Climate and Land Use

Presentation to the Planning and Sustainability Commission
10.13.2020

- Fletcher Beaudoin – Director, PSU's Institute for Sustainable Solutions
- Dr. Paul Loikith – Associate Professor, Geography
- Dr. Vivek Shandas – Professor, Urban Studies and Planning

A Joint Commitment to a Thriving City

- A mission to serve the City
- Capacity in climate research and land use
- A history of collaborative research, training and engagement

Portland State UNIVERSITY

Dr. Paul Loikith

Climate Change Trends and Projections for Portland

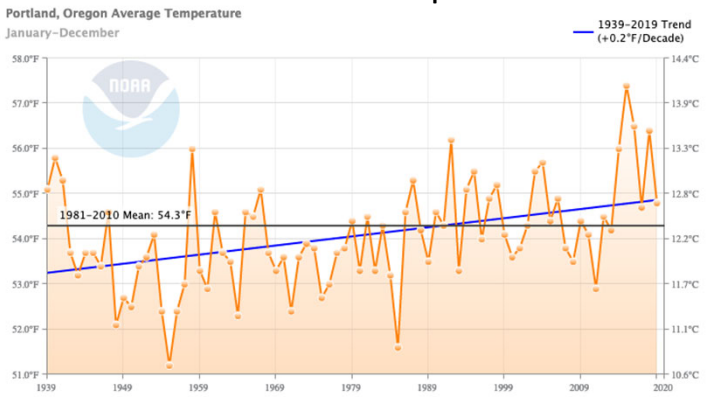
Paul Loikith
Portland State University
Associate Professor, Department of Geography
ploikith@pdx.edu

Phenomena presented:

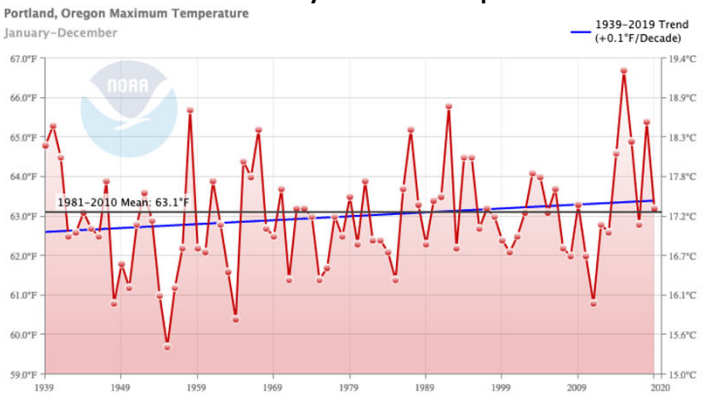
- Temperature
  - Mean, maximum, minimum, and extremes
- Precipitation
  - Mean and extreme precipitation
  - Snowfall
- Smoke/heat combined events

Mean Temperature - historical

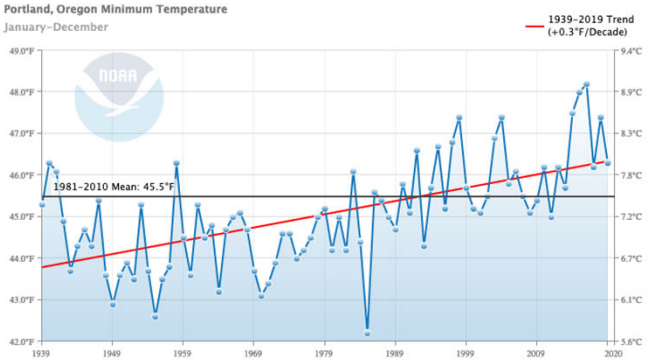
Annual Mean Temperature



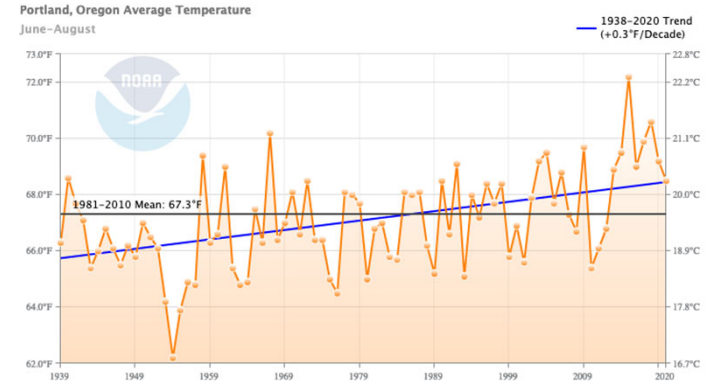
Annual Daily Max Temperature



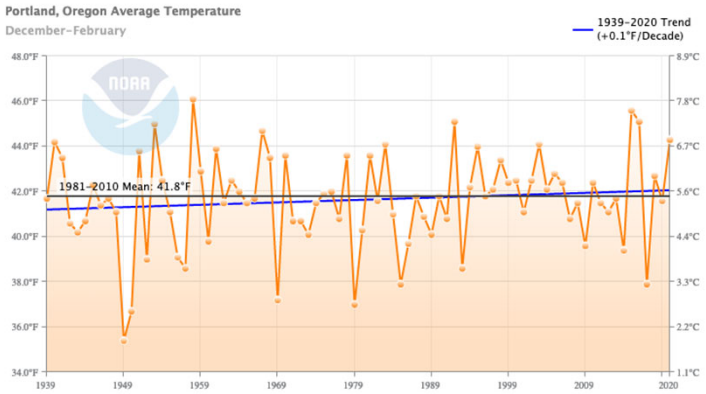
Annual Daily Min Temperature



Summer Mean Temperature



Winter Mean Temperature



- At the annual scale, nighttime low temperatures are warming faster than daytime high temperatures.
- Summer temperature is warming at a rate 3 times that for winter.

Mean Temperature - future

- Results at right are for the mid-21st century (near term) compared with late 20th century.
- Projections of future warming using a high-end emissions scenario (little or no global mitigation), show more warming in the summer than in other seasons in the Portland area.
- Winter, spring, and summer show about 2-3 degrees F of warming by 2050 (we're already on the way).
- Summer warming shows about 3-4 degrees F of warming by 2050 (we're already on the way).

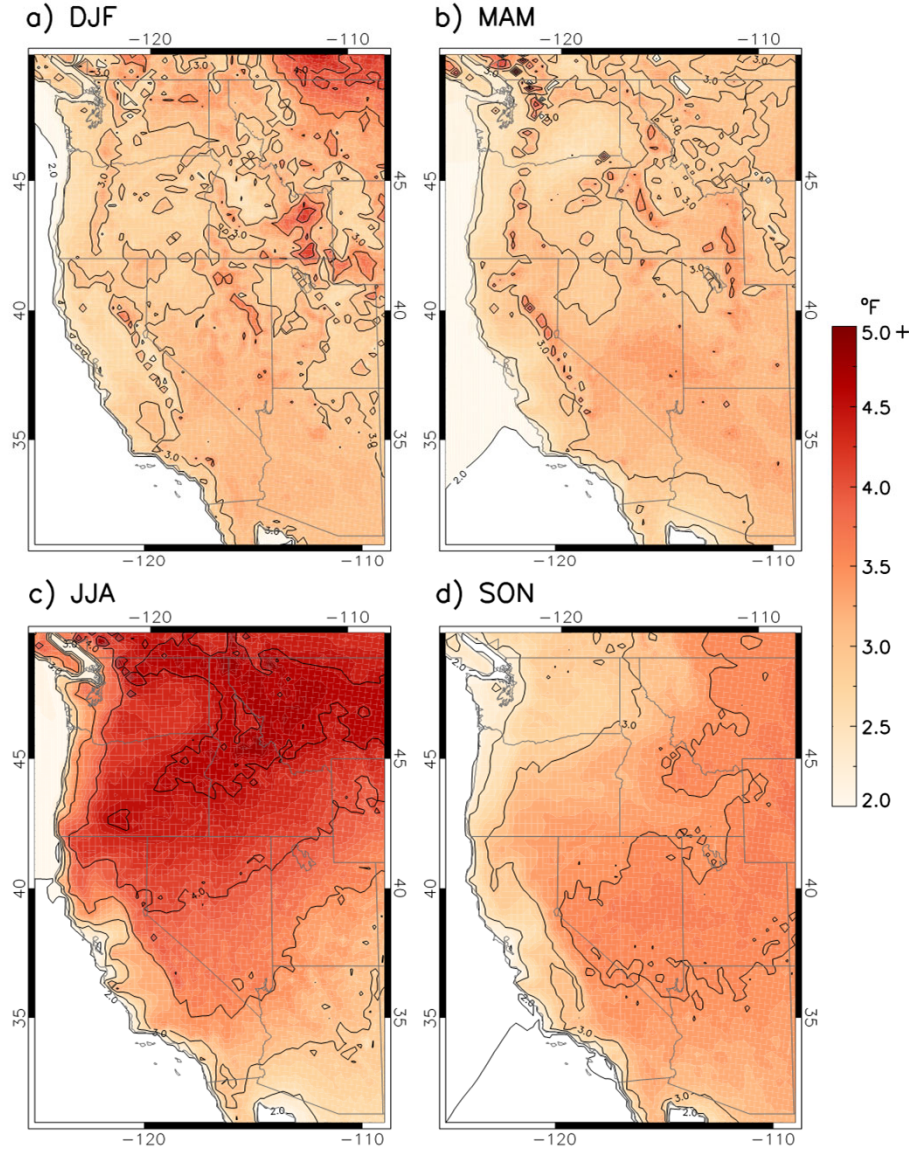
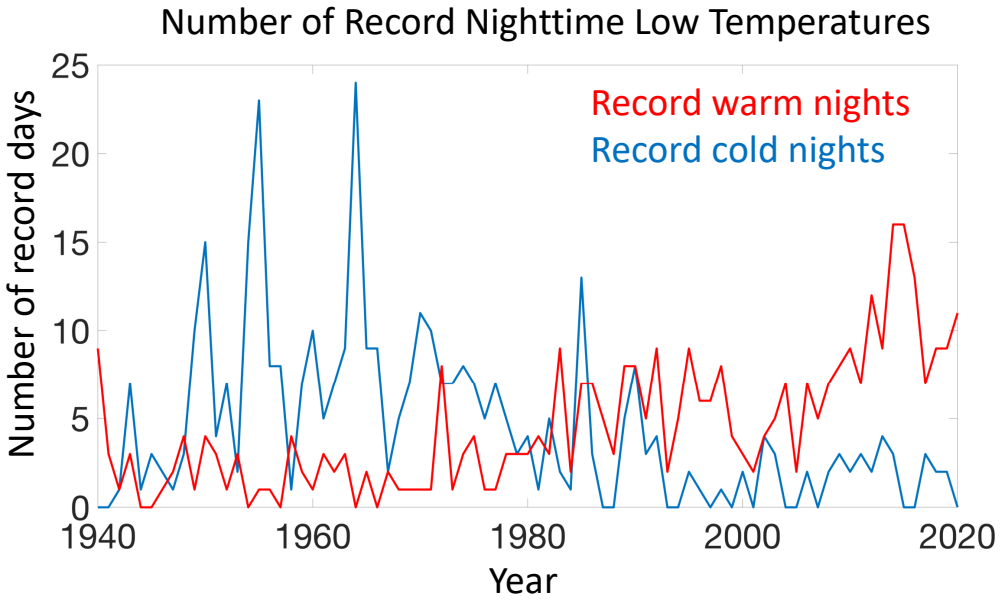
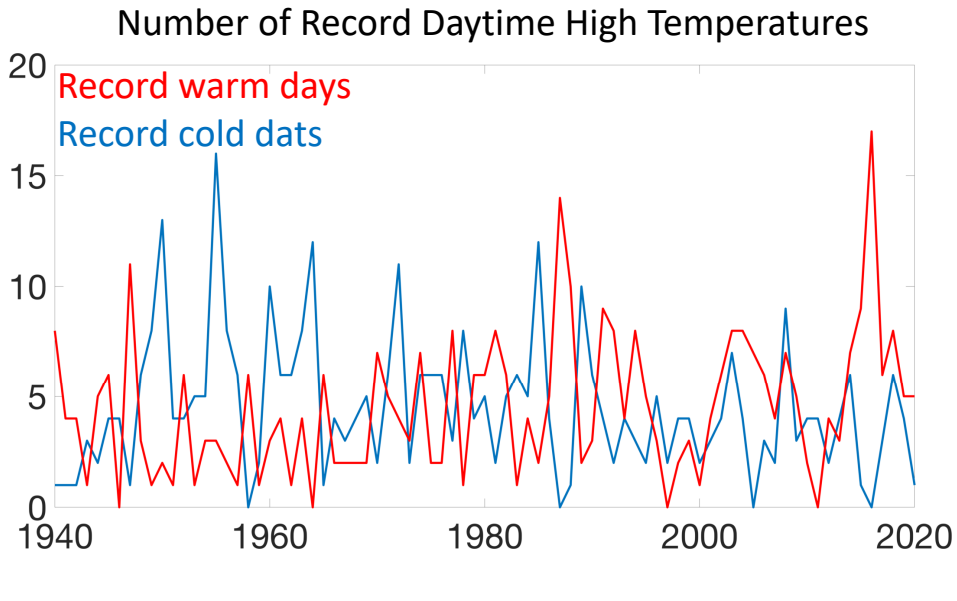


Figure from OCAR4

Extreme Temperature - historical



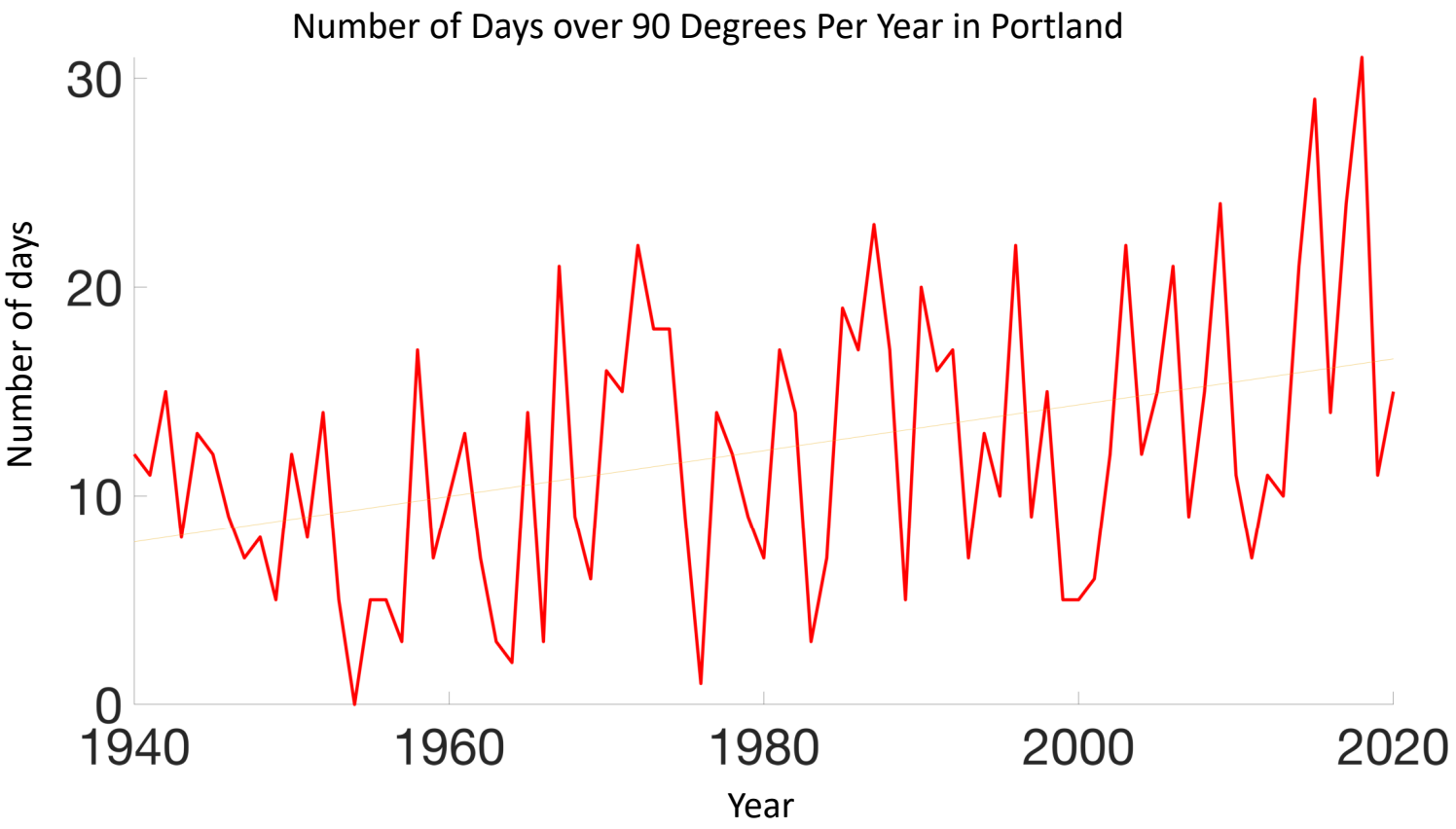


- Recent years have seen a large number of record warm nights. Few record warm nights occurred before 1980.
- Recent years have seen few record cold nights.

- There is very little pattern observable in record warm and record cold daytime high temperatures.

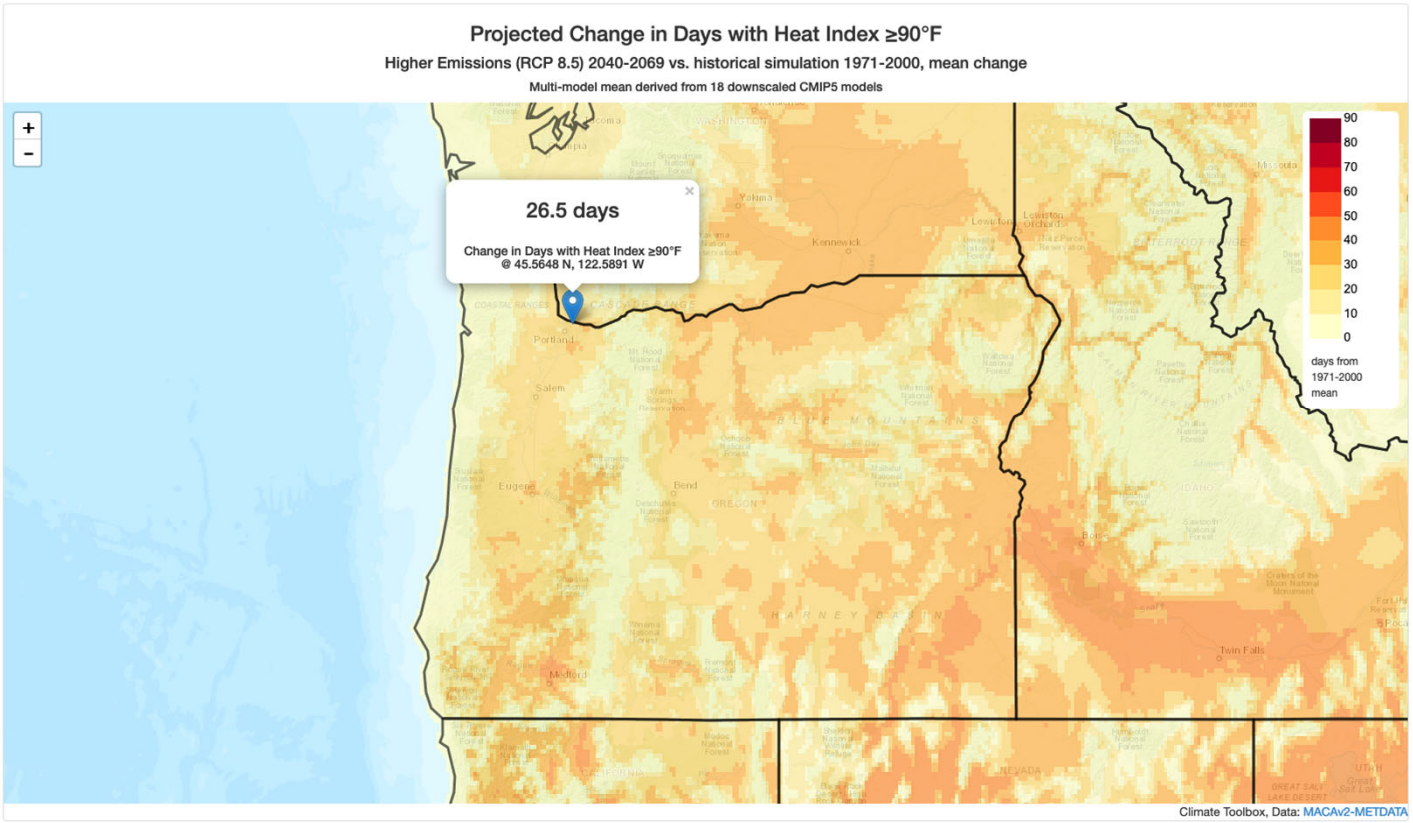
Nighttime extremes are warming faster in Portland than daytime highs.

Extreme Temperature - historical



- Portland has seen a steady increase in the number of days exceeding 90 degrees F
- There is considerable year-to-year variability
- Portland sees more than 8 more days above 90 degrees each summer now, compared with the mid-20th century.

Extreme Temperature - future

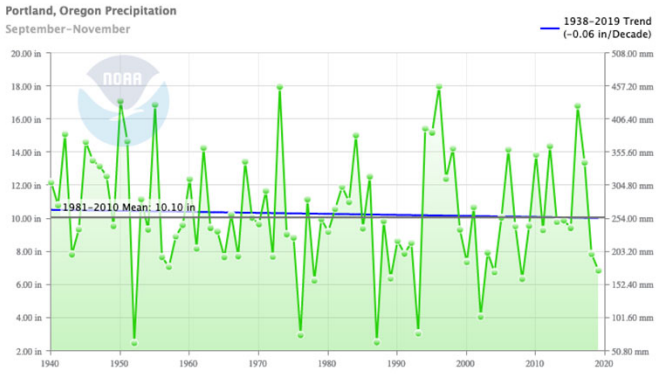


- Climate models project more than 26 additional days with temperatures exceeding 90 degrees in the Portland Metro by the middle of the 21st century compared with the late 20th century.

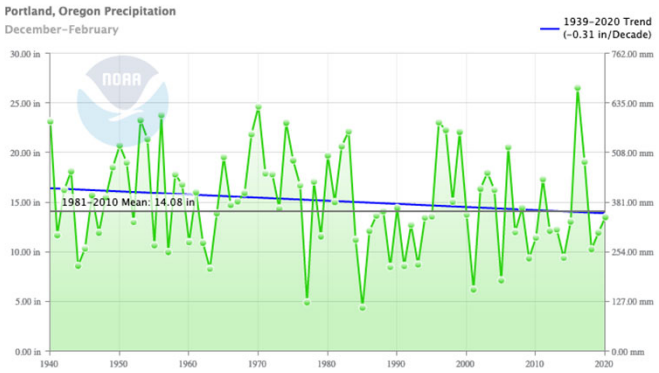
- *Note: this map is for "heat index" which combines humidity and temperature. Because Portland doesn't experience humid heatwaves (and likely won't in the future either), the heat index is very similar to the actual temperature.*

Mean Precipitation - historical

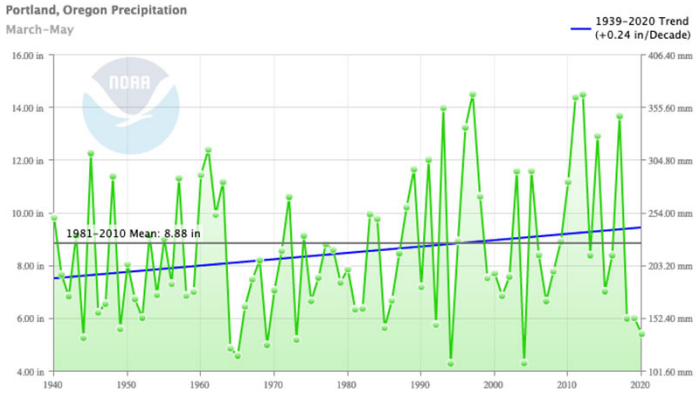
Fall Rainfall



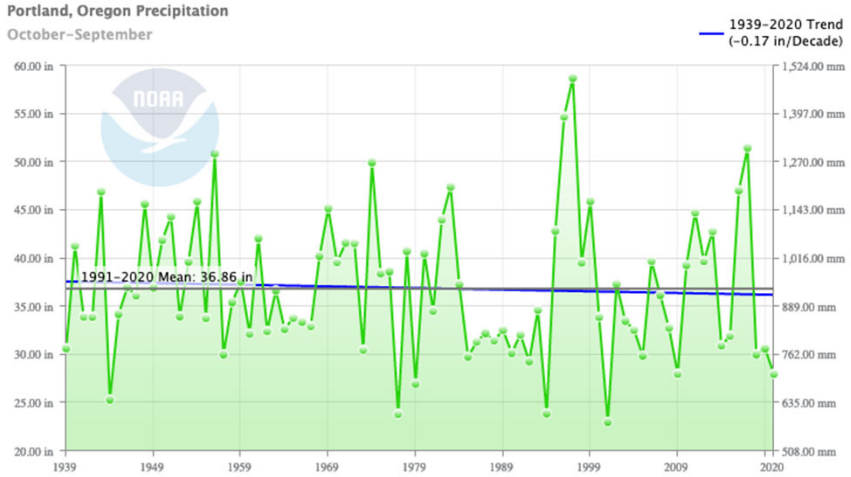
Winter Rainfall



Spring Rainfall



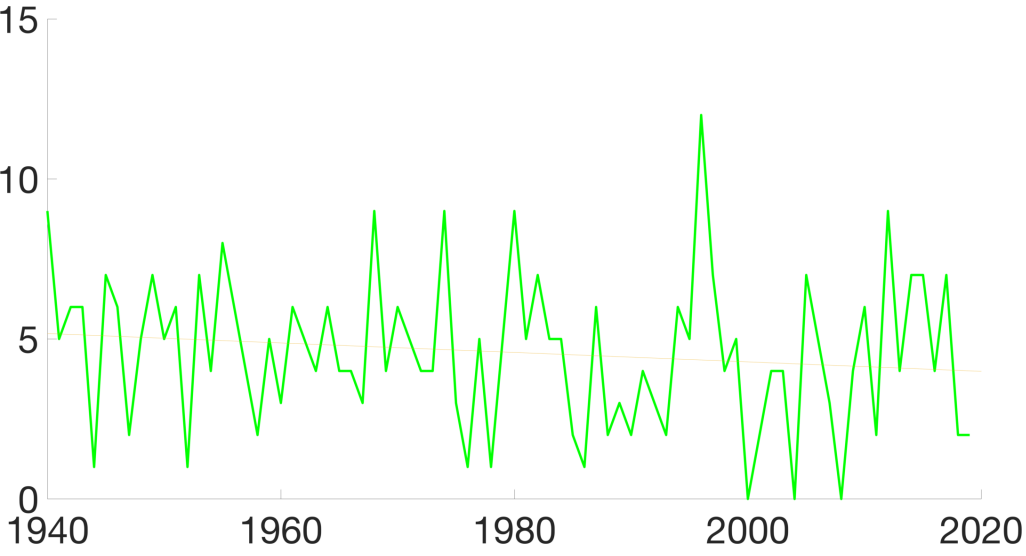
Water Year Rainfall



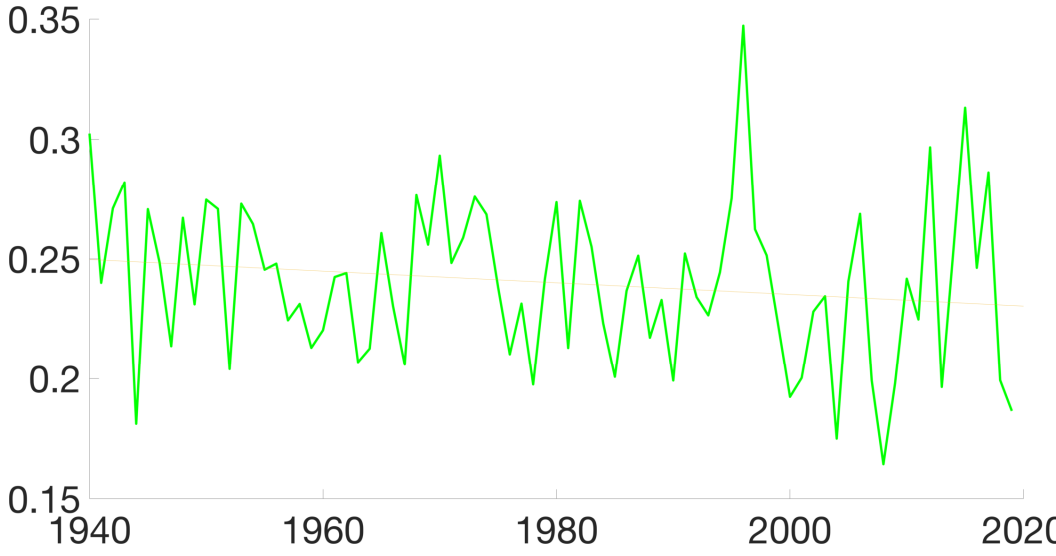
- Portland has seen little to no change in precipitation over the historical record, with an exception of spring showing a modest long-term increase.
- Portland's rainfall is dominated by large year-to-year variability rather than systematic trends towards a wetter or drier climate.

Extreme Precipitation - historical

Days with over 1 inch of rain per year

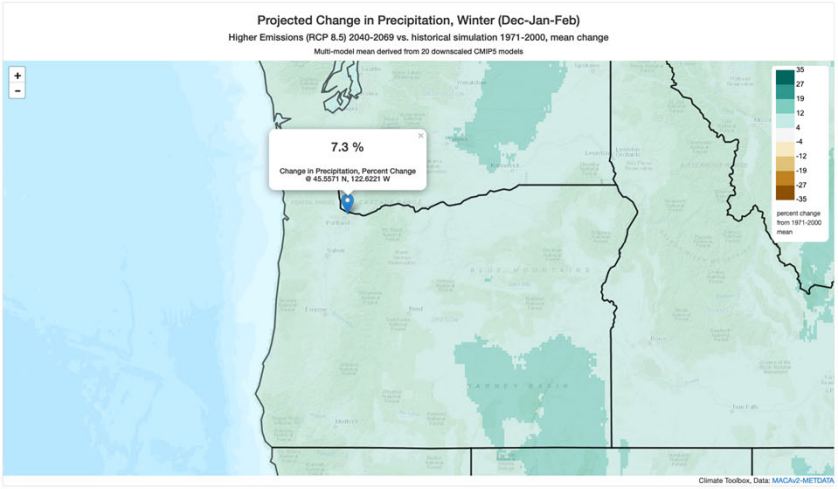


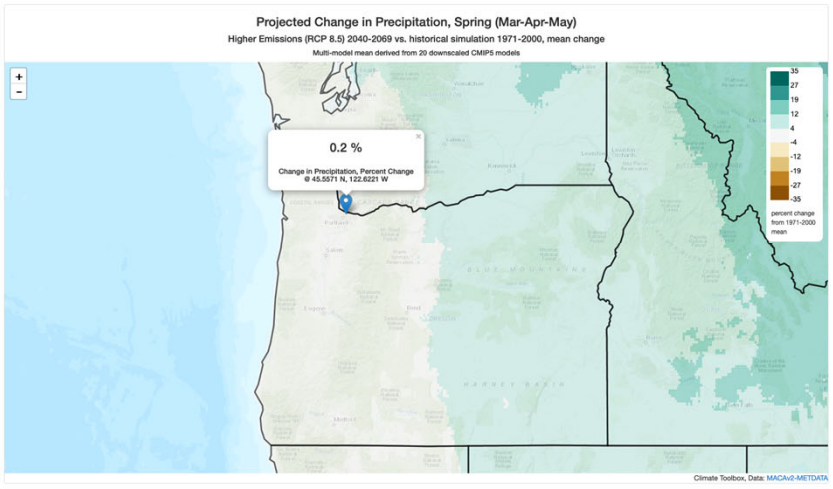
Average rainfall rate for each year (in inches)

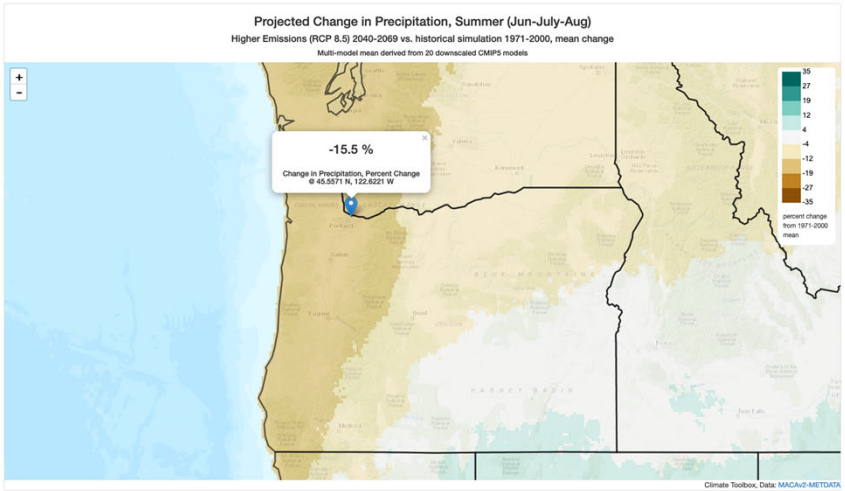


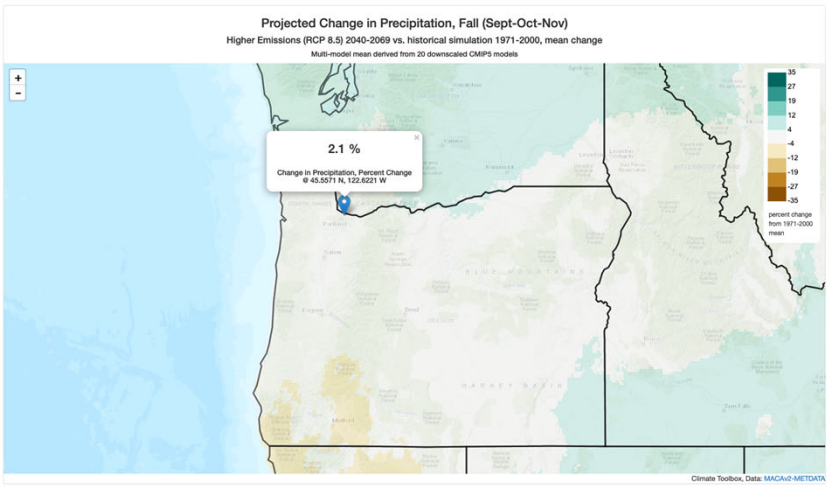
- To date, Portland has not seen any meaningful change in extreme precipitation.
- If anything, Portland has seen a trend towards less intense precipitation when it does rain.
- It is unlikely that these changes are the result of climate change, but strongly indicate that climate change is not resulting in any increase in rainfall intensity in Portland at this point.

Mean Precipitation - future







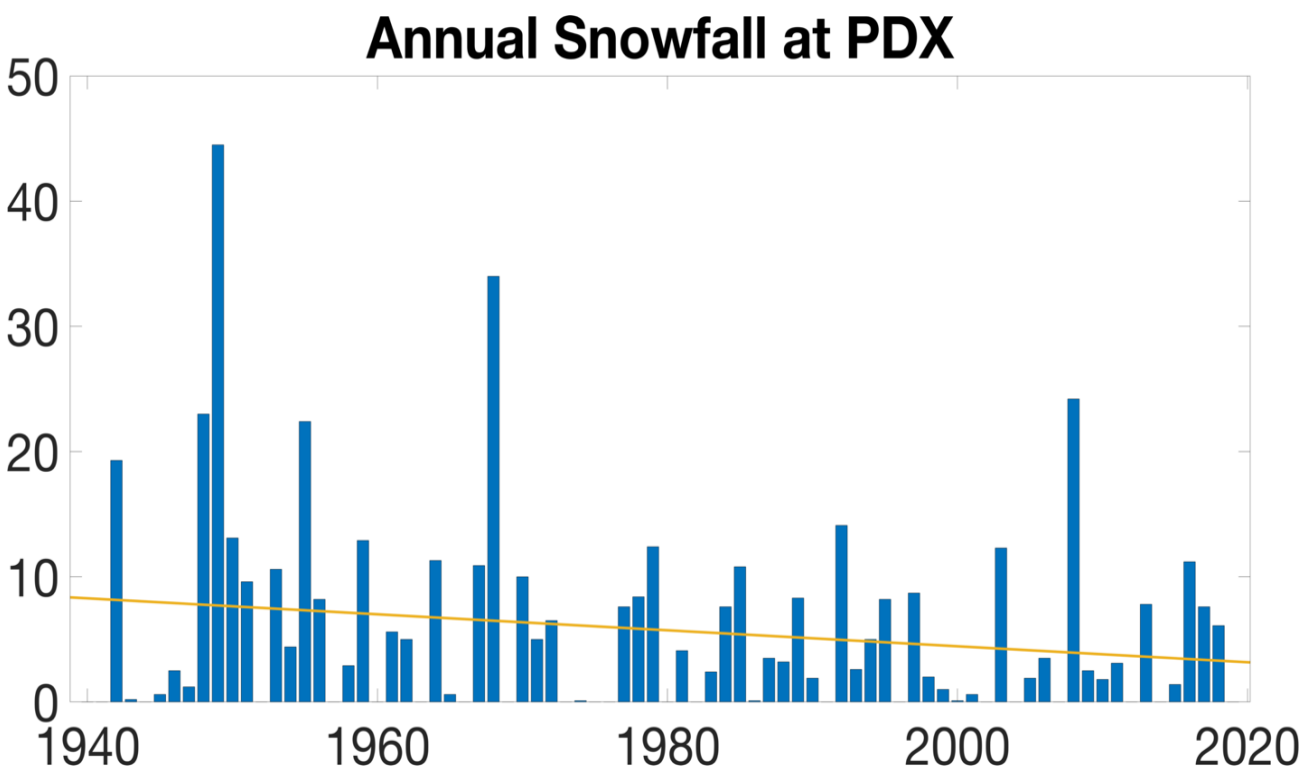


- Climate models generally project a small increase in winter rainfall by the middle of the 21st century.
- Summer is projected to get drier, but summer is already very dry.
- Little to no change projected for fall and spring.

Extreme Precipitation - future

- Projections of future extreme precipitation are unclear in the Portland Metro/West side of the Cascades.
- While the amount of precipitation that falls in very heavy events is confidently projected to increase globally (and already is), regional changes will be different. Because of the meteorological processes that drive extreme rainfall in Portland, the area may not see a large change in the amount of rainfall that comes in extremes and any change would take time to emerge.
- However, there is some uncertainty here and an increase in future extreme rainfall is possible.
- It is important to note that extreme rainfall in the past has caused major impacts in Portland. Such events will happen again, regardless of climate change influence, so being resilient to and prepared for low probability/high risk hydrological events is prudent.

Snowfall in Portland



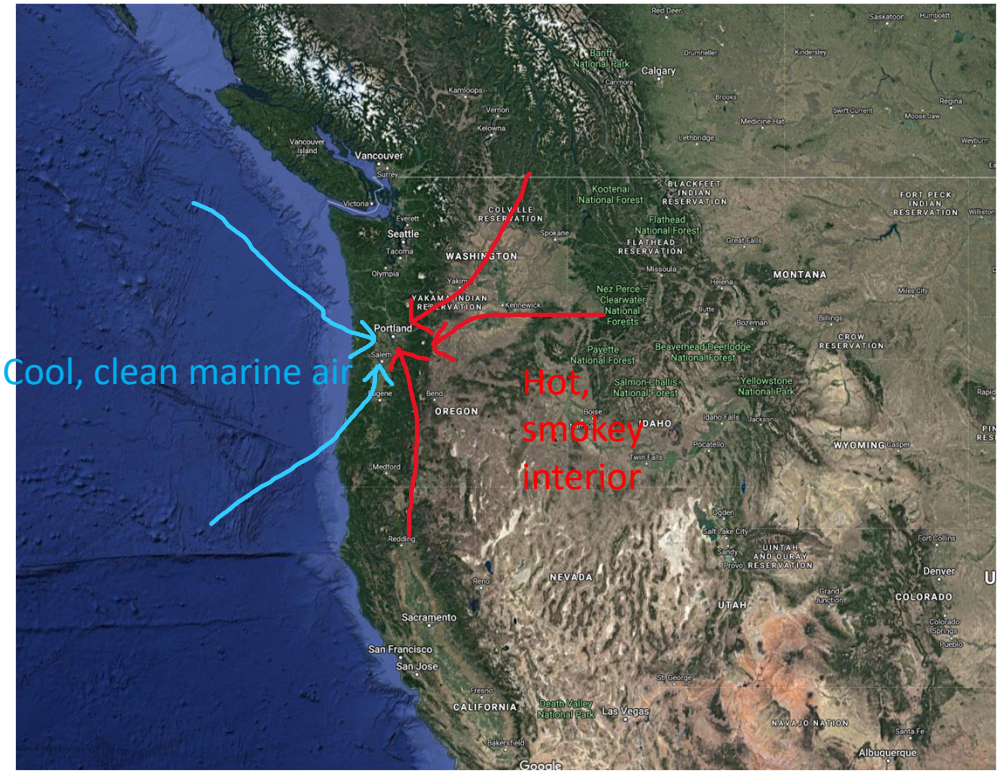
- Annual snowfall has decreased over time in Portland as temperatures have warmed.
- Because snow often falls at temperatures that are near freezing, a small increase in temperature would quickly decrease the amount of snowfall in the city.
- While there is not research specific to climate change and snowfall in Portland, it is a very reasonable assumption that snowfall will continue to become less common in the future.
- However, snow storms will still happen for years to come, even as they become less common.

Heat and Smoke – Cascading events

- The weather patterns that are conducive to wildfire smoke in Portland are often also conducive to heat.

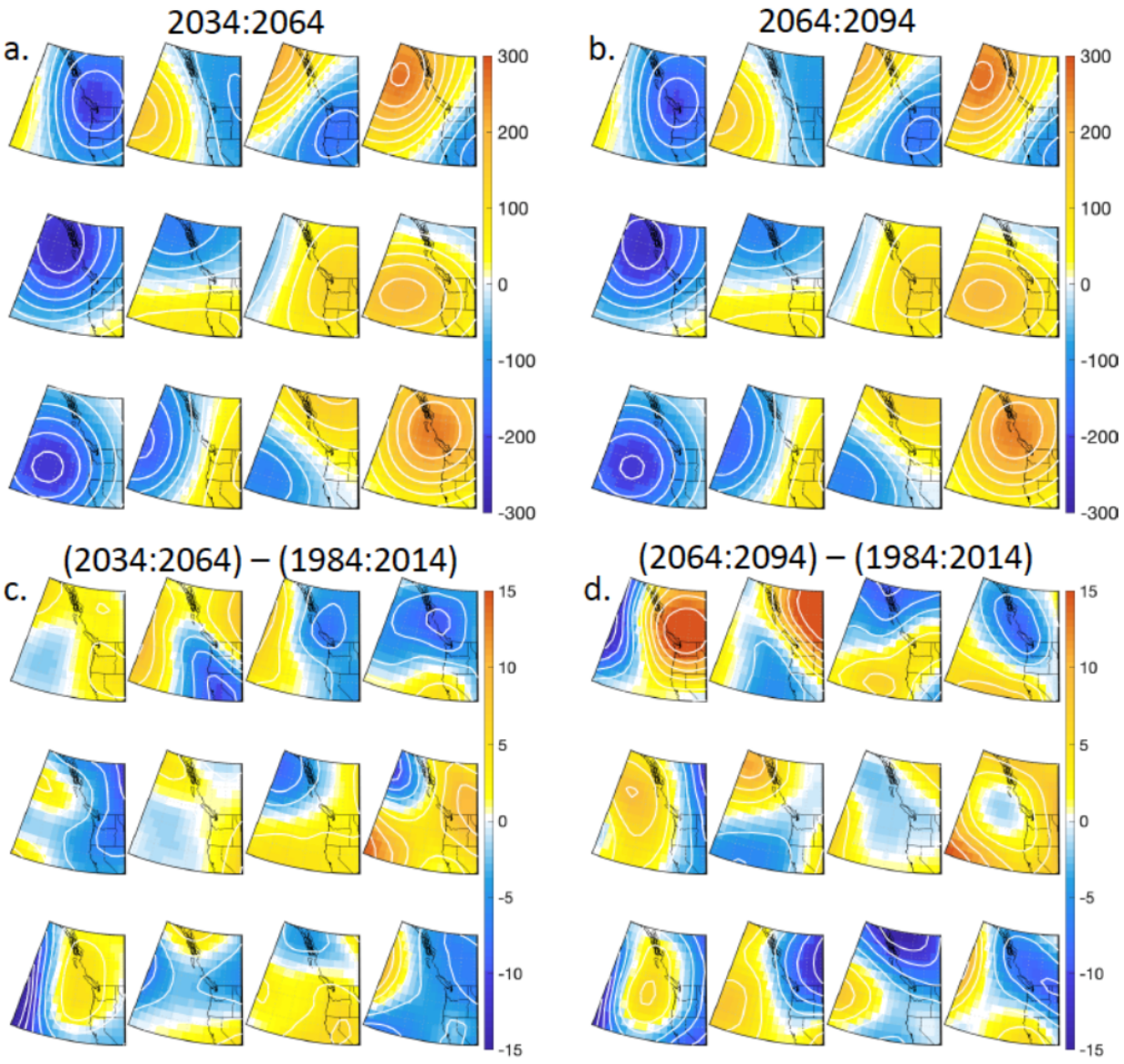
- This is because most fires are inland of Portland. So when we get smoke, we have winds that are not from the Pacific and therefore are likely to be warm.

- Because smoke events in Portland are often associated with heat, and wildfire activity is projected to continue increasing, the co-occurrence of heat and smoke will likely become more common.



Word with BES and PWB

- Project with BES used machine learning to understand the weather patterns that lead to combined sewer overflows in Portland.
- Project with PWB used a similar approach to understand weather patterns that lead to both heavy rainfall and prolonged dry periods in Bull Run. Looks at how patterns are projected to change under future climate change.



Summary

- **Climate change impacts are being observed in Portland.**

- Impacts are mostly from those directly related to temperature
  - The number of 90 degree+ days has been increasing
  - Record warm nighttime temperatures has been increasing
  - Summer is warming faster than winter, and this is projected to continue into the future

- Precipitation and extreme precipitation have shown little change in the historical record.

- Future projections of precipitation show generally little change in the future overall, with possibly wetter winters and drier summers. *Confidence is only modest on this as some climate models show increase in rainfall, some show decrease, and some show no change.*

- Precipitation intensity has shown a modest decrease overall in the historical record, however this is probably not related to climate change. Future projections of extreme precipitation are subject to some uncertainty, but do not conclusively point to a change.

- Annual snowfall amount in Portland has declined over the past several decades and will likely continue to gradually decline as winters warm.

Key Take Home Points

- **Warming temperatures provide the most pressing challenge related to climate change for Portland.**
  - While Portland's baseline temperature is relatively mild, and humidity is not an issue with heat as it is in some places, Portland is not as well-adapted to a hotter environment compared with historically warmer cities.

- While there is no clear picture of increasing extreme precipitation, heavy precipitation has caused major impacts in the city in the past, and will cause major impacts in the future. Building resilience to such events would be beneficial.

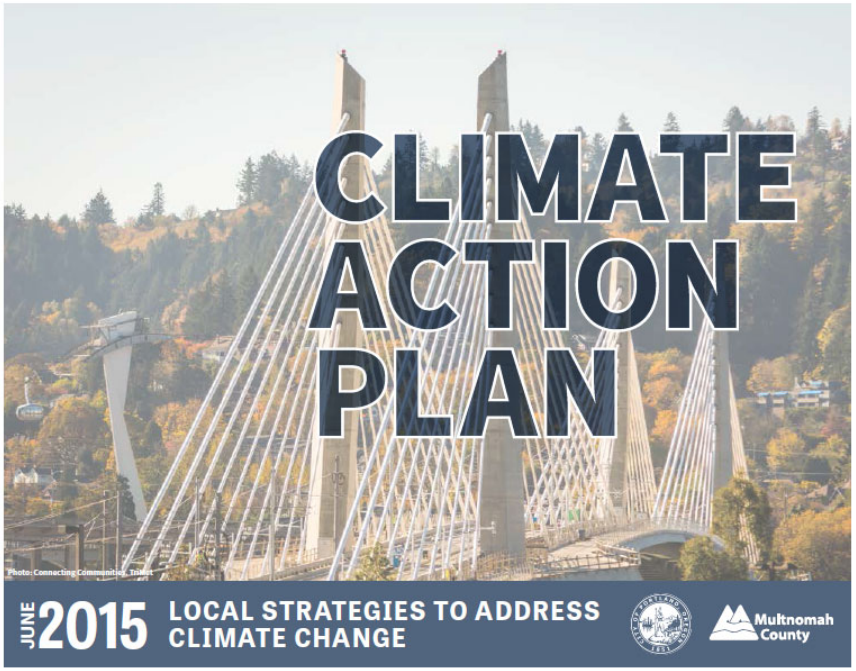
- As wildfires continue to become more extensive and common across the West, poor air quality in summer may become more common. This often co-occurs with heat because of wind patterns. This co-occurrence will pose challenges to those who do not have access to air conditioning/filtered indoor air.

Portland State UNIVERSITY

Dr. Vivek Shandas

City Commitments

Hotter, drier summer with more high-heat days



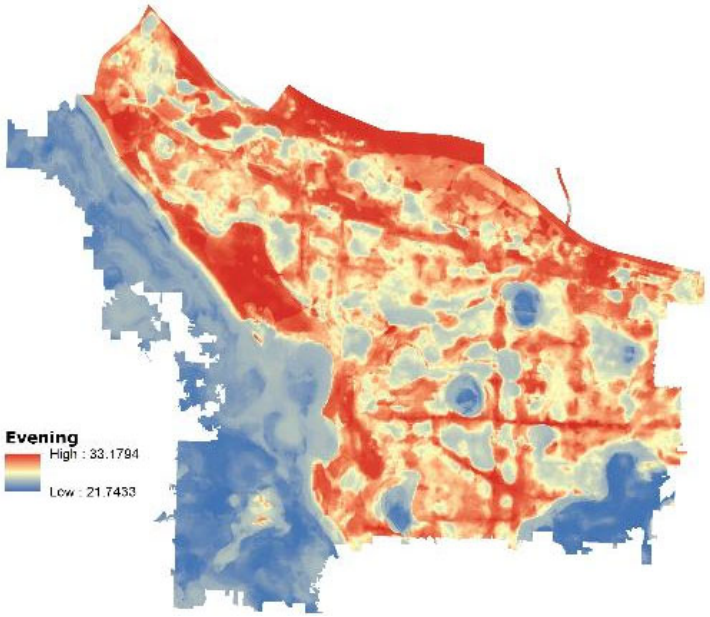
CLIMATE CHANGE PREPARATION

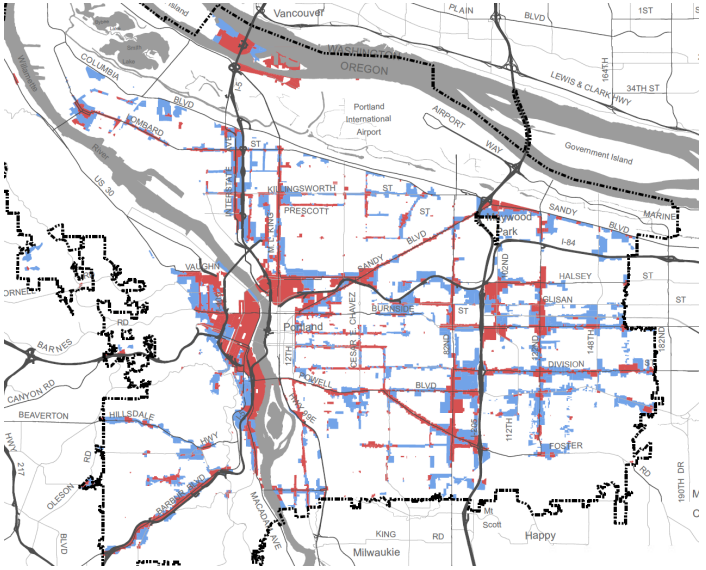
2030 OBJECTIVE 14 — **Reduce risks and impacts from heat, drought and wildfire by preparing for hotter, drier summers with increased incidence of extreme heat days.**

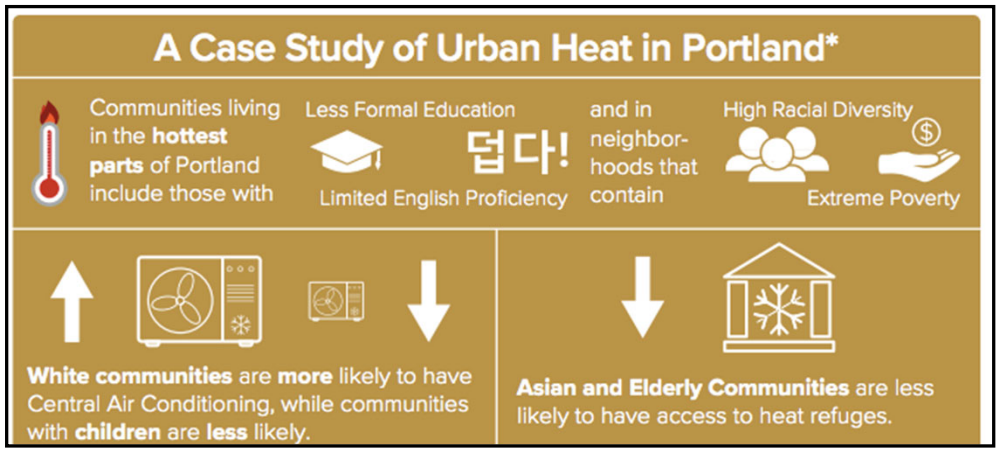
Hotter, drier summers may result in several significant impacts for the Portland area. Higher temperatures result in increased air pollution, such as ground-level ozone and pollen counts, exacerbating Portland's already high incidence of respiratory illnesses and allergies. Such conditions may be further exacerbated by air quality impacts resulting from the potential of increased wildfires. Higher temperatures and shifts in precipitation patterns also lead to increased surface water temperatures, reduced flows in rivers and streams and negative impacts on aquatic habitats and the fish and wildlife they support.

ACTIONS TO BE COMPLETED BY 2020		Impact	Lead agency	Timeframe
14A	**Decrease Urban Heat Islands —** Decrease the urban heat island effect, especially in areas with populations most vulnerable to heat, through strategies such as revegetation, tree preservation planting and maintenance, depaving and porous pavement, green infrastructure like bioswales and ecoroofs and site development performance standards.	$ E	**City:** BES, PP&R, BPS **County:** HD	Mid-term
14B	**Urban Heat Island Maps —** Utilize current science, best practices and updated maps of urban heat islands and populations most vulnerable to heat to help inform decisions and priorities about projects and programs that help to cool the urban environment.	$ E	**City:** BPS, BES, PP&R **County:** HD	Near-term
14C	**Resilient Infrastructure —** In infrastructure project design, consider planting [illegible] and infrastructure specifications and materials that will be resilient to heat-related climate change impacts and be cost-effective over the lifetime of the asset.	$ E	**City:** PBOT, BES, PP&R	Long-term
14D	**Health Impacts of Extreme Heat —** Minimize health issues caused by extreme heat days and associated poor air quality, especially for populations most vulnerable to these impacts by improving the preparation for and response to heat by health, community service, public safety and emergency response staff and services.	$ E	**City:** PBEM, Fire, Police **County:** HD, OS	Existing and/or ongoing
14E	**Cooling Centers —** Coordinate operations of readily accessible and culturally appropriate cooling centers, and develop early warning and response plans and systems that alert community members, especially those most vulnerable to heat, when projected heat conditions or poor air quality days pose a health risk.	$ E	**City:** PBEM **County:** DCHS, HD, MCEM	Existing and/or ongoing

Zoning and Urban Heat







International Journal of Environmental Research and Public Health

Open Access Article

Assessing Vulnerability to Urban Heat: A Study of Disproportionate Heat Exposure and Access to Refuge by Socio-Demographic Status in Portland, Oregon

by Jackson Voelkel [1], Dana Hellman [1], Ryu Sakuma [2] and Vivek Shandas [1,*]

[1] School of Urban Studies and Planning, Portland State University, Portland, OR 97201, USA

[2] Peace Winds Japan, Tokyo 151-0063, Japan

* Author to whom correspondence should be addressed.

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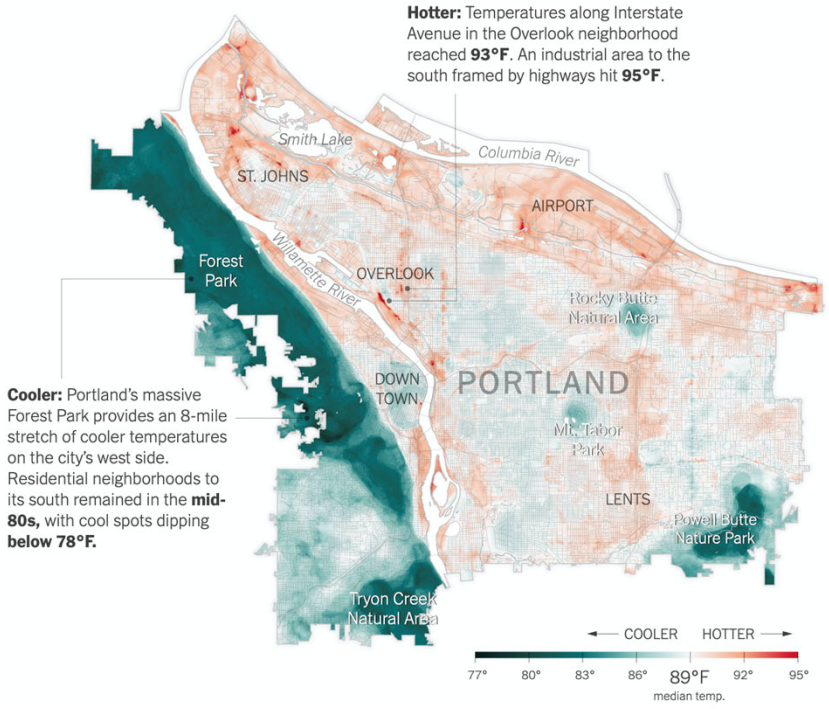
(This article belongs to the Special Issue Climate Change and Human Health)

The Oregonian

Historically racist housing policies exacerbating climate change effects in low-income Portland neighborhoods

Updated Jan 21, 2020; Posted Jan 20, 2020



PORTLAND, ORE.

AFTERNOON RANGE: 77°F TO 95°F

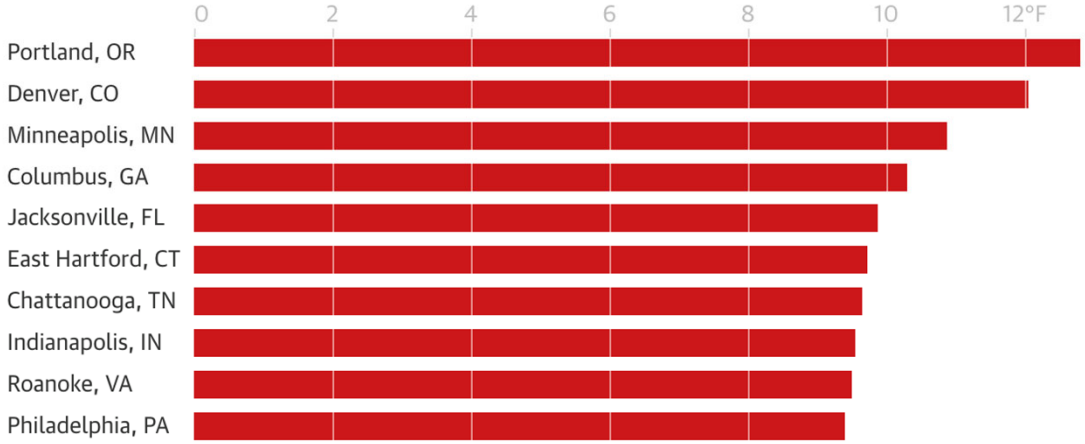
The New York Times

SCIENTIFIC AMERICAN®

The Guardian

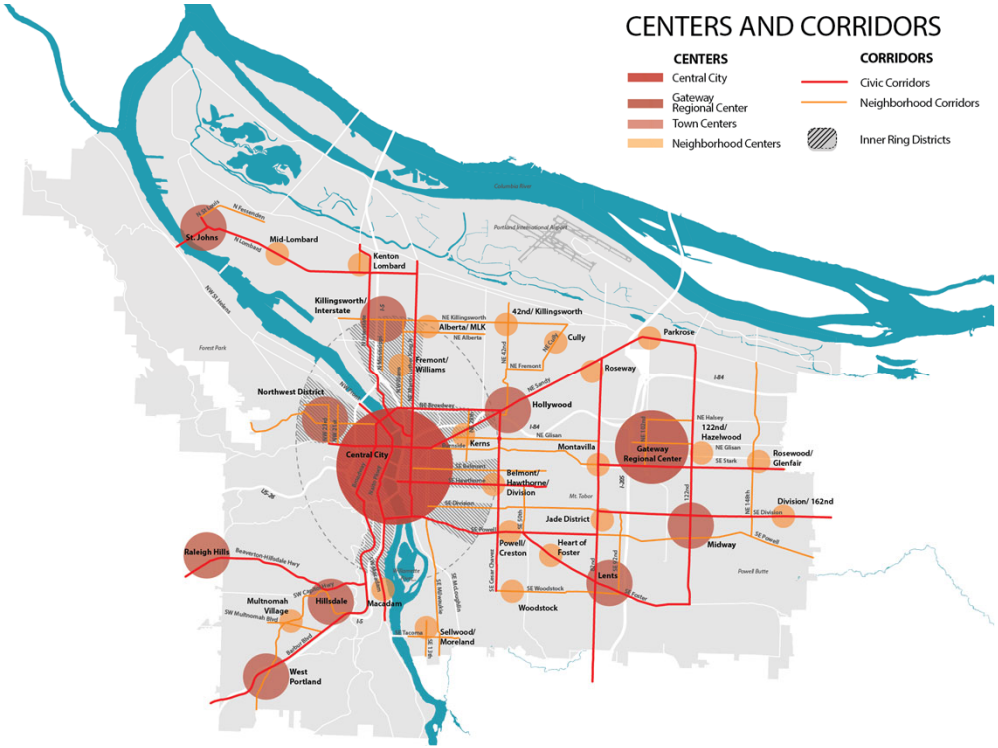
A new study found that temperatures in formerly redlined and non-redlined neighborhoods within cities differ by up to 12.6°F

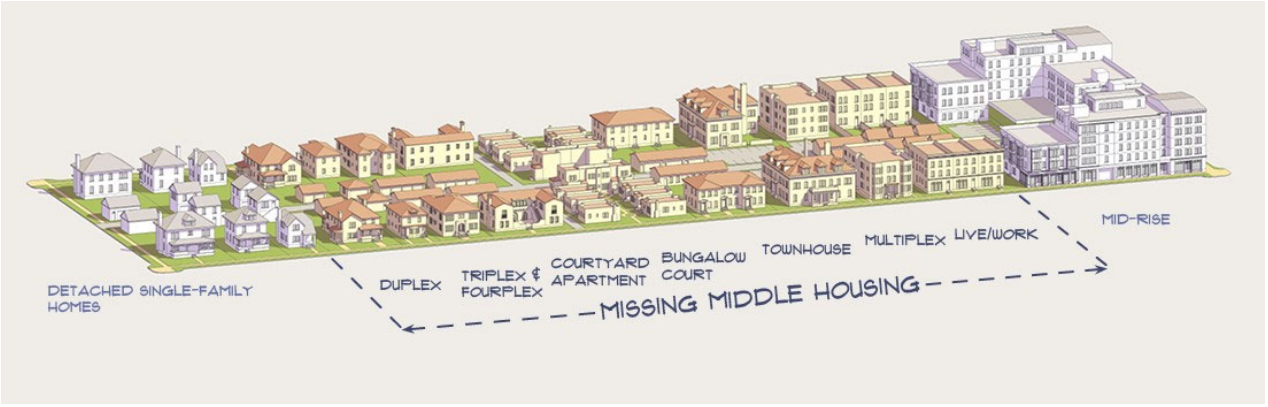
Heat differences between redline and non-redlined neighborhoods (fahrenheit)



Guardian graphic | Researchers from the Science Museum of Virginia, Portland State University and Virginia Commonwealth University

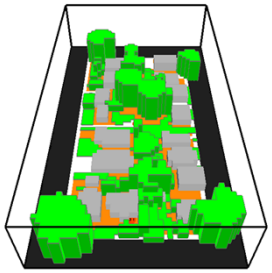
Hoffman, Shandas, Pendleton, 2020


CENTERS AND CORRIDORS
CENTERS
Central City
Gateway Regional Center
Town Centers
Neighborhood Centers
CORRIDORS
Civic Corridors
Neighborhood Corridors
Inner Ring Districts
St. Johns
Mid-Lombard
Kenton Lombard
Killingsworth/ Interstate
Alberta/ MLK
42nd/ Killingsworth
Cully
Parkrose
Fremont/ Williams
Roseway
Northwest District
Hollywood
Central City
Kerns
Montavilla
Gateway Regional Center
122nd/ Hazelwood
Rosewood/ Glenfair
Belmont/ Hawthorne/ Division
Division/ 162nd
Jade District
Raleigh Hills
Powell/ Creston
Heart of Foster
Midway
Lents
Multnomah Village
Hillsdale
Macadam
Woodstock
Sellwood/ Moreland
West Portland

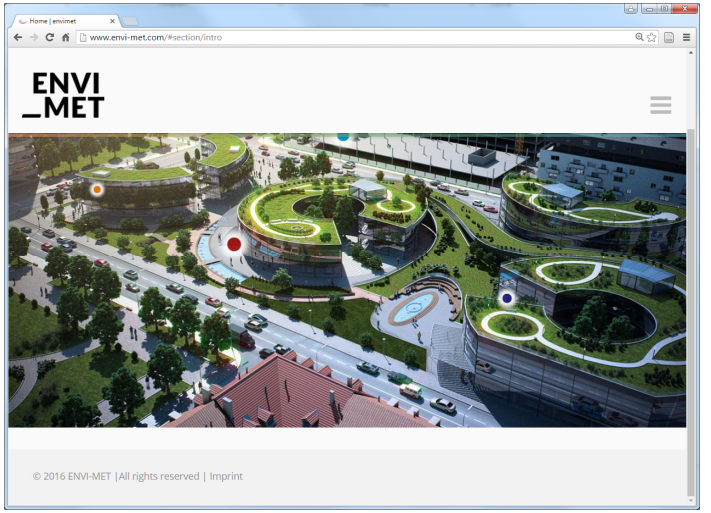

DETACHED SINGLE-FAMILY HOMES
DUPLEX
TRIPLEX & FOURPLEX
COURTYARD APARTMENT
BUNGALOW COURT
TOWNHOUSE
MULTIPLEX
LIVE/WORK
MID-RISE
MISSING MIDDLE HOUSING

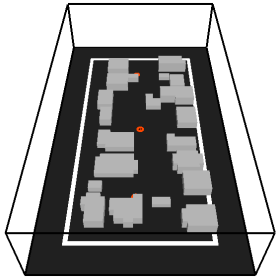
Density without Heat?

- Parameter calibration using Wunderground data
- Simulation date
  - August 18th 2017
- Sample Scenarios
  - Base: Current, Base model
  - Sim1: Paving (asphalt), no greenspace (asphalt)
  - Sim2: Greening, add trees along the sidewalk and parking lot, and grass on exposed soil

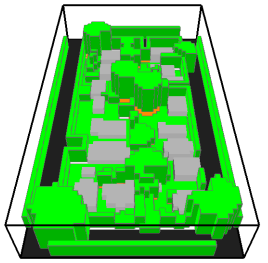


Base



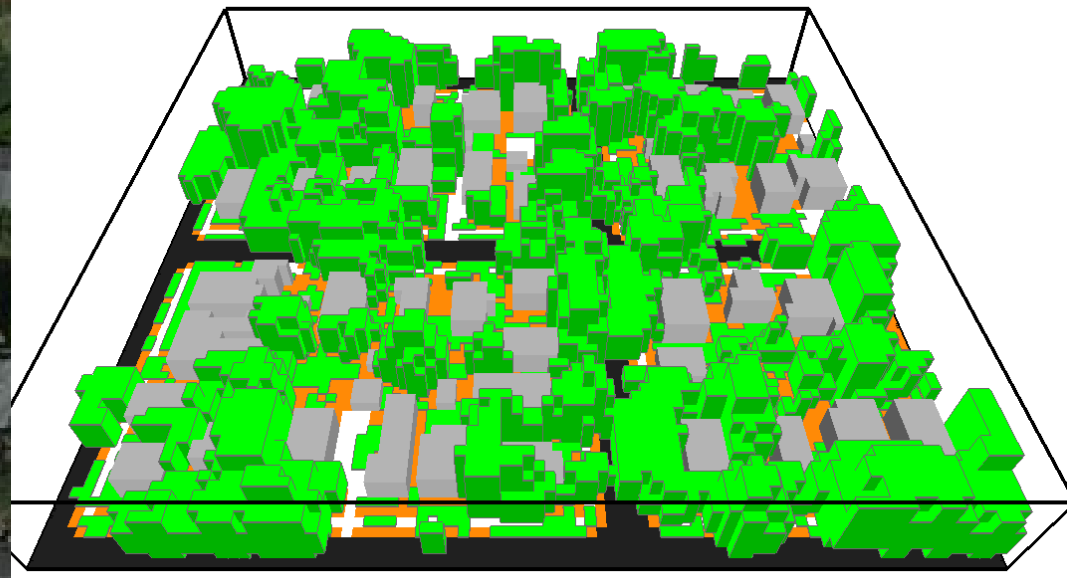


Sim1



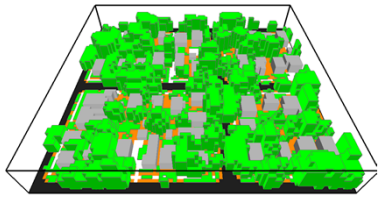
Sim2

Scenario 1: High Canopy Neighborhood (HCN)

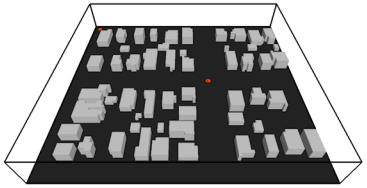


Scenario 1: High Canopy Neighborhood

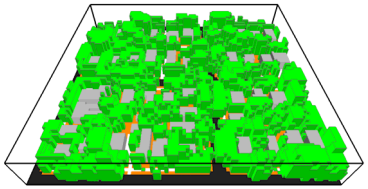
Temperature Profiles & Effects of Change



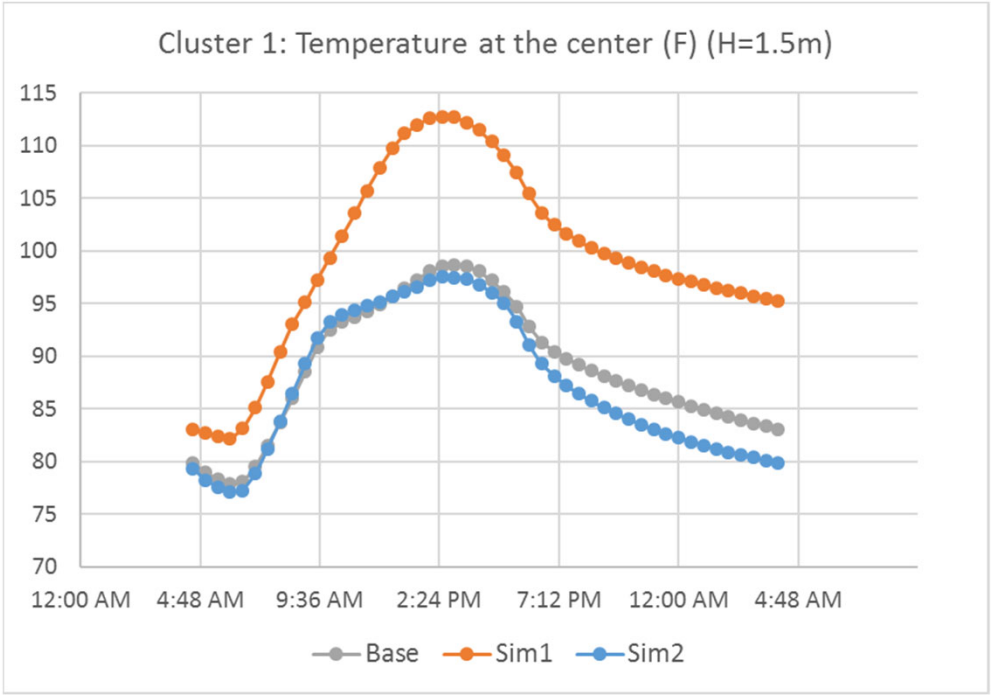
Base

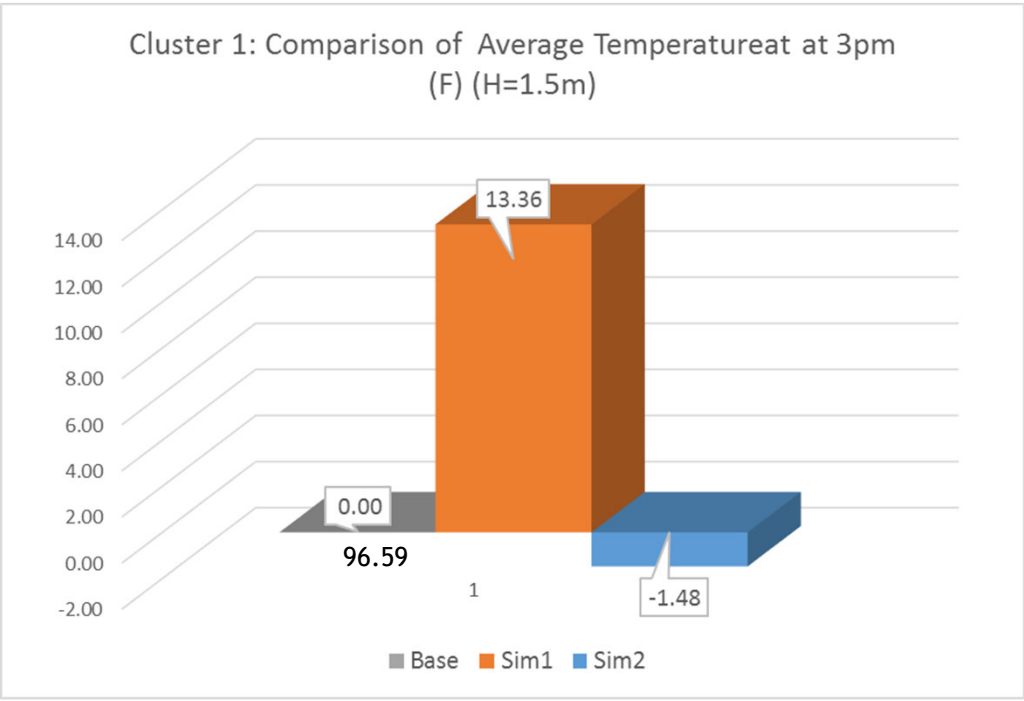


Sim1

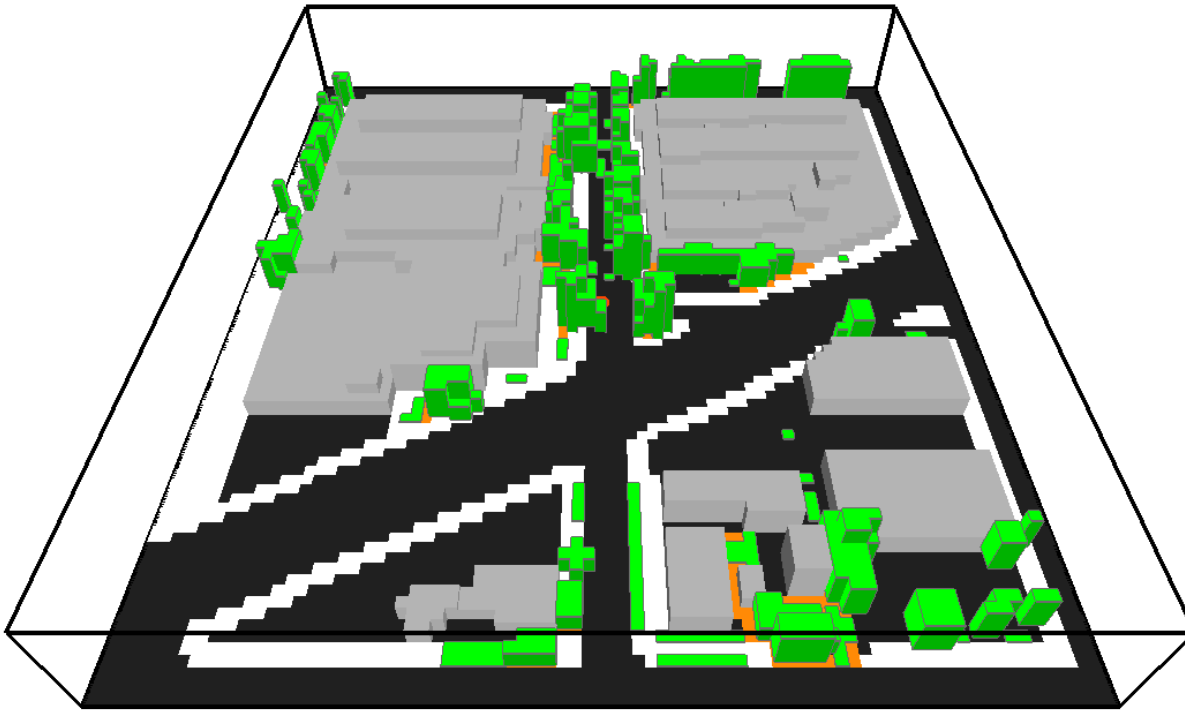


Sim2



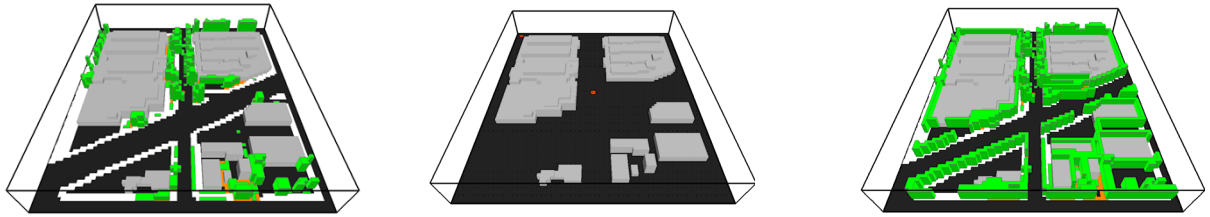


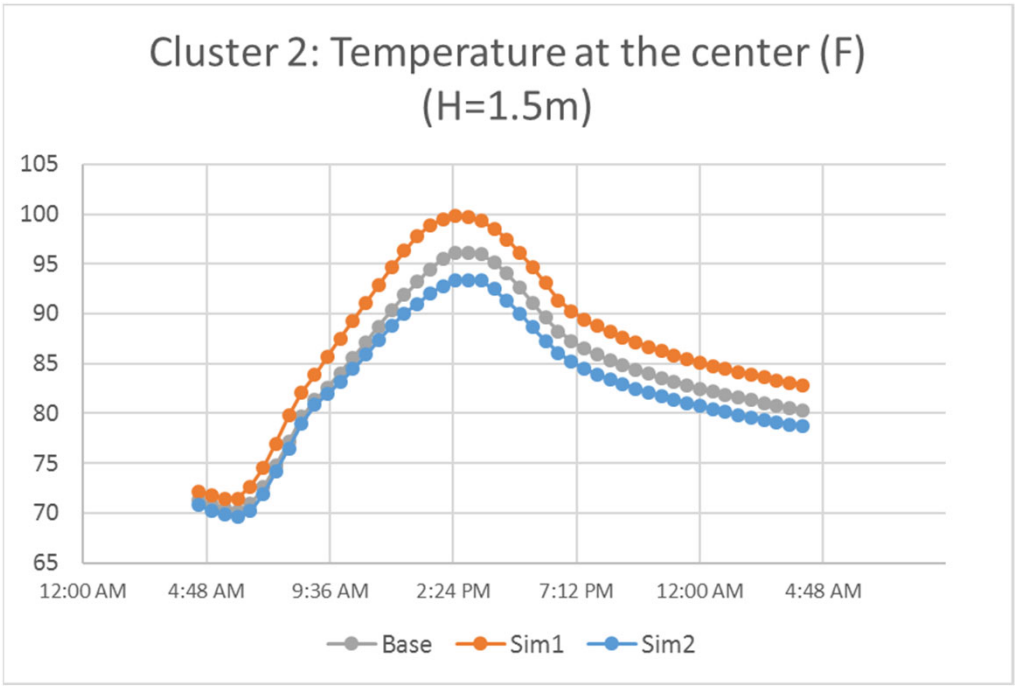
Scenario 2: Urban District (UD)

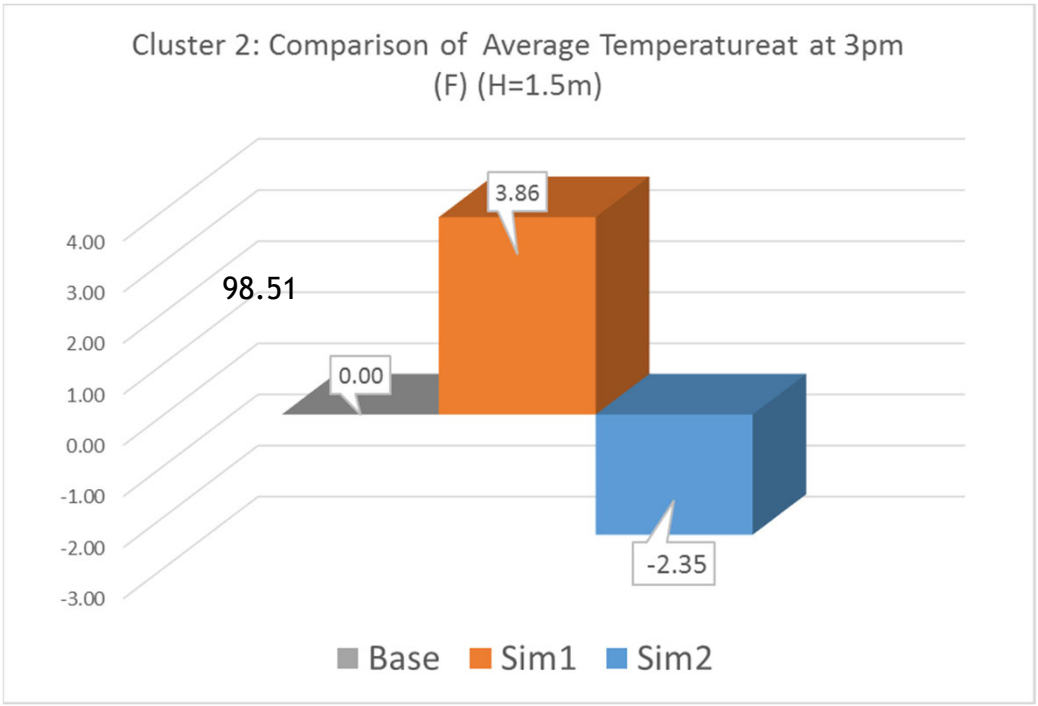


Scenario 2: Urban District

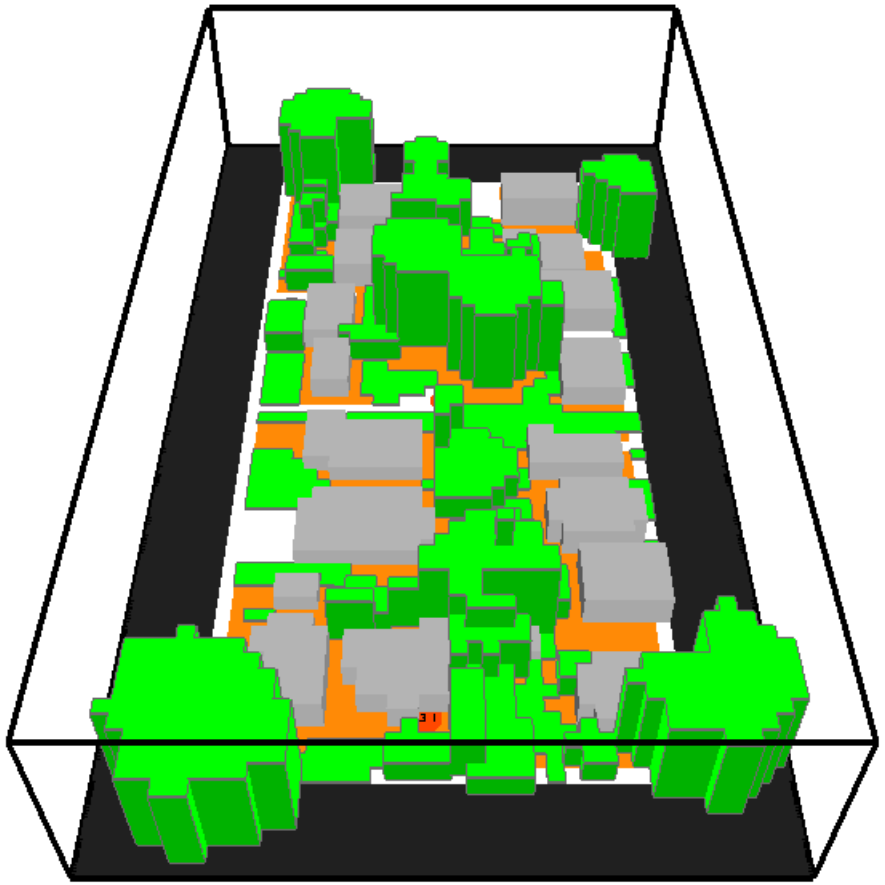
Temperature Profiles & Effects of Change





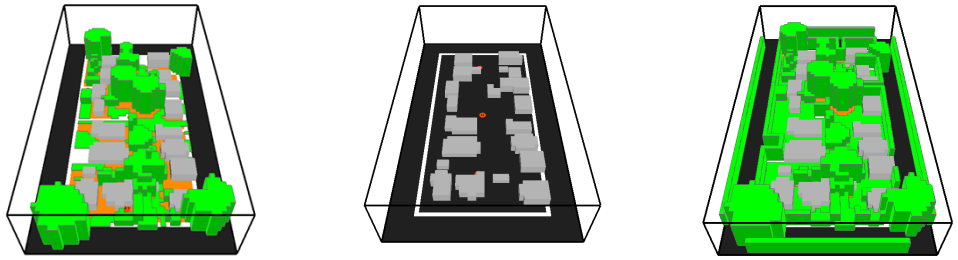


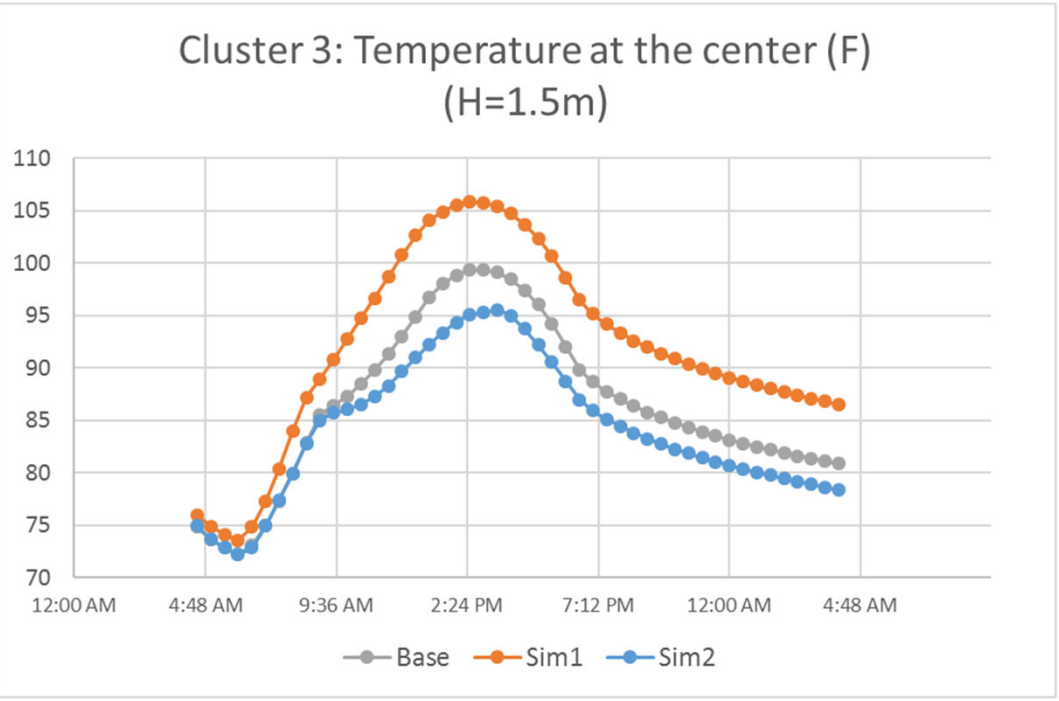
Scenario 3: Large Lot Neighborhoods

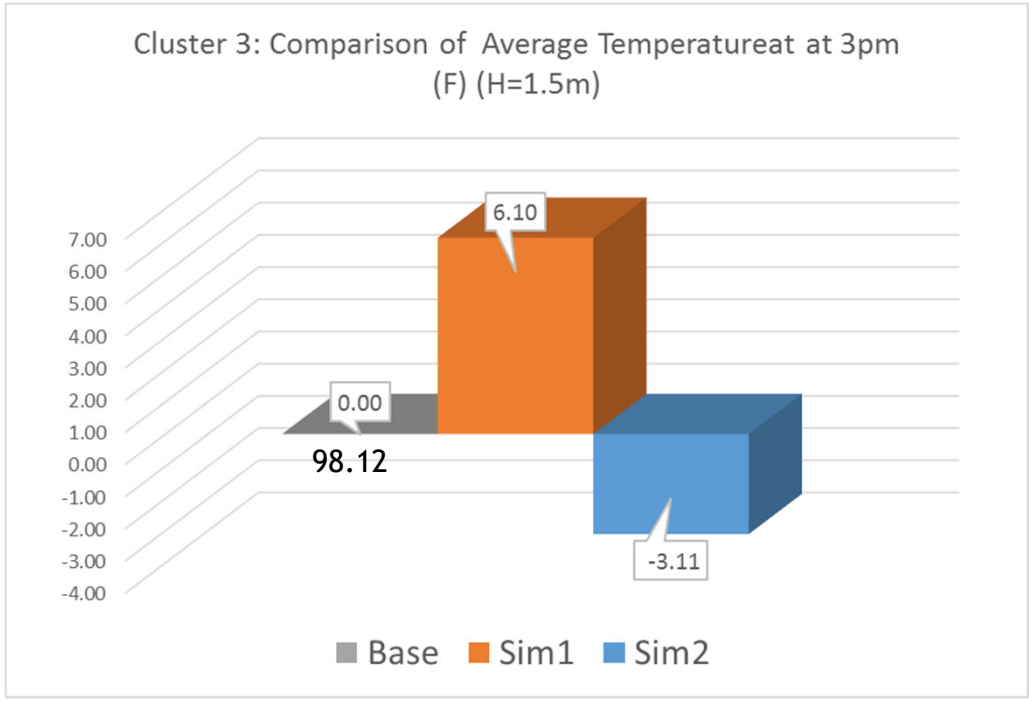


Scenario 3: Large Lot Neighborhoods

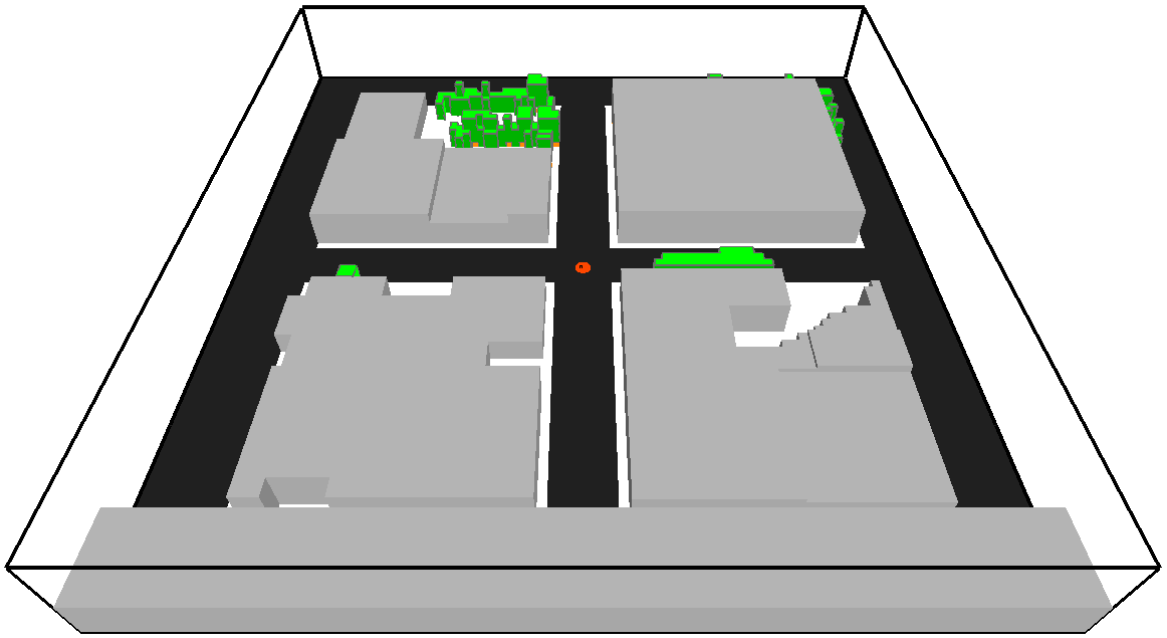
Temperature Profiles & Effects of Change





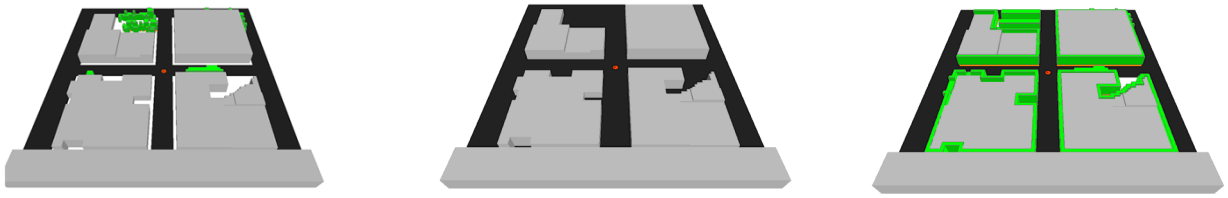


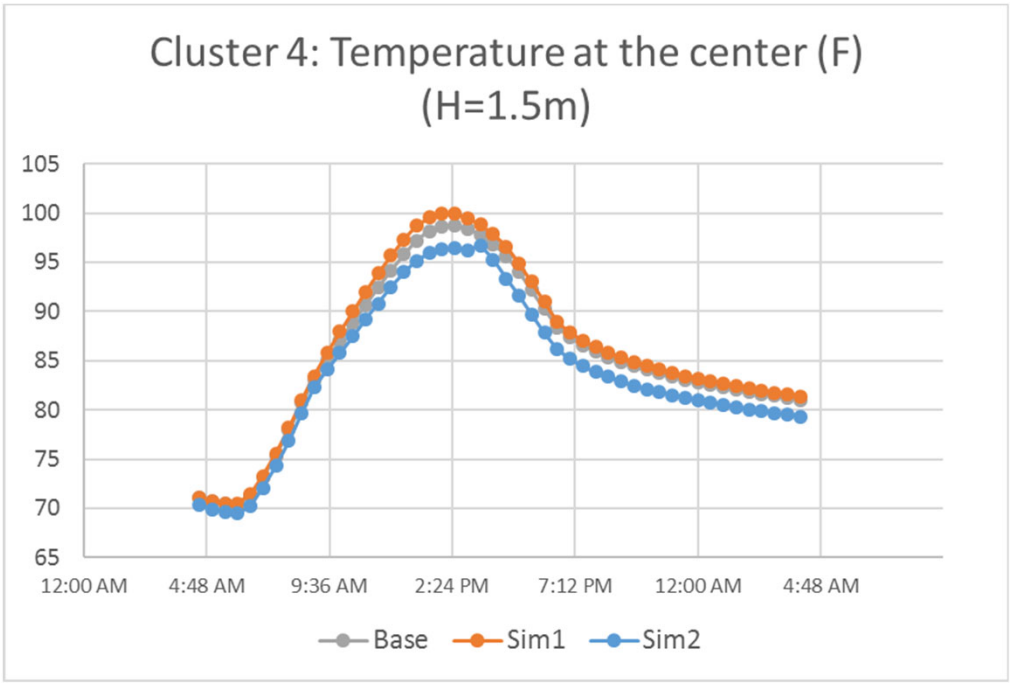
Scenario 3: Industrial Neighborhoods

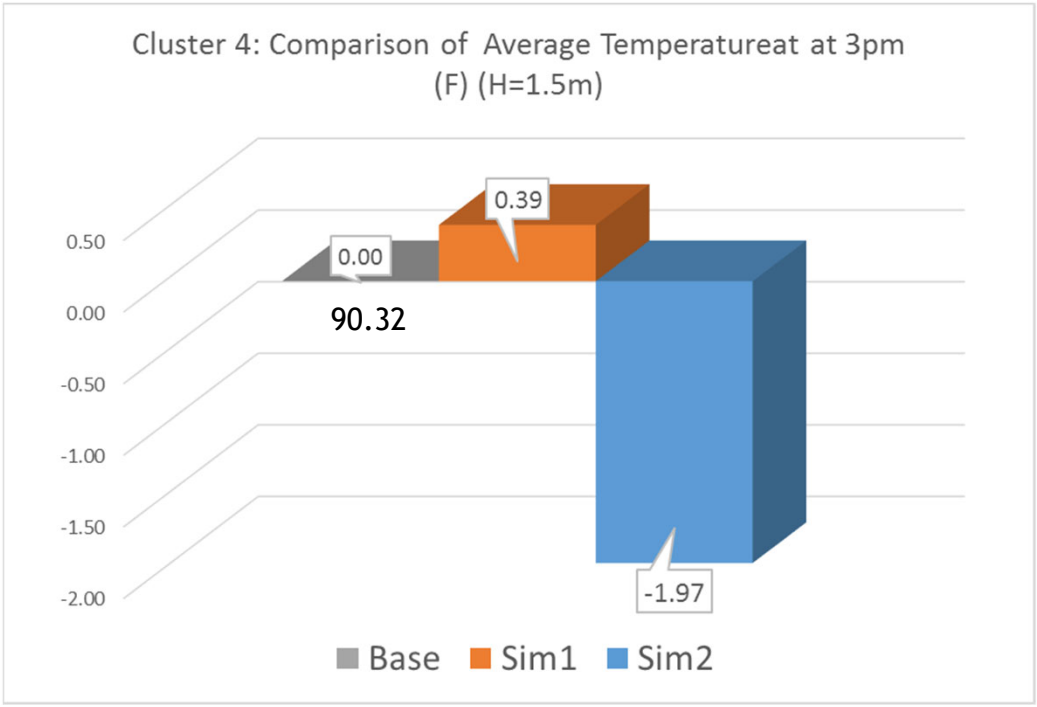


Scenario 4: Industrial Neighborhoods

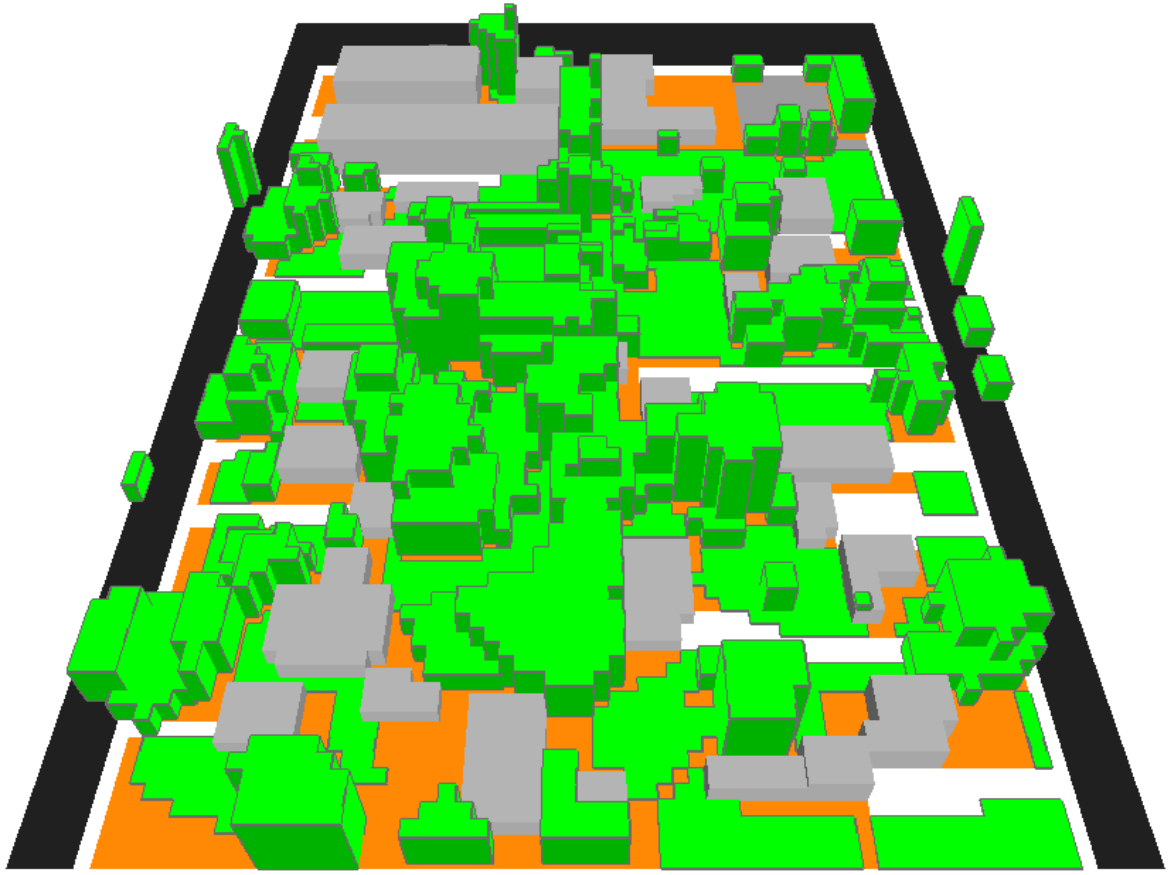
Temperature Profiles & Effects of Change





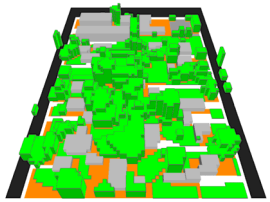
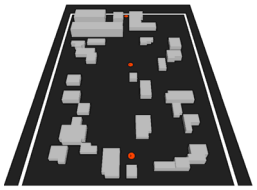
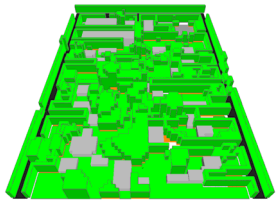


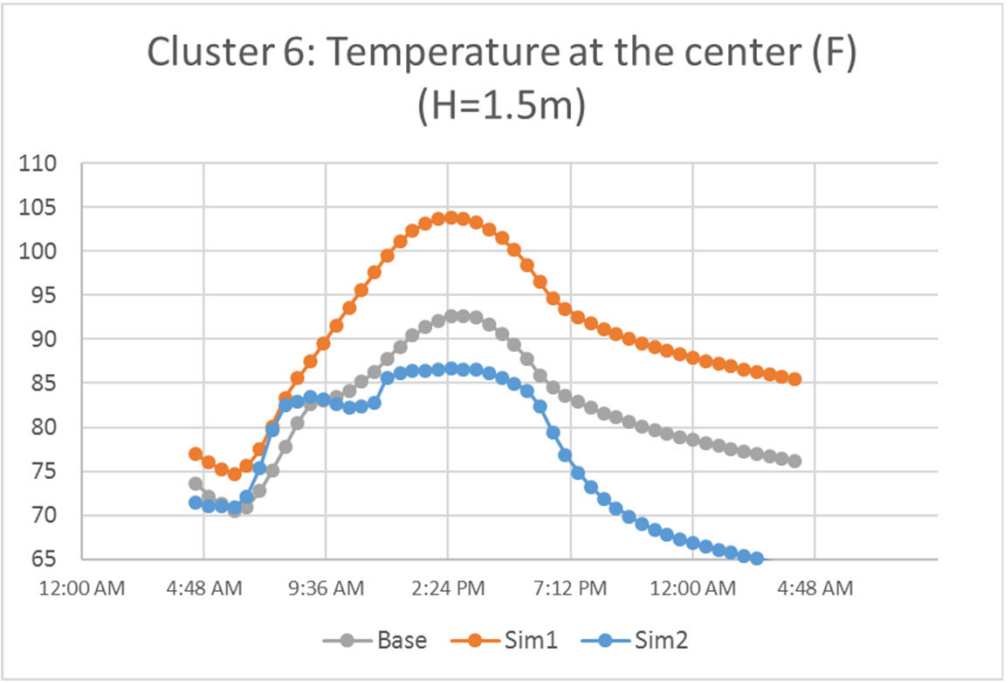
Scenario 5: Semi-Rural

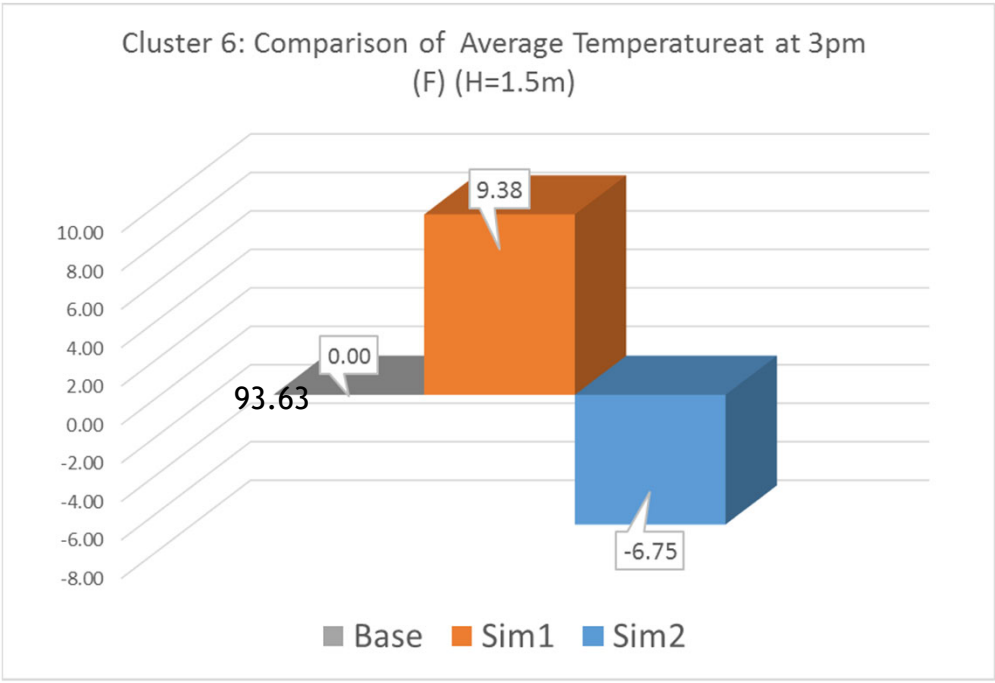


Scenario 5: Semi Rural

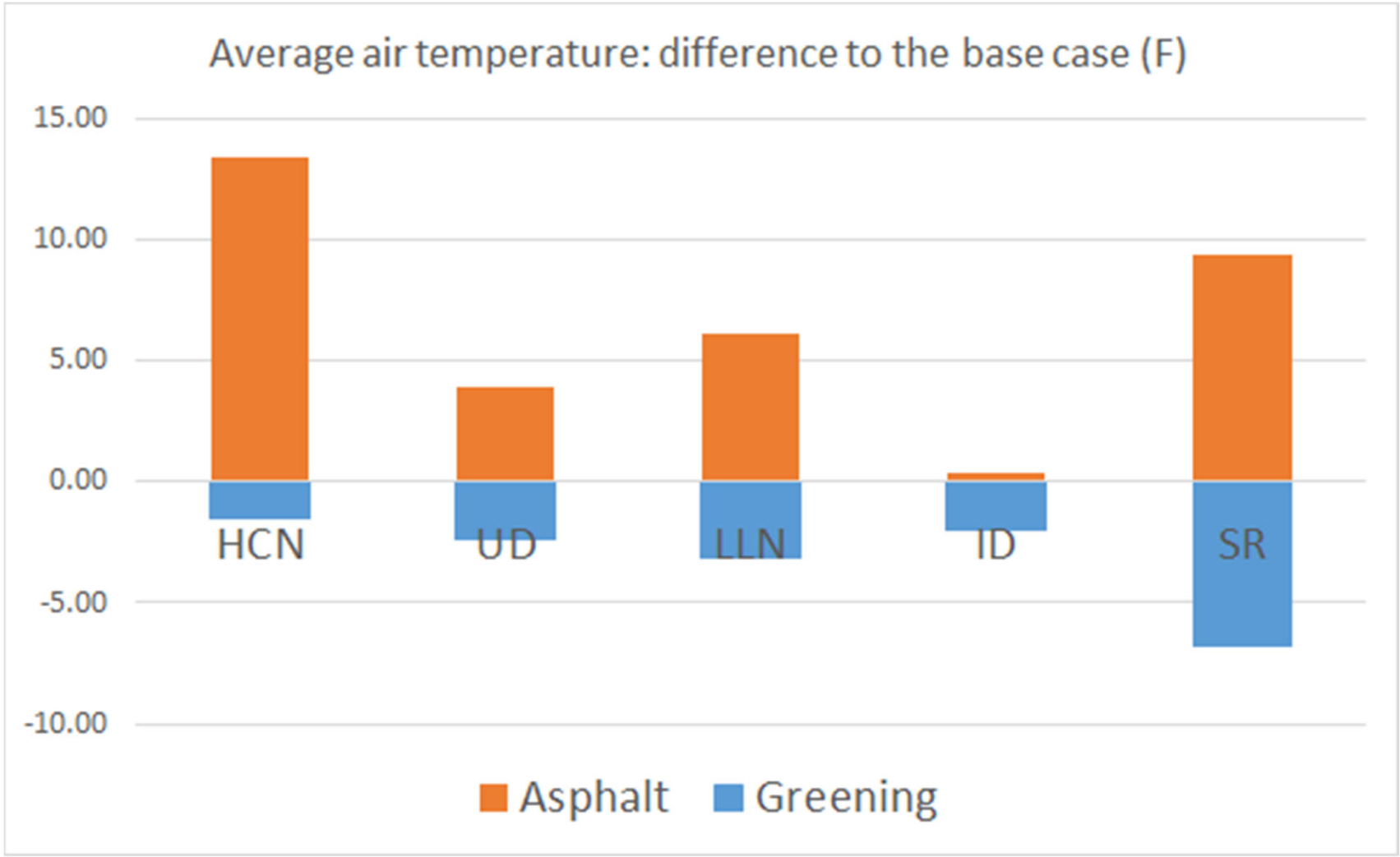
Temperature Profiles & Effects of Change

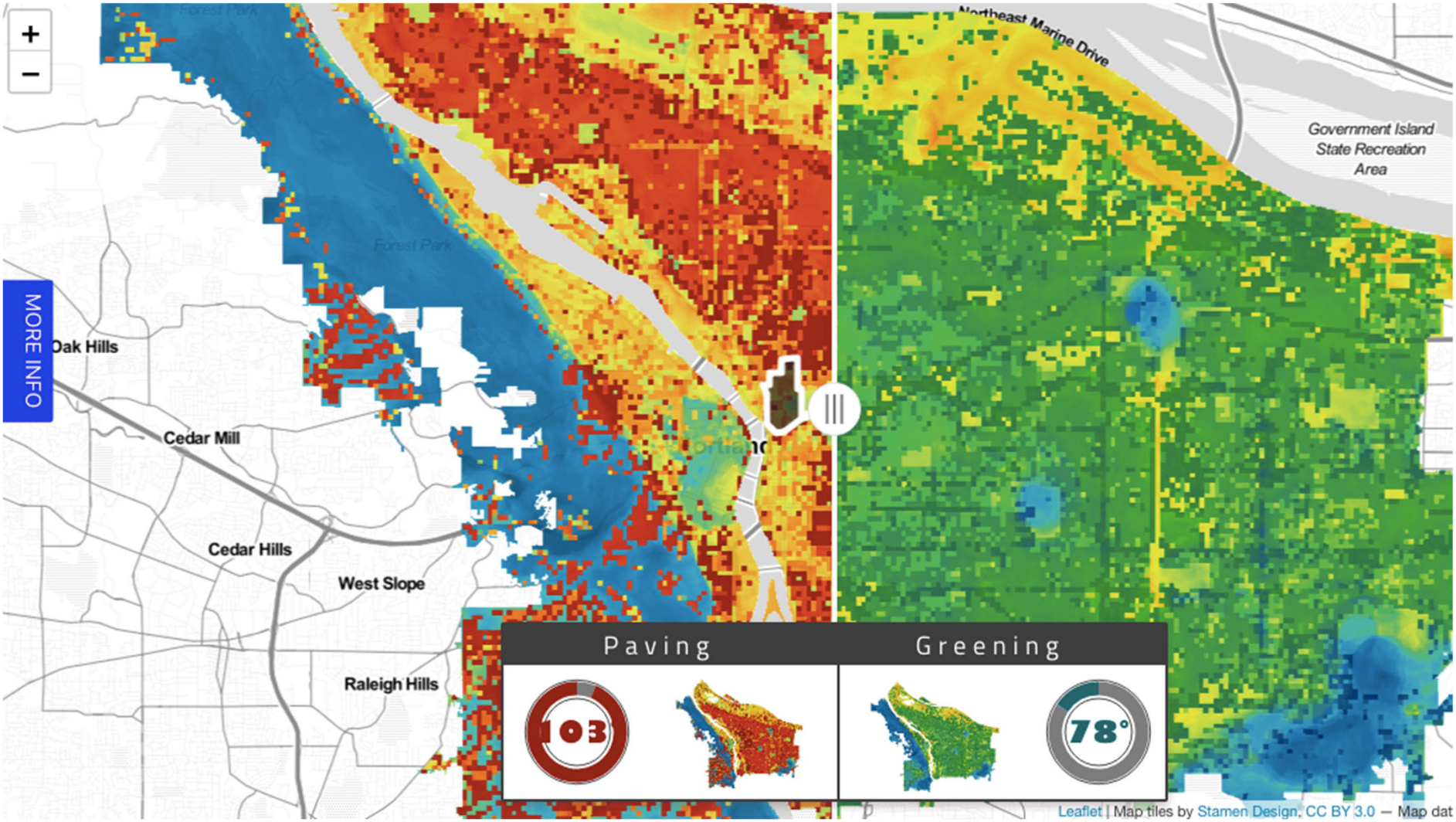




Summary: Development Scenarios & Changes in Temperatures

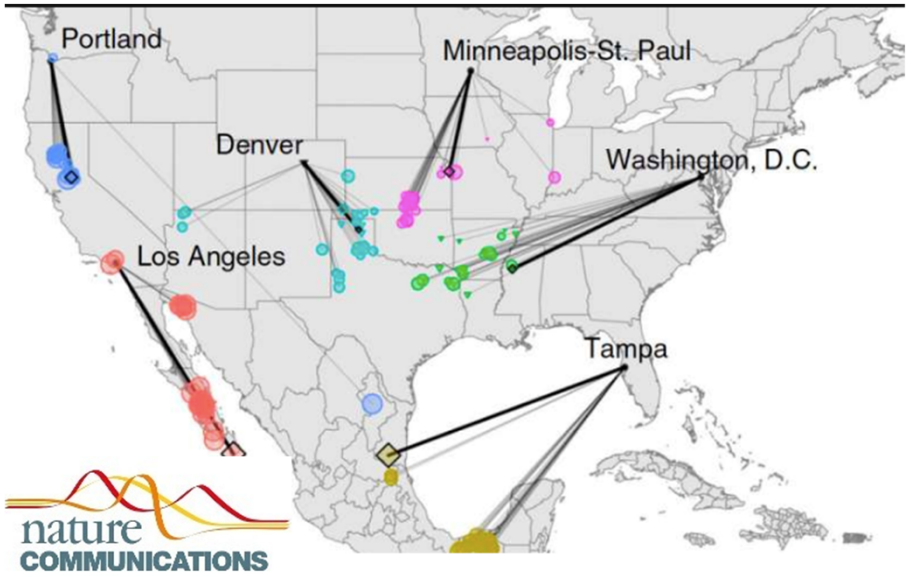


Adapting the Built Environment

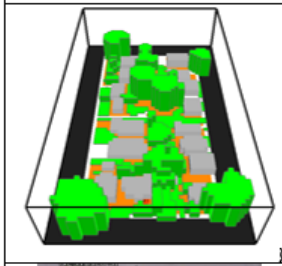
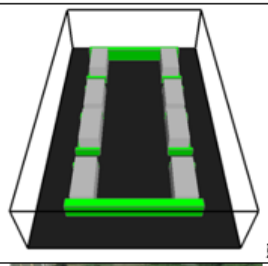
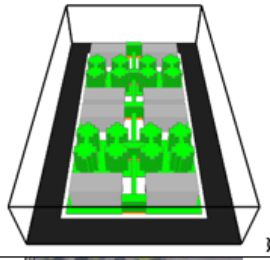
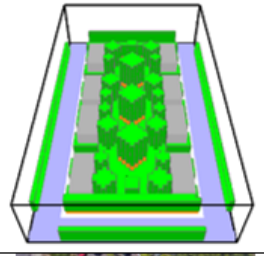


So many options for increasing density.....

...which one will we support?



Policy Relevance: BHBD

Base·case¤	Prototype·A¤	Prototype·B¤	Prototype·C¤
Existing·conditions·of·a·typical·neighborhood·block,·with·parking·(white)·and·roads·(black),·vegetation·(green),·soil·(brown)·and·buildings·(gray).¤	Multifamily·buildings·(gray)·with·large·amounts·of·asphalt·paving·and·surface·parking·(black),·and·small·amounts·of·vegetation·(green).·¤	Multifamily·buildings·(gray)·with·smaller·amounts·of·surface·parking·(white)·and·increased·vegetation·(green).·¤	Multifamily·buildings·(gray)·with·surface·parking·eliminated·and·vegetation·maximized·(green).·Also,·increased·reflectivity·(albedo)·of·roadway·paving·by·use·of·concrete·(blue·gray).·¤
			
			
Temperature:·· represents·base·case·for·comparisons.¤	Temperature:·Increased·5.57·degrees·Fahrenheit·above·the·base·case.¤	Temperature:·Increased·1.26·degrees·Fahrenheit·above·the·base·case.¤	Temperature:·Decreased·3.15·degrees·Fahrenheit·below·the·base·case.¤