CLIMATE ADAPTATION
RESEARCH SYMPOSIUM

MEASURING & REDUCING SOCIETAL IMPACTS

Integrating Climate and Transportation Planning

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Ida Sami
University of Arizona

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RESEARCH SYMPOSIUM
MEASURING & REDUCING SOCIETAL IMPACTS

UCLA Luskin Center for Innovation

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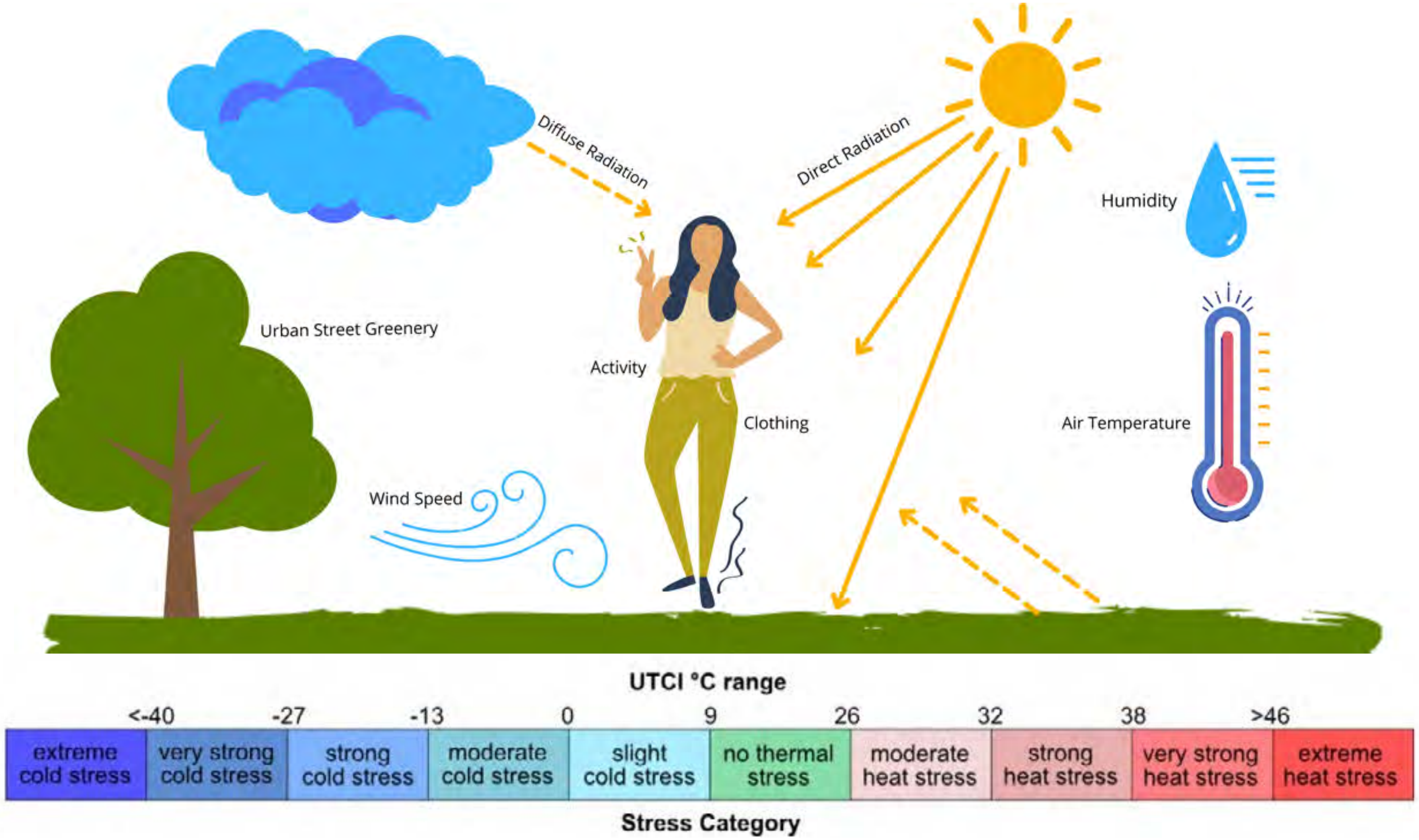
Increasing Heat Resilience Through Thermal Comfort Assessment in Sun Link Streetcar Stops, Tucson AZ

Outdoor Thermal Comfort Assessment at Tucson Sunlink Streetcar Stops

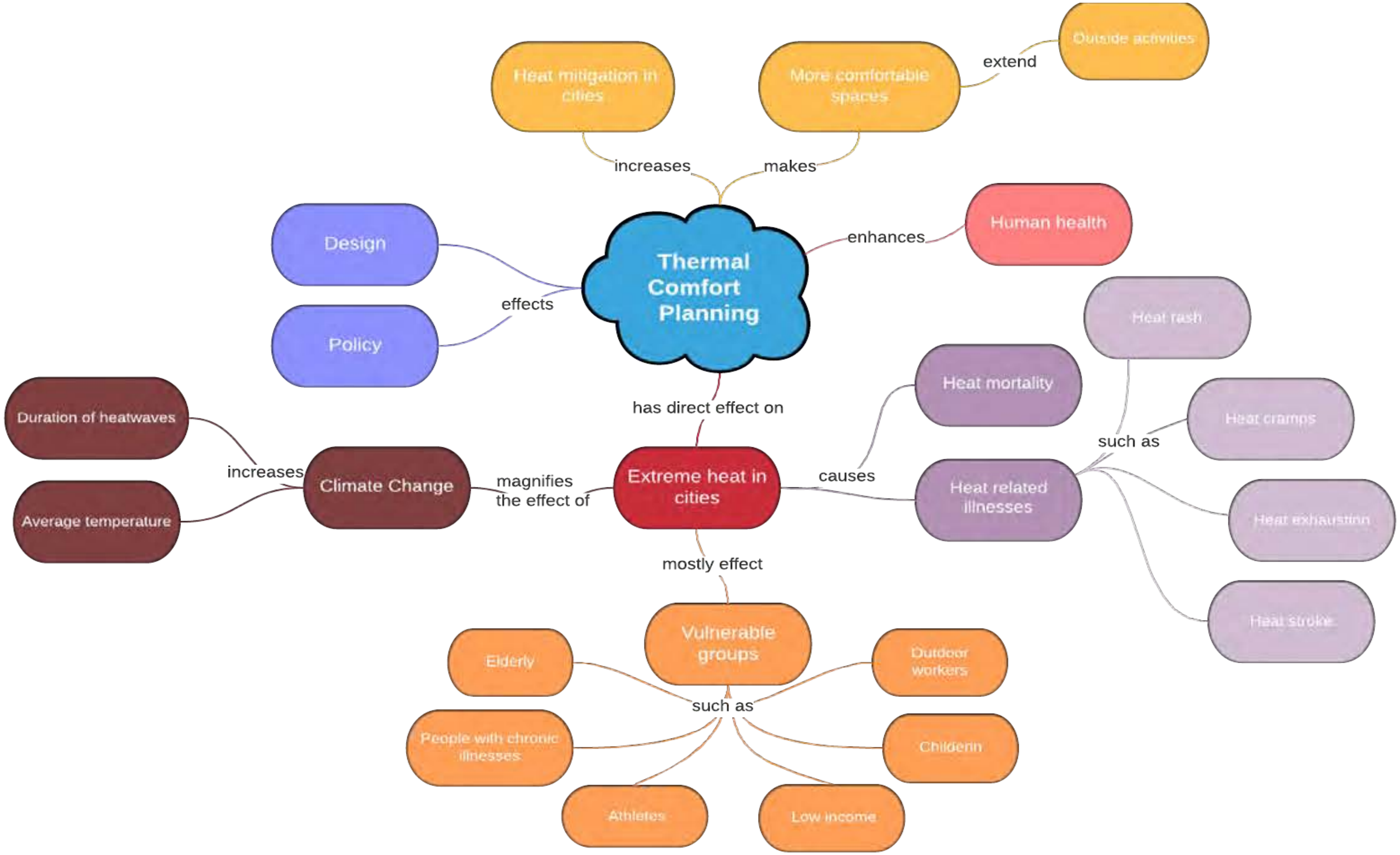
Ida Sami, PhD Candidate
Dr. Ladd Keith, Assistant Professor

Outdoor Thermal Comfort and Human

The heat exchanges in a space determine human comfort. As indicated in the diagram below, a number of elements influence a person's comfort in outdoor environments.



Why Thermal comfort planning?



Aim of the Study

This study aims to gain a better understanding of streetcar users' thermal comfort in five distinct urban typologies: the University of Arizona, Main Gate Square, Fourth Avenue, Downtown, and the Mercado. In the spring, summer, and extremely hot summer of 2021, this research focuses on ambient and radiant temperatures in each station to better understand the impact of heat stress on users' thermal comfort while waiting for a streetcar. Co-production for Thermal Comfort Evaluation in Tucson Streetcar Stations involves the **PAG, Shade Tucson**, **Sun Link, and The City of Tucson Transportation Planning Department.**

Research Question and Methodology

Q: Do seasonal differences have different effects on streetcar rider's comfort levels?

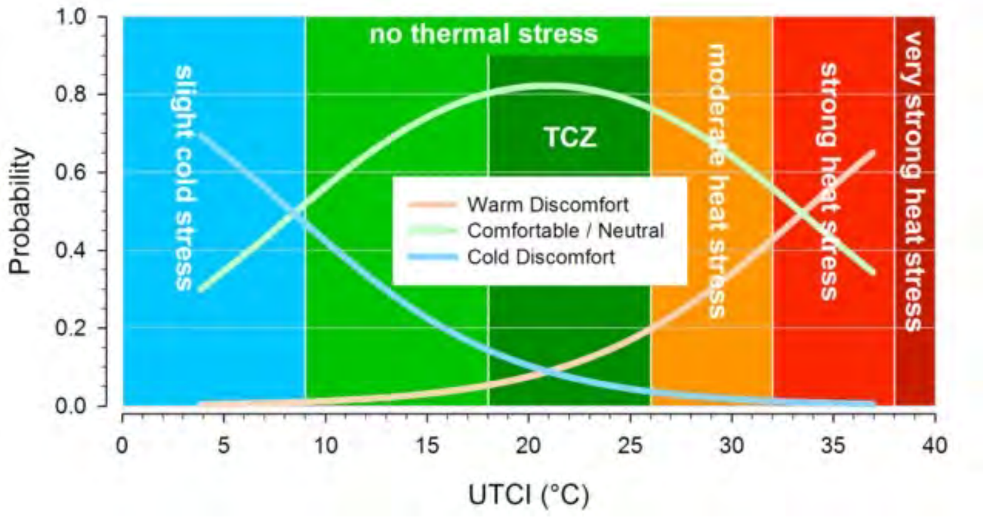
M: The data was collected in the months of April and July of 2021, during the spring, summer, and extremely hot summer. Between 12 p.m. and 2 p.m., microclimatic variables were gathered. Air temperature (Ta), relative humidity (RH), wind speed (Ws), and globe temperature were all measured (Tg). The data was collected using a Kestrel 5400 and an Etekcity Infrared Thermometer 800.

Case Study Map

Outdoor Thermal Comfort Assessment

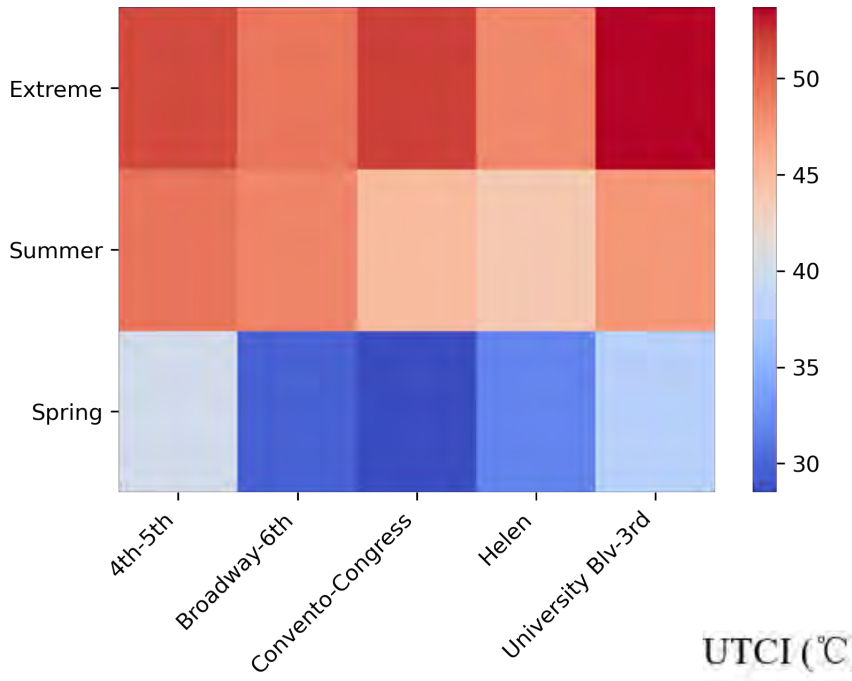
To analyze the outdoor thermal comfort, a quantitative method is used in which the thermal comfort is quantitated using a thermal index, Universal Thermal Climate Index (UTCI). UTCI is defined as "the isothermal air temperature of the reference condition that would elicit the same dynamic response (strain) of the physiological model" than the actual environment. One of the important factors to calculate the UTCI is MRT (Mean Radiant Temperature). MRT is a critical physical quantity that describes how humans react to radiation in their surroundings. We used the belove formula to calculate MRT.

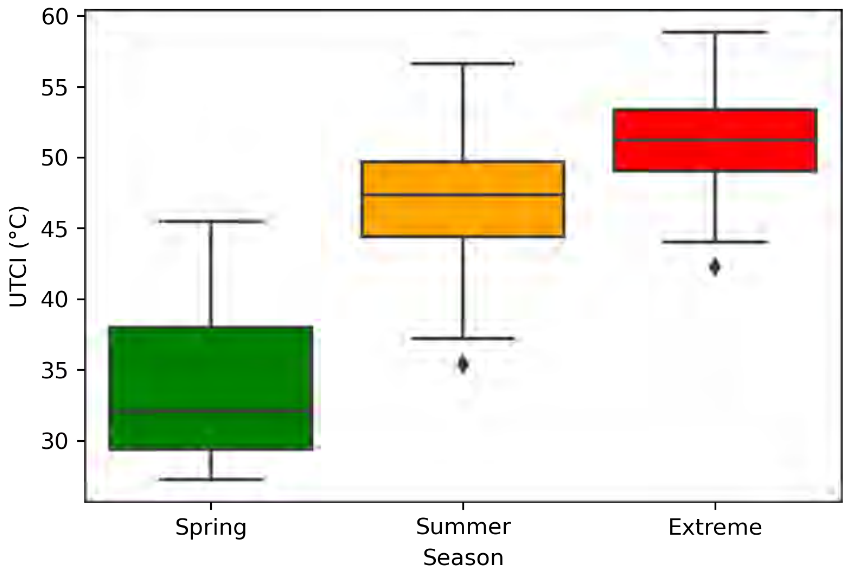
$$T_{mrt} = T_{mrt}(T_a, \mathrm{V},)$$



Bröde, P., Krüger, E., & Rossi, F. (2011). Assessment of urban outdoor thermal comfort by the Universal Thermal Climate Index UTCI. In *INTERNATIONAL CONFERENCE ON ENVIRONMENTAL ERGONOMICS* (Vol. 14).

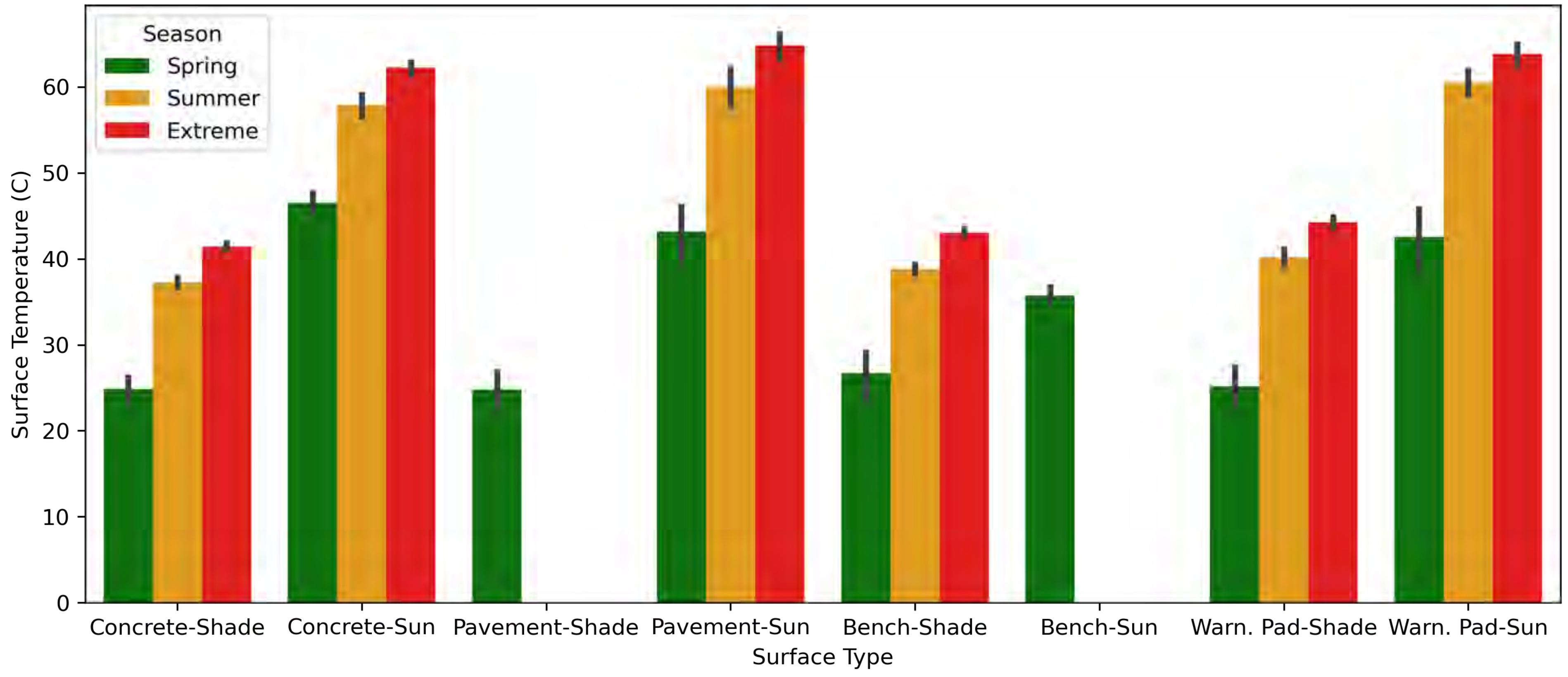
Outdoor Thermal Comfort Assessment





UTCI (℃) range	Stress category
Above +46	Extreme heat stress
+38 to +46	Very strong heat stress
+32 to +38	Strong heat stress
+26 to +32	Moderate heat stress
+9 to +26	No thermal stress

Surface Temperatures of Selected Streetcar Stops



Conclusion

- Data was taken using a Kestrel 5400 in five stops between 12 and 2 p.m. in the spring, summer, and extremely hot summer. In addition, surface temperatures for various materials were recorded every 15 minutes in the sun and shade.

- The UTCI Index is calculated using air temperature, wind speed, mean radiant temperature, and relative humidity.

- According to the UTCI, stops are in the moderate heat range throughout the spring, the strong to very strong heat stress range during the summer, and the extreme heat stress range during the week of extremely hot weather.

- In the sun and shade, the most significant surface temperature differences were 21 °C in concrete and 25 °C in the warning pad.

Thank You

Thank you for your attention. This is part of my PhD dissertation research, and as part of this collaborative project, I will continue to collect surveys from streetcar users and conduct interviews with my stakeholders. If you have any additional questions, please contact me by email at: sami@email.arizona.edu.

Montana Eck

Ph.D. Candidate, University of North Carolina at Chapel Hill

@moaleck

How a Changing Climate Is Influencing Car Crash Risk in the Carolinas

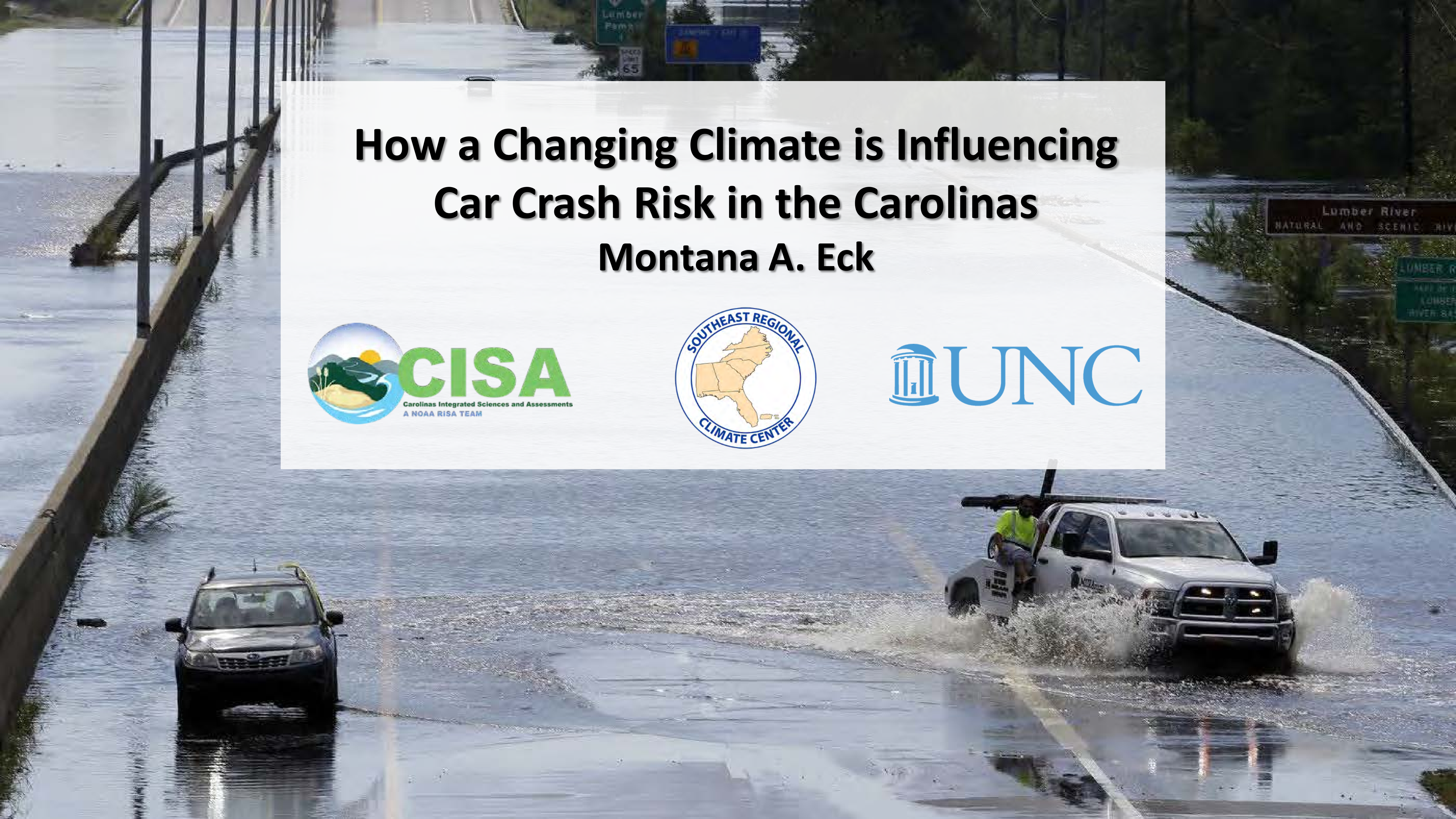
How a Changing Climate is Influencing Car Crash Risk in the Carolinas

Montana A. Eck

CISA
Carolinas Integrated Sciences and Assessments
A NOAA RISA TEAM

SOUTHEAST REGIONAL CLIMATE CENTER

UNC



Car Crashes a Concern in a Changing Climate

- **~23% of the average six million** annual U.S. car crashes are linked to adverse weather
  - Majority of which are attributed to rain or wet pavement in crash reports
- Increase in the frequency of **heavy rain events has led to more severe and fatal car crashes**
  - Response-time to assist those in crashes is also delayed significantly during heavy rain
- Despite improvements to car and driver safety in recent years, car crashes rank as **leading cause of death** for age groups under 35

Road Weather Conditions	10 Year Average (2007 - 2016)
Wet Pavement	860,286 crashes
	324,394 persons injured
	4,050 persons killed
Rain	556,151 crashes
	212,647 persons injured
	2,473 persons killed
Snow/Sleet	219,942 crashes
	54,839 persons injured
	688 persons killed
Icy Pavement	156,164 crashes
	41,860 persons injured
	521 persons killed

USDOT

Connecting Climate Research with the NCDOT

- SERCC and **Carolinas Integrated Sciences and Assessment** started collaborative project with NCDOT in 2018
- Preliminary comparisons were made between accidents and the **weather conditions listed in police reports**
  - Common Issues:
    - Conflicting weather conditions reported
    - **Winter weather being present in the summer months**
- Spatial variation in accidents highlighted the need for a more detailed regional analysis
  - **Rain and snow can be spatially varied in the state**. Important to compare across our unique geographic regions.

219

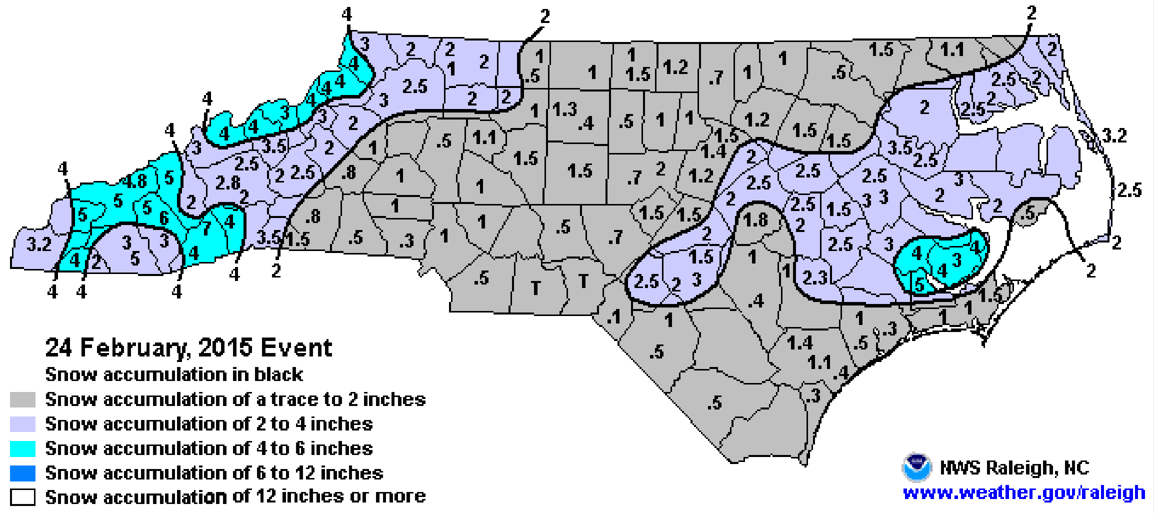
Accidents associated with *snow* in summer months

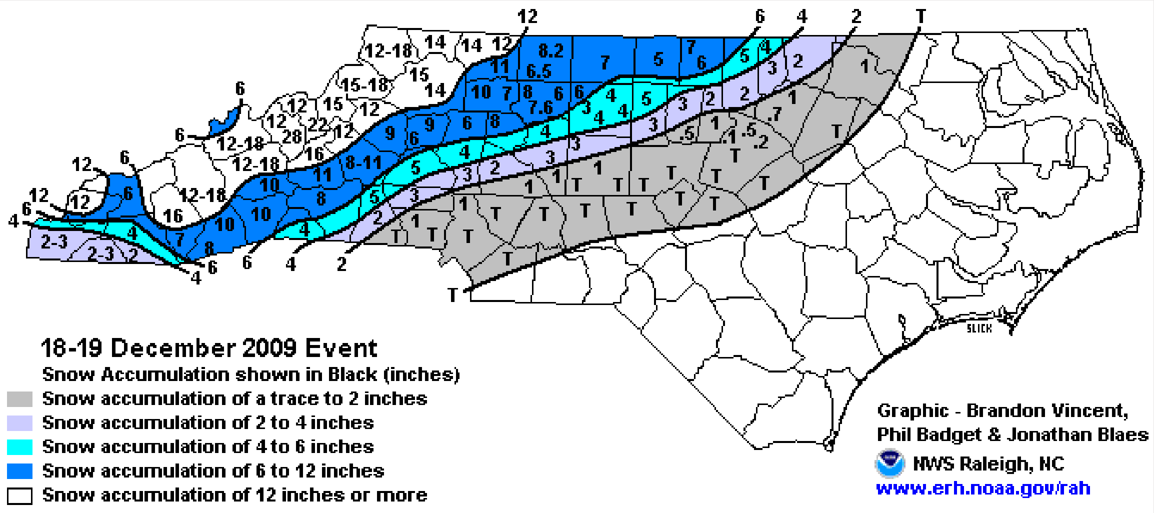
959

Accidents associated with *RAIN* & *CLEAR* *conditions reported*

Top 10 Statewide Accident Days

Rank	*Date*	*Number of Accidents*
1	December 16, 2010	2690
2	January 25, 2013	2645
3	February 15, 2016	2444
4	December 8, 2017	2364
5	February 24, 2015	2335
6	January 23, 2003	2220
7	January 25, 2004	2011
8	January 28, 2014	1915
9	December 18, 2009	1862
10	January 17, 2018	1842





Accounting for NCDOT Needs

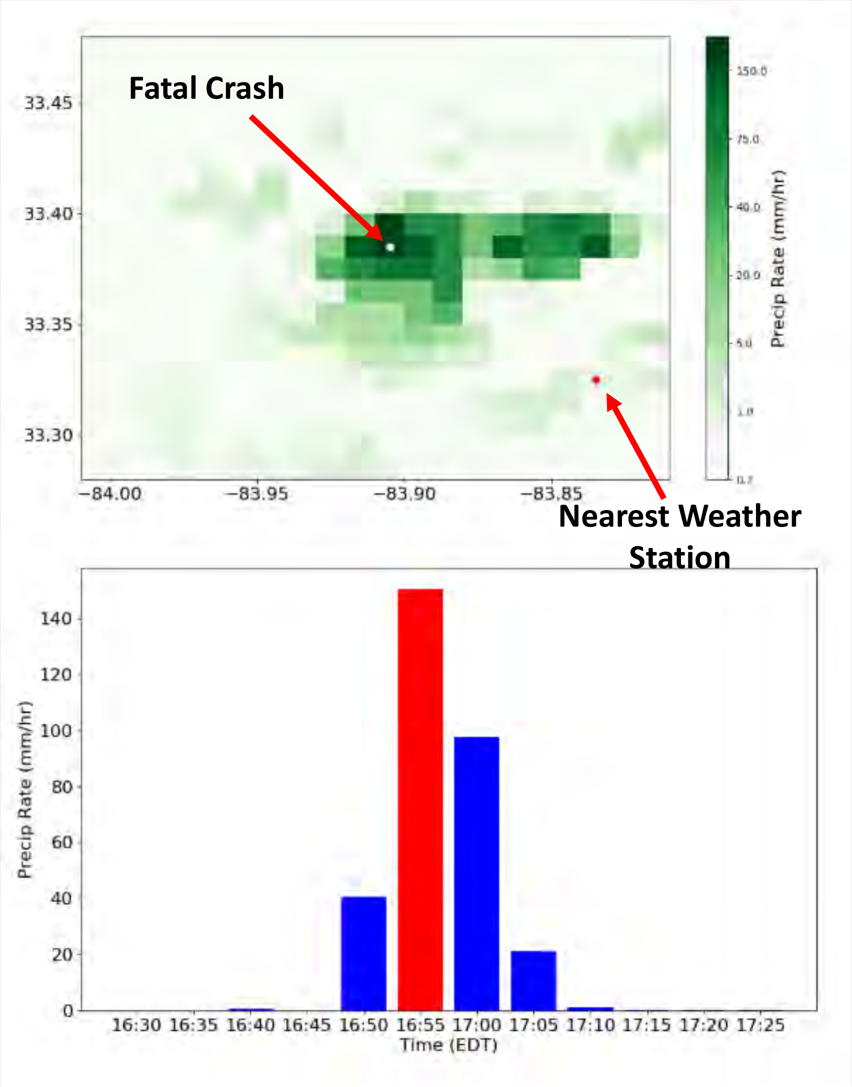
- NCDOT understands the public concern and high numbers of accidents during winter weather but view **rainfall as a more consistent threat** to public safety
    - Considerable attention needs to be given to the rate and duration rather than just total precipitation

- NCDOT desires to understand how patterns of crashes in rural and suburban areas differ from the highly trafficked urban interstates

- Ultimate goal for the DOT is to pinpoint counties, towns, and roadways which experience a disproportionate number of crashes during a rain event
    - **Viewed as a means for helping lower the number of fatal accidents on isolated roadways**

Research on the Weather-Accident Relationship

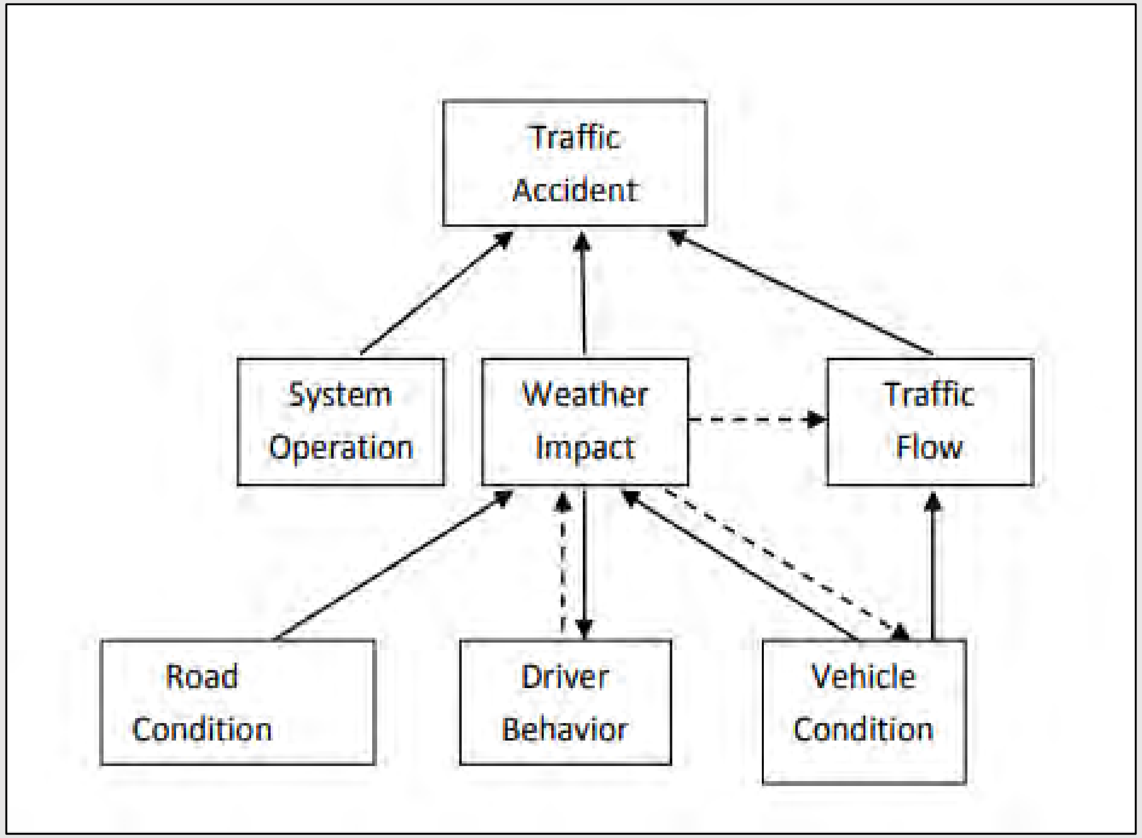
- Research has relied heavily on the **relative accident risk** (RAR)
  - Number of crashes for hours with precip divided by crashes with no precip across matched pairs
- The effect of **precipitation** on crashes is **frequently underestimated** as many studies rely only on concurrent weather information
- Rainfall may have a lagged **protective effect**
  - **Ex: Change in driver behavior after heavy rain event**
- Use of weather station observations for analysis can introduce **significant error** as precipitation varies on **small temporal and spatial scales**



Stevens et al., 2019

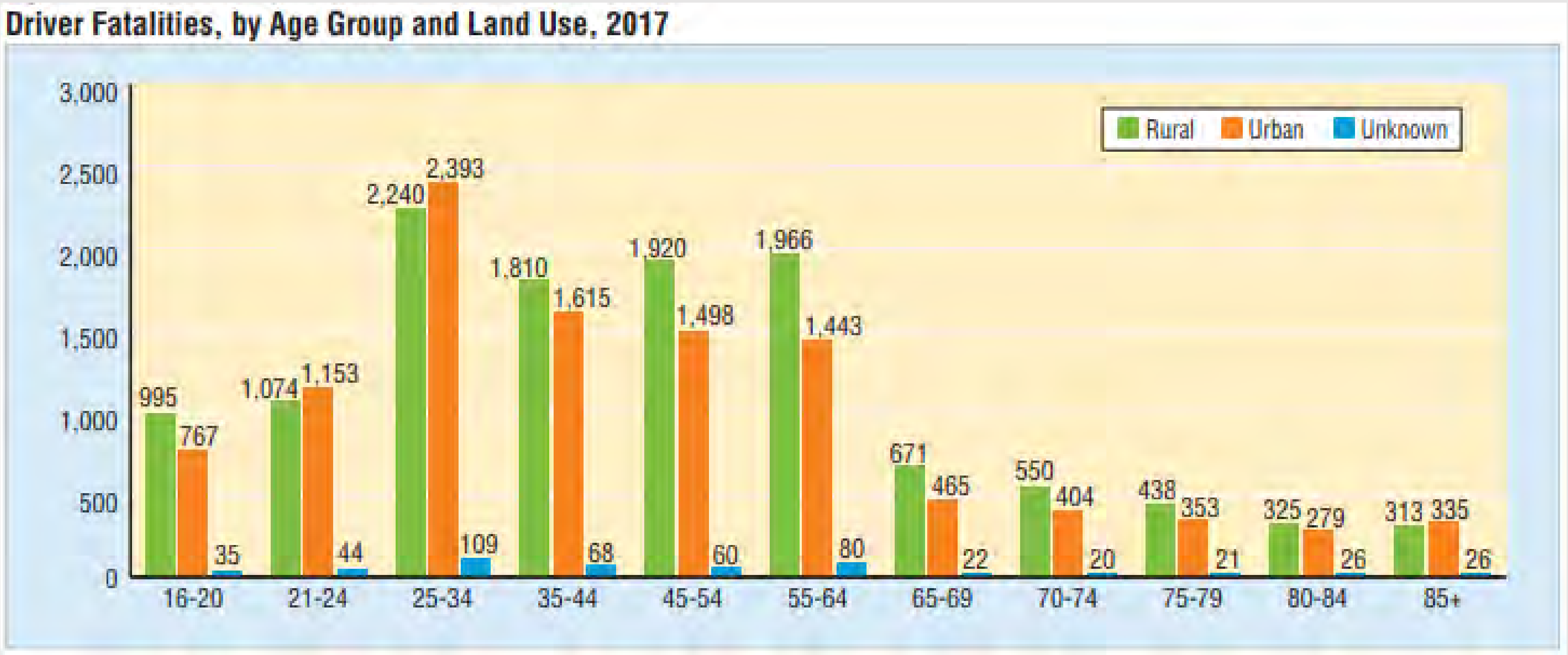
Rainfall Increases Risk and Influences Behavior

- 46% of all weather-related fatalities occur during active rainfall and **78% of all weather-related injuries** occur on wet pavement
- **Traffic volume decreases** proportional to the intensity of precipitation
- Perception of hazard risk can also influence the likelihood of individual-level driver behavior
  - **Ex: Increased driving distance and decreased speed**
- By not accounting for changes to traffic volume and driver behavior in the methods there is a chance of **misrepresentative risk estimates**



Liu, 2013

Severe Crash Outcomes More Frequent in Rural Areas



Rural roads experience a **2.6 times higher rate of fatal crashes** than those designated as urban

Lack of public transportation and **necessity for car usage** puts drivers in rural areas on the road for longer periods of time

Individual-level **safety measures are less likely to be taken** on rural roads during inclement weather.

Research Questions

1. What are the spatiotemporal patterns of precipitation-related car crash risk in the Carolinas?

2. How do precipitation characteristics such as duration, intensity, frequency, and time between precipitation events influence relative crash risk?

3. How does crash risk differ across the rural-urban gradient in the Carolinas and does this relative risk vary across physiographic regions?

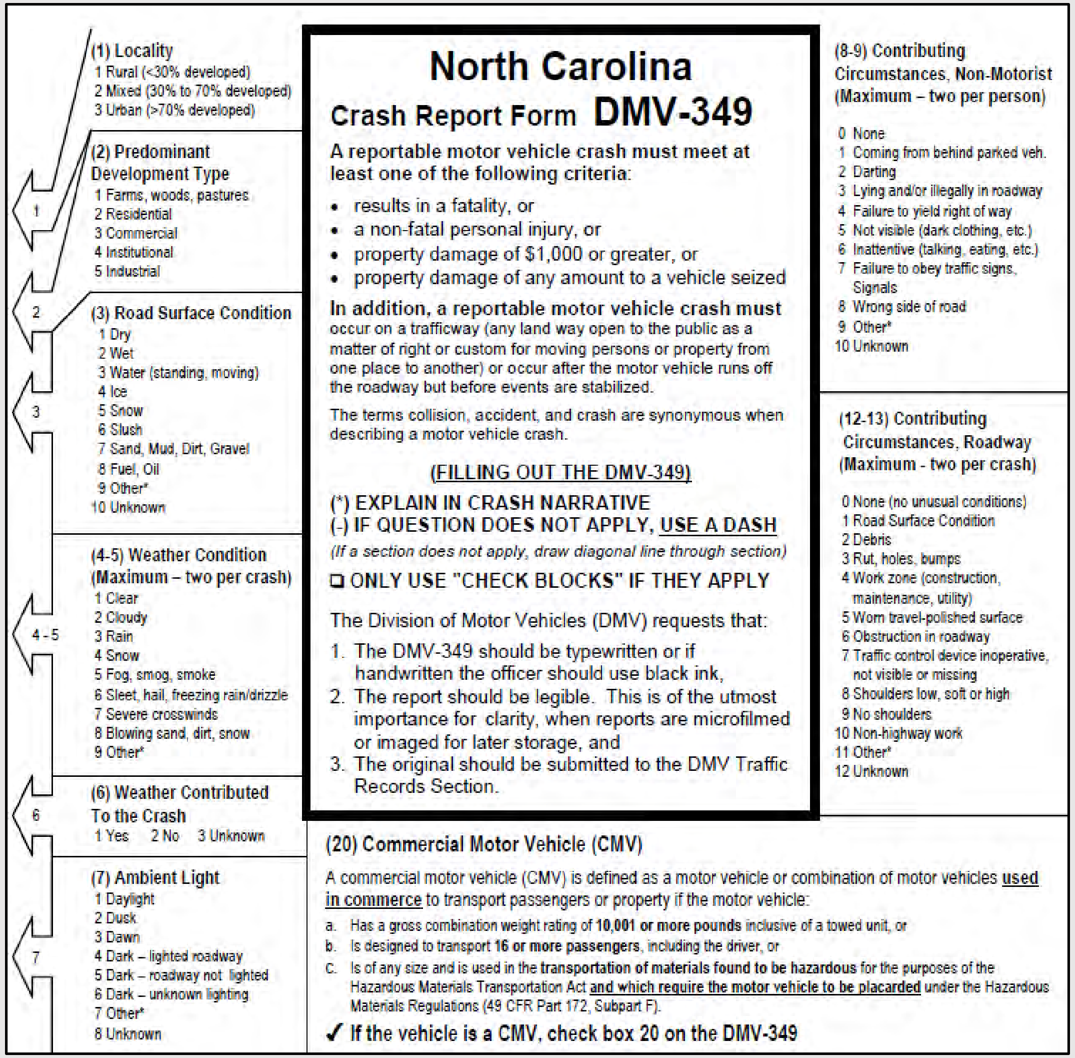
Car Crash Data

- NCDOT and SCDPS maintain statewide crash databases that compile individual police-filed crash reports in each state
    - NCDOT Data (2003-2019)
    - SCDPS Data (2003-2019)

- Reportable motor vehicle crash must meet at least one of the following criteria
    - **Results in a fatality, Non-fatal injury, or Property Damage > $1,000**

- Crash reports do have reporting errors but remain the most robust dataset for estimating crash frequency and risk
    - **Disregarding report-indicated weather condition and road condition**

- Data allows for crashes to be aggregated by geographic location and time-of-day



(1) Locality
1 Rural (<30% developed)
2 Mixed (30% to 70% developed)
3 Urban (>70% developed)

(2) Predominant Development Type
1 Farms, woods, pastures
2 Residential
3 Commercial
4 Institutional
5 Industrial

(3) Road Surface Condition
1 Dry
2 Wet
3 Water (standing, moving)
4 Ice
5 Snow
6 Slush
7 Sand, Mud, Dirt, Gravel
8 Fuel, Oil
9 Other*
10 Unknown

(4-5) Weather Condition (Maximum – two per crash)
1 Clear
2 Cloudy
3 Rain
4 Snow
5 Fog, smog, smoke
6 Sleet, hail, freezing rain/drizzle
7 Severe crosswinds
8 Blowing sand, dirt, snow
9 Other*

(6) Weather Contributed To the Crash
1 Yes 2 No 3 Unknown

(7) Ambient Light
1 Daylight
2 Dusk
3 Dawn
4 Dark – lighted roadway
5 Dark – roadway not lighted
6 Dark – unknown lighting
7 Other*
8 Unknown

North Carolina
Crash Report Form DMV-349

A reportable motor vehicle crash must meet at least one of the following criteria:

- results in a fatality, or
- a non-fatal personal injury, or
- property damage of $1,000 or greater, or
- property damage of any amount to a vehicle seized

In addition, a reportable motor vehicle crash must occur on a trafficway (any land way open to the public as a matter of right or custom for moving persons or property from one place to another) or occur after the motor vehicle runs off the roadway but before events are stabilized.

The terms collision, accident, and crash are synonymous when describing a motor vehicle crash.

(FILLING OUT THE DMV-349)

(*) EXPLAIN IN CRASH NARRATIVE
(-) IF QUESTION DOES NOT APPLY, USE A DASH
(If a section does not apply, draw diagonal line through section)
❑ ONLY USE "CHECK BLOCKS" IF THEY APPLY

The Division of Motor Vehicles (DMV) requests that:

1. The DMV-349 should be typewritten or if handwritten the officer should use black ink,
2. The report should be legible. This is of the utmost importance for clarity, when reports are microfilmed or imaged for later storage, and
3. The original should be submitted to the DMV Traffic Records Section.

(8-9) Contributing Circumstances, Non-Motorist (Maximum – two per person)
0 None
1 Coming from behind parked veh.
2 Darting
3 Lying and/or illegally in roadway
4 Failure to yield right of way
5 Not visible (dark clothing, etc.)
6 Inattentive (talking, eating, etc.)
7 Failure to obey traffic signs, Signals
8 Wrong side of road
9 Other*
10 Unknown

(12-13) Contributing Circumstances, Roadway (Maximum - two per crash)
0 None (no unusual conditions)
1 Road Surface Condition
2 Debris
3 Rut, holes, bumps
4 Work zone (construction, maintenance, utility)
5 Worn travel-polished surface
6 Obstruction in roadway
7 Traffic control device inoperative, not visible or missing
8 Shoulders low, soft or high
9 No shoulders
10 Non-highway work
11 Other*
12 Unknown

(20) Commercial Motor Vehicle (CMV)

A commercial motor vehicle (CMV) is defined as a motor vehicle or combination of motor vehicles used in commerce to transport passengers or property if the motor vehicle:

a. Has a gross combination weight rating of **10,001 or more pounds** inclusive of a towed unit, or
b. Is designed to transport **16 or more passengers**, including the driver, or
c. Is of any size and is used in the **transportation of materials found to be hazardous** for the purposes of the Hazardous Materials Transportation Act **and which require the motor vehicle to be placarded** under the Hazardous Materials Regulations (49 CFR Part 172, Subpart F).

✓ If the vehicle is a CMV, check box 20 on the DMV-349

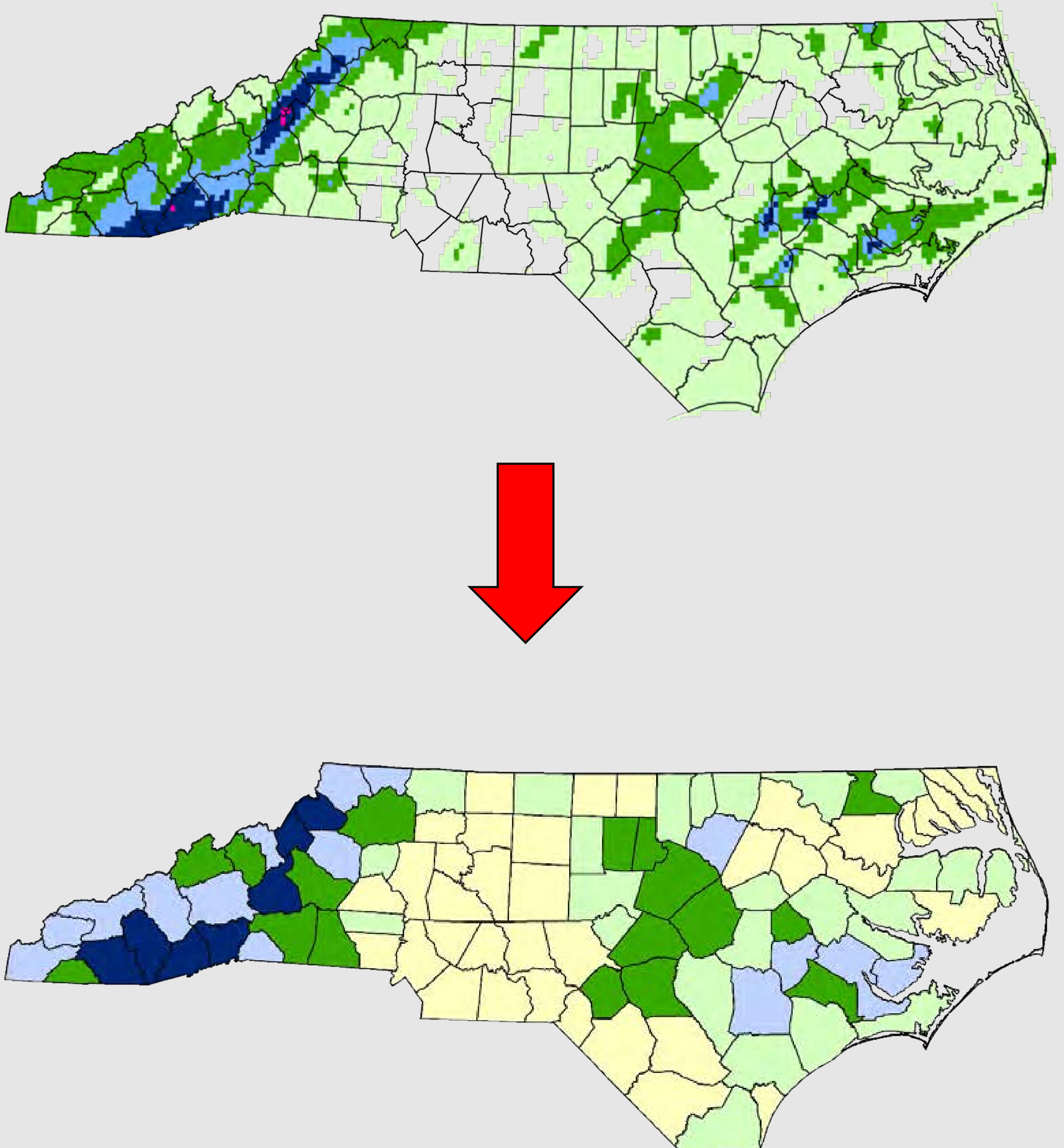
Example segment of the North Carolina Crash Report Form (DMV-349)

Precipitation Data

- Hourly-gridded and daily precipitation data were collected from the NCEP Multi-Sensor Precipitation Estimates (MPE) dataset from 2003-2019
  - **Blend of radar estimates and station gauge observations**

- Resolution of the data helps overcome limitations of station-based research and is known for **high performance of capturing high rainfall rates**

- ERA-Interim reanalysis temperature data will be incorporated to remove help **remove potential winter-weather related contamination** of risk calculation
  - Improves upon previous research that limited analysis to “warm season” crashes



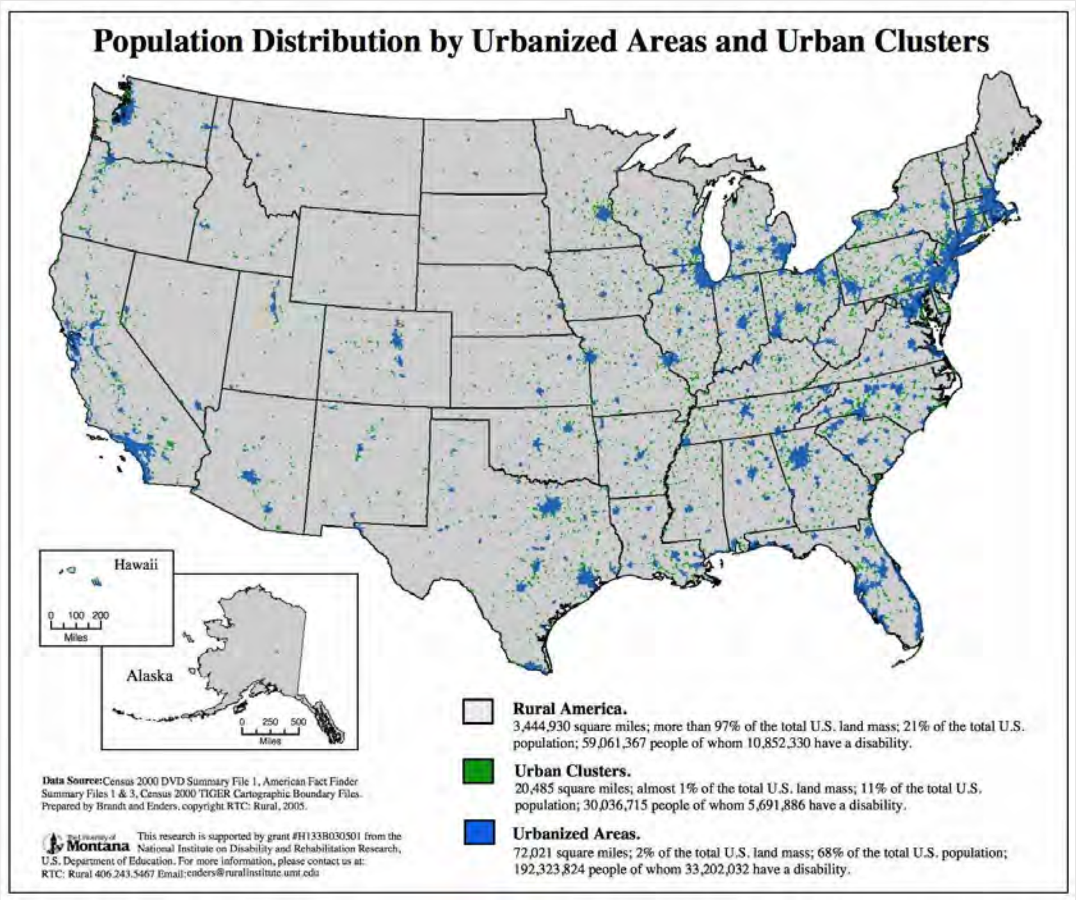
Rurality: An Elusive Concept in Crash Research

- The U.S. Census Bureau carefully defines urban areas through a set of pre-determined measures but simply **designates rural as that which is not urban**

- Black et al. (2017) attempts to overcome this problem by designating counties as urban or rural based on population density (50,000+ = urban)
  - Rural counties were divided into two distinct categories based on the presence of an interstate

- Lack of public transportation and distance to work/necessities requires drivers from rural areas to be on the road for longer periods of time

- N. Carolina is home to the 2nd largest rural population in the U.S.



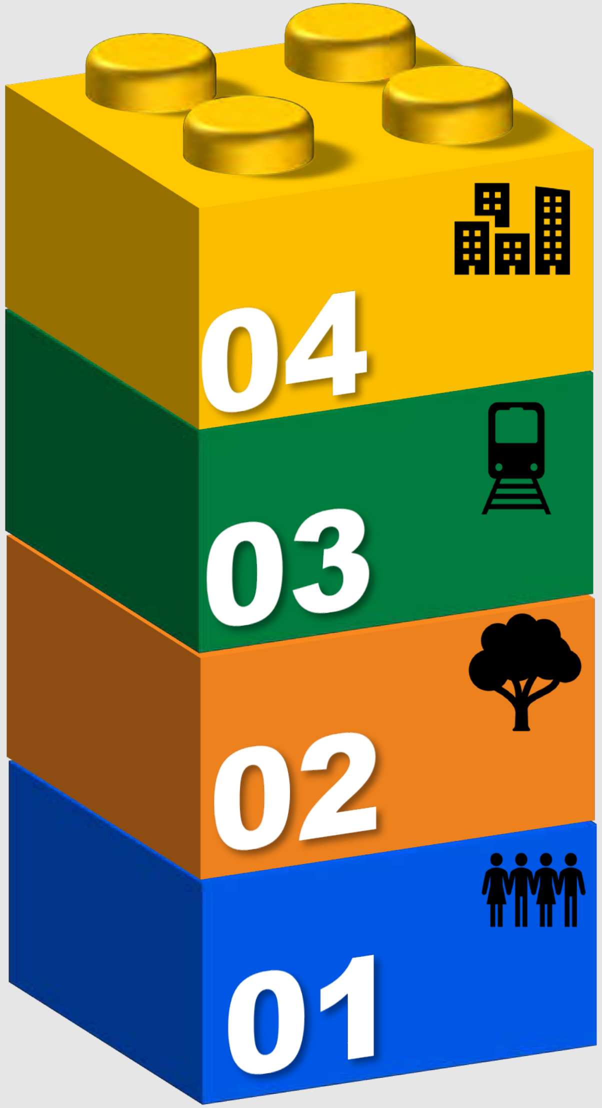
Defining Rurality for this Project

- Building off Waldorff (2006) *Index of Relative Rurality* which provides a continuous multidimensional measure of rurality that moves beyond the assignment of a binary (Rural v. Urban)

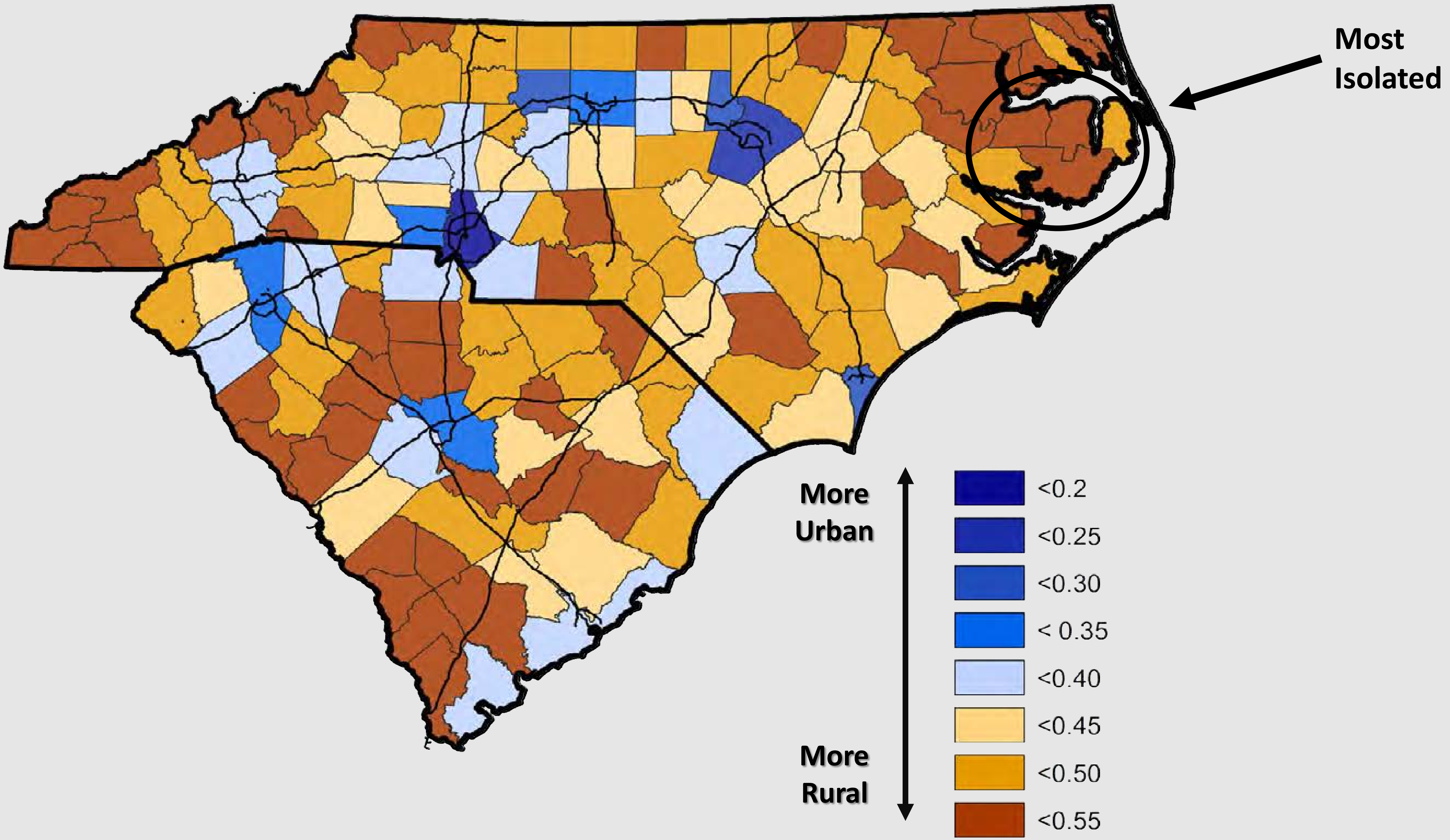
- Index will place counties on a scale that allows for the designation of sub-urban, peri-urban, semi-rural, and isolated communities

- Logarithmic transformations for population size and density corrects for their skewed distributions

- **Geographic focus**:
  - Local scale: Rural/urban designation should be relative to each state/neighboring state rather than across the whole United States



Applying Relative Rurality to the Carolinas



Methods

- Matched-Pair design allows for analysis of precipitation-crash risk **across unique time-steps**
  - Matched with control days that occurred exactly one week prior to or following the identified event
- Odds ratio was calculated to represent the relative risk of a crash on an event day to the odds of a crash on a control day
  - **Values greater than 1 indicate an increased risk of crash during a precipitation day**
- Compared relative crash risk across the rural-urban spectrum using the Index of Relative Rurality
  - **Considers more than population and goes beyond the traditional census definition of "rural"**

March 5th
0.38"

March 19th
0.0"

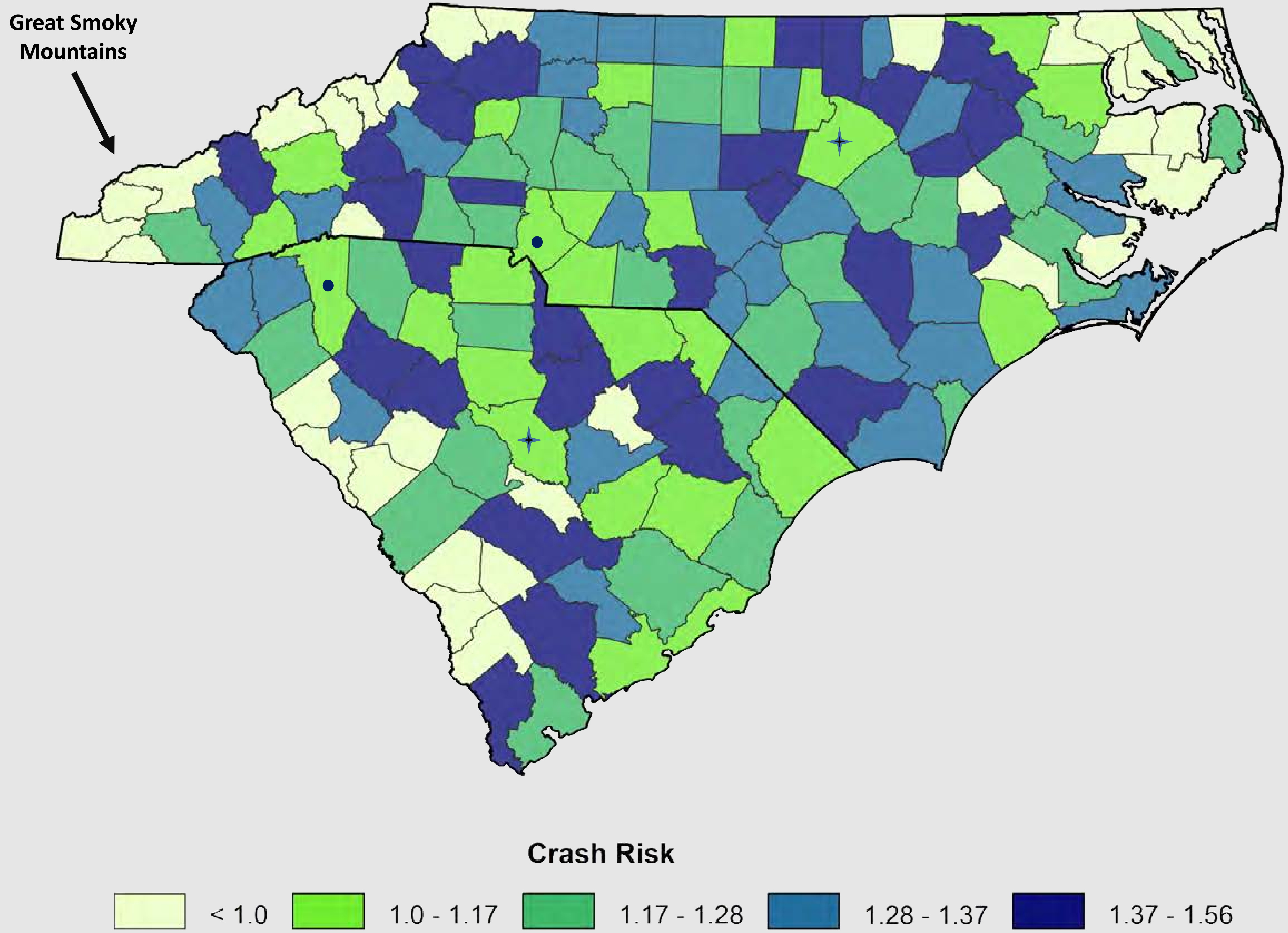
March 12th
0.65"
Event

Precipitation Event Crashes

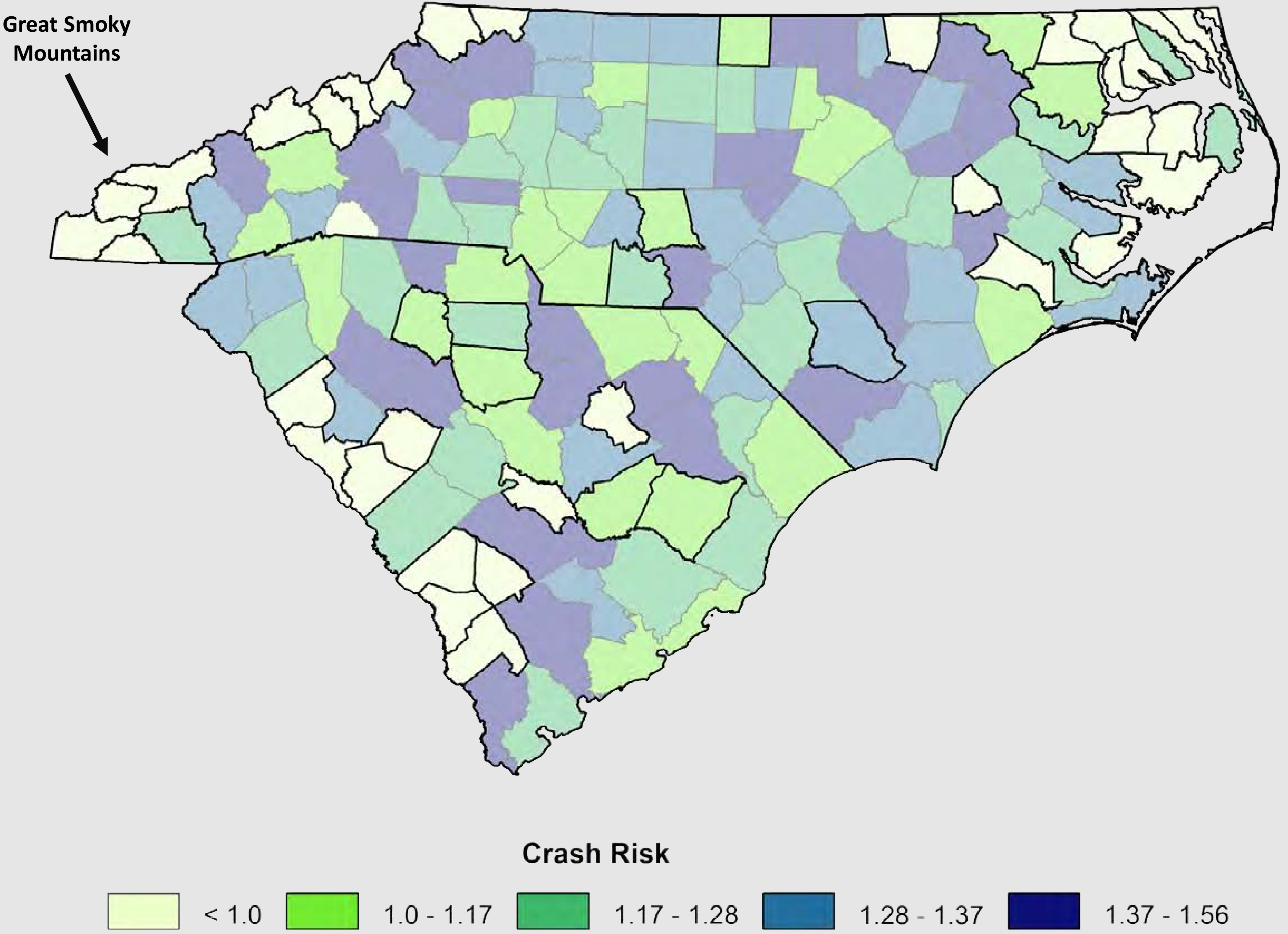
Event-Match (Dry Period)

$$ORi = \left(\frac{Ai}{C}\right) / \left(\frac{Bi}{D}\right)$$

Number of Safe Outcomes



Great Smoky Mountains
Crash Risk
< 1.0
1.0 - 1.17
1.17 - 1.28
1.28 - 1.37
1.37 - 1.56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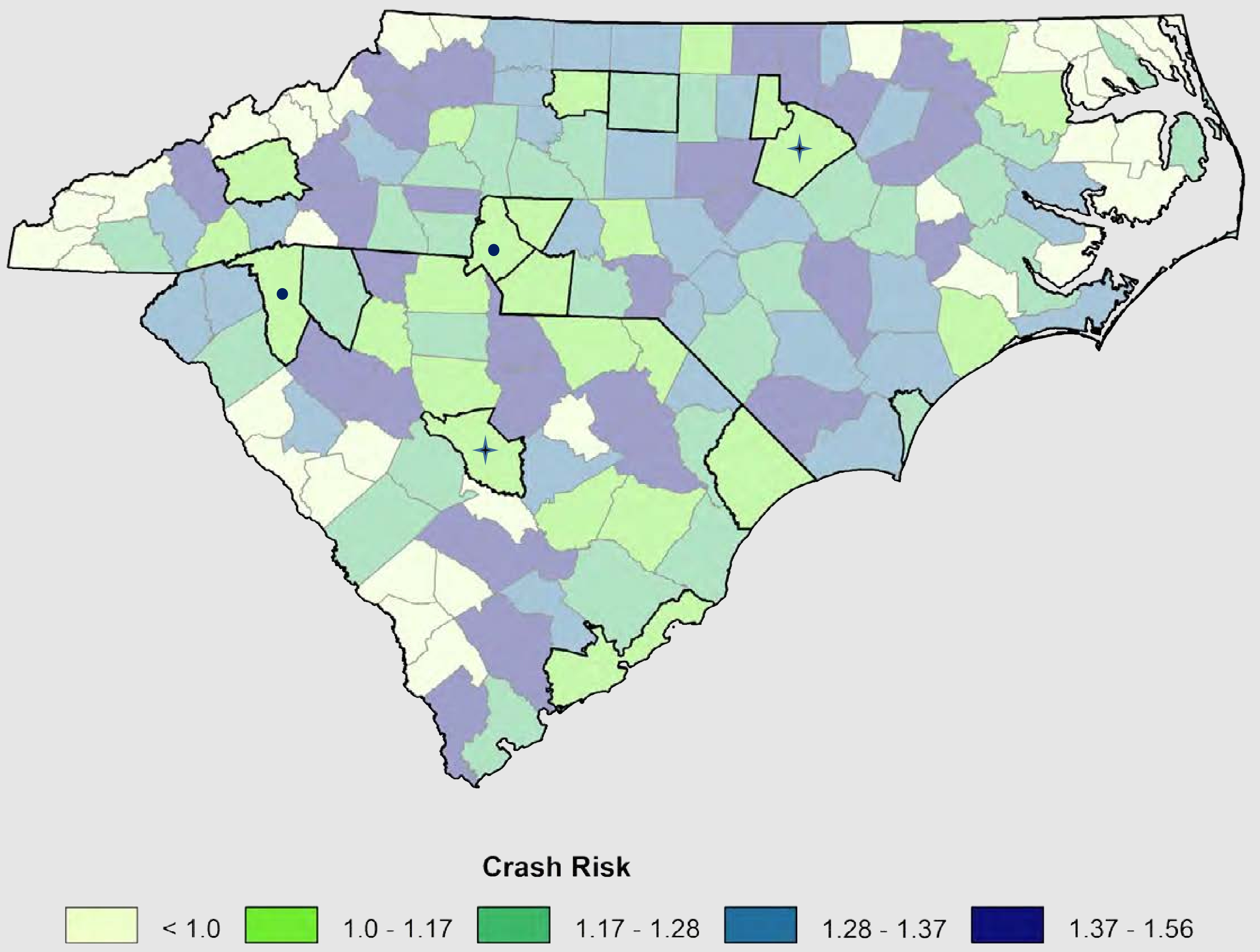

Crash Risk
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1.0 - 1.17
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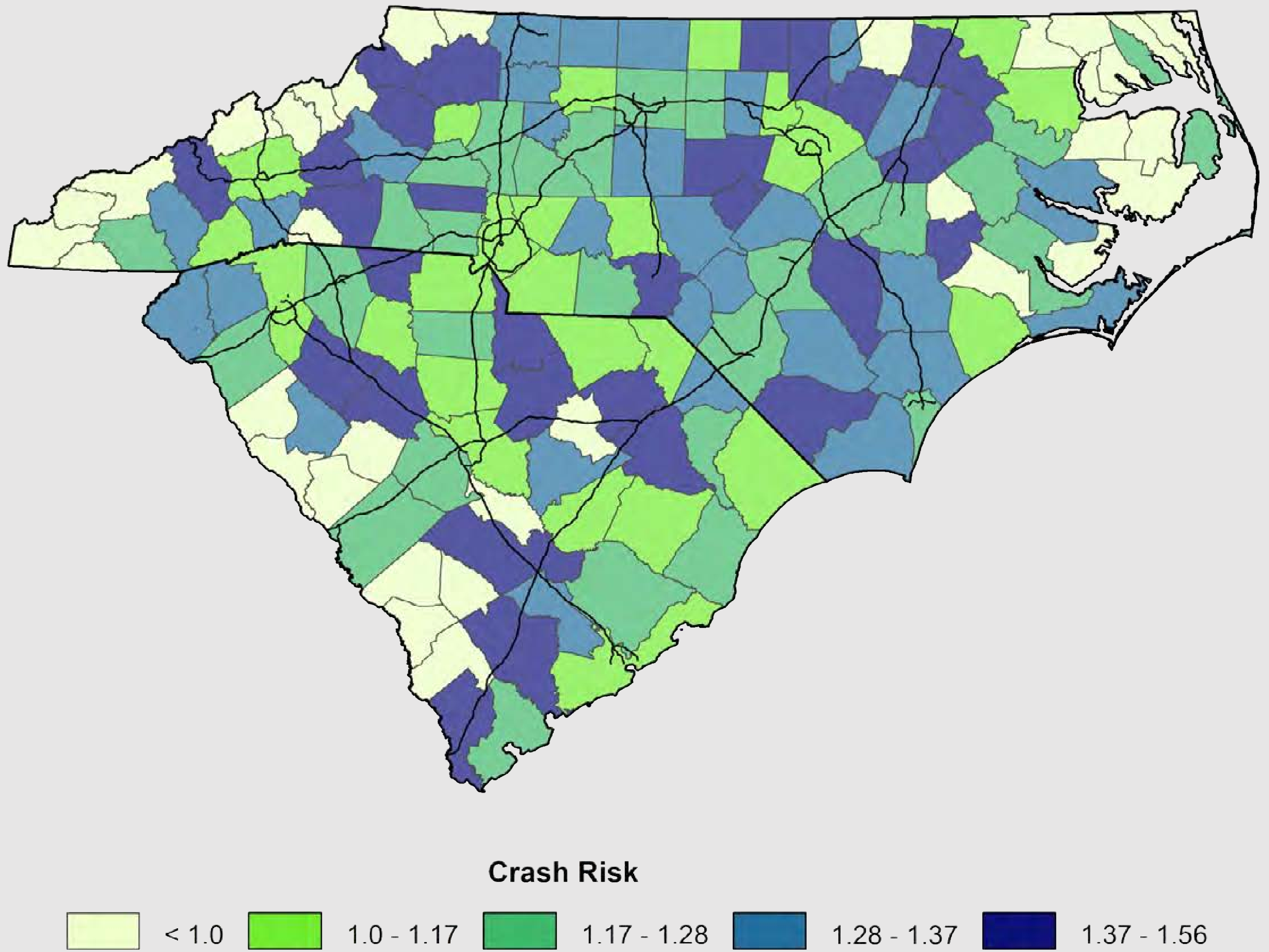

Crash Risk
< 1.0
1.0 - 1.17
1.17 - 1.28
1.28 - 1.37
1.37 - 1.56

Comparing Risk Across the Rural Urban Index

- Highly developed and isolated counties in North Carolina have **much lower relative risk** of weather-related crashes
- Important to consider how many rural and intermediary counties consist of residents that **commute greater distances** for work and leisure activities
- North Carolina is home to the **2nd largest rural population** with an average 44.5 miles of commuting a day

Category	Risk
Urban	1.14
Suburban	1.26
Intermediary	***1.40***
Rural	***1.30***
Isolated	0.95

Next Steps: Precipitation Characteristics

Duration

&

Intensity

- Investigate differences in car crashes relative to the rate and duration of weather events
  - **Thunderstorm vs. Multi-Day Event**
- Compare precipitation crash rates across accumulation thresholds
  - **Minor Event (<.05”) vs. Major Event (2+”)**
- Analyze differences in relative accident rates by time of day with precip
  - **Rush Hour, Lunch Break**
  - **Weekend vs. Weekday**

Applying the Results of the Work

- Despite no trend in annual precipitation totals, the Carolinas have experienced a significant increase in extreme rainfall events over the last 50 years.
  - 2018 set statewide records in North Carolina for wettest day, month, and year

- Results from analyses will be shared with the NCDOT and SCDPS in the hopes that they will be able to address areas where precipitation-related crash risk is significantly high
  - **Ex: Variable speed limit road signage**

- Data and visualizations will be incorporated into the Hazardous Extremes Risk Assessment Toolkit at SERCC/CISA

- Precipitation data and methodological routine will be used for future research on other climate-impact related research in the southeastern U.S.

Brian Yueshuai He

Postdoctoral Researcher, UCLA

Travel Behavior and Emission Analysis in the Era of CAV

UCLA Mobility Lab

UCLA Institute of Transportation Studies

Travel Behavior and Emission Analysis in the Era of CAV

Presenter: Dr. Brian Yueshuai He
PI: Dr. Jiaqi Ma
Team member: Qinhua Jiang
Mobility Lab, Department of Civil and Environmental Engineering

Agenda

1. Background
2. State of the Art & Practice
3. Methodology
4. Research Findings
5. Conclusion

Background

Connected and Automated Vehicle (CAV)

- Connected Vehicles are vehicles that can communicate with other vehicles, infrastructure and devices.
- Automated Vehicles are vehicles that can operate with little to no human assistance.

Big Moves in the CAV Industry and Governments/Agencies

- Waymo officially started its commercial self-driving-car service in the suburbs of Phoenix in 2018. Other companies also include Argo AI, Cruise, and self-driving trucks from TuSimple, etc.
- The U.S. DOT issued Federal Automated Vehicles Policy in September 2016, and as of spring 2019, 44 states have proposed, and 30 states have enacted legislation pertaining to autonomous vehicles.

State of the Art & Practice

Transportation Demand Forecasting in CAV Era

- Potential Impacts of CAVs on ABM in Seattle, WA - Childress et al (2015)
- Impacts of intra-household shared CAV on ABM in the Chicago sub-area – Xu et al (2019)
- Incorporating features of CAVs in ABM for Columbus, OH – Vyas et al (2019)

Research Gaps

- Short of CAV related data or CAV preference data
- Unable to capture impacts on activity generation
- Not applicable for large scale models

Problem Statement

Our research aims to explore the changing trend of travel demand and traffic emission in the era of CAV.

State of the Art & Practice

This research is part of our ongoing project: "**Developing Planning-level Analysis Tools for Connected Automated Vehicle Technologies and Services**", which is funded by the California Statewide Transportation Research Program (SB 1) Program. The project aims to investigate the changing trend in people's travel behaviors and travel demand with the implementation of CAV and develop planning-level analysis tools based on existing models to support CAV-related decision-making for MPOs and other public agencies.

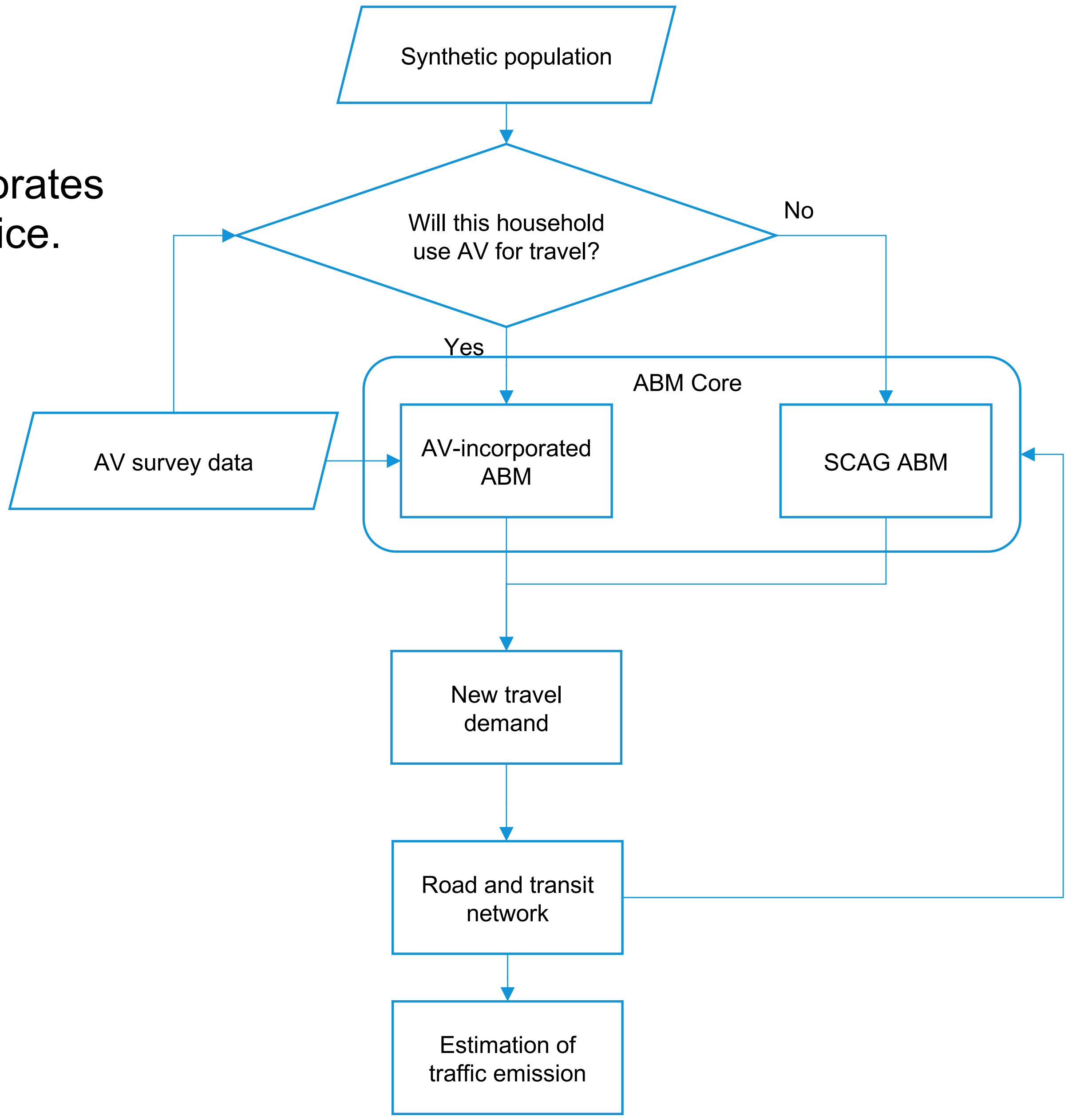
Contributions

- Collected people's intent to use CAV in Southern California, and their activity-related preferences
- Incorporated behavior changes in the SCAG ABM framework, from long term to short term
  - Work arrangement
  - Location choice
  - Activity frequency
  - Mode choice
- Estimated the changes in VMT and GHG emissions across the SCAG area

Methodology

We adopted an activity-based approach which incorporates CAV features from long-term choice to short-term choice.

- Long-term:
  - Work arrangement
    - Weekly work duration
    - Workplace location type
    - Number of jobs
- Medium-term:
  - Activity frequency
    - Mandatory activity,
    - Non-mandatory activity
  - Location choice
  - School escort
- Short-term:
  - Mode choice



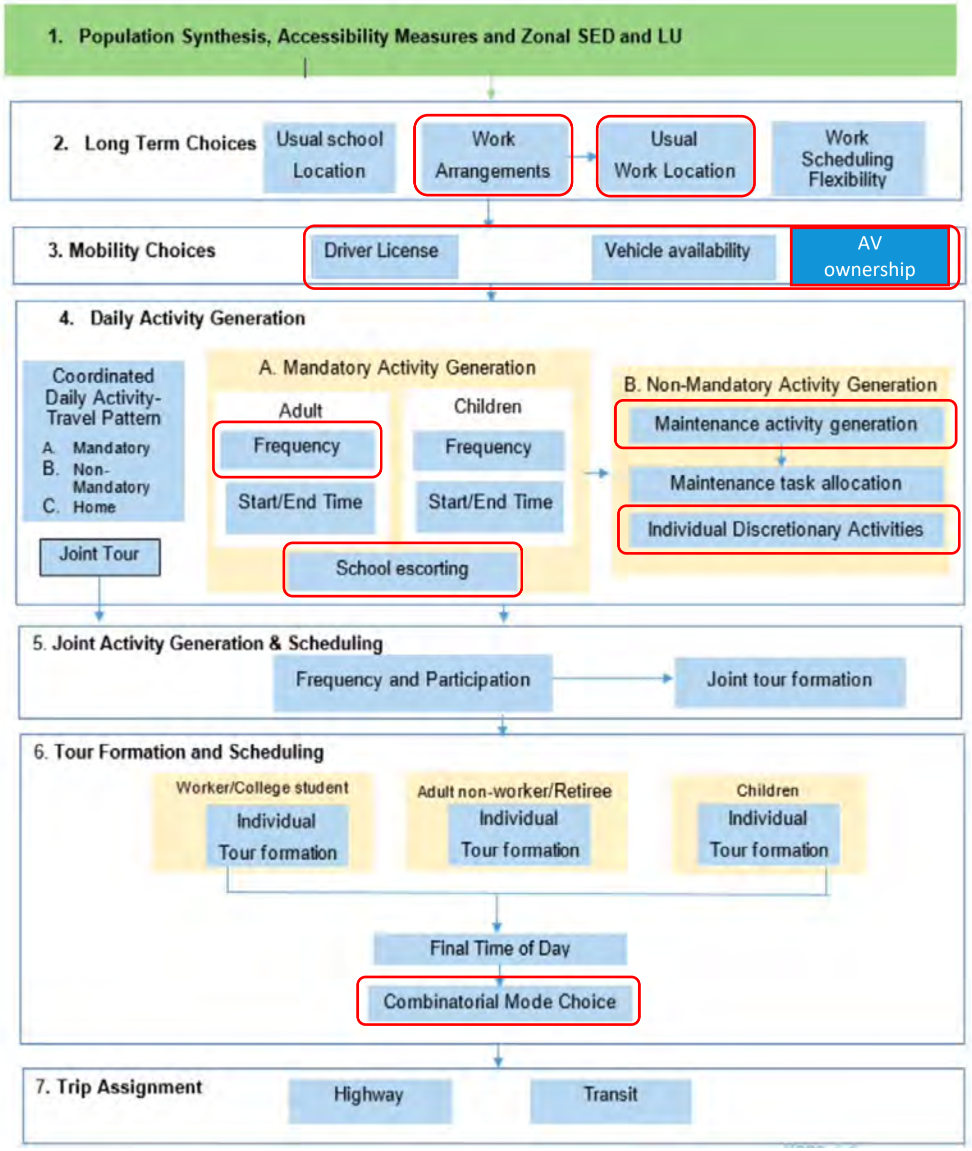
Methodology

SCAG ABM

- Activity-based travel demand model developed by SCAG, covering six counties in southern California
- One of the largest ABM in the world
- Detailed demographic and socio-economic information
- Addressed both household-level and person-level travel choices with the consideration of intrahousehold interactions

CAV-incorporated ABM

- Developed upon SCAG ABM framework
- Re-calibrate existing sub-models and develop new sub-models with new CAV preference data
- Incorporated both personal-owned and shared CAV in the mode choice model



SCAG ABM System Design (source: 2016 Regional Travel Demand Model and Model Validation)

Methodology

Data Collection

An online **Stated Preference** survey was designed and distributed to collect people's intent to use CAV in their daily travels and activity-related changes due to CAV.

- Two-stage survey
  - CAV choice: ask questions about people's intent to use CAV and their demographic information, 687 valid responses collected
  - Activity choice: for CAV users only, ask questions about changes in their daily activity choices, 675 valid responses collected
- Multiple control attributes
  - Household size/income/number of vehicles
  - Personal age/education attainment/work status

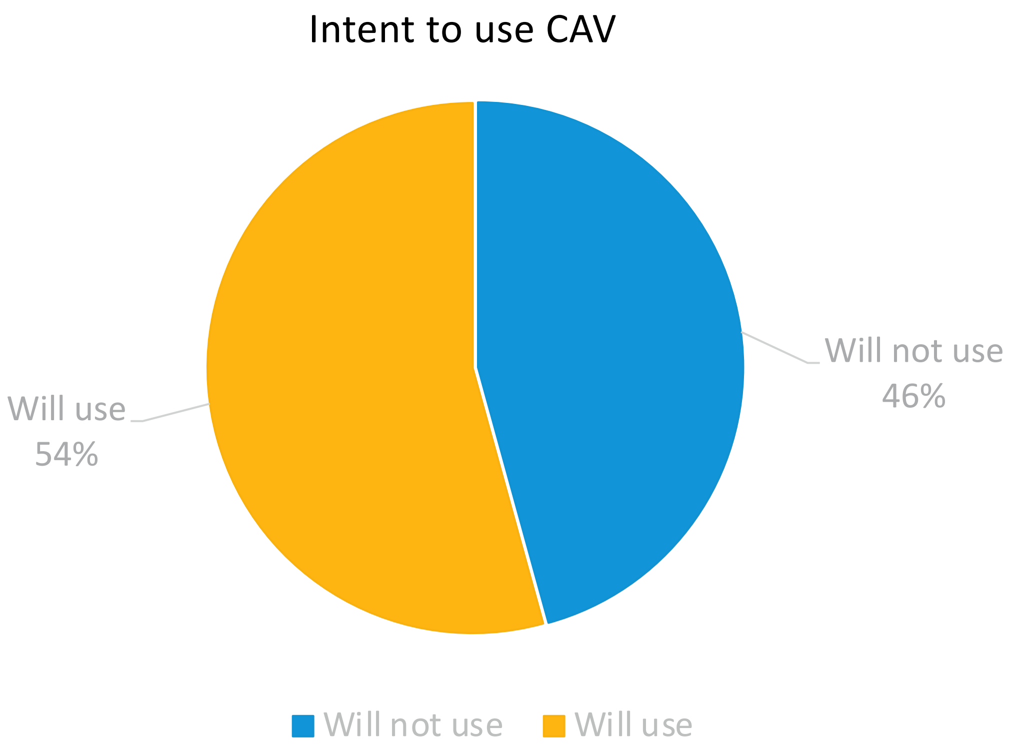
Comparison of data collected and quota from SCAG model

Age	Quota	Data
16~17	4.9%	2.9%
18~24	14.3%	14.3%
25~39	37.0%	34.4%
40~64	29.9%	30.1%
65+	14.0%	18.3%

Research Findings

Survey results

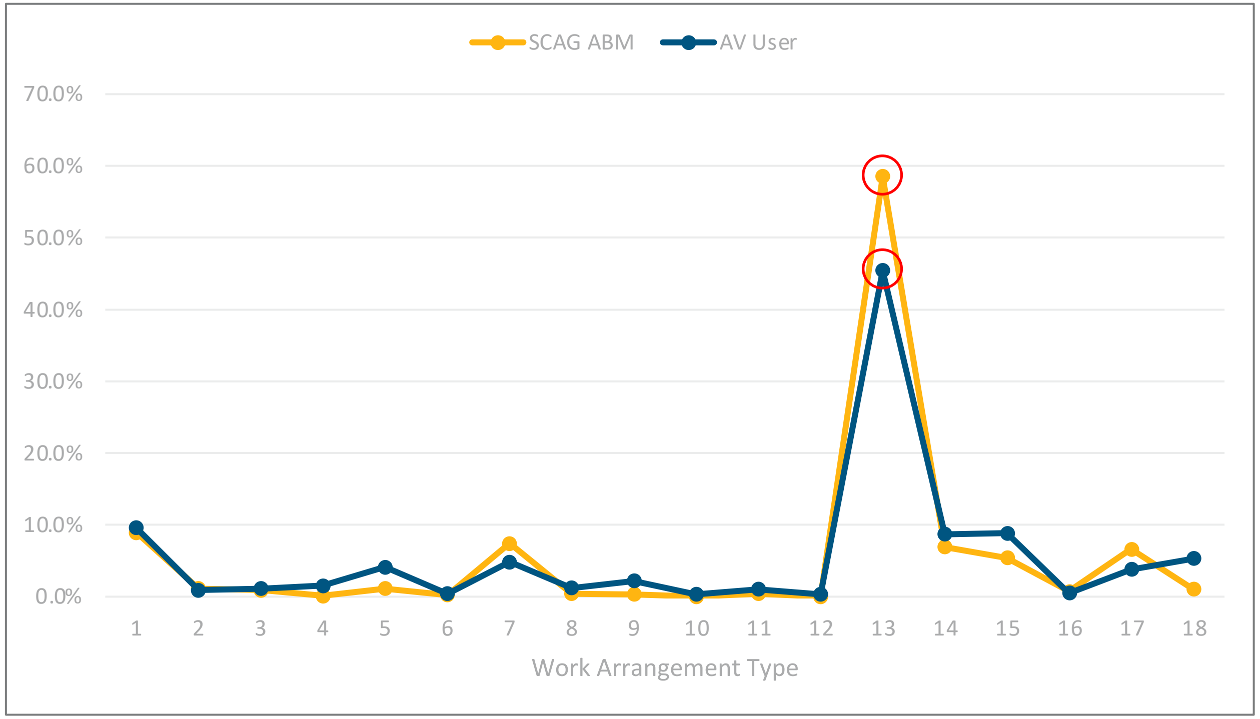
- At the first stage, about 54% of people choose to use CAV for their daily travel, which is close to the result (52%) of the 2017 California Vehicle Survey. The data collected from the second stage were used to re-calibrate/develop activity-related sub-models.



Research Findings

CHANGES IN WORK ARRANGEMENT

Distribution of work arrangement type



Lookup table of work arrangement type

ID	Work Duration	Workplace Type	Number of Jobs
1	Short	Fixed	One
2	Short	Fixed	Multiple
3	Short	Home	One
4	Short	Home	Multiple
5	Short	Variable	One
6	Short	Variable	Multiple
7	Medium	Fixed	One
8	Medium	Fixed	Multiple
9	Medium	Home	One
10	Medium	Home	Multiple
11	Medium	Variable	One
12	Medium	Variable	Multiple
13	Long	Fixed	One
14	Long	Fixed	Multiple
15	Long	Home	One
16	Long	Home	Multiple
17	Long	Variable	One
18	Long	Variable	Multiple

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Research Findings

CHANGES IN WORK LOCATION CHOICE

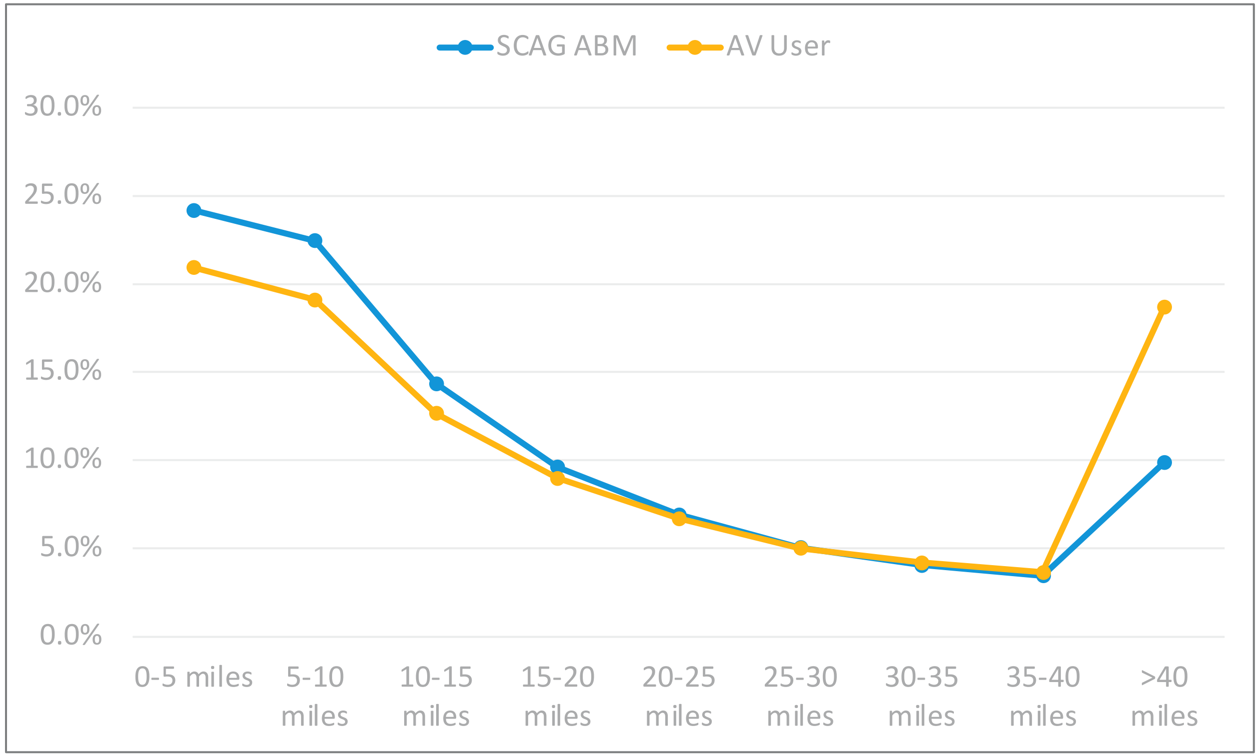
In SCAG model, the candidates of work location choice model are determined by a sample-by-importance approach. The utility of a candidate TAZ is:

$$V_{ij} = -\beta_1 * d_{ij} - \beta_2 * d_{ij}^2 + \ln(S_j)$$

where S_j is the number of employment at the workplace TAZ. At most 30 TAZs can be selected for each worker.

In the CAV-incorporated model, we calibrated the β_1 and β_2 with the consideration of additional travel time accepted by CAV users.

Distribution of home-work location distance

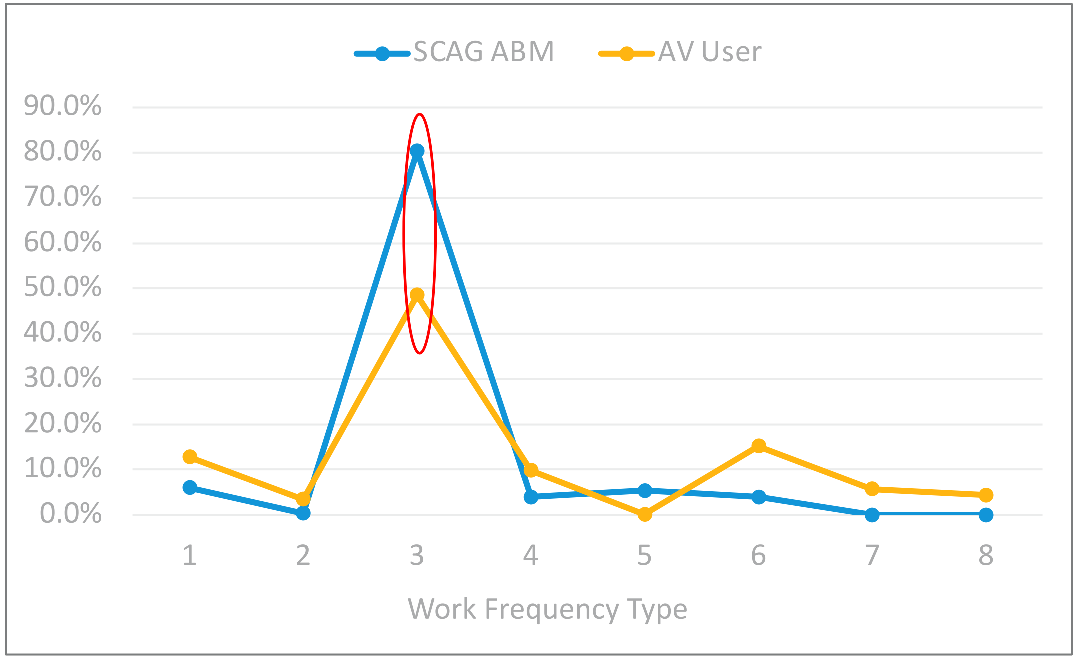


Average home-work distance changed from 16.47 miles to 21.71 miles.

Research Findings

CHANGES IN ACTIVITY FREQUENCY

Distribution of work frequency/order type



Work frequency and order type explanation

- “W” represents for Work activity, which refers to usual work activity.
- “B” means Business activity, which indicates short and flexible business activity, e.g., business meeting.

Lookup table of work frequency/order type

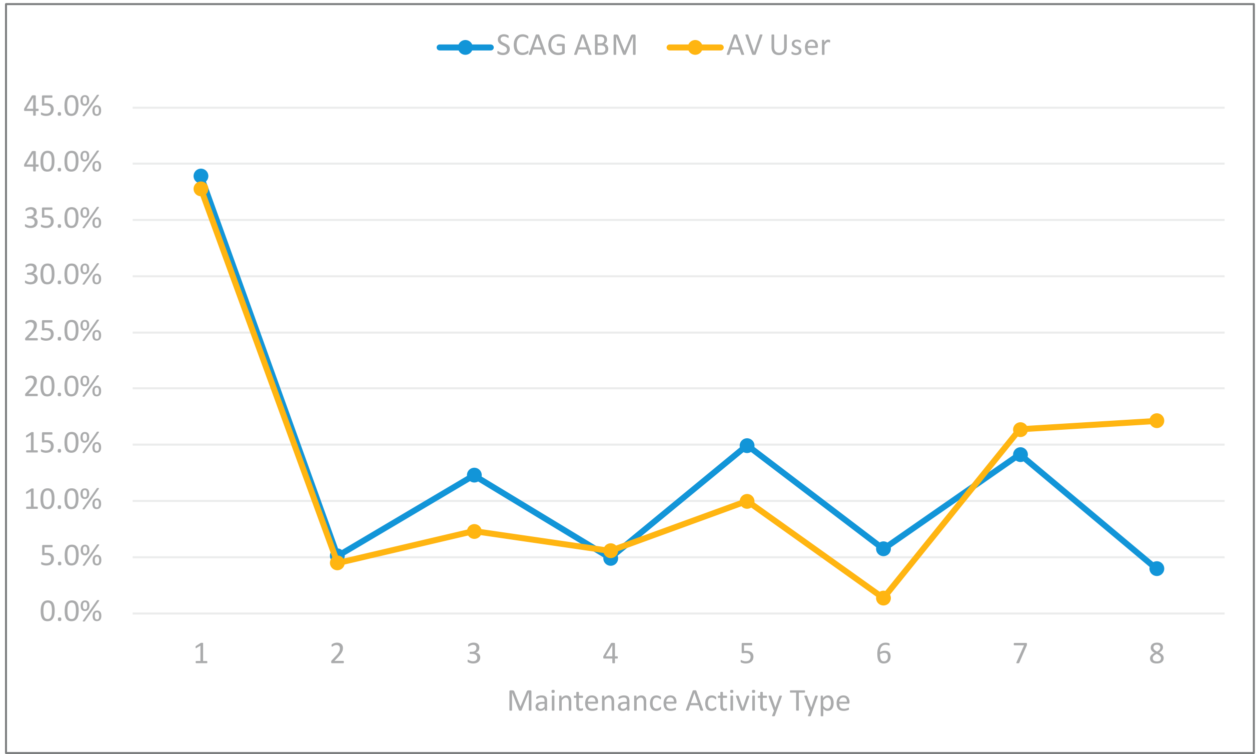
ID	Type	ID	Type
1	B	5	WBB
2	BB	6	WW
3	W	7	WWB
4	WB	8	WWBB

The number of work trips increased from 20.5M to 23.5M when CAV is available.

Research Findings

CHANGES IN ACTIVITY FREQUENCY

Distribution of maintenance activity type



Non-mandatory activity is categorized as household maintenance activity and individual discretionary activity under the SCAG ABM framework.

Under the household maintenance activity, there are three sub-categories: grocery shopping (“S”), household errand (note as “M”), and escort (“E”).

Lookup table of maintenance activity type

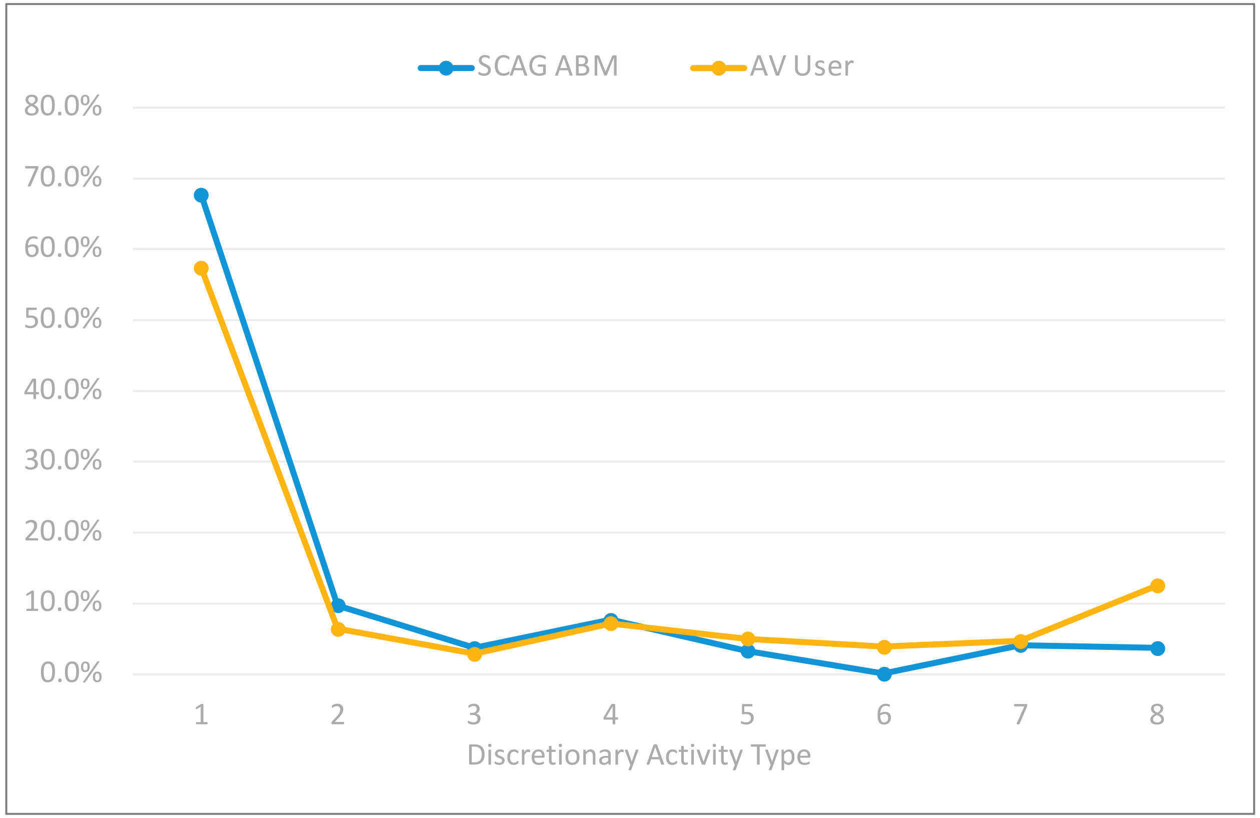
ID	Type	ID	Type
1	None	5	S
2	E	6	SE
3	M	7	SM
4	ME	8	SME

The number of household maintenance trips increased from 15.3M to 16.9M when CAV is available.

Research Findings

CHANGES IN ACTIVITY FREQUENCY

Distribution of discretionary activity type



Under the individual discretionary activity, there are 3 sub-categories: visit (“V”), discretionary (“D”), and individual maintenance (“M”).

Lookup table of discretionary activity type

ID	Type	ID	Type
1	None	5	V
2	M	6	VM
3	D	7	VD
4	DM	8	VDM

The number of individual discretionary trips increased from 18.0M to 20.4M when CAV is available.

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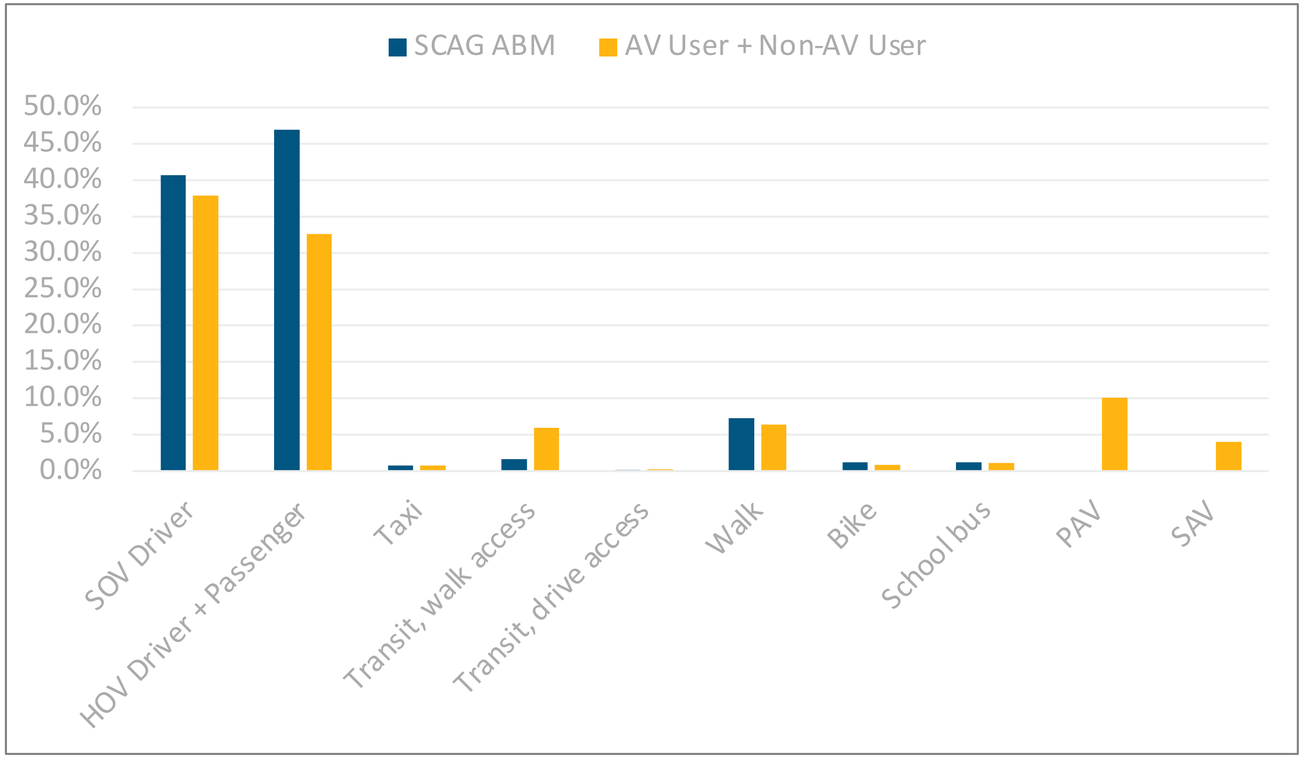
Research Findings

CHANGES IN MODE CHOICE

Comparison of Mode Choice



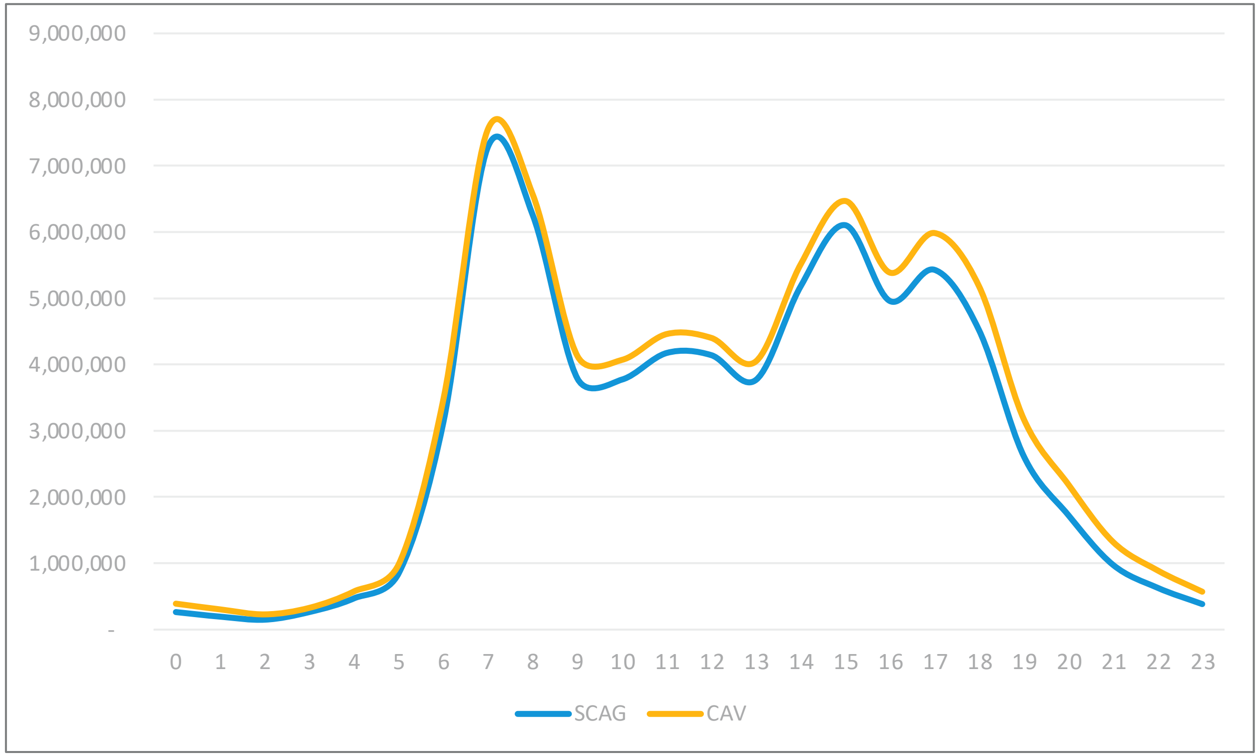
Mode	SCAG	SCAG_CAV	Change in %
SOV Driver	28938995	29604931	+2%
HOV Driver + Passenger	33380974	25515985	-24%
Taxi	560894	607587	+8%
Transit, walk access	1143218	4695632	+311%
Transit, drive access	119466	220067	+84%
Walk	5182693	5015013	-3%
Bike	861157	651143	-24%
School bus	850162	903878	+6%
PAV	N/A	7863047	N/A
SAV	N/A	3129376	N/A
Total	71037559	78206659	+10%

PAV and SAV take about 14.1% of total trips.

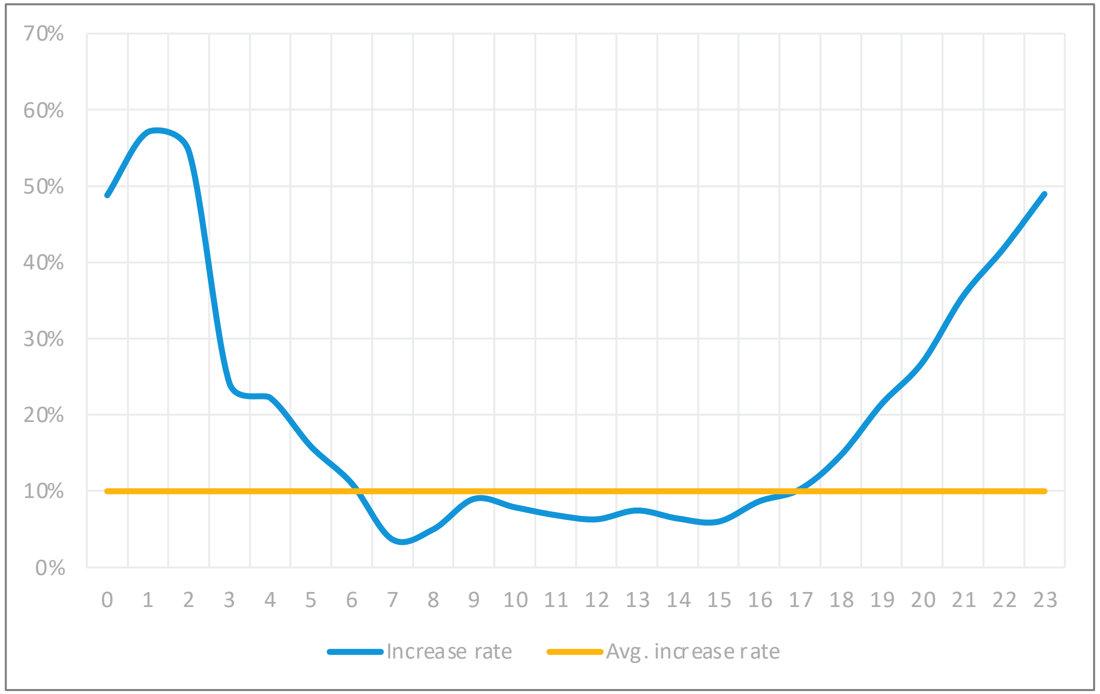
Research Findings

DEPARTURE TIME ADJUSTMENT

Eliminate 50% of Maintenance and Discretionary tours during nighttime.



Distribution of trip departure time



Increase rate of trip departure time

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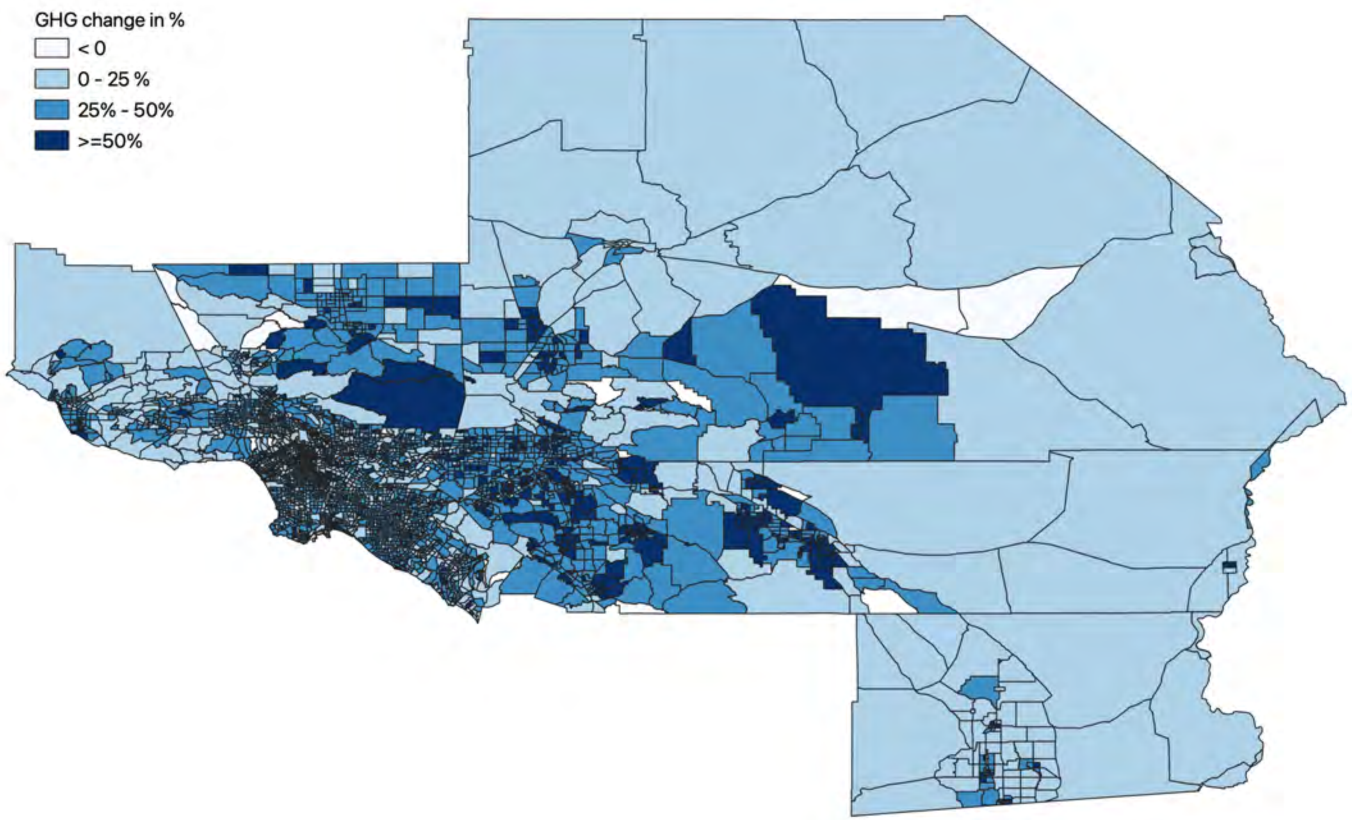
Research Findings

Changes in Number of Trips			
Trip Purpose	SCAG	SCAG_CAV	Change in %
Work	20,533,312	23,641,137	+15%
Household Maintenance	15,262,859	14,858,406	-3%
Discretionary	18,005,284	18,693,853	+4%
Changes in Total VMT			
VMT	470M	575M	+22%
Changes in Work-Home Distance(mile)			
Avg. Distance	16.5	19.8	+20%

Research Findings

- We adopted the Emission Factors (EMFAC) model to calculate the transportation emission
- Calculated the running exhaust emissions from passenger cars using gasoline



Change of GHG emission per TAZ

Conclusion

Conclusion

- According our survey, only half (54%) of the population is willing to adopt CAV for travel
- When CAV is available, people's travel behaviors changed significantly:
  - More flexible work arrangement is preferred
  - Longer home-work distance is accepted
  - More business/non-mandatory trips are expected
  - SOV trips are more likely to shift to CAV
- The total number of trips increased by 4.9% and the VMT increased by 22% after the CAV implementation
- GHG emissions increased significantly in sub-urban area

Acknowledgement

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Thank You

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Transportation finance, public transit and innovative mobility

Coming up Tomorrow!

Break-out 5 | 8:30-10am PT

SESSION 5.1

The Cumulative Costs of Climate Change

SESSION 5.2

Heat Vulnerability Affecting Workers, Healthcare, and Neighborhoods

SESSION 5.3

Innovative Toolkits for Urban Heat Adaptation

SESSION 5.4

Housing and Hazards: How Should We Protect Vulnerable Homes?

Break-out 6 | 10:15-11:45am PT

SESSION 5.1

Emerging Research on Financial Adaptations to Climate Impacts

SESSION 5.2

Wading into the Economic Impacts of Climate Change on Water

SESSION 5.3

Equitable Adaptation to Climate-Related Flood Risks: Part 2

CLIMATE ADAPTATION
RESEARCH SYMPOSIUM

MEASURING & REDUCING SOCIETAL IMPACTS

Thanks for tuning in!

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