UNIVERSITY OF CENTRAL FLORIDA

Traffic Crashes Under Low Visibility Due to Fog in Florida

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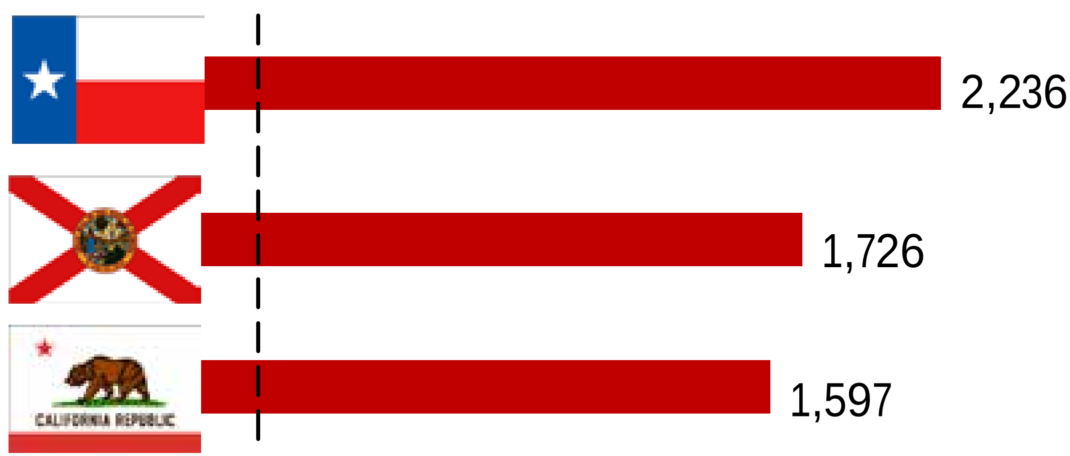
Overview: Traffic Crashes Under Low Visibility Conditions

Fog/Smoke Crash

- Florida is among the top state in the US regarding traffic safety problems resulting from adverse visibility conditions due to fog or smoke.

Fog/smoke related Fatal Crashes (2001-2010)

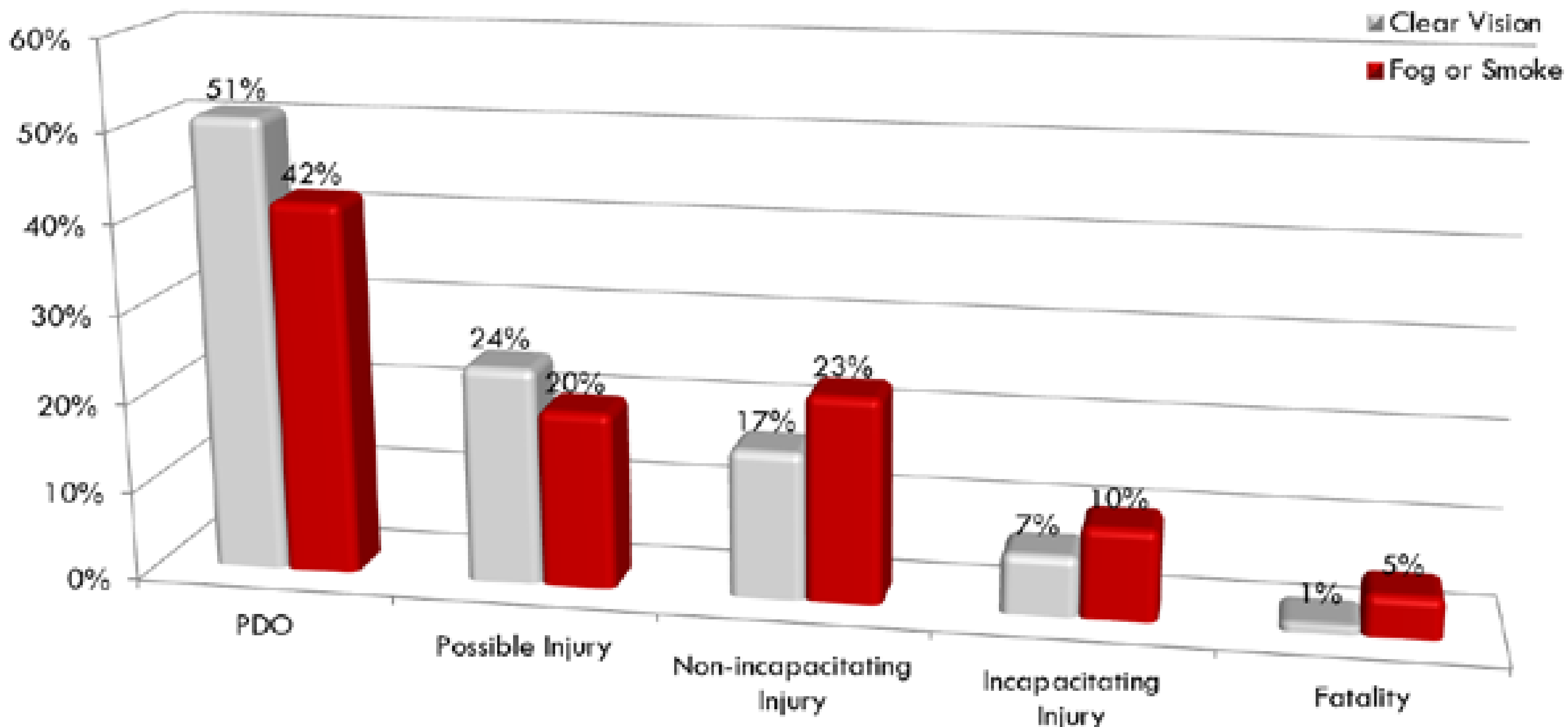


National average per state: 363

Source: Fatality Analysis Reporting System

Comparison of Severities Between Fog and Other Crashes

- Crashes due to reduced visibility from fog/smoke are more severe compared to those without vision obstructions.



Macro- and Micro-level Fog Crash Hotspot Identification

Hotspot Identification

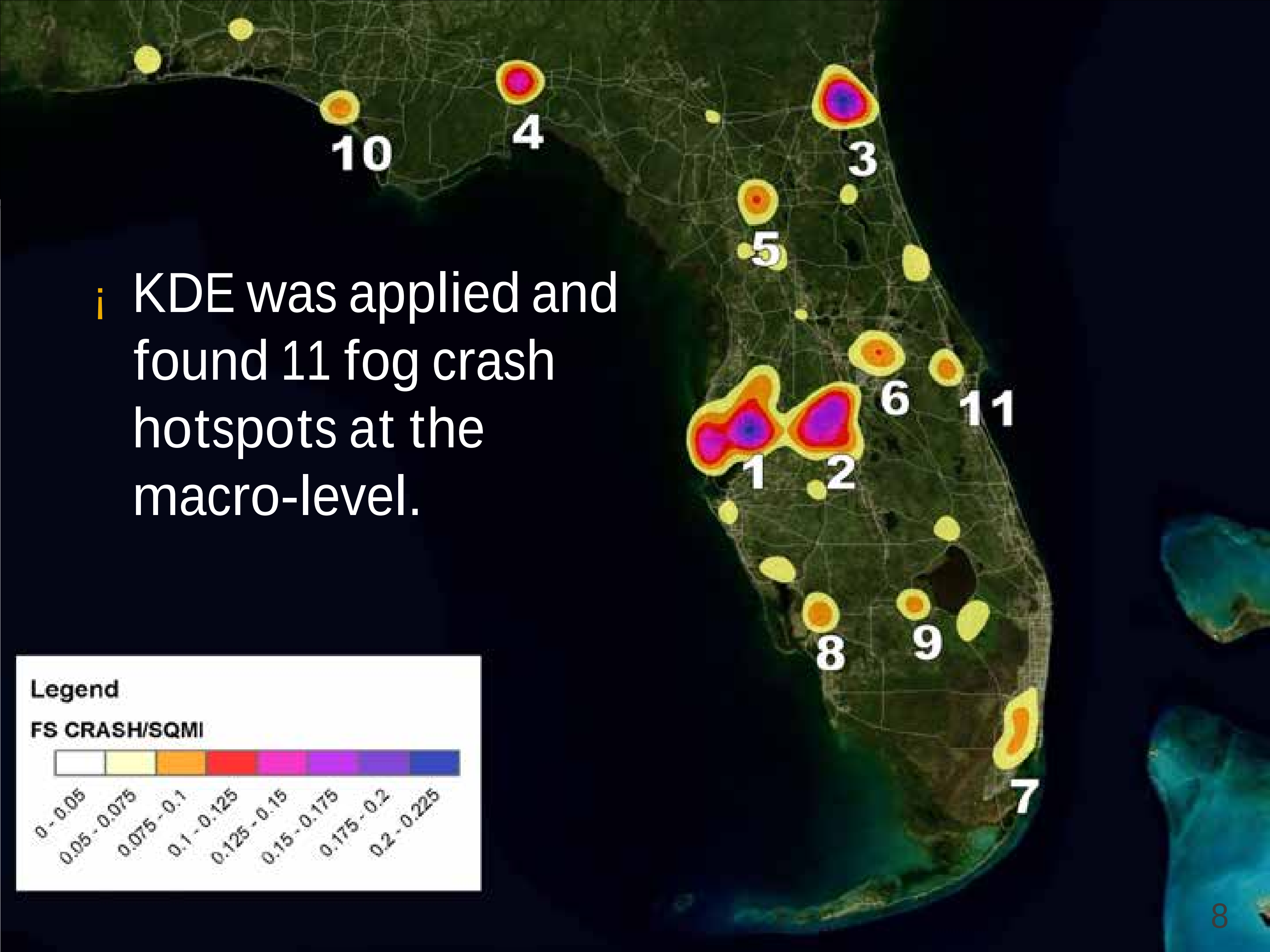
Macroscopic Screening

- Area-wide Analysis
- Kernel Density Estimation

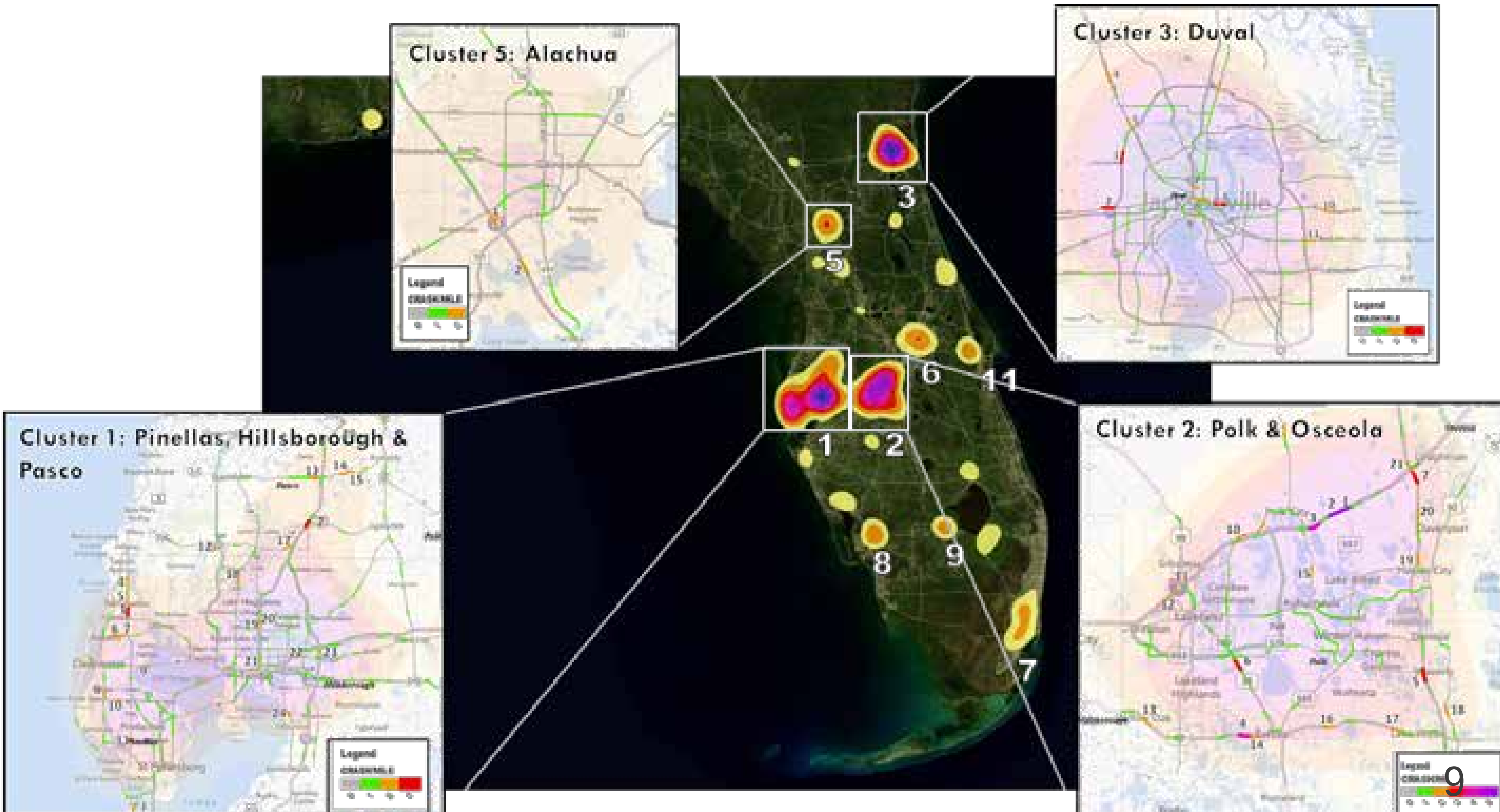
Microscopic Screening

- Segment-based Analysis
- Fog crashes per mile

- KDE was applied and found 11 fog crash hotspots at the macro-level.



- The 11 hotspots were magnified and then fog crashes were counted based on 1-mile segments.



Detection of Fog on the Roadway Using Airport Weather Data

Airport Weather Stations

- There are about 70 airports in Florida.
- Most of the airports have weather stations and provide hourly weather data.

Image acquired from http://en.wikipedia.org/wiki/Weather_station

Airport Weather Data Structure

- Sky conditions, visibility, weather, temp, humidity, wind speed, etc.

U.S. Department of Commerce
National Oceanic & Atmospheric Administration

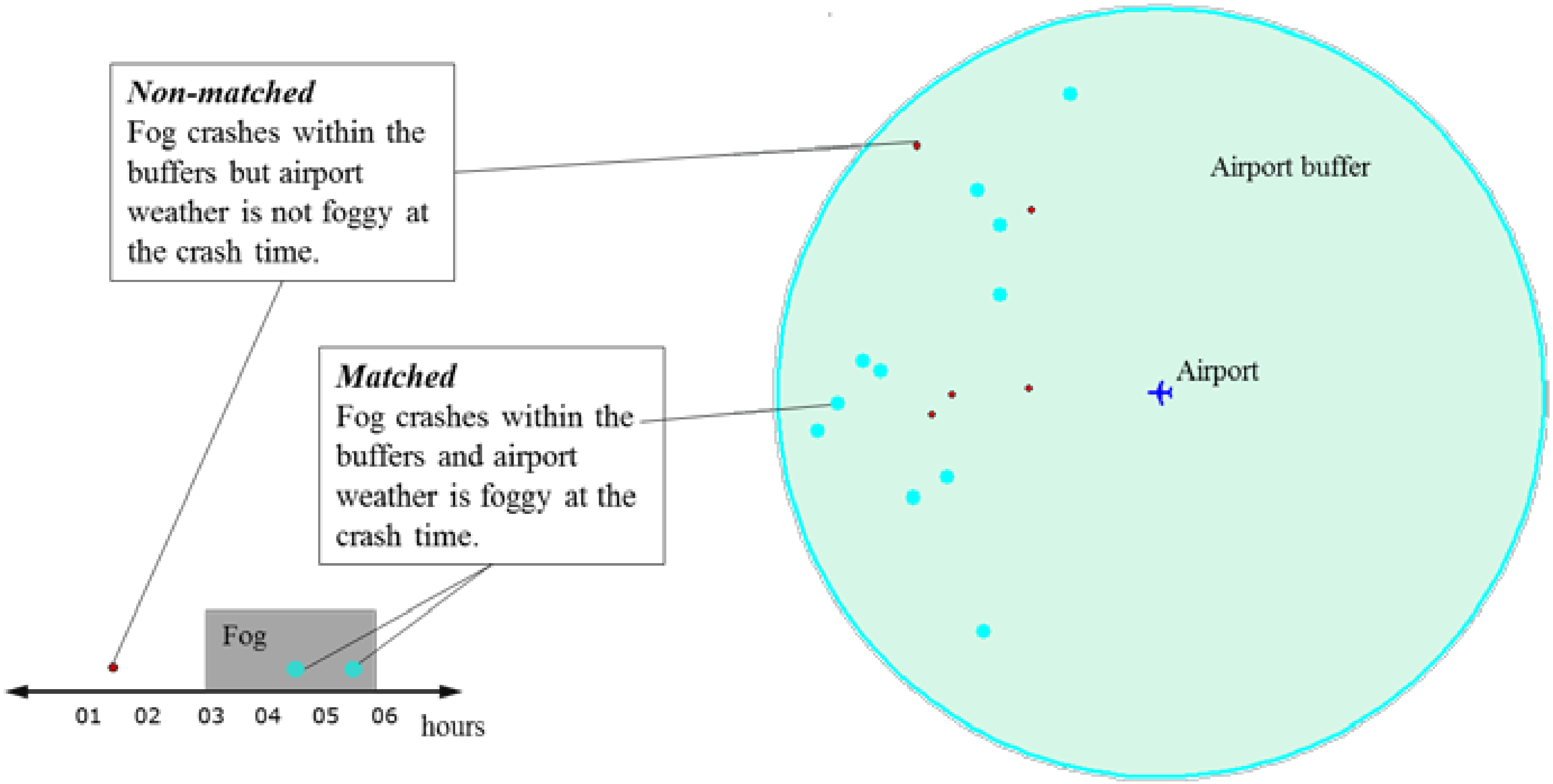
QUALITY CONTROLLED LOCAL
CLIMATOLOGICAL DATA
(may be updated)
HOURLY OBSERVATIONS TABLE
ORLANDO INTERNATIONAL AIRPORT (12815)
ORLANDO, FL
(06/2014)

National Climatic Data Center
Federal Building
151 Patton Avenue
Asheville, North Carolina 28801

Elevation: 90 ft. above sea level
Latitude: 28.433
Longitude: -81.325
Data Version: VER2

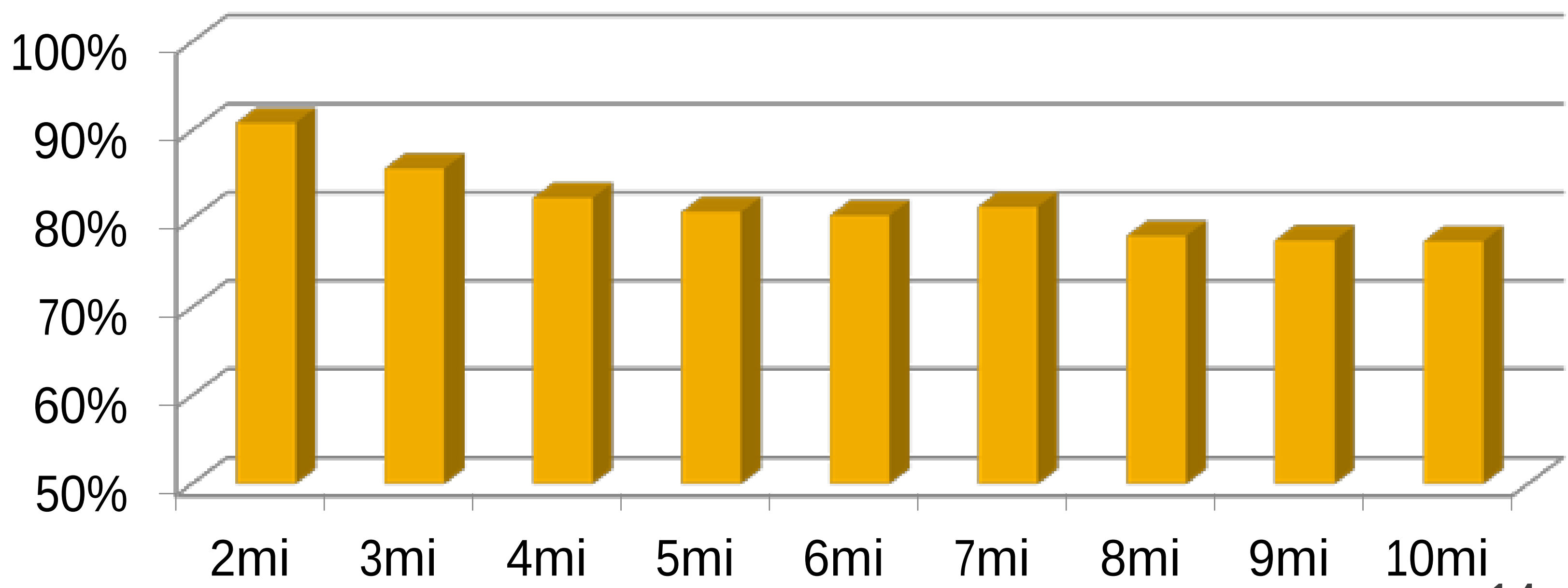
Date	Time (LST)	Station Type	Sky Conditions	Visibility (SM)	Weather Type	Dry Bulb Temp (F)	Dry Bulb Temp (C)	Wet Bulb Temp (F)	Wet Bulb Temp (C)	Dew Point Temp (F)	Dew Point Temp (C)	Rel Humd %	Wind Speed (MPH)	Wind Dir	Wind Gusts (MPH)	Station Pressure (in. hg)	Press Tend	Net 3-hr Chg (mb)	Sea Level Pressure (in. hg)	Report Type	Precip. Total (in)	Alti-meter (in. hg)
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
01	0053	11	FEW019 OVC300	10.00		76	23.9	73	22.7	72	22.2	88	6	110		29.93			30.03	AA		30.04
01	0153	11	FEW019 BKN300	10.00		74	23.3	71	21.6	70	21.1	87	7	080		29.93			30.03	AA		30.04
01	0253	11	FEW019 BKN300	10.00		74	23.3	72	22.2	71	21.7	90	7	080		29.92			30.02	AA		30.03
01	0353	11	FEW020 BKN300	10.00		74	23.3	71	21.5	69	20.5	84	7	070		29.93			30.03	AA		30.04
01	0453	11	FEW020 FEW150 BKN300	10.00		74	23.3	71	21.5	69	20.5	84	6	080		29.93			30.03	AA		30.04
01	0553	11	FEW030 FEW200 BKN300	10.00		73	22.8	70	21.3	69	20.5	87	3	090		29.95			30.05	AA		30.05
01	0653	11	FEW030 FEW200 BKN300	10.00		77	25.0	72	22.4	70	21.1	79	8	050		29.96			30.06	AA		30.07
01	0753	11	FEW030 FEW150 BKN300	10.00		80	26.7	74	23.3	71	21.7	74	10	080		29.97			30.08	AA		30.08
01	0853	11	SCT021 OVC300	10.00		83	28.3	75	24.1	73	22.2	70	11	080		29.97			30.08	AA		30.08
01	0953	11	FEW024 FEW150 OVC300	10.00		84	28.9	74	23.5	70	21.1	63	10	070		29.97			30.08	AA		30.08
01	1053	11	FEW032 BKN250 OVC300	10.00		85	29.4	75	23.7	70	21.1	61	9	120		29.97			30.07	AA		30.08
01	1142	11	FEW025 BKN034 BKN150	10.00		80	26.7	74	23.2	71	21.7	74	15	060		29.98			M	SP		30.09
01	1153	11	SCT029 BKN036 OVC300	4.00	-RA BR	76	24.4	73	22.9	72	22.2	87	18	030	30	29.98			30.09	AA	0.02	30.09
01	1208	11	SCT029 BKN036	10.00	-RA	76	24.4	74	23.3	73	22.8	90	13	040		29.98			M	SP		30.10
01	1253	11	FEW030 FEW080 SCT200	10.00		79	26.1	74	23.1	71	21.7	77	14	040		29.96			30.06	AA	T	30.07
01	1353	11	FEW030 FEW075 BKN100	10.00		81	27.2	74	23.4	71	21.7	72	10	040		29.96			30.06	AA	T	30.07
01	1453	11	SCT026 BKN036 BKN100	10.00		80	26.7	73	22.9	70	21.1	72	15	100	26	29.96			30.06	AA	T	30.06
01	1553	11	SCT025 BKN046 OVC075	10.00	-RA	81	27.2	74	23.4	71	21.7	72	20	080	29	29.95			30.05	AA	0.01s	30.05
01	1557	11	BKN018 BKN036 OVC075	4.00	RA	79	26.1	74	23.1	71	21.7	77	21	090	25	29.95			M	SP		30.05
01	1601	11	BKN018 BKN036 OVC070	1.75	+RA	76	24.4	73	22.5	71	21.7	86	15	090		29.96			M	SP		30.07
01	1609	11	BKN018 BKN040 OVC070	4.00	-RA BR	75	23.9	73	22.7	72	22.2	90	13	090		29.96			M	SP		30.07
01	1623	11	FEW011 SCT018 BKN038	9.00		76	24.4	73	22.9	72	22.2	87	9	110		29.95			M	SP		[illegible]
01	1653	11	FEW013 SCT022 BKN070	10.00		77	25.0	74	23.4	73	22.8	88	11	100		29.95			30.05	AA	0.10	[illegible]
01	1753	11	SCT018 BKN040 BKN090	10.00		79	26.0	75	24.0	74	23.3	88	10	100		29.96			30.06	AA	T	30.07
01	1853	11	SCT018 BKN080 OVC110	10.00	-RA	77	25.0	74	23.4	73	22.8	88	6	090		29.97			30.07	AA	T	30.08

Combining Airport Weather Data with Fog Crashes



Matching Airport Weather Data with Fog Crashes

Buffer size	2mi	3mi	4mi	5mi	6mi	7mi	8mi	9mi	10mi
Fog crashes	11	28	51	78	97	113	128	152	169
Matched case	10	24	42	63	78	92	100	118	131
Non-matched case	1	4	9	15	19	21	28	34	38
Matching rate	90.9%	85.7%	82.4%	80.8%	80.4%	81.4%	78.1%	77.6%	77.5%



Warn Drivers to Be Prepared for Fog

- If fog conditions are predicted using the airport weather data, the authority should
  - Reduce the speed limits (VSL)
  - Inform drivers of fog conditions (VMS)
  - Close entrance ramps onto the highway with dense fog.

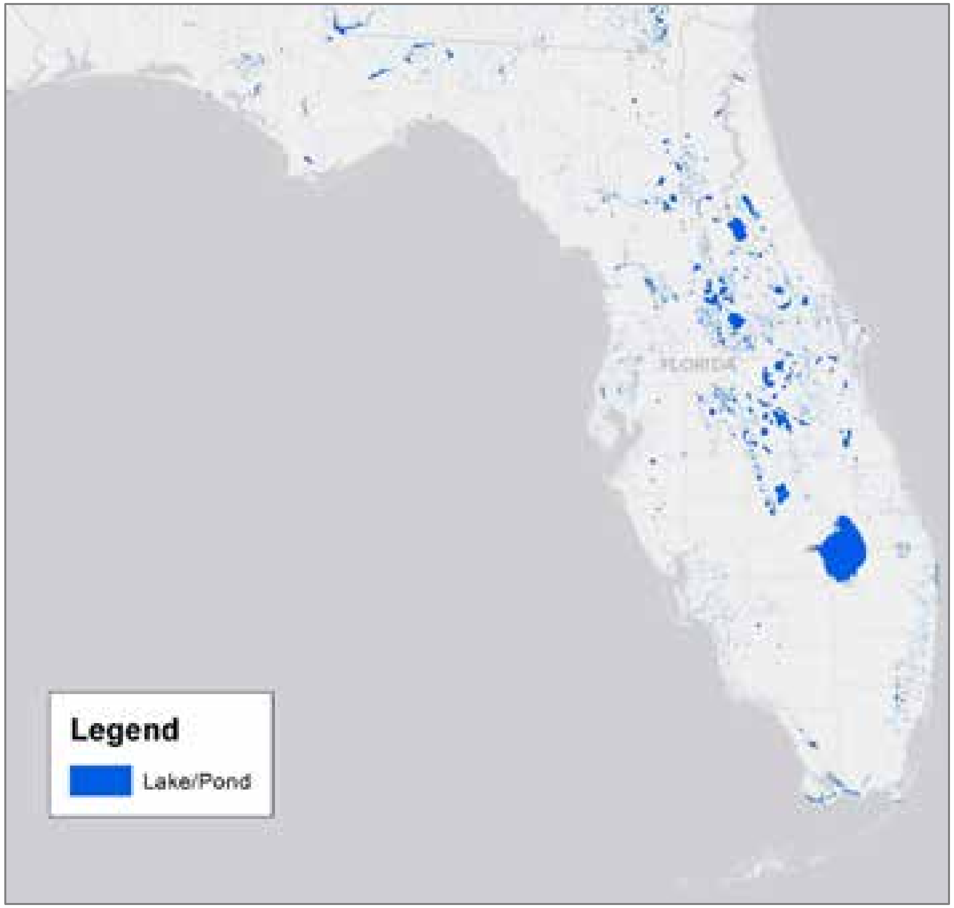
Source: FHWA

Source: FHWA

Images acquired from
http://safety.fhwa.dot.gov/speedmgt/vslimits/docs/vslexamples.ppt
http://ops.fhwa.dot.gov/weather/best_practices/CaseStudiesFINALv2-RPT.pdf

Fog Crash Modeling with In-land Water Data

In-land Water in Florida



- FL has more than 7,700 named lakes over 20 acres and countless ponds from 1-20 acres.
- The existence of lakes/ponds increases the probability of fog on nearby roads.

Data Collection

- The study area
  - 9 in-land counties in Central Florida
  - not affected by sea-water
- Collected data
  - Roadway, AADT*, and fog crashes

    (from Florida DOT)

*AADT: Annual Average Daily Traffic

Data Process

- Distance between the roadway and the closest lakes/ponds were calculated and incldued as a variable in the model.

N=4,477

Variable	Mean	SD	Min	Max
Fog crash #	0.0578	0.2889	0	4
AADT	16361.82	19097.24	150	184000
Distance (m)	545.699	765.031	0	6275.11
Length (mi)	3.076	1.989	0.104	9.999

Fog Crash Modeling

- Negative Binomial Model

$$\text{Predicted Crashes} = \exp[a + \beta_1 * \ln(\text{AADT}) + \beta_2 * \text{distance} + \ln(\text{Segment Length})]$$

- Results

Parameter	Coefficient	Estimate	SE	95% CI		*p*
Intercept	a	-16.8245	1.3573	-19.4846	-14.1643	<.0001
ln(AADT)	β_1	1.1493	0.1416	0.8719	1.4268	<.0001
distance	β_2	-0.0005	0.0002	-0.0009	-0.000	0.0352

  - As the distance between roadway and lake/pond is closer, it is likely to have more fog crashes.

Summary and Conclusion

Summary & Conclusion

- Fog crashes were analyzed using GIS.
- Hotspot Identification was conducted both at the macroscopic and microscopic levels.
- Airport weather data can be used for predicting fog conditions nearby roads.
- Distance to the closest lakes/ponds for each segment was calculated and it was found to be a negative and significant predictor of fog crashes.

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