The Writing's on the Wall
Recent Cool Wall Research and Measures

February 22, 2018

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Urban Climate and Other Co-benefits

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Investigating the Influence of Cool Wall Adoption on Climate in the Los Angeles Basin

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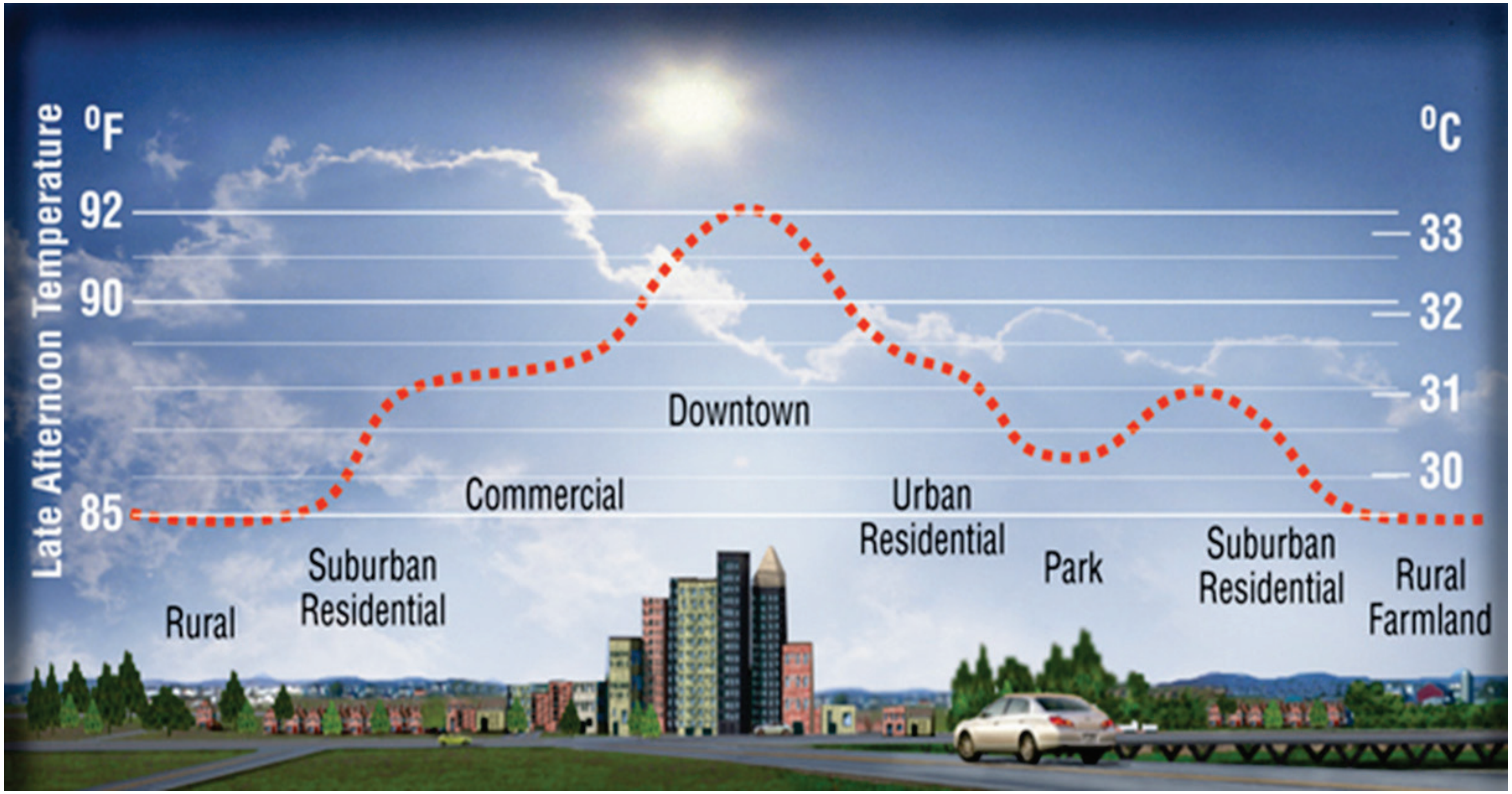
The urban heat island (UHI) effect describes cities being warmer than rural surroundings



City dwellers are facing severe heat-related challenges

Adverse impacts of UHI:

Heat stroke & exhaustion

Summertime peak energy use

Some strategies for reducing urban heat

Cool (reflective) roofs

Cool pavements

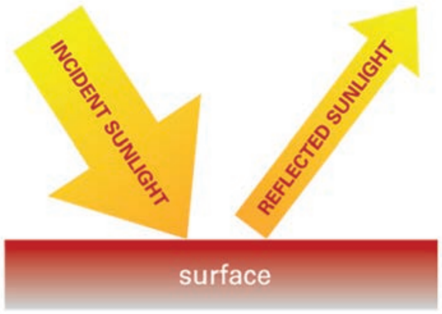
Vegetative roofs

Street level vegetation

Some strategies for reducing urban heat

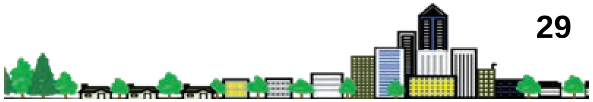
What about solar reflective cool walls?

Have not yet been systematically investigated



High albedo (a.k.a. solar reflectance)

Albedo: The ratio of reflected to incident sunlight

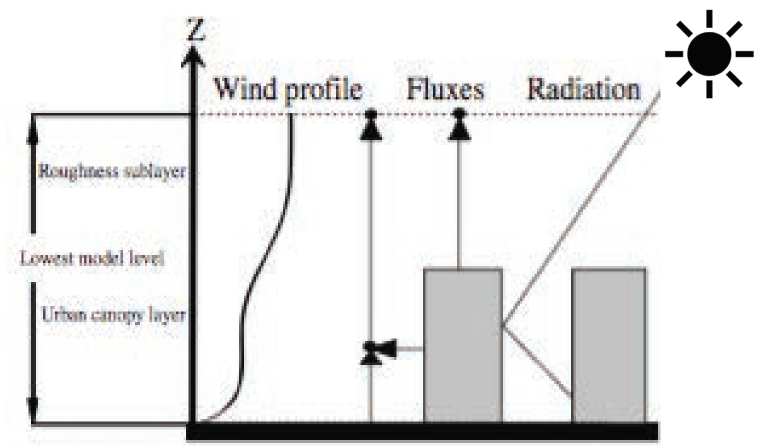


Research goals

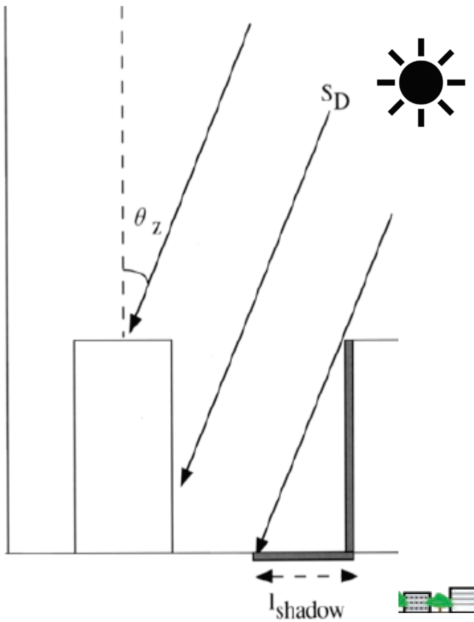
- Quantify the climate effects of hypothetical cool wall adoption in the Los Angeles basin
    - Increases in reflected sunlight out of the city
    - Air temperature reductions in urban canyon
- Compare the climate effects of cool walls to cool roofs

We use a WRF Single Layer Urban Canopy Model for our climate simulations

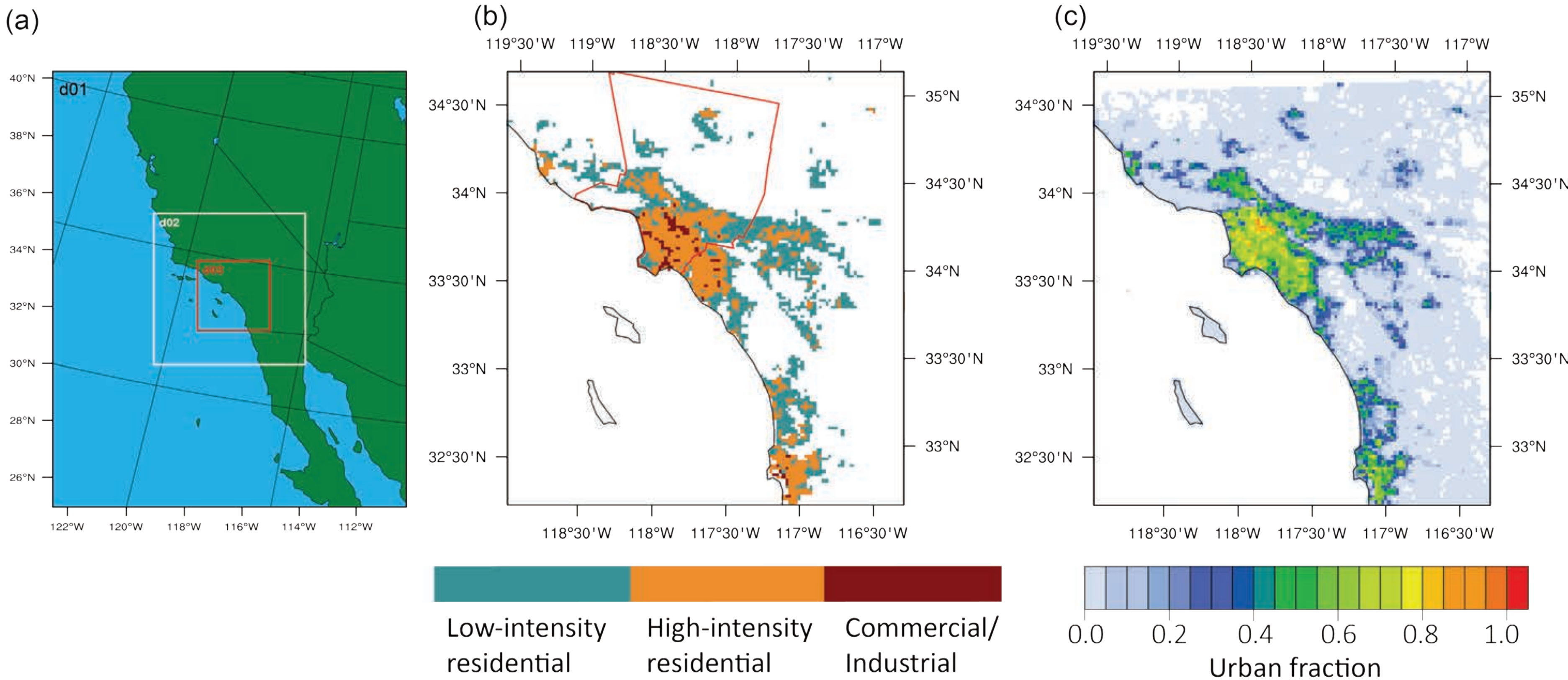
- Weather Research & Forecasting (WRF) model (Version 3.7)
- National Land Cover Database land use classification
- Single layer urban canopy model used for urban grid cells



Single Layer Urban Canopy Model (SLUCM)



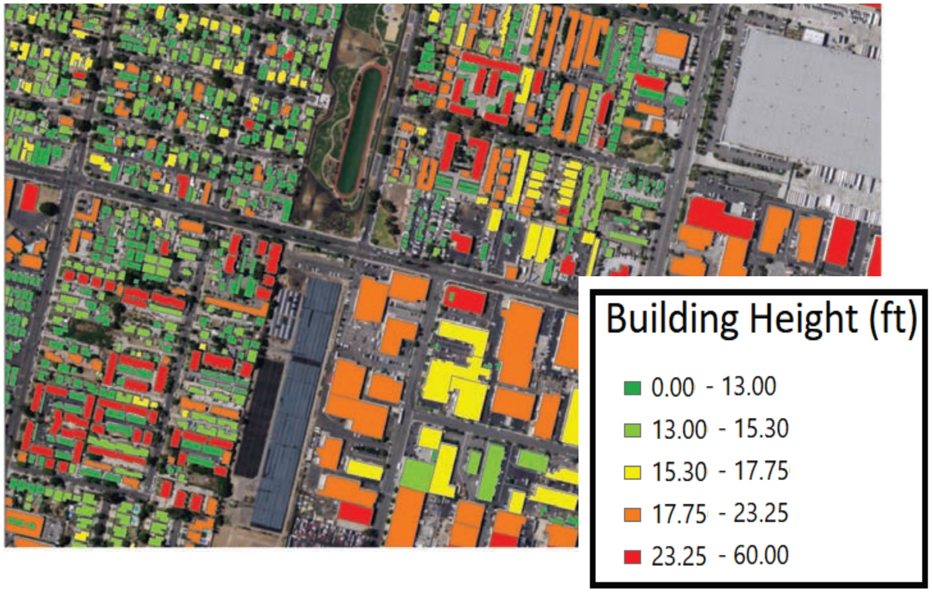
Domain/configuration for WRF simulations



Deriving realistic urban morphology per urban land use type

Ground width, roof width, and building height are derived from Los Angeles Region Imagery Acquisition Consortium (**LARIAC**) program

- Building data (footprint and height for each building in Los Angeles County)
- Street centerlines



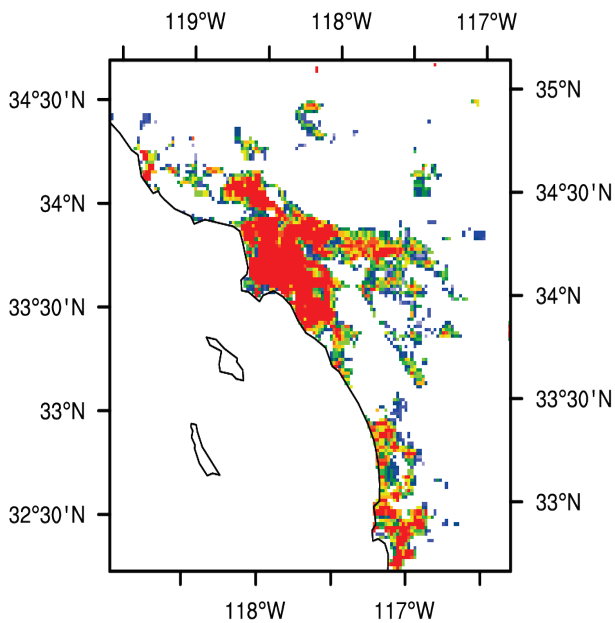
Simulated scenarios

Scenario	Wall albedo	Roof albedo
CONTROL	0.10	0.10
COOL_WALL_LOW	0.50	0.10
COOL_WALL_HIGH	0.90	0.10
COOL_ROOF_LOW	0.10	0.50
COOL_ROOF_HIGH	0.10	0.90

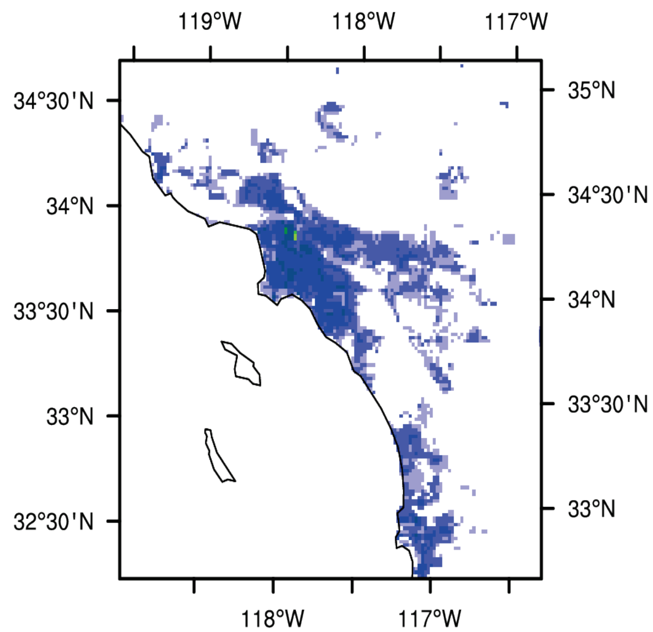
- Simulated July 2012
- Ground albedo = 0.10 in all cases
- We simulated three ensemble members per case

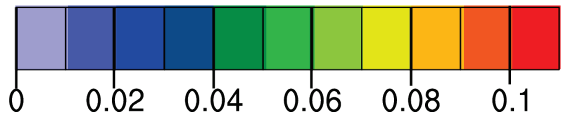
Grid cell albedo increases from cool walls are largest in the early morning (and late afternoon) where urban fraction is highest

6 am Local standard time



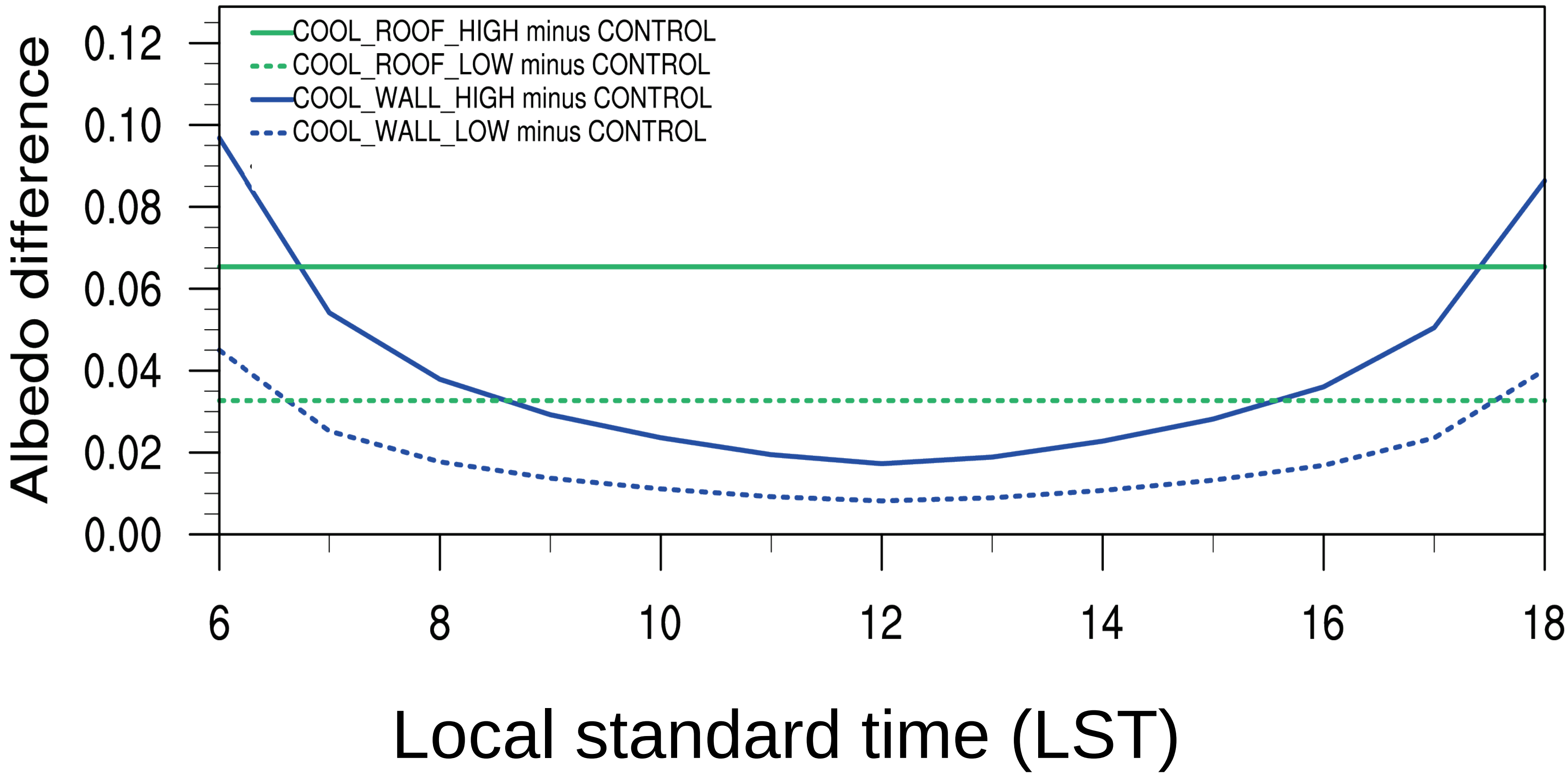
12 pm Local standard time





Change in grid cell albedo

Grid cell albedo increases from cool walls are larger than from cool roofs in the early morning and late afternoon



The daytime cumulative increase in reflected solar radiation induced by cool walls is 43% of that induced by cool roofs

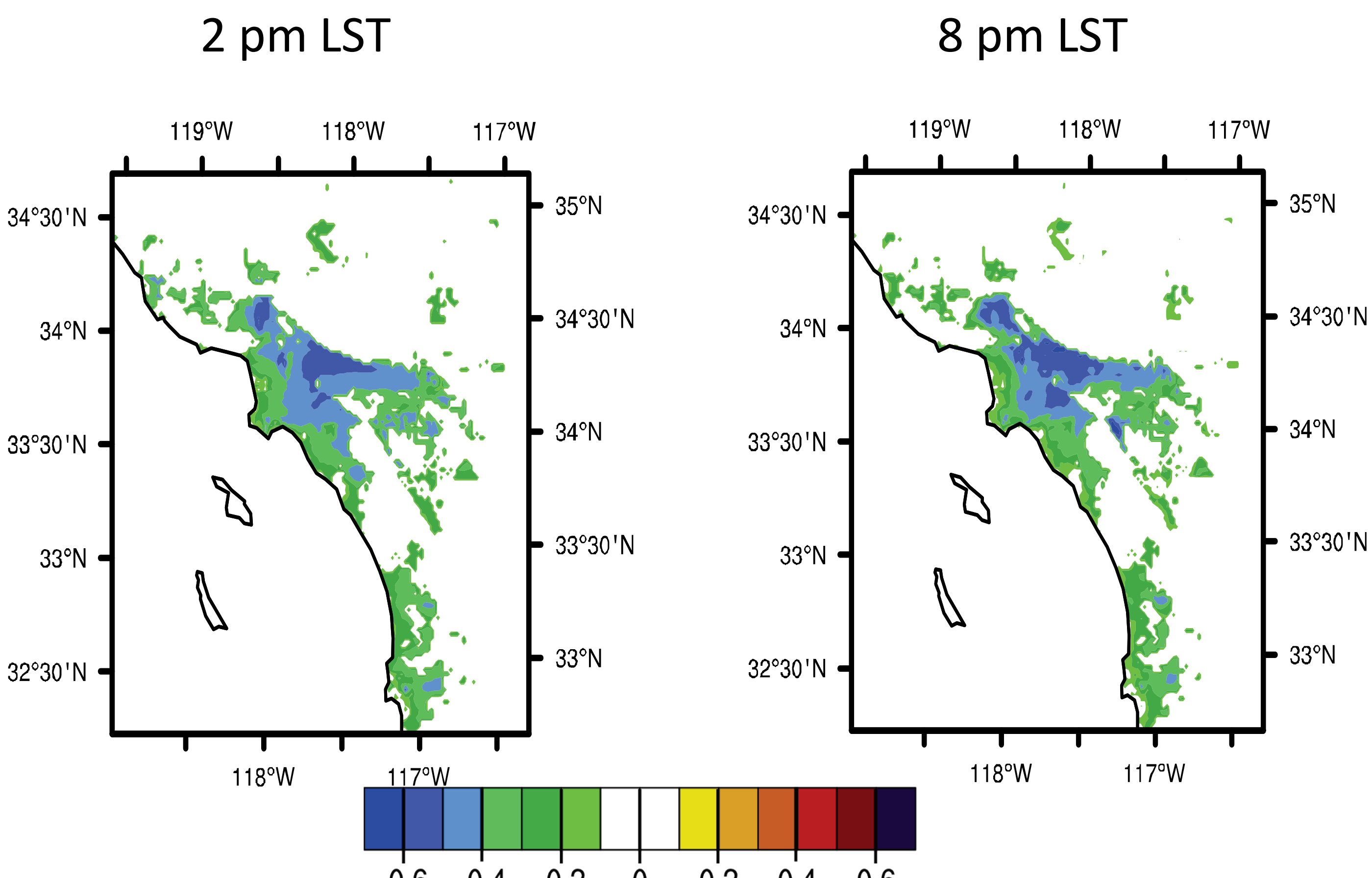
- Solar irradiance (W m^{-2}) on walls is about 40% that on roofs in July in LA County
- Net wall area (excluding windows) is about 60% greater than roof area in Los Angeles
- Solar radiation that is reflected by walls is partially (50-59%) absorbed by opposing walls and pavements, while that reflected by roofs escapes the canopy.

Daytime cumulative increase relative to CONTROL

COOL_WALL_HIGH: 783 kJ m^{-2}
COOL_ROOF_HIGH: 1840 kJ m^{-2}

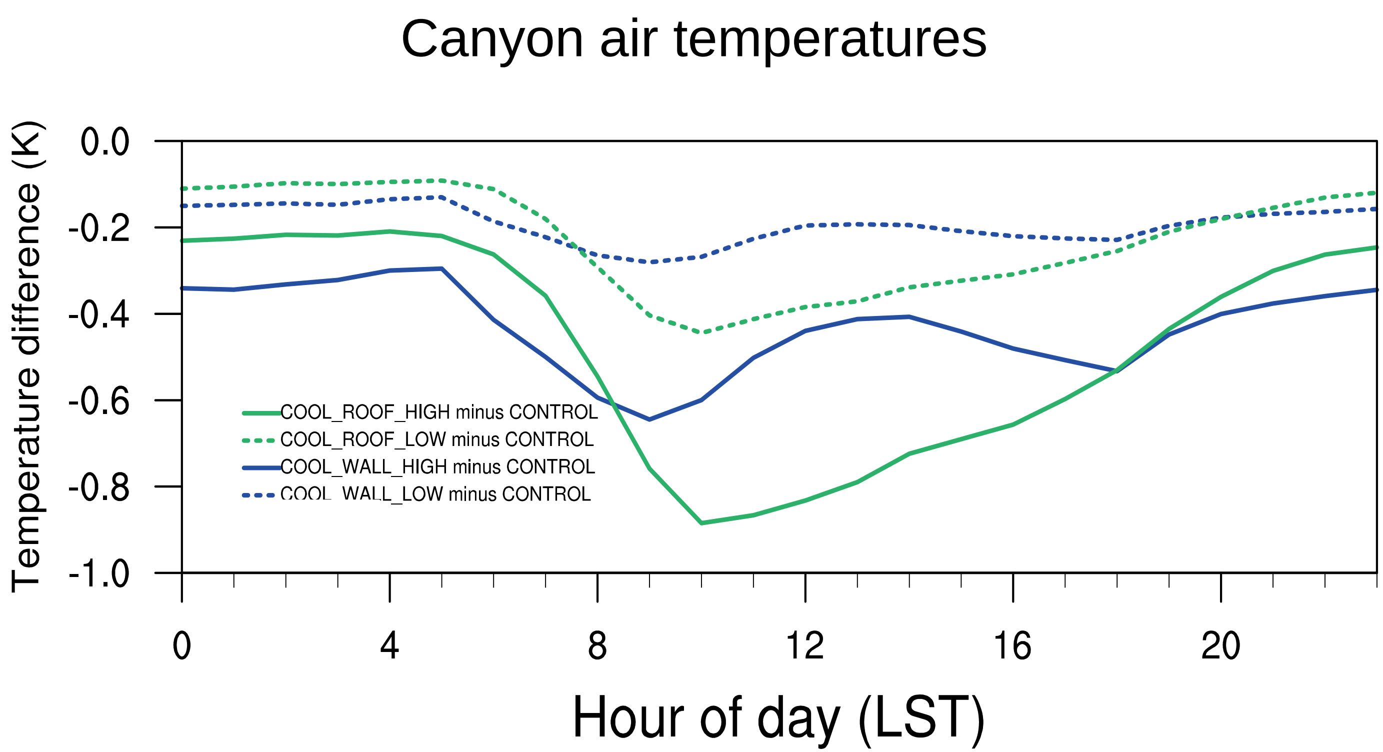
Cool walls reduce canyon air temperatures throughout the LA basin

Implemented a new parameterization to diagnose "canyon" air temperature (Theeuwes et al., 2014)



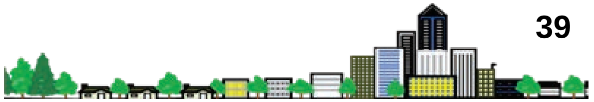
Change in canyon air temperature (K)

Cool walls lead to less cooling than cool roofs for most daytime hours



Major contributors to the shape of diurnal cycle:

- Increase in reflected solar radiation
- Planetary boundary layer height (peak at 1 pm)
- Accumulation of solar heat gain



Daily average temperature reduction per 0.10 facet albedo increase

Scenario	Daily average canyon air temperature reduction (K) per 0.10 albedo increase
COOL_WALL_LOW	0.048
COOL_WALL_HIGH	0.054
COOL_ROOF_LOW	0.057
COOL_ROOF_HIGH	0.059

Conclusions – climate in LA county

- The daytime cumulative increase in upwelling sunlight (W m^{-2}) induced by cool walls is 43% of that induced by cool roofs
- Canyon air temperature reductions from cool walls are largest in the early morning and late afternoon
- Daily mean canyon air temperature reductions are similar for cool walls (0.05 K per 0.1 wall albedo increase) and roofs (0.06 K per 0.1 albedo increase)

Acknowledgements

- Research group at USC
- Pouya Vahmani (LBNL)
- Gert-Jan Steeneveld (Wageningen University)
- Joachim Fallmann (Institute of Meteorology and Climate Research, Germany)
- Ravan Ahmadov & Stu McKeen (National Oceanic and Atmospheric Administration)
- Dan Li (Boston University)
- Pablo Rasodo & Haley Gilbert (LBNL)

- South Coast Air Quality Management District and California Air Resources Board

Funding:

FUNDING PROVIDED BY THE CALIFORNIA ENERGY COMMISSION

NSF

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