

Comparison of HERE Travel Speeds with Bluetooth and INRIX Speeds

presented by
Ashutosh Kumar

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Purposes



- Identify common auto travel speed ‘themes’ on the corridors where Bluetooth data was collected
- Is there a relationship between HERE, INRIX and Bluetooth auto speed data?
 - If yes, can we utilize HERE or INRIX for corridor planning studies instead of collecting Bluetooth or Floating car speed data?
- What are the free flow and congested speeds in these corridors?
 - How do they compare against the local travel demand model speeds?
 - Is there a need to update model’s free flow speeds? How will it impact model’s congested speeds?

Background



- Bluetooth Data
 - Collected by FDOT D4 prior to the commencement of planning studies
 - 15-minute interval speed data along four corridors available (2012 & 2013)
 - No data clean-up required [performed by the software]
- INRIX Data
 - Purchased by FDOT Central Office
 - 12-month period (2010-2011) 5-minute interval average speed data
 - No further data clean-up required
- HERE Data
 - October 2013 data acquired by FDOT D4 from FHWA
 - Formatting similar to INRIX but not processed for outliers -> clean-up required

Corridors



Corridors	Timeframe of Bluetooth Data Collection	Segment with Bluetooth Data	Segment Length (miles)	Number of Lanes*	Average Posted Speed (mph)	Average Daily Traffic Volume
SR-7 / US-441	October 2012	Golden Glades to Marina Boulevard	27.5	4LD-6LD (5.6LD Average)	45.1	49,000 (2009 AADT)
SR-817 / University Drive	November 2012	Golden Glades to Sawgrass Expressway	26.1	4LD-6LD (5.8LD Average)	45.0	50,000 (2011 AADT)
SR-820 / Hollywood/Pines Boulevard	Sept-Nov 2013	US-27 to A1A	19.4	4LD-6LD (5.7LD Average)	41.0	38,000 (2012 AADT)
SR-5 / US-1	Sept-Nov 2013	Aventura Mall to Broward Boulevard	11.4	4LD-6LD (5.1LD Average)	39.3	40,000 (2012 AADT)

*with few exceptions

These corridors were selected because all three data sources were available.



Methodology

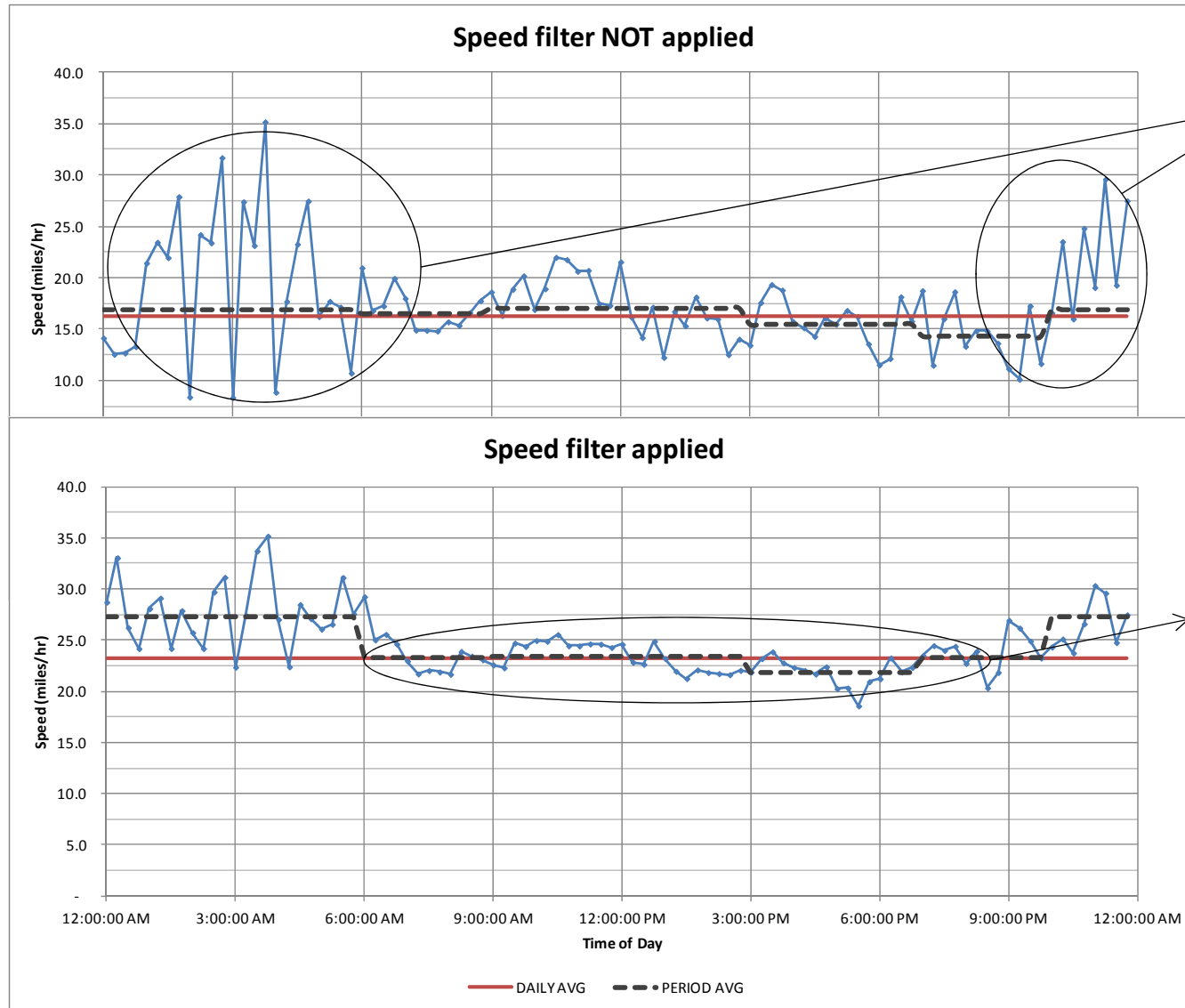


- Used Tuesdays, Wednesdays and Thursdays data
- Five time periods used for analysis
 - AM Peak (6AM – 9AM), Midday (9AM – 3PM), PM Peak (3PM – 7PM), Evening (7PM – 10PM) and Night (10PM – 6AM)
- Speed data of ‘all vehicles’ is summarized by direction, by period, by segment for four corridors in Broward County
 - Average Speed (*period, segment*) = $\frac{\text{Sum of all TMC distances (period, segment)}}{\text{Sum of all travel times (period, segment)}}$
- 66 data points per period from each source
- HERE data filter - removed data with speeds ≤ 5 mph and ≥ 60 mph (cliffs based on data mining)

HERE Data Speed Filtering – Example



Plots for all Hollywood EB TMCs at every 15 min interval



Very high variability in speeds

Smoother curve during AM, MD and PM periods

HERE Data Filtering – Why Necessary?



- Very high fluctuation in Evening and Night speeds compared to the day time speeds
- Speed variations are not specific to one TMC
- Abnormal observations ('noise') found on TMCs where speed at a given time (t) is very low compared to:
 - Speeds on the same TMC at t+5 and t-5 minutes
 - Speeds on adjacent TMCs at the same time (t)
- Little to no diurnal variations in speed
- Similar conclusions from both Hollywood and SR-7 corridor data
- Speed filtering removes the variations and abnormal observations in the data

Key Findings from Data Analysis

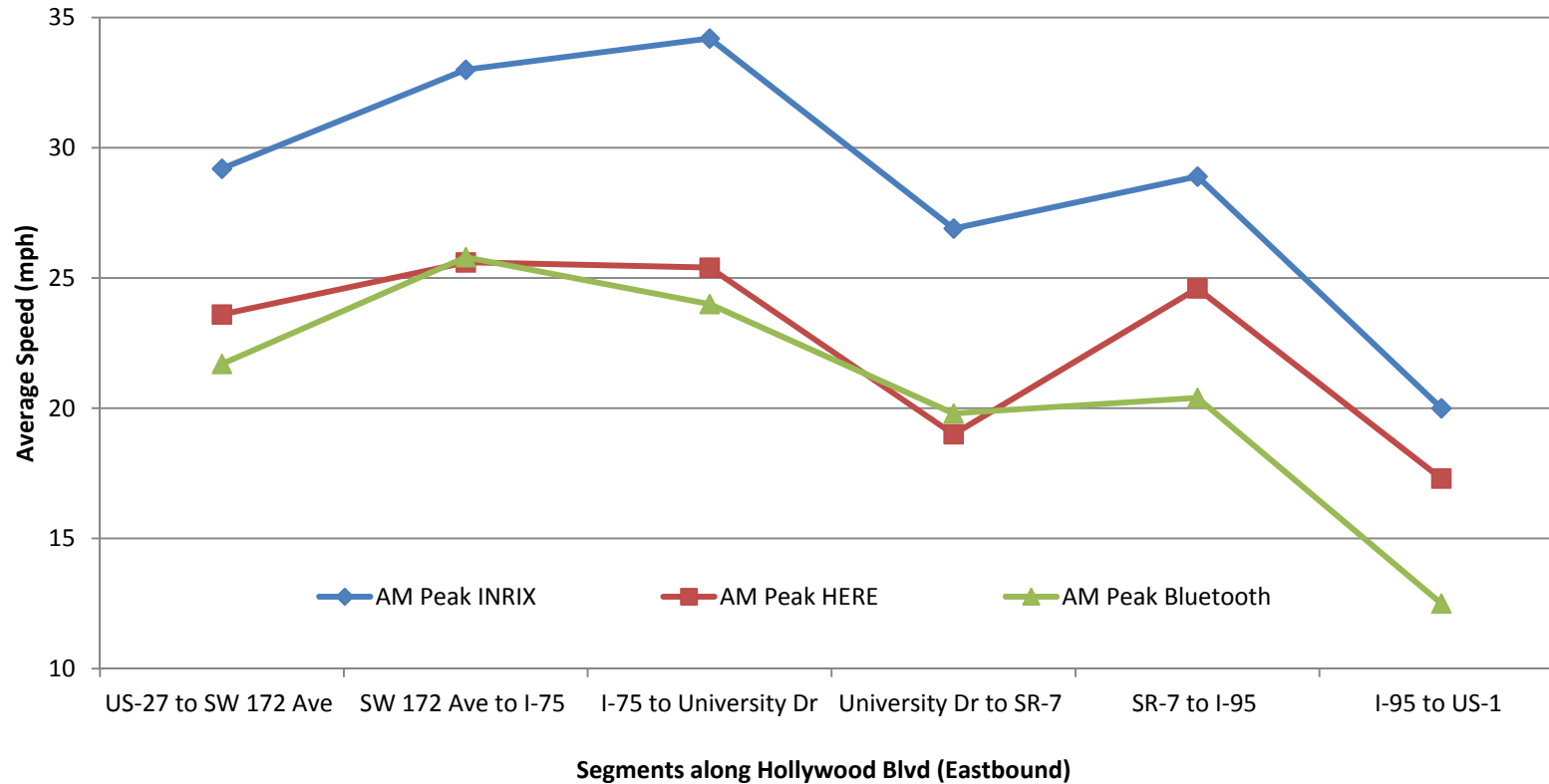


- All three data sources estimate largely similar speed profiles both diurnally and along the roadway segments
- Bluetooth and HERE data sets estimate remarkably similar “average” time of day travel speeds, even at a segment-level
 - INRIX speed > HERE speed for almost all data points across all five time periods
- Bluetooth and HERE travel speeds are in general 5 to 10 miles per hour lower than INRIX speeds during the day
- Greater variation in the night/early morning travel speeds in the three data sets than the day speeds
- The travel speeds estimates from the local travel demand model are generally higher than all three data sources, especially for the mid-day period

Key Findings (1 of 5)



Average Speed for AM Peak (Hollywood Blvd Eastbound)



All three data sources estimate largely similar speed profiles both diurnally and along the roadway segments.

Key Findings (2 of 5)



Comparison	Stats	AM Peak	Mid-day	PM Peak	Evening	Night
INRIX vs. HERE	Mean Error (mph)	6.3	4.8	5.0	7.1	7.8
	Mean Percent Error	26%	20%	22%	29%	29%
	Mean Absolute Error (mph)	6.3	4.8	5.1	7.1	7.9
	Mean Percent Absolute Error	26%	20%	23%	29%	29%
	Root Mean Square Error (mph)	7.2	5.6	6.1	8.0	8.8
	Root Mean Square Percent Error	30%	22%	27%	34%	33%
Bluetooth vs. HERE	Mean Error (mph)	1.3	0.9	-0.2	3.6	4.9
	Mean Percent Error	5%	3%	-1%	15%	18%
	Mean Absolute Error (mph)	2.9	3.1	2.9	4.6	5.7
	Mean Percent Absolute Error	12%	13%	13%	19%	21%
	Root Mean Square Error (mph)	3.9	3.9	4.0	5.7	6.6
	Root Mean Square Percent Error	16%	16%	17%	24%	25%

Bluetooth and HERE data sets estimate remarkably similar “average” time of day travel speeds even at a segment-level.



Key Findings (3 of 5)



Comparison	Stats	AM Peak	Mid-day	PM Peak	Evening	Night
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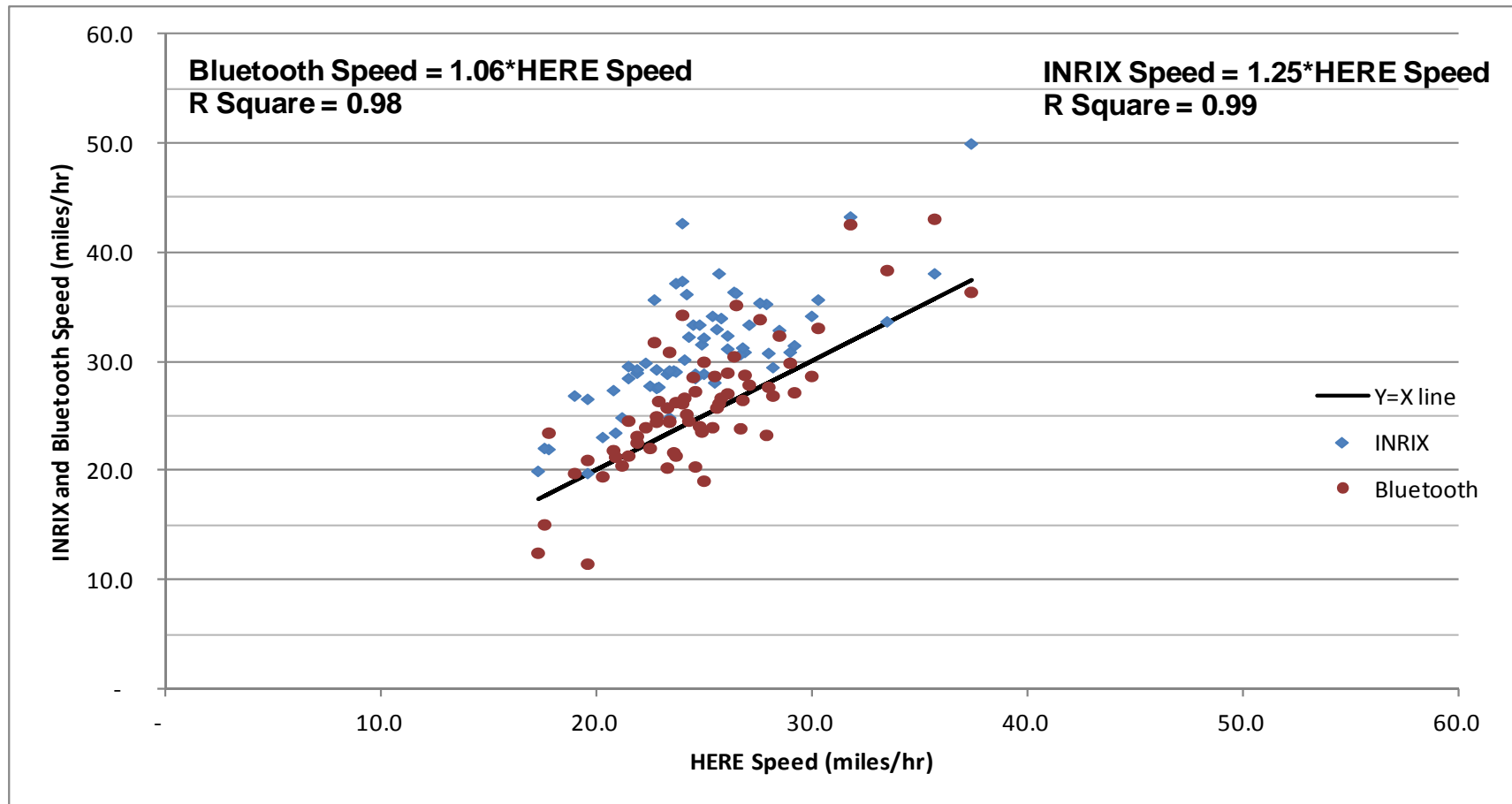
There is a greater variation in the night/early morning travel speeds in the three data sets than the day speeds.



Key Findings (4 of 5)



AM Peak



Bluetooth and HERE travel speeds are in general 5 to 10 miles per hour lower than INRIX speeds during the day.



Key Findings (5 of 5)



- Model free flow speeds on an average 10% faster than the observed Bluetooth speeds
- Model mid-day speeds similar to free flow speeds
 - Observed Bluetooth speeds are significantly slower
 - Difference of up to 15mph in certain segments (45% overall)
- Both AM and PM peak model auto speeds in faster than observed Bluetooth speeds
 - PM peak travel times on these corridors are severely under-estimated (average 30% overall)

The travel speeds estimates from the demand model were generally higher than all three data sources, especially for the mid-day period.



Common Corridor Themes



- The overall average travel speed during the day in the four corridors is 20-25 mph
 - Approximately half of the posted speed limits
 - **Mid-day is as congested as the AM peak**
 - Slowest travel speeds during the PM Peak
- Generally no peak direction of travel - both directions are equally congested -> function of the nature of the corridors selected
- Bluetooth free flow speeds (10 PM to 6 AM) are between 29-37 mph
 - Generally close to or lower than SERPM 6.7 (and 7) depending on the corridor

Recommendations



- For a planning study, if the HERE data is available for a corridor similar to the ones analyzed
 - No need to collect Bluetooth or floating car speed data
 - Filtering process necessary to remove the data noise
- Similar analysis necessary for other facility types when observed data becomes available
- Other potential usage of HERE data for planning and operational purposes should be explored further

Acknowledgments



- Scott Seeburger, FDOT District 4
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- Sujith Rapolu and Hongbo Chi, AECOM





TECHNICAL APPENDIX

Corridor End-to-End Speed Comparison

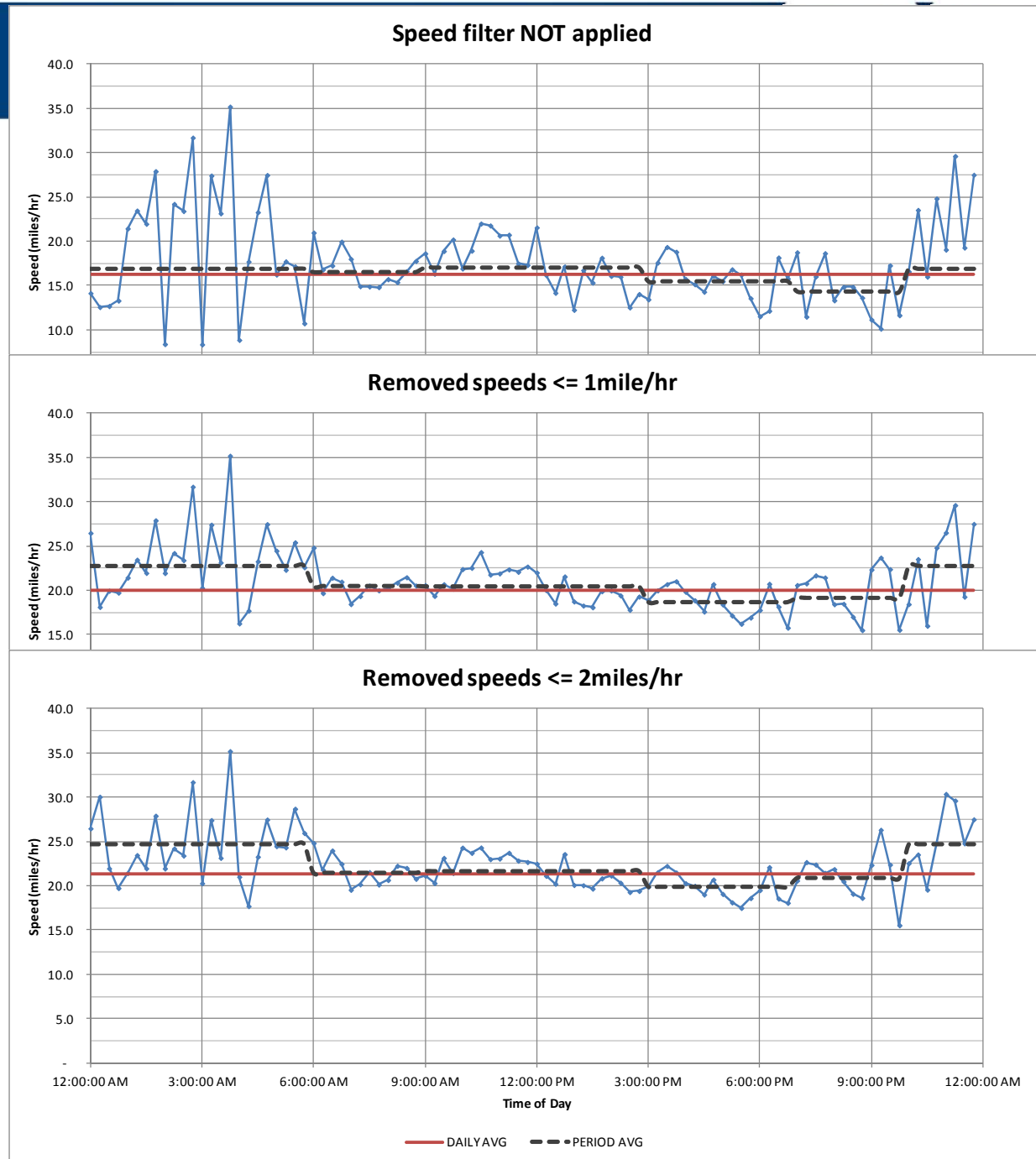


Time Period	Data Source	SR-7 Corridor		University Dr. Corridor		Hollywood Blvd. Corridor		US-1 Corridor	
		NB	SB	NB	SB	EB	WB	NB	SB
AM Peak	INRIX	28	30	30	31	29	29	29	29
	HERE	25	25	26	25	23	24	24	22
	Bluetooth	24	24	28	26	21	22	25	23
Mid-day	INRIX	27	29	28	30	26	27	27	28
	HERE	25	24	25	25	23	23	23	22
	Bluetooth	23	23	27	27	23	23	25	24
PM Peak	INRIX	32	27	31	29	26	27	27	28
	HERE	24	23	23	23	22	22	22	20
	Bluetooth	22	20	22	22	21	22	24	21
Evening	INRIX	35	32	36	32	30	30	30	30
	HERE	25	25	26	24	23	23	25	22
	Bluetooth	29	27	30	30	27	24	27	28
Night	INRIX	34	36	34	35	36	35	33	32
	HERE	28	27	28	28	27	27	28	25
	Bluetooth	30	32	35	36	30	28	32	35

Speeds in mph

HERE Data Filtering (1/3)

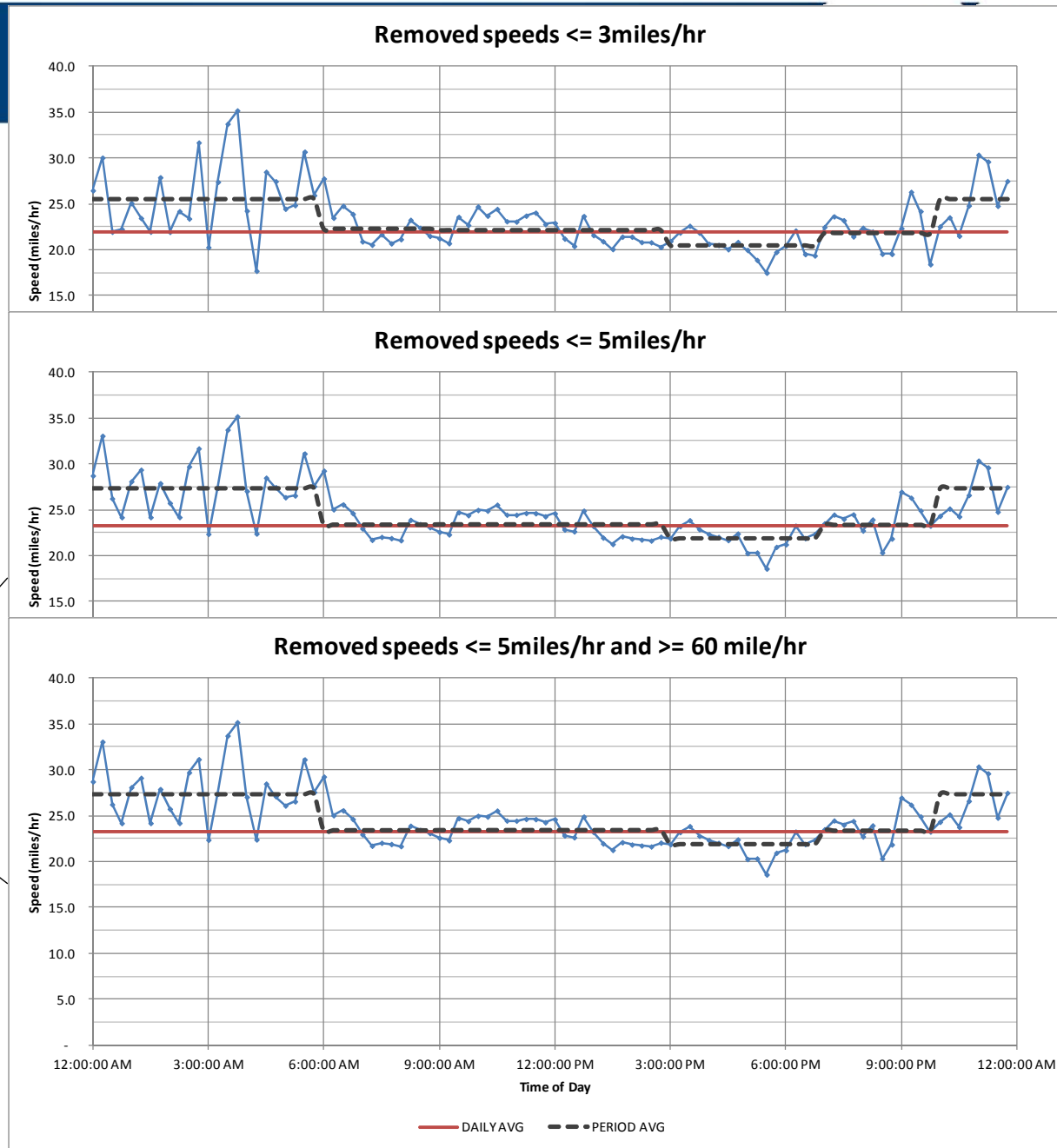
Plots for all Hollywood EB TMC's at every 15 min interval



HERE Data Filtering (2/3)

Plots for all Hollywood EB TMC's at every 15 min interval

Almost no difference after removing speeds ≥ 60 miles/hr





HERE Data Filtering (3/3)

Average speed by period after application of each filter
(based on plots on previous two slides)

Filter	AM Peak	Mid-day	PM Peak	Evening	Night
None	16.5	17.0	15.5	14.3	16.9
<= 1 mile/hr	20.5	20.5	18.7	19.2	22.8
<= 2 miles/hr	21.4	21.6	19.8	20.8	24.7
<= 3 miles/hr	22.3	22.1	20.5	21.8	25.5
<= 5 miles/hr	23.3	23.4	21.8	23.3	27.3
<= 5 miles/hr and >= 60 miles/hr	23.3	23.4	21.8	23.3	27.3