



UNIVERSITY OF CENTRAL FLORIDA

# Real Time Monitoring and Prediction of Reduced Visibility Events on Florida's Highways

Mohamed A. Abdel-Aty, Ph.D., P.E.

Amr Oloufa, Ph.D., P.E.

Yichuan Peng, Ph.D.

Tsung-Sei Shen, Ph.D.

Jaeyoung Lee, Ph.D.

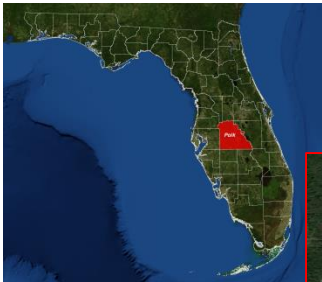
# Project Objectives

- Analyzing the effect of weather parameters on reduced visibility
- Investigating the impact of reduced visibility on traffic flow characteristics



# Data Collection

- Traffic and weather data were collected from the 9 stations installed on I-4 in Polk County.



# Weather Data Structure

## Basic Weather Data

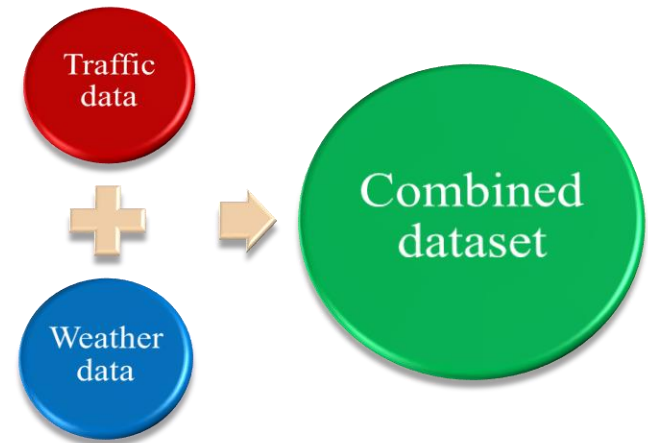
- Air temperature, dew point, surface moisture, humidity, wind speed, barometric pressure, etc.
- Visibility distance (WX)

## Fog Prediction Data

- Air temperature, surface moisture, humidity, wind speed
- Fog index

# Integrating Traffic & Weather Data

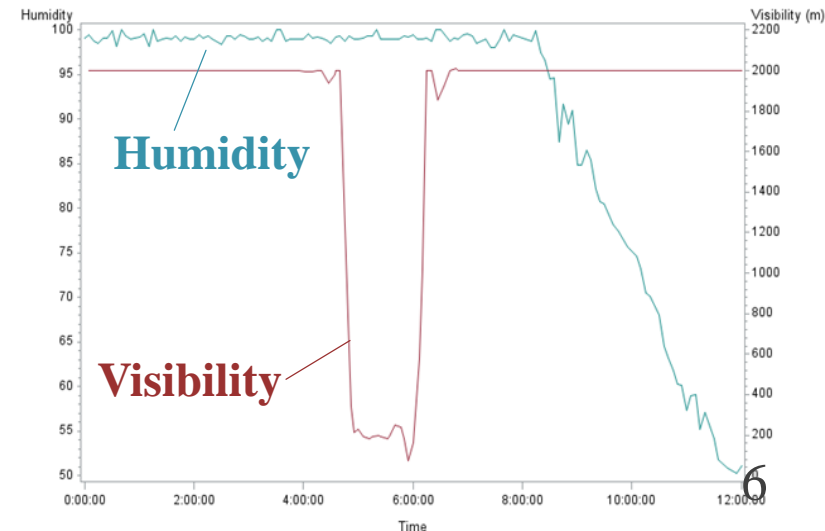
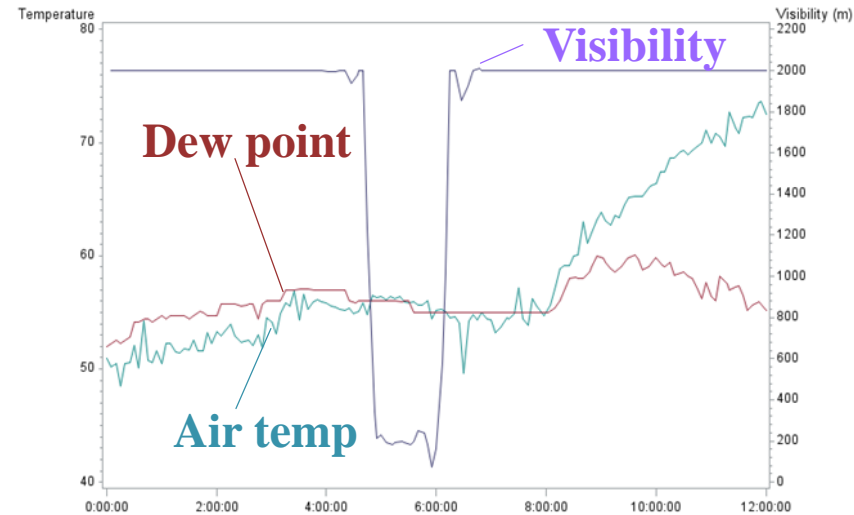
- Traffic & weather datasets were combined using date and time.



<i>Date/time</i>		<i>Traffic data</i>					<i>Weather data</i>	
Data	Time	Lane	Speed	Length	Range	Classification	Duration	Visibility (m)
02/12/2014	21:08.8	1	73.7	17.8	72	1	219	2000
02/12/2014	21:09.0	2	81.6	15.4	84	1	179	2000
02/12/2014	21:09.6	3	76.7	18.1	157.1	1	213	2000
02/12/2014	21:11.3	4	68.9	19.4	170.1	1	251	2000
:	:	:	:	:	:	:	:	:

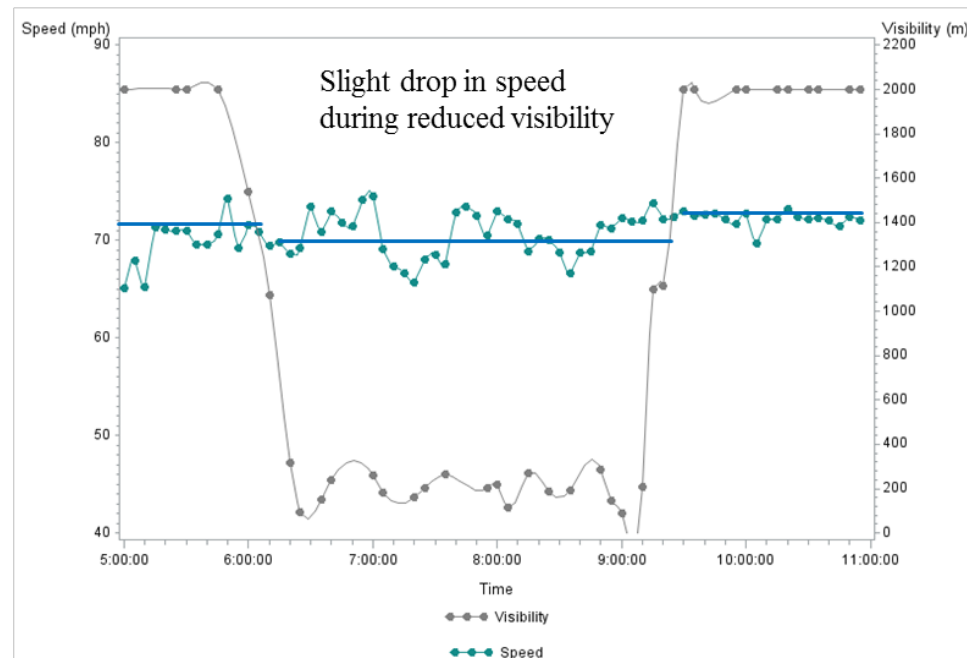
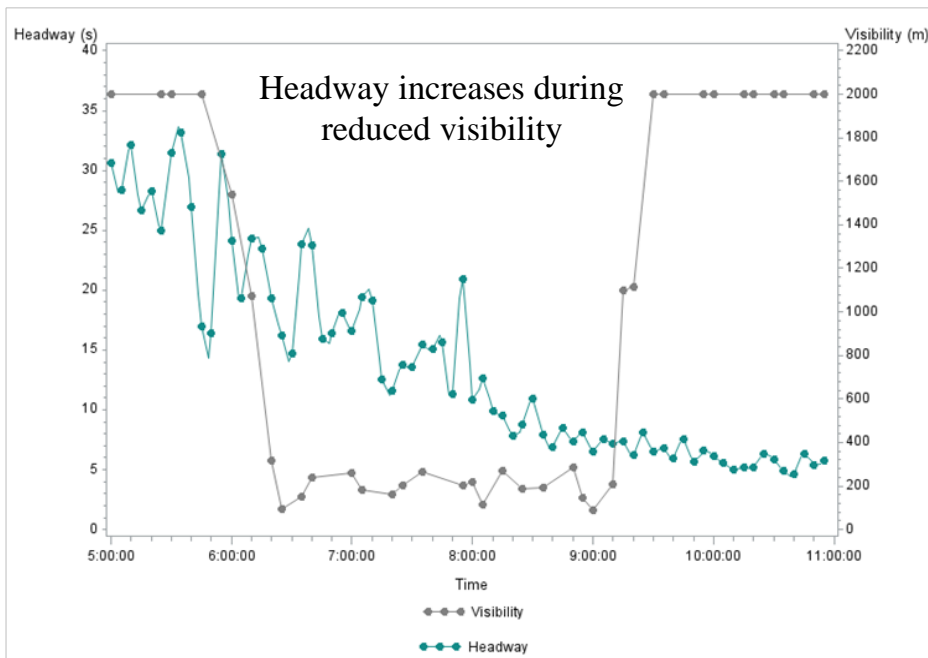
# Effect of Weather Parameters on Reduced Visibility

- Fog is more likely to form when
  - **humidity** is higher and close to 100%,
  - **wind speed** is lower,
  - **subsurface moisture** is higher, and
  - **air temperature** is very close to the **dew point**.



# Impact of Reduced Visibility on Traffic Flow Characteristics

- **Mean headway and headway variation are significantly higher while mean speed and volume are significantly lower in fog case.**





# Distribution & Factors of Fog Duration (2/3)

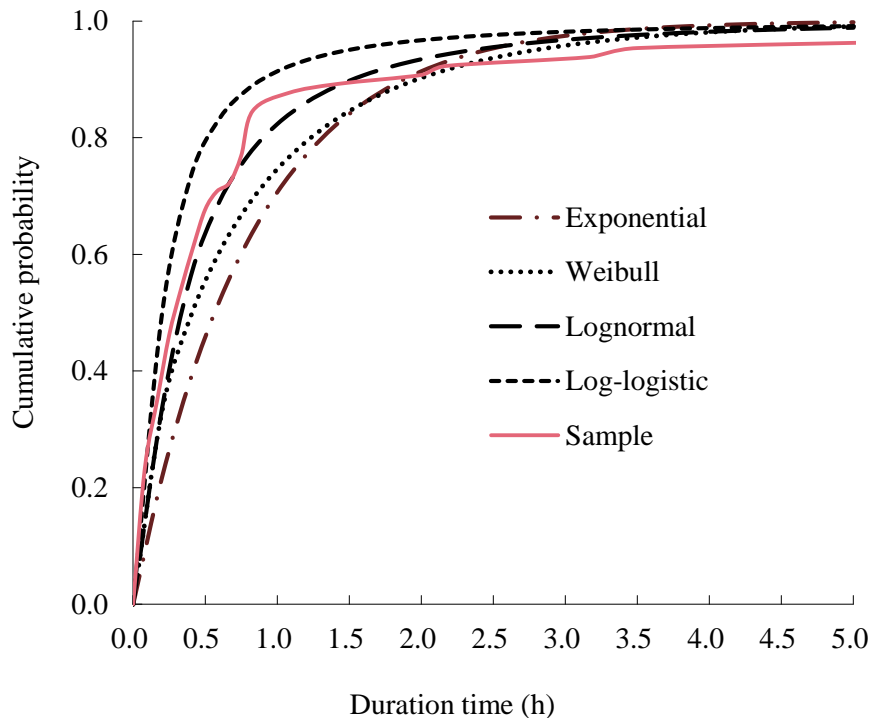
Parametric Estimated Results with Selection Model and Covariates Simultaneously

Variable	Exponential	Weibull	Lognormal	Log-logistic
Visibility	–	–	–	–
Air temperature	–	–	–	–
Humidity	–	–	–	0.022
Barometric pressure	–	–	–	2.737
Wind speed	-0.287	-0.246	-0.183	–
Solar radiation	-0.001	-0.001	-0.001	–
Subsurface moisture	4.440	–	–	–
CONS	-0.804	0.386	-0.409	-85.302
$\gamma(\sigma)$	None	0.857	1.088	0.607
LL	-106.746	-107.018	-97.736	-97.507
BIC	230.189	230.734	212.170	211.712
AIC	221.491	222.036	203.472	203.014

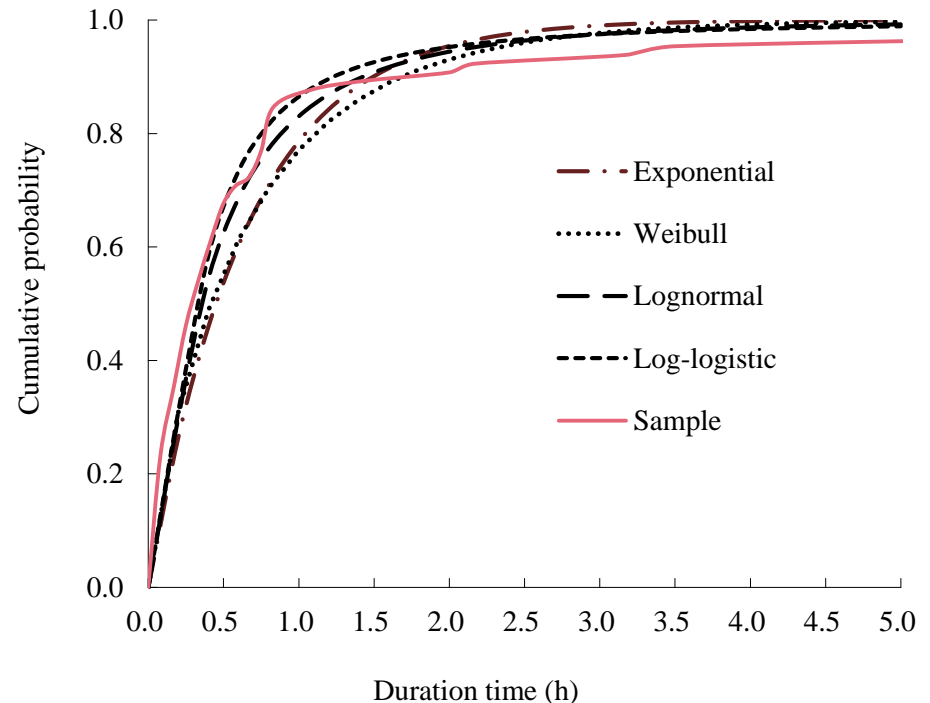


# Distribution & Factors of Fog Duration (3/3)

- The log-logistic model provides the best description of fog duration with covariates.

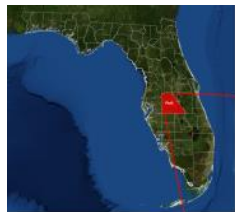


Cumulative distribution of fog duration time without covariates

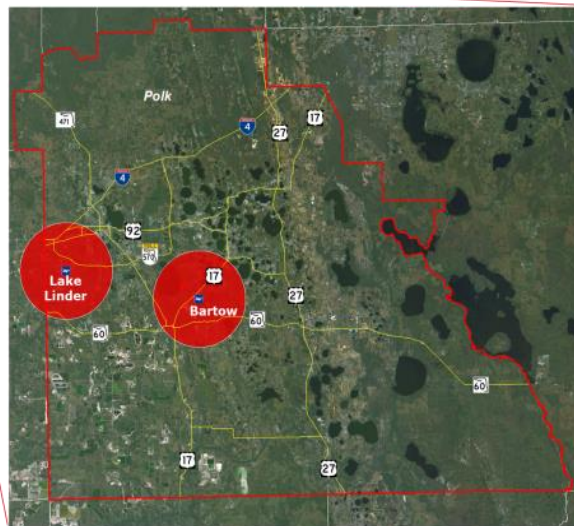


Cumulative distribution of fog duration time with covariates

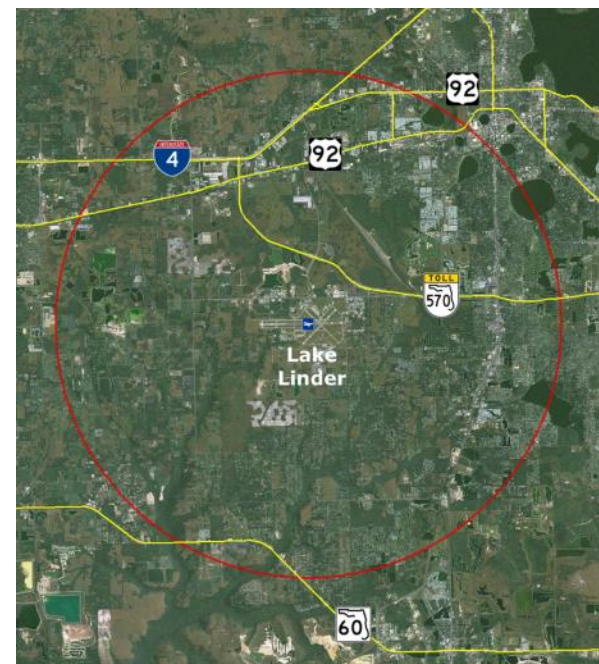
# Relationship Between Traffic Flows & Visibility Using RITIS & Airport Data (1/4)



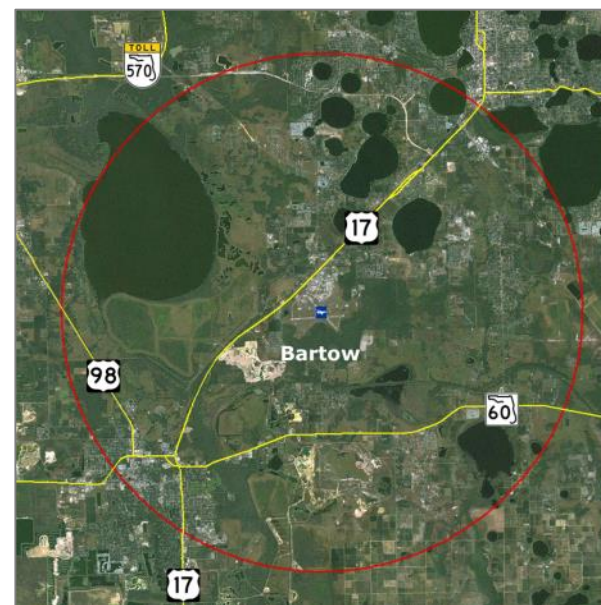
## Polk County



- Weather data were collected from two airports in Polk County.

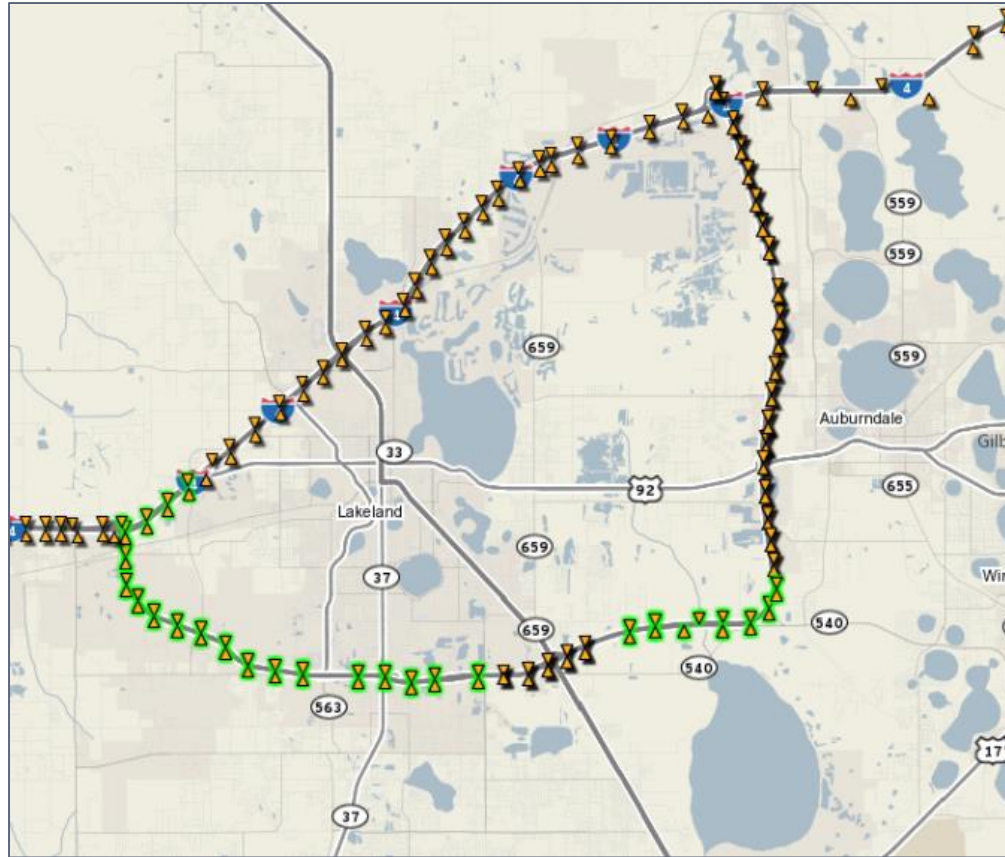


**Lake Linder Airport**



**Bartow Airport**

# Relationship Between Traffic Flows & Visibility Using RITIS & Airport Data (2/4)



- Traffic data were obtained from RITIS (Regional Integrated Transportation Information System).
- There are 60 traffic sensors nearby the two airports in Polk County.
- Traffic and weather data were combined using date/time.

# Relationship Between Traffic Flows & Visibility Using RITIS & Airport Data (3/4)

- Matched case control logistic regression model
  - It can control the effect of other factors (location, time period, geometric design, etc.) and we could focus only on the relationship between traffic flow variables and visibility conditions.
- Response variable: visibility levels
  - 0: good visibility (more than 1 mile)
  - 1: moderate visibility (between 0.25 and 1 mile)
  - 2: low visibility (less than 0.25 mile)



# Relationship Between Traffic Flows & Visibility Using RITIS & Airport Data (4/4)

- Matched case control logistic regression modeling results indicated that higher variance of speed, headway, variance of headway, occupancy, and lower speed can be key precursors of reduced visibility conditions.

Parameter	Parameter Estimate	Standard Error	Chi-Square	Pr > ChiSq	Hazard Ratio
Speed	-0.03857	0.01075	12.8625	0.0003	0.962
SD of Speed	0.02152	0.00602	12.7908	0.0003	1.021
Headway	0.03039	0.00497	37.4117	<.0001	1.031
SD of Headway	0.30653	0.07281	17.7224	<.0001	1.359
Avg Occ	0.00594	0.00374	2.5189	0.1125	1.006

# Summary & Conclusion (1/2)

- Fog is more likely to form when the values of humidity and subsurface moisture are higher, the wind speed is lower and the air temperature is more close to the dew point.
- Mean headway and headway variation are significantly higher while the mean speed and volume are significantly lower in fog case.
- The mean and standard deviation of headway and standard deviation of speed increase while the mean speed decrease when the visibility drops.

# Summary & Conclusion (2/2)

- The log-logistic model revealed that the increase of humidity, barometric pressure, and subsurface moisture increase the fog duration time. Meanwhile, the increase of wind speed and solar radiation decrease the fog duration time.
- Matched case control logistic regression modeling results indicated that higher variance of speed, headway, variance of headway, occupancy, and lower speed can be key precursors of reduced visibility conditions.



# Follow-up Research Topics

- Improving the fog detection algorithm to develop a more accurate model to describe the relationship between weather parameters and visibility and to predict the fog formation.
- Applying other statistical methods to further explore the relationship between reduced visibility and traffic flow characteristics.
- Comparing the effect of fog with other weather types such as rain or smoke on traffic flow characteristics.
- Investigating the effect of reduced visibility on traffic crashes.
- Expanding the analysis to the whole state to get a more comprehensive and generalized results.