Monitoring the Urban Heat Island Effect and the Efficacy of Future Countermeasures

The Issue

The prevalence of dark, dry surfaces and man-made heat in cities creates urban heat islands (UHIs) of elevated near-surface air temperature. Urban heat island countermeasures, such as reflective surfaces and urban vegetation, can save cooling energy, promote indoor and outdoor thermal comfort in summer, reduce air-pollutant emissions, improve health, and locally offset climate change. Real-world observations and fine-resolution modeling of UHIs are needed to assess the potential benefits and performance of future UHI mitigation programs.

Project Description

This project improved understanding of the variability in near-surface air temperature within Los Angeles, including its dependence on roof reflectance and tree cover. In collaboration with local governments and organizations in the Los Angeles Basin, the team designed and installed several research-grade stationary weather monitors, supplemented with mobile monitoring and data from existing weather station networks. These measurements were used to (a) assess spatial and temporal variations in near-surface air temperature; (b) evaluate the effects of UHI countermeasures, such as cool surfaces and urban vegetation; and (c) validate the climate/meteorological models so that they can be applied in the future to assess potential benefits of UHI countermeasures throughout the State.

The project

- identified and characterized two study regions in the Los Angeles Basin;
- developed a monitoring plan, designed instrumentation, installed stationary weather monitors, and conducted mobile transects to measure the air temperature variations in the selected study regions; and
- collected and analyzed weather data from stationary and mobile monitors.

An innovative aspect of this study is that the siting of sensors and integration with the wider existing monitor networks was guided by meso-urban modeling, building upon work performed for the California Environmental Protection Agency in developing an urban heat island index. In turn, the observational datasets generated in this study were used to validate the fine-resolution models so that they can be applied to other locations in California.

The team's calibrated meteorological model accurately identified the localized urban heat and cool islands observed in this study. Interested stakeholders/researchers can use the same modeling approach and calibration/validation methodologies to characterize the intra-urban microclimate variations elsewhere in California, and apply them to analyze the benefits of UHI countermeasures.

This study provided the first observational evidence from analysis of a network of personal weather stations that increases in roof albedo at neighborhood scale are associated with reductions in near-surface air temperature. This was corroborated by the analysis from mobile transect measurements and correlation of observed air temperature with neighborhood-scale albedo and vegetation canopy cover. The latter revealed a cooling effect from area-wide increase in albedo and/or canopy cover.

Mobile monitor on quick-install roof mount. Inset at upper right shows high-accuracy temperature sensor centered in white solar shield.

Anticipated Benefits for California

Extensive prior research indicates that the UHI mitigation attainable through cool community strategies, such as cool roofs, cool pavements, and urban vegetation, can save electricity, reduce peak power demand, and lower strain on the electrical grid. The work performed in this project helps maximize the benefits from future UHI countermeasures by (a) verifying through modeling and measurements the relationships between the urban heat island effect and land use/land cover; (b) using the measurements to calibrate and validate the models used to estimate the benefits of UHI mitigation measures; and (c) leaving in place a set of research-grade weather monitors that can be used to track changes in urban temperatures. All of this will further facilitate a more region-optimized deployment of UHI mitigation technologies and thus maximize the benefits to the California ratepayers.

Project Specifics

Contractor:	Lawrence Berkeley National Laboratory
Subcontractors:	Altostratus, Inc. and University of Southern California
Partners:	Los Angeles Regional Collaborative for Climate Action and Sustainability
	Los Angeles Department of Water and Power
	Office of Los Angeles Mayor Eric Garcetti
	Los Angeles Unified School District
Amount:	$500,000
Co-funding:	$4,000 from Altostratus, Inc.
Term:	July 2015 to December 2018