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Title: Impact of Photovoltaic Canopy Shade on Outdoor Thermal Comfort in a Hot Desert City

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Shade plays an important role in designing pedestrian-friendly outdoor spaces in hot desert cities. This study investigates the impact of photovoltaic canopy shade on thermal comfort through microclimate observations and field surveys at a pedestrian mall on Arizona State University's Tempe campus. Six stationary sensors under solar canopies and in nearby sun-exposed and tree-shaded locations monitored 5-min temperature and humidity for a year. On selected clear calm days representative of each season, we conducted hourly microclimate transects from 7:00AM to 6:00PM and surveyed 1284 people about their thermal perception, comfort, and preferences. Shade lowered thermal sensation votes by approximately 1 point on the Likert scale, increasing thermal comfort in all seasons except winter. The shade type (tree or solar canopy) did not significantly impact perceived comfort, suggesting that artificial and natural shade are equally efficient in semi-arid desert environments. Globe temperature explained 50% of the variance in thermal sensation votes and was the only statistically significant meteorological predictor. Important non-meteorological factors include adaptation level, gender, thermal comfort vote, thermal preference, season, and time of day. A regression of perceived comfort on Physiological Equivalent Temperature yielded a neutral temperature of 28.6°C. The acceptable comfort range was 19.1°C-38.1°C with a preferred temperature of 20.8°C. Respondents exposed to above neutral temperatures felt more comfortable if they had been in air-conditioning 5 minutes prior to the survey, indicating a lagged response to outdoor conditions. Our study highlights the importance of active solar access management in hot urban areas.