

# The influence of built-in and portable ionizers on ozone concentration in vehicle cabins

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# Background

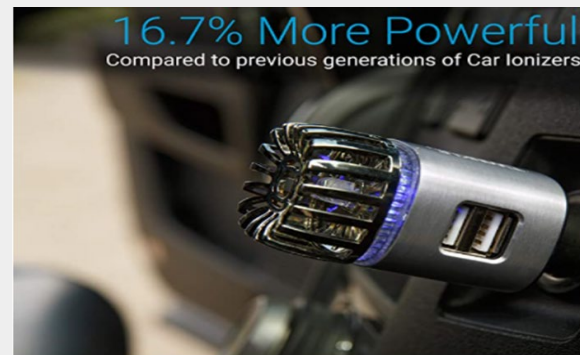
- Ozone is a regulated but harmful pollutant
- Passengers are exposed to ozone on the road as it infiltrates the cabin.
- Portable and integrated ionizers can increase in-cabin ozone concentration.

# Introduction

- Ionizers generate reactive ions
- May produce ozone as a by product
- Used to combat foul odors
- Portable ionizers are easily accessible to consumers
- Luxury automobiles have built-in ionizers

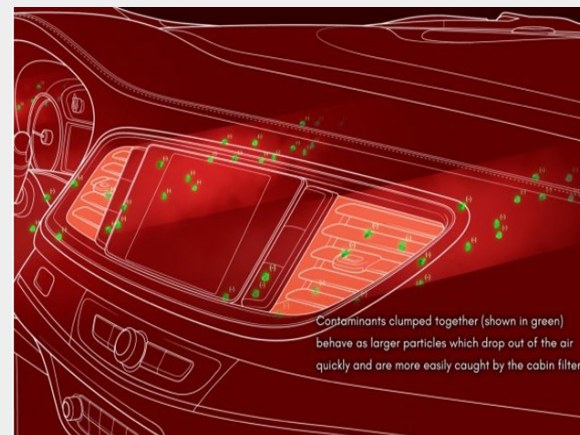
Source: [https://www.amazon.com/TwinkleBirds-Car-Purifier-Ionizer-Plug/dp/B07C7D366L/ref=sr\\_1\\_3?crd=3FBZYOVEKSKOH&dchild=1&keywords=vehicle+ionizer+air+purifier+ozone&qid=1627147504&srefix=vehicle+ionizer%2Caps%2C257&sr=8-3](https://www.amazon.com/TwinkleBirds-Car-Purifier-Ionizer-Plug/dp/B07C7D366L/ref=sr_1_3?crd=3FBZYOVEKSKOH&dchild=1&keywords=vehicle+ionizer+air+purifier+ozone&qid=1627147504&srefix=vehicle+ionizer%2Caps%2C257&sr=8-3)

Source: <https://gmauthority.com/blog/2021/03/2021-buick-enclave-deletes-air-ionizer-feature/>



16.7% More Powerful  
Compared to previous generations of Car Ionizers

Most Effective When Used Over a Period of Time



Contaminants clumped together (shown in green) behave as larger particles which drop out of the air quickly and are more easily caught by the cabin filter.

# Portable ionizers tested

	Brand	Model
Ionizer A	Twinkle Birds	Car Air Purifier & Dual USB Car Charger
Ionizer B	U-12	Car Air Purifier
Ionizer C	CleanAirGuard	Dual-Mode Mini Ozone Ionic Air Purifier

# Built-in ionizers tested

## Hyundai Genesis



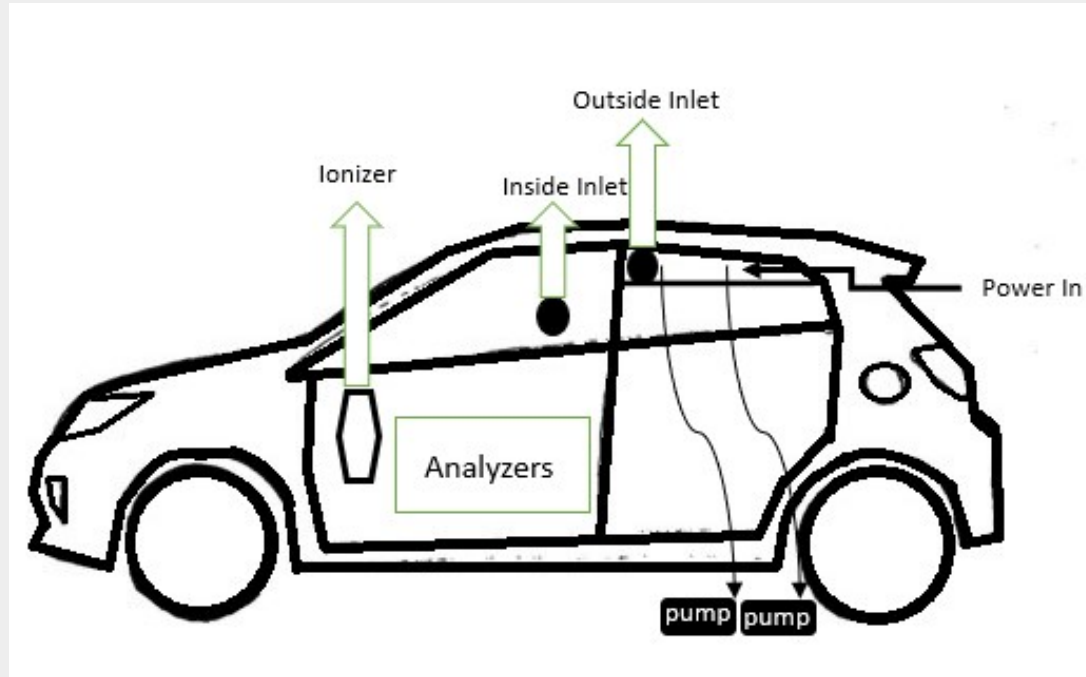
## GM Enclave



Source: <https://www.caranddriver.com/photos/g15187258/2018-buick-enclave-awd-instrumented-test-gallery/?slide=1>:

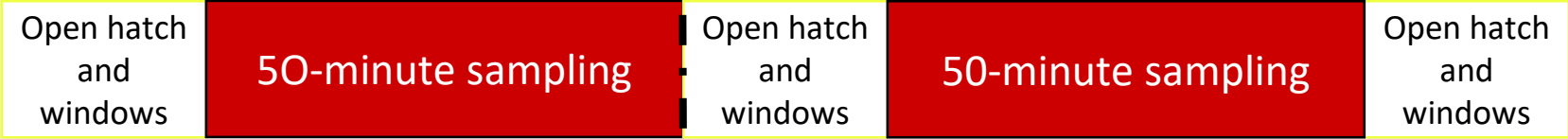
Source: <https://www.caranddriver.com/photos/g15187258/2018-buick-enclave-awd-instrumented-test-gallery/?slide=1>:

# Methods – Setup

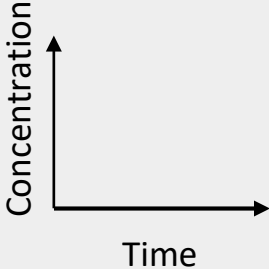
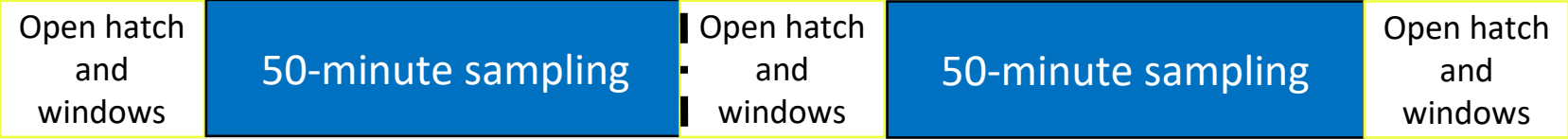


# Static test

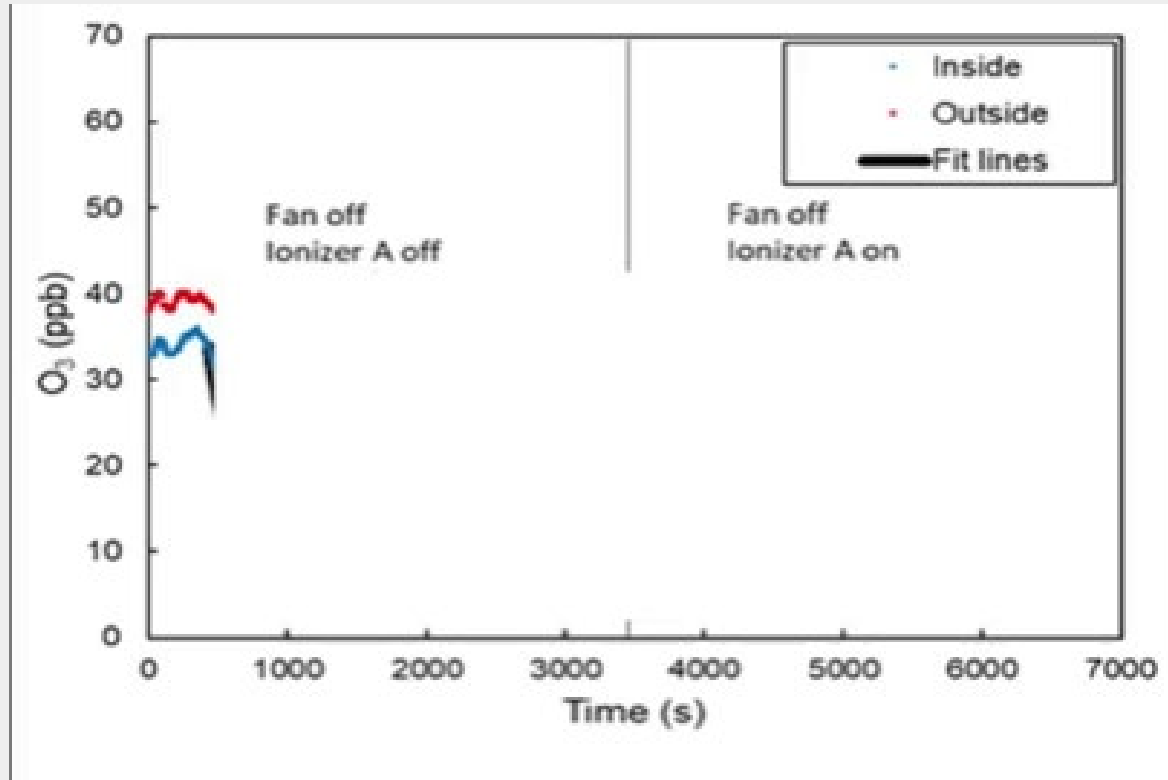
Outside



Inside



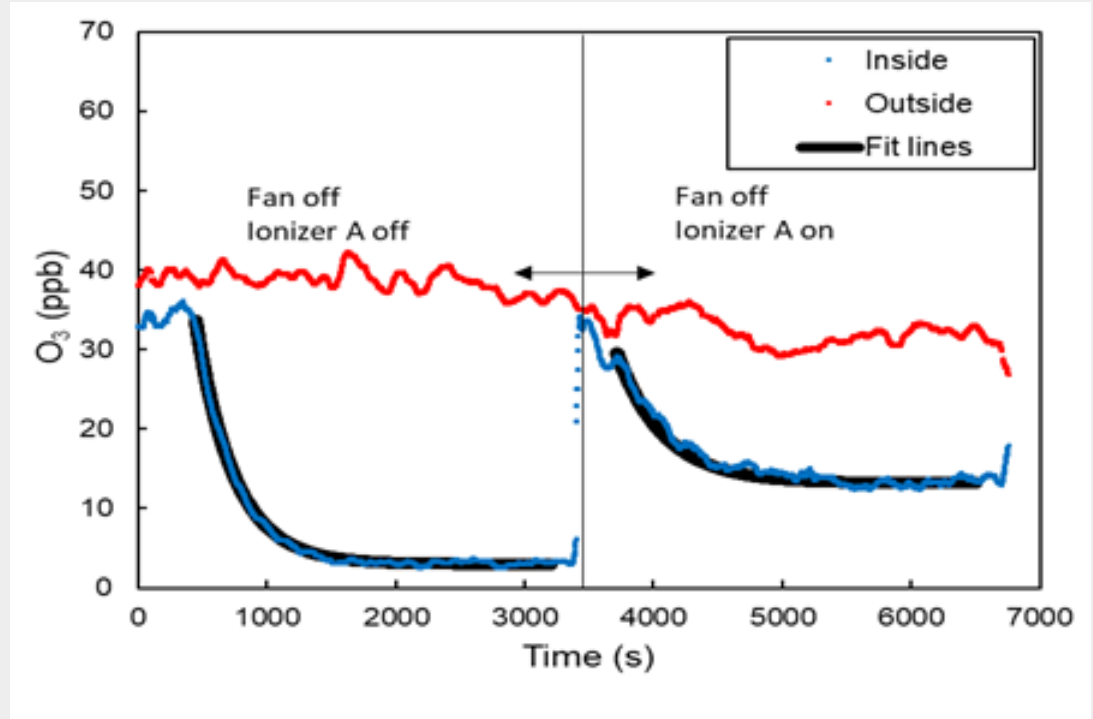
# Ventilation off – Ionizer A





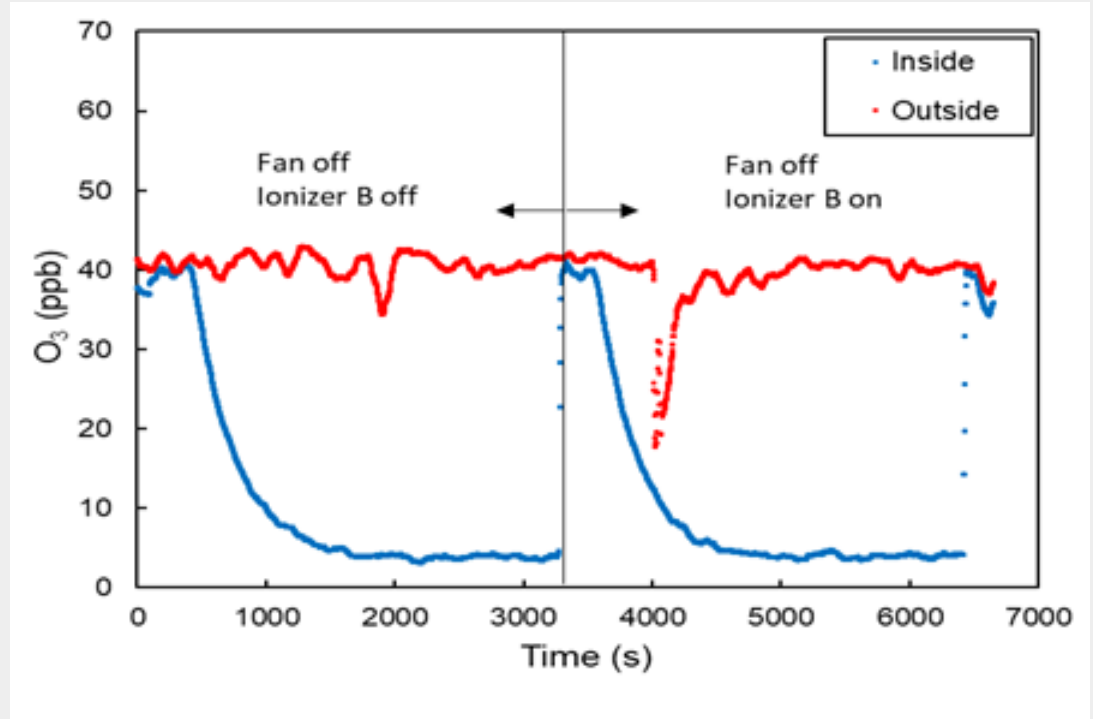
# Ventilation off – Ionizer A

- 10 ppb higher steady state when compared to baseline



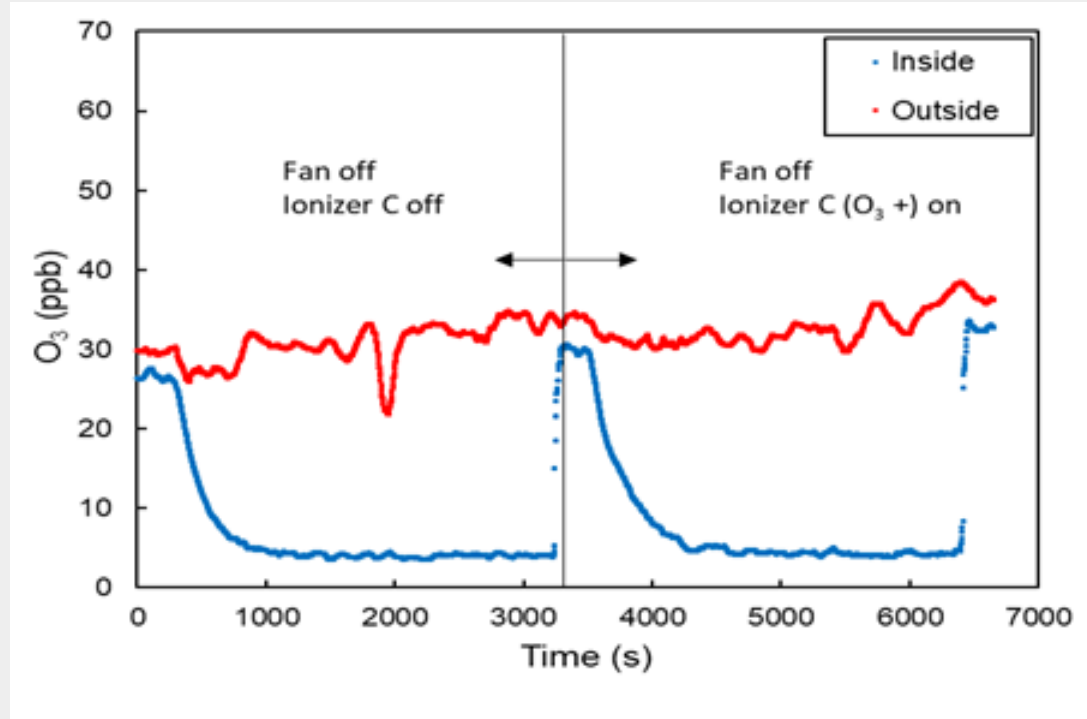
# Ventilation off – Ionizer B

- No detectable ozone production from Ionizer B



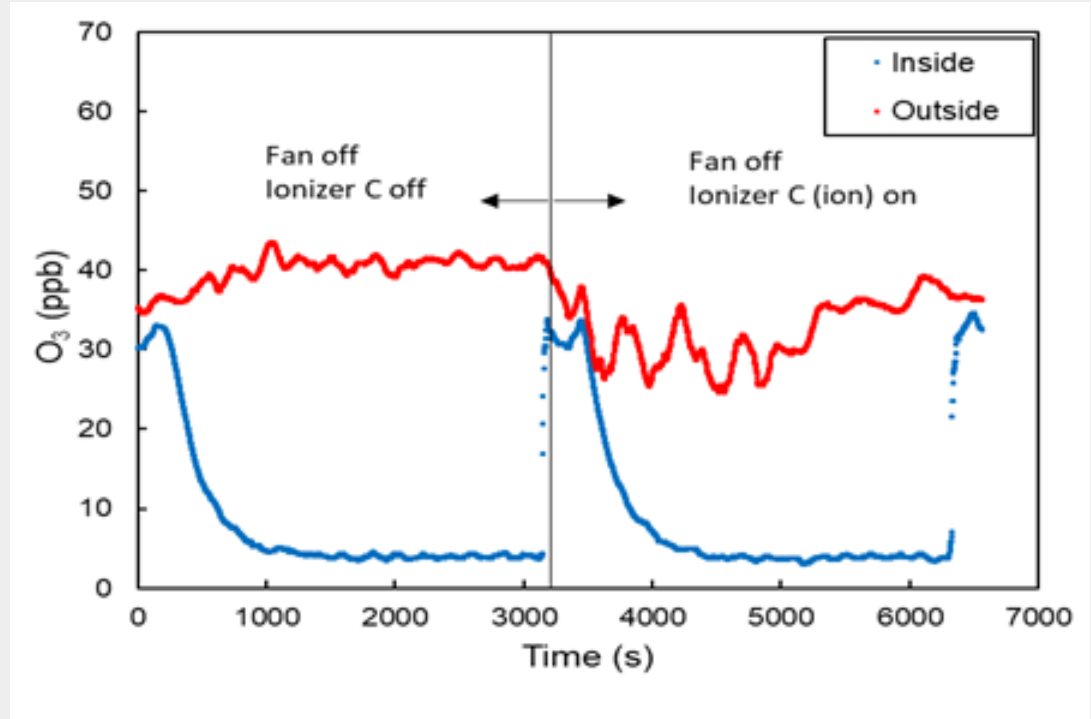
# Ventilation off – Ionizer C ( $O_3$ + mode)

- No detectable ozone production from Ionizer C in  $O_3$  + mode



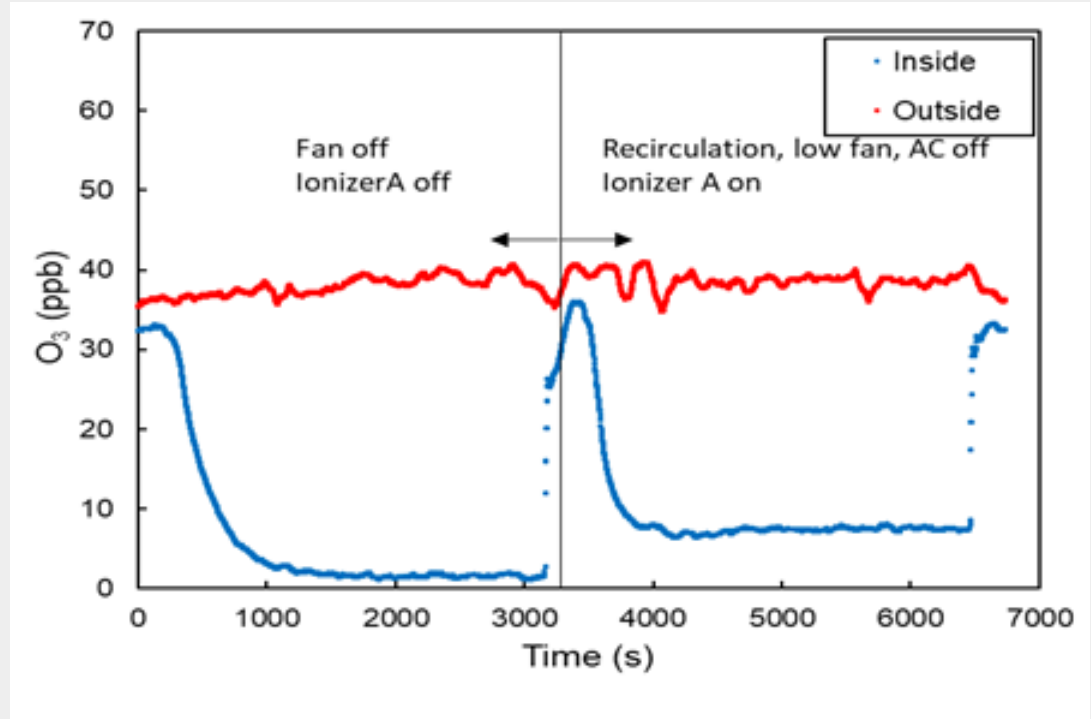
# Ventilation off – Ionizer C (ion mode)

- No detectable ozone production from Ionizer C in ion mode



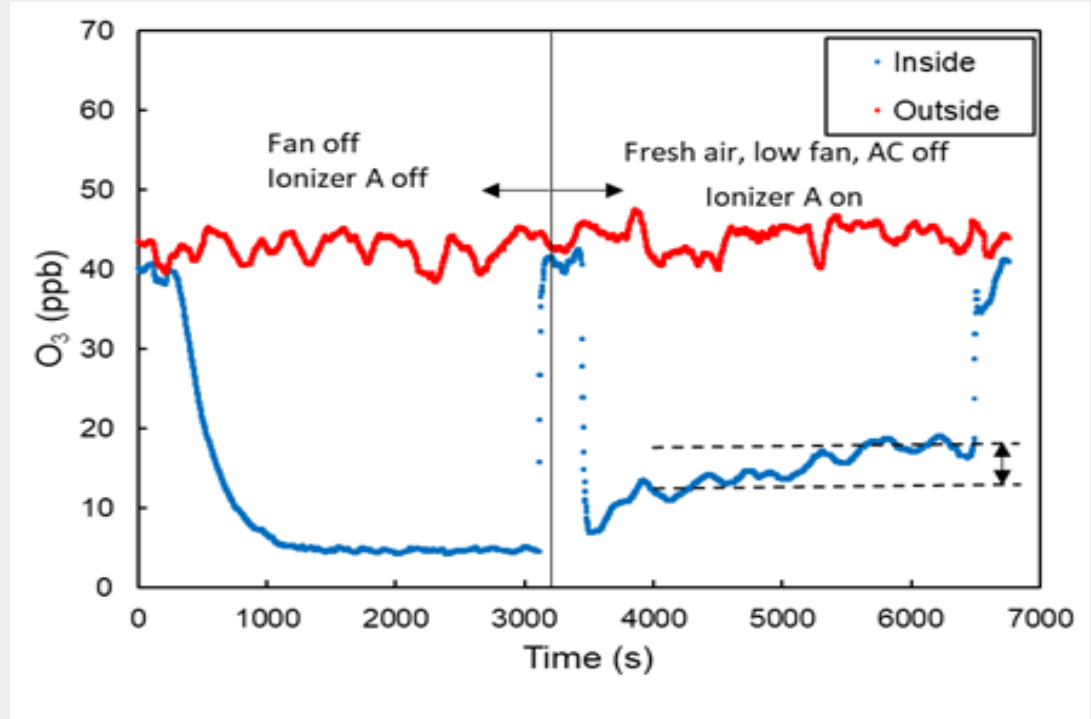
# Ventilation on – Ionizer A Recirculation

- Recirculating air comes in contact with more surface area in the HVAC ducts leading to rapid ozone decrease
- 8 ppb higher steady state than baseline



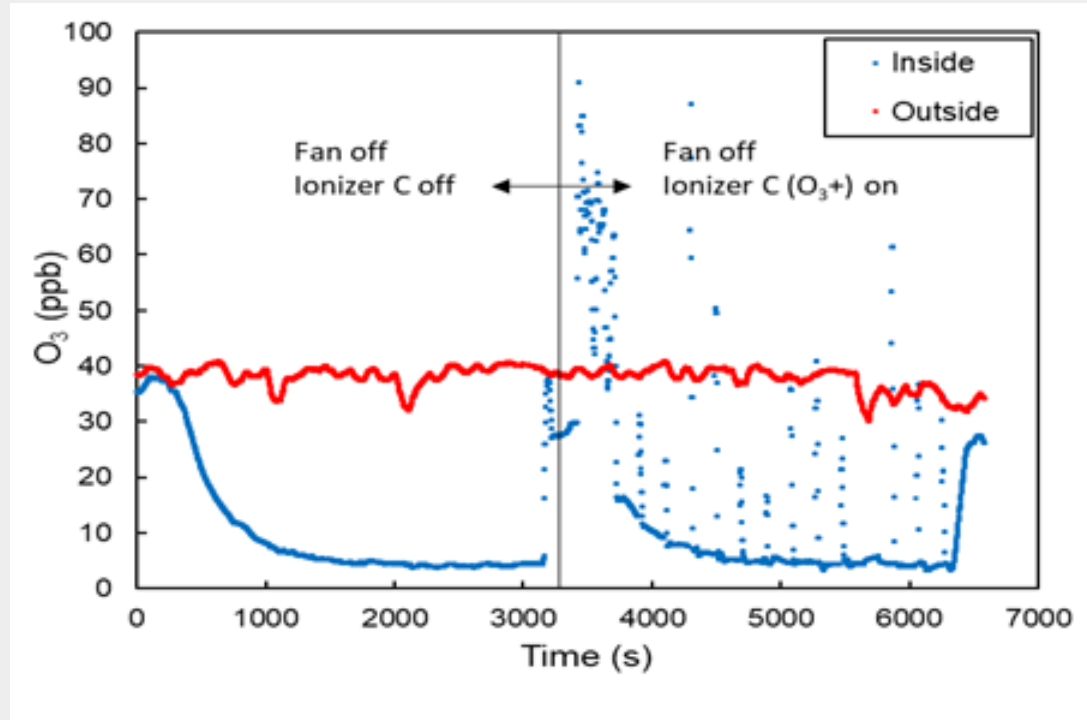
# Ventilation on – Ionizer A fresh air

- Outside transport of ozone into the cabin should follow the outside trend
- The apparent increase can be due to other species being transported into the cabin and reacting with ozone



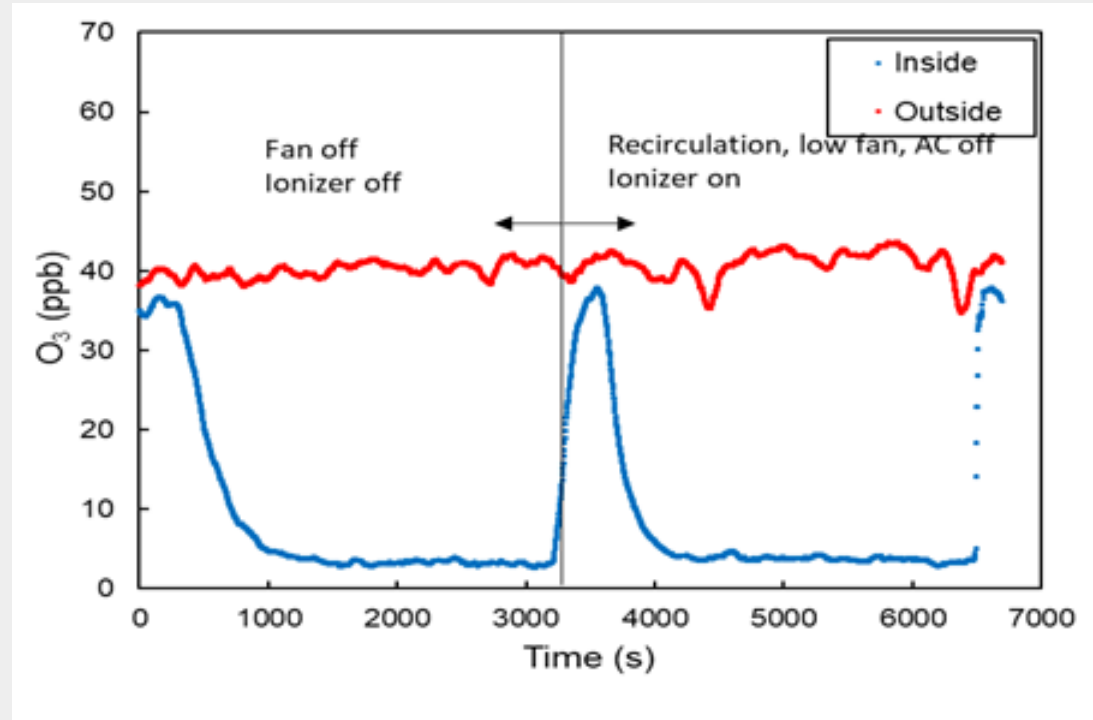
# Closer sample port location – Ionizer C (O<sub>3</sub> + mode)

- Ionizer A, B, and C (ion mode) showed no difference
- 91 ppb was the highest concentration
- Overall trend similar to the sample port location at shoulder height



# Ventilation on Recirculation Mode– 2018 Buick Enclave

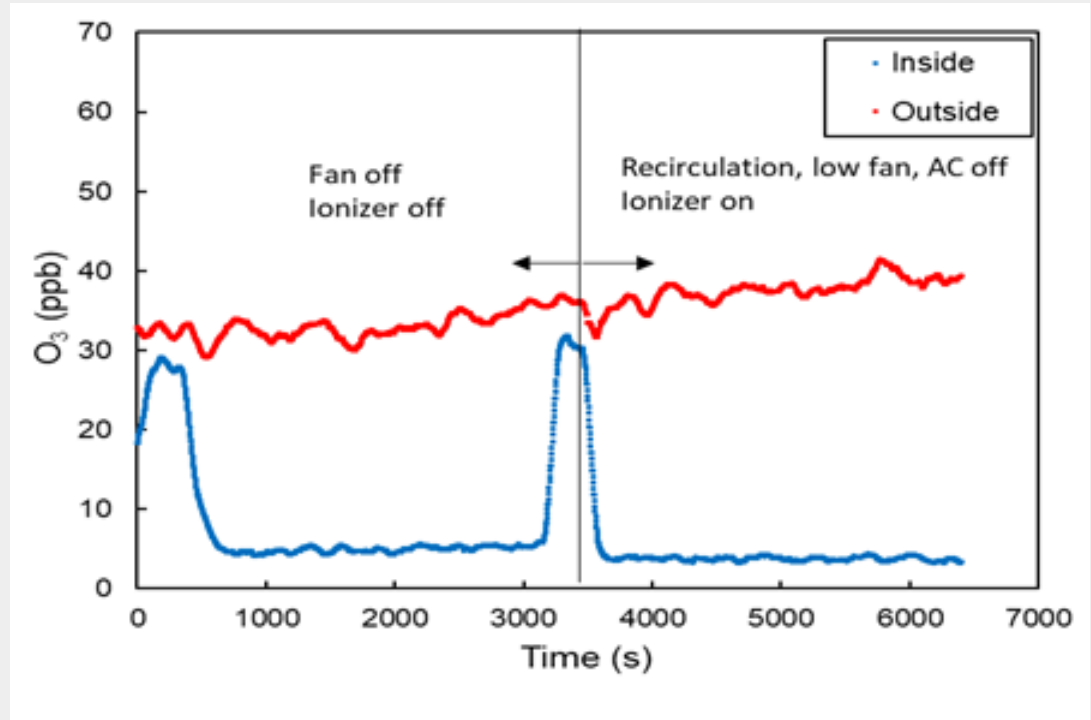
- Enclave ionizer turns on whenever the fan is on
- A detectable ozone contribution would show in recirculation mode





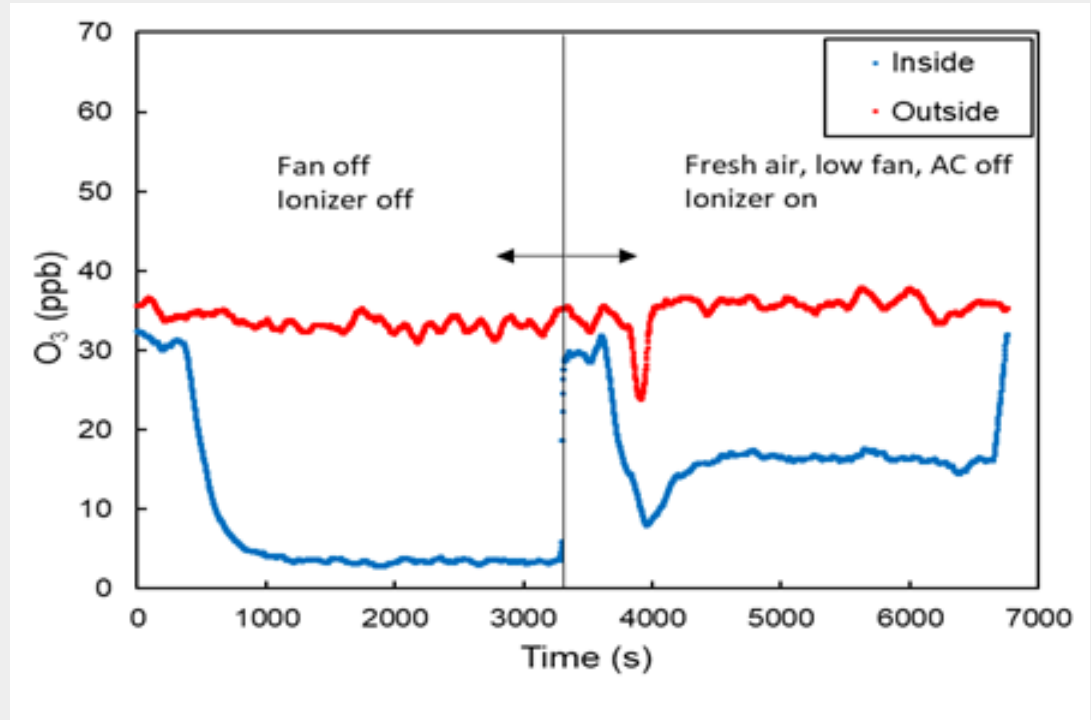
# Ventilation on Recirculation Mode – 2015 Hyundai Genesis

- Genesis does not have an indicator of when the ionizer is on
- We speculate that auto manufacturers switch off ionizers during recirculation to prevent ozone accumulation



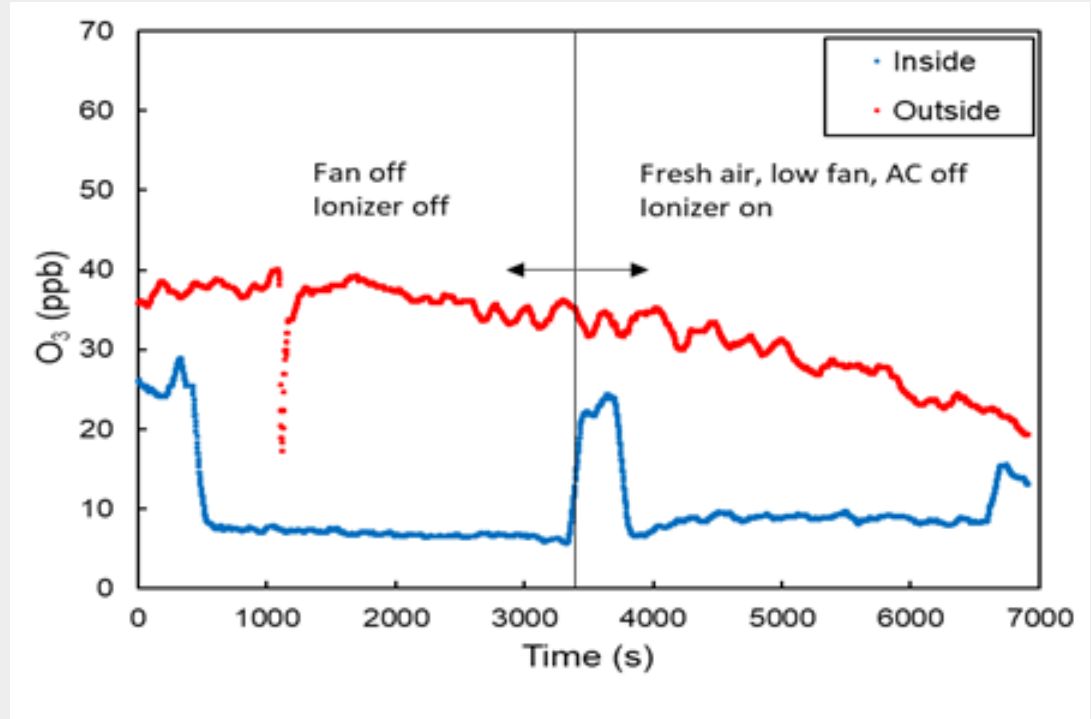
# Ventilation on Fresh Air Mode – 2018 Buick Enclave

- The right panel shows in-cabin concentration following the ambient trend
- No discernable contribution



# Ventilation on Fresh Air Mode – 2015 Hyundai Genesis

- Sampled during the evening
- Expected a decreasing trend inside the vehicle
- Small difference and thus inconclusive



# Takeaways

- Ionizers can contribute to the in-cabin ozone concentration
- Built-in ionizers showed no conclusive results for vehicles tested
- Auto manufacturers should list specifications and indicators for their built-in ionizers
- Sample port location matters in developing testing methodologies
- The vehicle cabin micro environment requires further research

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