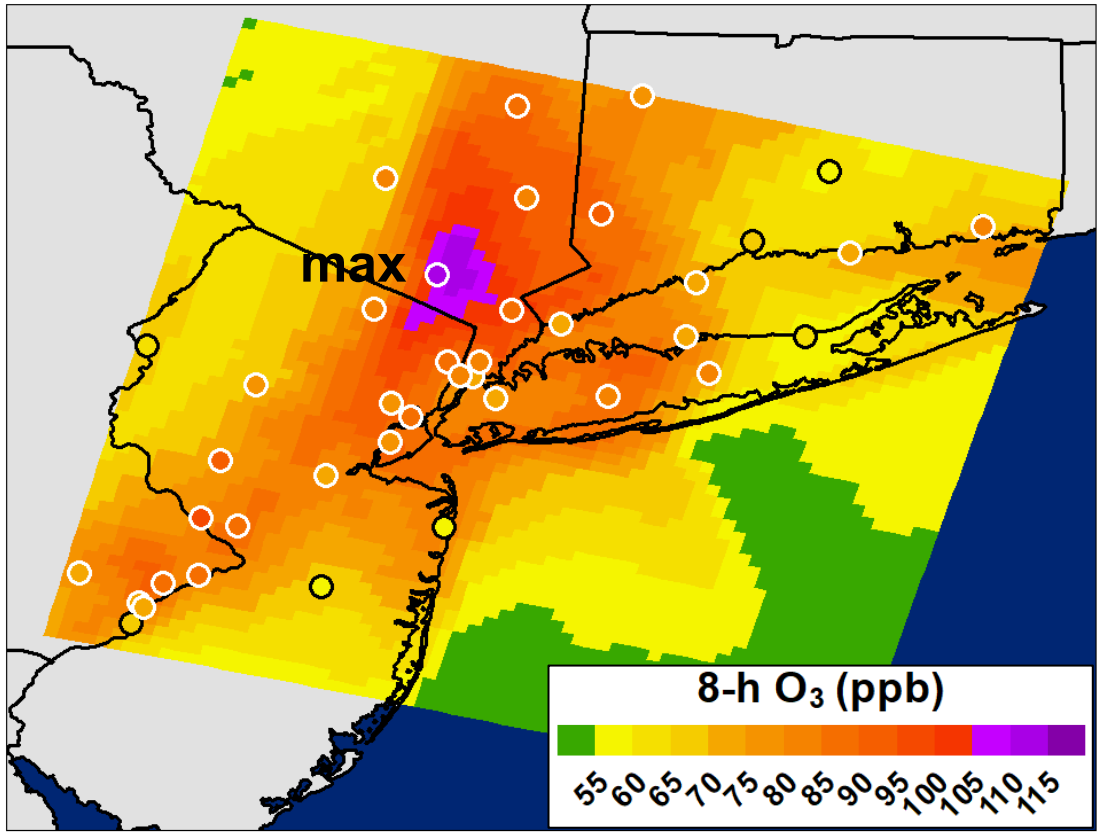

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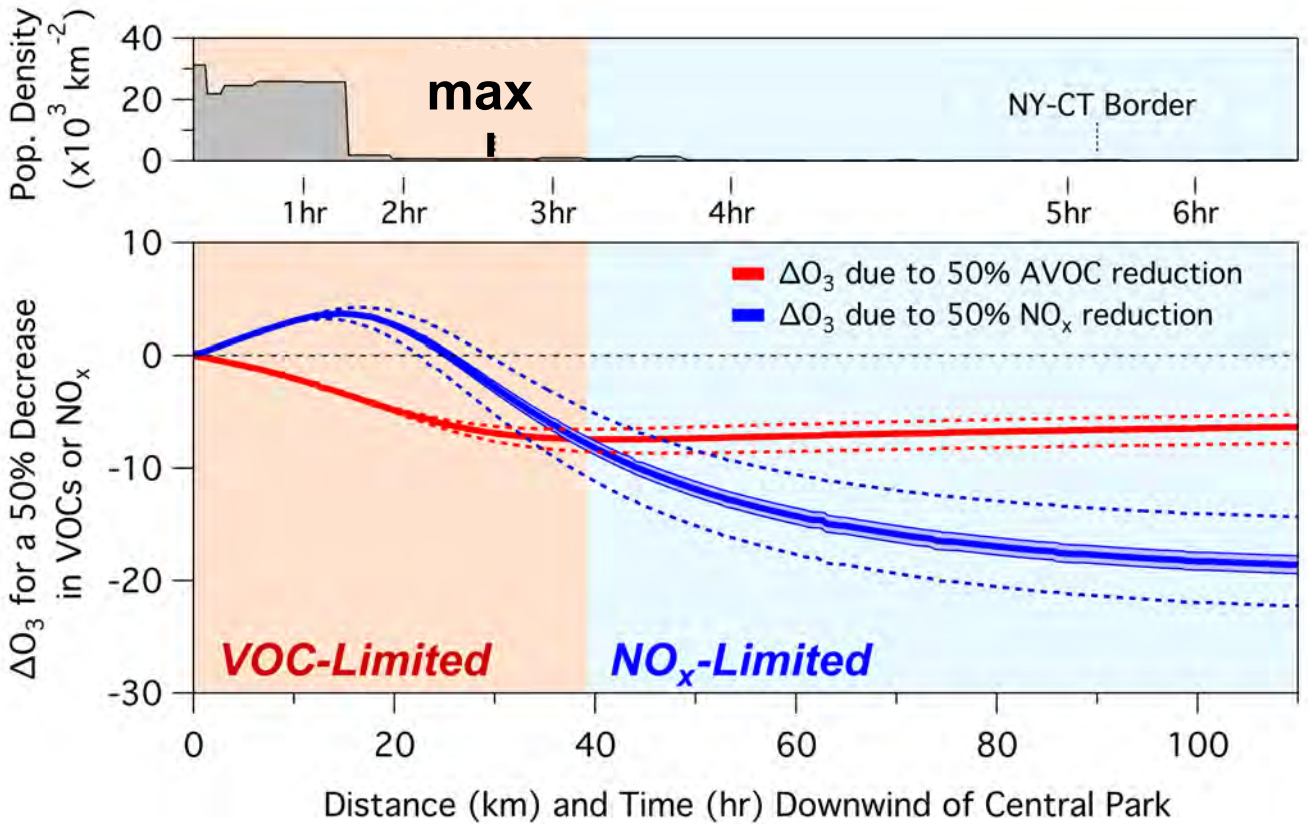
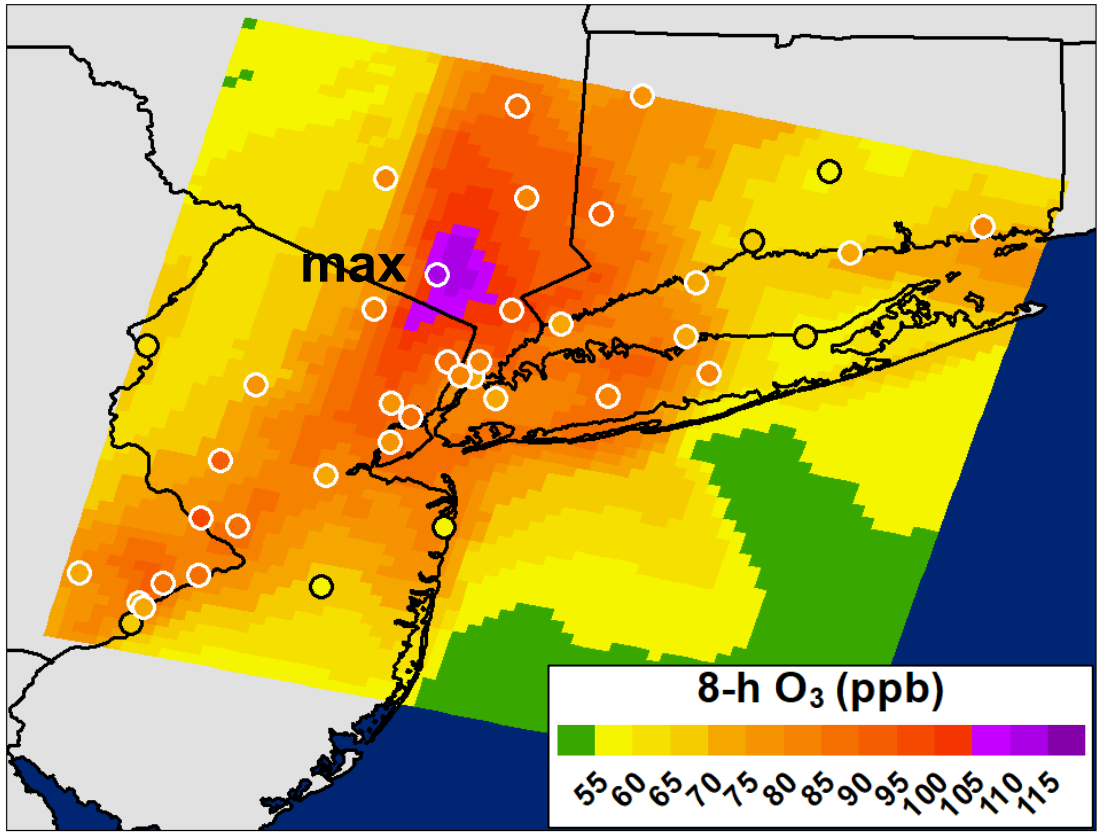


Ozone production is sensitivity to anthropogenic VOCs in the urban core

Coggon et al. (PNAS, 2021)

VCPs play an important role in ozone formation

Ozone during heatwave, July 2, 2018



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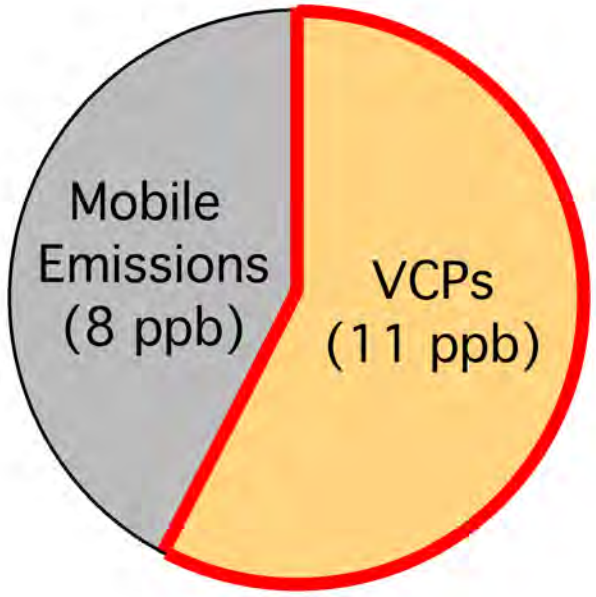
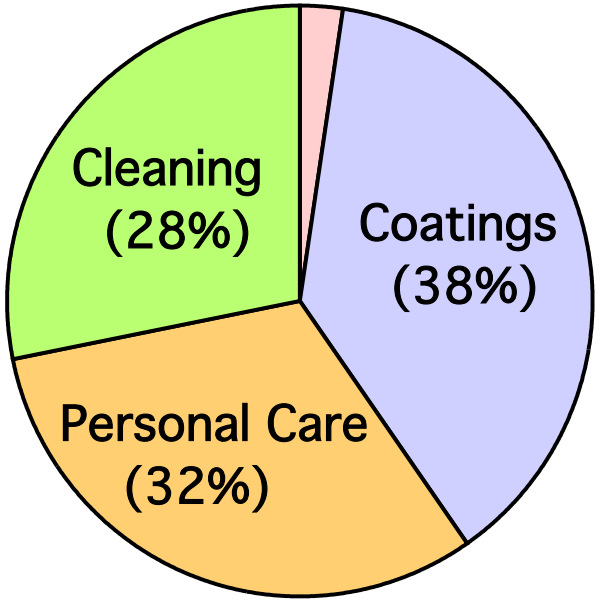
Breakdown of Anthropogenic Ozone

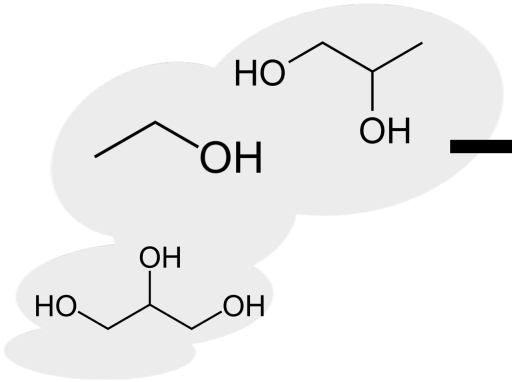
Total Ozone from Anthropogenic VOCs



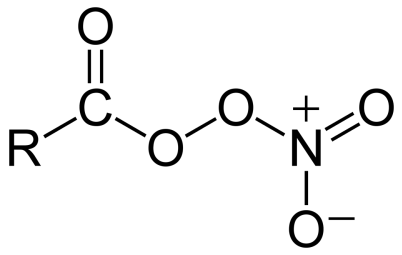
Ozone from VCP Emissions



Emissions and Chemistry Matter!



… Atmospheric Chemistry …



Peroxy Acyl Nitrates – Key NO_x reservoir

Treat Emissions as Alkanes (default assumption)

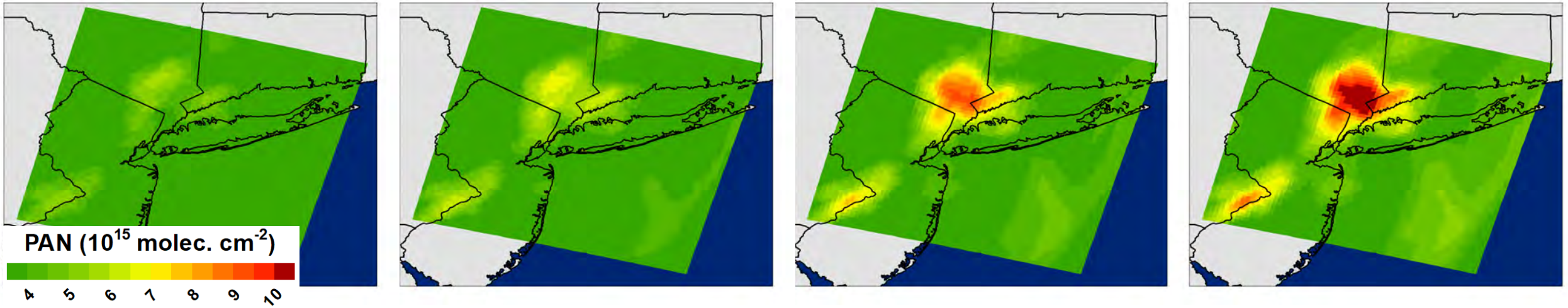
Use Explicit Oxygenate Chemistry

NO_x and BVOC only

+ Fossil Fuel VOC

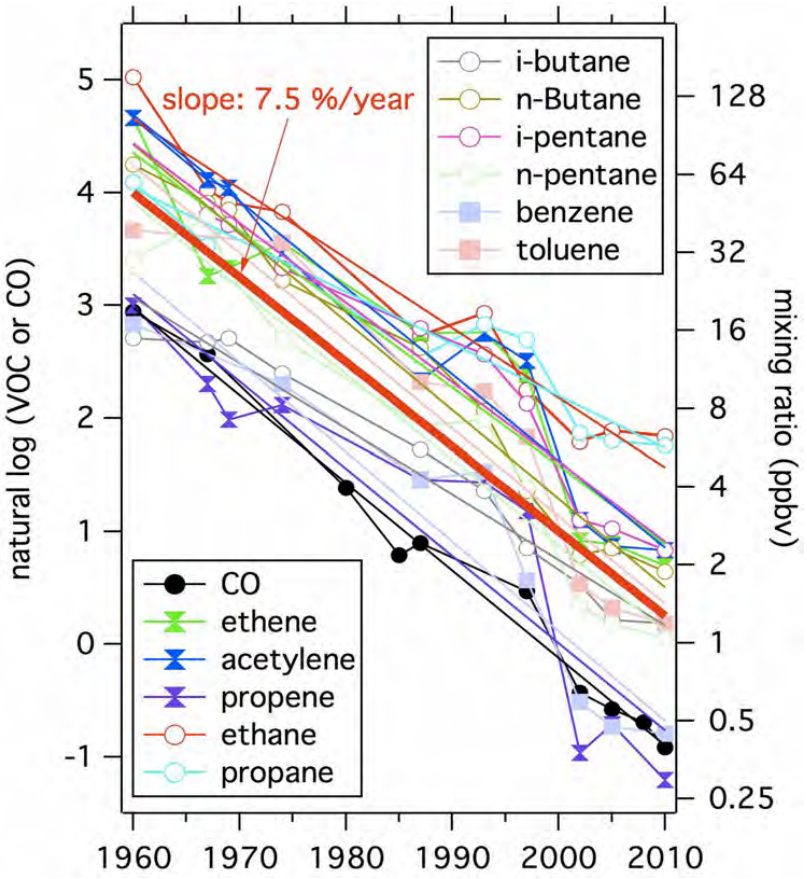
+ VCP VOC

+ oVCP Chemistry

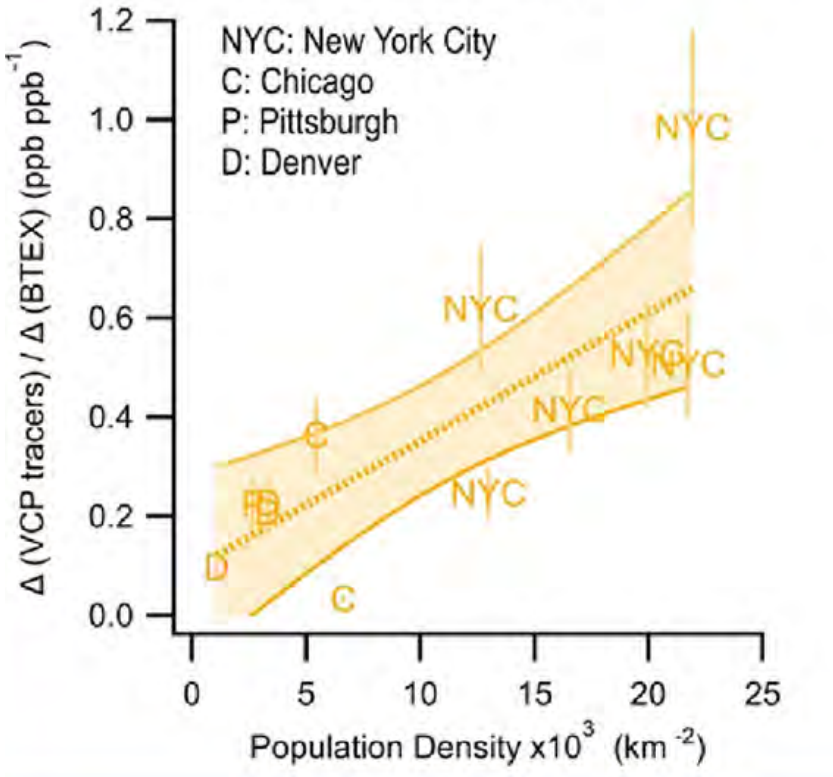


Conclusions

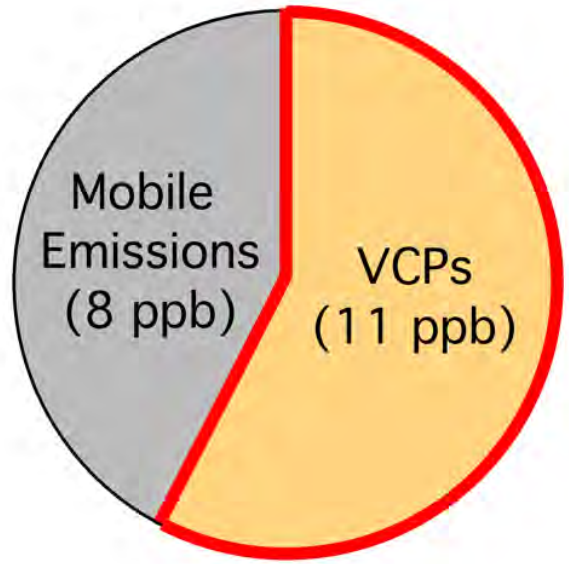
The urban environment has changed and fossil fuels no longer dominant urban VOCs



Emissions profile in each city depends on population size, vehicle miles driven, restaurant density, other (?)



Models need good representation of emissions *and* chemistry to simulate air quality



Anthropogenic Ozone Distribution from NYC modeling