

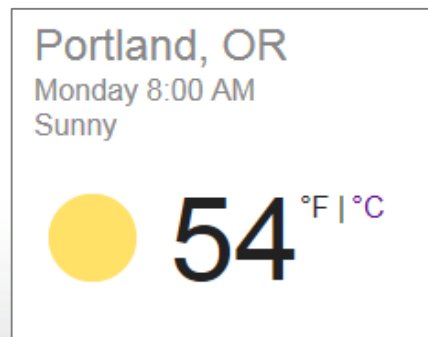


***Homogenization of vegetation structure
across residential neighborhoods:
Effects of climate, urban morphology, and socio-economics***

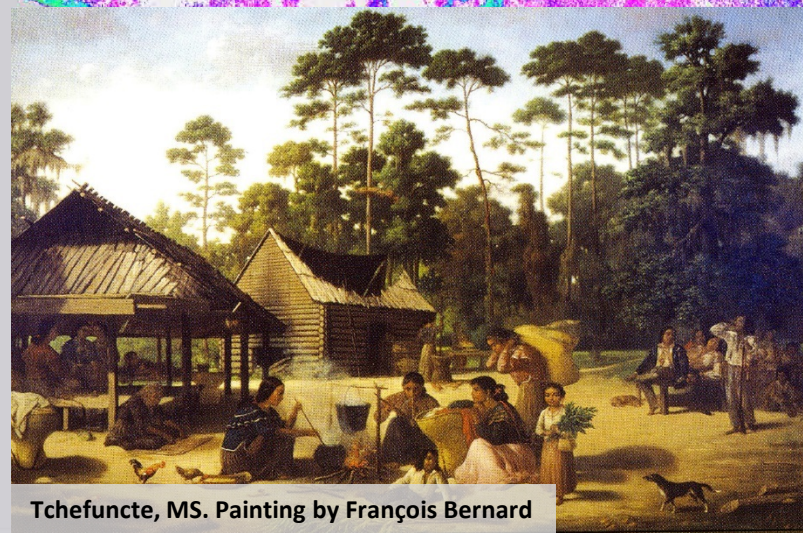
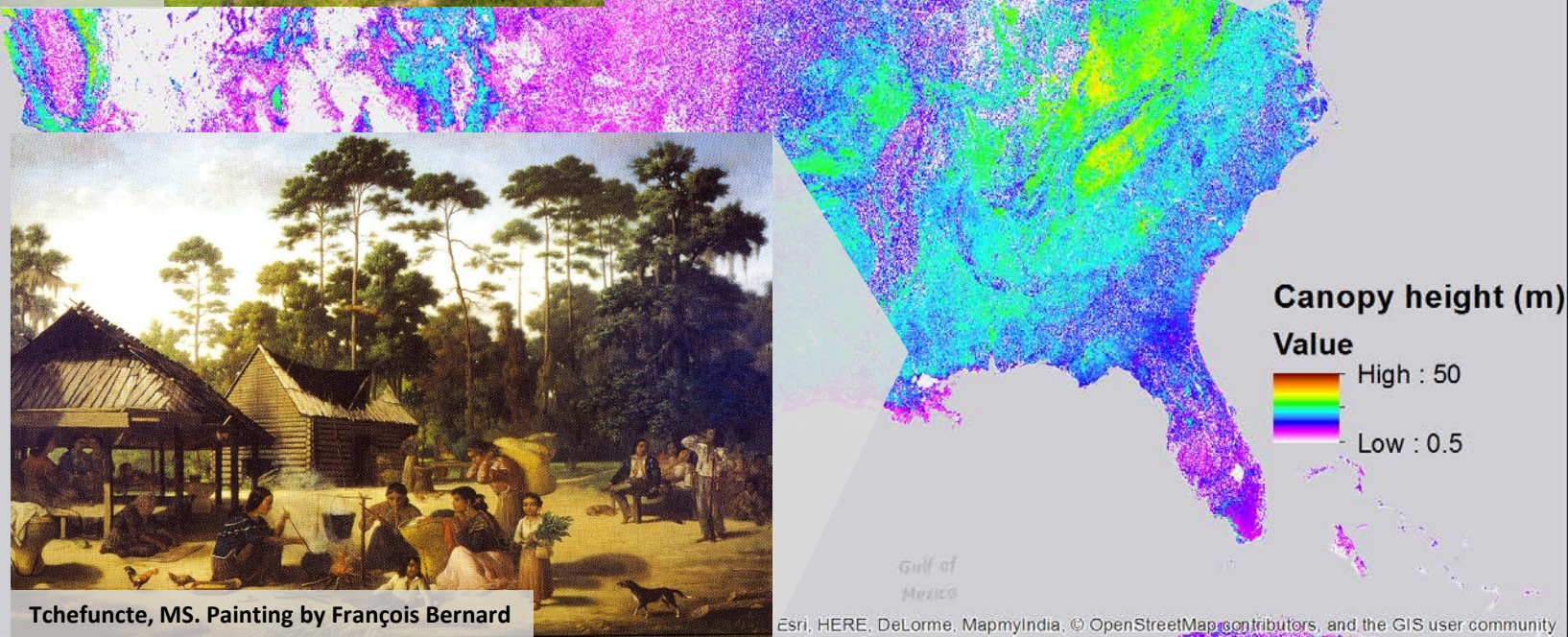
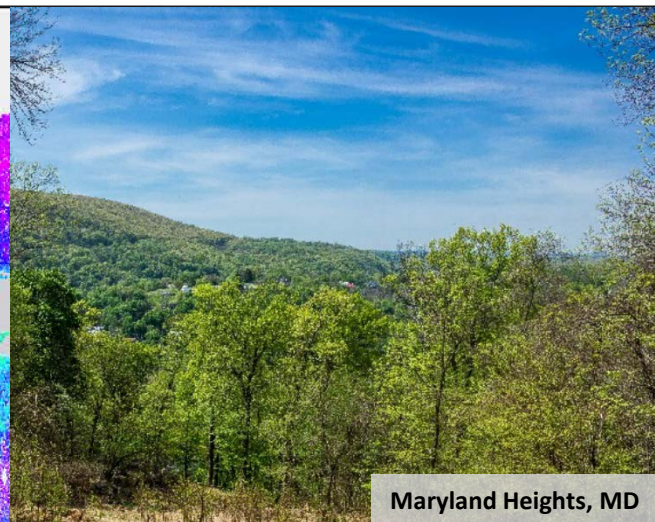
Alessandro Ossola & Matthew E. Hopton

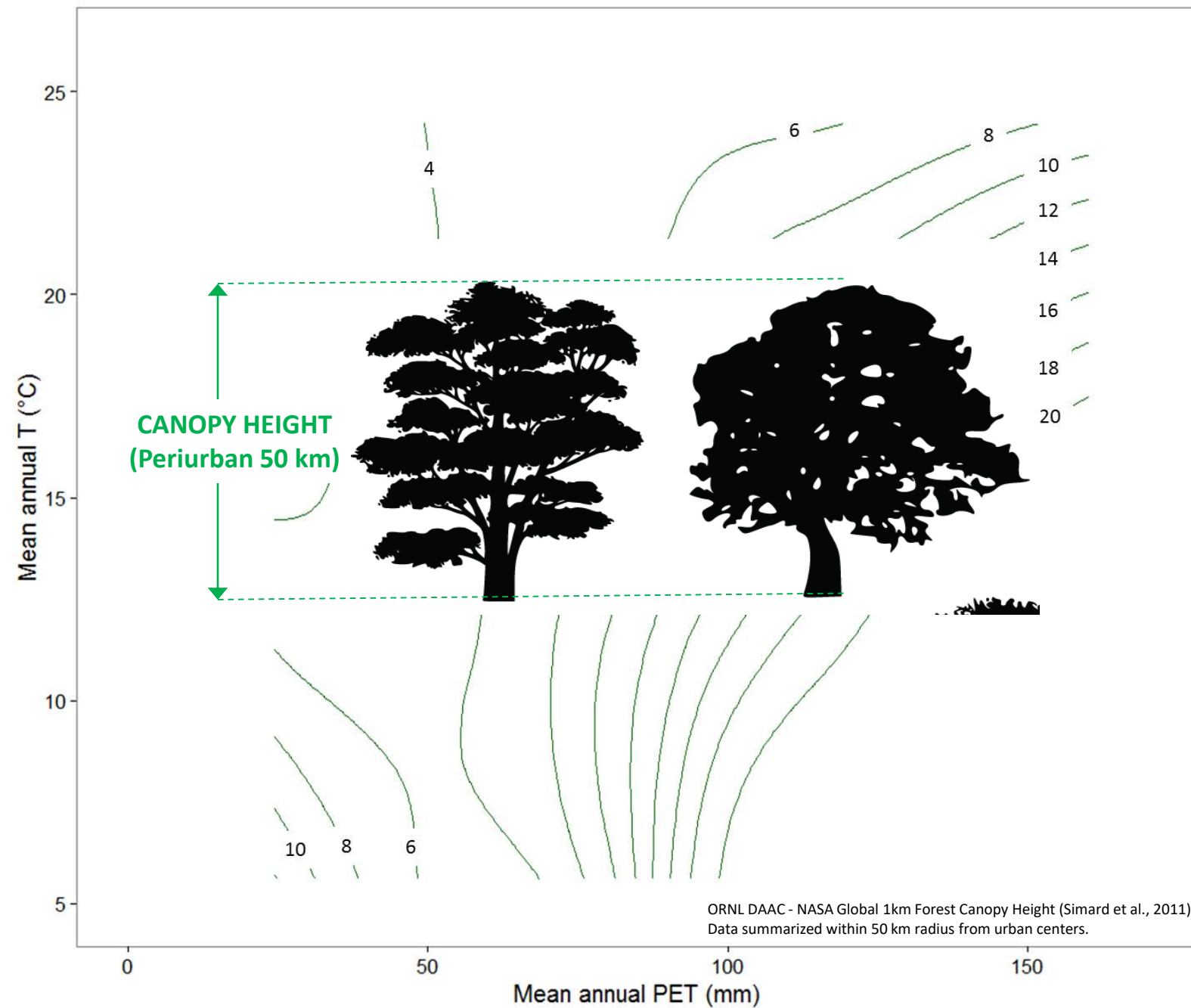


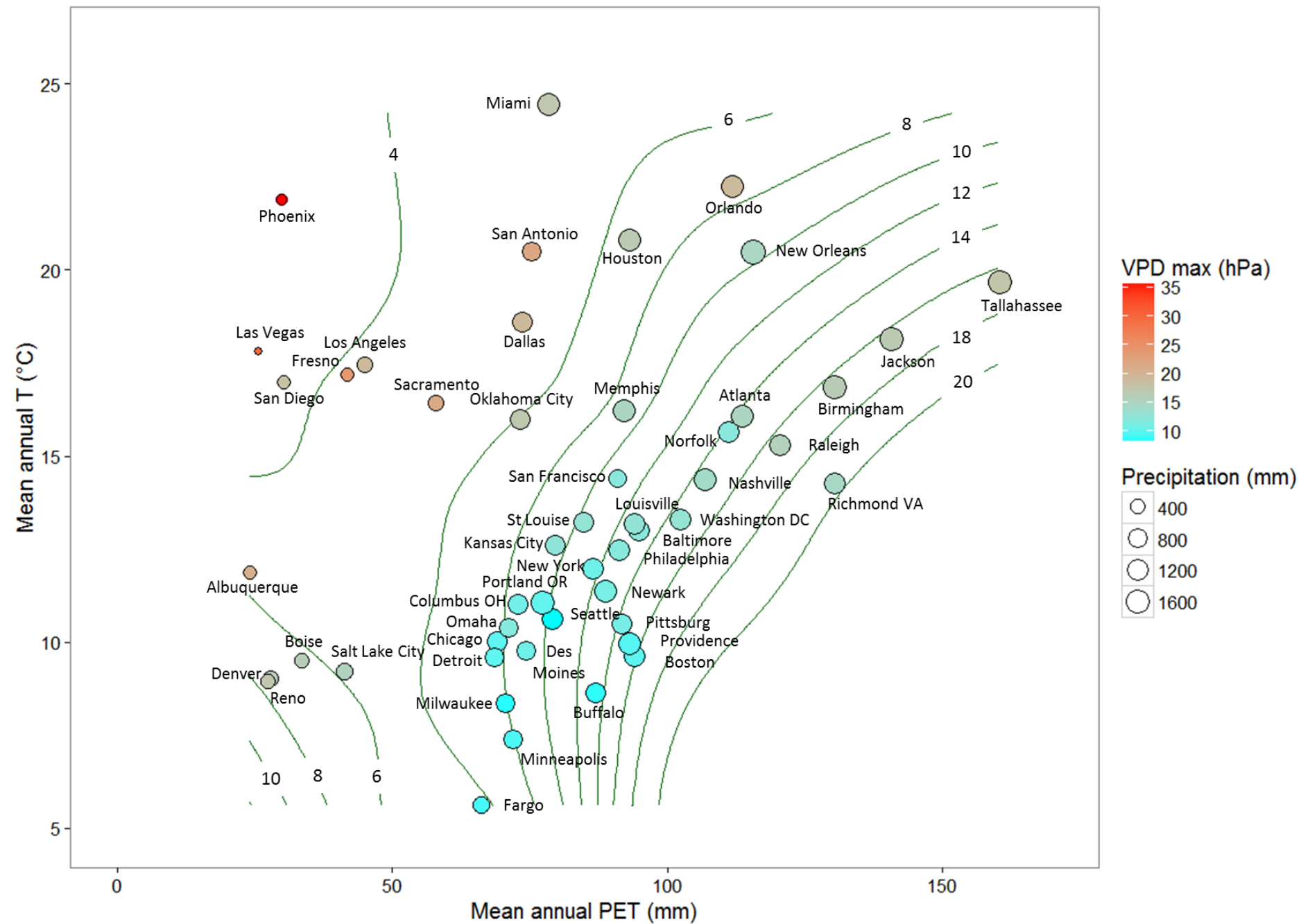
- Recent evidence suggests urban vegetation cover to be homogenized
- Socio-economics and urban morphology are linked to urban vegetation cover, but little information exists on their effect upon vegetation structure (i.e., height, volume)
- Vegetation structure, rather than canopy cover, affects urban ecological and hydrological processes (e.g., stormwater interception, decomposition, habitat for biodiversity, etc.).
- Homogenization of the US urban macrosystem (Groffman et al. 2014)
 - Lawn care and management (Polski et al. 2014)
 - Lawn micro-climate (Hall et al. 2016)
 - Lawn plant communities (Wheeler et al. 2017; Trammell et al. 2016)

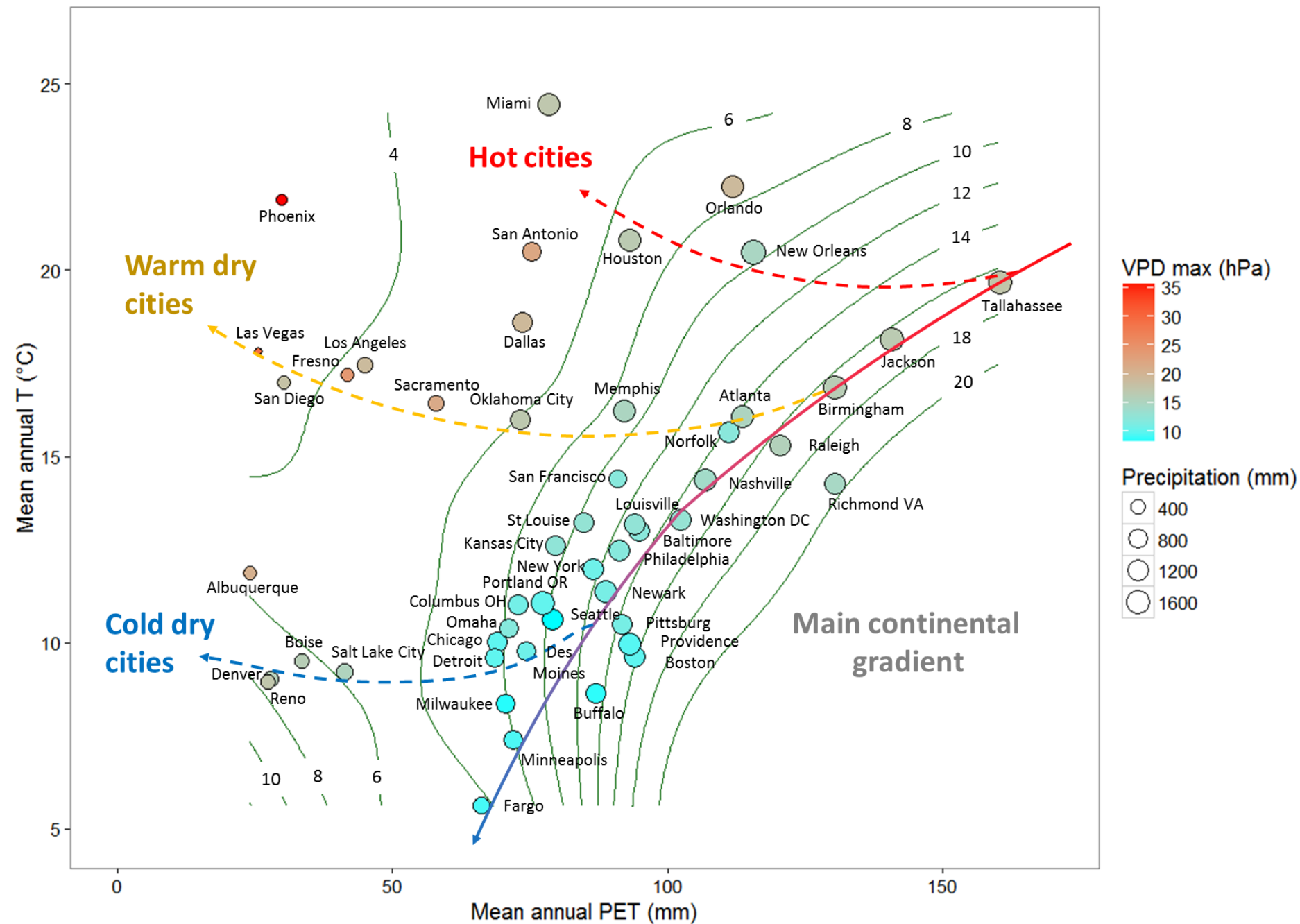


ORNL DAAC - NASA Global 1km Forest
Canopy Height (Simard et al., 2011)

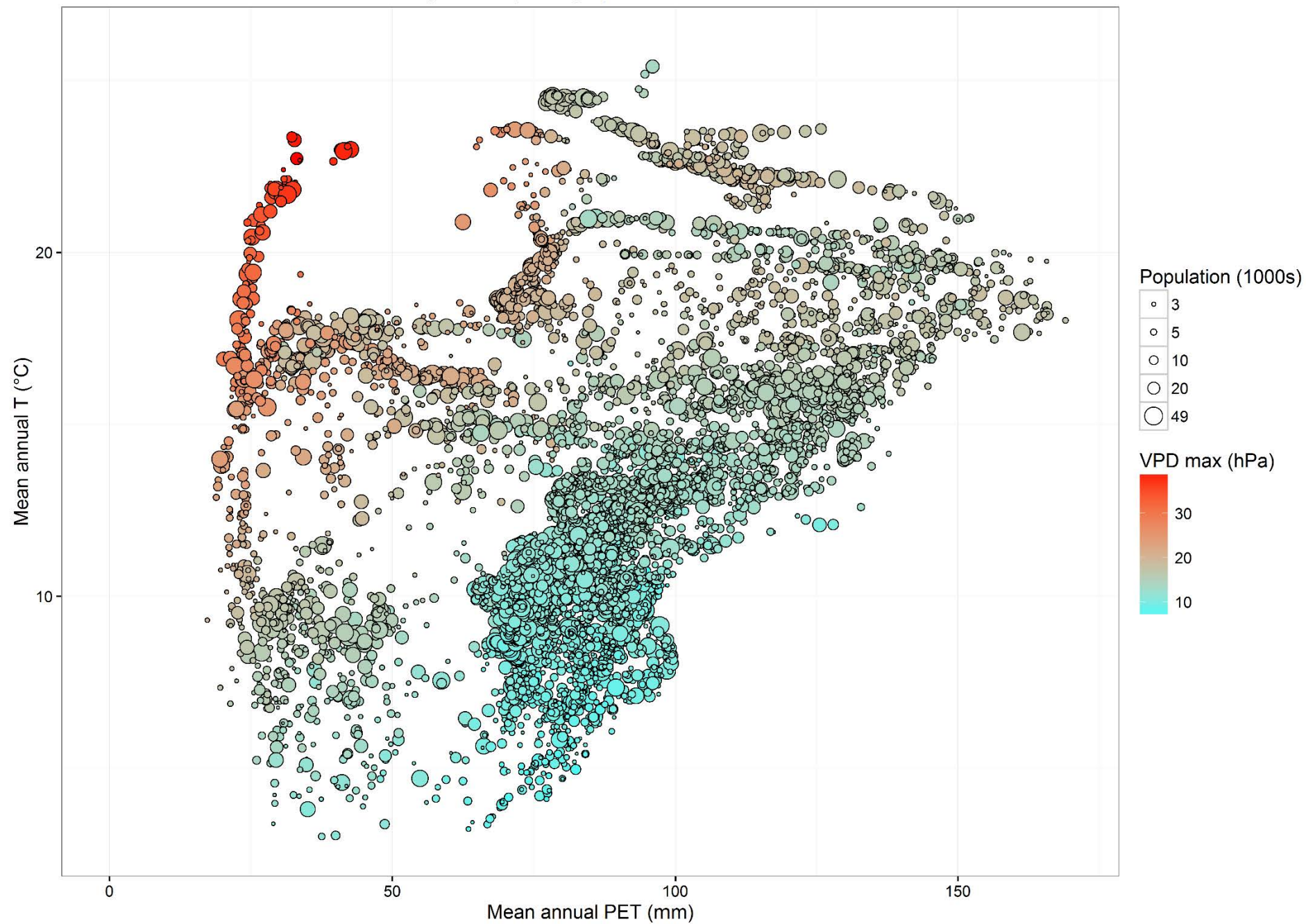








US urban clusters (n=7928) with population 2,500-50,000 inhabitants



MAT (°C)

25

20

15

10

5

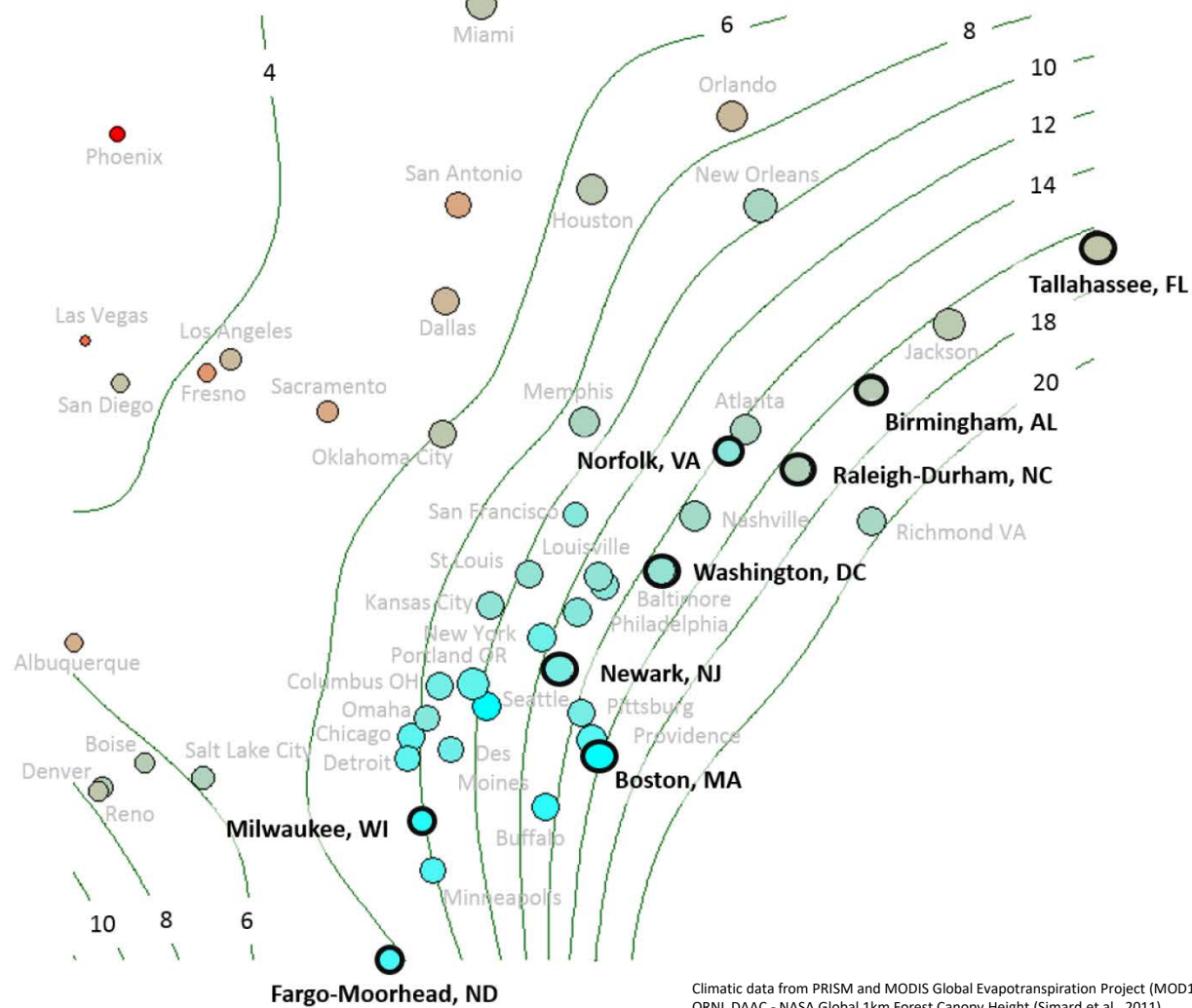
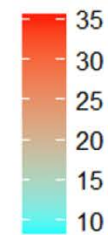
0

50

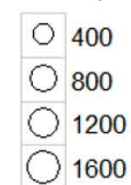
PET (mm)

100

150

VPD_{max} (hPa)

MAP (mm)



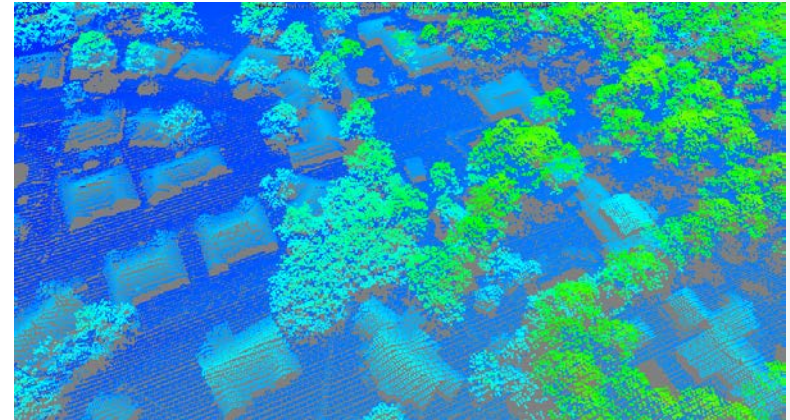
Forest canopy volume
(m³ m⁻²) within 50 km
from urban centers



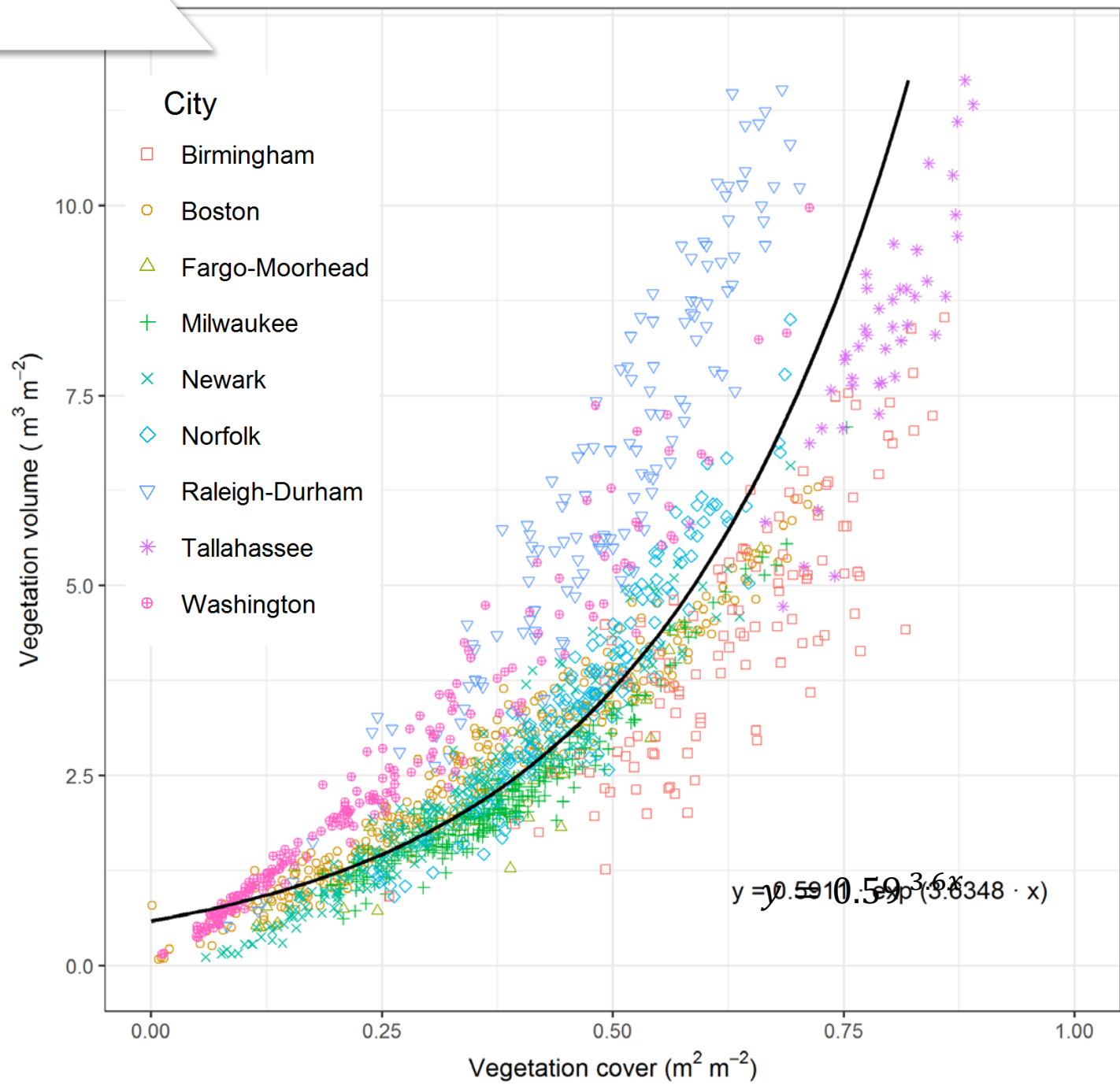
Climatic data from PRISM and MODIS Global Evapotranspiration Project (MOD16).
ORNL DAAC - NASA Global 1km Forest Canopy Height (Simard et al., 2011).
Data summarized within 50 km radius from urban centers.

- Does macro-climate affect the structure of vegetation across US residential landscapes?
- What is the relationship between structural parameters (e.g., vegetation cover, height and volume), urban morphology and socio-economic characteristics of neighborhoods?
- Is the vegetation structure homogenized across US residential landscapes?

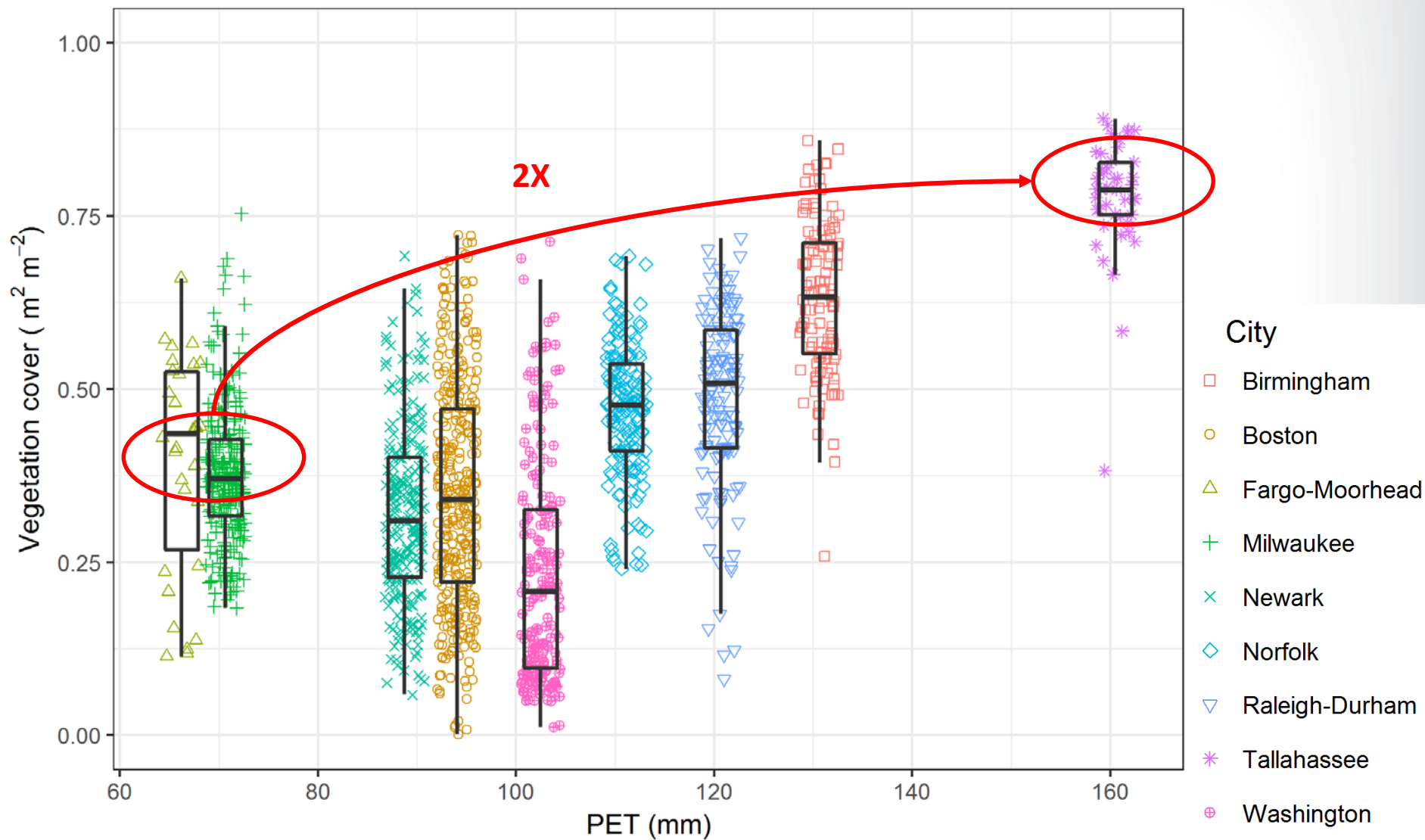
- 9 cities investigated, 1500+ neighborhoods (i.e., census tracts), 1.4M+ residential parcels.
- Airborne LiDAR point clouds collected in 2013-15 at ~ 2 points/m² (NPS=0.7), total 50B+ points.
- Multispectral imagery (RGB, NIR) at 1 m resolution collected in 2013-2015 (USDA-NAIP).



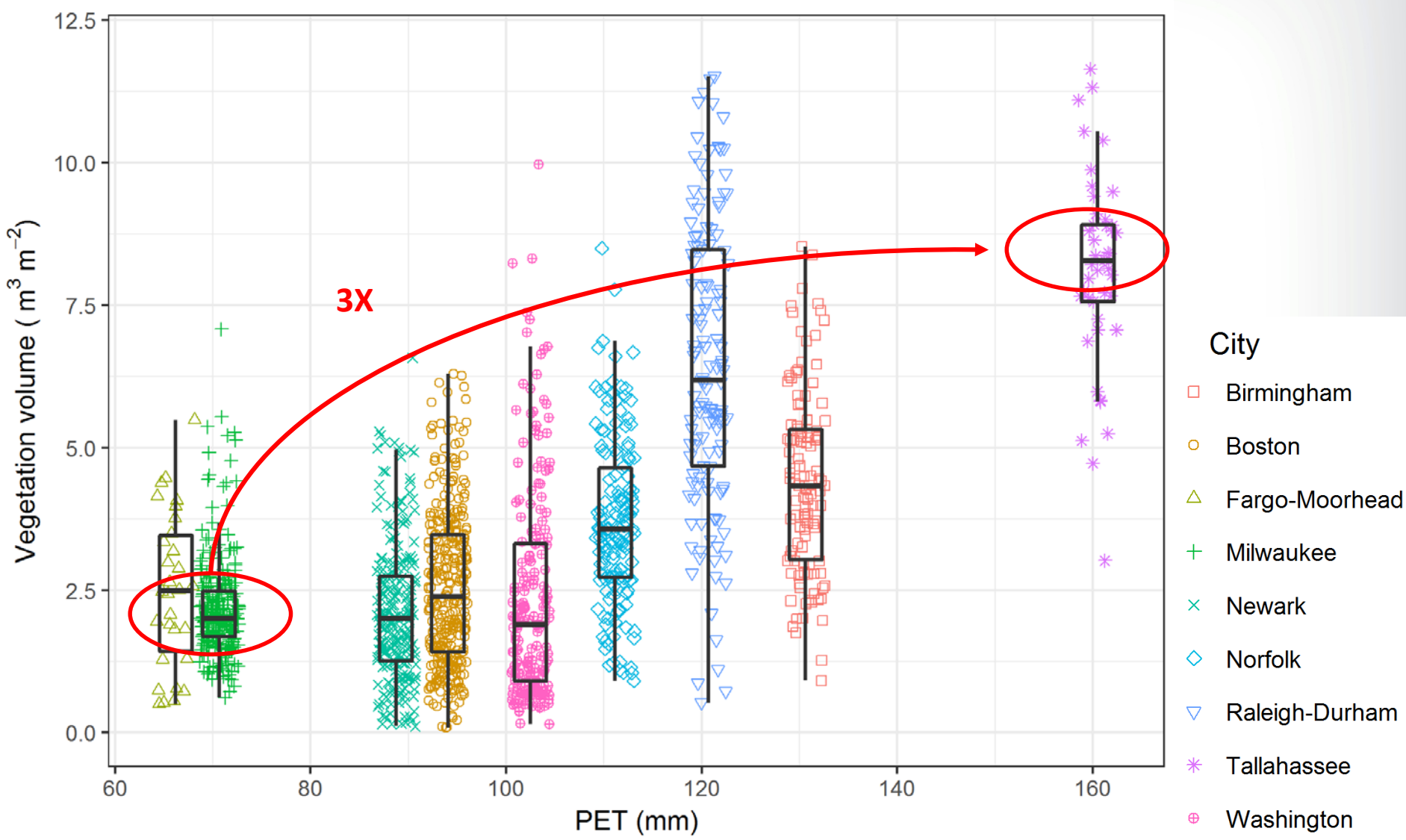
RESULTS



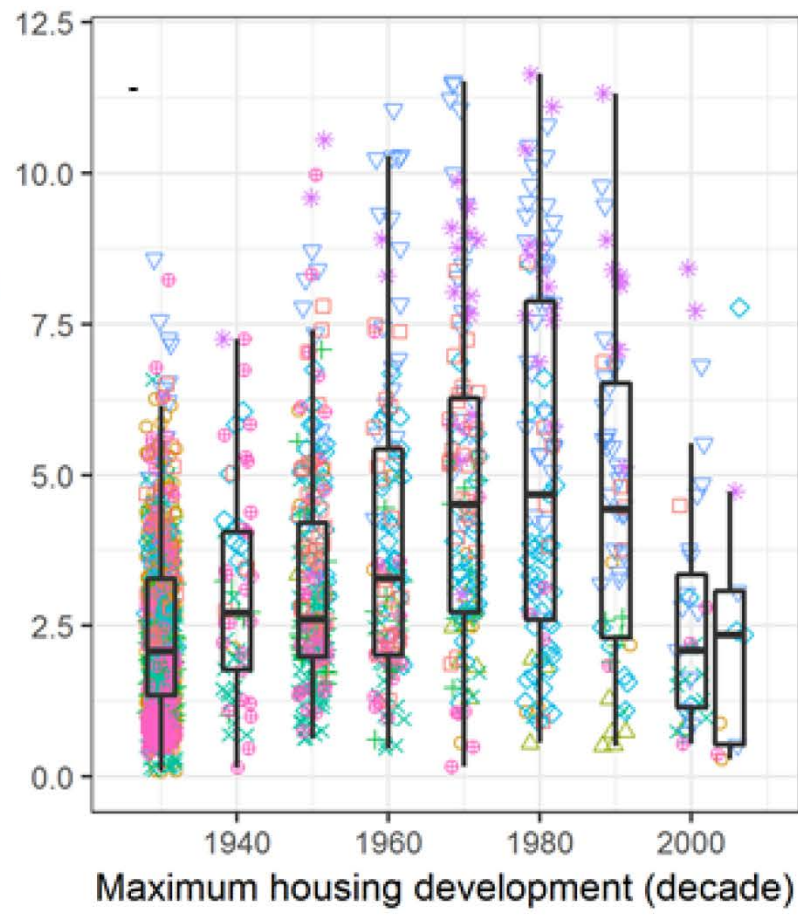
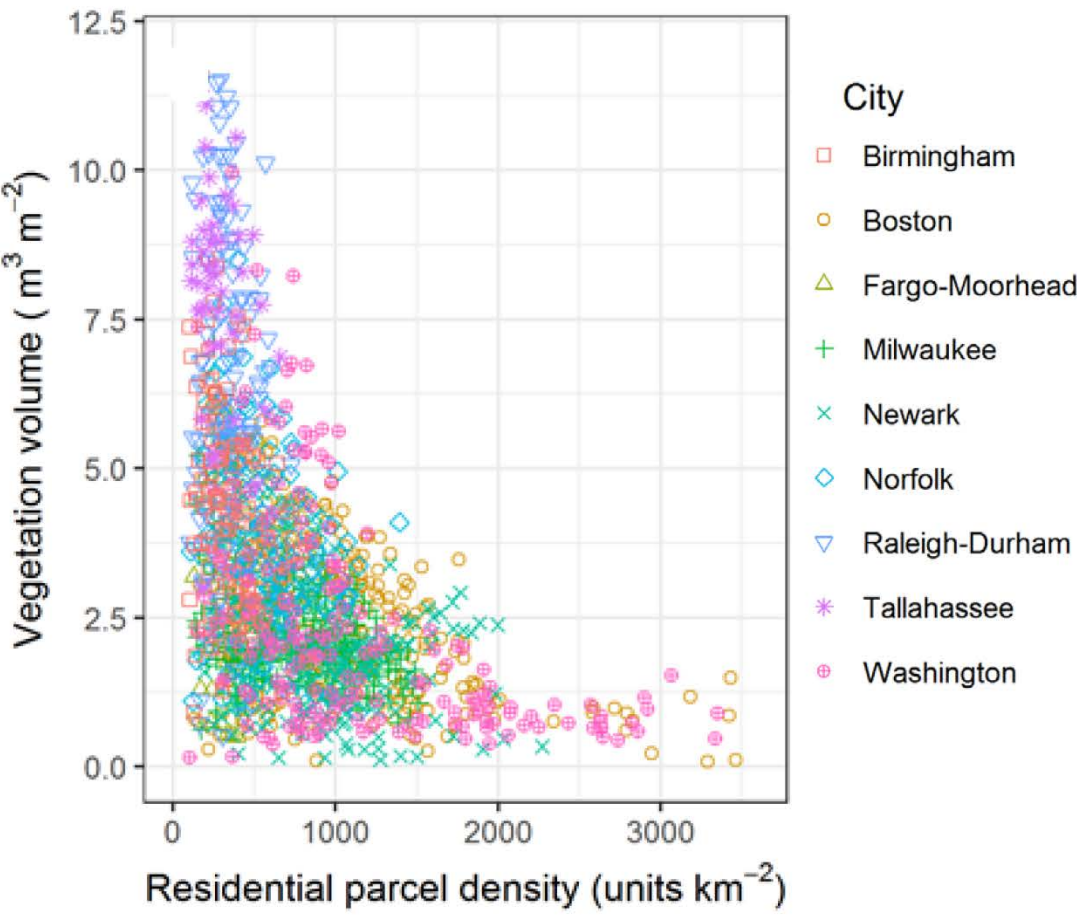
RESULTS



RESULTS



RESULTS



	Variable
<i>Climate</i>	Potential evapotranspiration, PET (mm yr ⁻¹)
<i>Urban morphology</i>	Residential parcel density (units km ⁻²)
	Residential land cover (%)
	Maximum housing development (decade)
<i>Socio-economic</i>	Vacant residential units (%)
	Median population age (y)
	Race diversity index
	Income inequality - Gini index
	Unemployment rate 20 to 64 years (%)
	Median monthly rent (\$)

Response variable: vegetation cover

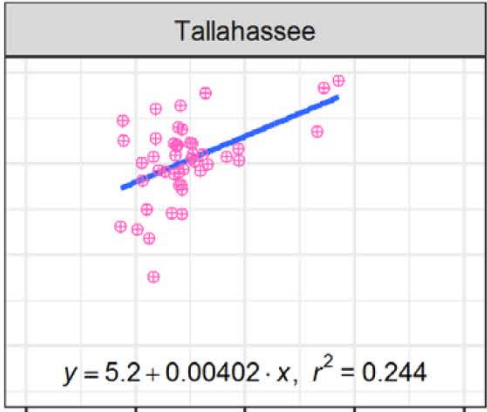
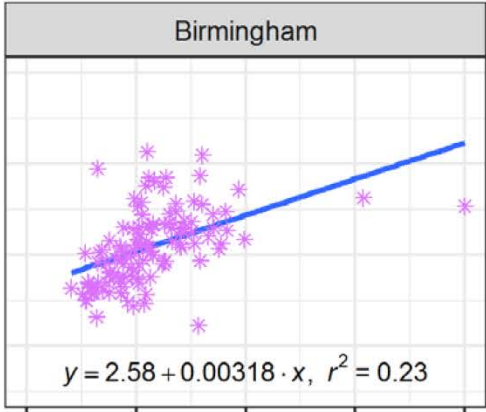
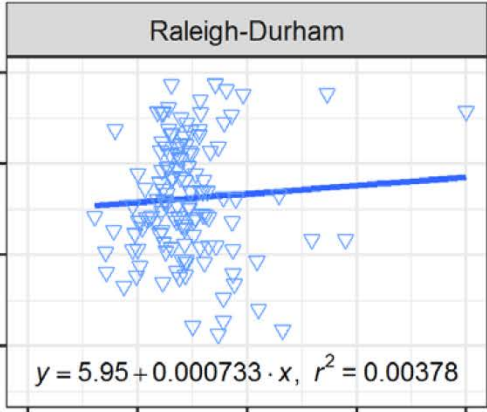
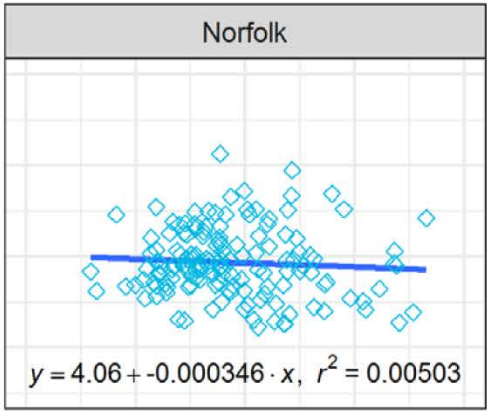
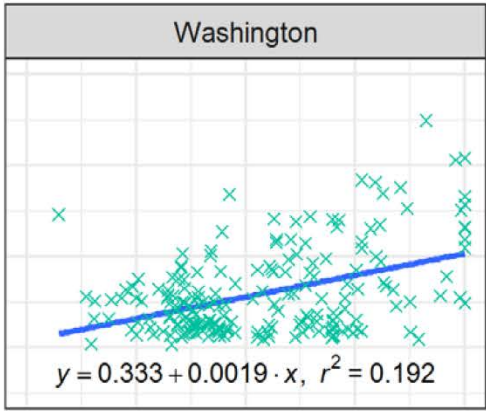
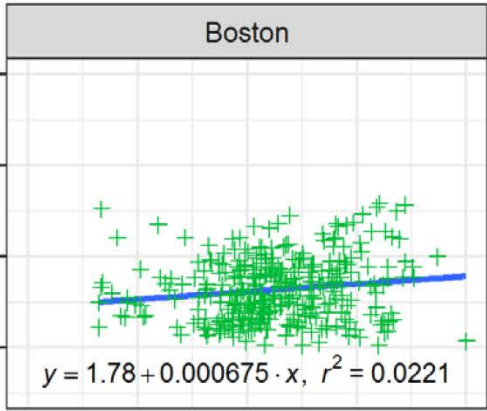
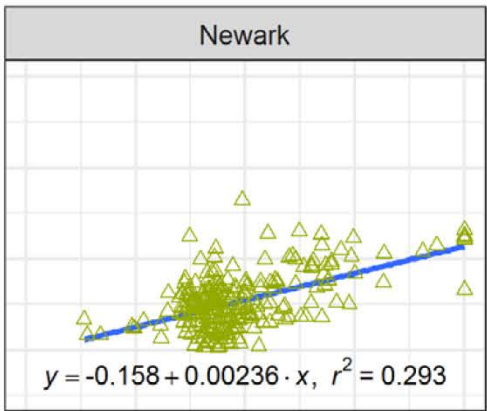
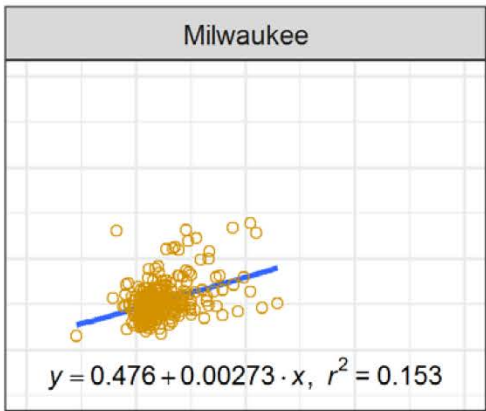
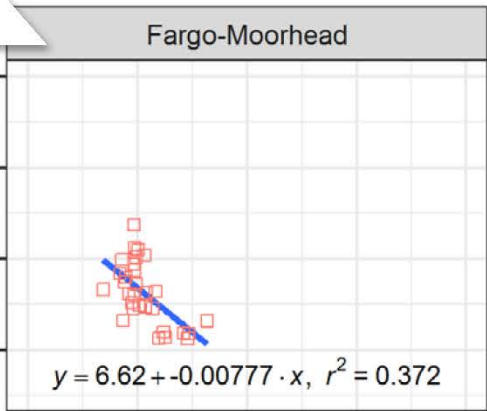
Model	N. parameters	AIC	Δ AIC	AIC weights
<i>Climate – urban morphology</i>	8	1212.69	0.00	1.00
<i>Climate</i>	3	1223.13	10.44	0.00
<i>Global</i>	15	1224.73	12.04	0.00
<i>Climate – socio-economics</i>	10	1230.22	17.54	0.00
<i>Urban morphology</i>	6	1254.10	41.41	0.00
<i>Urban morphology – socio-economics</i>	13	1259.91	47.22	0.00
<i>Socio-economics</i>	8	1356.38	143.69	0.00

Response variable: vegetation volume

Model	N. parameters	AIC	Δ AIC	AIC weights
<i>Global</i>	17	691.70	0.00	1.00
<i>Climate – urban morphology</i>	9	709.82	14.93	0.00
<i>Urban morphology – socio-economics</i>	15	904.67	212.97	0.00
<i>Urban morphology</i>	7	917.35	222.45	0.00
<i>Climate – socio-economics</i>	12	1381.84	690.14	0.00
<i>Climate</i>	4	1579.76	888.06	0.00
<i>Socio-economics</i>	10	1972.88	1281.17	0.00

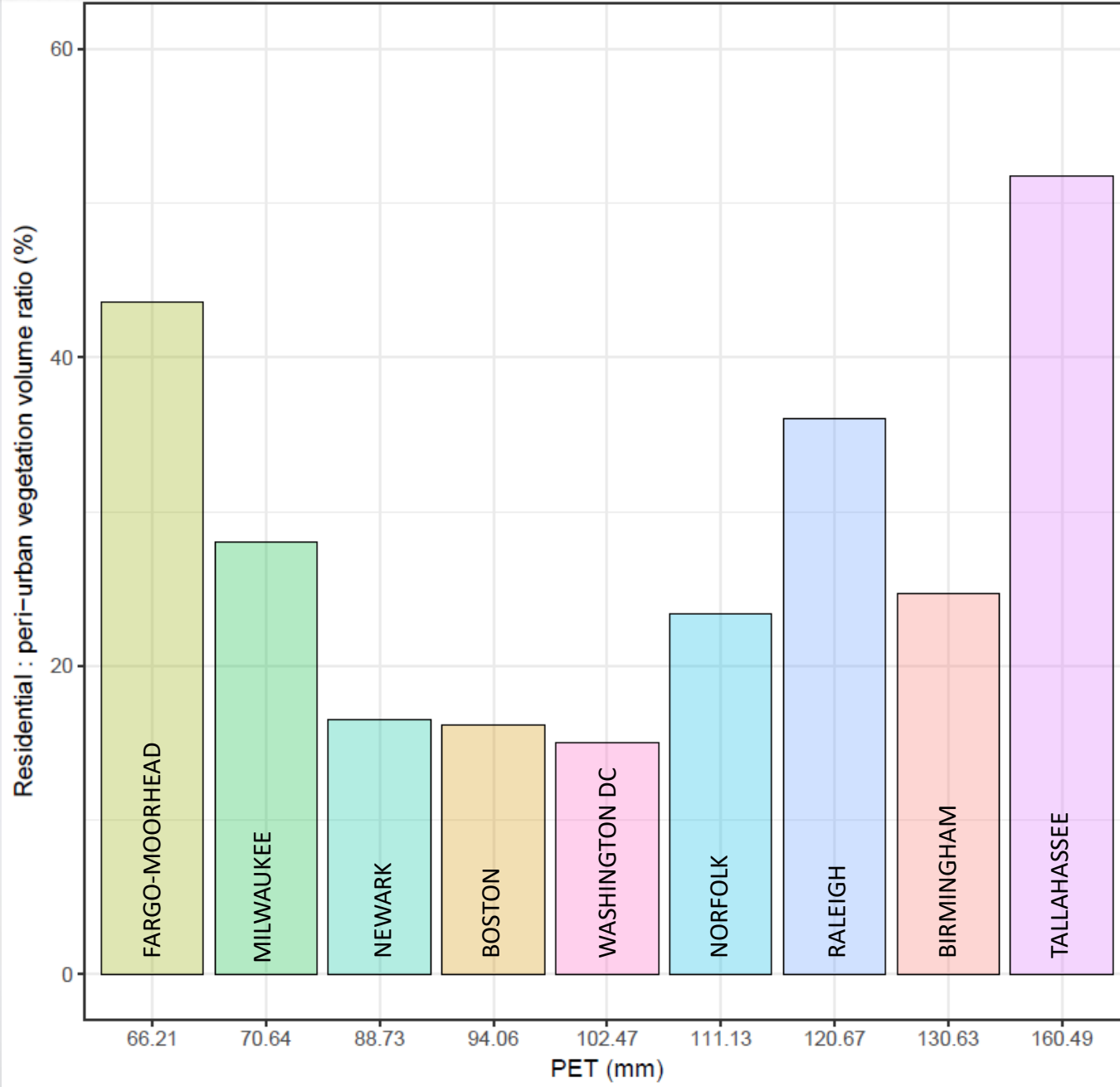
RESULTS

Vegetation volume ($\text{m}^3 \text{m}^{-2}$)



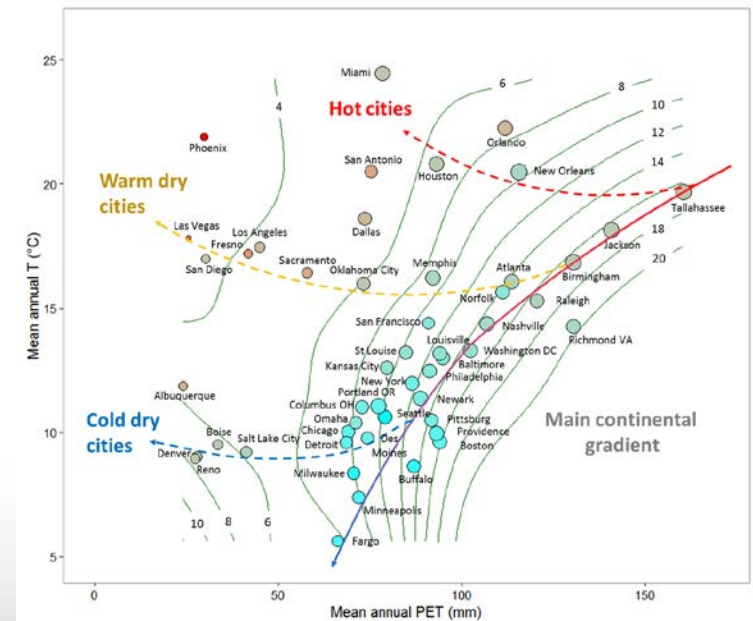
Median monthly rent (\$)

HOW FAR FROM NATURE?



CONCLUSIONS

- Climate and urban morphology differentiate vegetation structure across US residential neighborhoods
- Socio-economics have local fine-scale effects on residential vegetation structure
- Management and planning intervention aimed to enhance canopy cover and vegetation structure need to consider climatic and urban form settings and set realistic greening targets
- New efforts are needed to investigate “*climatic signals*” in urban vegetation structure along other climatic gradients



- AO holds a National Research Council Research Associateship Award at the U.S. Environmental Protection Agency.
- Daryl Masten (City of Fargo, ND), Nicole Grams (Milwaukee County, WI), Ali Sheikhzeinoddin (Jefferson County, AL), Hope Morgan (North Carolina Department of Public Safety, NC), Jason Cox, Greg Mauldin (Leon County, FL) and Michelle VonReaden (USDA, Salt Lake City, UT) are warmly thanked for their assistance with geospatial datasets.

Disclaimer: The views expressed in this presentation are those of the authors and do not necessarily represent the views or policies of the U.S. Environmental Protection Agency.

