ASU researchers test environmental risks of tire emissions on Arizona highways

ADOT-sponsored research prompts conversations about accuracy in emissions modeling

By Hannah Weisman, ASU News
March 17, 2025

The Greater Phoenix area's roadway grid system is the envy of urban planners everywhere, and the Arizona Department of Transportation, or ADOT, strives for nothing less than spectacular when designing and maintaining the state's roadway network.

So, when reviewing a potential new pavement option for Arizona's highways, ADOT asked ASU researchers to test if the new pavement surface would impact the pollution associated with tire wear and the lifespan of travelers' tires.

Among the researchers were Matthew Fraser, a professor of sustainable and environmental engineering in the Ira A. Fulton Schools of Engineering at Arizona State University, Hasan Ozer, a Fulton Schools associate professor of civil, environmental and sustainable engineering, and Pierre Herckes, a professor in ASU's School of Molecular Sciences.

In a recent publication in the scientific journal Atmosphere, the researchers reported detecting no difference in pollution between the old and new pavements, but they observed a phenomenon in their data that has them questioning the methods for modeling emissions in urban areas.

"ADOT asked us to quantify if the switch in paving surfaces would impact tire wear," Fraser says. "What we found was that standard practices in modeling emissions might not properly assess the extent of tire wear."

Exhausting every option

As various transportation industries switch to electric vehicles, researchers are directing their attention to investigating non-exhaust emissions, such as those generated by brakes and tires.

The textured patterns on tires, known as tread, increase friction with roads — thus enabling a vehicle to reduce speed and stop effectively. As the tread wears down over time, it releases heavy metals and microplastics into the environment. Furthermore, electric vehicles tend to be as much as 40% heavier than traditional cars, leading to an increase in torque-induced responsiveness, friction and tire wear.

“We know tire treads wear down over time, but people don’t often question where the tread goes,” Fraser says. “They become particles that end up in the roadway and atmosphere, sometimes getting washed out into streams.”

When faced with new pavement options, ADOT assembled an interdisciplinary team of specialists in asphalt, air quality and atmospheric chemistry in Ozer, Fraser and Herckes to ensure the switch from asphalt to diamond grind concrete wouldn’t generate a negative environmental impact even while realizing benefits like noise control, safety and sustainability.

Treading into new territory

Accurately mimicking the unique driving styles of Arizonans proved to be a significant hurdle. Fraser says that because most tire wear research is conducted in lab settings, data collection is a challenge.

Different tire manufacturers use different materials during production, which complicates the process of selecting the specific additives, known as tire markers, that should be tracked for analysis. One popular class of tire markers is benzothiazole, though it only accounts for 0.5% of the tire material and was confirmed to be toxic for fish when rain runoff carries the microplastics into rivers.

On top of that, drivers seldom operate vehicles consistently or in the same way. Whether drivers are distracted, stuck in gridlock traffic or driving the speed limit, the user experience of driving is hardly uniform enough to replicate in a controlled environment.

“Most research on tire wear is conducted in a lab or tunnel, but even then, bits of the tire get stuck in the tubes of sensors and are challenging to catch,” Ozer says. “To test the realities of the pavement per ADOT’s requirements, the lab wasn’t an option for us.”

The team had to get creative to test on-site at various highway locations, deciding to normalize their data by simultaneously lighting road flares with known emissions to standardize their data collection.

“It’s much more challenging to track tire markers in an open environment like a highway because the tire markers are going everywhere,” Ozer says. “The flares were a very smart way to establish a baseline.”

They factored in different traffic levels, seasons and roadways for 18 months. The team collected data by setting up their instruments on freeway overpasses during rush hour traffic on Arizona’s highways in the Phoenix metropolitan area. Their data suggested no significant difference in tire emissions between the two pavement surface types, though they uncovered an abnormal phenomenon that challenges established methods for modeling emissions.

'State-of-the-science'

The current standard for emissions modeling is the Motor Vehicle Simulator, known as MOVES, which estimates emissions for mobile sources at the national, county and project levels for criteria air pollutants, greenhouse gases and air toxics. Though this model is widely used on a national scale, it is classified as “state-of-the-science” instead of “state-of-the-art” due to its limited transferability and assessment capabilities.

“We expected the high summer temperatures to have some impact but didn’t quite anticipate how dramatic it would be until we started doing the winter sampling,” Fraser says. “The winter data showed drastically fewer — but still proportional — amounts of tire markers.”

The researchers didn’t observe a difference in tire wear between the types of asphalt ADOT asked them to compare; however, the data reflected a marked contrast in winter and summer emissions that was lower than most common values found in the established literature.

“A lot of models are based on relatively limited data and extrapolated over a national scale,” Fraser says. “It was not entirely unexpected that the emissions were significantly lower than was predicted by MOVES, but not to this scale.”

The researchers speculate the abnormality could be caused by a shift in particle distribution in wintertime, given that colder temperatures make tires more brittle and could have made the particles break off in larger chunks than the sampling devices could detect. Still, the discrepancies in their data highlight the shortcomings of the MOVES model.

“We are learning how difficult it is to measure tire wear in active environments, but it is necessary,” Ozer says. “There needs to be a continuous effort in capturing these particles more accurately in different seasons and climates.”

Road work ahead

While confirming that the more durable diamond ground concrete paving surface does not increase the rate at which tire wear particles are released into the environment, the team’s breakthrough into active, open-field data collection highlights the need to advance modeling methods and improve observational databases.

Herckes says that the main accomplishment was capturing real driving conditions and initiating a conversation about accurate emissions modeling.

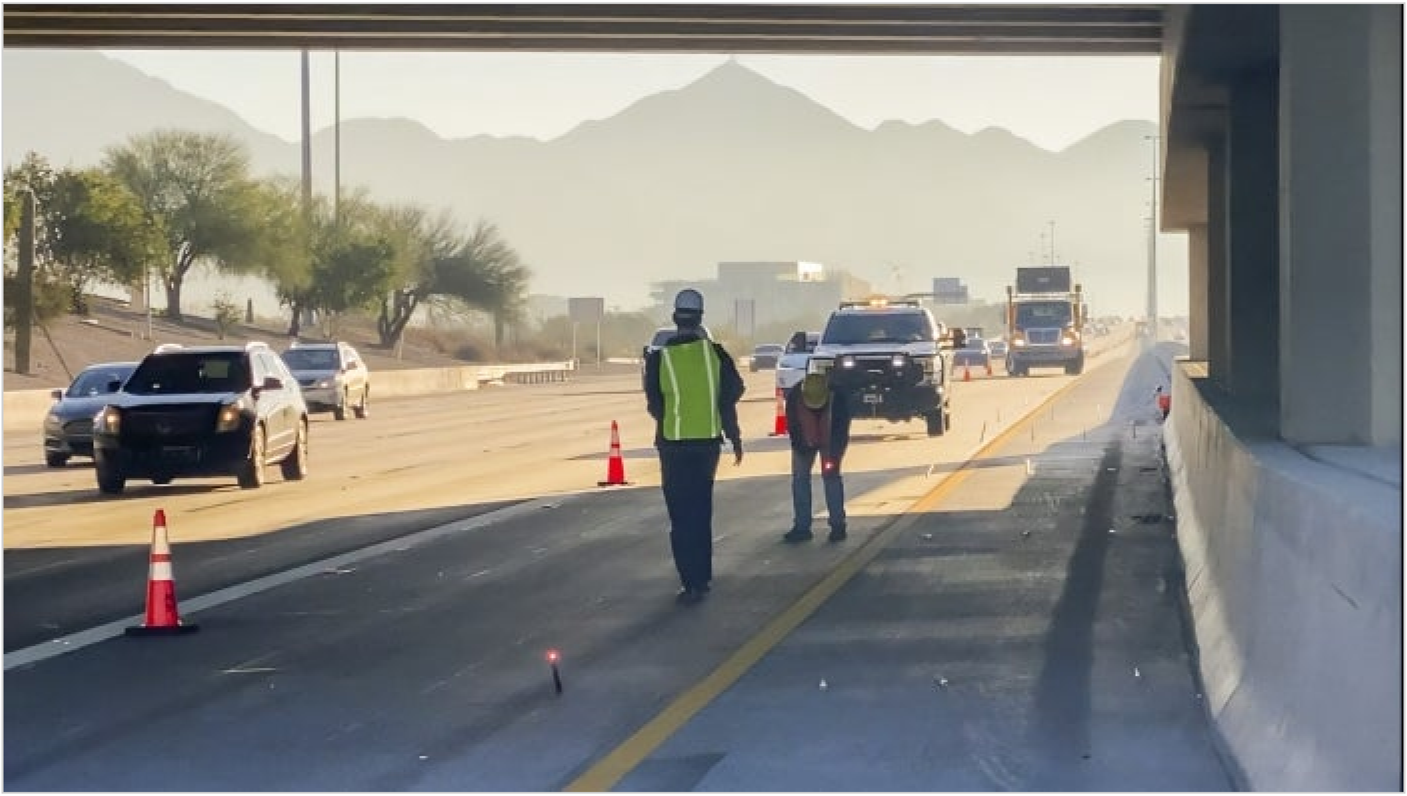
“We could find out that the model just doesn’t work in Arizona or that it works perfectly in Massachusetts, but we need to face what we don’t know,” Herckes says. “In the meantime, tire wear emissions will become more important and abundant as we use more electric vehicles.”

The researchers are interested in testing tire markers at various distances from roads to observe how concentrations of emissions disperse. While they focus on validating and verifying their work in Arizona, they encourage other researchers to validate the emissions modeling methodology in other climates.

“We need more studies in this area to perfect this field measurement technique,” Ozer says. “This is only the beginning — no research concludes everything by itself. We are tossing the ball to the next researchers to improve the field measurement technique for a phenomenon that’s going to be more and more important in quantifying vehicle emissions in increasingly populated urban spaces with more EVs of all sizes and shapes getting into the market.”

This story originally appeared on ASU News.

Main image



During a collaboration with the Arizona Department of Transportation to assess pavement attributes, ASU researchers collected data that challenges current standards for emissions modeling. Photo courtesy of Hasan Ozer

Text image(s)

Researchers lit road flares at the Sweetwater Road and the 101 highway to standardize the data. Photo courtesy of Hasan Ozer.