



I-95 Corridor Coalition

I-95 Corridor Coalition Vehicle
Probe Project: Validation of
INRIX Data
Monthly Report
North Carolina



June 2010

I-95 CORRIDOR COALITION VEHICLE PROBE PROJECT: VALIDATION OF INRIX DATA JUNE 2010

Monthly Report

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June 2010

Evaluation Results for the State of North Carolina

Executive Summary

Travel time samples were collected in North Carolina for two weeks from Tuesday, March 23, 2010 through Wednesday, April 7, 2010 and compared with travel time and speed data reported by INRIX as part of the I-95 Vehicle Probe project. The validation data represents approximately 1510 hours of observations along nine freeway TMC segments, totaling approximately 13 miles. In addition, a 5.6 mile long steep freeway segment in the mountainous parts of Interstate 40 was selected for analysis to investigate reports of unusual data in this area. The results of this analysis are noted separately.

ES Table 1, below summarizes the results of the comparison between the validation data and the INRIX data for freeway segments, not including the mountainous segment, for the same period. As shown, both the average absolute speed error and speed error bias were within specification for all speed bins. Even when errors are measured as a distance from the mean, INRIX data quality is deemed as satisfactory based on the same requirements.

State	Absolute Speed Error (<10mph)		Speed Error Bias (<5mph)		Number of 5 Minute Samples	Hours of Data Collection
	Comparison with SEM Band	Comparison with Mean	Comparison with SEM Band	Comparison with Mean		
0-30 MPH	3.40	4.60	1.80	2.10	456	38.0
30-45 MPH	6.40	8.80	2.90	3.90	204	17.0
45-60 MPH	3.10	6.20	1.30	3.50	701	58.4
> 60 MPH	1.80	3.90	-1.30	-2.40	16768	1397.3
All Speeds	1.94	4.06	-1.07	-1.99	18129	1510.8

Based upon data collected from Mar 23, 2010 through April 2, 2010 across 13.0 miles of roadway.

As part of the on-going validation process, vehicle probe data from each state is validated on a rotating basis. Since the inception of the validation process, data on roadways in the State of North Carolina were validated on three occasions: October 2008, July 2009, and March 2010. This represents more than 2720 hours of observations along nearly 98 miles of freeway segments in North Carolina. ES Table 2 provides a summary of the cumulative validation effort. As shown, both the absolute average speed error and speed error bias were within specification for all speed bins.

ES Table 2 - North Carolina - Cumulative to Date						
State	Absolute Speed Error (<10mph)		Speed Error Bias (<5mph)		Number of 5 Minute Samples	Hours of Data Collection
	Comparison with SEM Band	Comparison with Mean	Comparison with SEM Band	Comparison with Mean		
0-30 MPH	3.98	4.99	2.27	2.50	763	63.6
30-45 MPH	8.14	10.23	0.93	1.48	439	36.6
45-60 MPH	3.63	6.65	0.97	2.84	1290	107.5
> 60 MPH	2.22	4.67	-1.86	-3.49	30181	2515.1
All Speeds	2.40	4.83	-1.61	-3.03	27954	2722.8

As mentioned, travel time samples were also collected along a 5.6 mile long steep freeway segment in a mountainous part of Interstate 40 in response to reports from users of suspect data. The results of the test indicated a large negative bias of 11.4 mph in the highest speed bin. Upon closer observation of the data, it was apparent that the data feed consistently reported speeds of 40 to 50 mph consistent with large trucks climbing a steep grade, whereas the Bluetooth validation data revealed a bimodal distribution, with the majority of traffic traveling at or near the speed limit, and a small portion traveling at lower speed. It was inferred that along these steep grades passenger vehicles can sustain higher speeds, while the truck traffic consistently travel at an average speed of approximately 45 mph. Based on that inference, INRIX data may be biased toward the speed of the heavier vehicles, though the majority of traffic (that is the passenger vehicles) can maintain speeds at or near the speed limit, thus the larger negative bias in the upper speed bin.

Data Collection

Bluetooth sensor deployments in North Carolina started on Tuesday, March 23, 2010. The actual deployments in North Carolina were performed with the assistance of North Carolina Department of Transportation (NCDOT) personnel. Sensors remained in the same position until they were retrieved two weeks later on Wednesday, April 7, 2010. This round of data collections in North Carolina was designed to cover segments of the highways along which both recurrent and non-recurrent congestions could be expected during both peak and off-peak periods.

Figure 1 presents snapshots of the roadway segments over which Bluetooth sensors were deployed in North Carolina.

Table 1 presents a list of specific TMC segments that were selected as the validation sample in North Carolina. In total, results of validation on nine freeway TMC segments are reported in this document. These segments cover a total length of approximately 13 miles. In addition, a 5.6 mile long steep freeway segment in a mountainous part of Interstate 40 was selected to study the potential effects of crawling heavy trucks in the validation process. Results obtained for this segment are reported separately at the end of this document. The coordinates of the locations at which the Bluetooth sensors were deployed

throughout the state of North Carolina are reported in Table 2 which also presents the distances that have been used in the estimation of Bluetooth speeds based on travel times.

Analysis of Results

Table 3 summarizes the data quality measures obtained as a result of comparison between Bluetooth and all reported INRIX speeds. In all speed bins, INRIX data meets the data quality measures set forth in the contract when errors are measured as a distance from the 1.96 times the standard error band. It should be noted that while the total number of observations in the low speed bins across all TMC segments are reasonable, as Table 3 indicates, the number of observations in low speed bins for some of the individual TMC segments are low.

Table 4 shows the percentage of the time intervals that fall within 5 mph of the SEM band and the mean for each speed bin for all TMC segments in North Carolina. Tables 5 and 6 present detailed data for individual TMC segments in North Carolina in similar format as Tables 3 and 4 respectively. Note that for some TMC segments in some speed bins the comparison results may not be reliable due to small number of observations.

Figures 2 and 3 show the overall speed error bias for different speed bins, and the average absolute speed errors for all segments in North Carolina, respectively. These figures correspond to Table 3.

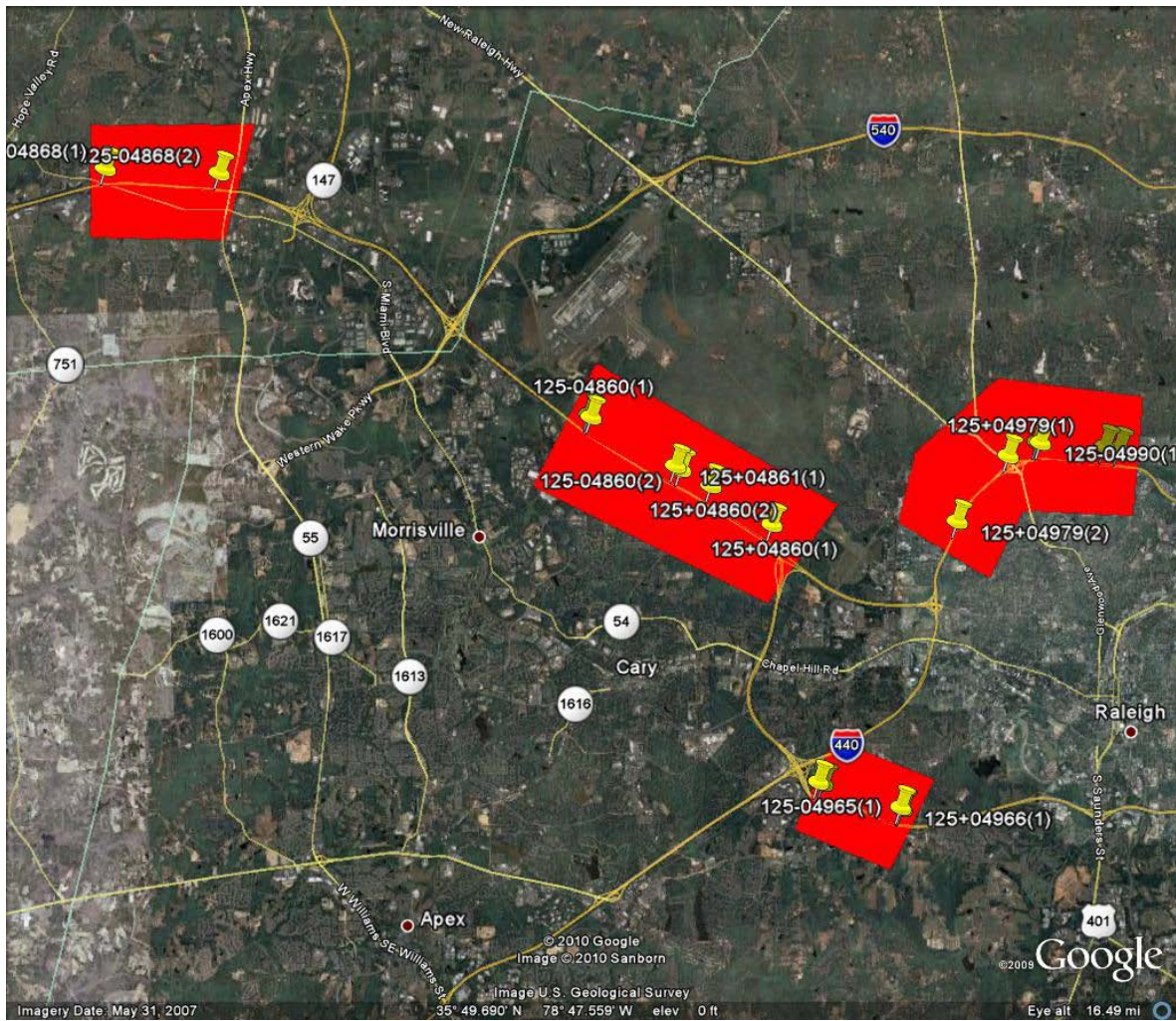


Figure 1
TMC segments selected for validation in North Carolina



Figure 1 (Cont'd)
TMC segments selected for validation in North Carolina

Table 1
Traffic Message Channel segments picked for validation in North Carolina

TYPE	TMC	HIGHWAY	STARTING AT	ENDING AT	COUNTY	DIRECTION	LENGTH (mile)
Freeway	125+04966	I-440/I-40	GORMAN ST/EXIT 295	US-64/US-1/EXIT 293	WAKE	WESTBOUND	1.3
Freeway	125+04860	I-40	I-40	HARRISON AVE/EXIT 287	WAKE	WESTBOUND	1.2
Freeway	125+04861	I-40	HARRISON AVE/EXIT 287	AVIATION PKWY/EXIT 285	WAKE	WESTBOUND	1.6
Freeway	125-04965	I-440/I-40	US-64/US-1/EXIT 293	GORMAN ST/EXIT 295	WAKE	EASTBOUND	1.4
Freeway	125-04860	I-40	AVIATION PKWY/EXIT 285	HARRISON AVE/EXIT 287	WAKE	EASTBOUND	1.7
Freeway	125-04868	I-40	FAYETTEVILLE RD/EXIT 276	NC-55/EXIT 278	DURHAM	EASTBOUND	1.9
Freeway	125+04979	I-440	US-70/NC-50/GLENWOOD AVE/EXIT 7	LAKE BOONE TRL/EXIT 5	WAKE	SOUTHBOUND	1.4
Freeway	125+04991	I-440	SIX FORKS RD/EXIT 8	US-70/NC-50/GLENWOOD AVE/EXIT 7	WAKE	WESTBOUND	1.1
Freeway	125-04990	I-440	US-70/NC-50/GLENWOOD AVE/EXIT 7	SIX FORKS RD/EXIT 8	WAKE	EASTBOUND	1.3
Freeway	125-05308	I-40		NC-2531/DUNSMORE AVE/EXIT 66	BUNCOMBE	WESTBOUND	5.6
TOTAL							18.5

Table 2
TMC segment lengths and distances between sensor deployment locations in the state of North Carolina

SEGMENT TYPE	TMC	STANDARD TMC					SENSOR DEPLOYMENT					ERROR IN SEGMENT LENGTH (%)
		Endpoint (1)		Endpoint (2)		Length (mile)	Endpoint (1)		Endpoint (2)		Length (mile)	
		Lat	Long	Lat	Long		Lat	Long	Lat	Long		
Freeway	125+04966	35.752402	-78.707860	35.758660	-78.730188	1.34	35.752685	-78.707637	35.759772	-78.730763	1.43	6.5%
Freeway	125+04860	35.819971	-78.742267	35.829601	-78.759534	1.17	35.820287	-78.742722	35.829863	-78.759418	1.14	-2.5%
Freeway	125+04861	35.834566	-78.769609	35.847343	-78.794146	1.63	35.834315	-78.768602	35.848132	-78.795242	1.77	8.5%
Freeway	125-04965	35.759067	-78.731419	35.752046	-78.707501	1.45	35.758715	-78.730805	35.752090	-78.707465	1.41	-2.7%
Freeway	125-04860	35.846769	-78.793589	35.833688	-78.768109	1.69	35.845912	-78.792632	35.833010	-78.768148	1.63	-3.3%
Freeway	125-04868	35.909190	-78.932065	35.907177	-78.899010	1.86	35.909100	-78.932390	35.907187	-78.900003	1.82	-1.8%
Freeway	125+04979	35.834104	-78.672996	35.819126	-78.688505	1.38	35.833992	-78.673397	35.818200	-78.689405	1.44	4.3%
Freeway	125+04991	35.835421	-78.644850	35.837032	-78.664369	1.10	35.835495	-78.644115	35.836877	-78.665617	1.21	10.3%
Freeway	125-04990	35.836913	-78.663522	35.834767	-78.640787	1.28	35.836710	-78.664060	35.834750	-78.641172	1.30	1.1%
Freeway	125-05308	35.623779	-82.196948	35.619301	-82.284038	5.55	35.623713	-82.194918	35.619413	-82.283315	5.62	1.3%
						18.46						18.78

Table 3
Data quality measures for freeway segments greater than one mile in North Carolina

SPEED BIN	Data Quality Measures for				No. of Obs.
	1.96 SE Band		Mean		
	Speed Error Bias	Average Absolute Speed Error	Speed Error Bias	Average Absolute Speed Error	
0-30	1.8	3.4	2.1	4.6	456
30-45	2.9	6.4	3.9	8.8	204
45-60	1.3	3.1	3.5	6.2	701
60+	-1.3	1.8	-2.4	3.9	16768

Table 4
Percent observations meeting data quality criteria for freeway segments greater than one mile in North Carolina

SPEED BIN	Data Quality Measures for				No. of Obs.
	1.96 SE Band		Mean		
	Percentage falling inside the band	Percentage falling within 5 mph of the band	Percentage equal to the mean	Percentage within 5 mph of the mean	
0-30	24%	80%	0%	74%	456
30-45	17%	55%	0%	43%	204
45-60	26%	77%	0%	43%	701
60+	44%	89%	0%	72%	16768

Table 5
Data quality measures for individual freeway segments greater than one mile in the
state of North Carolina

TMC	Standard TMC length	Bluetooth distance	SPEED BIN	Data Quality Measures for				No. of Obs.
				1.96 SE Band		Mean		
				Speed Error Bias	Average Absolute Speed Error	Speed Error Bias	Average Absolute Speed Error	
125+04860	1.18	1.14	0-30	3.3	5.7	3.9	7.5	40
			30-45	1.3	11.2	1.5	13.8	14*
			45-60	1.3	3.3	2.4	5.2	128
			60+	0.0	1.3	0.3	3.0	1758
125+04861	1.77	1.77	0-30	2.0	2.0	2.9	3.3	2*
			30-45	3.6	7.5	6.2	10.6	12*
			45-60	0.5	2.2	3.3	5.7	12*
			60+	-1.1	1.4	-2.1	3.1	2075
125+04966	1.55	1.43	0-30	1.1	2.3	1.4	3.6	171
			30-45	5.5	7.0	7.9	11.1	51
			45-60	2.8	3.9	5.5	7.3	207
			60+	0.0	1.4	0.2	3.3	1590
125+04979	1.46	1.44	0-30	7.1	7.7	7.7	8.8	21*
			30-45	4.7	6.3	5.8	8.4	16*
			45-60	-0.4	2.5	0.5	5.4	88
			60+	-1.3	1.6	-2.5	3.7	1278
125+04991	1.30	1.21	0-30					
			30-45	13.7	13.7	19.1	19.1	3*
			45-60	1.4	2.0	4.0	5.3	122
			60+	0.1	0.8	0.2	3.0	1319
125-04860	1.73	1.63	0-30	1.4	3.2	1.6	4.3	203
			30-45	0.0	4.3	0.0	5.7	87
			45-60	-2.0	4.1	-0.2	7.8	48
			60+	-3.0	3.1	-5.3	5.8	1945
125-04868	1.86	1.82	0-30	6.2	7.2	6.4	7.7	6*
			30-45	7.5	8.2	8.0	9.2	11*
			45-60	1.3	4.5	2.3	6.4	19*
			60+	-1.9	2.1	-3.4	4.1	2588
125-04965	1.54	1.41	0-30	3.4	3.4	3.5	4.2	3*
			30-45	6.8	9.9	9.6	13.3	4*
			45-60	1.5	3.5	6.2	9.0	29*
			60+	-2.5	2.6	-4.5	5.0	2057
125-04990	1.44	1.30	0-30	2.7	5.7	2.9	6.5	10*
			30-45	5.0	8.7	5.5	10.6	6*
			45-60	1.8	1.9	4.0	4.5	48
			60+	-1.3	1.5	-2.6	3.5	2158

*Results in the specified row may not be reliable due to small number of observations

Table 6
Observations meeting data quality criteria for individual freeway segments greater than one mile in the state of North Carolina

TMC	SPEED BIN	Data Quality Measures for								No. of Obs.
		1.96 SE Band				Mean				
		Speed Error Bias		Average Absolute Speed Error		Speed Error Bias		Average Absolute Speed Error		
		No. falling inside the band	% falling inside the band	No. falling within 5 mph of the band	% falling within 5 mph of the band	No. equal to the mean	% equal to the mean	No. within 5 mph of the mean	% within 5 mph of the mean	
125+04860	0-30	11	28%	27	68%	0	0%	24	60%	40
	30-45	0	0%	6	43%	0	0%	4	29%	14*
	45-60	22	17%	97	76%	0	0%	67	52%	128
	60+	899	51%	1680	96%	1	0%	1518	86%	1758
125+04861	0-30	1	50%	2	100%	0	0%	1	50%	2*
	30-45	1	8%	5	42%	0	0%	4	33%	12*
	45-60	4	33%	10	83%	0	0%	5	42%	12*
	60+	916	44%	1946	94%	0	0%	1658	80%	2075
125+04966	0-30	52	30%	150	88%	0	0%	133	78%	171
	30-45	14	27%	24	47%	0	0%	15	29%	51
	45-60	35	17%	140	68%	0	0%	58	28%	207
	60+	826	52%	1479	93%	2	0%	1290	81%	1590
125+04979	0-30	4	19%	8	38%	0	0%	8	38%	21*
	30-45	3	19%	10	63%	0	0%	5	31%	16*
	45-60	30	34%	70	80%	0	0%	49	56%	88
	60+	629	49%	1161	91%	6	0%	931	73%	1278
125+04991	0-30									
	30-45	0	0%	1	33%	0	0%	0	0%	3*
	45-60	39	32%	112	92%	0	0%	64	52%	122
	60+	872	66%	1267	96%	1	0%	1085	82%	1319
125-04860	0-30	35	17%	168	83%	0	0%	160	79%	203
	30-45	15	17%	57	66%	0	0%	51	59%	87
	45-60	18	38%	33	69%	0	0%	15	31%	48
	60+	655	34%	1495	77%	0	0%	976	50%	1945
125-04868	0-30	0	0%	3	50%	0	0%	3	50%	6*
	30-45	1	9%	5	45%	0	0%	5	45%	11*
	45-60	2	11%	12	63%	0	0%	6	32%	19*
	60+	914	35%	2259	87%	2	0%	1715	66%	2588
125-04965	0-30	1	33%	2	67%	0	0%	2	67%	3*
	30-45	0	0%	1	25%	0	0%	1	25%	4*
	45-60	7	24%	22	76%	0	0%	5	17%	29*
	60+	726	35%	1729	84%	0	0%	1242	60%	2057
125-04990	0-30	5	50%	7	70%	0	0%	7	70%	10*
	30-45	0	0%	3	50%	0	0%	2	33%	6*
	45-60	22	46%	41	85%	0	0%	33	69%	48
	60+	937	43%	1989	92%	4	0%	1615	75%	2158

*Results in the specified row may not be reliable due to small number of observations

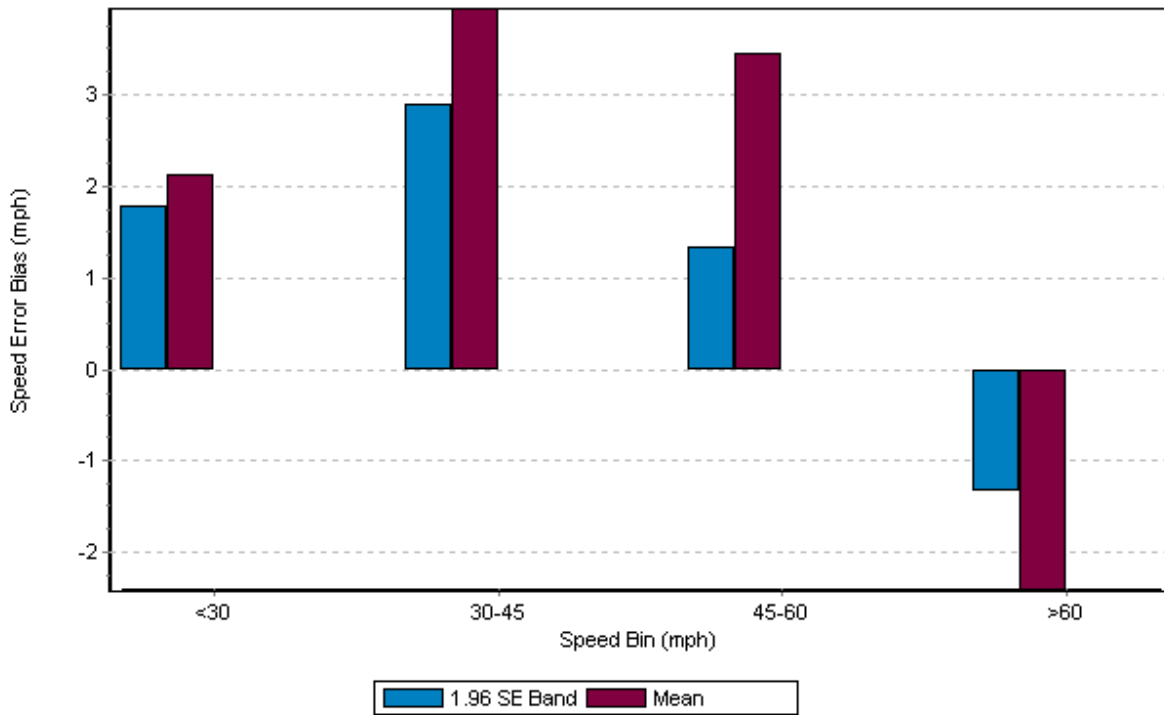


Figure 2
Speed error bias for freeway segments greater than one mile in North Carolina

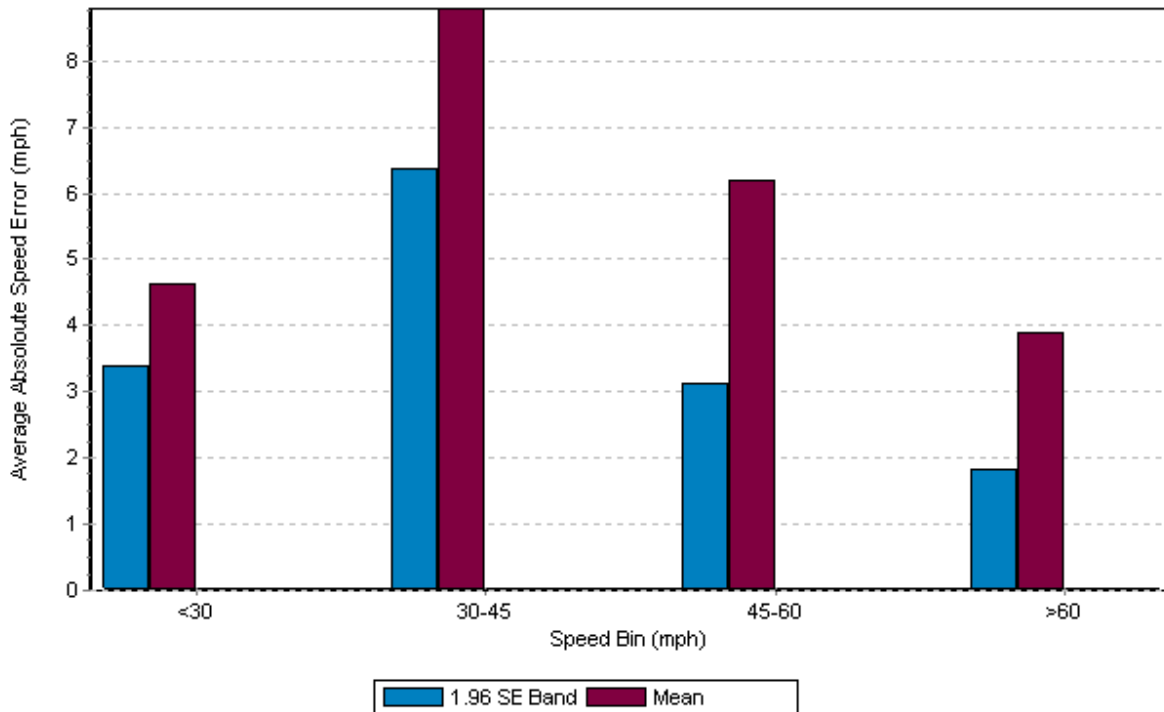


Figure 3
Average absolute speed error for freeway segments greater than one mile in North Carolina

Analysis of Results for a Steep Segment

Table 7 summarizes the data quality measures obtained as a result of comparison between Bluetooth and all reported INRIX speeds on the single steep freeway segment (125-05308) considered in this round of validation. In the two middle speed bins (between 30 mph and 60mph), INRIX data meets the data quality measures when errors are measured as a distance from the 1.96 times the standard error band. In addition, no observation is made in the speed bin below 30mph. However, in the highest speed bin (above 60 mph) reported INRIX data fail to pass the data quality measures.

Table 8 shows the percentage of the time intervals that fall within 5 mph of the SEM band and the mean for each speed bin for this freeway segment in North Carolina. Note that in some speed bins the comparison results may not be reliable due to small number of observations.

Figures 4 and 5 show the overall speed error biases for different speed bins, and the average absolute speed errors for this particular freeway segment, respectively. These figures correspond to Table 7.

Table 7
Data quality measures for single steep freeway segment in the state of North Carolina

TMC	Standard TMC length	Bluetooth distance	SPEED BIN	Data Quality Measures for				No. of Obs.
				1.96 SE Band		Mean		
				Speed Error Bias	Average Absolute Speed Error	Speed Error Bias	Average Absolute Speed Error	
125-05308	5.70	5.62	0-30					
			30-45	1.3	1.3	5.4	7.0	24*
			45-60	-4.1	4.4	-7.4	9.1	231
			60+	-11.4	11.4	-14.6	14.7	93

*Results in the specified row may not be reliable due to small number of observations

Table 8
Observations meeting data quality criteria for single steep freeway segment in the state of North Carolina

TMC	SPEED BIN	Data Quality Measures for								No. of Obs.
		1.96 SE Band				Mean				
		Speed Error Bias		Average Absolute Speed Error		Speed Error Bias		Average Absolute Speed Error		
		No. falling inside the band	% falling inside the band	No. falling within 5 mph of the band	% falling within 5 mph of the band	No. equal to the mean	% equal to the mean	No. within 5 mph of the mean	% within 5 mph of the mean	
125-05308	0-30									
	30-45	20	83%	22	92%	0	0%	12	50%	24*
	45-60	100	43%	138	60%	0	0%	69	30%	231
	60+	8	9%	20	22%	0	0%	10	11%	93

*Results in the specified row may not be reliable due to small number of observations

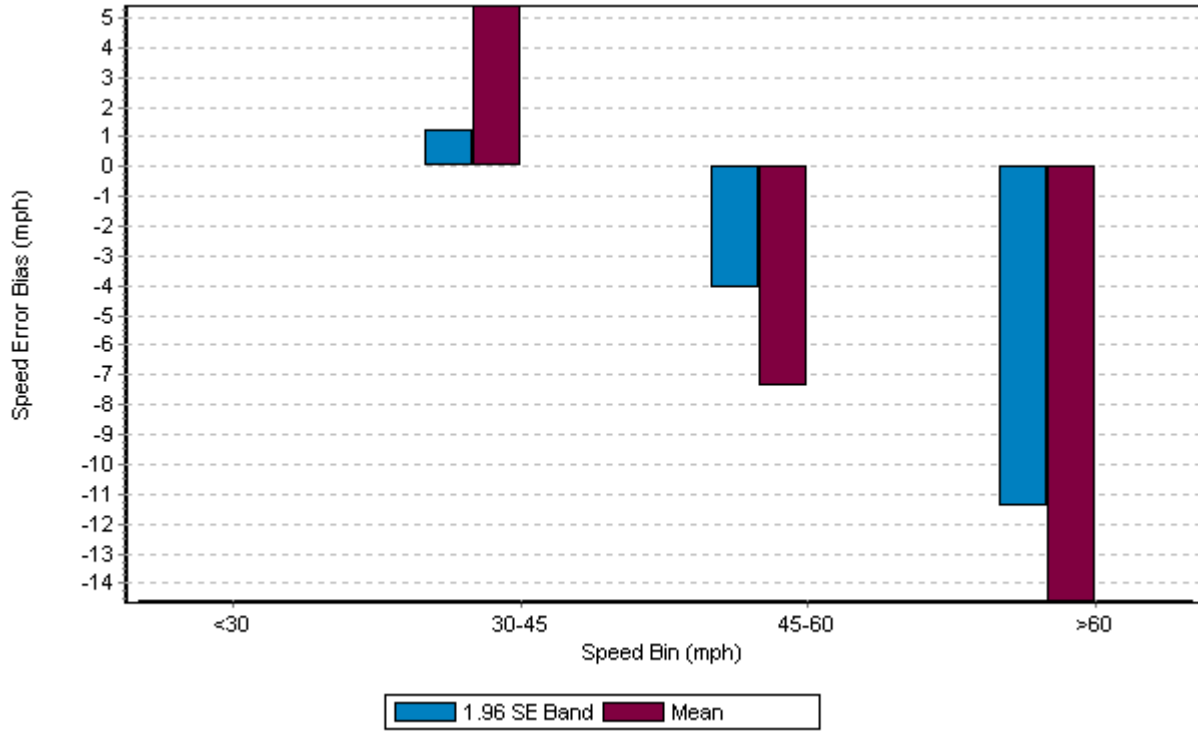


Figure 4
Speed error bias for single steep freeway segment in North Carolina

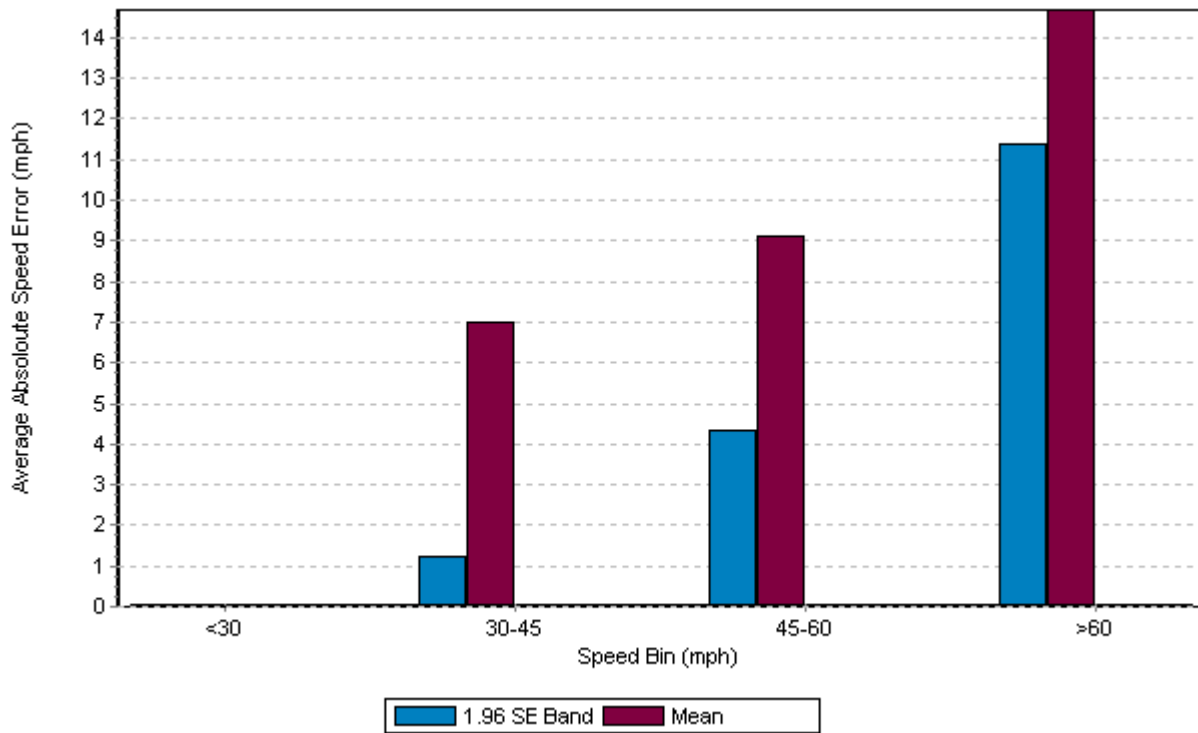


Figure 5
Average absolute speed error for single steep freeway segment in North Carolina