Maryland
Department of the Environment

A Review of Traffic Trends and Implications in 2020

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2021 MARAMA Mobile Sources Workshop

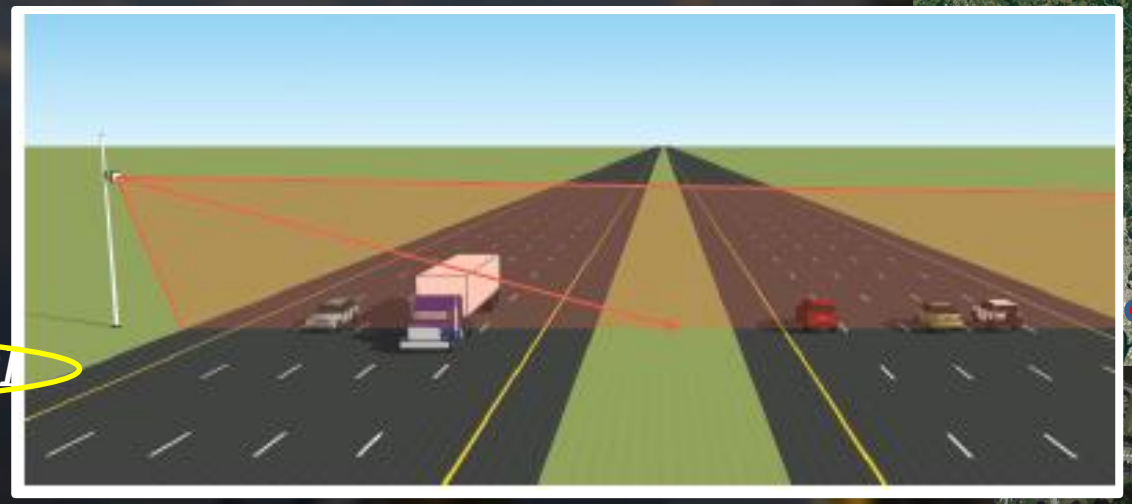
Session 3 - Lockdown Impacts on Transportation Air Quality
March 16, 2021

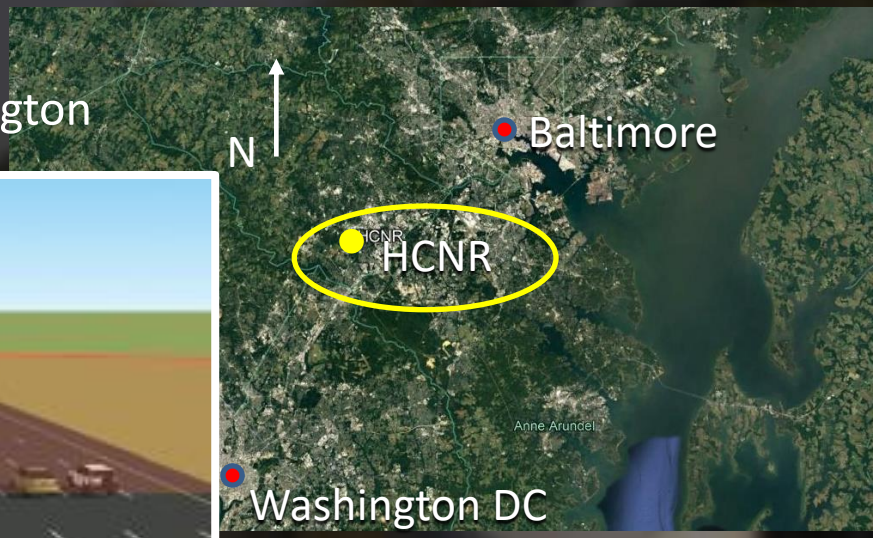
What to Look For:

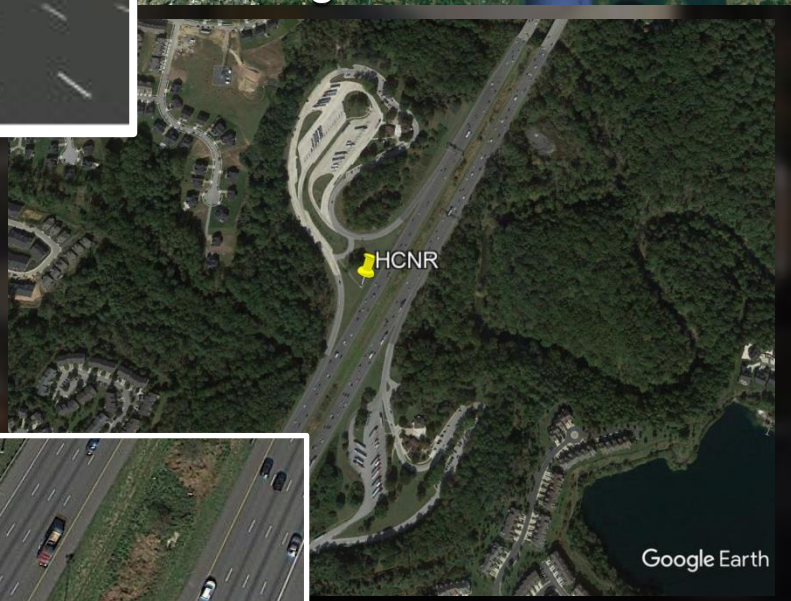
- Traffic Counts and Patterns (Maryland I-95, between DC and Baltimore)
- Count Classification Breakdown and Evolution in 2020 (LDV vs HDD)
- Disparity of impact by road type (SHA statewide road data)
- Annual, Weekly (Friday Effect), and Diurnal Traffic and Pollutant profiles
  - Diurnal & Annual Profiles:
    - Impacts on NOx & CO

MDE HOWARD CO. NEAR ROAD SITE

- Site is approximately 15 m from Interstate 95-S between Baltimore and Washington DC at a major rest stop
- Trace gas/aerosol measurements:
  - Air Toxics/VOCs (1 in 6 days)
  - Black Carbon (Hourly)
  - Ultrafine Particles (Hourly)
  - Carbon Monoxide (Hourly)
  - NO_x (NO_2 & NO) (Hourly)
  - Fine Particulates (PM2.5) (Hourly)
  - ***Traffic Counter [24.125 GHz (K band)]***
- Normal weekday counts: ~200,000 vehicles daily (86% passenger vehicles; C1)







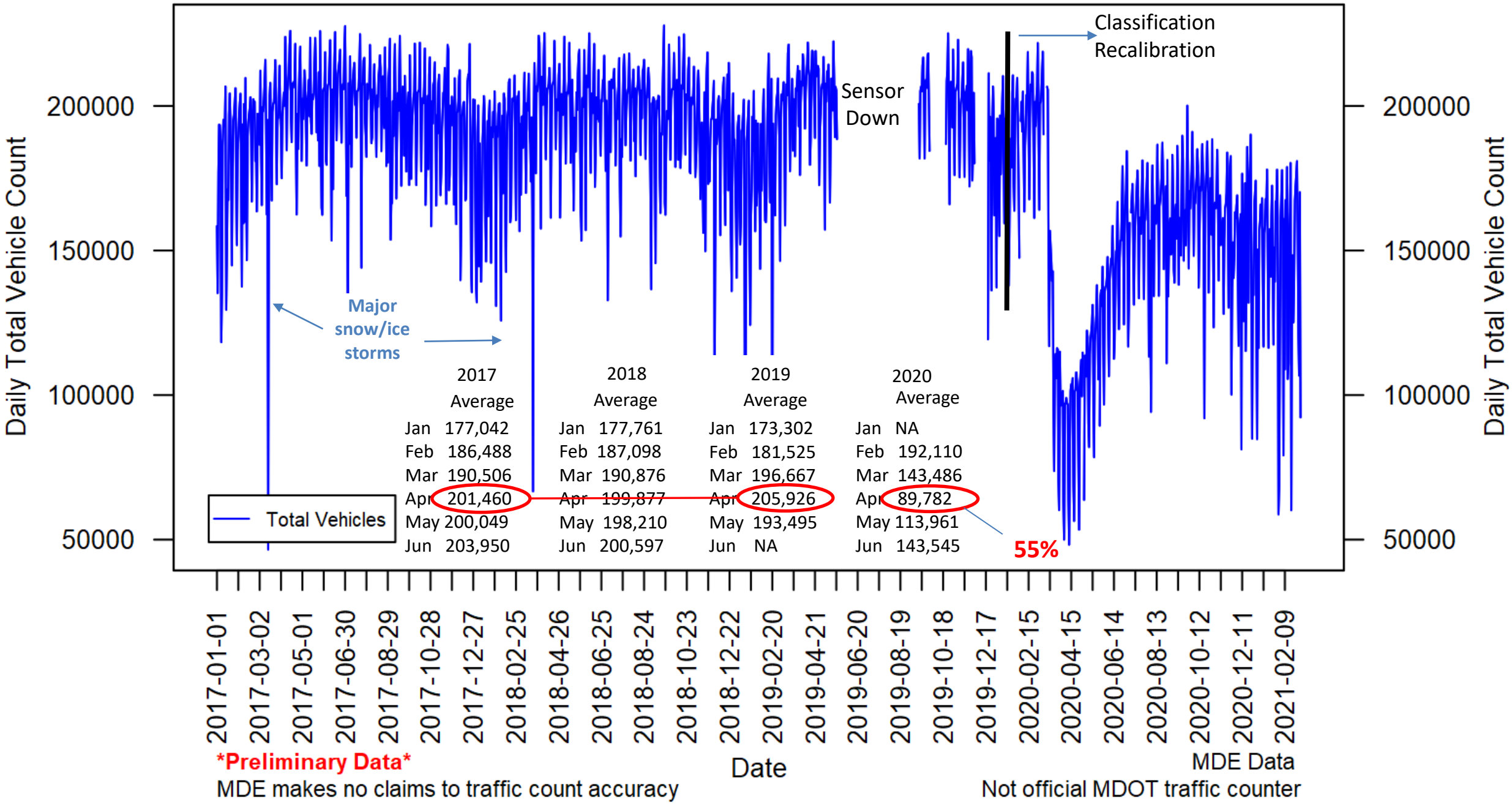
Information on vehicle speed, number, and length at one minute resolution.
- Length "bins" must be pre-defined.
- Current length configuration: (Tested and reconfigured Feb 3, 2020)

Class 1 (C1): 0-24' passenger cars and small trucks [LDV]
Class 2 (C2): 25-35' Larger truck, small box trucks or trucks pulling trailers
Class 3 (C3): 36-49' Medium to large size box trucks, motor homes, or buses
Class 4 (C4): 50-120' Semis [HDD]

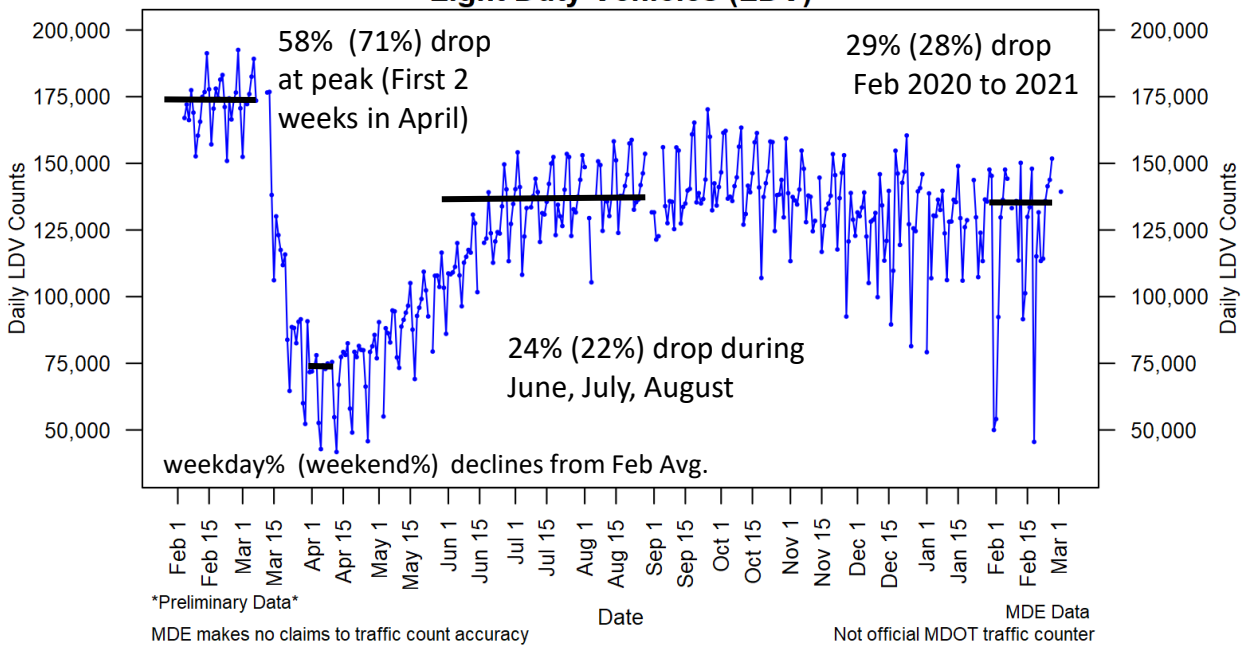
MDE data is not considered official, but comparisons to a nearby MDOT site show consistency within ~2%

Traffic counter: Wavetronix SmartSensor HD *NOx: Chemiluminescence Teledyne API 200*

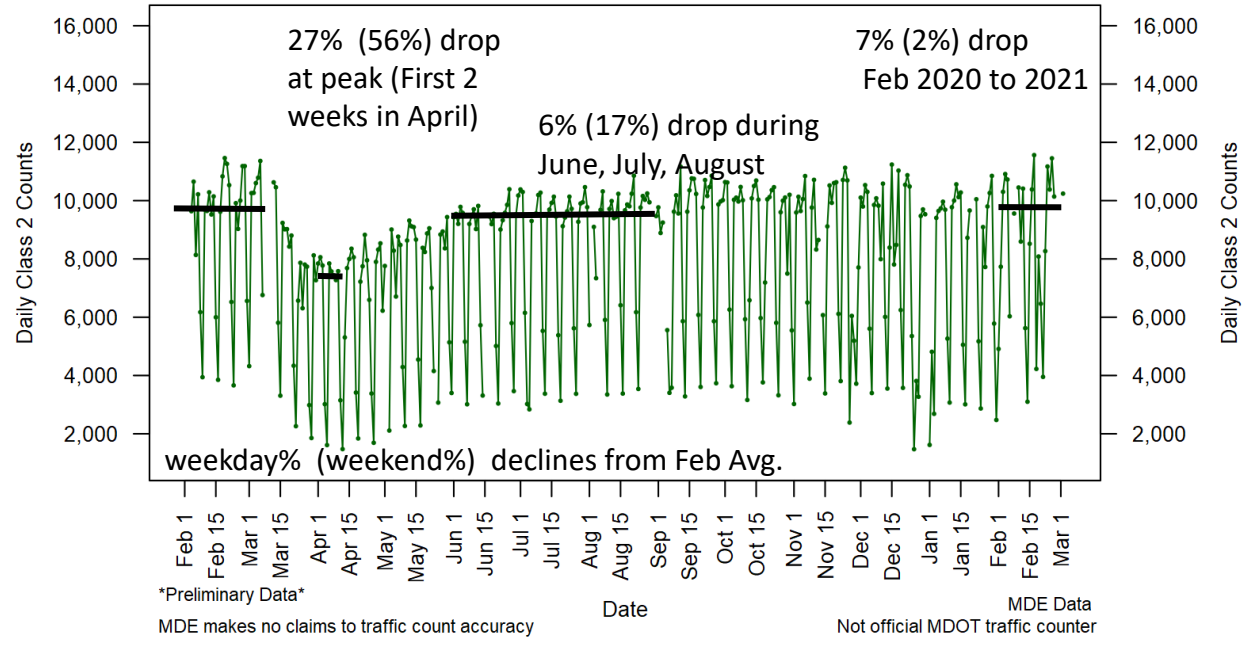
MDE Traffic Counter at I-95 Near-Road Site 2017- Feb 2021



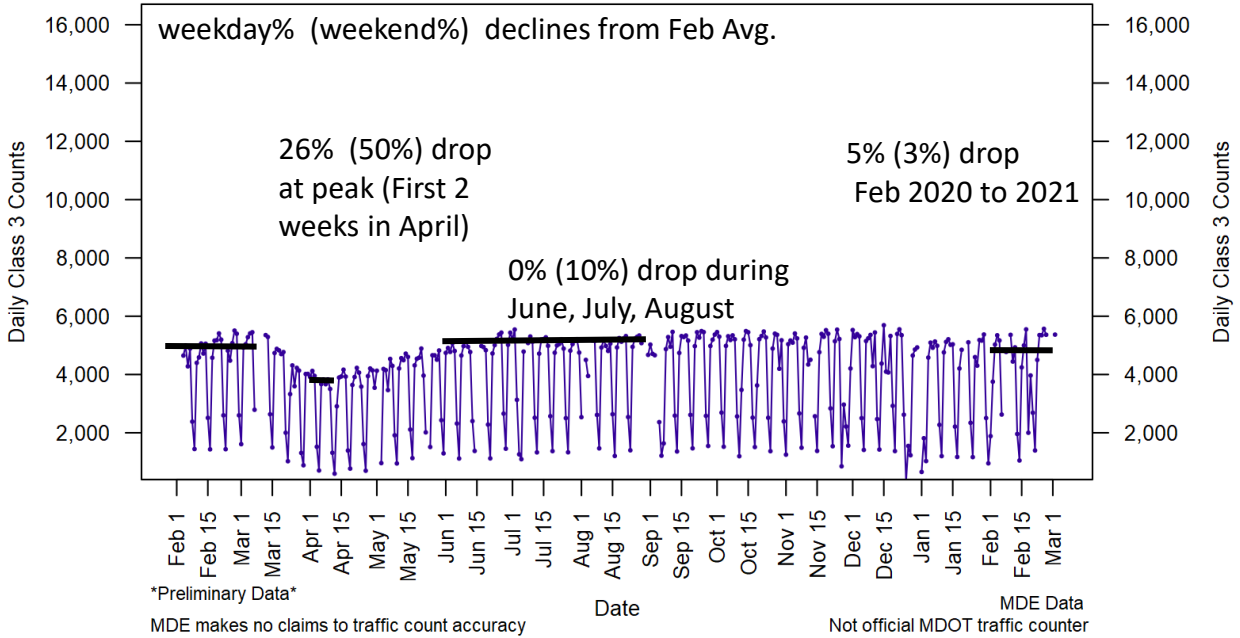
MDE Traffic Counter at I-95 Near-Road Site (Feb 4, 2020 - Mar 3, 2021)
Light Duty Vehicles (LDV)



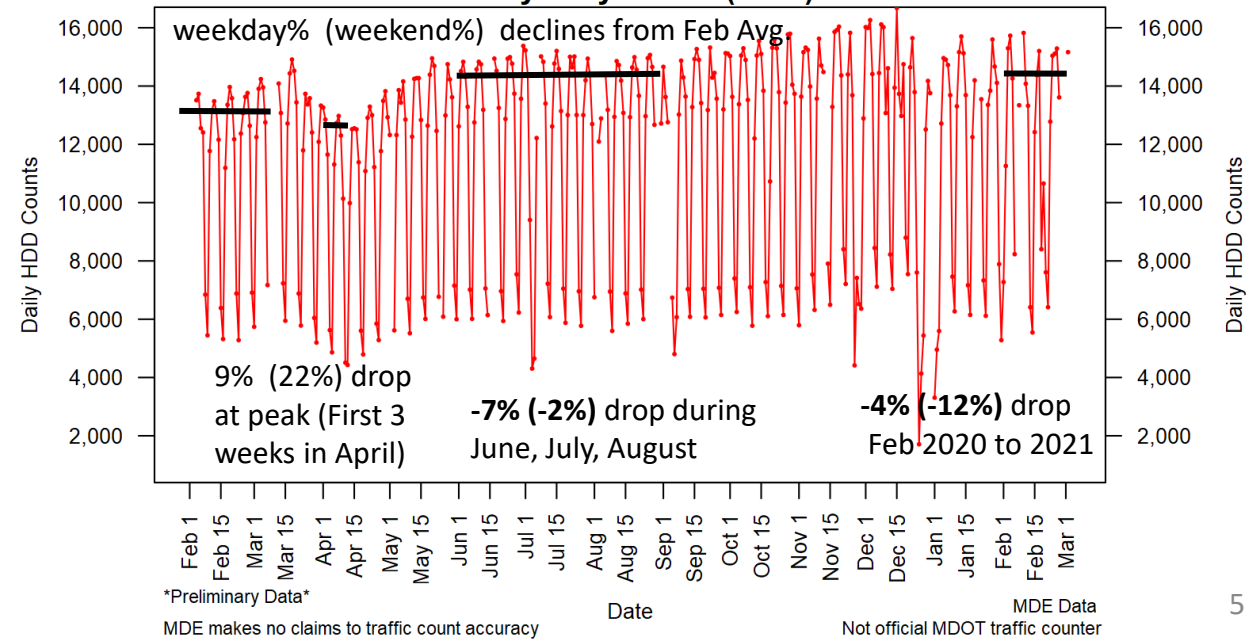
MDE Traffic Counter at I-95 Near-Road Site (Feb 4, 2020 - Mar 3, 2021)
Class 2



MDE Traffic Counter at I-95 Near-Road Site (Feb 4, 2020 - Mar 3, 2021)
Class 3

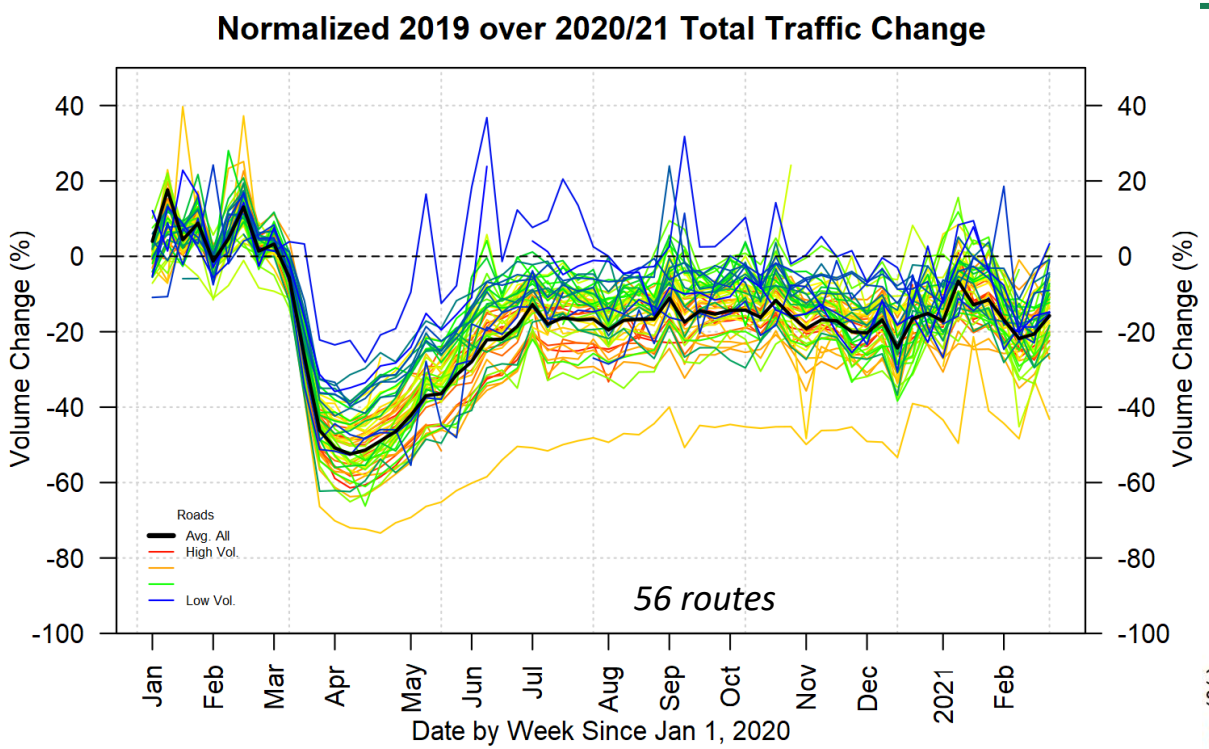


MDE Traffic Counter at I-95 Near-Road Site (Feb 4, 2020 - Mar 3, 2021)
Heavy Duty Diesel (HDD)



*all content considered preliminary

SHA YEAR/YEAR NORMALIZED REDUCTIONS



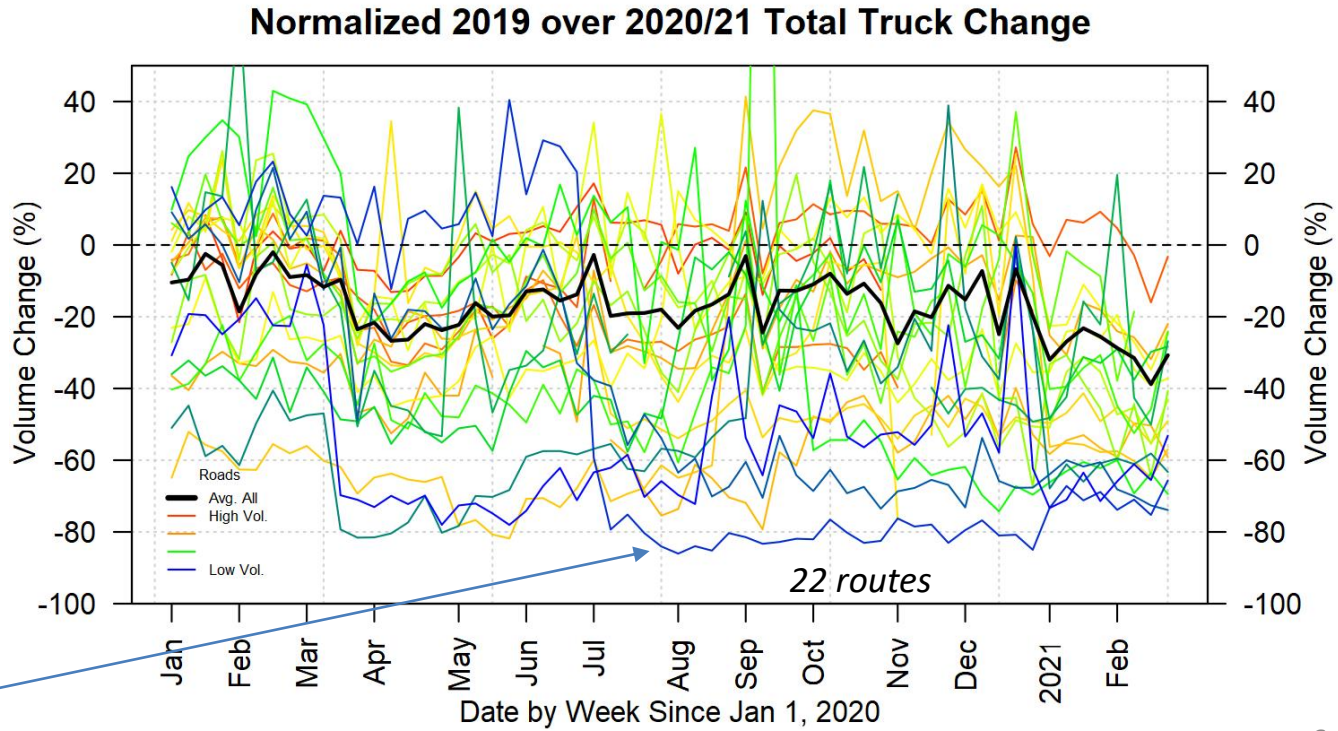
Data Source: MD State Highway Admin.

Some months have 5-week comparisons to 2019

- Trucks less clear
- Most traveled roads by trucks (reds) generally saw the least change while those least traveled saw the greatest percentage change (blues)
- Impacted by non-lockdown factors

MD 5 - .20 Mile North of Fresh Pond Neck Rd (ATR#87)
St. Mary's County (Extreme S. Maryland)
Eating Establishment Directive, June 12, 2020?

- Least traveled roads (blues) had the least TOTAL vehicular change
- Most traveled (reds; interstates) had greatest TOTAL volume change



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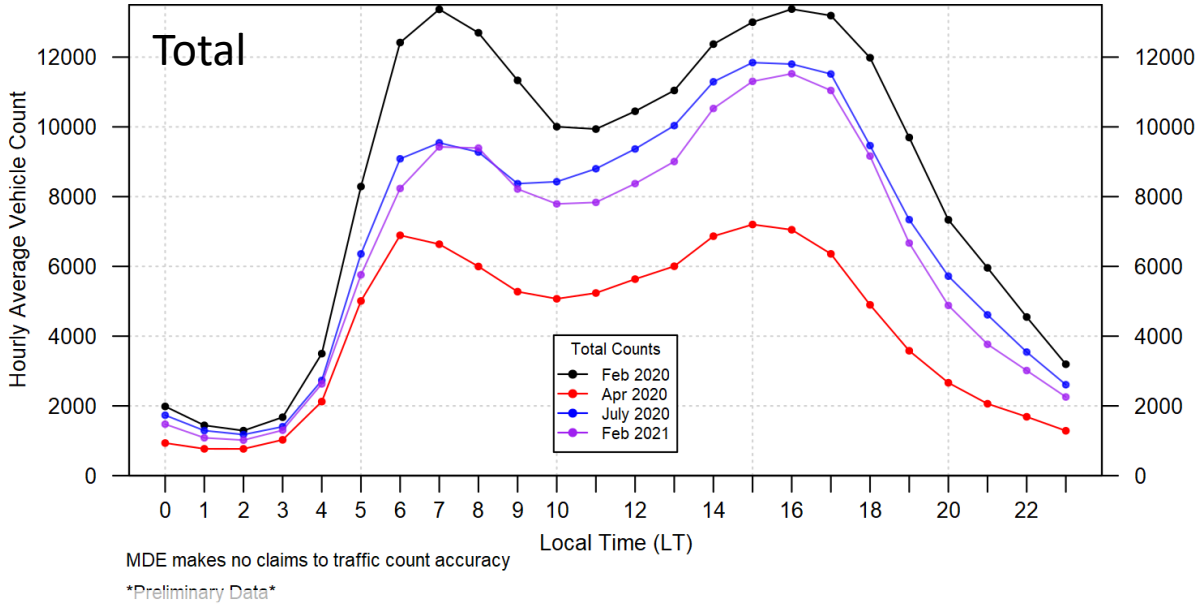
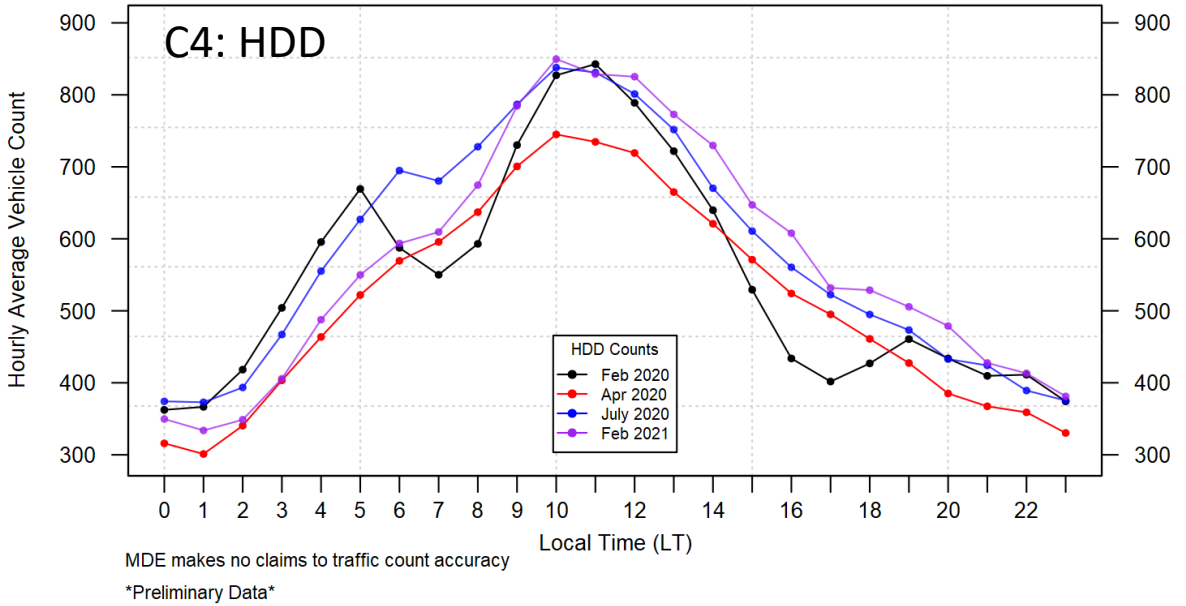
Some months have 5-week comparisons to 2019

I-95 Diurnal Counts and Evolution (Feb 2020 – Feb 2021)



- Noticeable but fairly uniform drop in C2 & C3 for April. Bigger profile differences in Total(C1) and HDD
- C1 April profile showed similar morning and evening "rush" for total counts (~50% reduction)
- C1 July profile had morning traffic 28% below February, but near normal peak afternoon traffic (12% reduction at 4pm)
- Trucks well above normal at the same time (29% higher at 4pm!)

- For trucks, reduction in April's profile (red) occurred pre-morning rush-hour and at midday (12%; Satellite?)
- In July, trucks were near normal volume during midday, with 17% volume increase 6am-9am and 22% volume increase 3pm-6pm.

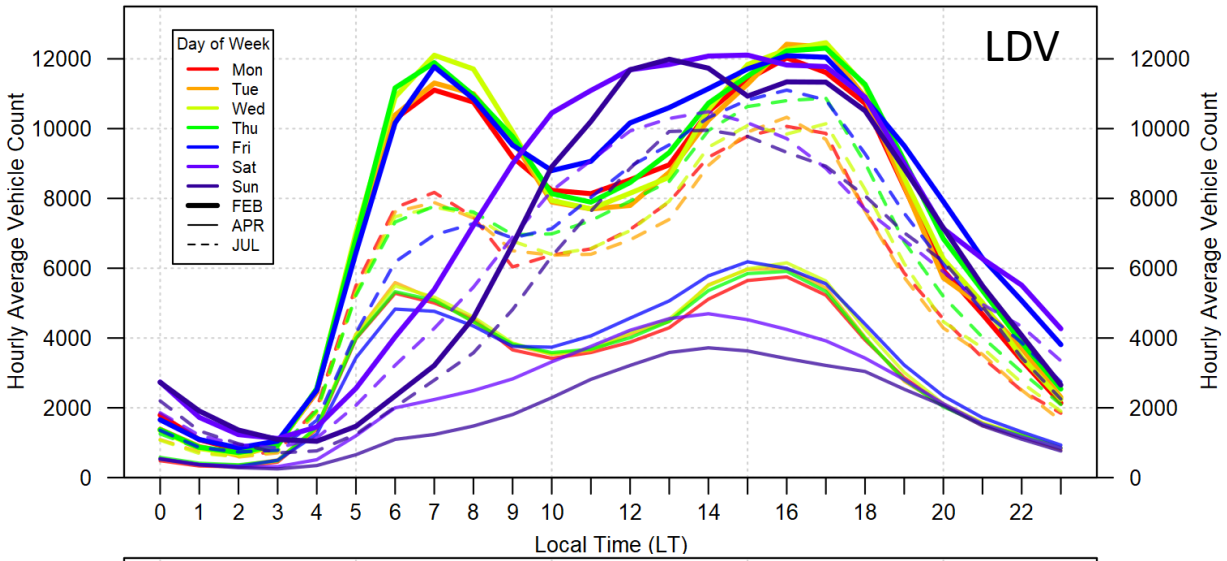


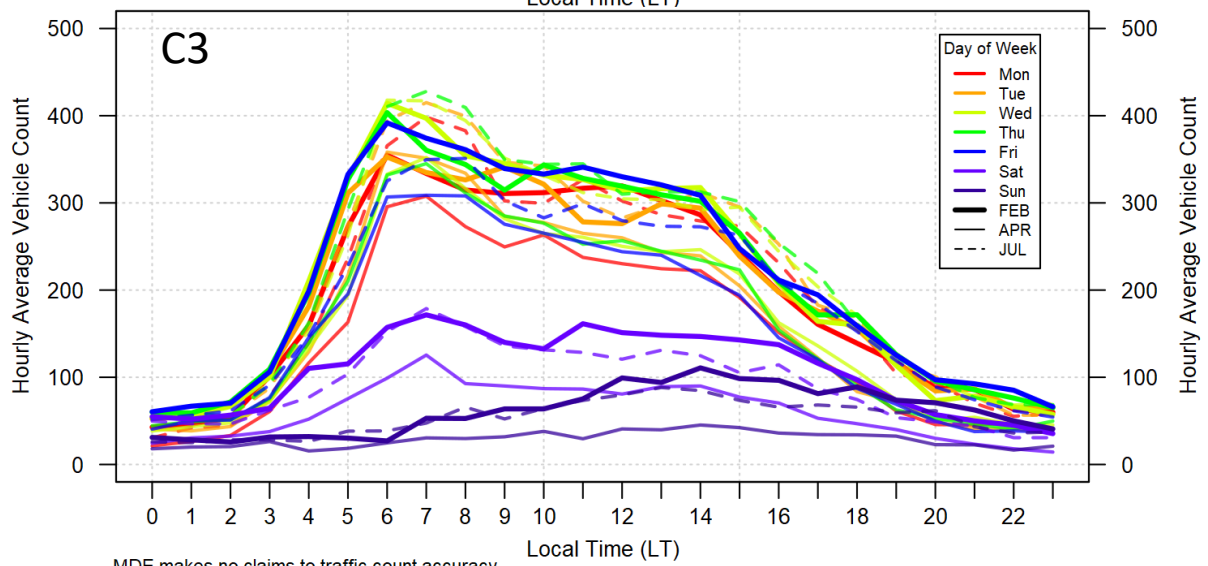
6-9am			3-6pm		
% change	Total	HDD	% change	Total	HDD
April	-50	2	April	-50	14
July	-27	17	July	-13	22

*all content considered preliminary

Diurnal & Day of Week Trends in 2020

- **Friday peak (C1)**

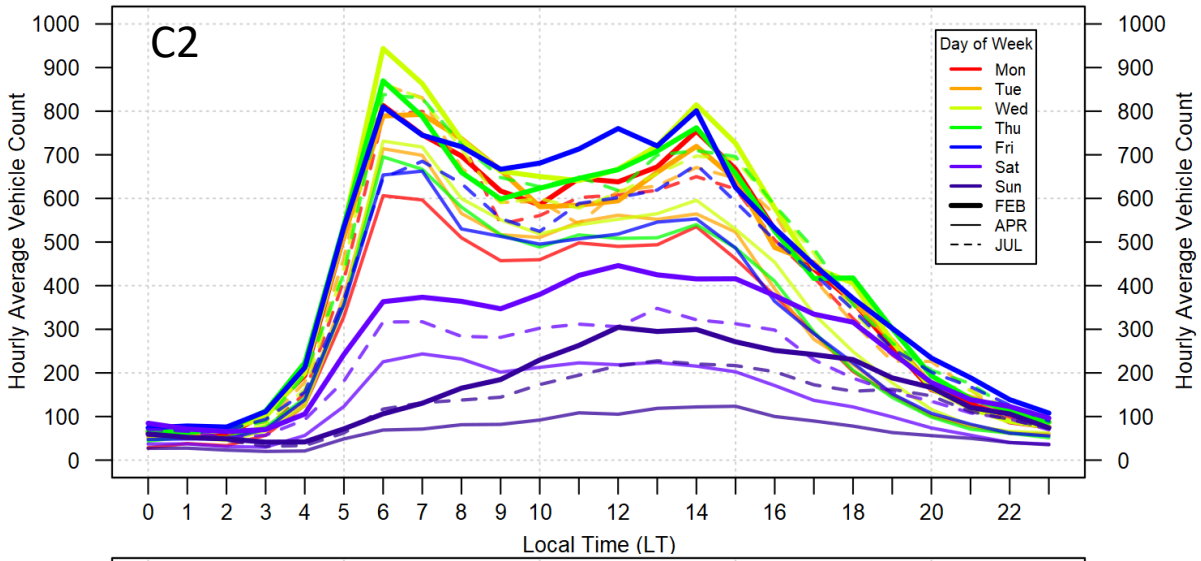


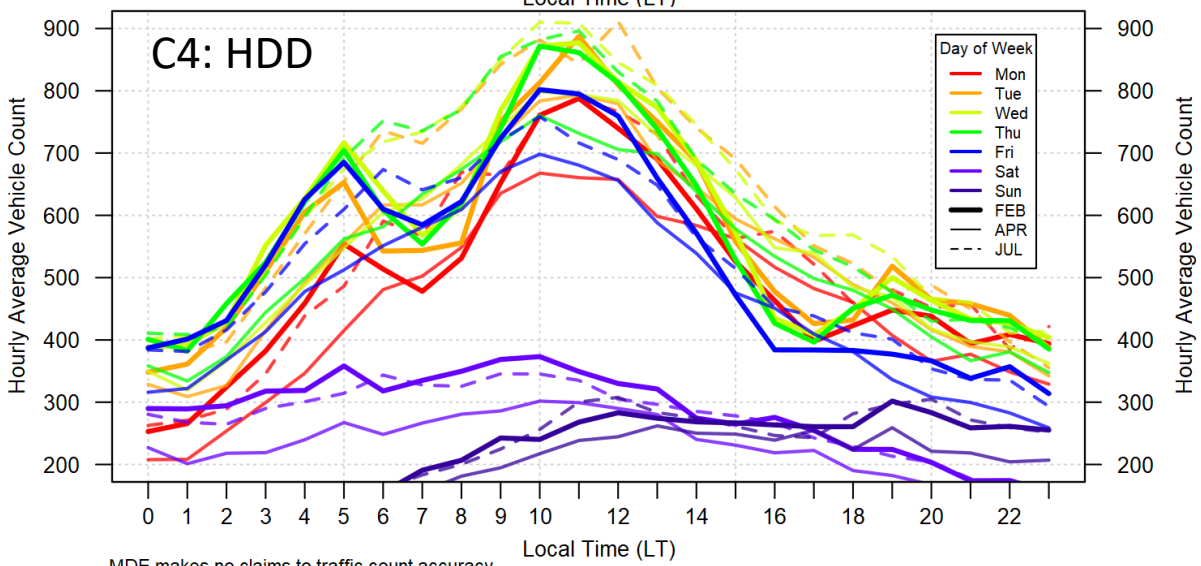


MDE makes no claims to traffic count accuracy

Preliminary Data

- **Midweek peak for HDD**





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Preliminary Data

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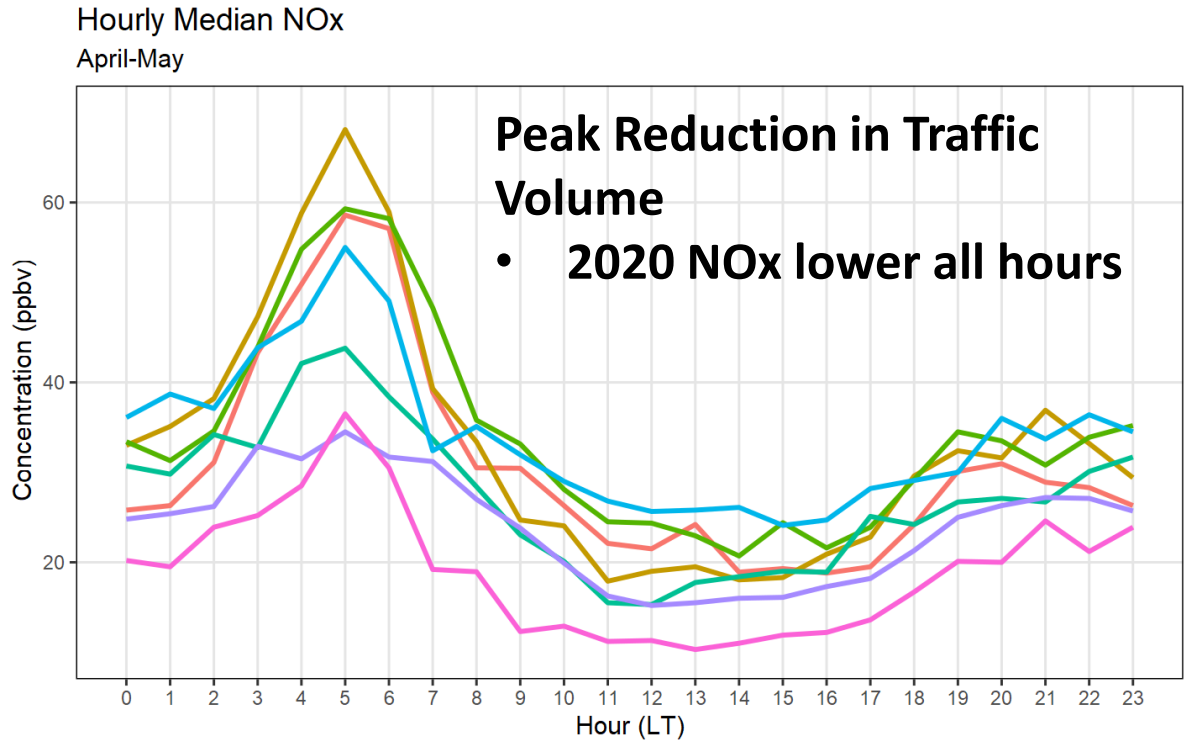
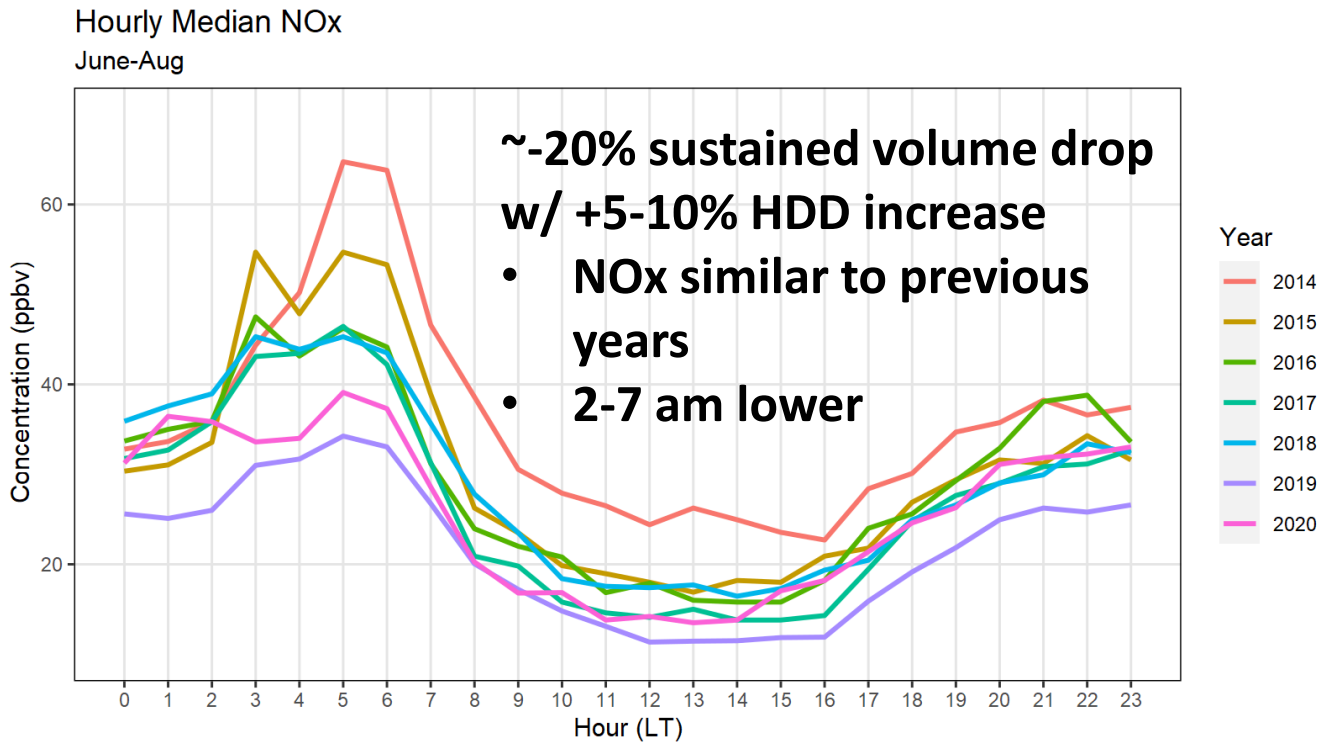
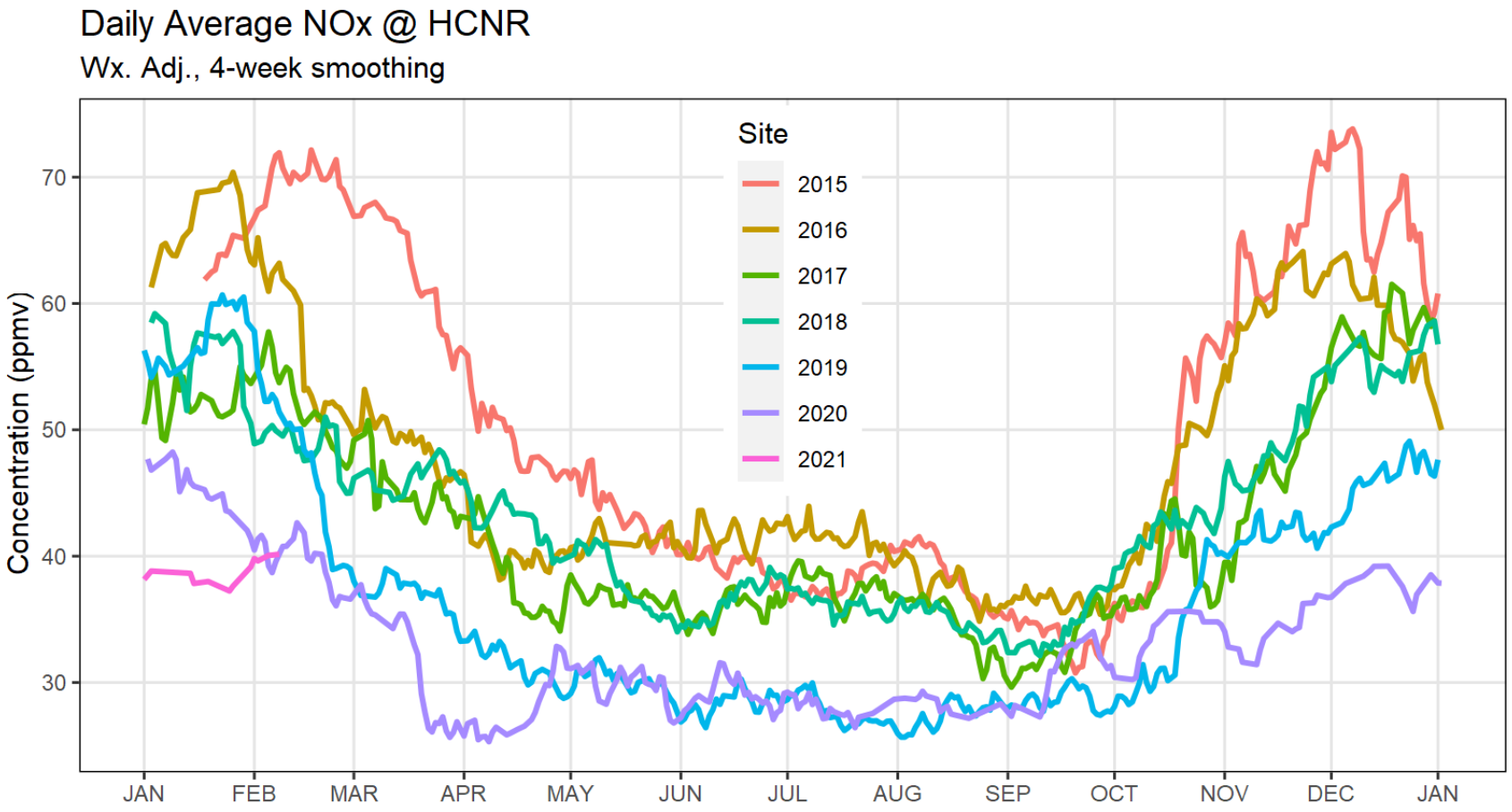
What do the traffic pattern changes mean? (HCNR NOx)





- **April's diurnal cycle was distinctly lower through the day (all classifications of vehicle counts dropped during April)**
- **By July, only the morning hours had lower NOx than most previous years (excluding 2019); increased afternoon total vehicle counts by July 2020**
- **By July, despite continued ~20% lower daily volume, NOx was similar to previous years much of the day -> *NOx driven by HDD* ["-13% Total Vehicle afternoon emissions compensated by +22% HDD"]**

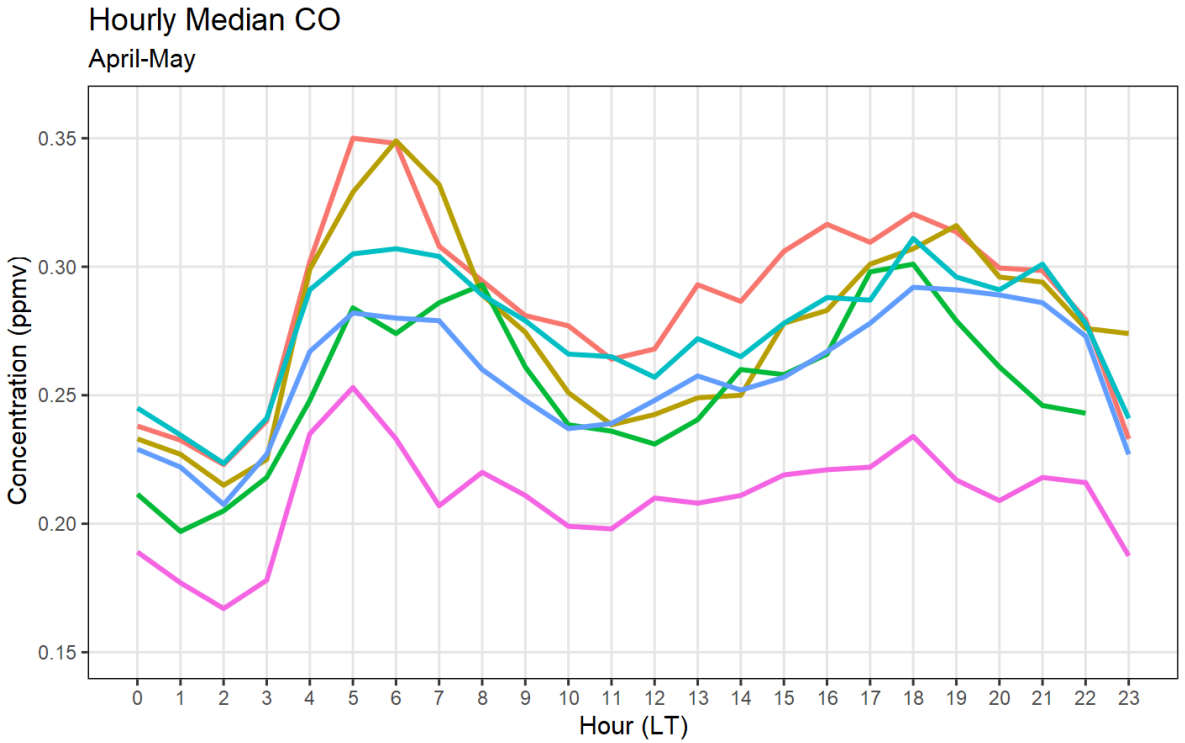
Annual Changes (NOx)

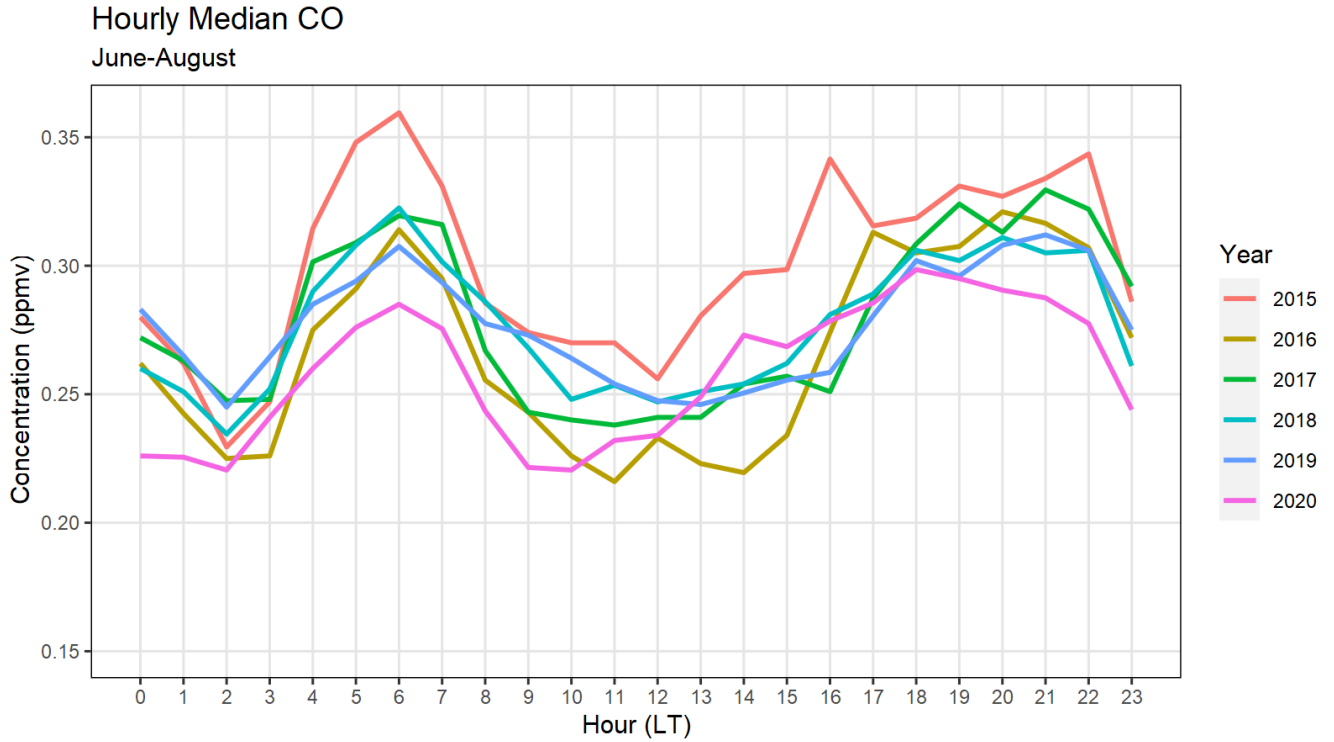


- NOx observations when wind is 25°-225° and at least 2 mph (temperature not accounted for)
- NOx had a 25% reduction at April peak
- NOx back to 2019 levels by June 1
- NOx back to 2017/18 levels by mid July
  - LDV still ~20% below normal daily volume at site
  - Trucks 6% greater in volume by July past site

*all content considered preliminary

What do the traffic pattern changes mean? (HCNR CO)





- **April's CO diurnal cycle was lower through the day (all classifications of vehicle counts dropped during April)**
- **By July, only the morning hours had lower CO than all previous years; increased afternoon total vehicle counts by July 2020 (particularly noticeable in CO by noon)**
- **Despite continued ~20% lower daily volume, why is CO similar to previous years much of the day -> CO from HDD?**

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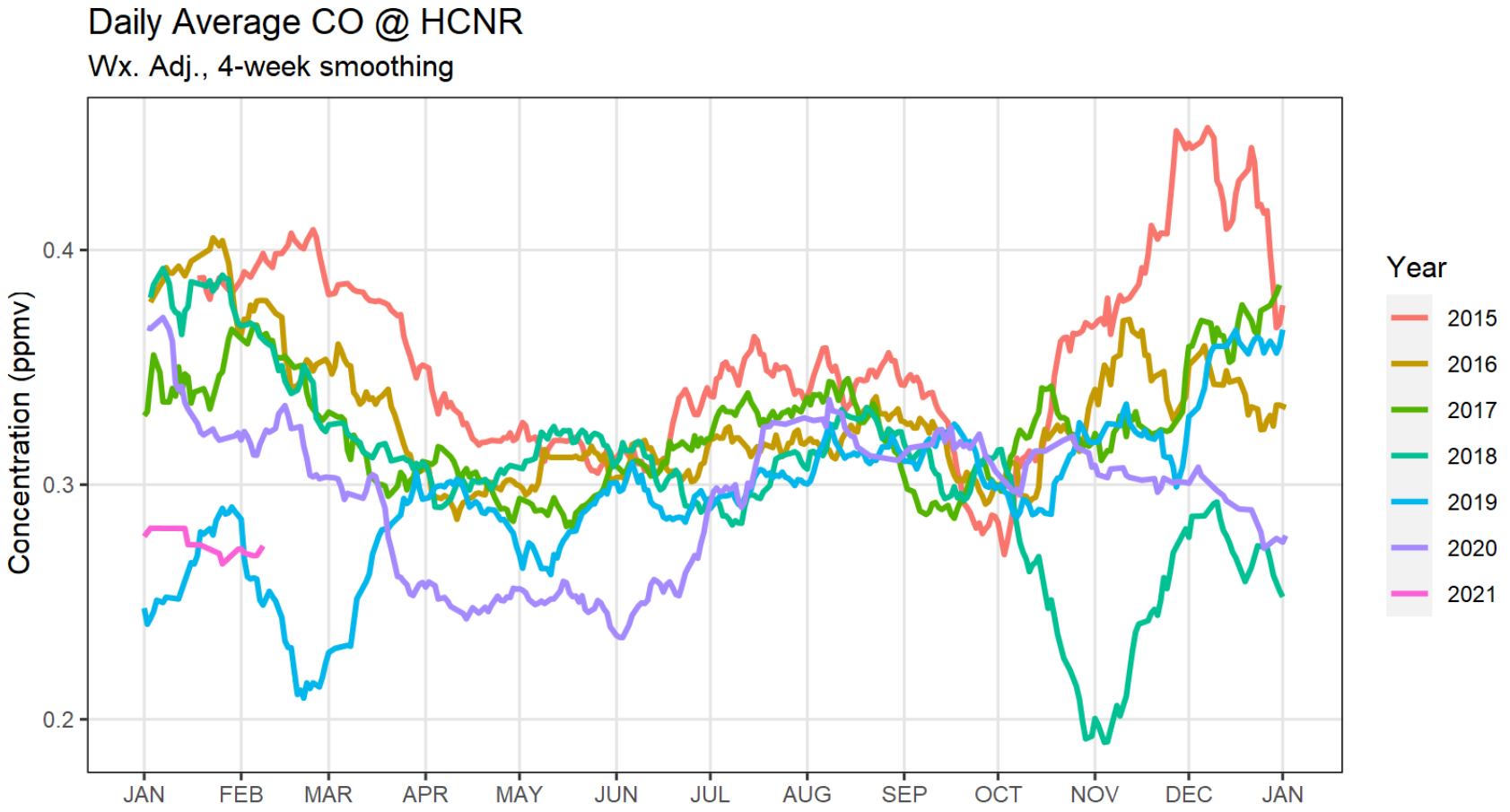
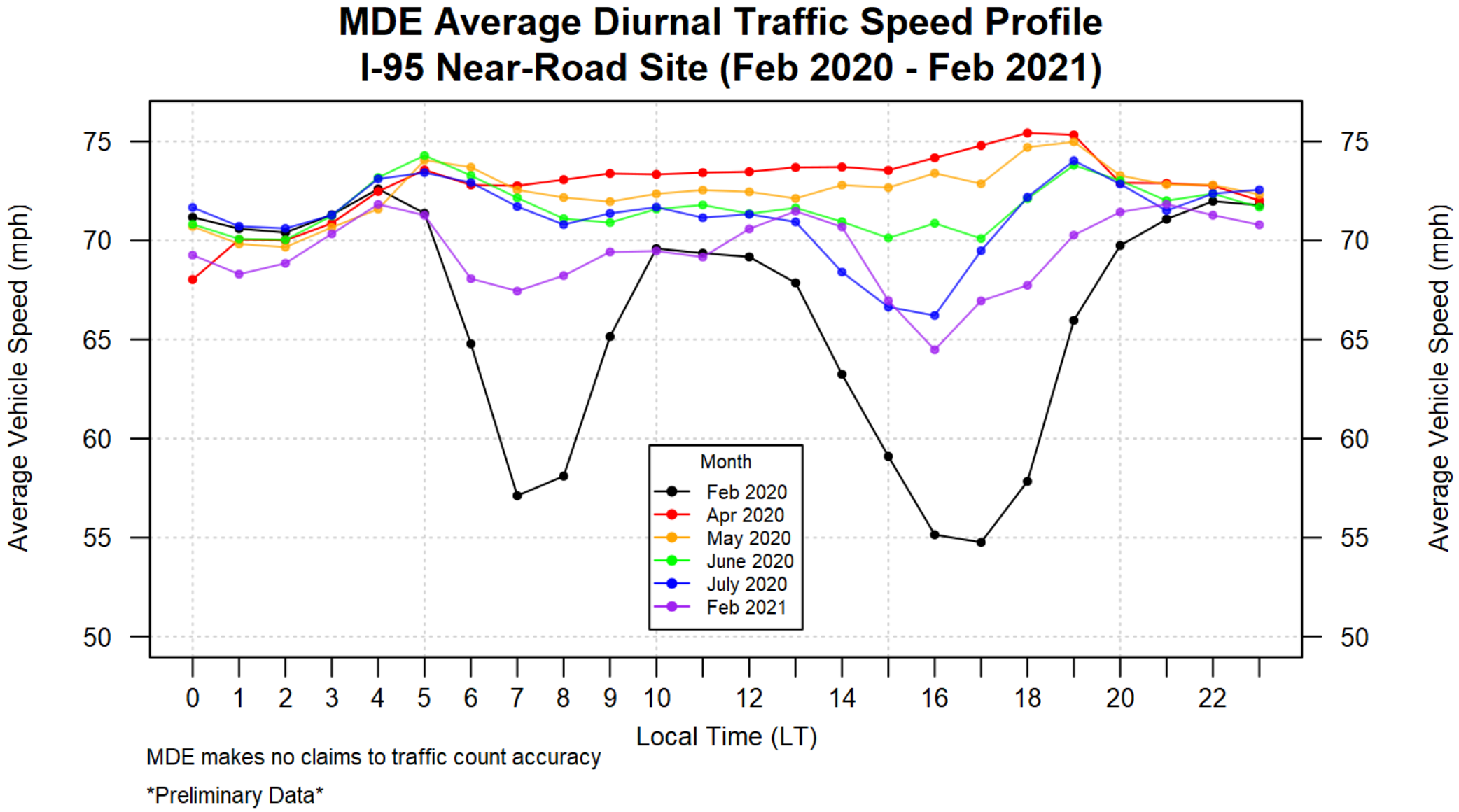
Annual Changes (HCNR CO)



- CO had a ~25% reduction at April peak
- CO back to previous year levels by July 1
- Why?
  - LDV still ~20% below normal daily volume at site
  - Trucks 6% greater in daily volume by July past HCNR site but can that explain the CO?

Can’t rule out weekday speed reduction…



What can we conclude?

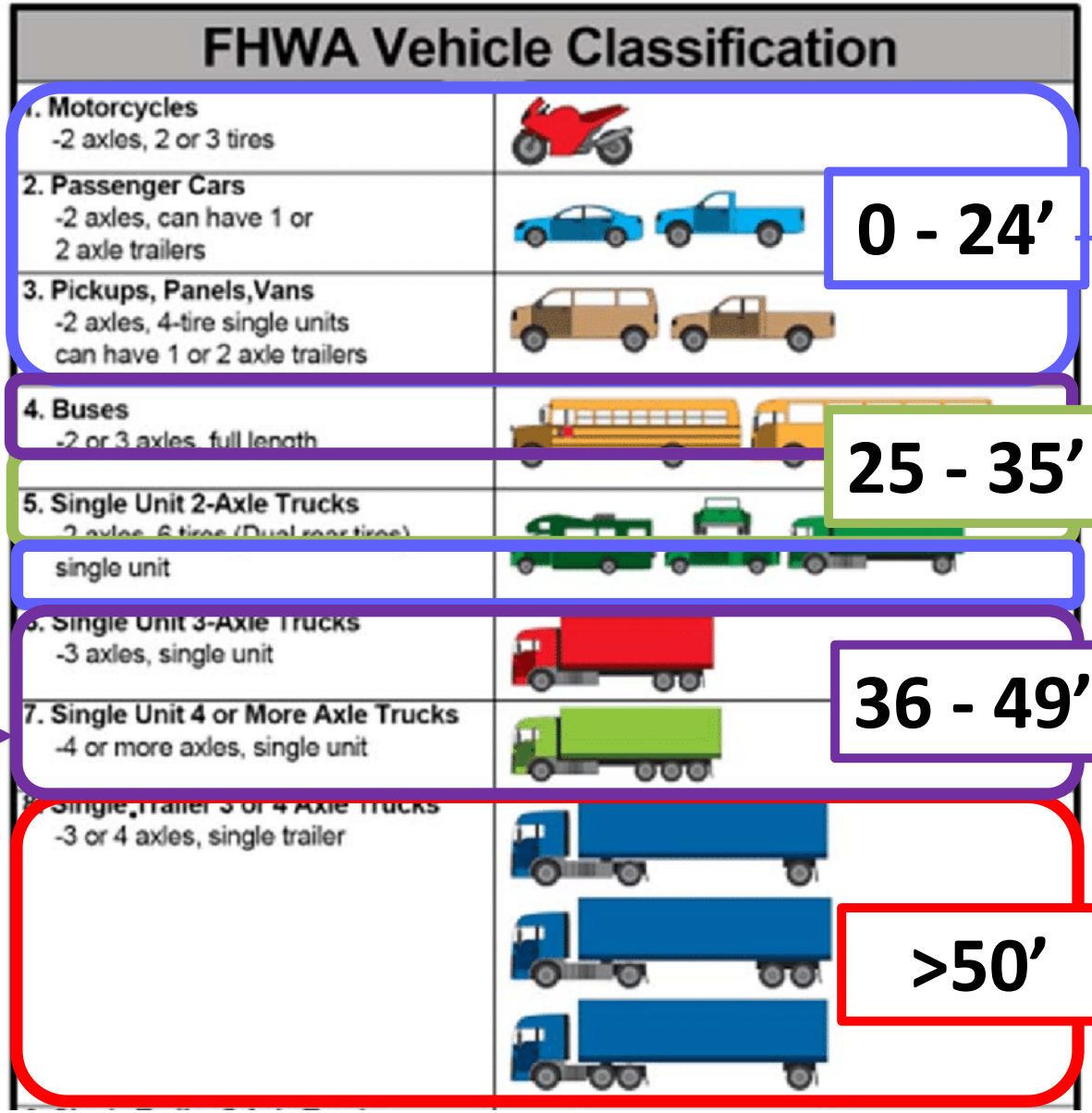
- LDV counts were most impacted through 2020; HDD counts INCREASED year over year on I-95
  - Sustained LDV decreases of ~20% since late June 2020 through present
  - Year over year increase 5-10% for trucks on interstates during same period
- Total vehicle declines were greatest at routes with the largest mean total vehicles
- HDD trucks declined least (by %) on routes with the largest mean total vehicles (pre lockdowns)
  - Truck traffic changes were route dependent and perhaps linked to local business practices

- Diurnal Impacts:
  - "Friday Effect" persisted – more LDV on Fridays, from midday onward; Is there a satellite signal?
  - Tues/Wed/Thurs – Trucks remained greater overall. By July 2020 increased truck number during rush hours, but midday peak is generally the same; Is there a satellite signal?
  - Goldberg et al., 2021, *Earth's Future,* https://doi.org/10.1029/2020EF001665 "NO_2 2.5% larger on Tuesday than a typical weekday, while Mondays and Fridays have 1.4% and 1.3% lower NO_2"
  - By July 2020 afternoon traffic counts were "closer" to normal than were morning traffic counts (~-20% daily departure)
  - Both NOx and CO back to "normal" by July, particularly after the morning rush-hour period.

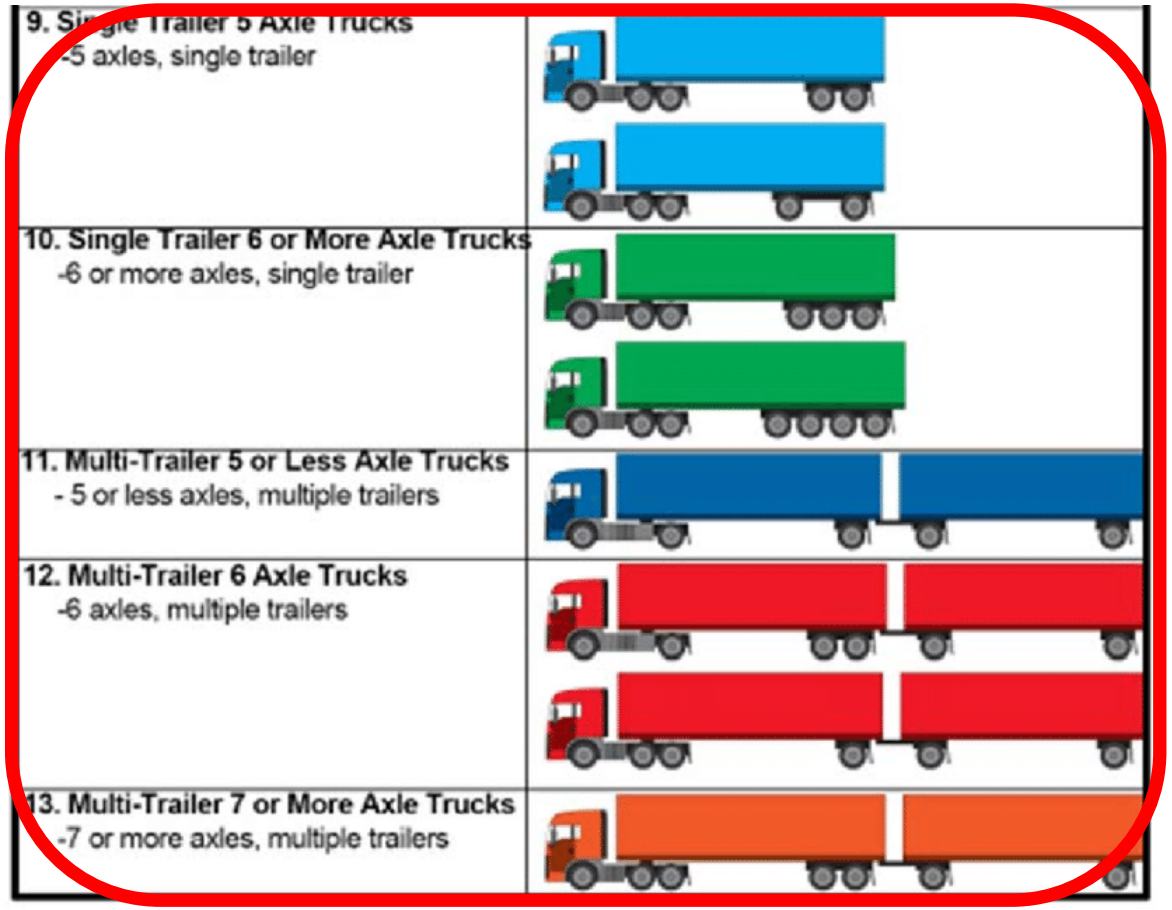
- Why important? Maryland missed ~8 exceedances by only 3 ppb or less! *Was that reduction in ozone due to massive reductions of cars on the interstate & loss of some morning NOx, or reductions of vehicles "everywhere else" (i.e., off the interstate), or something else or everything together?*

Extra Slides

Federal/State Highway Admin. Vehicle Classification

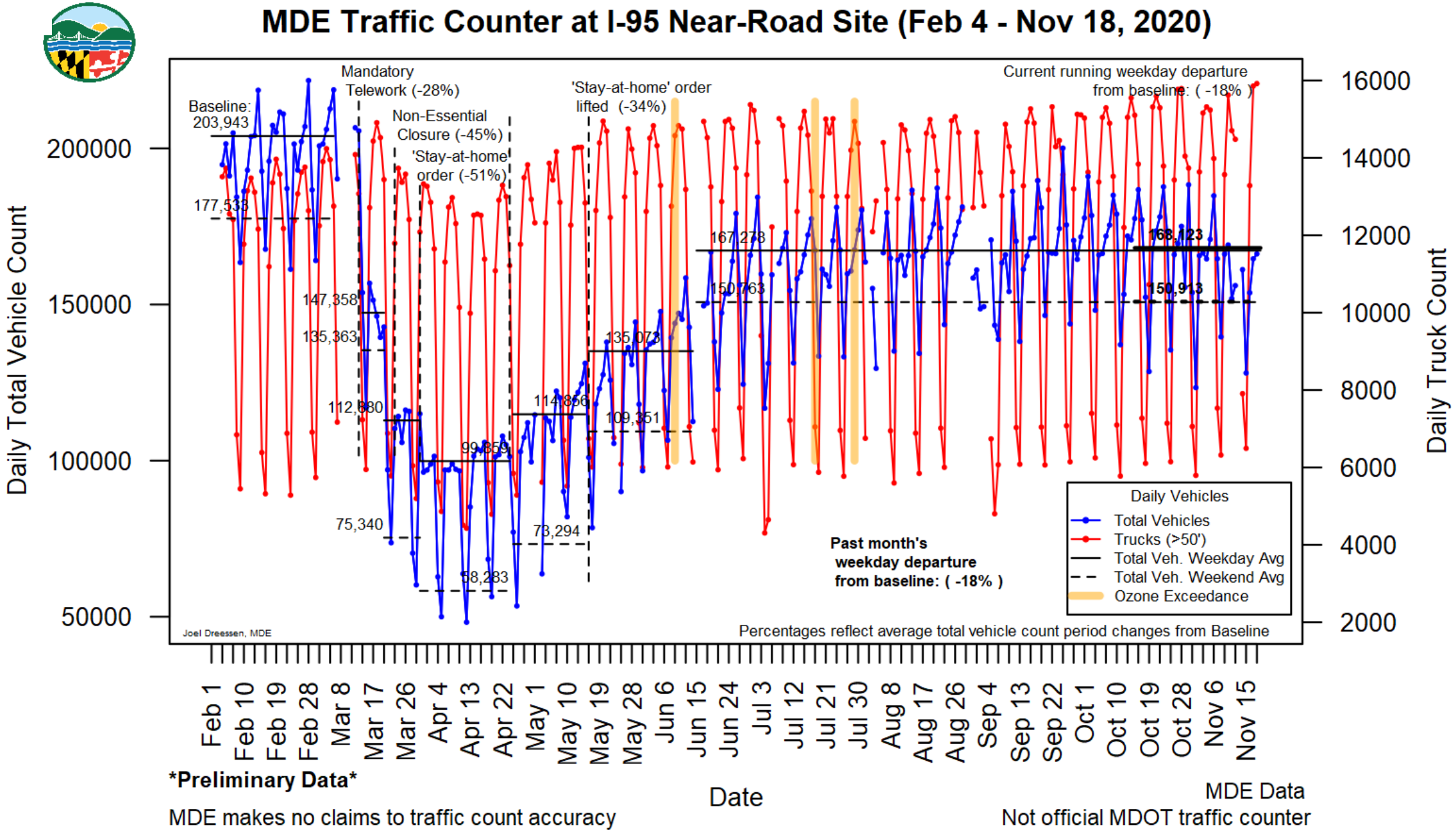


- State Highway Administration (SHA) uses in-road sensors
- Classification is done by number of axles (Trucks 5-13)
- MDE uses remote sensing and vehicle length (Trucks >50’)
- MDE Probably misses many diesel “dump trucks” within C1



*all content considered preliminary

MDE Counts



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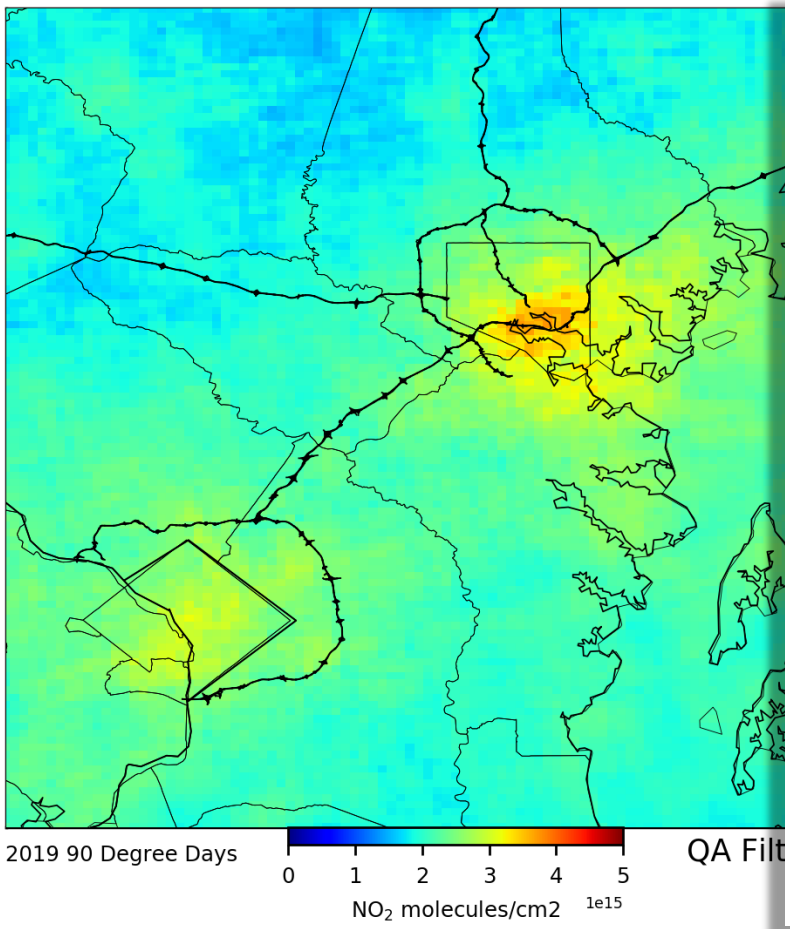
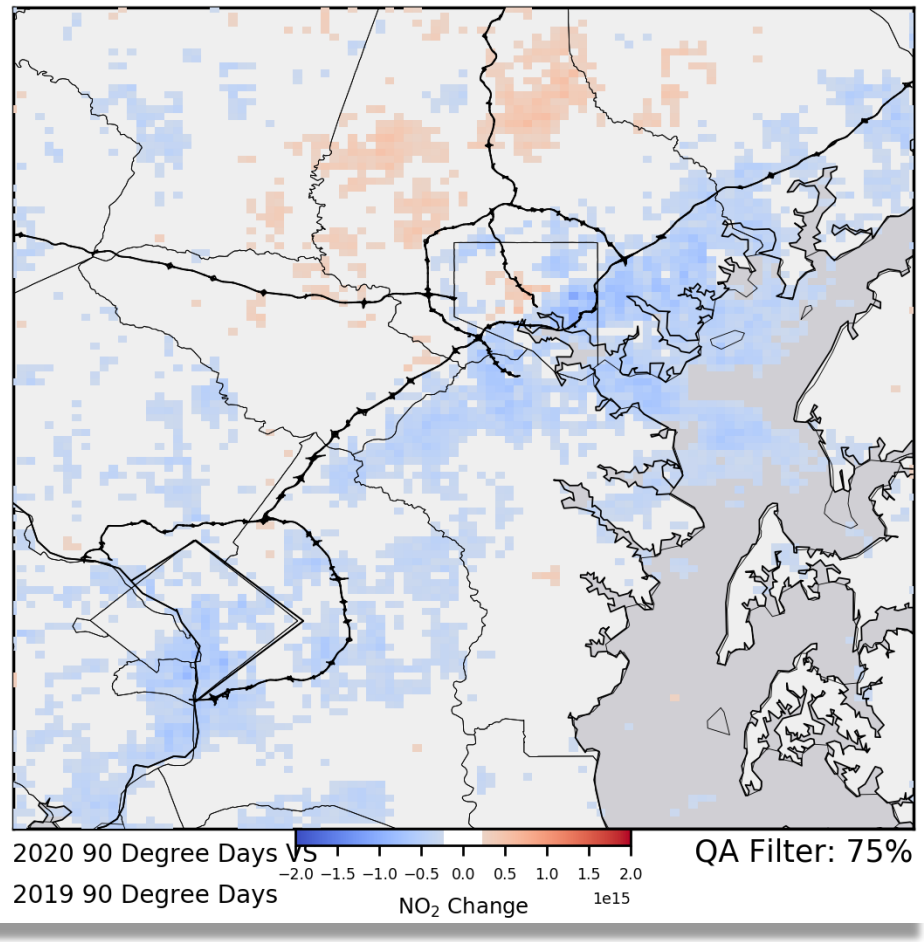
TROPOMI Satellite: 90º F Days

Figures: James Boyle, MDE

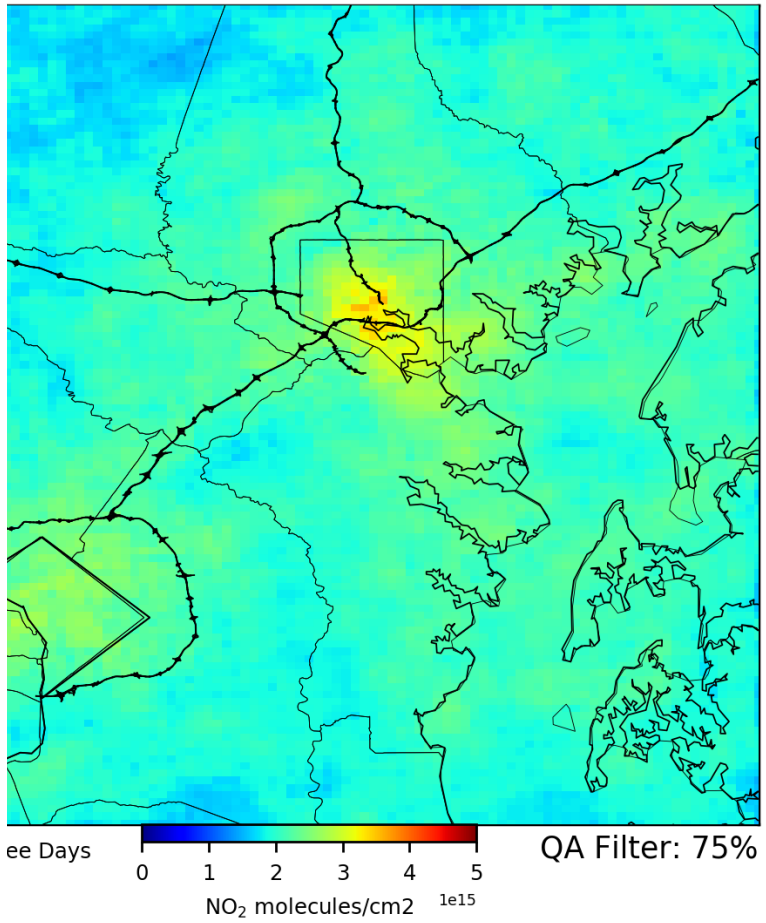
2019



2019 vs 2020



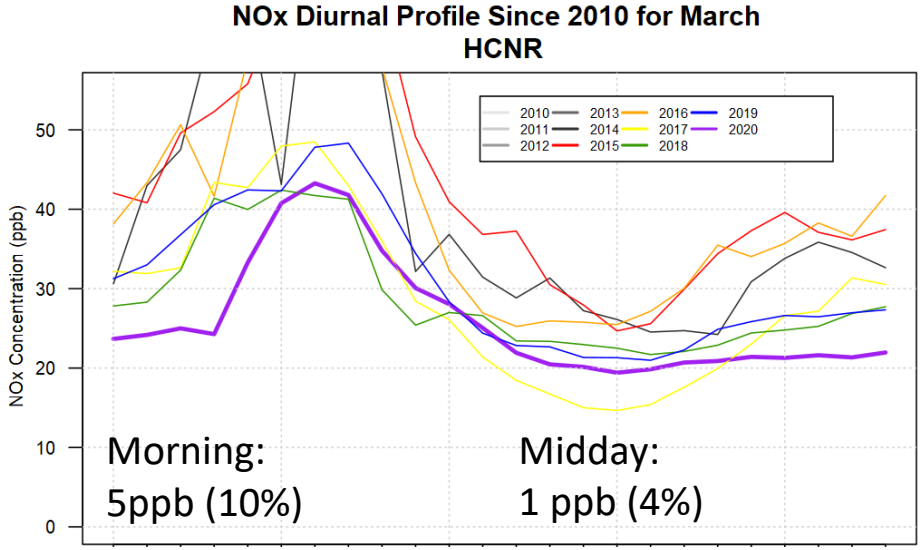
2020



- **Offline TROPOMI vertical column NO2 regridded to 1km on days greater than or equal to 90ºF**
- **QA Filter : 75%**

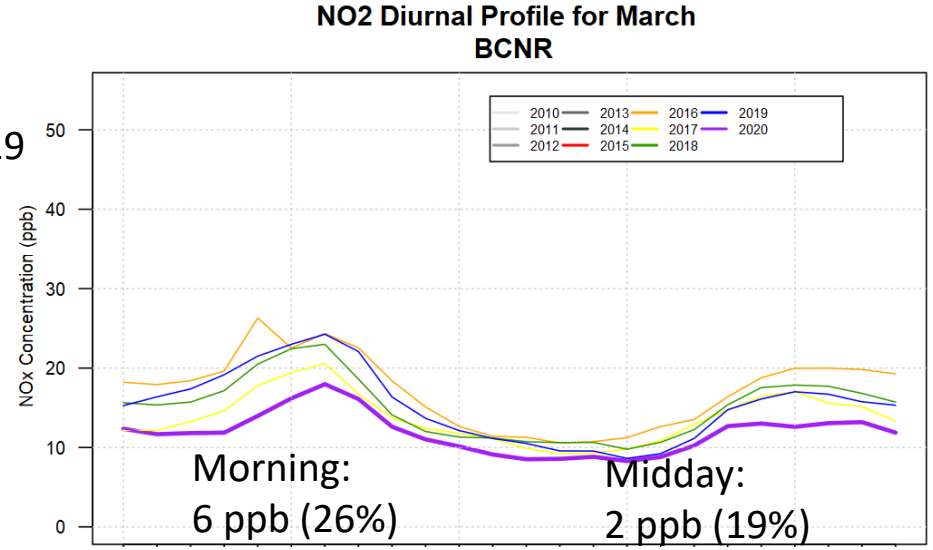
Where did the ozone go?
Weekday Diurnal Cycles –NO_x, NO_2, NO_y (All March Weekdays)

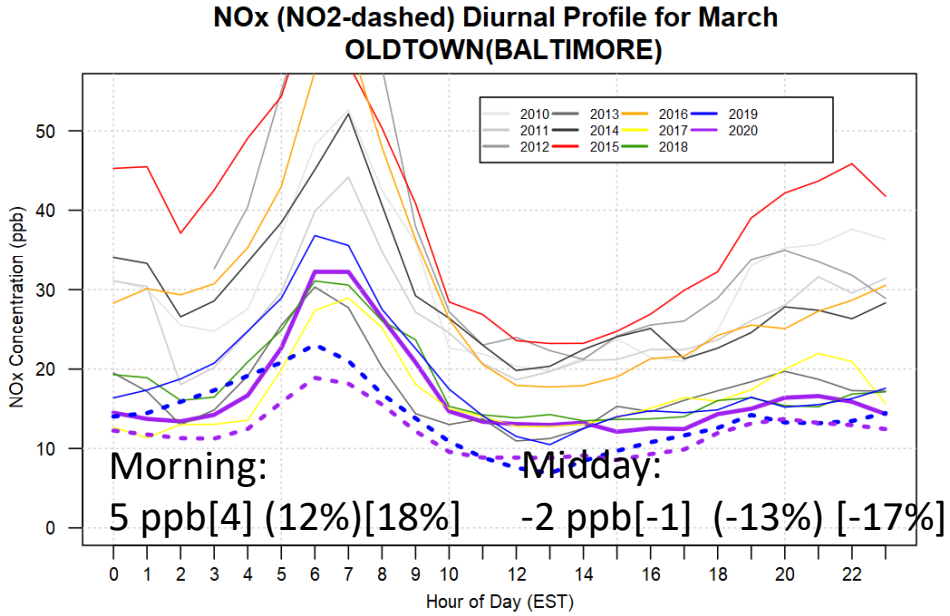
*all content considered preliminary

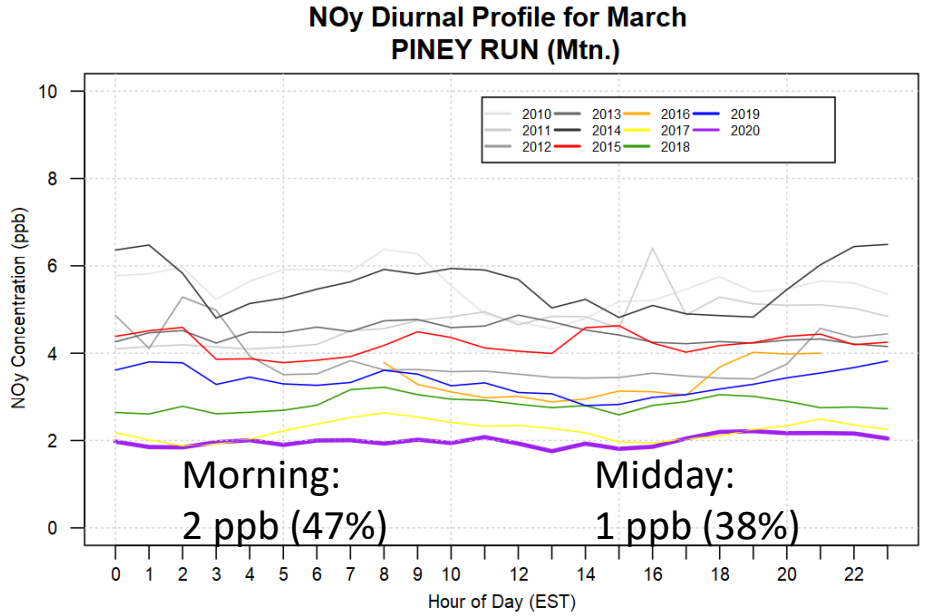


2020 to 2019 differences

2019-2020/ 2019 (%)







Where did the ozone go?
Weekday Diurnal Cycles –NO_x, NO_2, NO_y (All April Weekdays)

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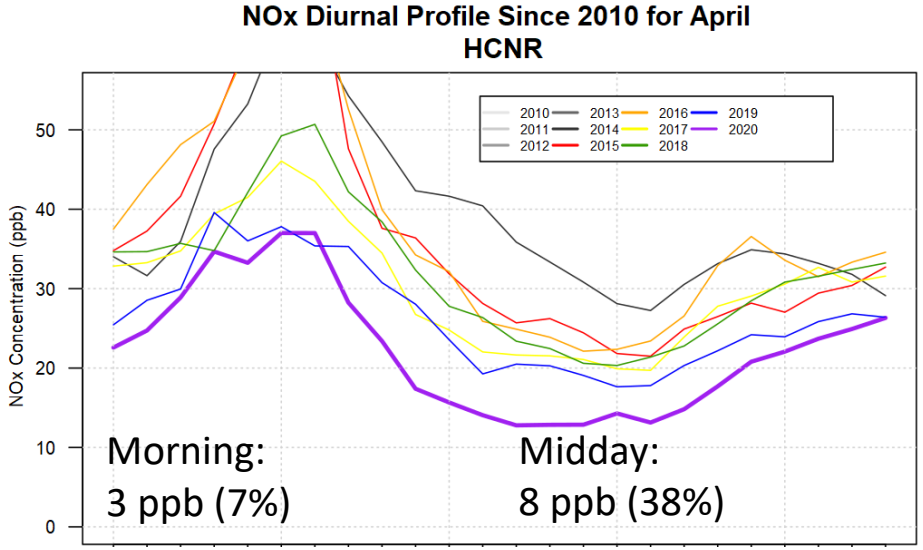
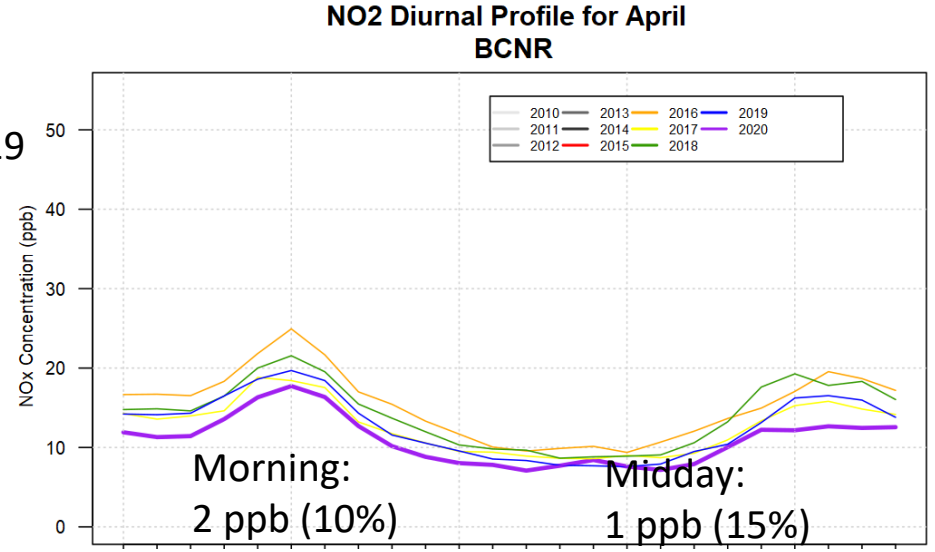
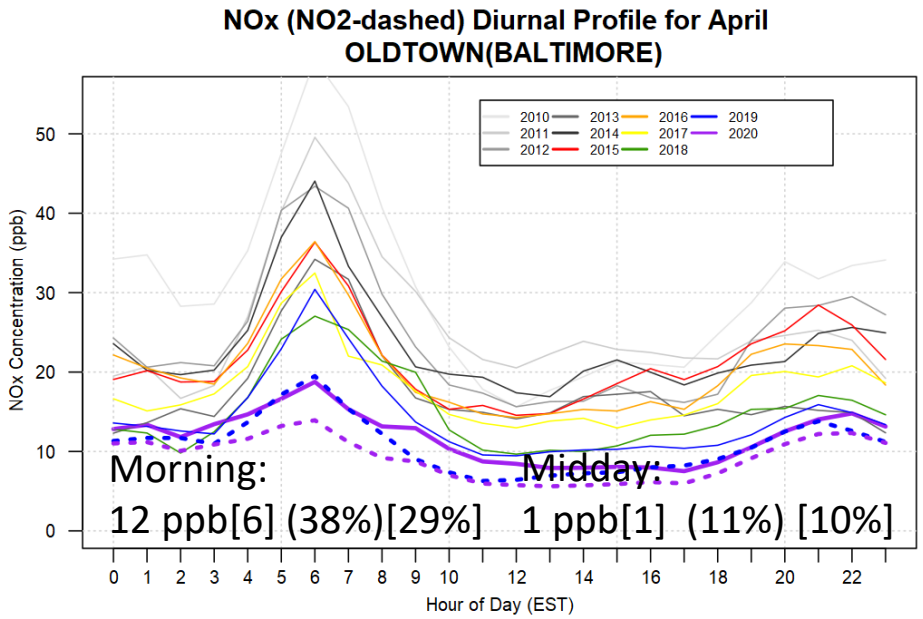


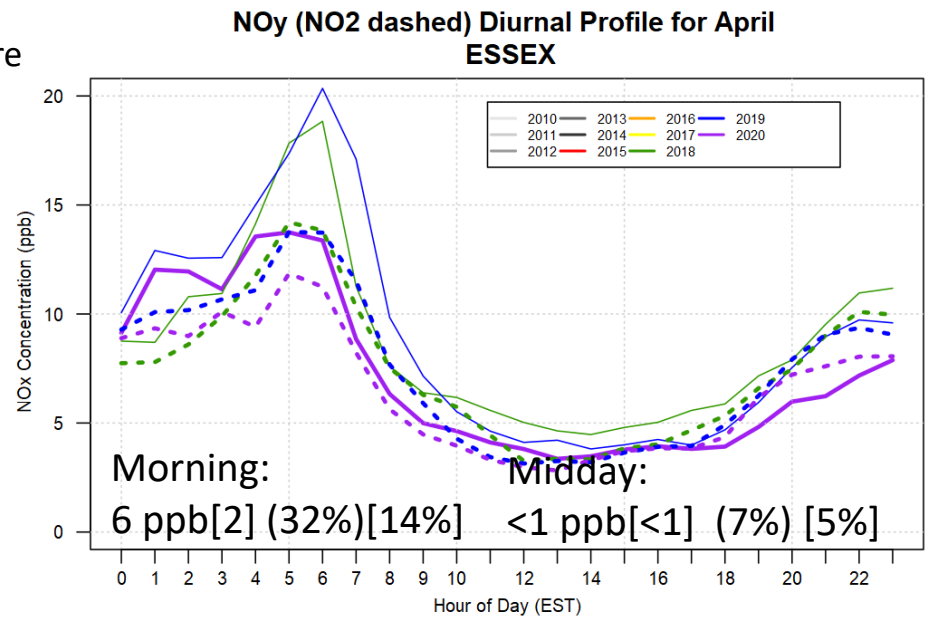


2020 to 2019 reduction

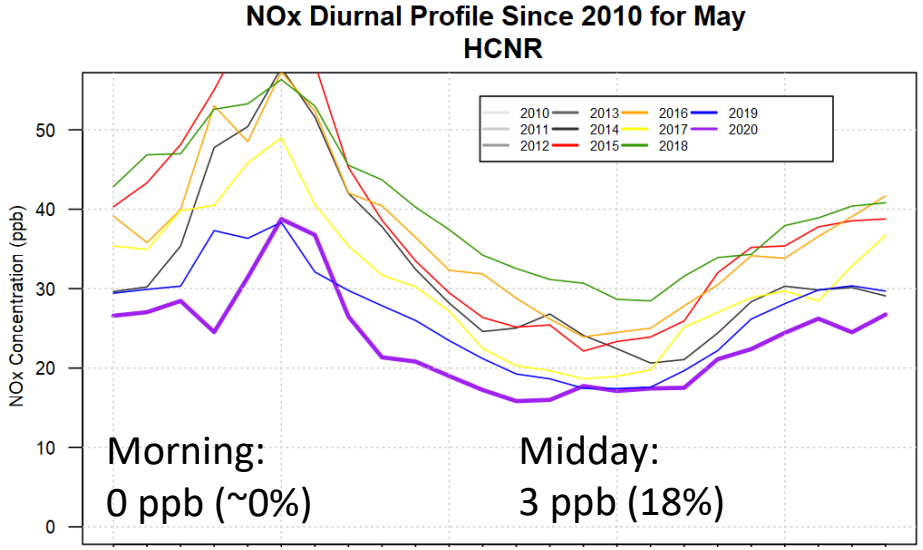
2019-2020/ 2019 (%)

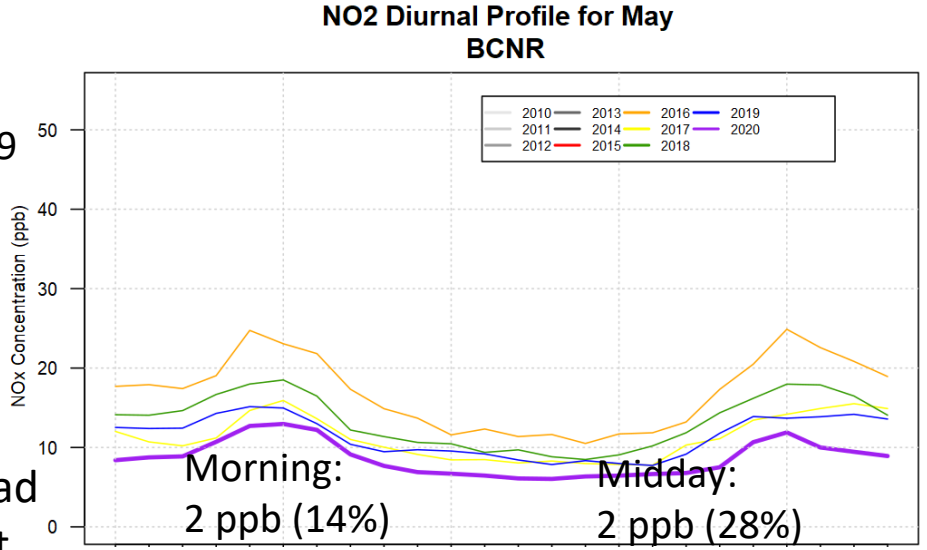


Morning reductions were determined by comparing the maximum concentration prior to 10 am in both 2019 and 2020



Weekday Diurnal Cycles –NO_x, NO_2, NO_y (All May Weekdays)

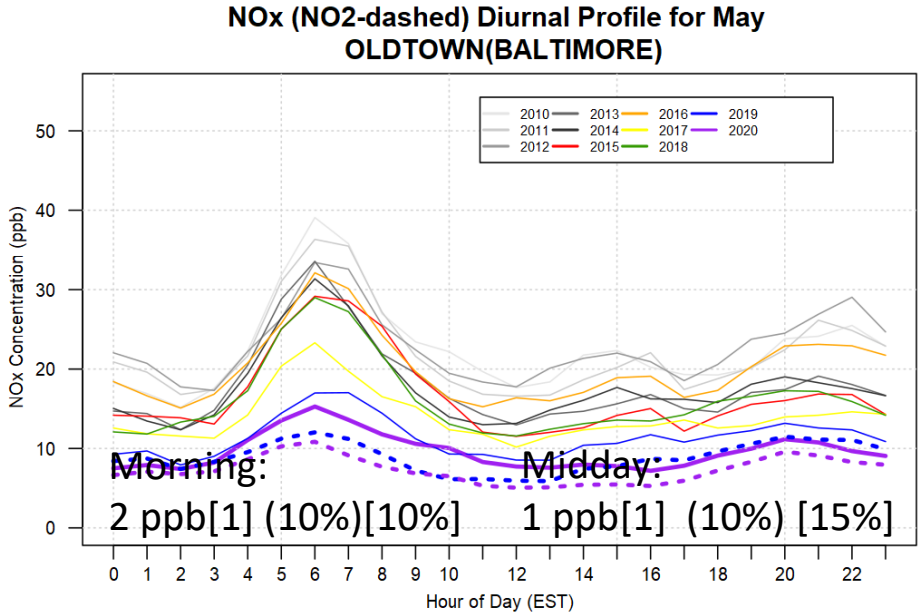


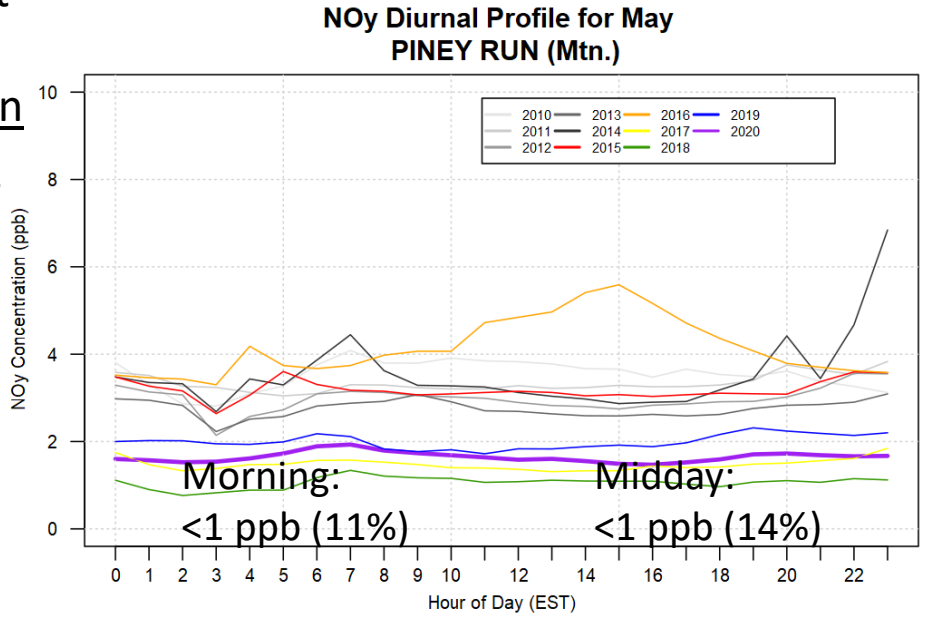


2020 to 2019 differences

2019-2020/ 2019 (%)

Note:
I-95 near-road site does not experience traffic jams in the morning commute





Where did the ozone go?
Weekday Diurnal Cycles –NO_x, NO_2, NO_y (All June Weekdays)

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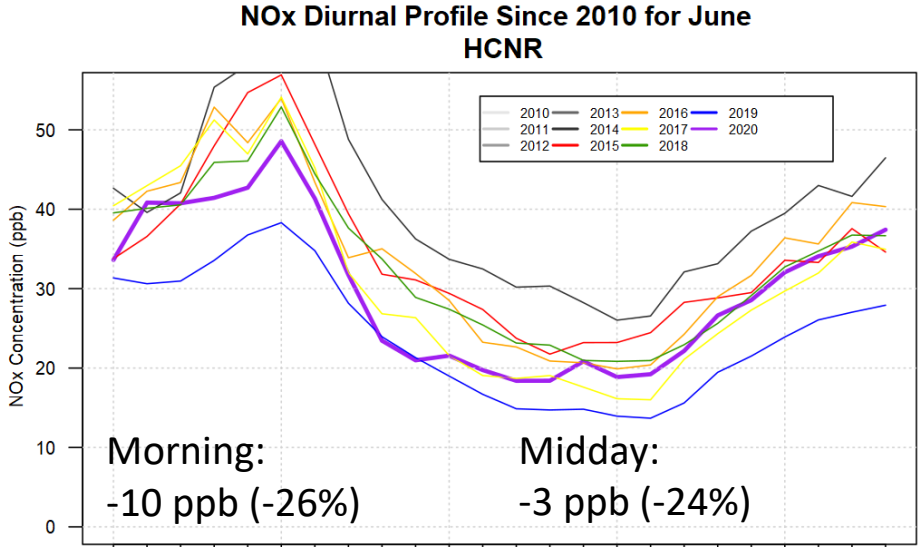

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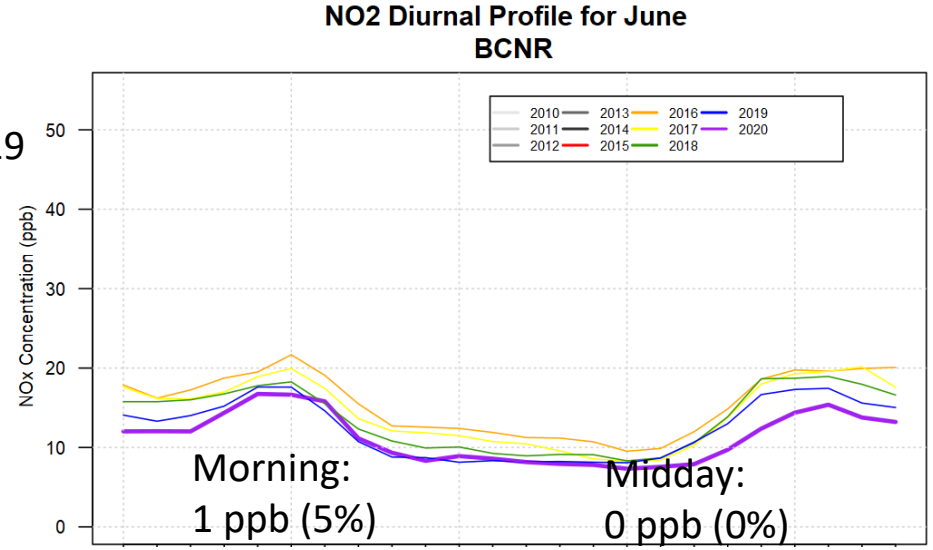
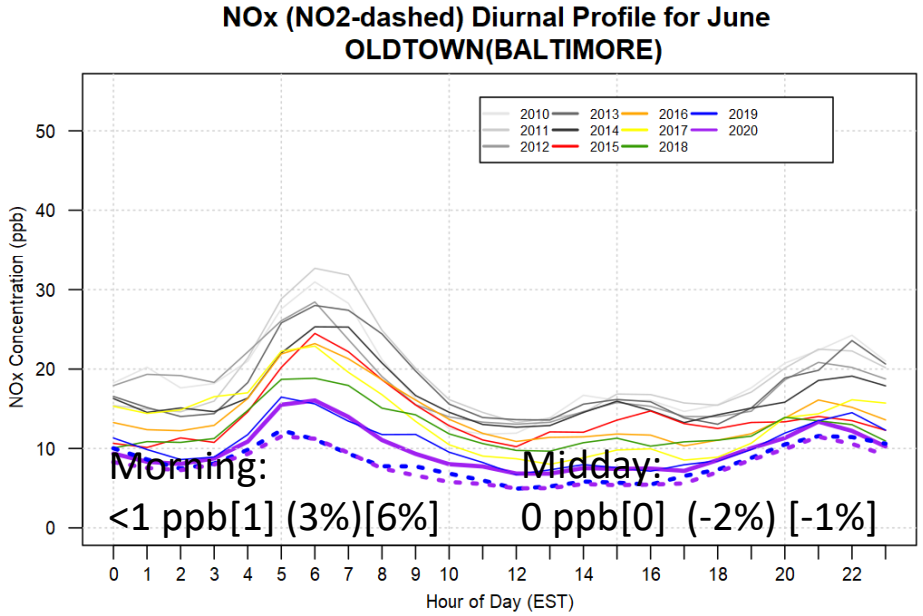
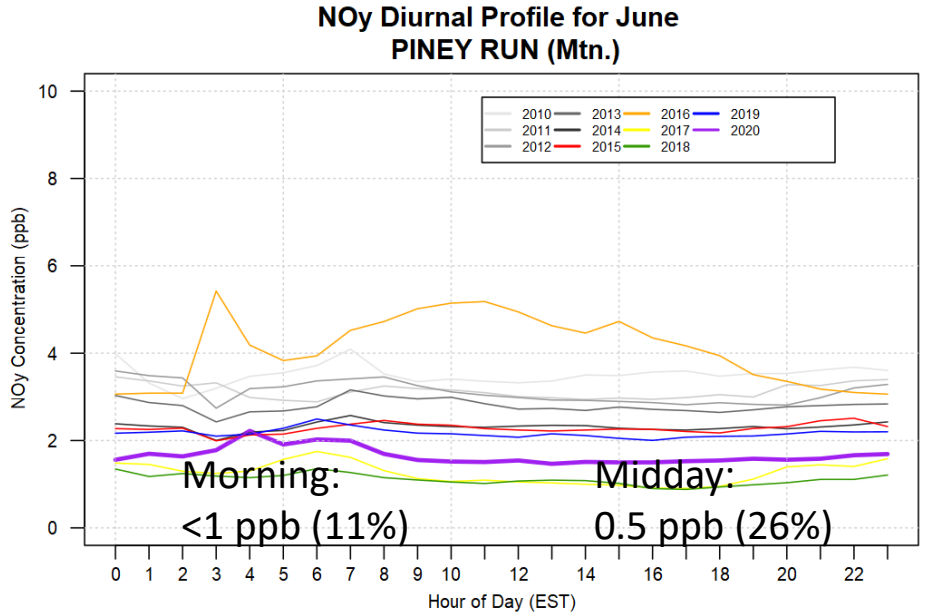
2019-2020/ 2019 (%)

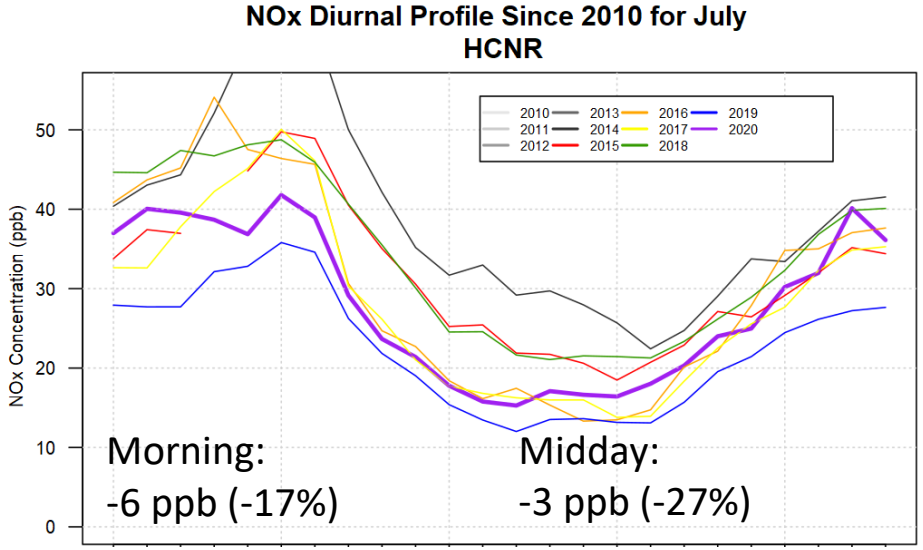






*all content considered preliminary

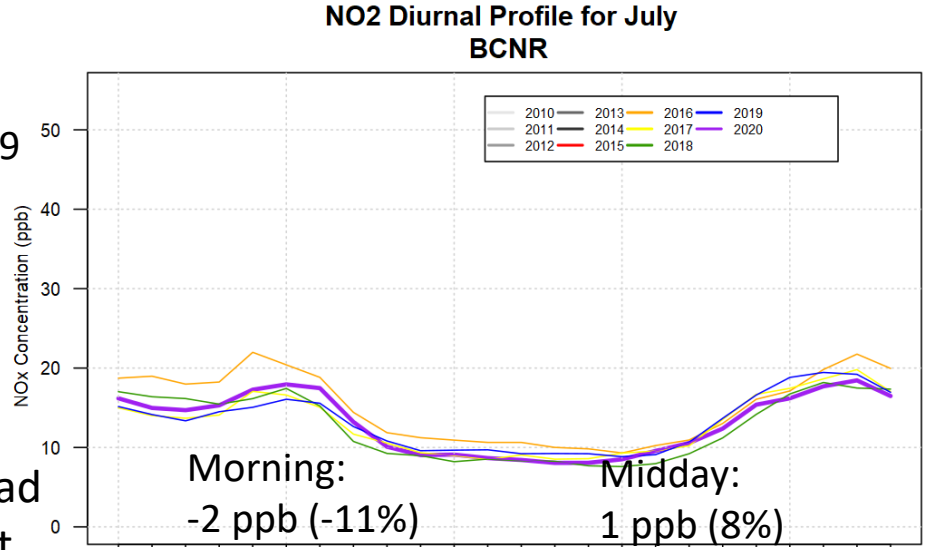
Weekday Diurnal Cycles –NO_x, NO_2, NO_y (All July Weekdays)

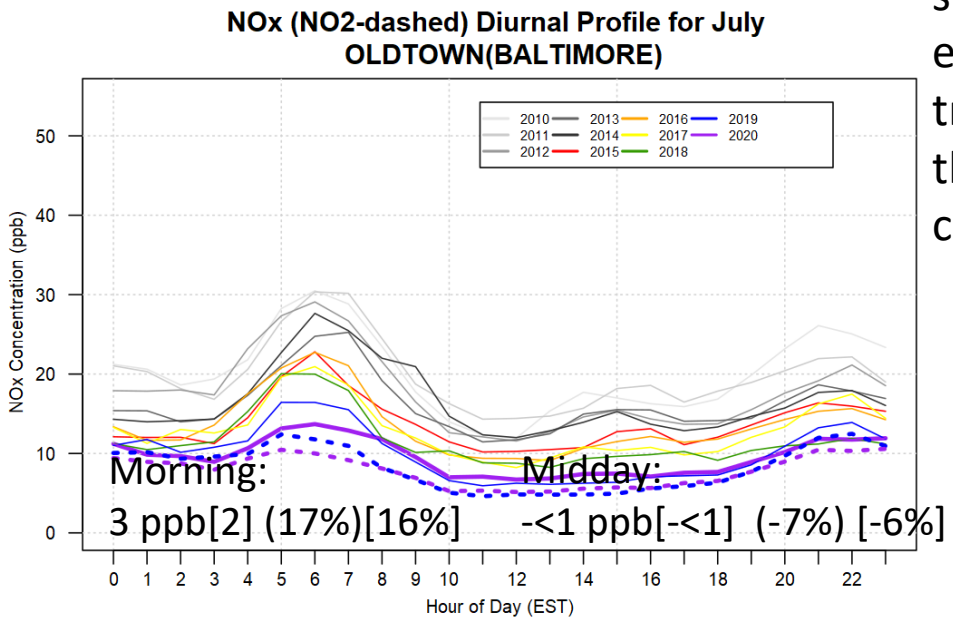


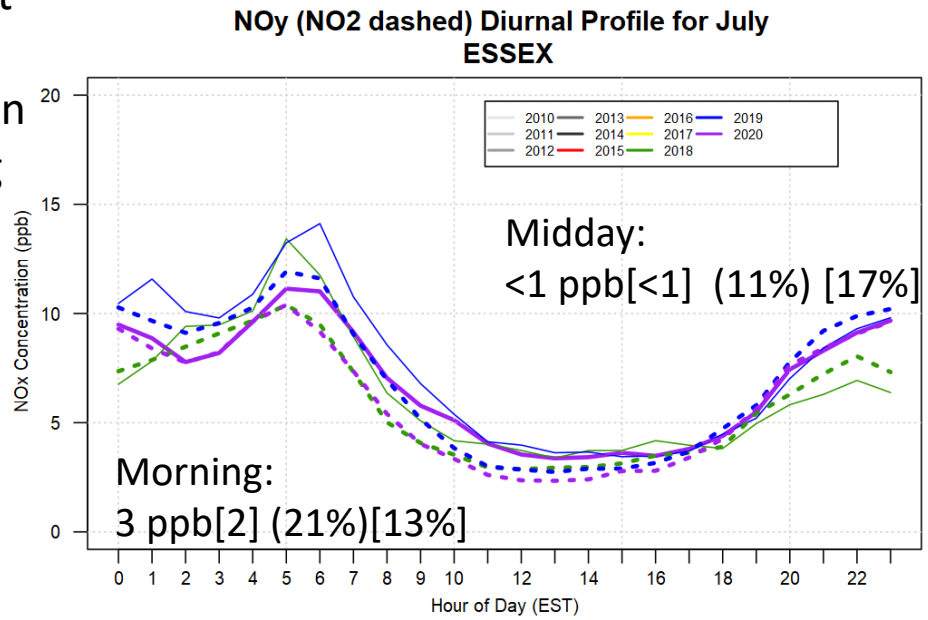
2020 to 2019 differences

2019-2020/ 2019 (%)

Note:
I-95 near-road site does not experience traffic jams in the morning commute

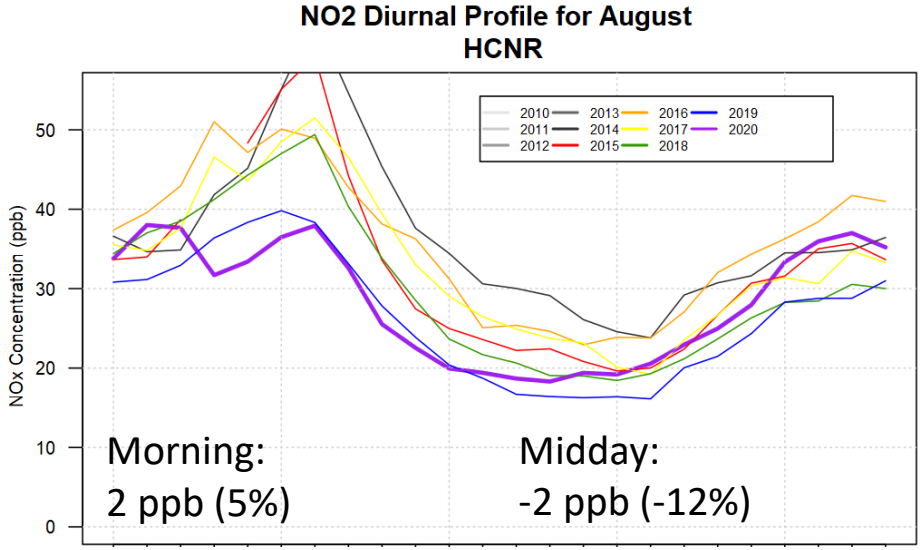






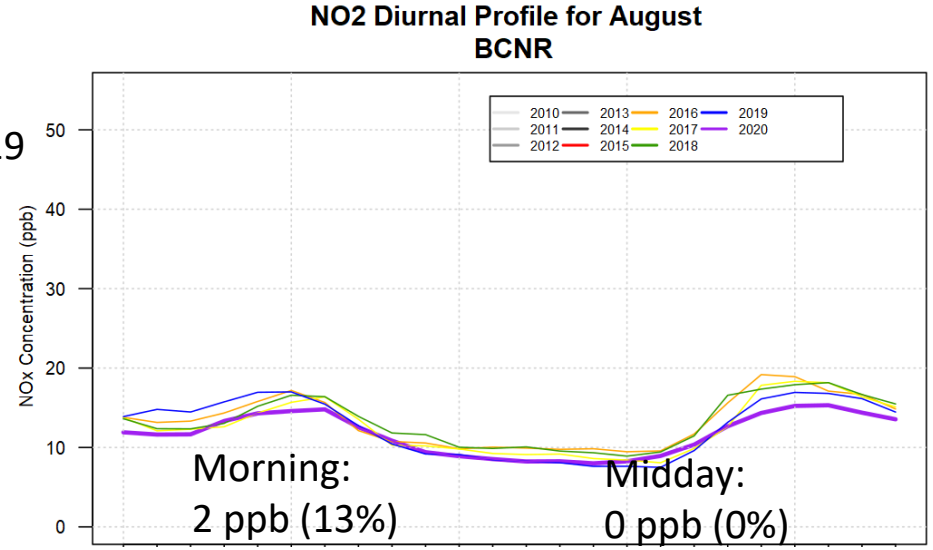
Where did the ozone go?
Weekday Diurnal Cycles –NO_x, NO_2, NO_y (All August Weekdays)

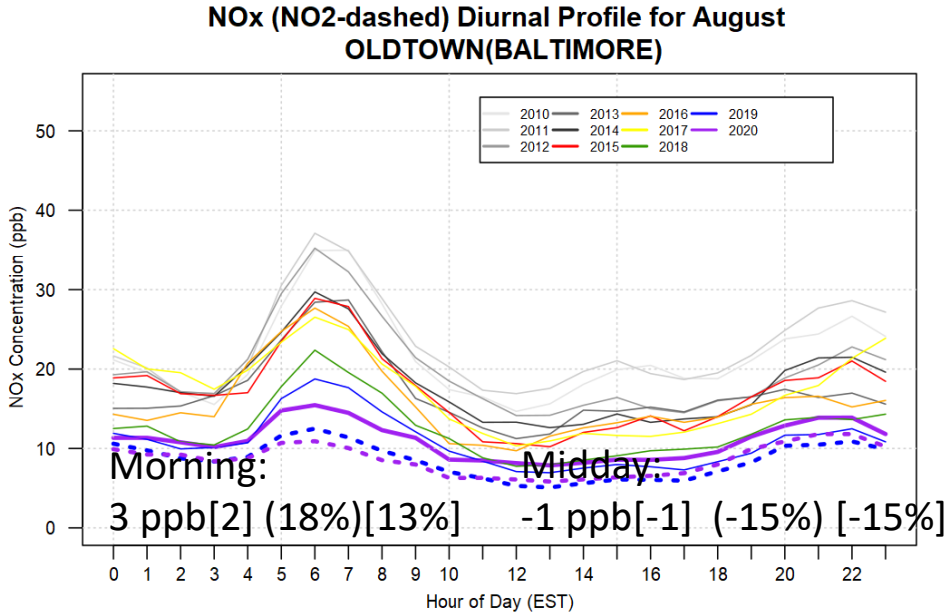
*all content considered preliminary

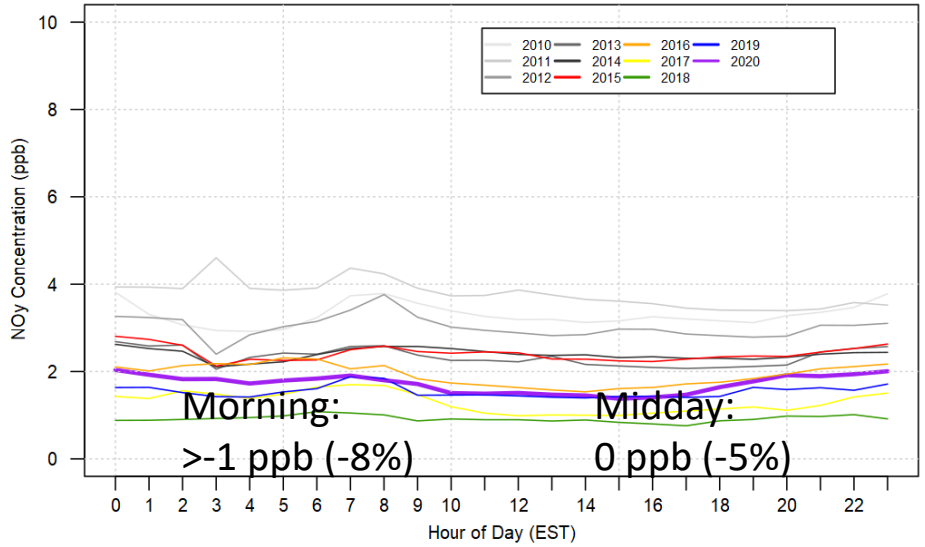


2020 to 2019 differences

2019-2020/ 2019 (%)



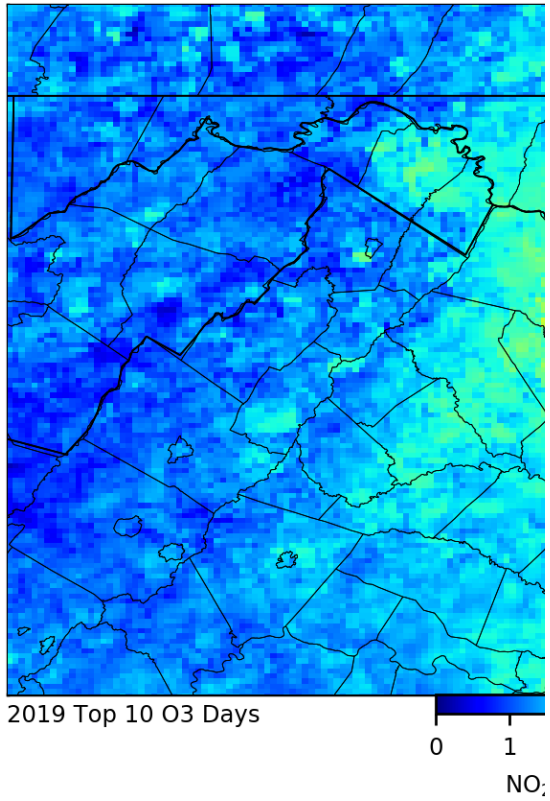


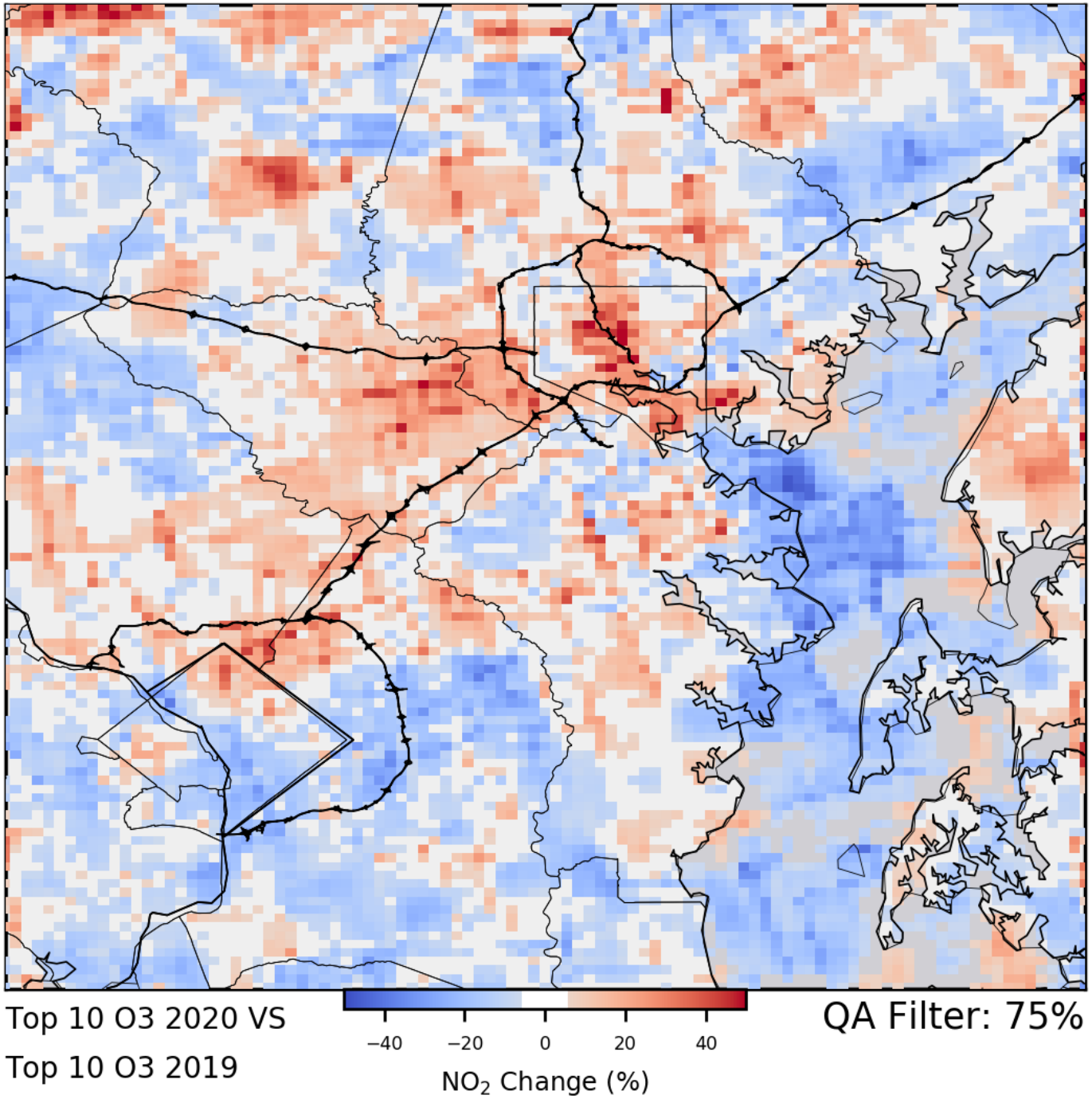


*all content considered preliminary

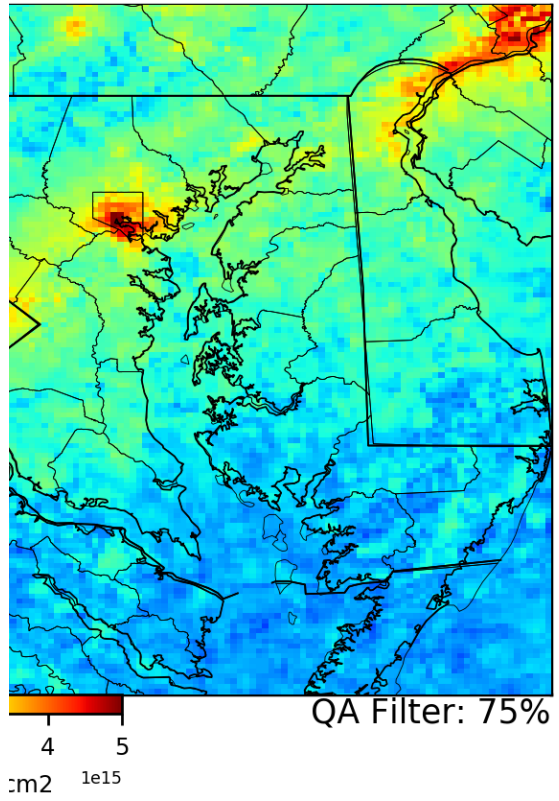
TROPC

2019





2020

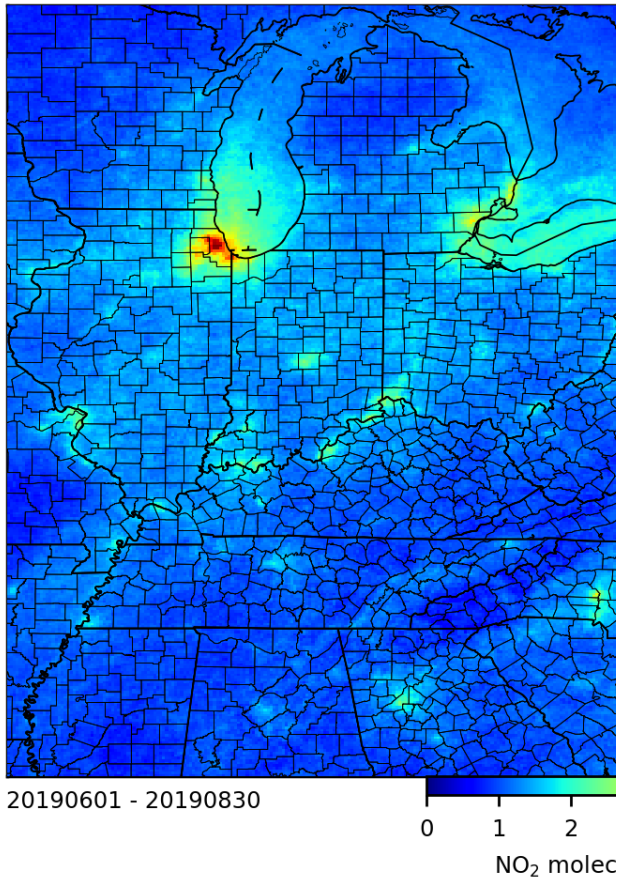


- **Offline TROPOMI ve** **19 vs 2020**
- **QA Filter : 75%**

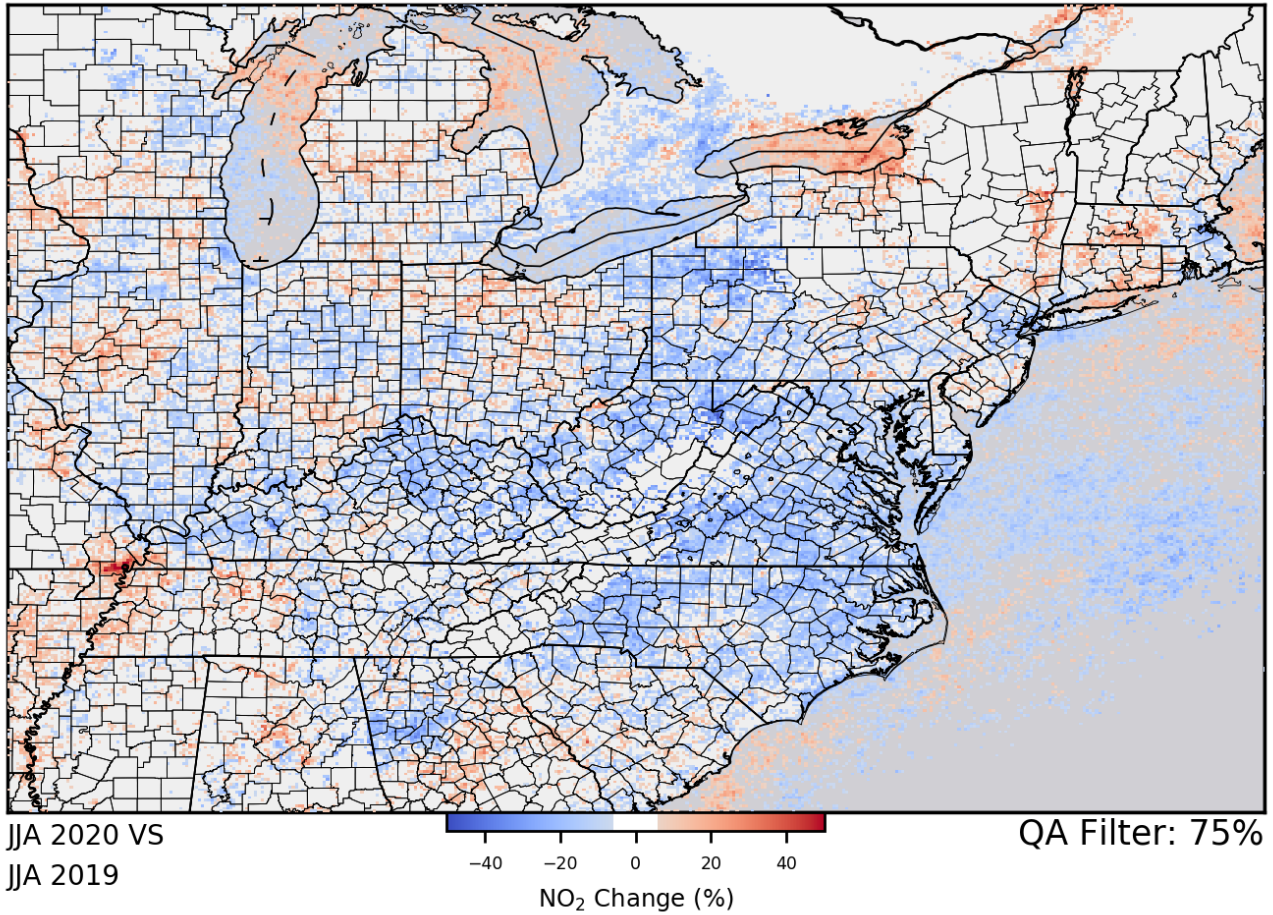
*all content considered preliminary

TROPOMI Satellite: Mid Atlantic - All JJA

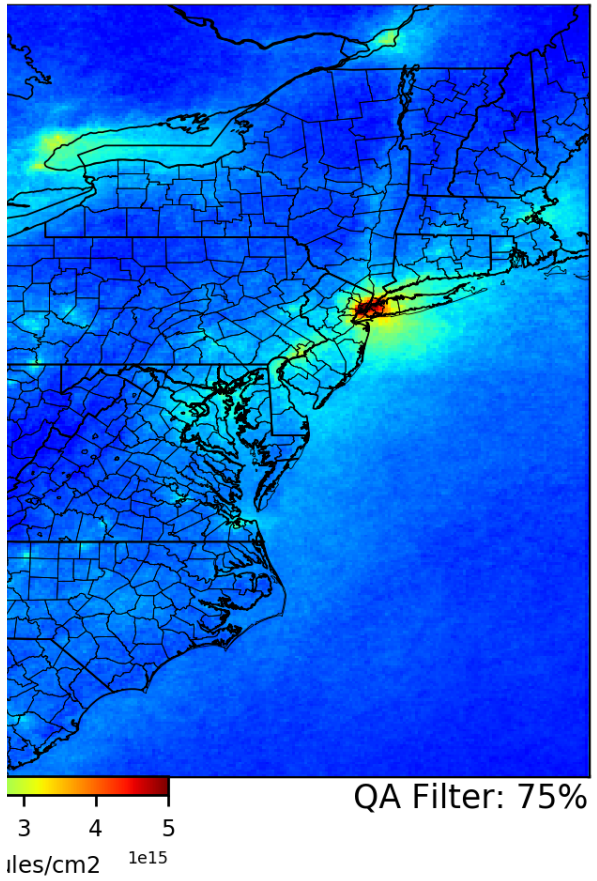
2019



2019 vs 2020



2020



- **Offline TROPOMI vertical column NO2 regridded to 1km on all June, July, and August (JJA) days**
- **QA Filter : 75%**