

Assessing effects of horizontal and vertical urban vegetation structures on land surface temperature using multisensor remote sensing data

2018 Joint UF/FL-ASPRS
Fall LiDAR Workshop
Apopka FL
Nov 9, 2016

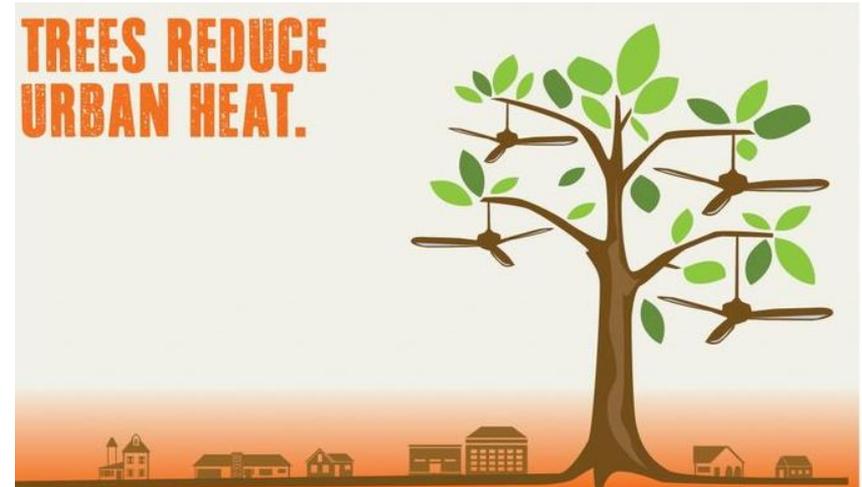


Qiuyan Yu
Research Assistant,
PhD Candidate
School of Geosciences

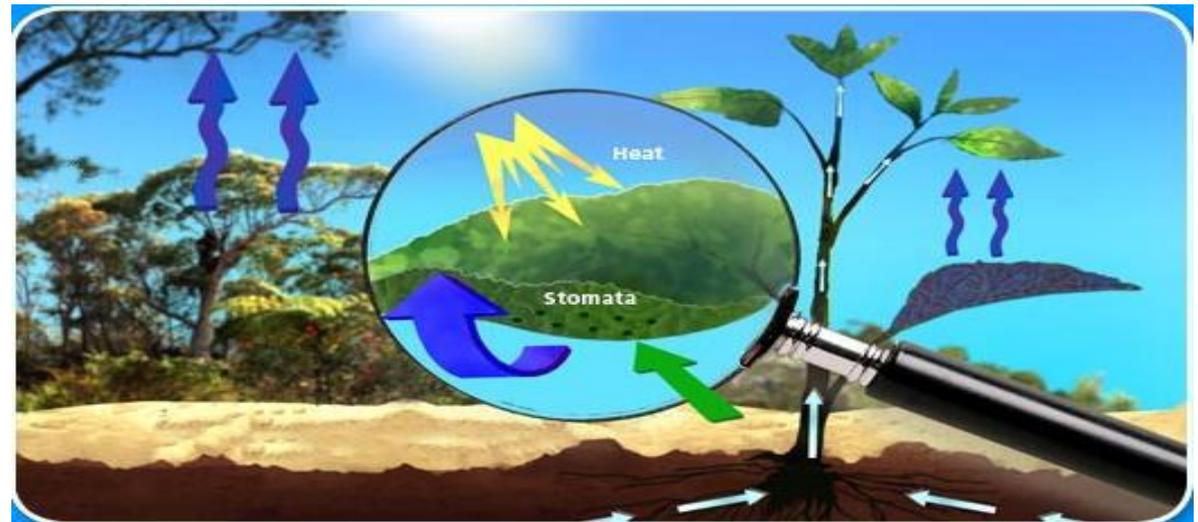
Shawn Landry
Associate Professor
School of Geosciences
Director, USF Water Institute

Background

- ▶ Urban vegetation mitigates UHI through evapotranspiration and providing shade.



<https://www.pinterest.com/investintrees/great-things-grow-on-trees/>



<http://climate.ncsu.edu/edu/k12/.evapo>

Vegetation structure and LST

- ▶ Previous studies have examined the relationship between land surface temperature (LST) and tree canopy cover/configuration
- ▶ The relationship between land surface temperature (LST) and tree/vegetation vertical structure has rarely been studied.
- ▶ The development of LiDAR facilitates the extraction of the vegetation vertical structure.



Variance in vegetation abundance and height on LST



Greater Abundance
Shorter Height

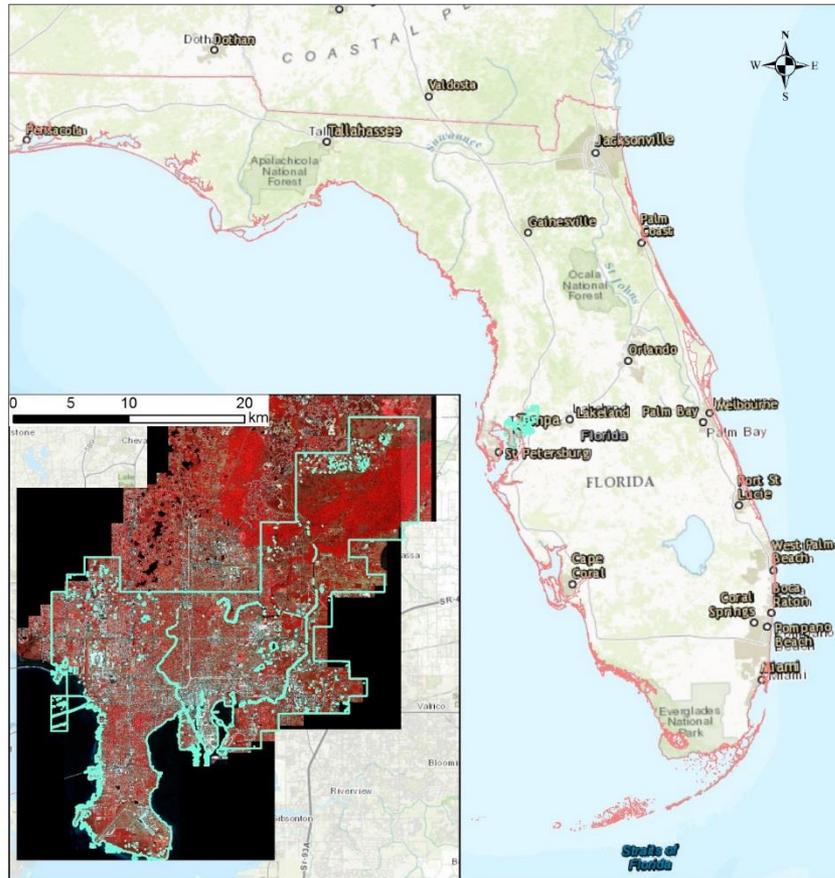


Lower Abundance
Taller Height

Research questions

- ▶ Is vegetation height correlated with Land Surface Temperature (LST) ?
- ▶ Is there a threshold level of vegetation height and vegetation abundance at which LST is significantly affected?

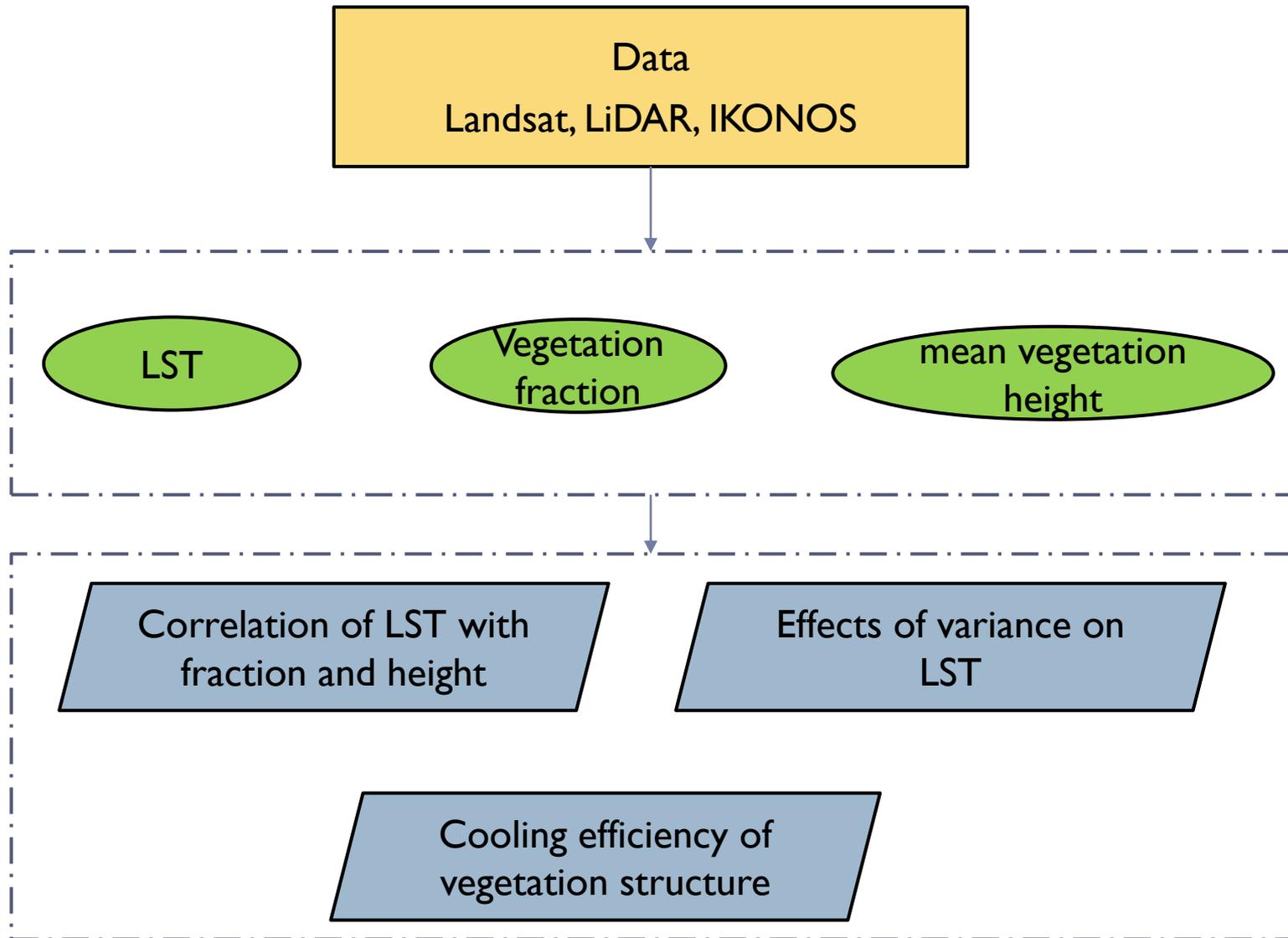
Study area and data



	Band	Spatial resolution (m)	Acquired date
Landsat5 TM	Thermal	120	Jan, 2007
IKONOS	Blue, Green, Red, and NIR	3.6	April, 2006
LiDAR* (DSM and DEM)	N/A	1	Jan, 2007

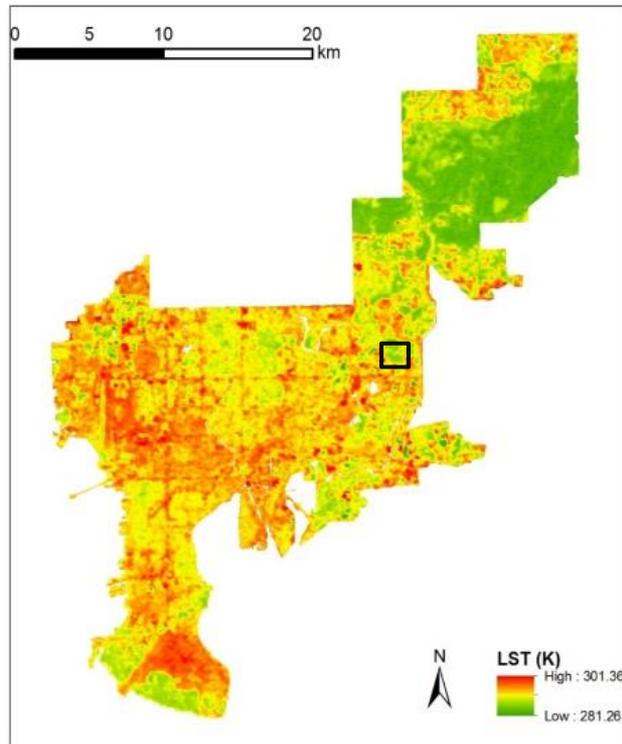
* LiDAR .las tiles provided by SWFWMD and processed using QT Modeler

Methods

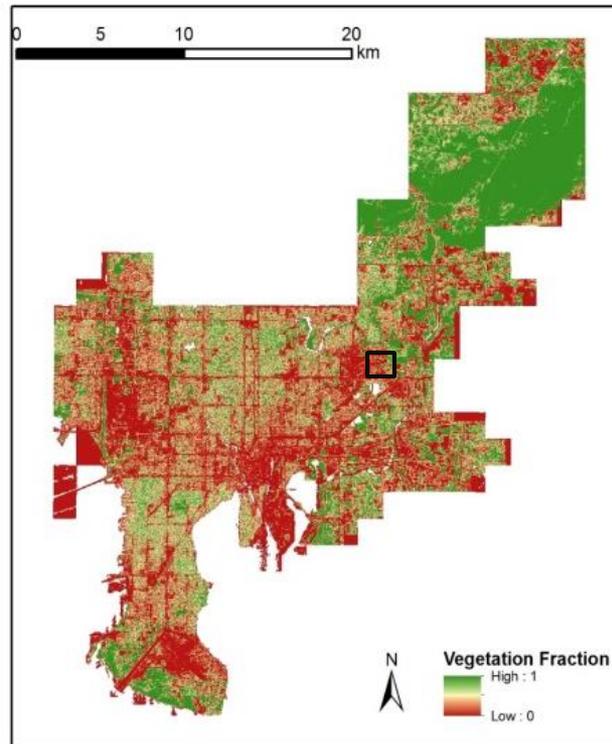


Results

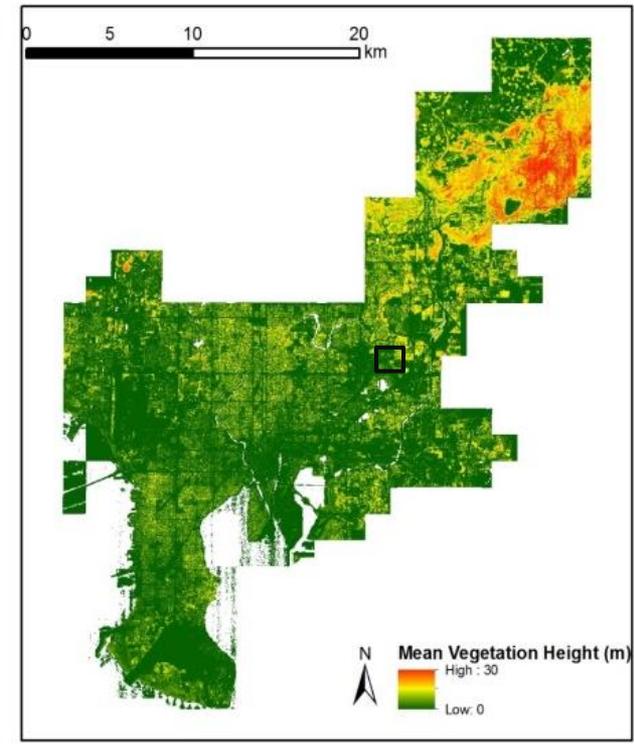
LST



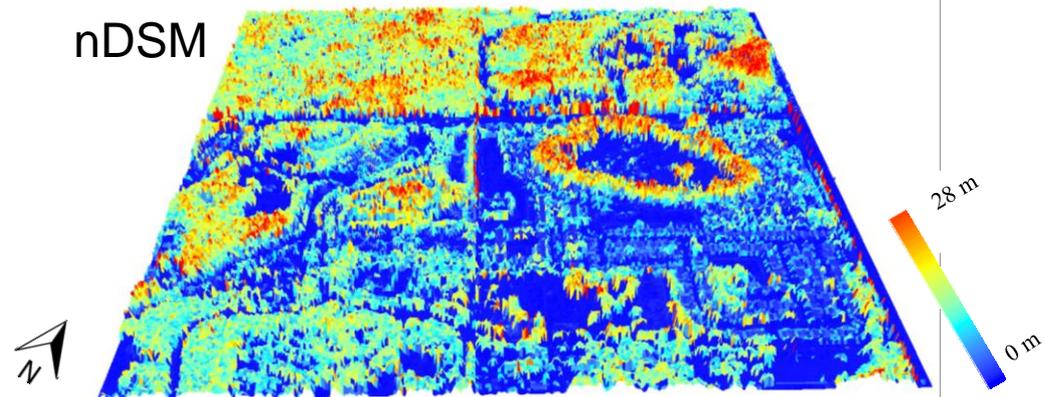
Vegetation Fraction



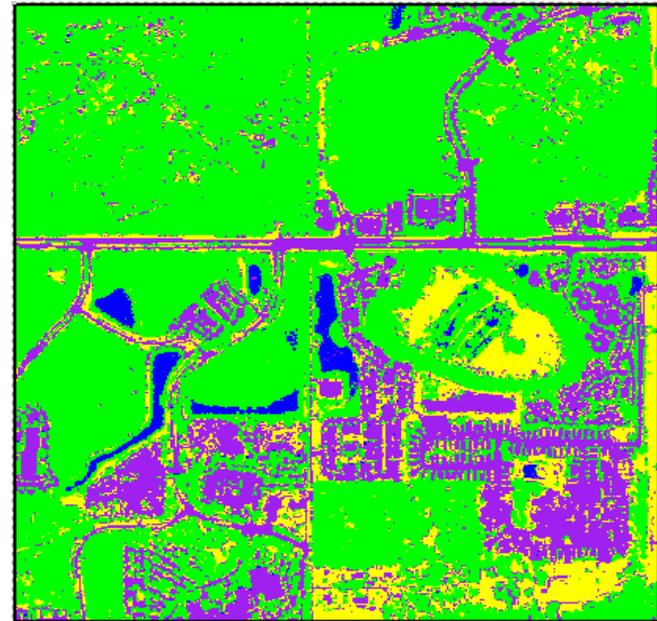
Vegetation Height



Results



Aerial Image



Vegetation Cover (green)

Vegetation Height and LST correction

<i>n=153,689</i>	<i>Vegetation fraction</i>	<i>Mean vegetation height</i>
<i>Pearson correlation</i>	-0.727^{**}	-0.742^{**}
<i>Partial correlation</i>	-0.365^{**}	-0.449^{**}

****: Correlation is statistically significant at $\alpha = 0.01$ level (2-tailed).

<i>n=153,689</i>	<i>Coefficient</i>	<i>Beta (standardized coefficients)</i>
<i>Constant</i>	288.623	
<i>VF</i>	-2.699	-0.384
<i>MVH</i>	-0.065	-0.448

Adjust R² = 0.612

- ▶ Vegetation fraction and height were negatively correlated with LST
- ▶ Variance of vegetation fraction and mean vegetation height together could explain 61.2% ($R^2 = 0.612$) of the total variance of LST.
- ▶ Standardized coefficients (beta) indicate that mean vegetation height (-0.448) was a stronger predictor of LST than vegetation fraction (-0.384).

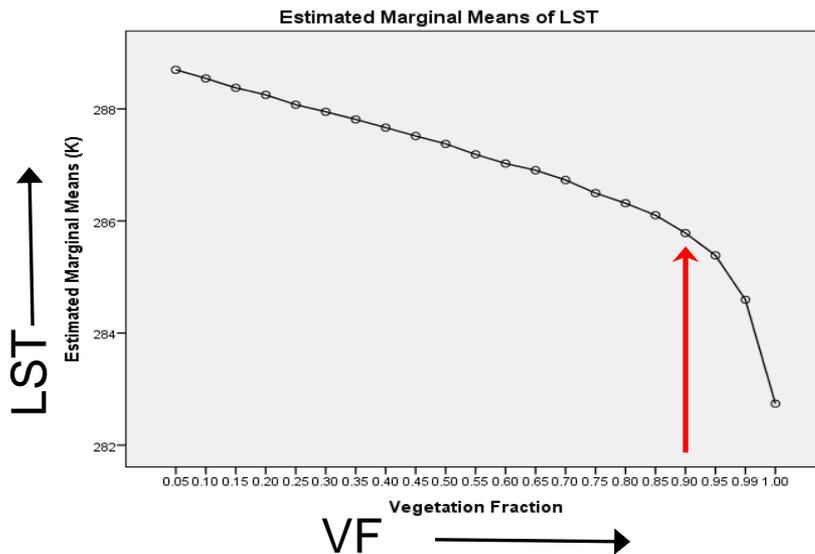
Cooling efficiency of vegetation structure

<i>n=153,689</i>	<i>Coefficient</i>	<i>Beta (standardized coefficients)</i>
<i>Constant</i>	288.709	
<i>VF</i>	-2.701	-0.368
<i>MVH</i>	0.170	0.376
<i>VF*MVH</i>	-0.379	-0.855
<i>Adjust R² = 0.629</i>		

- ▶ Mean vegetation height (MVH) and vegetation fraction (VF) interact to affect land surface temperature (LST)
 - ▶ Increasing MVH by 1m would lead to a change of LST as $0.170 - 0.379 \times VF$
 - ▶ Increase in VF by 10% would lead to a change of LST as $-0.270 - 0.038 \times MVH$

Threshold effect of vegetation fraction on LST

- ▶ Threshold level determined using ANOVA of MVH and VF intervals



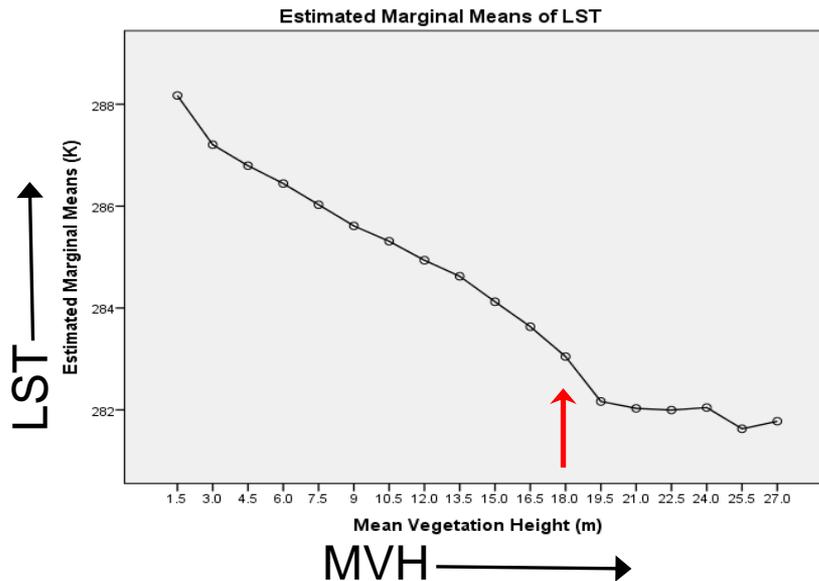
	< 90.0% (n=113,155)	≥ 90.0% (n=40,534)
<i>Pearson correlation</i>	-0.463**	-0.477**
<i>Partial correlation</i>	-0.255**	-0.315**

** : Correlation is significant at the 0.01 level (2-tailed).

Vegetation fraction threshold: 90%

Threshold effect of vegetation height on LST

- ▶ Threshold level determined using ANOVA of MVH and VF intervals



	< 18.00 m (n=147,074)	≥18.00 m (n=6,615)
<i>Pearson correlation</i>	-0.705**	-0.175**
<i>Partial correlation</i>	-0.370**	-0.171**
**: Correlation is significant at the 0.01 level (2-tailed).		

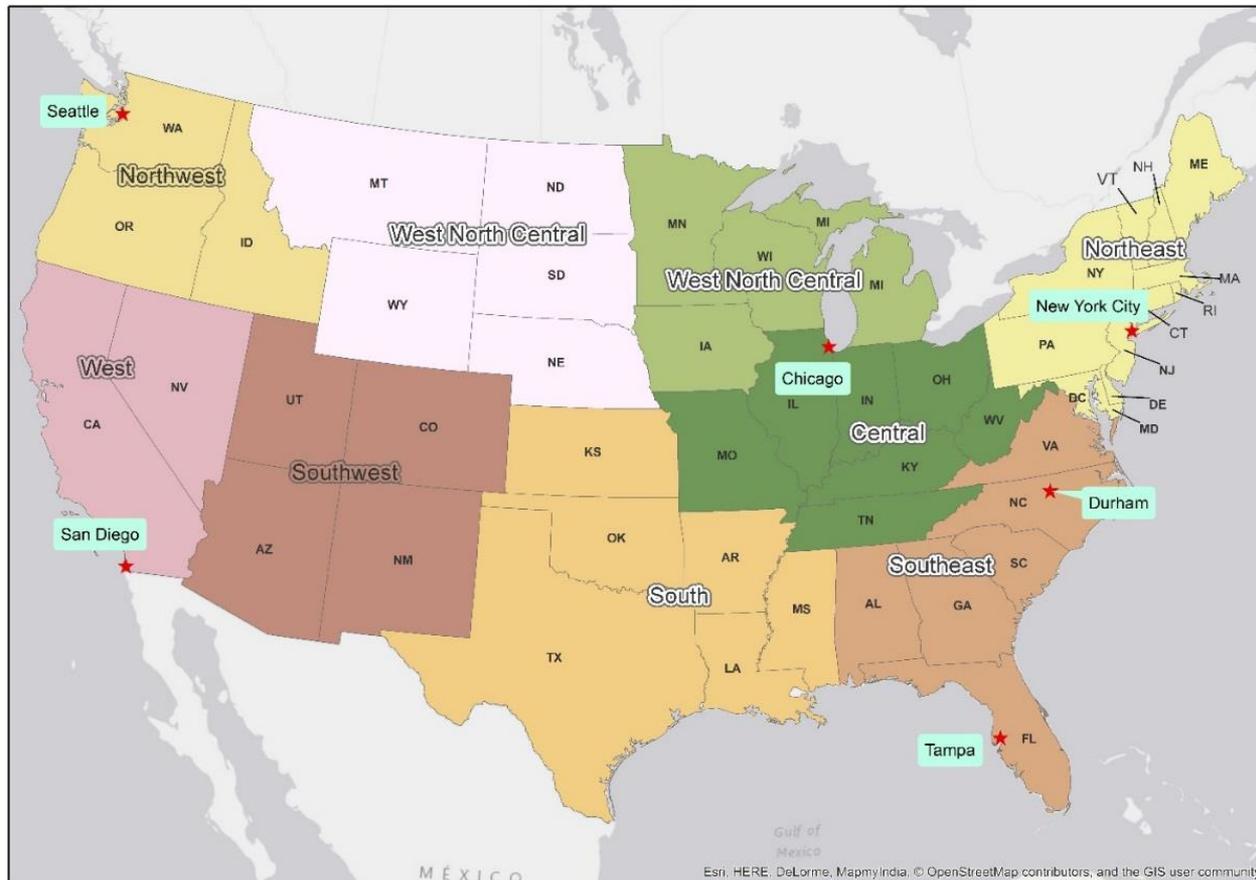
Vegetation height threshold: 18.0 m

Discussion and Conclusion

- ▶ **Correlation of vegetation fraction and height with LST**
 - ▶ Vegetation height has a stronger direct cooling effect
 - ▶ Interaction between vegetation fraction and vertical structure
- ▶ **Threshold effect of vegetation fraction and height**
 - ▶ vegetation fraction $>90\%$ has a much stronger cooling effect on LST than that by a lower vegetation fraction
 - ▶ vegetation height <18 m was more effective than trees >18 m
- ▶ **These results are season- and climatic zone- restricted**

Next Steps

- ▶ Compare the cooling effects of vegetation structure in different cities
 - ▶ Does the cooling efficiency vary with climatic conditions (e.g. precipitation and temperature)?





Questions?

Qiuyan Yu— qiuyanyu@mail.usf.edu

Shawn Landry — landry@usf.edu