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Bourns College of Engineering

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

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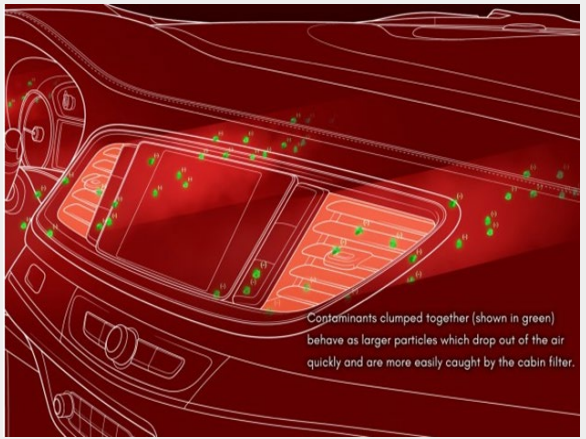
Background

- 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?crid=3FBZYOVEKSKOH&dchild=1&keywords=vehicle+ionizer+air+purifier+ozone&qid=1627147504&sprefix=vehicle+ionizer%2Caps%2C257&sr=8-3

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

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

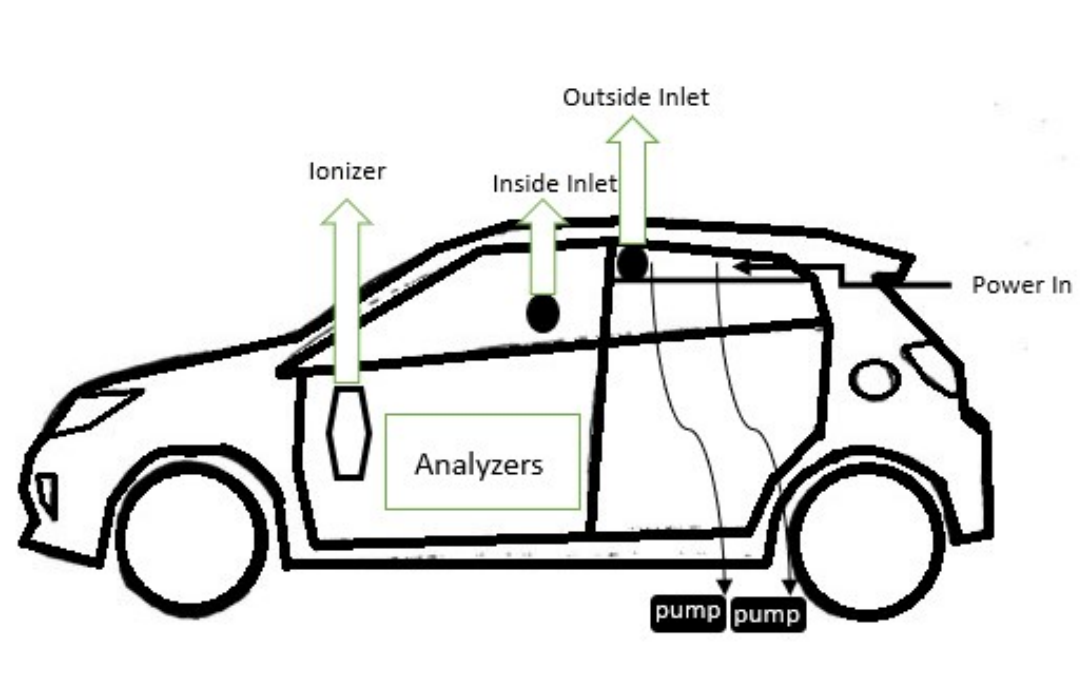
Hyundai Genesis

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

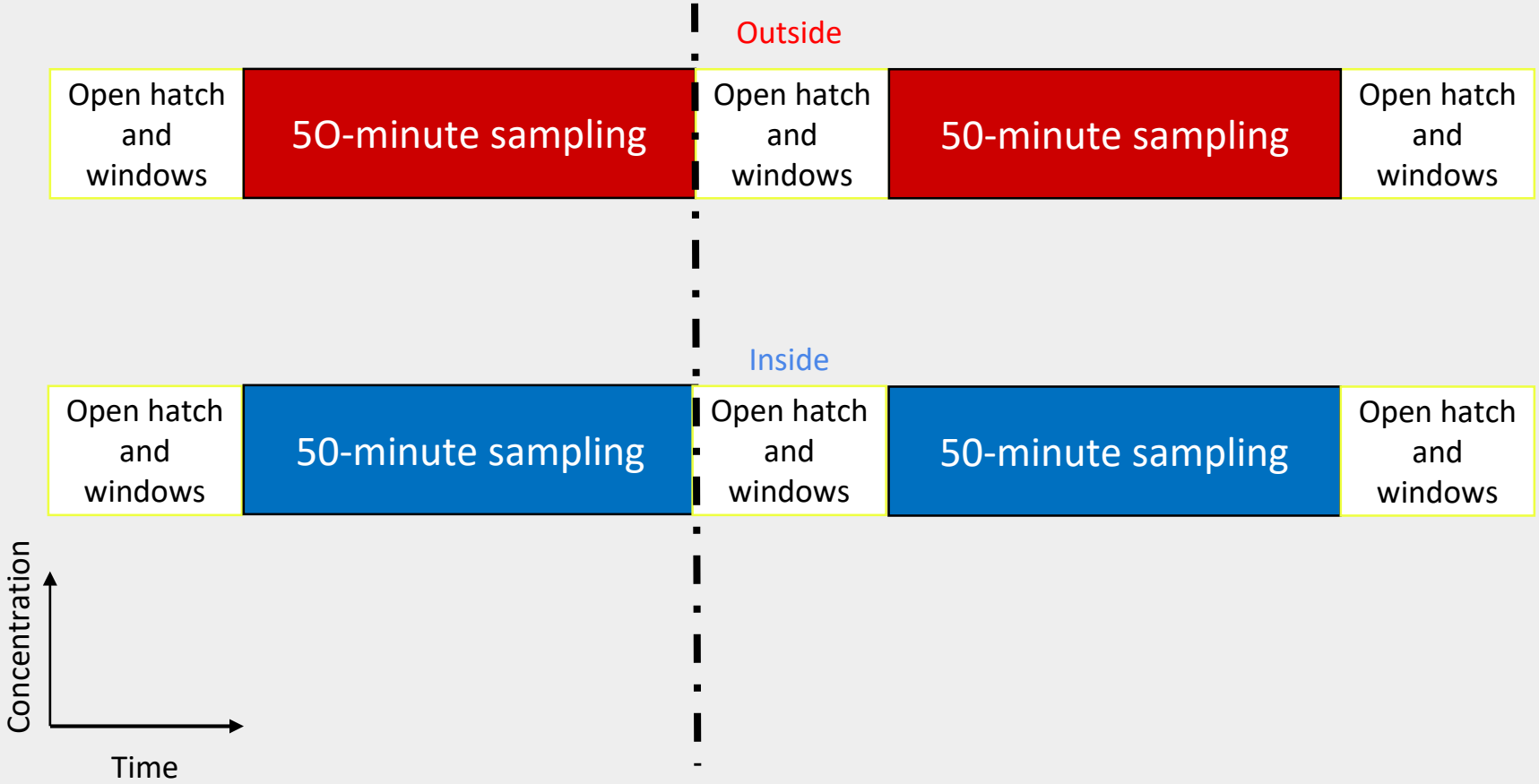
GM Enclave

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

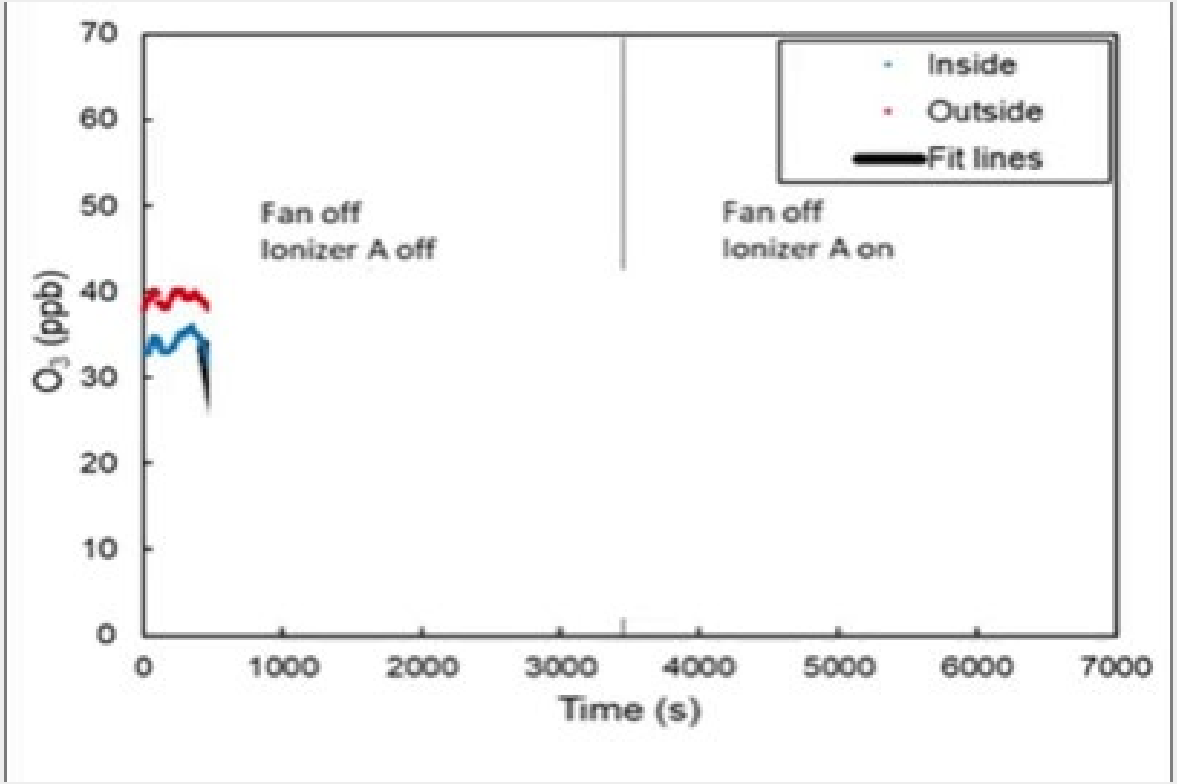
Methods – Setup



Static test

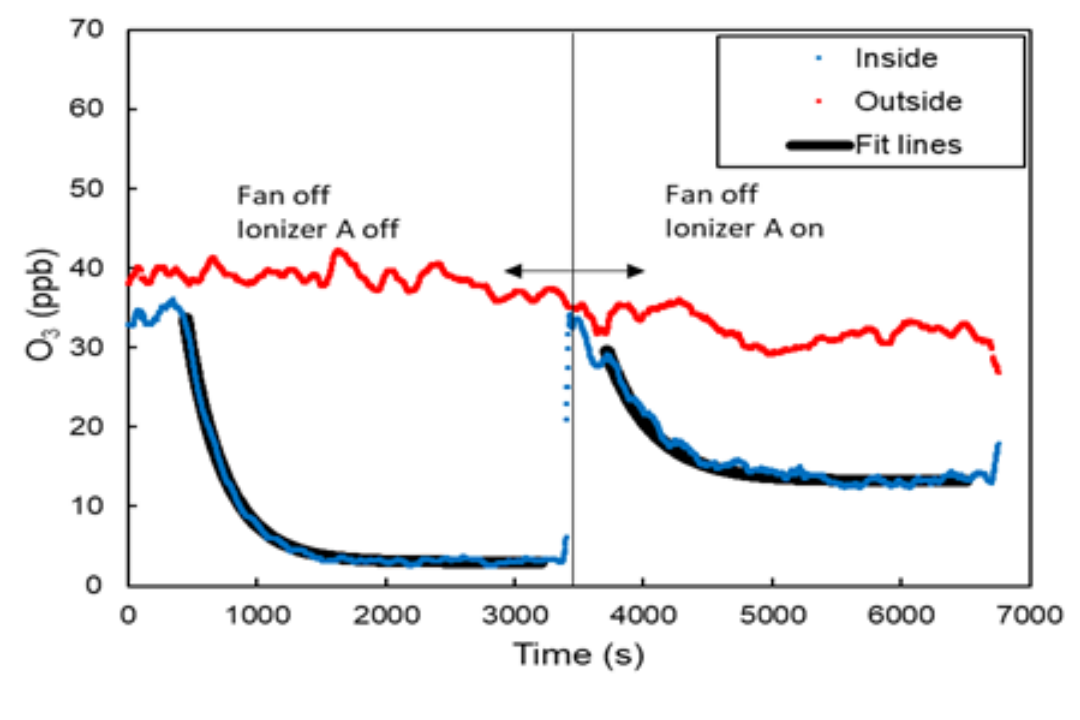

Outside
Open hatch and windows
50-minute sampling
Open hatch and windows
50-minute sampling
Open hatch and windows
Inside
Open hatch and windows
50-minute sampling
Open hatch and windows
50-minute sampling
Open hatch and windows
Concentration
Time

Ventilation off – Ionizer A



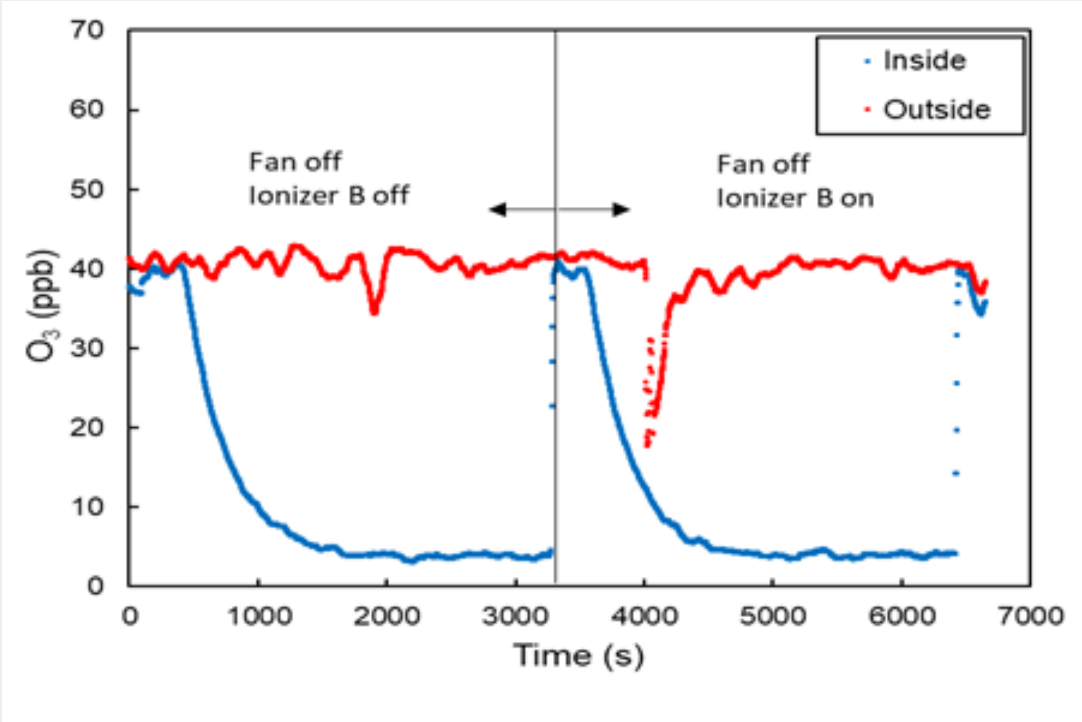
Ventilation off – Ionizer A

- 10 ppb higher steady state when compared to baseline



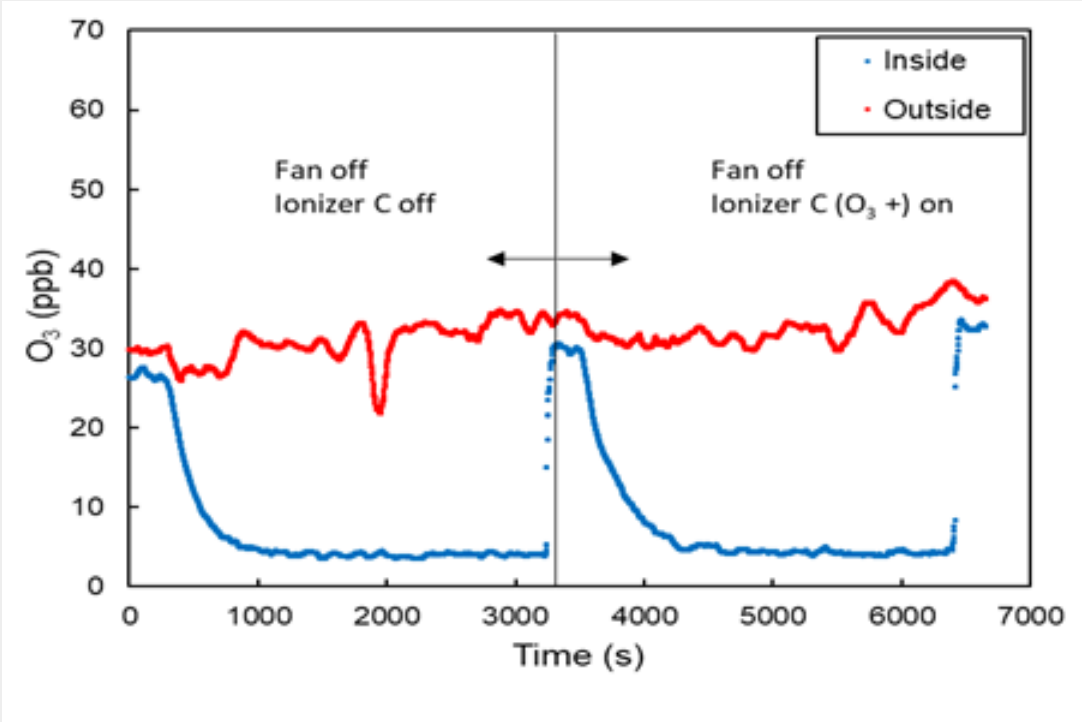
Ventilation off – Ionizer B

- No detectable ozone production from Ionizer B



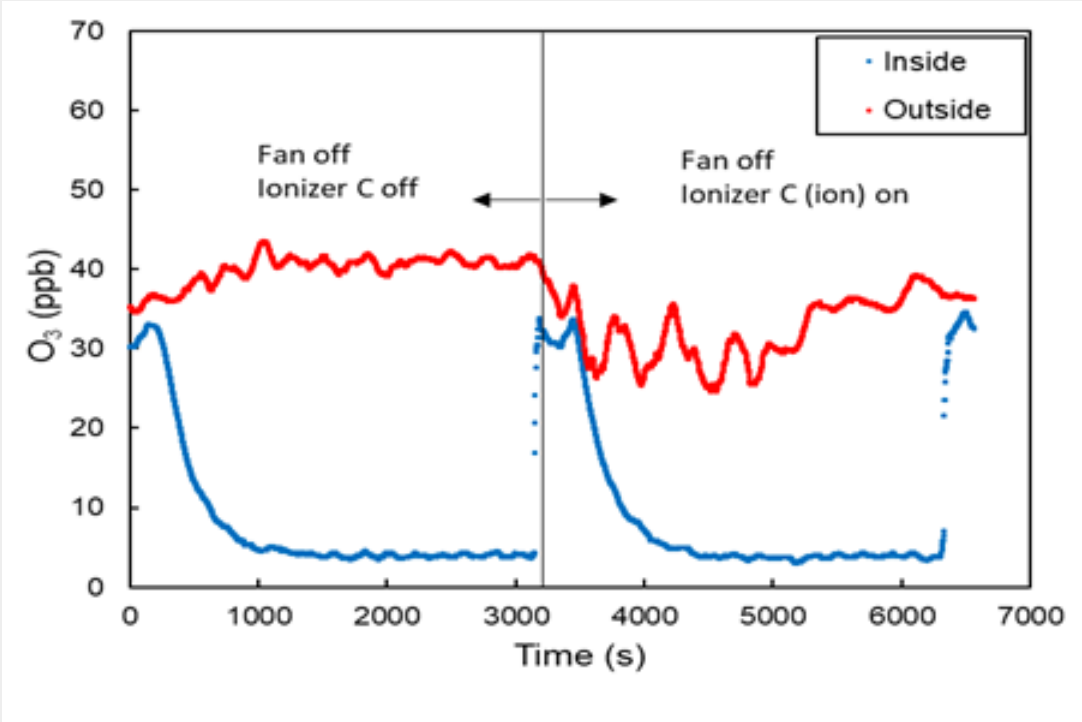
Ventilation off – Ionizer C (O_3 + mode)

- No detectable ozone production from Ionizer C in O3 + mode



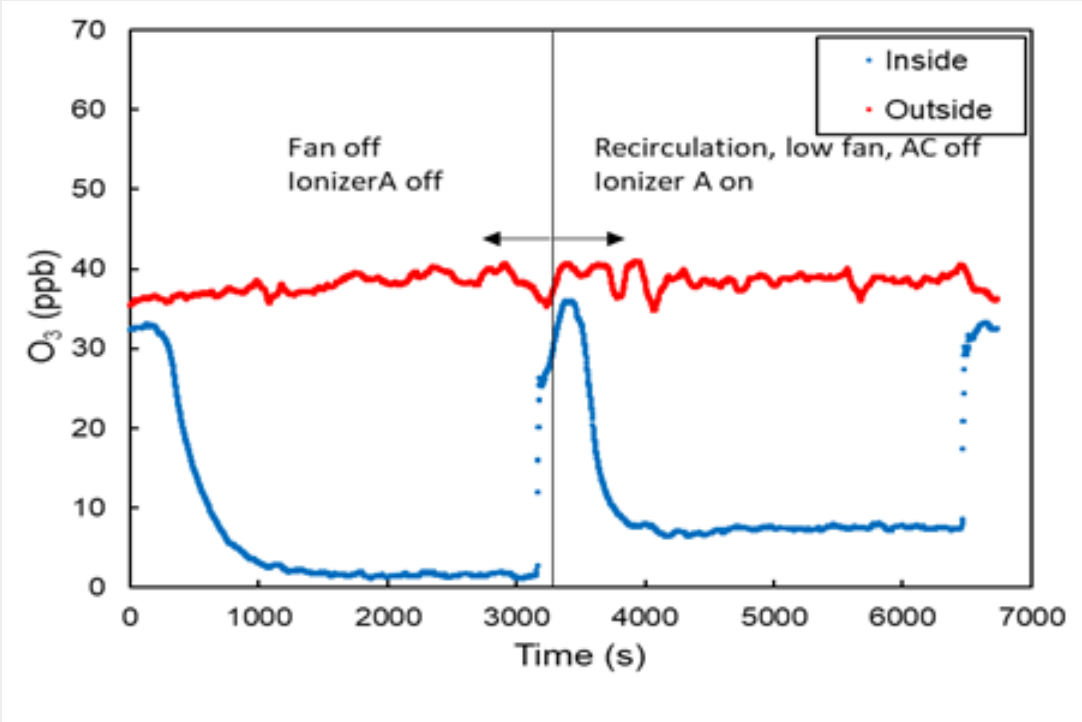
Ventilation off – Ionizer C (ion mode)

- No detectable ozone production from Ionizer C in ion mode



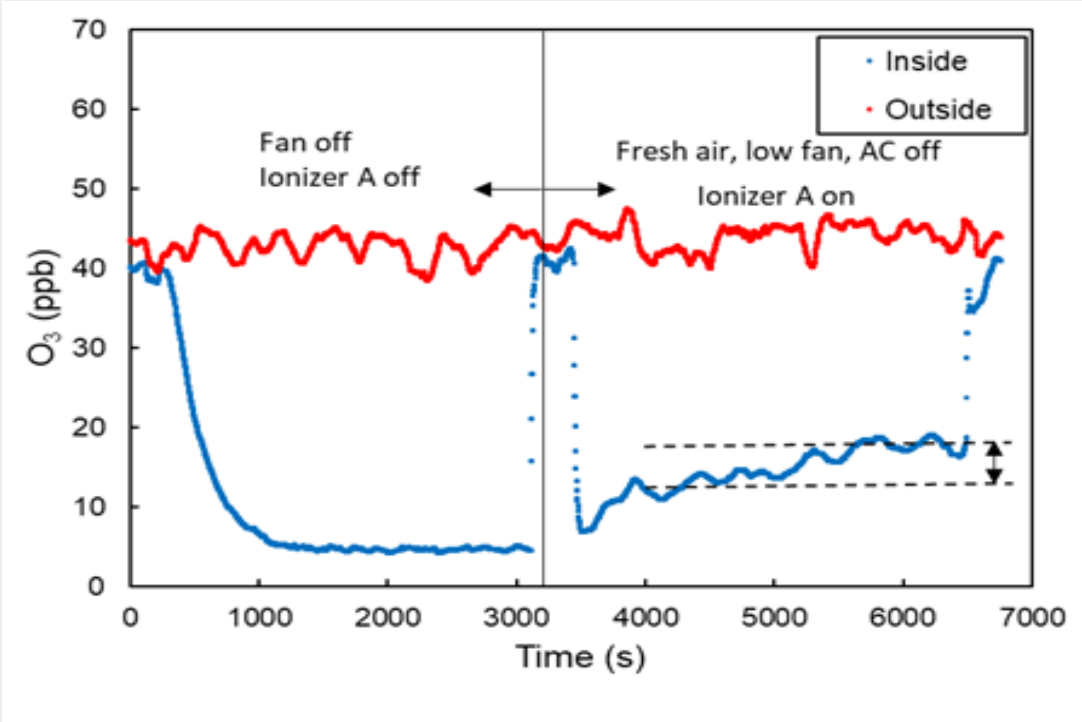
Ventilation on – Ionizer A Recirculation

- 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



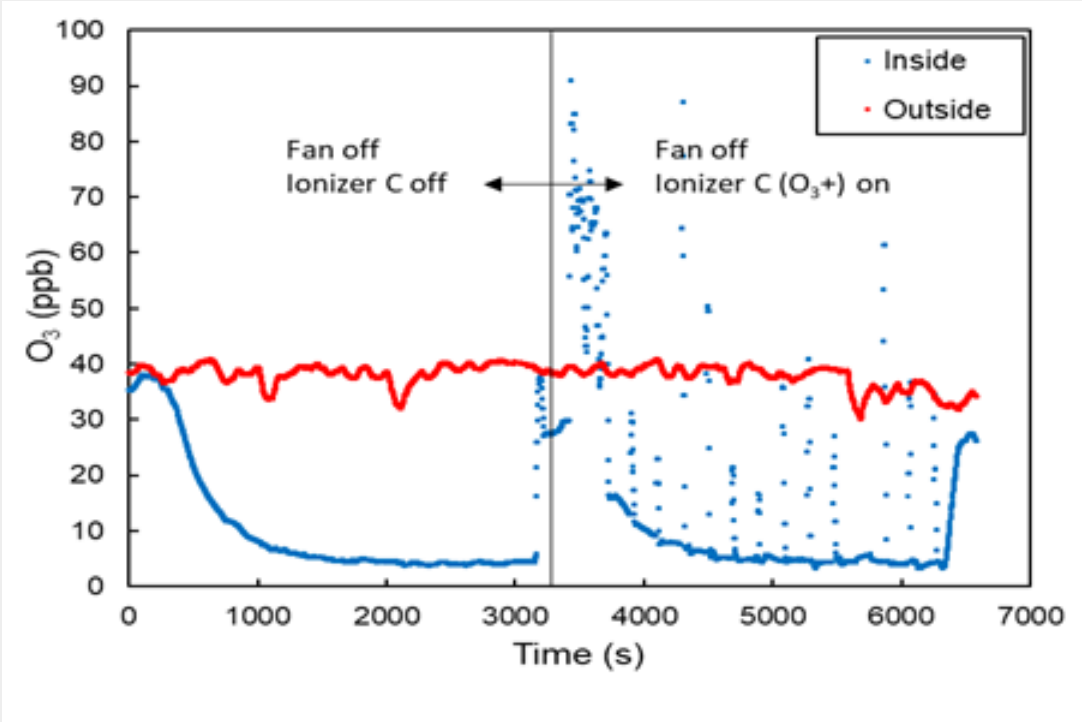
Ventilation on – Ionizer A fresh air

- 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



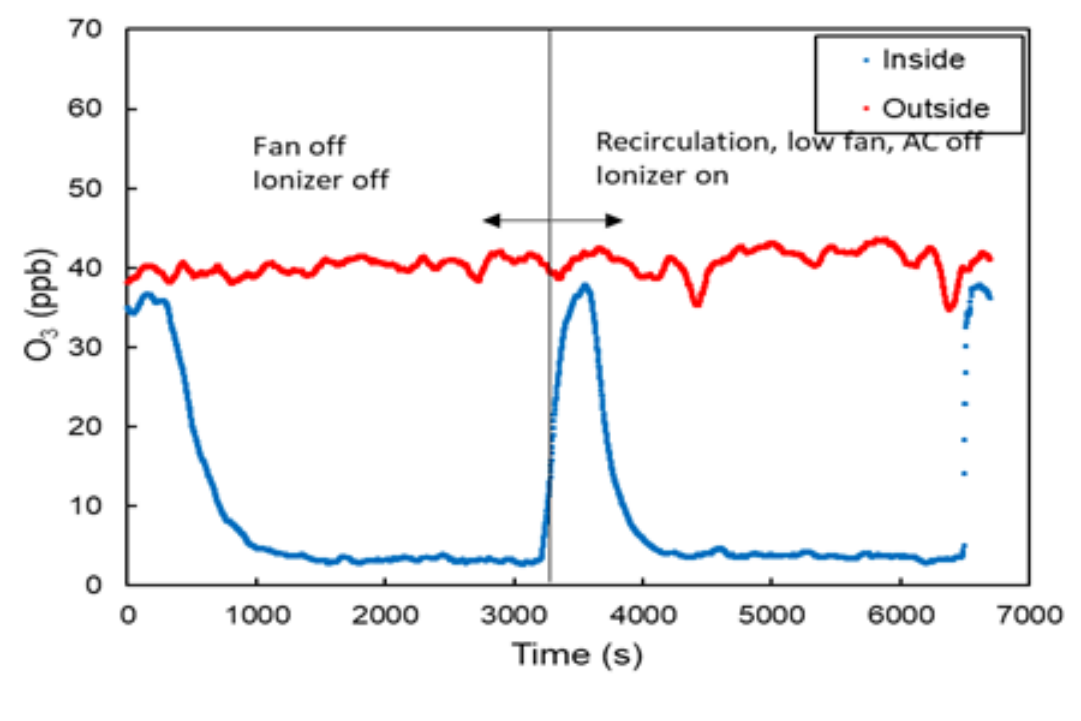
Closer sample port location – Ionizer C (O_3 + mode)

- 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



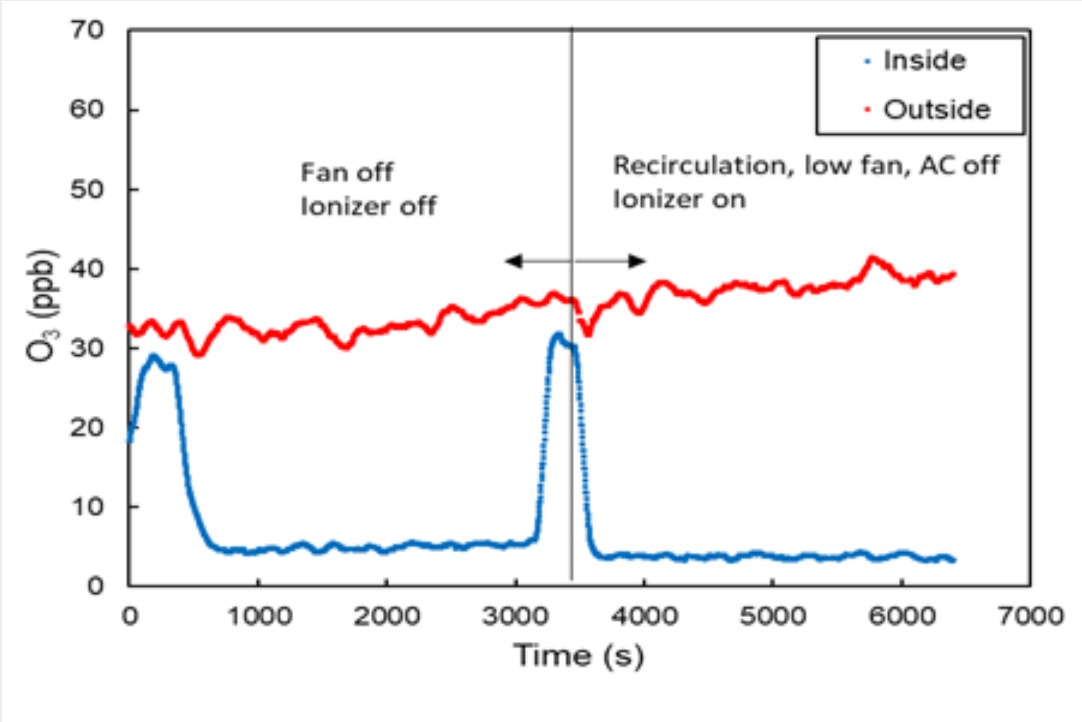
Ventilation on Recirculation Mode– 2018 Buick Enclave

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



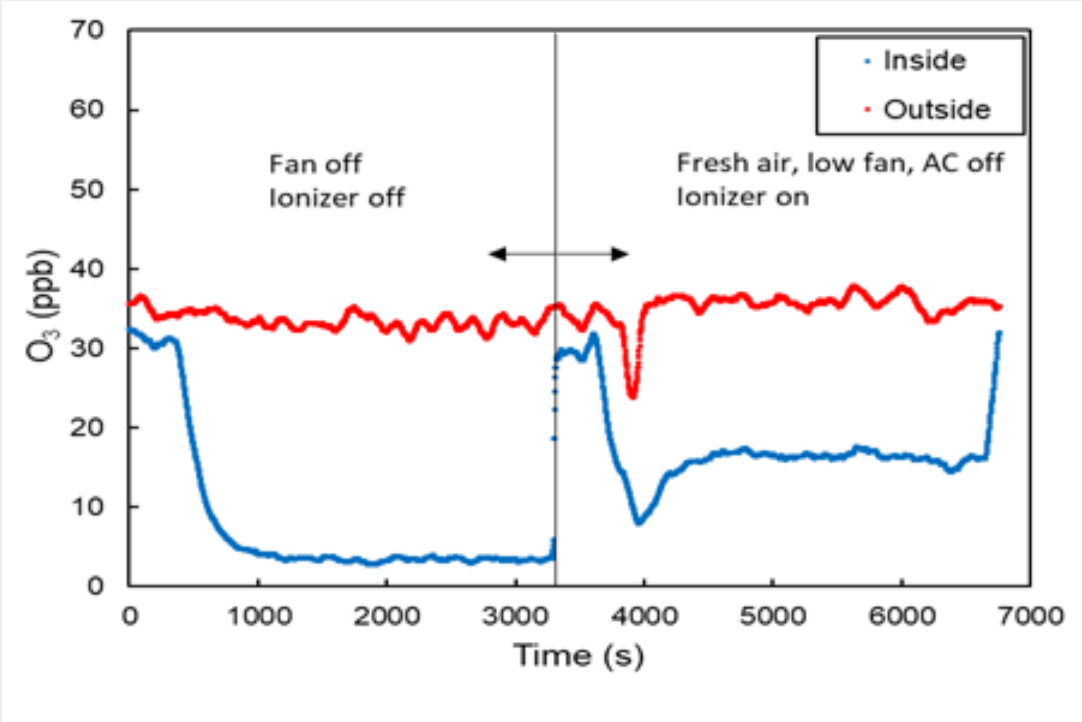
Ventilation on Recirculation Mode – 2015 Hyundai Genesis

- 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



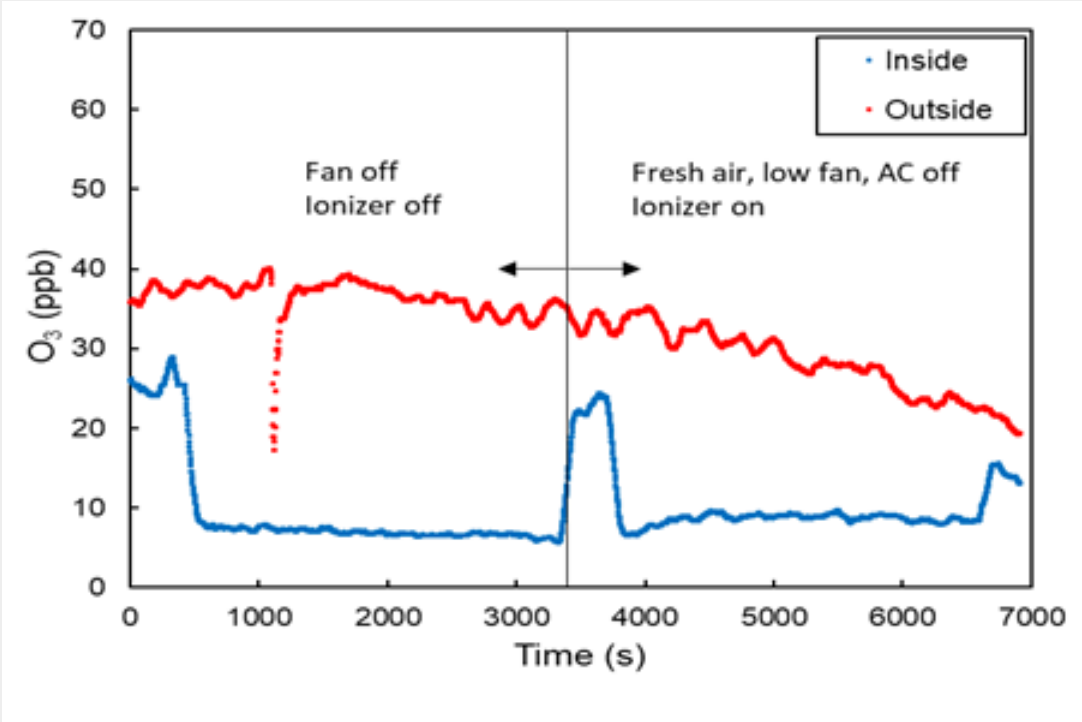
Ventilation on Fresh Air Mode – 2018 Buick Enclave

- 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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