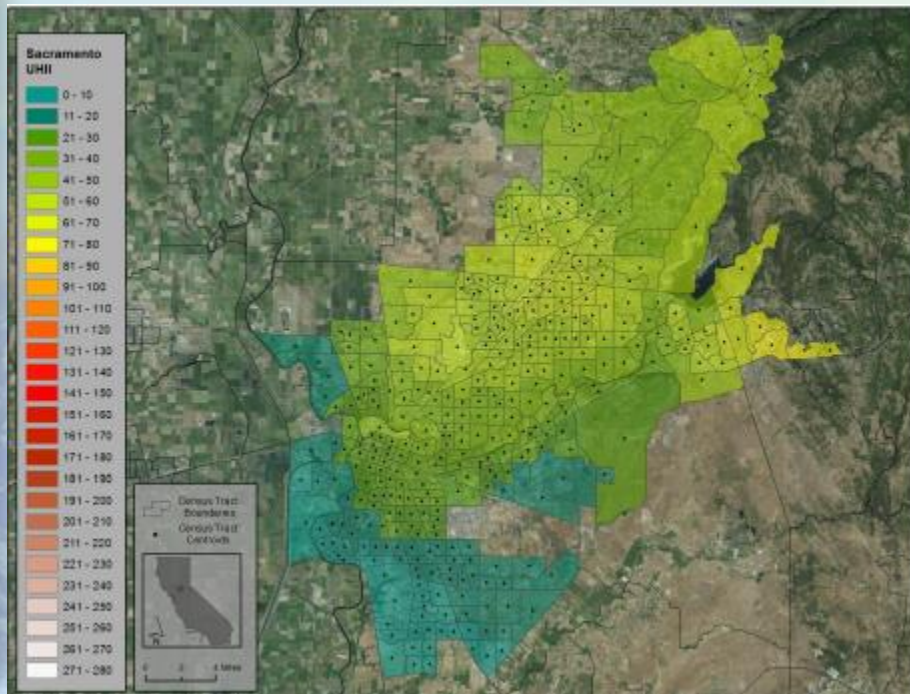


Creating and Mapping an Urban Heat Island Index for California

Bill Dean
California Environmental Protection Agency

April 19, 2016

Climate Action Team
Public Health Working Group



Overview

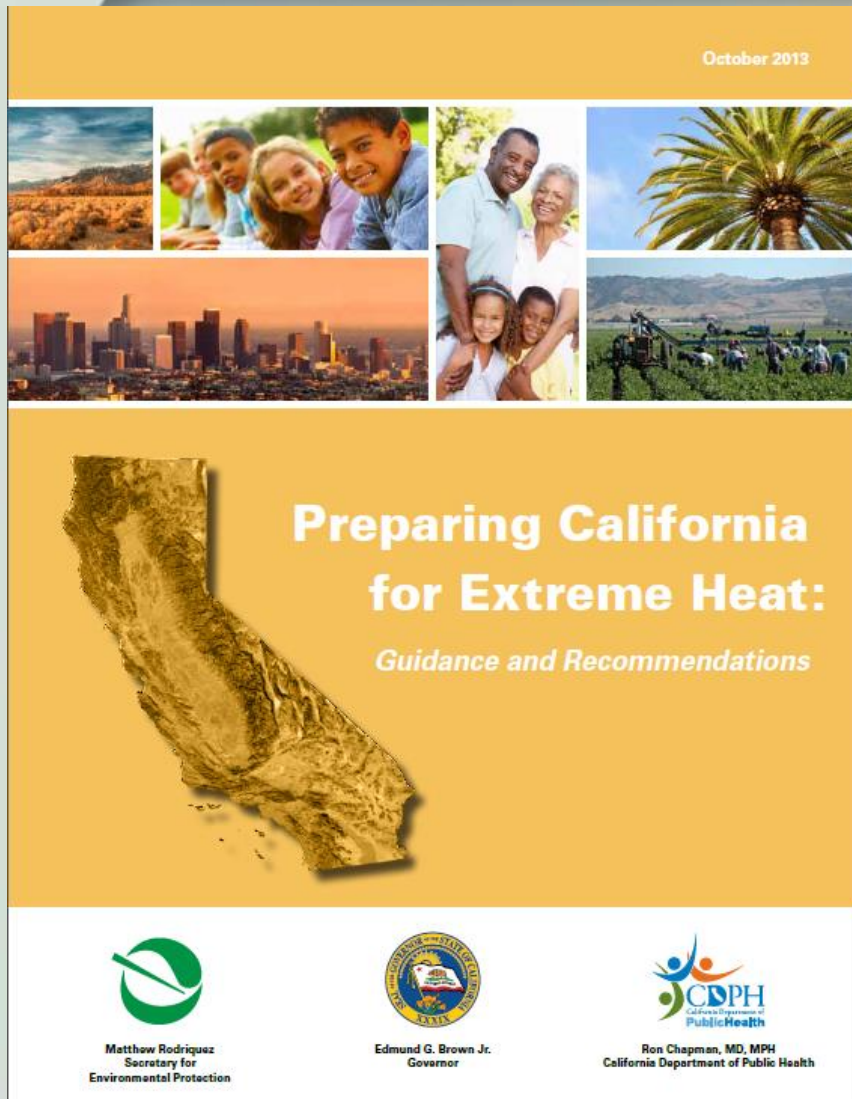
- Urban Heat Island (UHI)
 - Urban regions experience warmer temperatures than their non-urbanized surroundings
 - Caused by light-absorbing, impervious, dry surfaces such as buildings and roads
 - Can impact public health and GHG emissions
- Need to understand the range and extent of UHI in CA to consider Cool Communities policies that increase albedo and vegetation.

Catalyst: Assembly Bill 296

- Skinner, Chapter 667, Statutes of 2012
 - “The California Environmental Protection Agency shall develop a definition for the urban heat island effect. The definition shall include the extent and severity of an urban heat island effect index for California cities such that the cities can have a quantifiable goal for heat reduction.”
- Motivated by Caltrans concerns.



Catalyst: Recommendation from the Heat Guidance Document



- Meet the goals of AB 296.
- Ultimately include means to measure heat and GHG reduction benefits of various cool strategies.

Action: Contract with Altostratus

- To provide the State agencies with maps showing Urban Heat Island Index for California cities.
- Atmospheric modeling, averaged at the scale of census tract.
- 12 months, \$100k
- Status: completed May 2015.

**Creating and Mapping an Urban Heat Island Index
for California**

Cal/EPA / Altostratus Inc. Agreement No. 13-001

Principal Investigator: Haider Taha, Altostratus Inc.

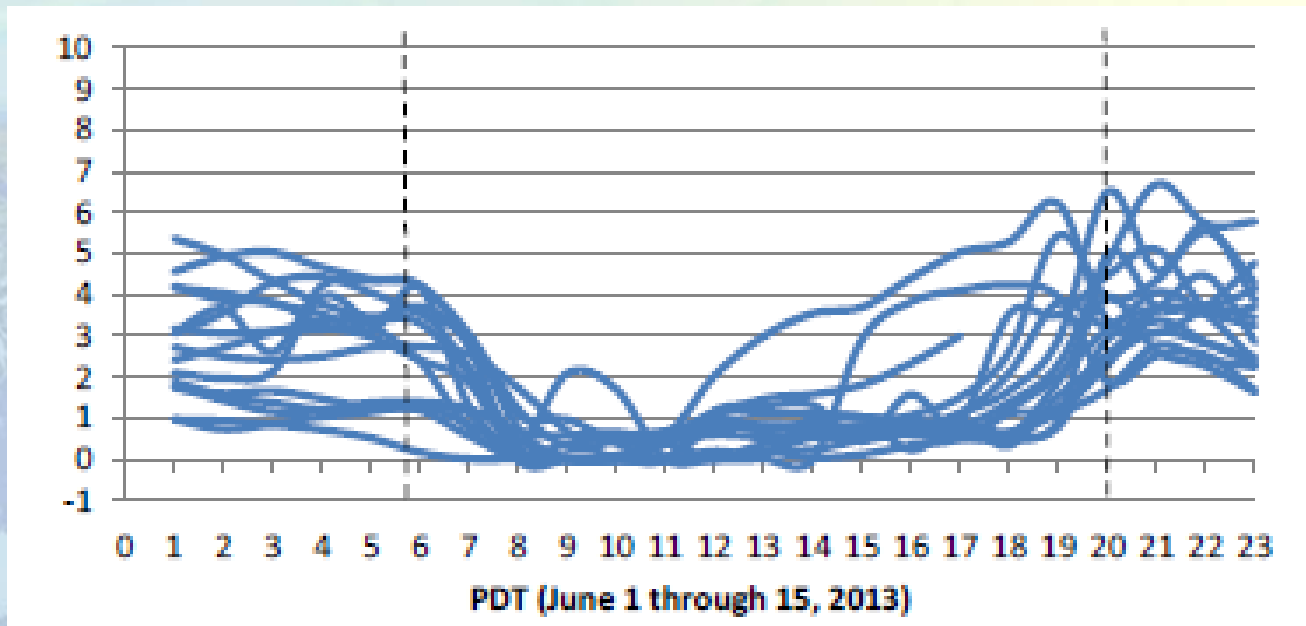
FINAL REPORT

Inter-agency Workgroup on Urban Heat Island Research

- Review team, in addition to CalEPA:
 - Air Resources Board
 - California Energy Commission
 - California Department of Forestry and Fire Protection
 - California Department of Transportation
 - California Department of Public Health
 - Office of Environmental Health Hazard Assessment
 - Office of Planning and Research
- This group:
 - Assisted CalEPA in determining the definition of urban heat island index
 - Performed technical review of the final report

Example: Modeled Temperature Differences

- UHI ($^{\circ}\text{C}$), positive differences only, in a suburb of Sacramento
 - Near Watt Avenue and Whitney Avenue



Product: Urban Heat Island Index (UHII)

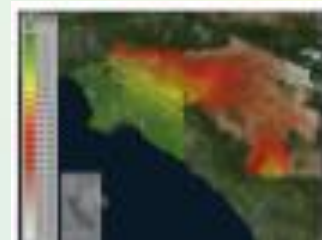
- The difference between the urban temperature and non-urban temperature, whenever the urban temperature is higher, summed over all hours.
 - Based on temperatures at 2 meters above ground level.
- June/July/August 2006 and 2013
 - Model output validated against actual data

Example: Dynamic Reference Points



Results: Spatial Variation

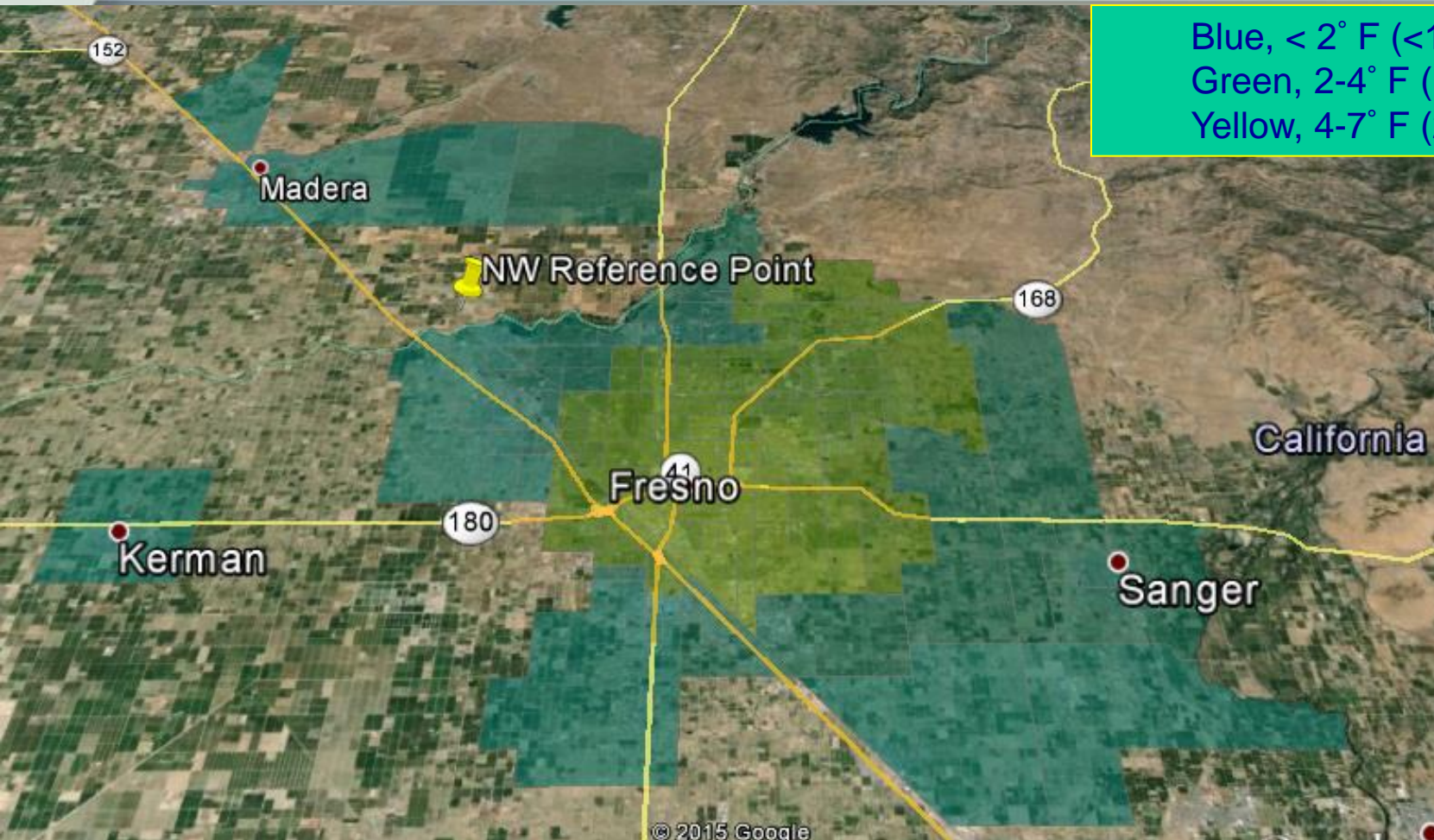
- Larger areas tend to have higher UHI.
 - Small areas (e.g. Napa)
 - Up to 5° F (3° C)
 - Single-cores (e.g. Fresno)
 - Up to 9° F (5° C)
 - Multi-cores (e.g. Sacramento)
 - Up to 9° F (5° C)
 - Urban archipelagos (e.g. LA basin)
 - Up to 19° F (11° C)



Maps: Napa, a Small Area



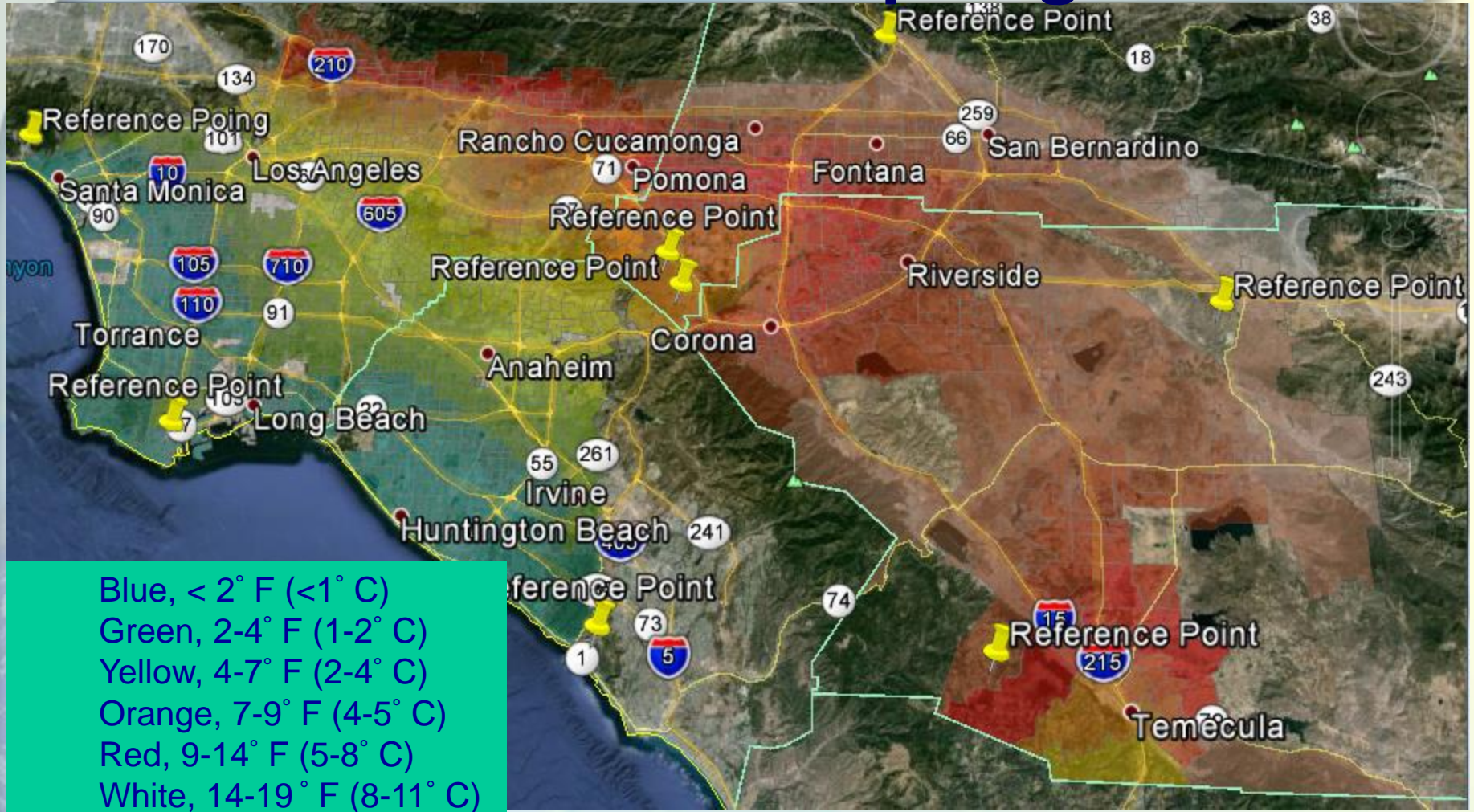
Maps: Fresno, a Single Core Island



Maps: Sacramento, a Multi-Core Area



Maps: Southern California, an Urban Archipelago

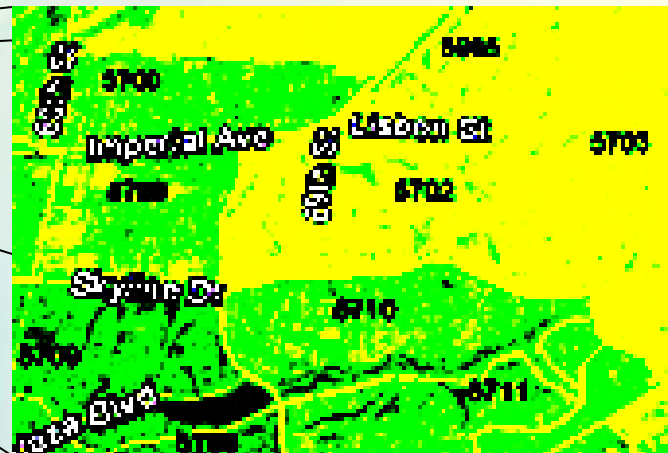


Results: Coastal Regions

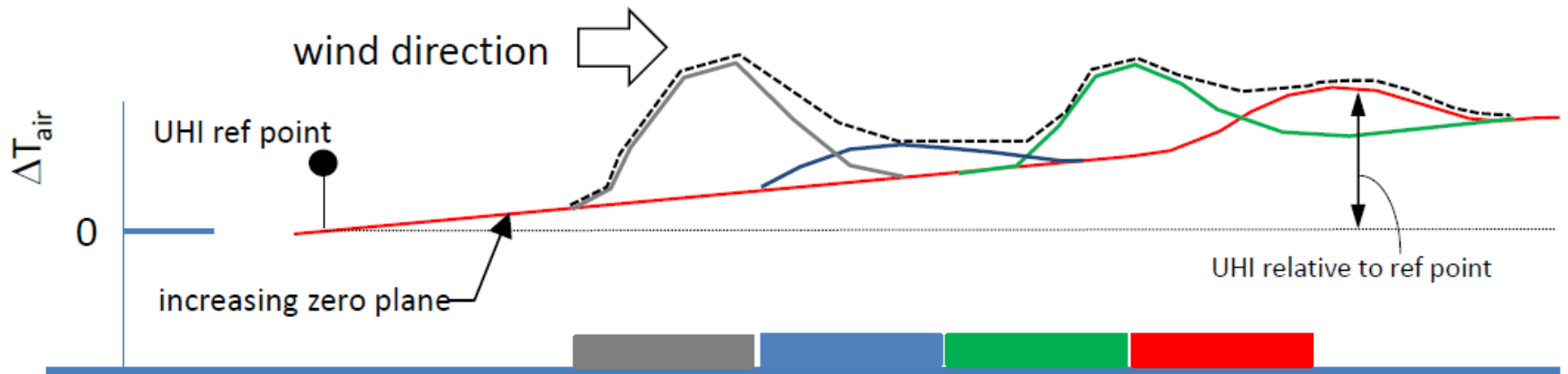
- UHI is higher downwind, especially in foothills.
- Most of this is due to on-shore warming and geography unrelated to urban land features.
- Neighboring census tracts exhibit UHI.



San Diego



UHI in Coastal Areas



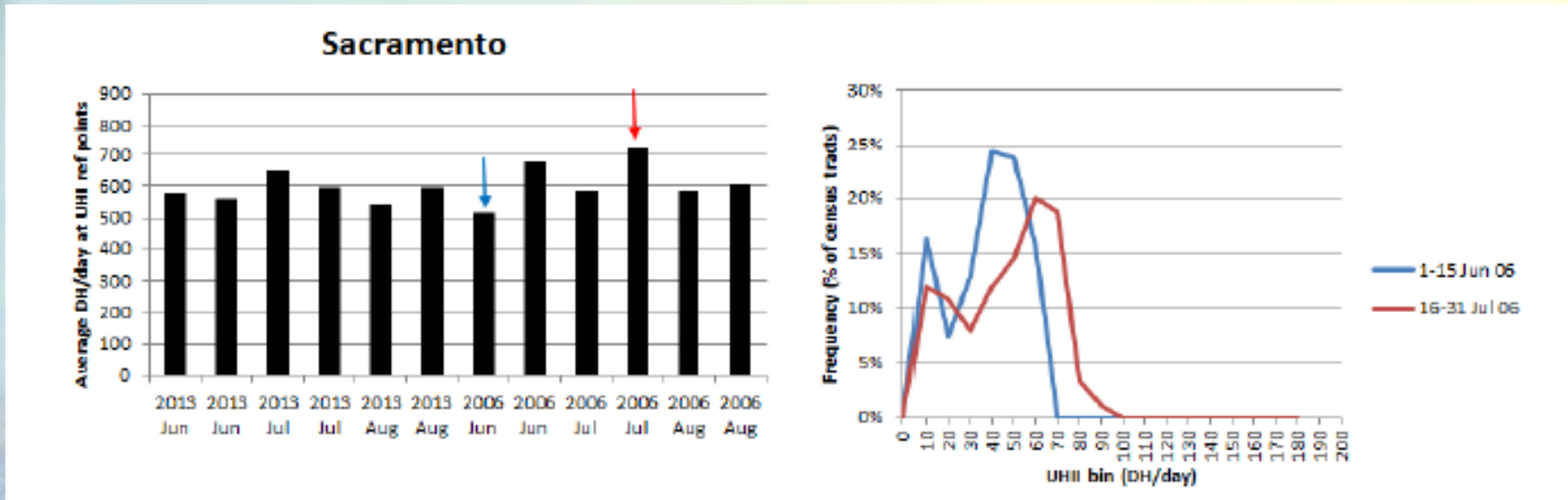
UHI and Ozone Transport

- UHI is highest near the Crestline air monitor, which often reports the highest ozone level in South Coast Air Basin.



Results: UHI and Heat Waves

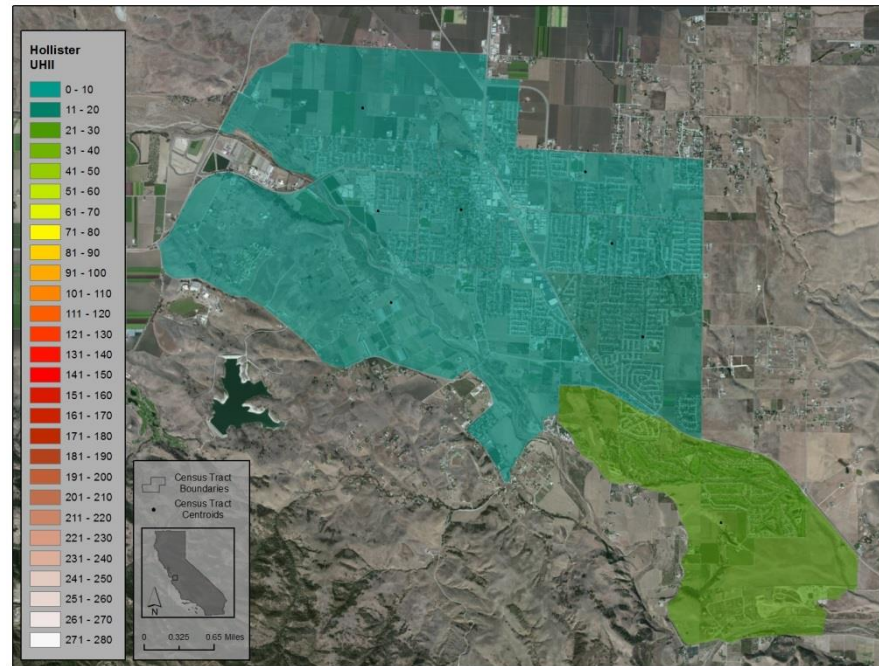
- UHI tends to increase during heat waves.



- Climate models project increases in the frequency, intensity, and duration of extreme heat events in the decades ahead.

Where to Find the Maps

- <http://www.calepa.ca.gov/UrbanHeat/Maps/default.htm>



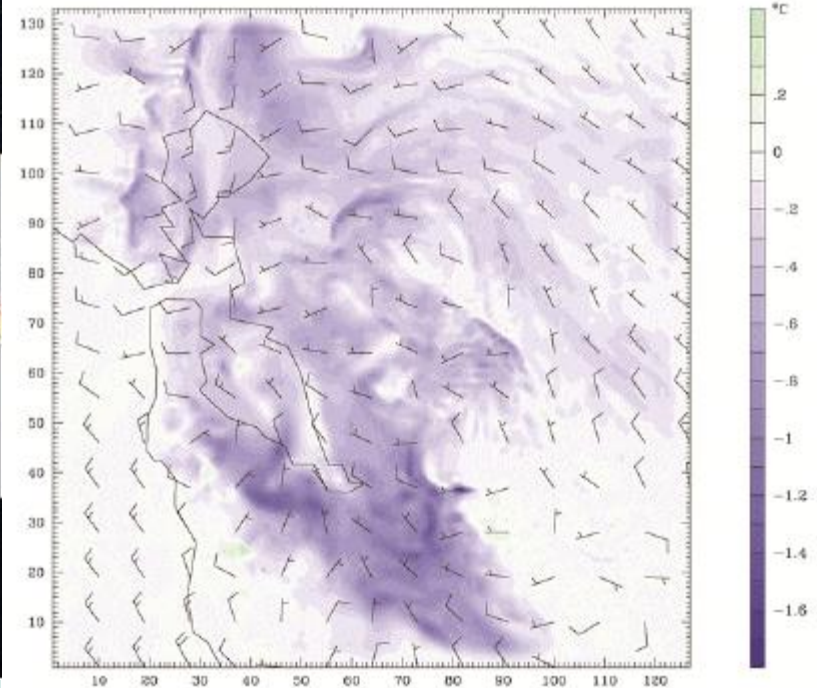
Cool Communities Strategies

How could communities reduce their UHII?

- Cool pavements
- Cool roofs
- Green roofs, green alleys, urban gardens
- Urban forests

Potential Impact of Cool Communities Strategies

Bay Area: hypothetical 50 percent increase in albedo of urban surfaces



Potential Next Steps

- Continue to work with Caltrans, CDPH, ARB, OEHHA on UHI issues.
- Potential further research
 - Model assignment of heat to its source in urban archipelagos
 - Model potential for cool communities strategies to reduce UHI



Model Verification

- Described in a 78-page progress report
- Compared model output with NCAR ds472 observational datasets
- Temperature in urban areas:

	MODEL	BENCHMARK
Bias	0.78 K	$\leq \pm 0.5$ K
Gross error	2.56 K	≤ 2 K
Index of Agreement	0.93	≥ 0.8

- Performance is reasonable.