

# Introduction to Cool Roofs

Phoenix UHITS Subcommittee - May 2021

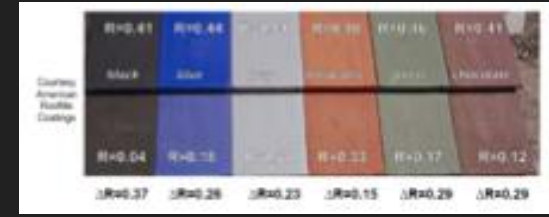
## About Cool Roofs

- Designed with **high solar reflectance**
- Typical roof = 5-15% reflective
- Cool roof = 65%+ reflective
  
- Roofs are 20-25% of land cover
- Converting all roofs is equivalent to a ~0.1 reduction in albedo

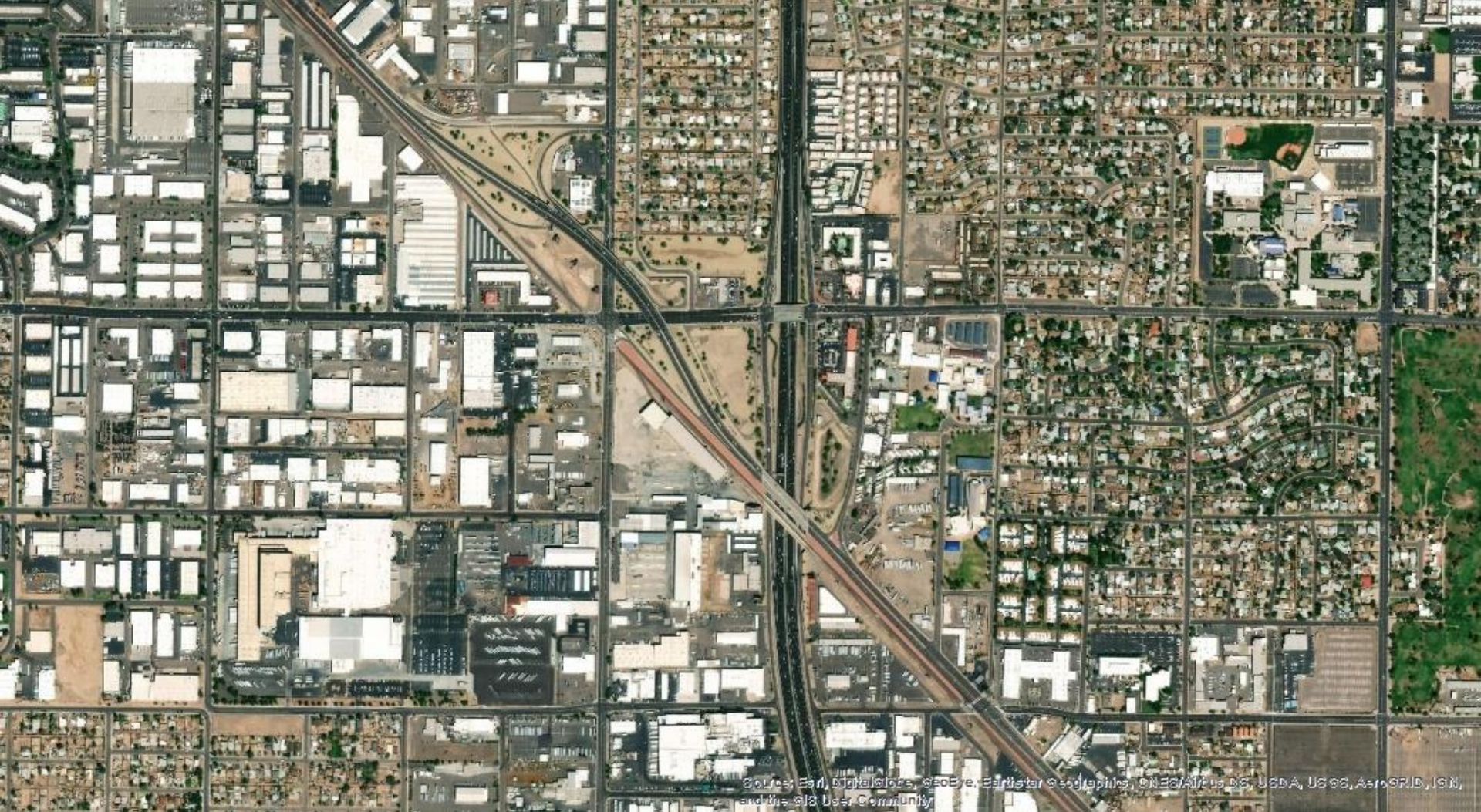
## About Cool Roofs

- Available in a wide variety of materials and colors
- Can reduce cooling bills, improve indoor comfort, and promote longevity of roofing materials
- Contribute to reductions in local air temperature, electricity load management, decreased emissions from power production

# Cool Roof Innovations



- High solar reflectance coatings/membranes (not new)
- Engineered reflectance spectra “cool” coatings with conventional color
- Passive daytime radiative cooling technologies (PDRC) with ultra high solar reflectance and thermal emissivity



Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

# Phoenix Cool Roofs Initiative

- Bloomberg supported grant program, 2013
- 70,000+ square feet of city buildings painted with reflective coating
- 17% reduction in energy consumption for participating buildings



# Cool Roofs in Phoenix Plans

## Land Use and Design Principles

**DESIGN** Encourage bioclimatic designs of buildings and approved natural materials for construction.

**DESIGN** Encourage high-performance building designs that conserve resources, while balancing energy-efficient, water-efficient, cost-effective and low-maintenance engineering solutions and construction products through whole building life cycle assessment.

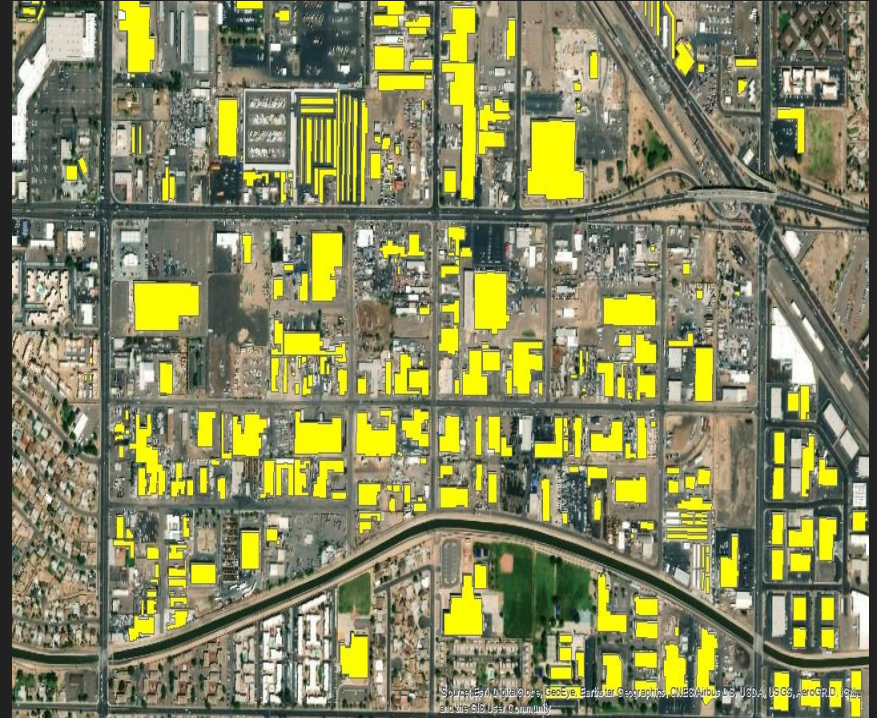
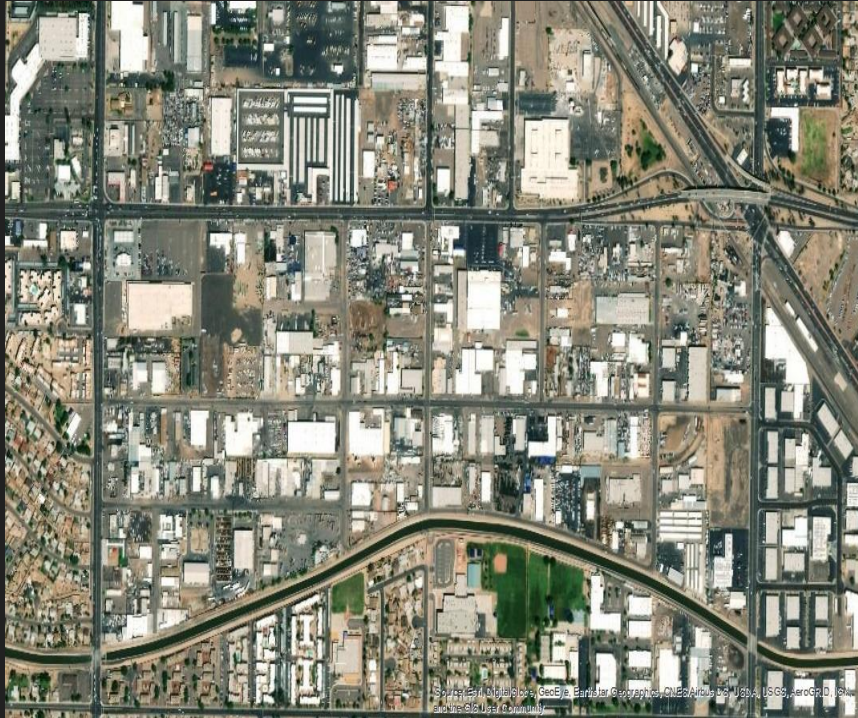
**DESIGN** Promote site development and land use which protects the natural environment by preserving vegetation and surface water, minimizes disturbances to the existing terrain and greenfields, and encourages development of brownfields in synergy to our the desert climate.

**DESIGN** Encourage the use of construction, roofing materials and paving surfaces with solar reflectance the thermal emittance values as shown in the Phoenix Green Construction Code or higher and which minimize heat island effects.

**DESIGN** Discourage the use of reflective glass on commercial properties whenever the commercial structure is adjacent to a residential area.



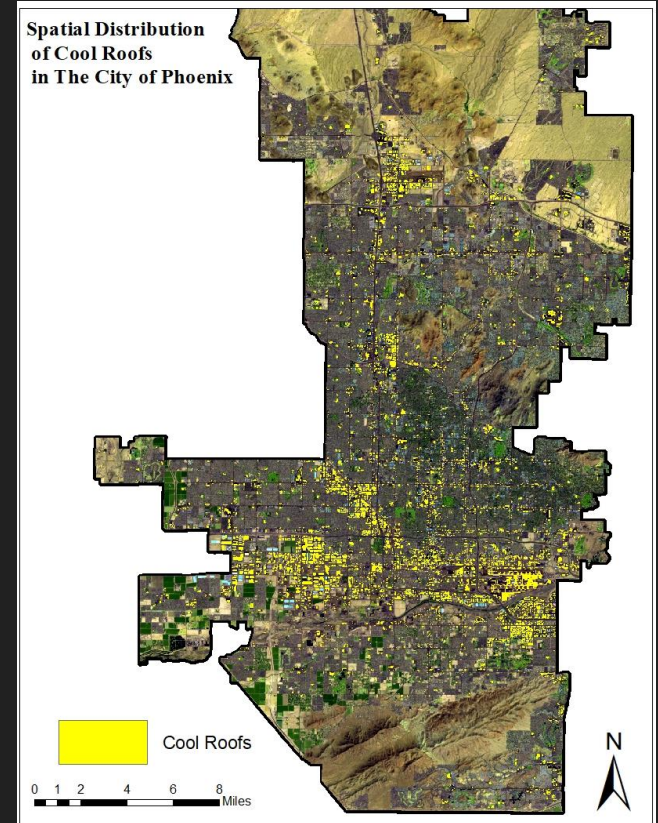
# Phoenix Cool Roof Assessment (ASU class project)



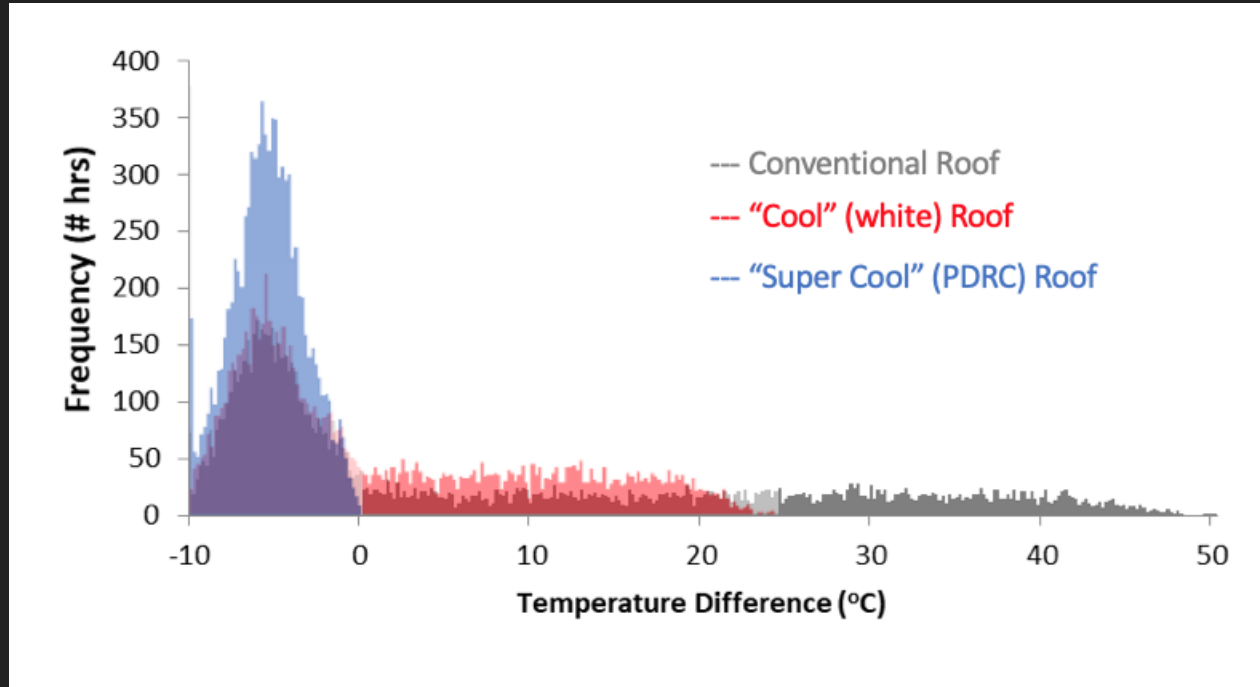


# Phoenix Cool Roof Assessment (ASU class project)

- ~15,000 buildings with cool roofs in Phoenix, roughly 3.5% of all buildings
- Cool roofs evident on a wide range of building sizes, but skewed toward large buildings



# Temperature difference between air and roof surface (Phoenix apartment, throughout the year)

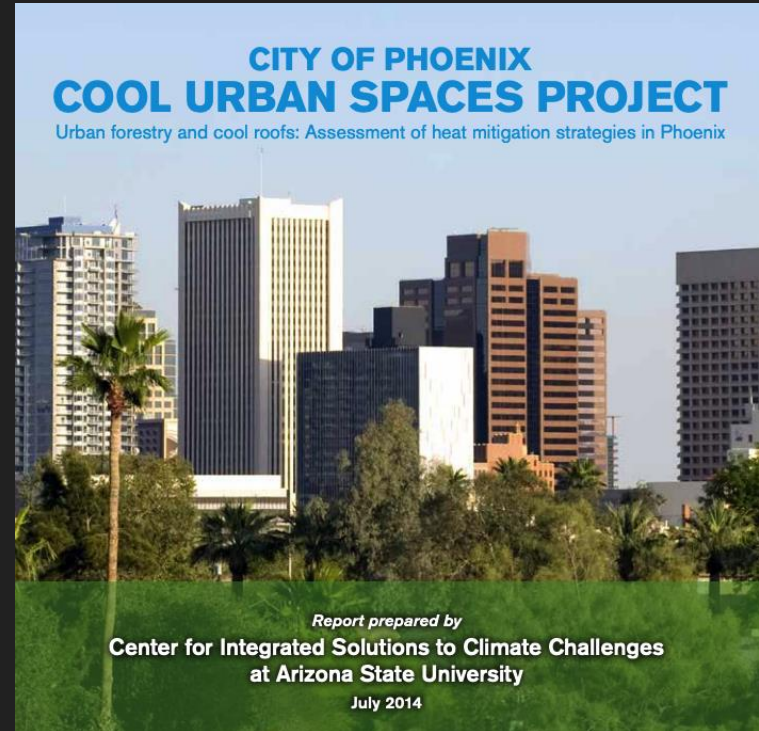


## Scientific Review of Heat Mitigation Studies

- **Albedo Cooling Effectiveness (ACE): 0.2 to 0.6°C (0.4 to 1.1°F) cooling per 0.10 albedo increase in neighborhood albedo**
- **Vegetation Cooling Effectiveness (VCE): 0.3°C cooling per 0.10 increase in (tree) canopy cover**
- Krayenhoff, E.S., A.M. Broadbent, E. Erell, L. Zhao, M. Georgescu, A. Middel, J.A. Voogt, A. Martilli, **D.J. Sailor**, 2021. "Cooling hot cities: A systematic and critical review of the numerical modelling literature," *Environmental Research Letters*, <https://doi.org/10.1088/1748-9326/abdcf1>

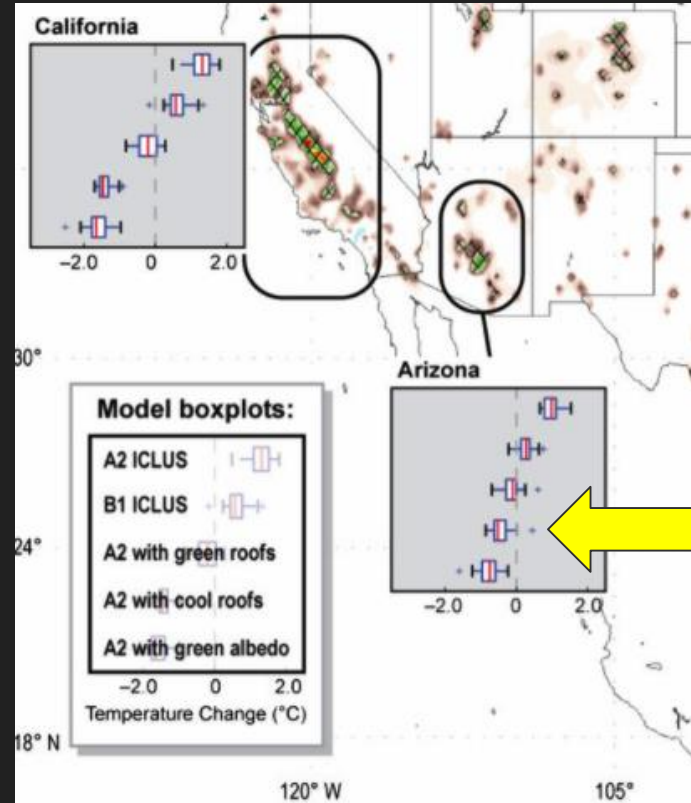
# Phoenix Cool Roof Modeling Study

- “Across all climate and tree scenarios, the effect of cool roofs on local daytime temperatures is relatively low. Air temperature reduction only amounts to 0.5°F (0.3°C) in the neighborhood.”
- Did not investigate potential cooling benefits arising from reduced air conditioner use

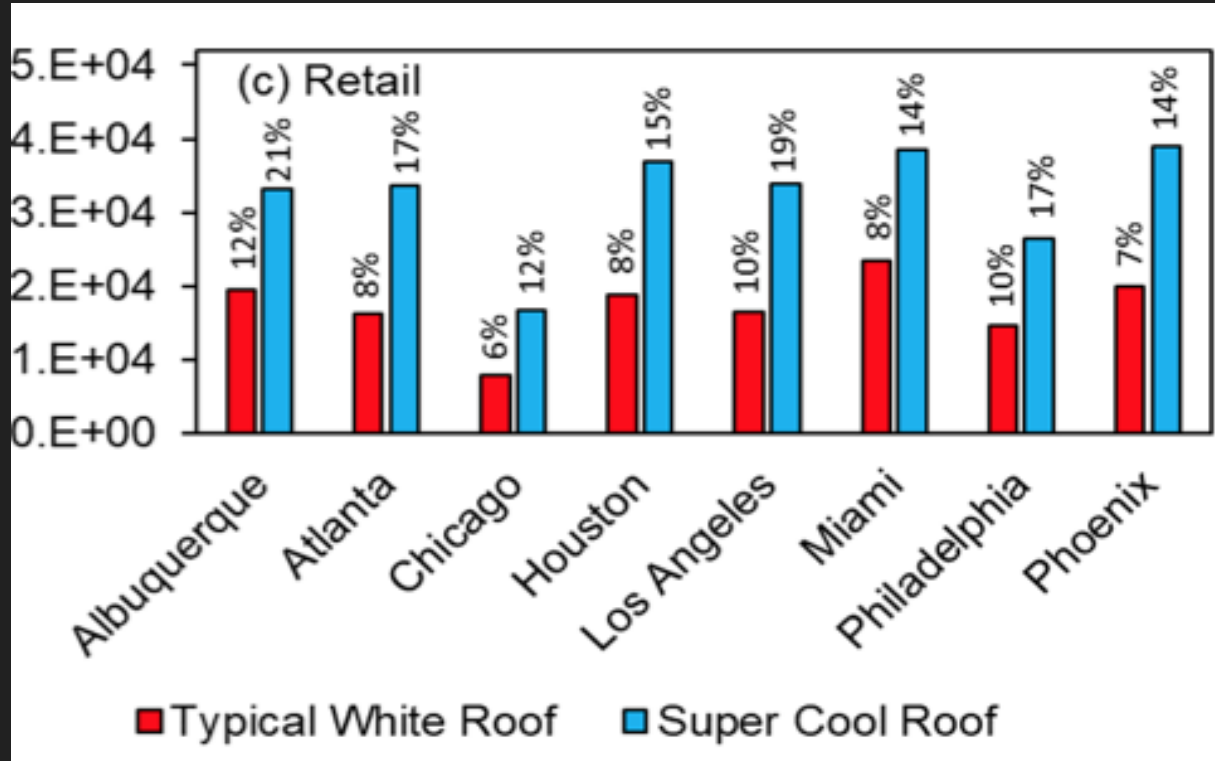


# National Cooling Strategy Modeling Study

- “Simulated cooling for each urban region, however is **greater for the cool roofs relative to the green roofs**, although this difference is accentuated over drier relative to humid regimes”



# Modeling Energy Savings (well insulated buildings)

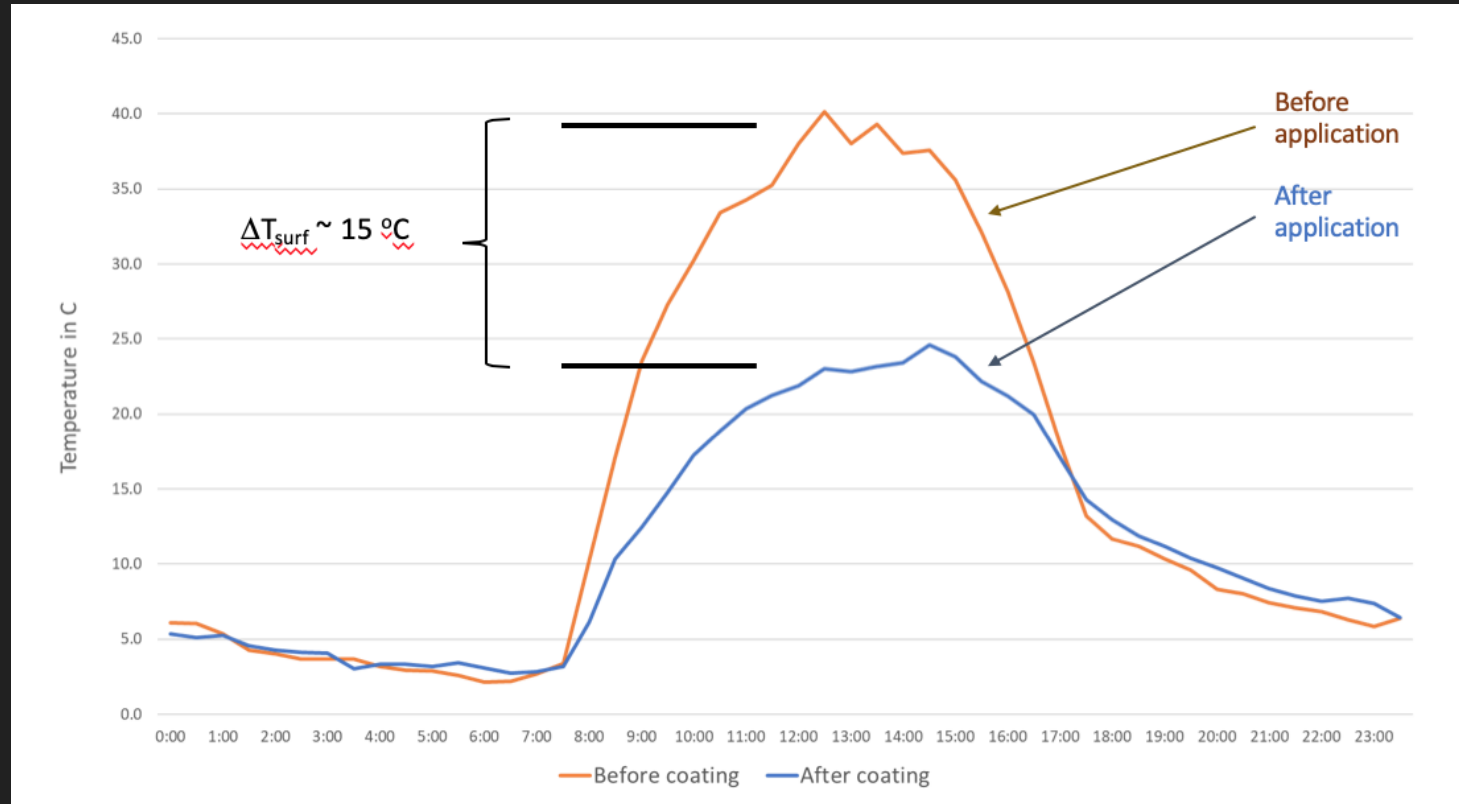


# Radiative Cooling Proof of Concept in Tempe

- Partnership involving ASU, 3M, & City of Tempe, with funding from the Zimin Institute
- Select 3 pairs of control and test shelters
- Modify 3 shelters and monitor performance over a year
  - Surface temperatures
  - Sensible heat fluxes
  - Thermal environment for shelter users
  - Radiative property evolution over time



# Preliminary Results - Winter pre/post application





# Cool Roof Programs

- Mentions in 52 of 175 “big city” plans (50 cities)
- San Antonio “Under One Roof”



CITY OF SAN ANTONIO  
**NEIGHBORHOOD & HOUSING  
SERVICES DEPARTMENT**



**Under 1 Roof**  
Residential Roof Repair Program

The Under 1 Roof Program replaces worn and damaged roofs with new, energy-efficient **white** shingle roofs for qualified homeowners. The City will place a restrictive covenant on the property requiring homeowners to maintain ownership and occupancy for 5 years after project completion.

- California building code requirement
- City of Los Angeles
- Toronto Eco-Roof Incentive Program

## Next steps?

- Gather more examples & impact data from Phoenix area
- Research policy approaches - incentives, mandates, etc.
- Review/revise language for Phoenix website/fact sheet?
- Invite cool roof expert for presentation?
- What else?

## Resources

- [https://www.epa.gov/sites/production/files/2017-05/documents/reducing\\_urban\\_heat\\_islands\\_ch\\_4.pdf](https://www.epa.gov/sites/production/files/2017-05/documents/reducing_urban_heat_islands_ch_4.pdf)
- <https://www.energy.gov/energysaver/design/energy-efficient-home-design/cool-roofs>
- And many, many more public and private organizations