High-resolution Measurement of Transit Riders' Extreme Heat Exposure across U.S. Cities

Recipient/Grant (Contract) Number: University of New Orleans; University of Florida/69A3552348337

Center Name: Center for Transit Oriented Communities (CETOC)

Research Priority: Preserving the Environment

Principal Investigator(s):
Xiang 'Jacob' Yan; University of Florida; xiangyan@ufl.edu; ORCiD: 0000-0002-8619-0065
Wesley Marshall, Department of Civil Engineering, University of Colorado Denver, wesley.marshall@ucdenver.edu, 0000-0002-3106-7342
Aditi Misra, Department of Civil Engineering, University of Colorado Denver, aditi.misra@ucdenver.edu, 0000-0002-5600-5973
Manish Shirgaokar, Department of Urban and Regional Planning, manish.shirgaokar@ucdenver.edu, 0000-0001-6458-1885

Project Partners: Two Florida transit agencies, Gainesville Regional Transit System and Miami-Dade Transit, will be engaged in this project. Moreover, two external researchers will collaborate on this project, including Xiaojiang Li (University of Pennsylvania) and Rafael H.M. Pereira (Institute of Applied Economic Research, Brazil).

Project Funding: $150,000 (USDOT) + $75,000 (matching funds) = $225,000

Project Start and End Date: 10/1/2024 – 5/31/2026

Project Description: Extreme heat events pose severe risks to public health and urban infrastructure. Public transit riders, especially in densely populated urban areas, are disproportionately affected by heat due to factors such as extended outdoor times, high urban temperatures, and inadequate heat-mitigating infrastructure. The challenges posed by increased heat events require that public transit systems also adapt to these environmental and sociodemographic changes. However, very few studies focus on the heat exposure of public transit riders. The challenges are twofold. First, prior studies do not consider exposure time as a factor in the calculation of heat exposure. With the longer walking and waiting time due to public transit's low reliability and first/last-mile problem, exposure time can be as important as the temperature. Second, there is a lack of high-resolution thermal comfort data at the individual level to sustain this measurement. Prior studies largely use air or ground temperature as the proxy of personal thermal comfort, which is not accurate enough to represent public transit riders' experience. To calculate a high-fidelity, high-resolution exposure during each transit trip, we need to calculate the fine-grained transit time and the corresponding thermal comfort temperature. To address these gaps, we propose a new system – Transport Heat Exposure Index (THEI) – as a comprehensive approach to quantify and analyze heat exposure across public transit systems. With high-performance computation and deep learning techniques, we will process high-resolution (1 meters) historical meteorological data, public transit General Transit Feed Specification (GTFS) schedule and real-time data, and urban 3D built environment data, including bus stops shelter, street-level tree canopy, buildings, and sidewalk inventory. The objective of this research is to develop a state-of-the-art framework to gauge high-resolution heat exposure of transit riders when accessing to different destinations with urban microclimate modeling and detailed transit network routing techniques. With the empirical findings and the methods, researchers and policymakers can more effectively understand heat exposure nuances and devise strategies to mitigate its public and urban impacts. Such insights will foster targeted interventions and informed planning, enhancing community resilience against escalating extreme heat events.

USDOT Priorities: Our project's focus on measuring and mitigating heat exposure in public transit systems is critical for developing heat-resilient infrastructure. The use of advanced urban microclimate simulation techniques and the consideration of tree canopies and building shades in our analysis contribute to designing infrastructure that can withstand the impacts of extreme heat. It addresses a critical but underexplored issue—heat exposure in public transit systems—using advanced, high-resolution data analysis and simulation techniques. The development of the Transit Heat Exposure Index (THEI) and the comprehensive analysis of heat exposure sources represent significant advancements in the field. This approach not only provides novel insights into the challenges of heat exposure in urban environments but also offers practical tools for policymakers and urban planners to develop targeted interventions.

Outputs: 1) A new methodology to measure transit-based heat exposure by analyzing GTFS, high-resolution meteorological data, and built environment data; 2) A new framework to guide city planners and transit authorities understand heat exposure and simulate the effects of potential changes in infrastructure or service patterns; 3) A comprehensive transit heat exposure database available to the public; 4) A final technical report to outline our findings and provide practical insights for transit authorities and city planners; 5) 1 - 2 manuscript(s) for publication and presentation.

Outcomes/Impacts: The main output of this project will be a transit heat exposure index database for cities across the US. The development of the Transit Heat Exposure Index (THEI) could lead to new guidelines or standards for managing heat exposure in public transit systems, influencing both local and national transportation policies. The implementation of the THEI system could significantly help bus shelters and transit stops redesigns, potentially including features like solar-powered fans or water mist systems. By reducing the risk of heat-related illnesses among transit users, the project enhances the overall safety and health of the public transit environment. The system can also improve thermal comfort and increase public transit ridership and satisfaction, thereby enhancing the reliability and quality of transit services. Effective heat mitigation strategies can also lead to cost savings by reducing the healthcare burden from heat-related illnesses and lowering energy costs through more efficient infrastructure design.

Final Research Report: (Link to be provided after project completion).