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Emissions Estimates for Formaldehyde and other VOCs

Dirk Felton
Division of Air Resources
Bureau of Air Quality Surveillance

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NYSERDA: Energy-Related Air Quality and Health Effects Workshop
Albany, NY

Emission Inventory Data

EPA National Emission Inventory (NEI)
Submitted by states and compiled every 3 years

Includes criteria pollutants and toxics for all major sectors

- Area (Non-Point) Sources
- Onroad Mobile Sources: gas & diesel (VMT, #, speed)
- Non-road Sources: marine, construction, trains
- EGU Point Sources: Location based
- Non-EGU Point Sources: sewage tr., asphalt, petroleum, manufacturing, landfills
- Biogenic Sources: Calculated from land use and Met.

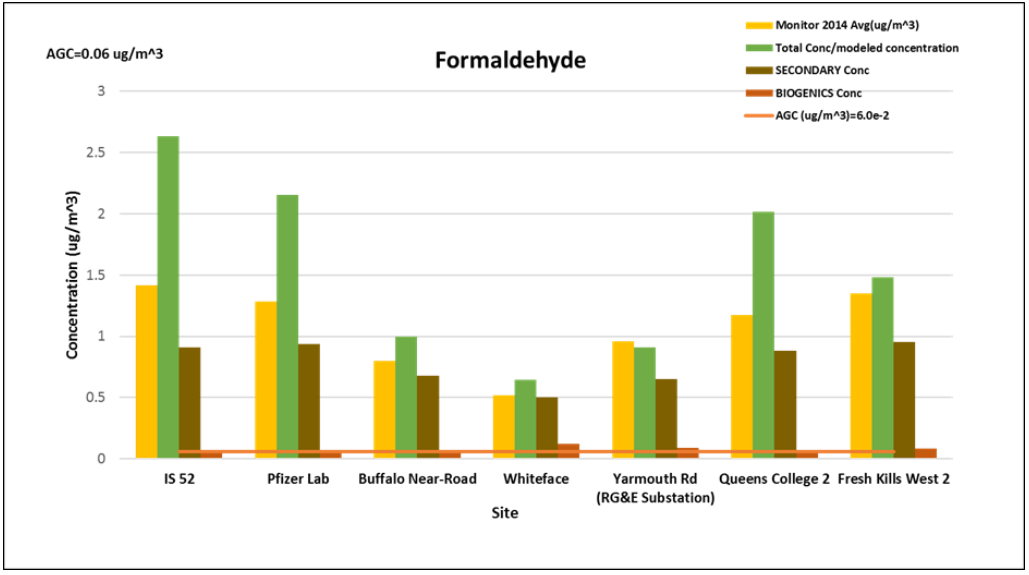
How do we use the NEI?

- NEI inventory data is county-level, annual, lumped species but air quality models need hourly, grid cell-level, speciated emissions
- Sparse Matrix Operator Kernel Emissions (SMOKE) Emission processing system
  - Spatially Allocate emissions from county-level to grid cell
  - Temporally Allocate emissions from Annual to hourly
  - Chemically Speciate lumped pollutants to individual species. (NOx to NO, NO2, VOC: isoprene, formaldehyde, benzene etc.)
  - Perform QA, generate reports, drive other models (BEIS, SMOKE-MOVES)

National Air Toxics Assessment

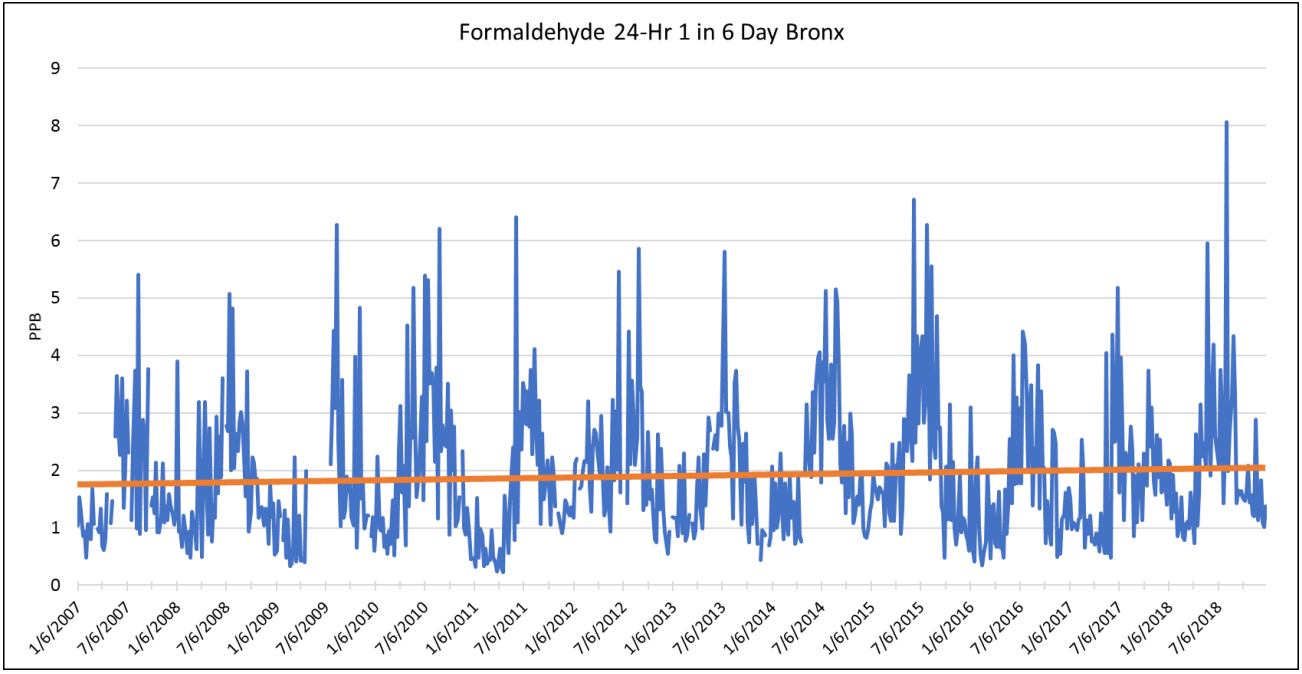
NATA calculates annual concentration and risk estimates from a single year's emissions data

NATA results are best applied to larger areas: comparisons to NY sites are inconsistent: better in rural areas



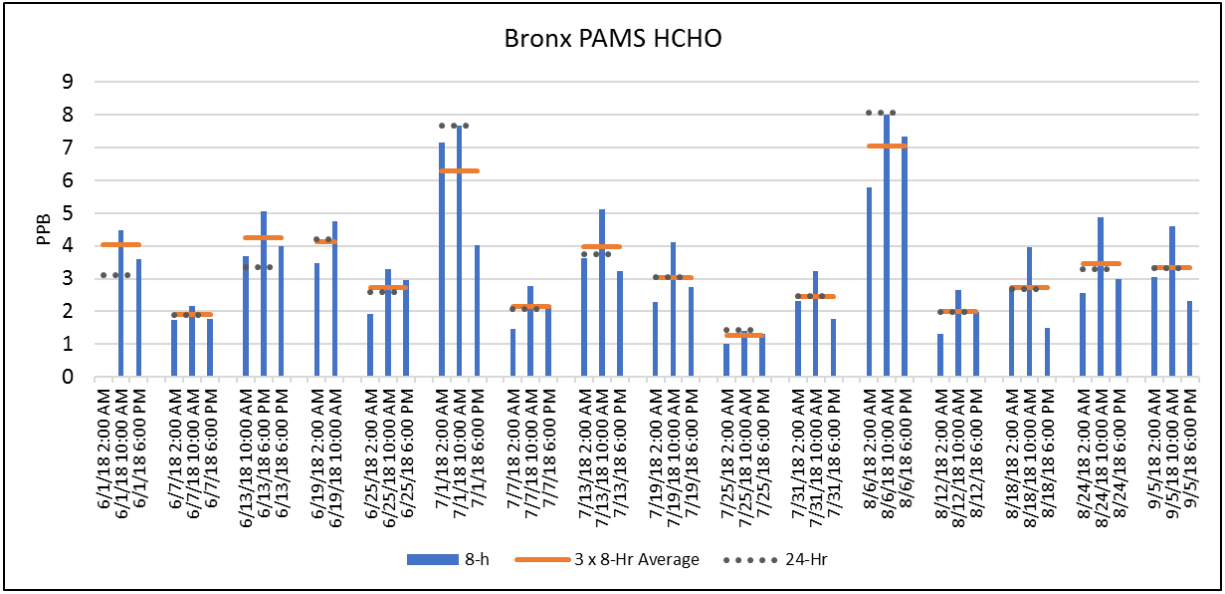
Formaldehyde: Bronx

24-Hr 1 in 6 Day data are not useful for Ozone modeling



Formaldehyde: Bronx

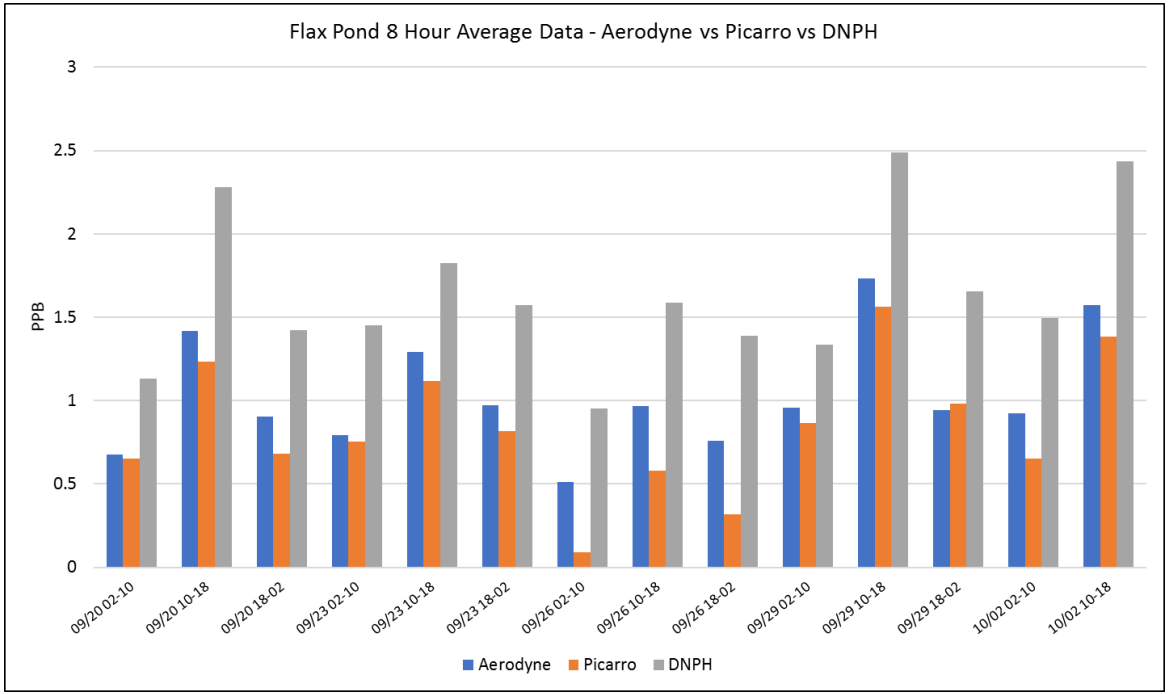
PAMS 8-Hr data (start at 4:00 am) are better but still not useful to understand local emissions



DNPH: Integrated method is the only approved EPA method

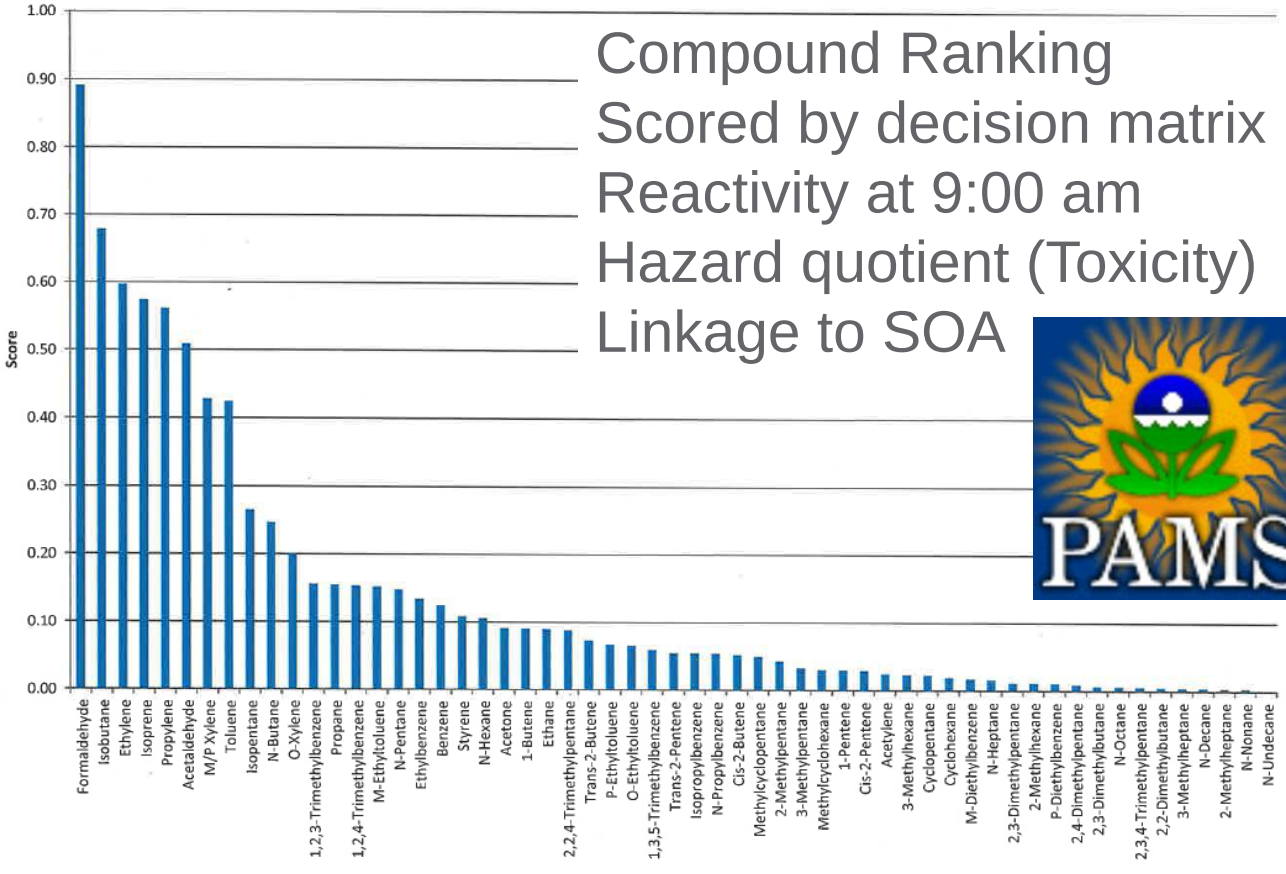
Formaldehyde Method Development: Flax Pond

Continuous methods are consistently lower than DNPH



DEC will operate hourly HCHO at the PAMS sites

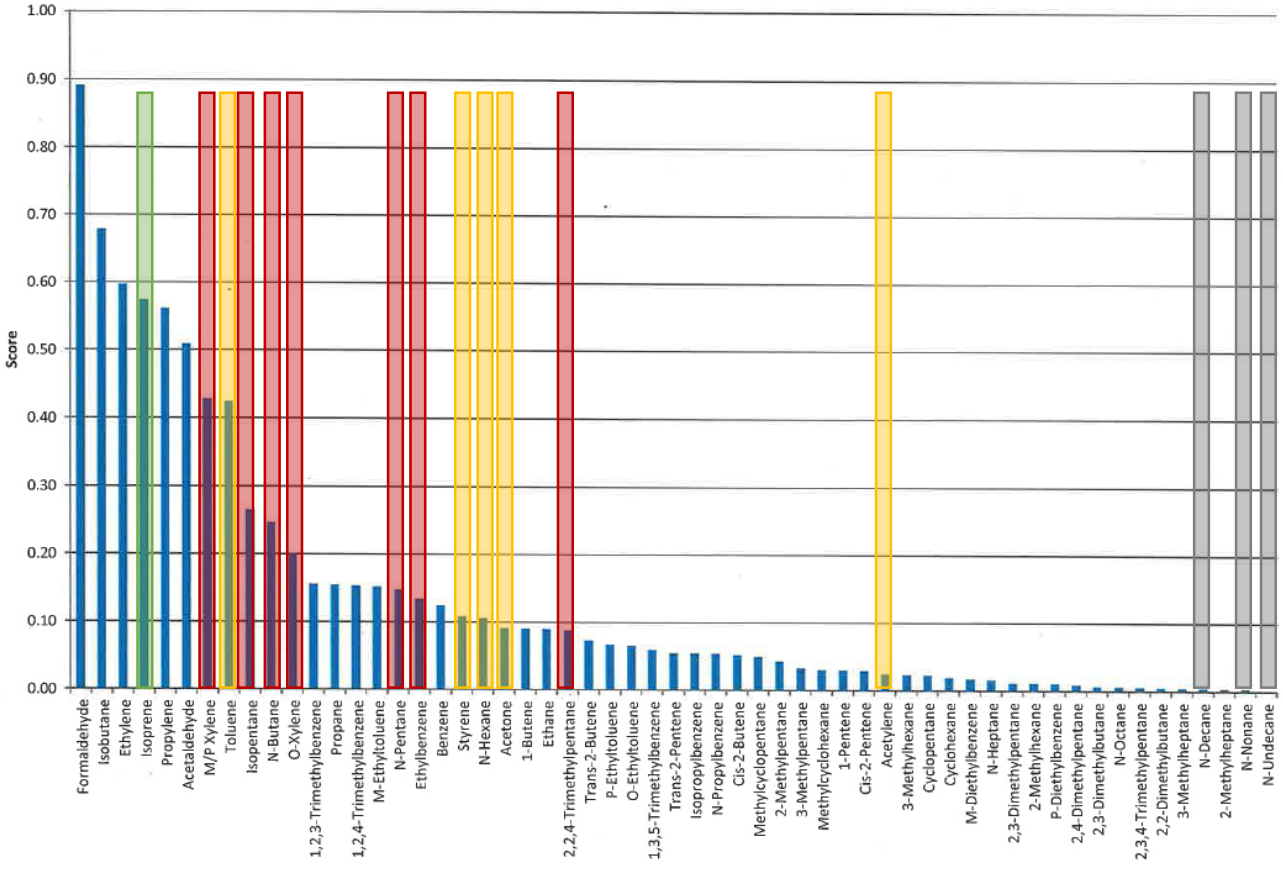
PAMS Priority Compounds

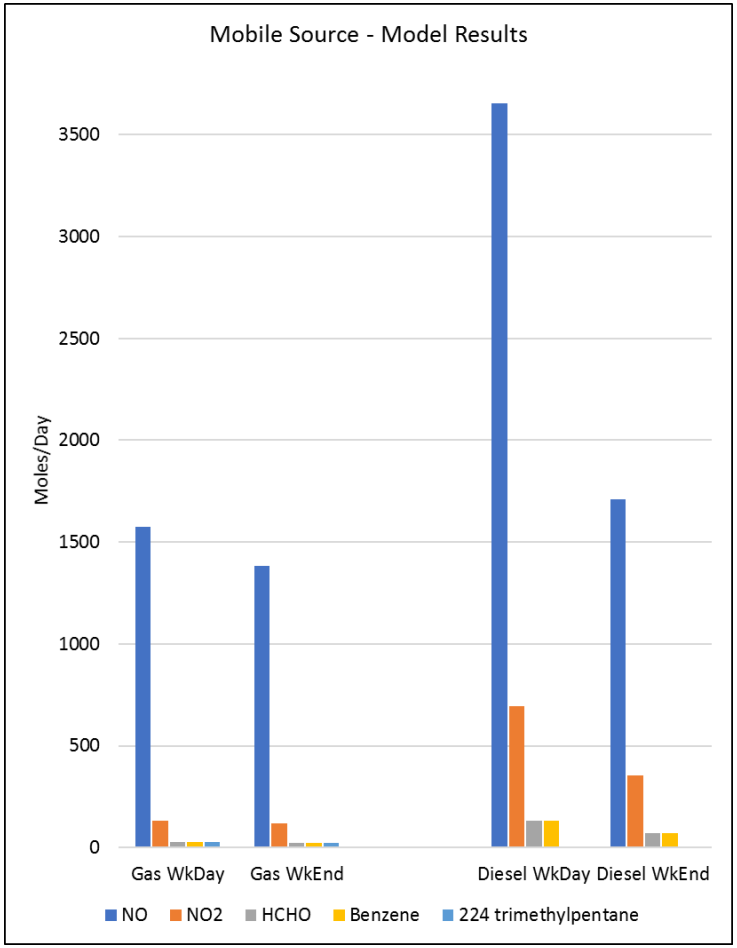


Compound Ranking
Scored by decision matrix
Reactivity at 9:00 am
Hazard quotient (Toxicity)
Linkage to SOA

PAMS

PAMS Priority Compounds





Bronx County Mobile Source Model Results (NEI – 2016 Beta)

- Summer Weekday and Weekend
- The speciated model results do not include most of the components of gas or diesel
- NO and NO2 are higher for diesel even though there are more cars on the road

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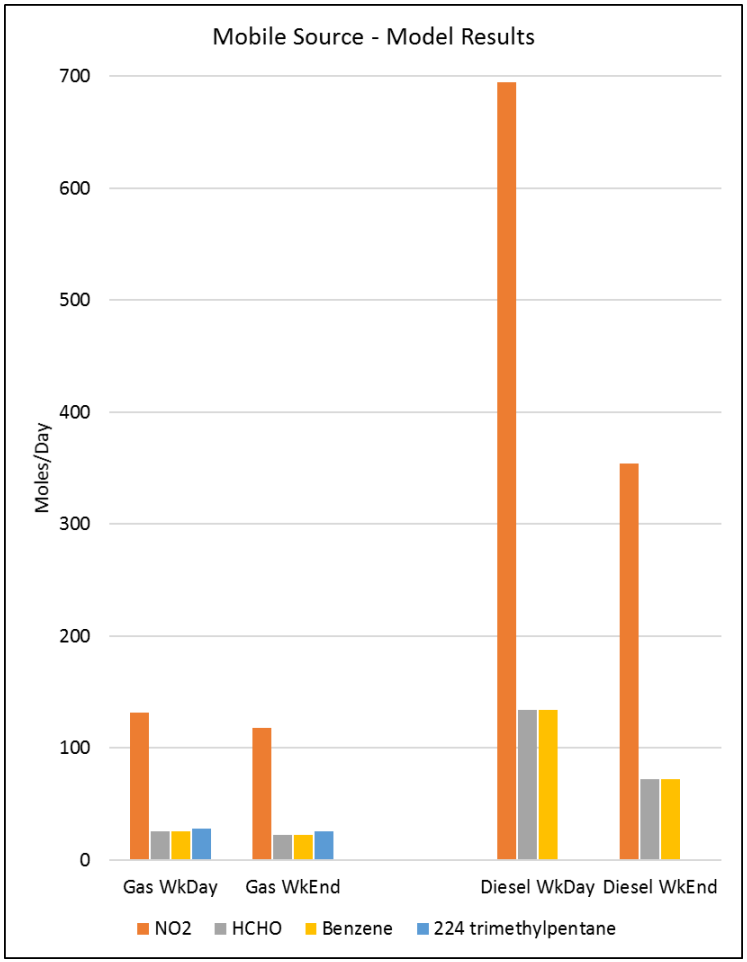


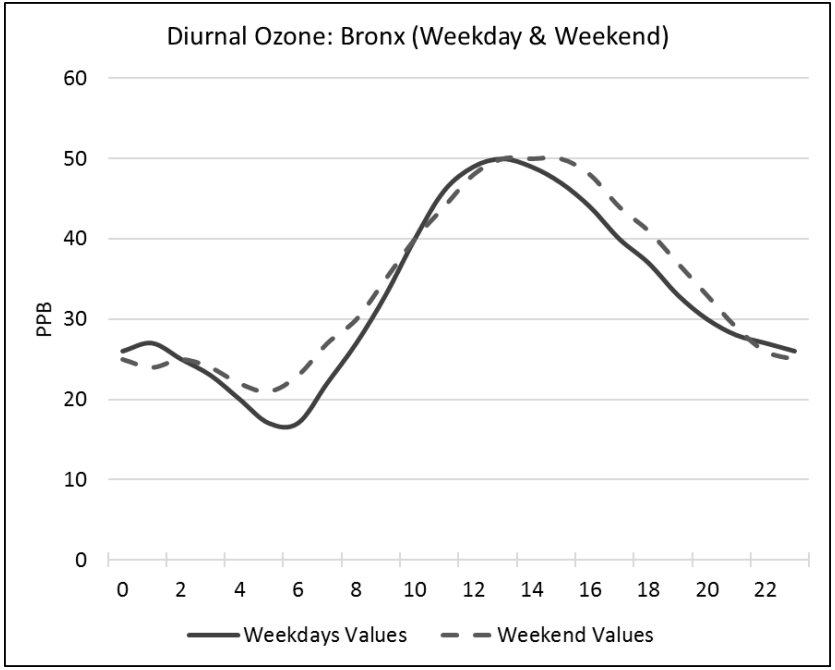
Bronx County Mobile Source Model Results (NEI - 2016)

NO is removed from this plot

2,2,4 trimethylpentane is a tracer for gasoline that is included in the speciated model results and it is a PAMS compound

What can monitoring data tell us about emissions?

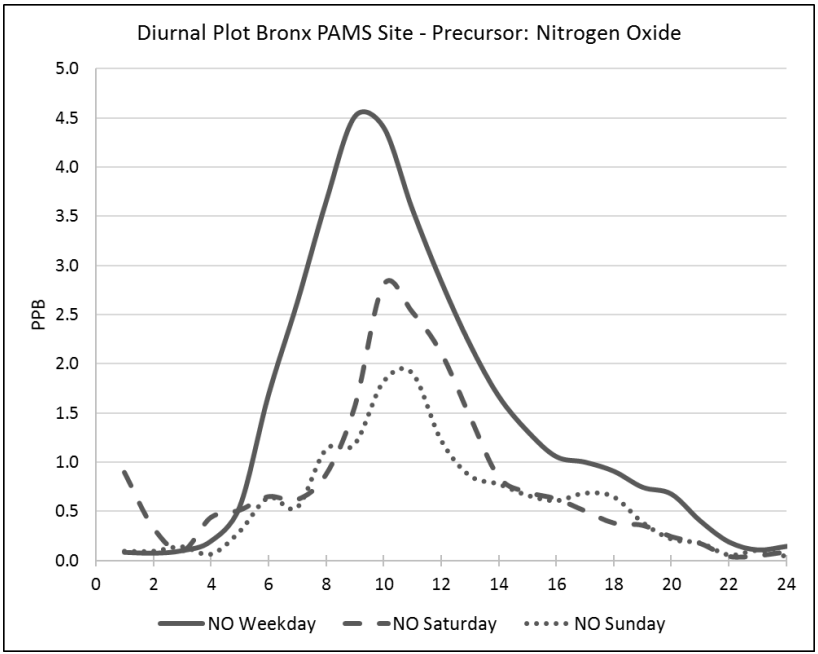
Ozone: Day of the Week Matters



June – July – August, 2018

- Day of the week differences are due to changes in local emissions
- Weekends: 4 PPB higher in mid-afternoon
- Bronx Site was classified as a Type 2 PAMS Site

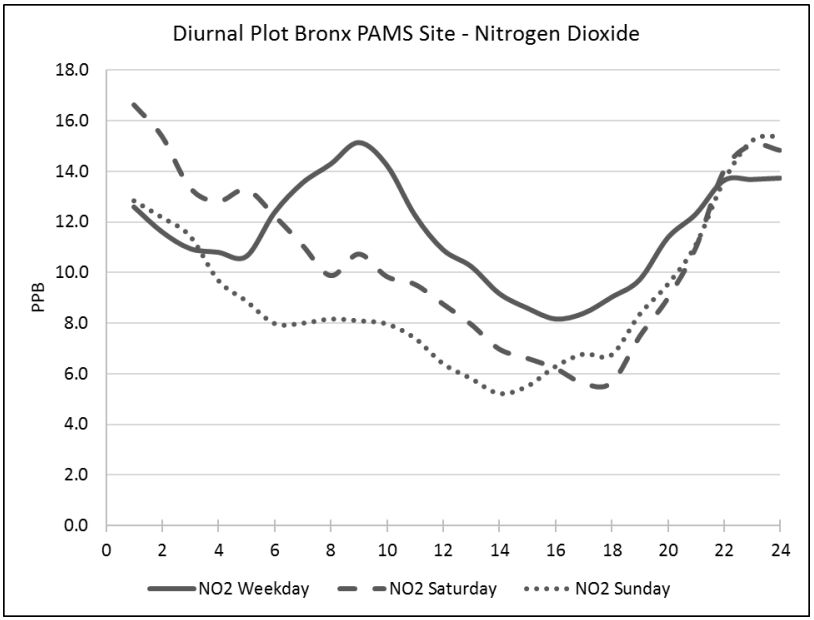
Emissions: NO is Local



Day of the week differences are due to changes in local sources

In the Bronx, average NO is more than twice as high on Weekdays

Ozone Precursors: NO2

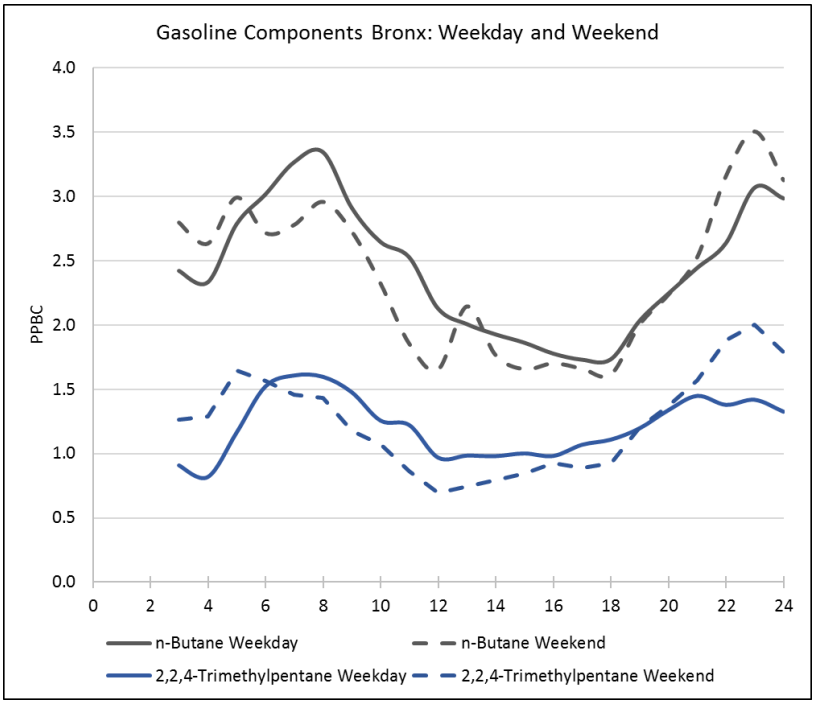


Weekdays: NO2 increases in the morning before the sun comes up

Weekends: NO2 does not increase during daylight hours

Sunday: NO2 daytime concentrations are lowest

Local Emissions: Motor Vehicles (Gas)



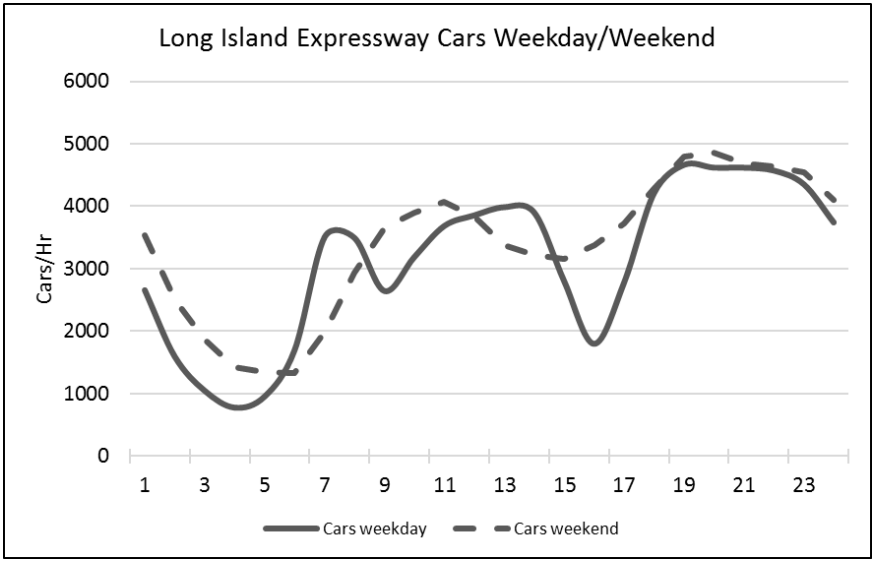
June – July – August, 2018

VOCs associated with gasoline emissions are only slightly higher on weekdays

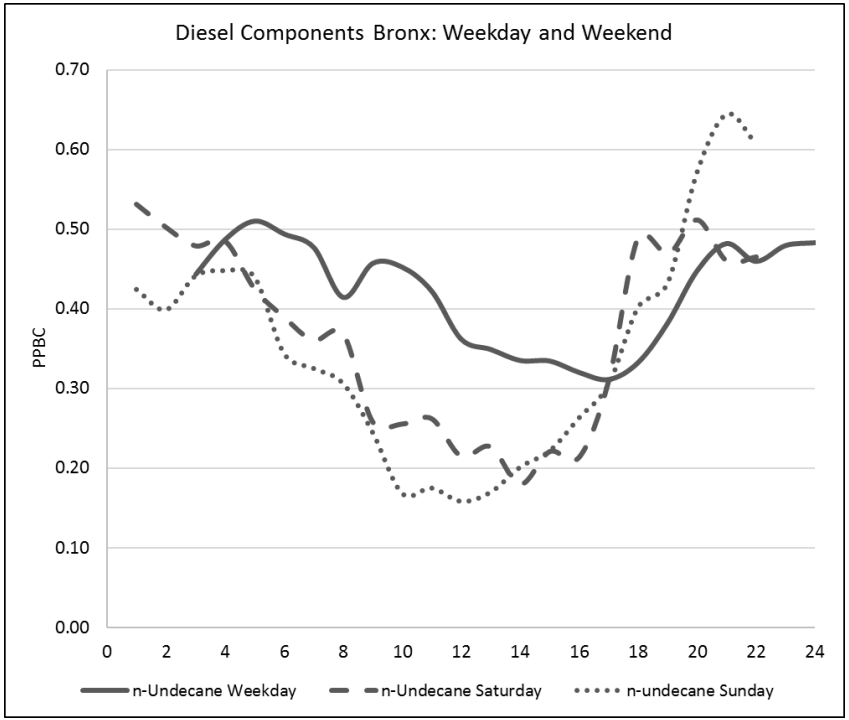
2,2,4 trimethylpentane is a tracer for gasoline that is a PAMS compound and is also included in the speciated model results

Local Emissions: Motor Vehicles (Traffic)

Car traffic is similar on weekdays and weekends
Afternoon gridlock drops weekday car count 50%



Local Emissions: Motor Vehicles (Diesel)

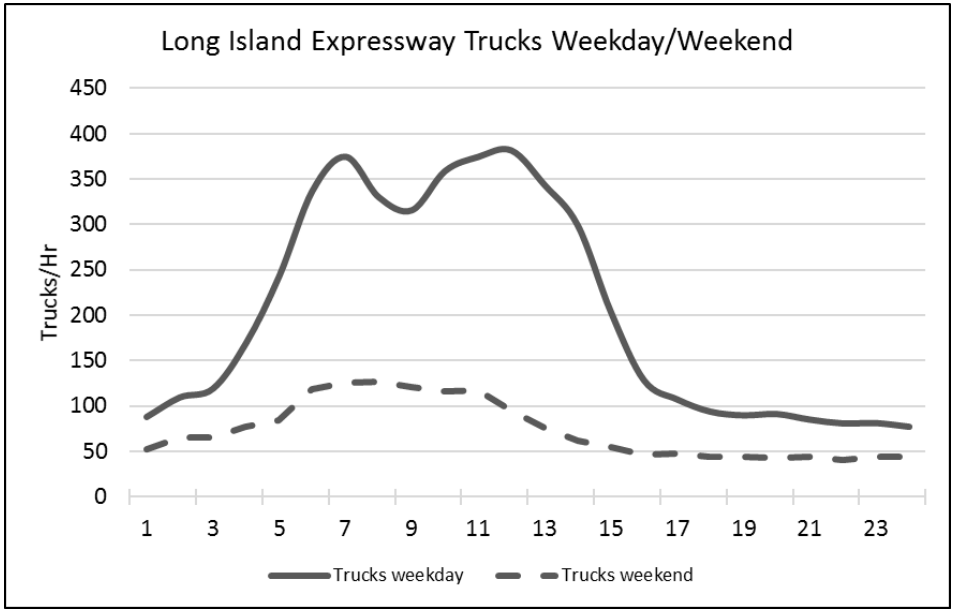


VOCs associated with diesel emissions are higher on weekdays and lowest on Sundays

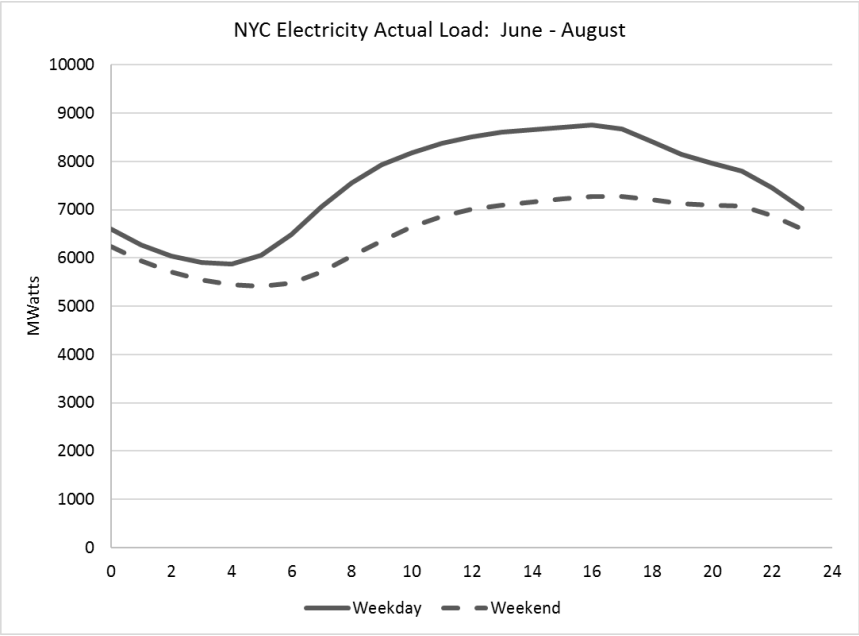
Diesel emissions increase after 3:00 am on weekdays

Local Emissions: Motor Vehicles (Traffic)

Truck traffic is much lower on weekends
Undecane and NO, NO2 are much lower on weekends



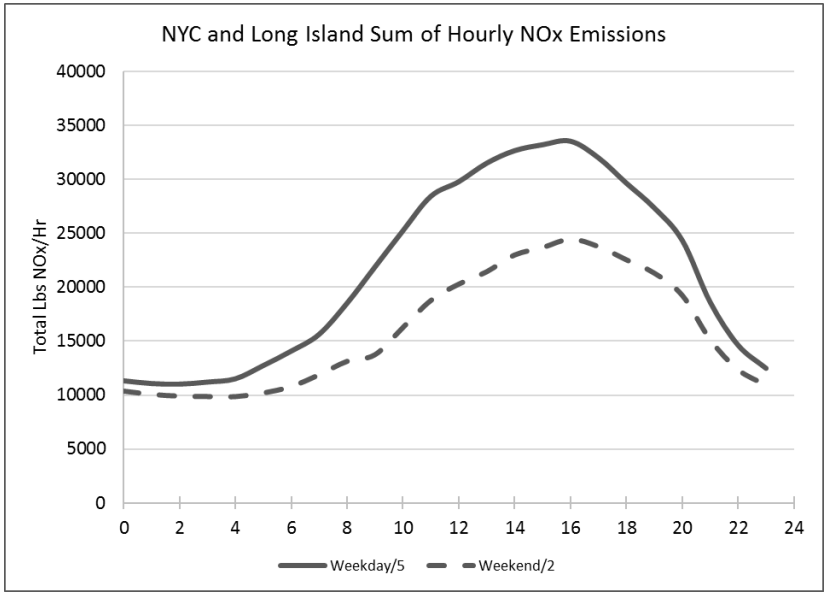
Local Emissions: Electricity Usage



In summer 2018, NYC Power usage was about 10% higher during the daytime on weekdays

Electricity usage data available from: https://www.nyiso.com/load-data

Local Emissions: Electricity Generation



In summer 2018, Power generation NOx emissions are approx 20% higher in the mid-afternoon on weekdays

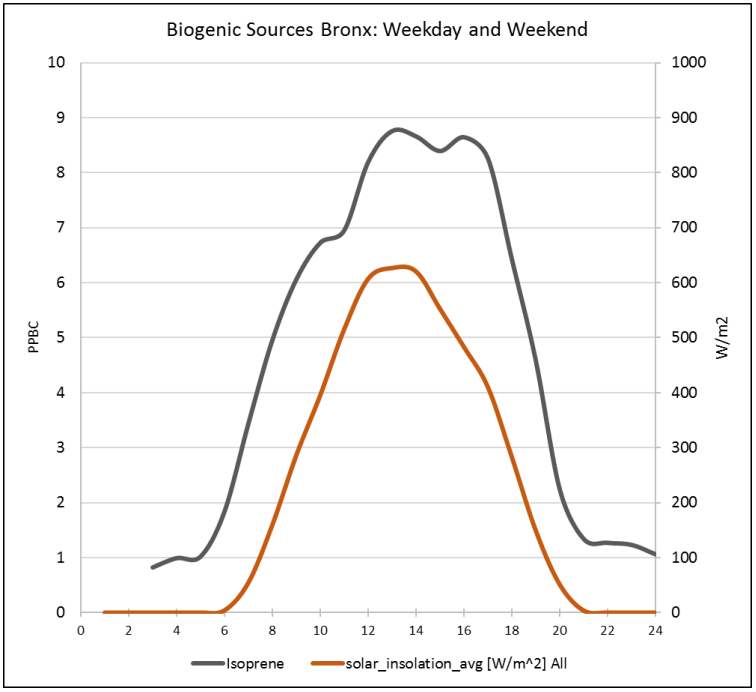
Power plant emissions peak well after morning rush hour

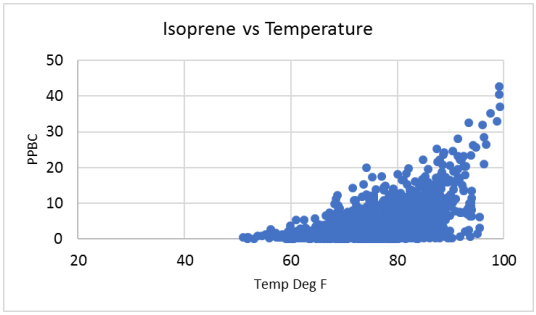
June – August, 2018

https://ampd.epa.gov/ampd/

Biologic Source Emissions:

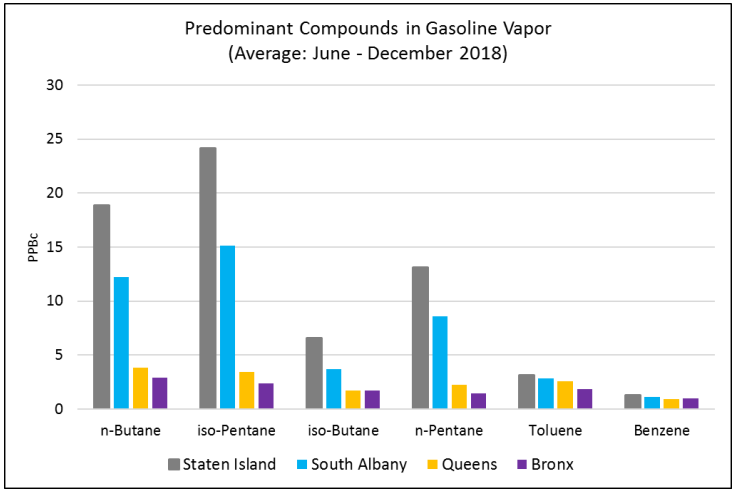
Isoprene: The only VOC that increases in the afternoon when production greatly exceeds removal (sunlight & high temp)

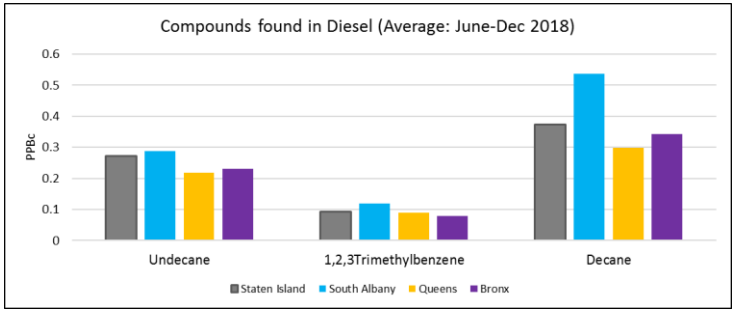




Alpha and beta pinene: low on average (0.31 and 0.073 PPBC) and not well resolved by the Auto-System

Local Sources: Evaporative Emissions - Fuel





Air Toxics 24-Hr canisters can be analyzed for PAMS target list

Staten Island site is near NJ refineries and fuel distribution facilities

South Albany site is downwind of fuel distribution facilities in the Ports of Albany and Rensselaer

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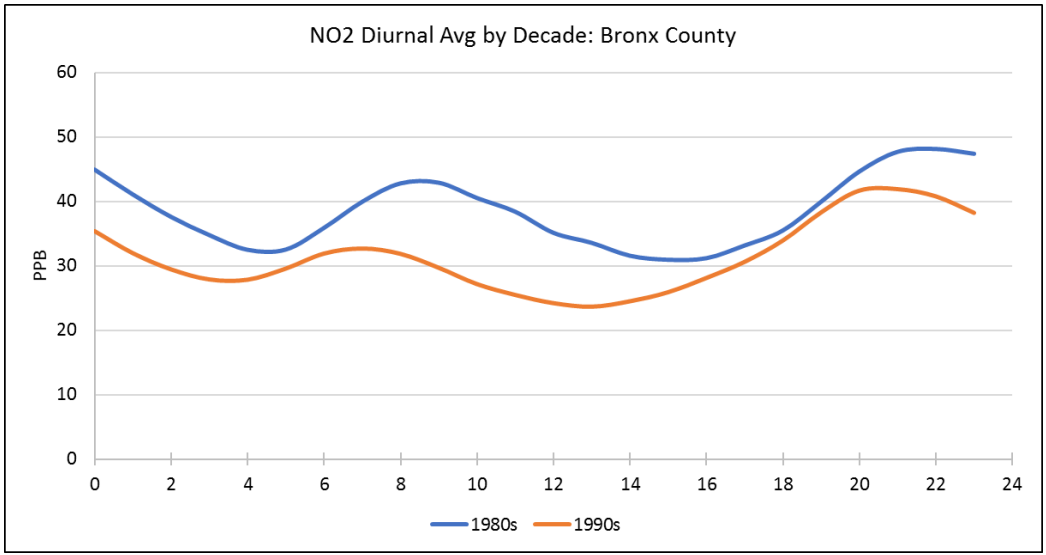
1st Conclusions

- Most of the increases in NO and NO2 on weekdays occur early in the morning before power generation emissions increase
- Cars are not a likely cause of weekday/weekend differences in NO and NO2 since car traffic is similar weekday/weekend
- Truck emissions are contributing to increases in weekday NO and NO2
- What does past NO and NO2 tell us?

Ozone Precursors: NO2 Long-term Trend

In the 1980s and 1990s NO2 daily peaks are in the evening

Traffic emissions are probably not the largest source

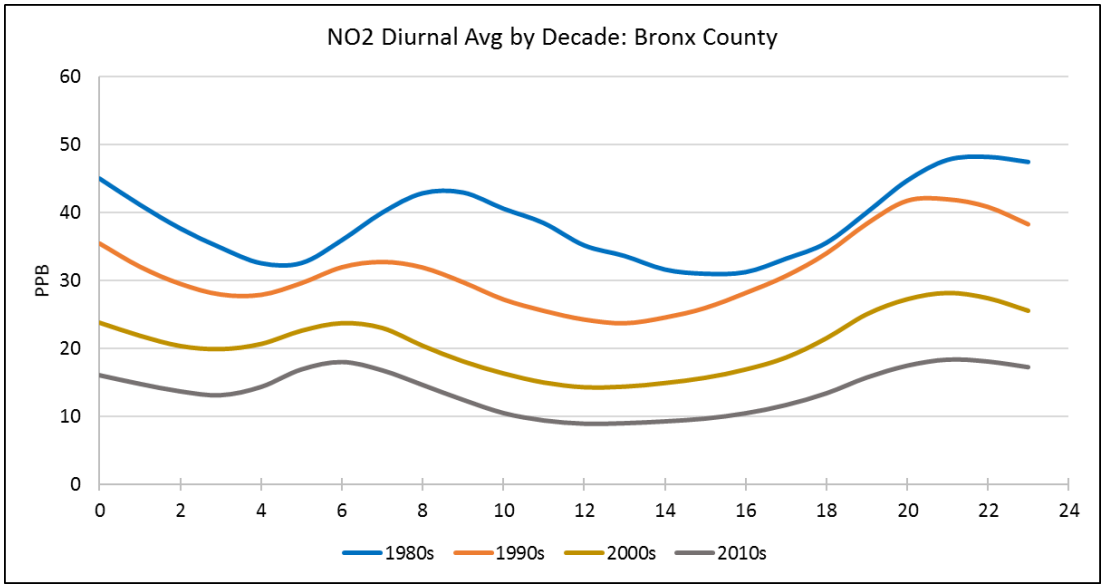


June – July – August

Ozone Precursors: NO2 Long-term Trend

In 2010s, NO2 peaks are just as likely in the morning or evening

Traffic emissions are more similar to other sources



2nd Conclusion

- Models need to speciate more of the PAMS compounds (reactive and tracers)
- Evaporative emissions from petroleum refining, storage and distribution need to be better defined in the inventory
- There is a need for current, representative motor fuel assays to better estimate emissions from ambient data

Thank You

- Dirk Felton
- Research Scientist
- 625 Broadway
  Albany, NY 12233-3256
- dirk.felton@dec.ny.gov
- 518-402-8508

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2017 Title V Emission Statements (VOCs)

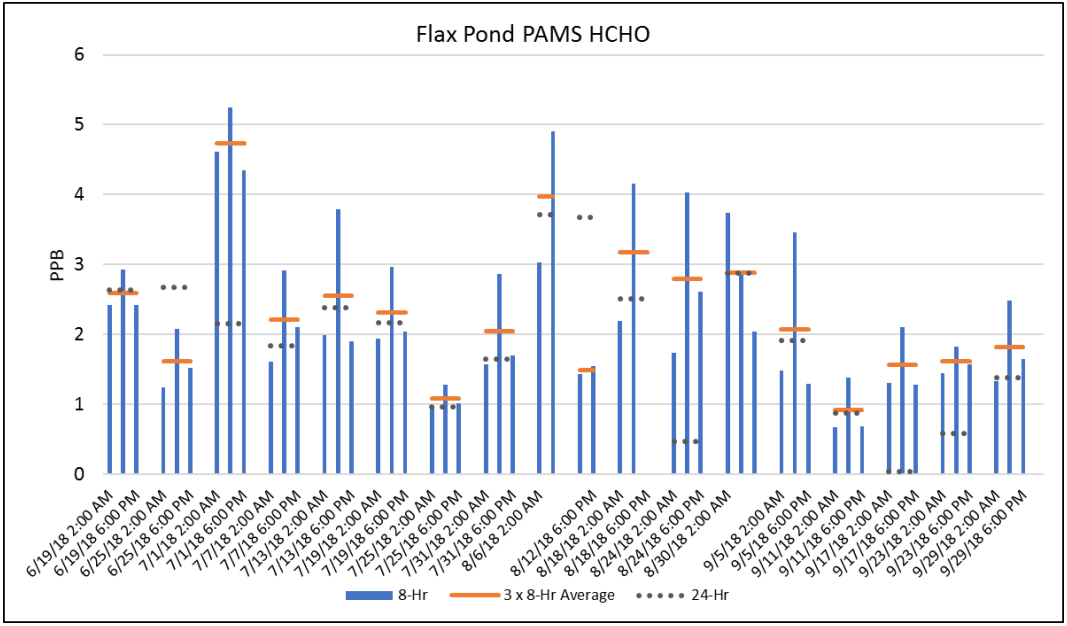
County	VOC Pollutant	Emissions from Title V Sources (Lbs/Yr) by County
Bronx	1,3-BUTADIENE	0.57
Bronx	ACETALDEHYDE	55.44
Bronx	ACROLEIN	8.21
Bronx	BENZENE	37.69
Bronx	BENZO(A)ANTHRACENE	16.44
Bronx	BENZO(A)PYRENE	0.01
Bronx	BENZO[K]FLUORANTHENE	0.01
Bronx	BUTANE	7807.19
Bronx	CHRYSENE	0.01
Bronx	DICHLOROBENZENE	4.46
Bronx	ETHYLBENZENE	35.84
Bronx	ETHYLENE OXIDE	0.81
Bronx	FORMALDEHYDE	835.79
Bronx	HEXANE	6691.88
Bronx	NAPHTHALENE	5.49
Bronx	PENTANE	9666.05
Bronx	PROPANE	5948.34
Bronx	PROPANE, 1,2-EPOXY-	32.42
Bronx	PROPYLENE	36.42
Bronx	TOLUENE	165.18
Bronx	UNSPECIATED VOC	19316.57
Bronx	XYLENE, M, O & P MIXT.	75.68

Data are submitted by permitted facilities and summed by county into an annual value

VOC data are often un-speciated

Formaldehyde: Flax Pond

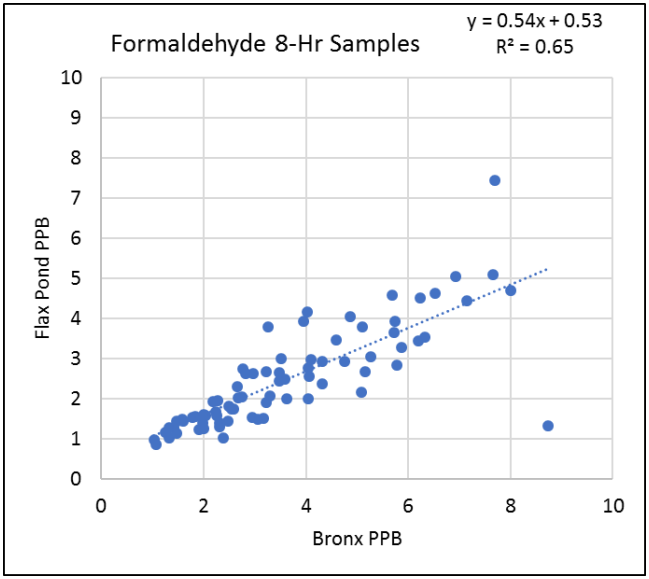
24-Hr and 8-Hr data (start at 4:00 am) are not as useful to understand local emissions or Ozone formation



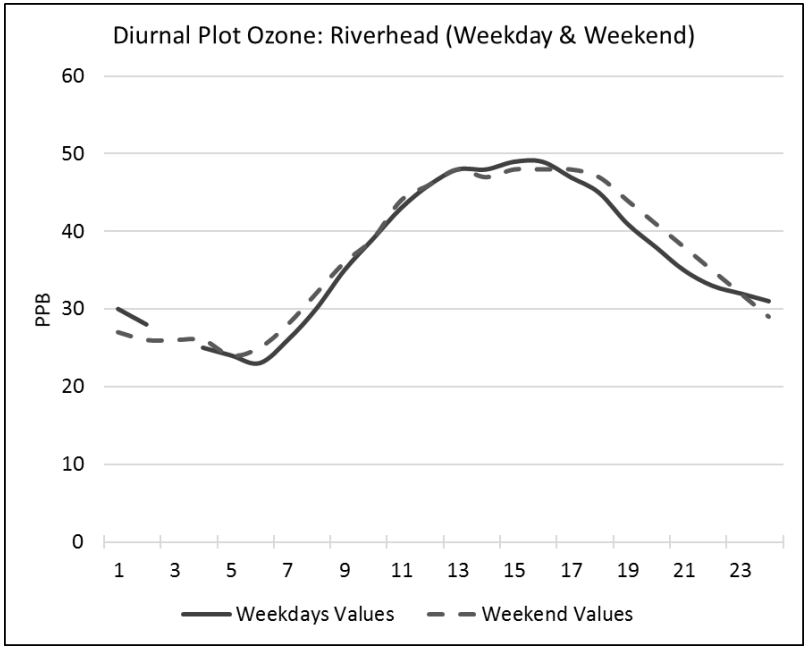
DNPH: Integrated method is the only approved EPA method

Formaldehyde: Bronx and Flax Pond

Bronx data are always higher than Flax Pond



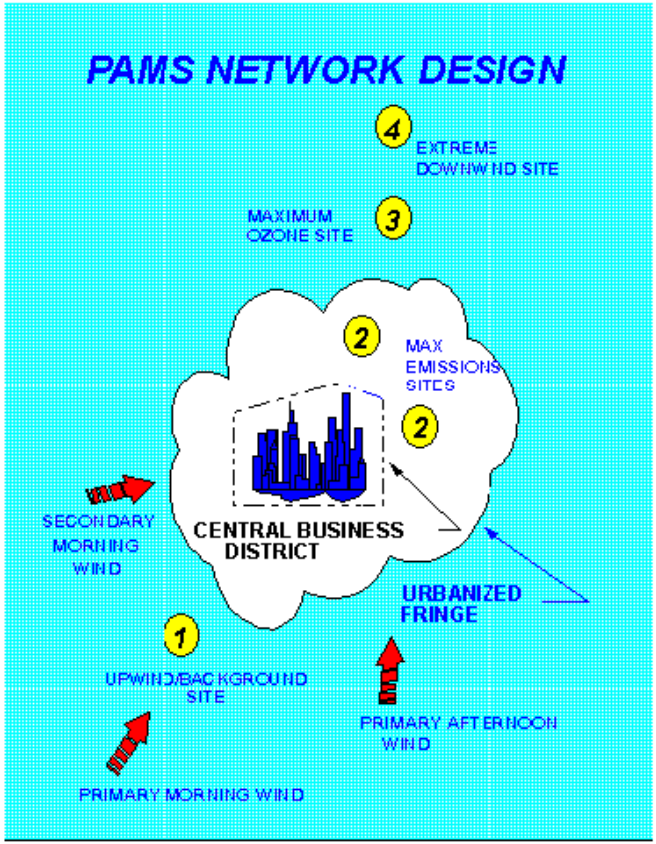
Ozone: Day of the Week - Riverhead



Day of the week differences are minimal further downwind of source regions

Bronx Site was classified as a Type 2 PAMS Site

June – July – August, 2018



Initial Network Design

1. Upwind background, Ozone and precursor conc. (upwind grid edge)
2. Max precursor conc. (up to two in larger cites)
3. Max Ozone conc.
4. Downwind transport of Ozone and precursors to adjacent MSA