Using Archived Data in the Validation of Travel Time Predictions

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motion maps

Introduction

- Background
- AZTech™ Phase III Project for I-17 Test
- Measures of Travel Time
- Pro and Cons of Snap Shot versus After-the-Fact Travel Times
- Collection of Pre-project Data
- Initial Comparisons using the Pre-project Data
- Expected Project Results
- Conclusions

Background

- An increasing number of Traveler Information Systems show travel times
- Users interested in how long it will take to get to their destination – with reliability
- Users assume times shown are accurate
- TMCs need to show accurate travel times
- Project for AZTech™ to test approaches to have accurate, predicted travel times that will rely in part on using archived data

Predictive Travel Times for I-17

- Literature review and survey of approaches being used by other TMCs
- Field test using GPS probes to observe travel times and compare to values calculated from the archived data
- Develop/adapt algorithm to predict travel times for a 10-mile section of I-17
- Off-line testing of the algorithm
- Possible future posting on VMSs

Measures of Travel Time

- **Snap Shot:** (spot speed based) for a given time interval, spot speed at "point" detectors are converted to link travel time, then those times are aggregated for a route
- **Snap Shot:** (link speed based) for a given time interval, link speeds (from toll tags) are aggregated for a route
- **After-the-Fact:** archived data can be analyzed after-the-fact, from detector speeds, to calculate link travel times that are then aggregated to route travel time
- **Probe:** field measurement that tracks the past time to travel a route – when the floating car procedure is used, it best represents the average "actual travel time"
- **Predicted:** mathematical projection of the near-term future time to travel a route

Value and Shortcomings of Using Snap Shot Travel Times

Time Interval	Link Travel Times Starting at Detector 1	2	3	4	5	6	7	8	9	Snap Shot	After-the Fact	Delta ATF-SS
1	20	20	20	20	20	20	20	20	20	3.00		
2	20	20	20	20	20	20	20	20	20	3.00		
3	20	20	20	20	20	20	20	20	20	3.00		
4	20	20	20	20	20	20	20	20	20	3.00		
5	20	20	20	20	20	20	20	20	20	3.00		
6	20	20	20	20	20	20	20	20	20	3.00		
7	20	20	20	20	20	20	20	20	20	3.00		
8	20	20	20	20	20	20	20	20	20	3.00		
9	20	20	20	20	20	20	20	20	20	3.00	3.00	0.00
10	20	20	20	20	20	20	20	20	20	3.00	3.00	0.00
11	20	20	20	20	20	20	20	20	25	3.08	3.08	0.08
12	20	20	20	20	20	20	20	25	30	3.25	3.17	0.17
13	20	20	20	20	20	20	25	30	40	3.58	3.42	0.42
14	20	20	20	20	20	25	30	40	50	4.08	3.67	0.67
15	20	20	20	20	25	30	40	50	60	4.75	4.08	1.08
16	20	20	20	25	30	40	50	60	70	5.58	4.50	1.50
17	20	25	25	30	40	50	60	70	80	6.67	5.08	2.08
18	25	30	30	40	50	60	70	80	80	7.75	5.50	2.50
19	25	30	40	50	60	70	80	80	100	8.92	6.42	3.33
20	30	40	50	60	70	80	80	100	120	10.50	7.17	3.92
21	40	40	60	70	80	80	80	100	120	11.17	8.08	4.50
22	30	40	60	70	80	80	80	80	80	10.00	7.83	3.75
23	40	40	60	70	80	70	70	80	60	9.50	7.75	3.00
24	30	40	60	70	60	60	60	60	40	8.00	7.92	2.33
25	40	40	60	60	60	50	50	50	30	7.33	7.83	1.17
26	30	40	50	50	50	40	40	40	20	6.00	7.58	(0.17)
27	40	40	50	40	50	30	30	30	20	5.50	7.42	(1.50)
28	20	40	40	40	40	25	25	20	20	4.50	6.67	(3.83)
29	30	30	40	30	30	25	20	20	20	4.08	6.33	(4.83)
30	30	30	30	30	25	20	20	20	20	3.75	5.58	(4.42)
31	25	30	30	25	20	20	20	20	20	3.50	5.42	(4.08)
32	20	25	25	20	20	20	20	20	20	3.17	4.75	(3.25)
33	20	20	20	20	20	20	20	20	20	3.00	4.67	(2.67)
34	20	20	20	20	20	20	20	20	20	3.00	4.08	(1.92)

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6	20	20	20	20	20	20	20	20	20	3.00		
7	20	20	20	20	20	20	20	20	20	3.00		
8	20	20	20	20	20	20	20	20	20	3.00		
9	20	20	20	20	20	20	20	20	20	3.00	3.00	0.00
10	20	20	20	20	20	20	20	20	20	3.00	3.00	0.00
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12	20	20	20	20	20	20	20	25	30	3.25	3.17	0.17
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8	20	20	20	20	20	20	20	20	20	3.00		
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5	20	20	20	20	20	20	20	20	20	3.00		
6	20	20	20	20	20	20	20	20	20	3.00		
7	20	20	20	20	20	20	20	20	20	3.00		
8	20	20	20	20	20	20	20	20	20	3.00		
9	20	20	20	20	20	20	20	20	20	3.00	3.00	0.00
10	20	20	20	20	20	20	20	20	20	3.00	3.00	0.00
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- Expect to find that most if not all of the TMCs are using snap shot travel times (SS_TT)
- Under steady flow SS_TT is accurate
- Can calculate for the current time interval (do in "real time")
- SS_TT underestimates actual travel time as congestion is building --

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1	20	20	20	20	20	20	20	20	20	3.00		
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5	20	20	20	20	20	20	20	20	20	3.00		
6	20	20	20	20	20	20	20	20	20	3.00		
7	20	20	20	20	20	20	20	20	20	3.00		
8	20	20	20	20	20	20	20	20	20	3.00		
9	20	20	20	20	20	20	20	20	20	3.00	3.00	0.00
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14	20	20	20	20	20	25	30	40	50	4.08	3.67	0.67
15	20	20	20	20	25	30	40	50	60	4.75	4.08	1.08
16	20	20	20	25	30	40	50	60	70	5.58	4.50	1.50
17	20	25	25	30	40	50	60	70	80	6.67	5.08	2.08
18	25	30	30	40	50	60	70	80	80	7.75	5.50	2.50
19	25	30	40	50	60	70	80	80	100	8.92	6.42	3.33
20	30	40	50	60	70	80	80	100	120	10.50	7.17	3.92
21	40	40	60	70	80	80	80	100	120	11.17	8.08	4.50
22	30	40	60	70	80	80	80	80	80	10.00	7.83	3.75
23	40	40	60	70	80	70	70	80	60	9.50	7.75	3.00
24	30	40	60	70	60	60	60	60	40	8.00	7.92	2.33
25	40	40	60	60	60	50	50	50	30	7.33	7.83	1.17
26	30	40	50	50	50	40	40	40	20	6.00	7.58	(0.17)
27	40	40	50	40	50	30	30	30	20	5.50	7.42	(1.50)
28	20	40	40	40	40	25	25	20	20	4.50	6.67	(3.83)
29	30	30	40	30	30	25	20	20	20	4.08	6.33	(4.83)
30	30	30	30	30	25	20	20	20	20	3.75	5.58	(4.42)
31	25	30	30	25	20	20	20	20	20	3.50	5.42	(4.08)
32	20	25	25	20	20	20	20	20	20	3.17	4.75	(3.25)
33	20	20	20	20	20	20	20	20	20	3.00	4.67	(2.67)
34	20	20	20	20	20	20	20	20	20	3.00	4.08	(1.92)

- Expect to find that most if not all of the TMCs are using snap shot travel times (SS_TT)
- Under steady flow SS_TT is accurate
- Can calculate for the current time interval (do in "real time")
- SS_TT underestimates actual travel time as congestion is building – and overestimates it when congestion is waning
- Ironically, that is when travelers need more accurate information and providers want to give it

Value and Shortcomings of Using After-the-Fact Travel Times

- Expect to find that After-the-Fact (ATF_TT) travel times calculated from archived data compare well to the travel times from probe vehicles and thus are accurate estimates of actual travel time
- Thus ATF_TT can be used for expected normal travel time or in testing alternative predictions
- However, ATF_TT is too late to directly do any good for users

Time	Link Travel Times Starting at Detector									Snap	After-the	Delta
Interval	1	2	3	4	5	6	7	8	9	Shot	Fact	ATF-SS
1	20	20	20	20	20	20	20	20	20	3.00		
2	20	20	20	20	20	20	20	20	20	3.00		
3	20	20	20	20	20	20	20	20	20	3.00		
4	20	20	20	20	20	20	20	20	20	3.00		
5	20	20	20	20	20	20	20	20	20	3.00		
6	20	20	20	20	20	20	20	20	20	3.00		
7	20	20	20	20	20	20	20	20	20	3.00		
8	20	20	20	20	20	20	20	20	20	3.00		
9	20	20	20	20	20	20	20	20	20	3.00	3.00	
10	20	20	20	20	20	20	20	20	20	3.00	3.00	
11	20	20	20	20	20	20	20	20	25	3.08	3.08	0.08
12	20	20	20	20	20	20	20	25	30	3.25	3.17	0.17
13	20	20	20	20	20	20	25	30	40	3.58	3.42	0.42
14	20	20	20	20	20	25	30	40	50	4.08	3.67	0.67
15	20	20	20	20	25	30	40	50	60	4.75	4.08	1.08
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27	40	40	50	40	50	30	30	30	20	5.50	7.42	0.75
28	20	40	40	40	40	25	25	20	20	4.50	6.67	(1.08)
29	30	30	40	30	30	25	20	20	20	4.08	6.33	(2.58)
30	30	30	30	30	25	20	20	20	20	3.75	5.58	(4.92)
31	25	30	30	25	20	20	20	20	20	3.50	5.42	(5.75)
32	20	25	25	20	20	20	20	20	20	3.17	4.75	(5.25)
33	20	20	20	20	20	20	20	20	20	3.00	4.67	(4.83)
34	20	20	20	20	20	20	20	20	20	3.00	4.08	(3.92)

Value and Shortcomings of Using After-the-Fact Travel Times

- Expect to find that After-the-Fact (ATF_TT) travel times calculated from archived data compare well to the travel times from probe vehicles and thus are accurate estimates of actual travel time
- Thus ATF_TT can be used for expected normal travel time or in testing alternative predictions
- However, ATF_TT is too late to directly do any good for users
- But, predictive travel times are really what users want and the providers need to estimate

Time	Link Travel Times Starting at Detector									Snap	After-the	Delta
Interval	1	2	3	4	5	6	7	8	9	Shot	Fact	ATF-SS
1	20	20	20	20	20	20	20	20	20	3.00		
2	20	20	20	20	20	20	20	20	20	3.00		
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4	20	20	20	20	20	20	20	20	20	3.00		
5	20	20	20	20	20	20	20	20	20	3.00		
6	20	20	20	20	20	20	20	20	20	3.00		
7	20	20	20	20	20	20	20	20	20	3.00		
8	20	20	20	20	20	20	20	20	20	3.00		
9	20	20	20	20	20	20	20	20	20	3.00	3.00	
10	20	20	20	20	20	20	20	20	20	3.00	3.00	
11	20	20	20	20	20	20	20	20	25	3.08	3.08	0.08
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Pre-project Data Collection

- Samples of pre-project data collected in Oct'01 and Jan and Feb'02
- GPS probe runs and 20 second interval archived data from the ADOT Freeway Management System (FMS) detectors
- About a 10-mile I-17 from about Peoria Ave. to about Grant St.

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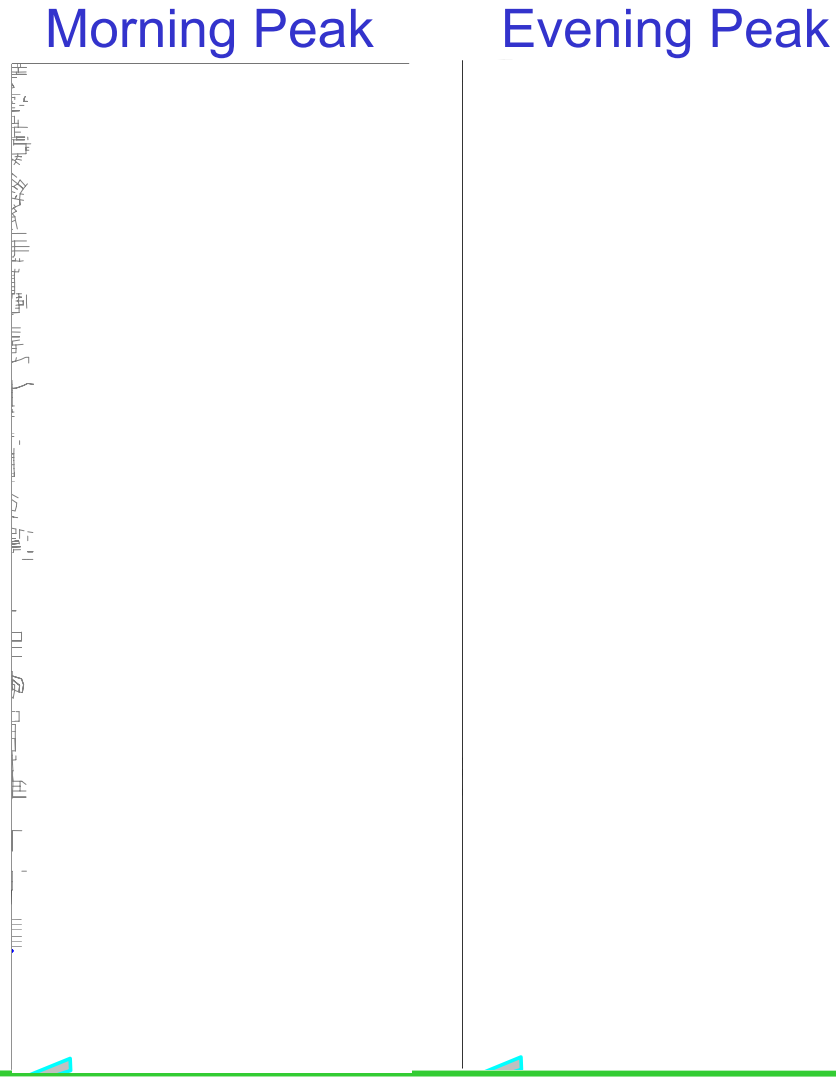
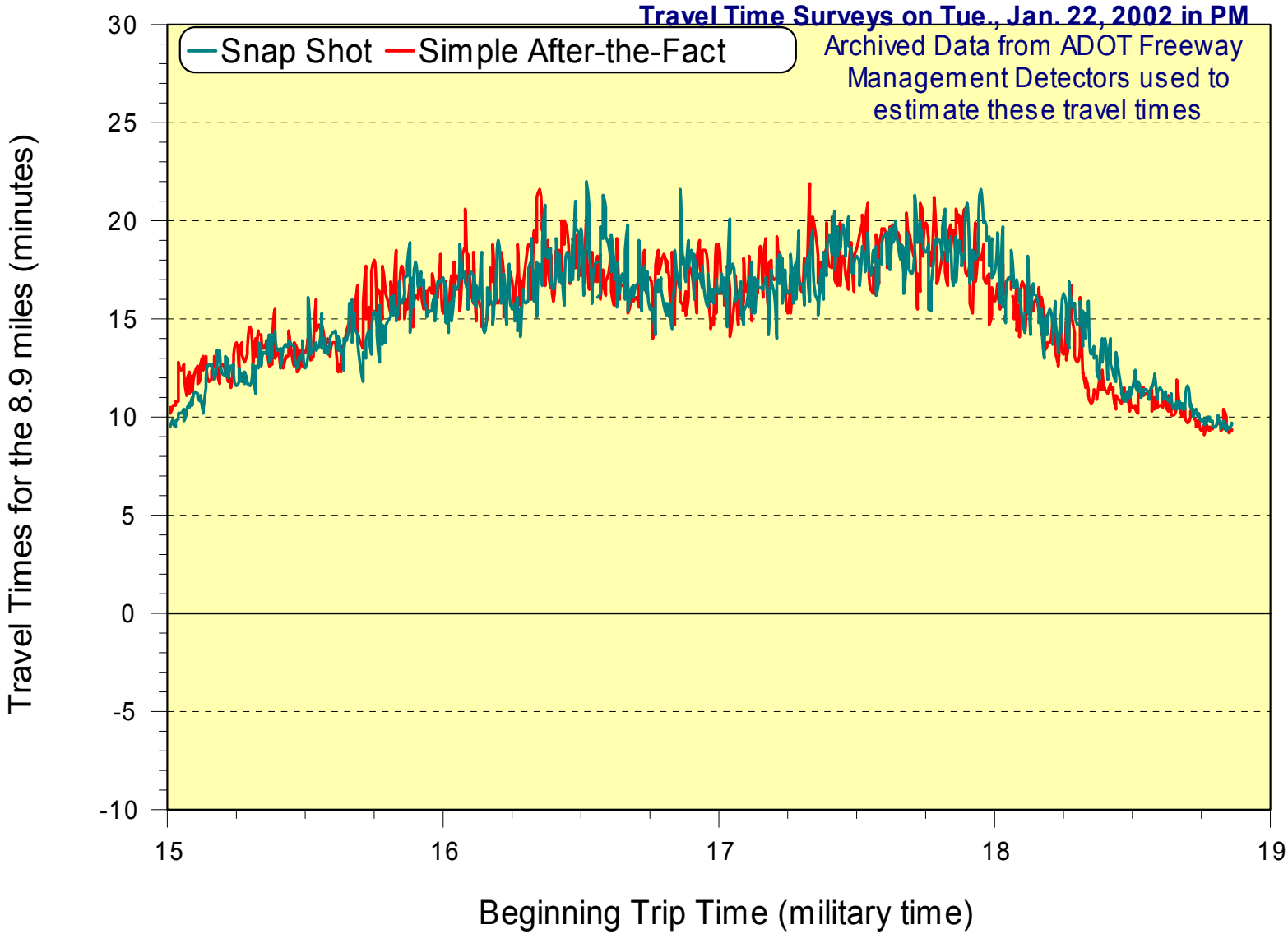


Initial Comparison of Travel Times

- Compared SS_TT to a simple estimate of ATF_TT for beginning time of the "trip" for both directions in AM and PM peak
- Examined marginal differences
- Compared those travel times to a smaller sample of the GPS probe travel times
- First cut is for cumulative travel times
- Also looked at variations along the corridor because that will be a necessary part of a predictive approach

Comparison of Travel Time Estimates for I-17: Northbound: Adams St. to Peoria Ave.



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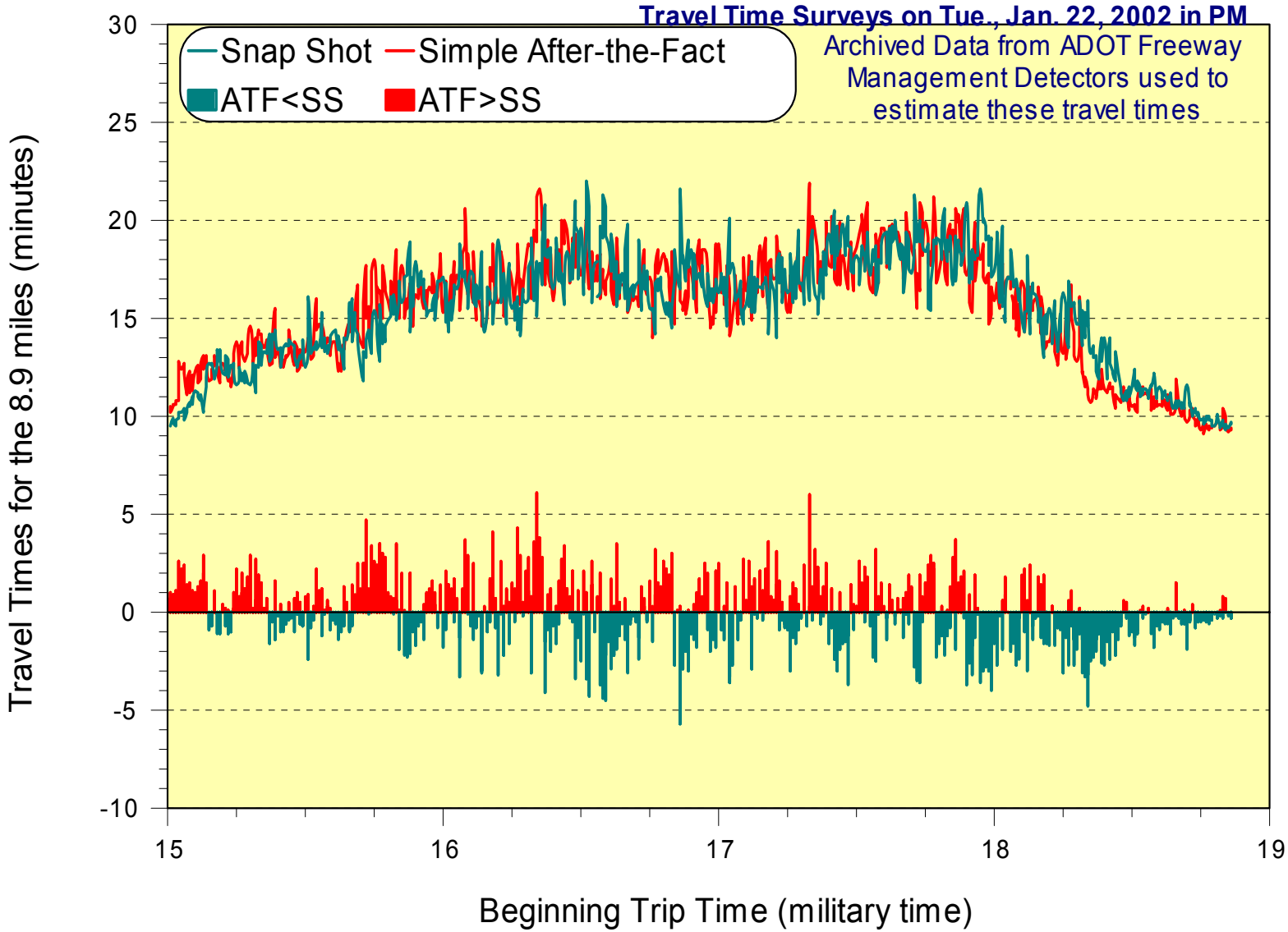

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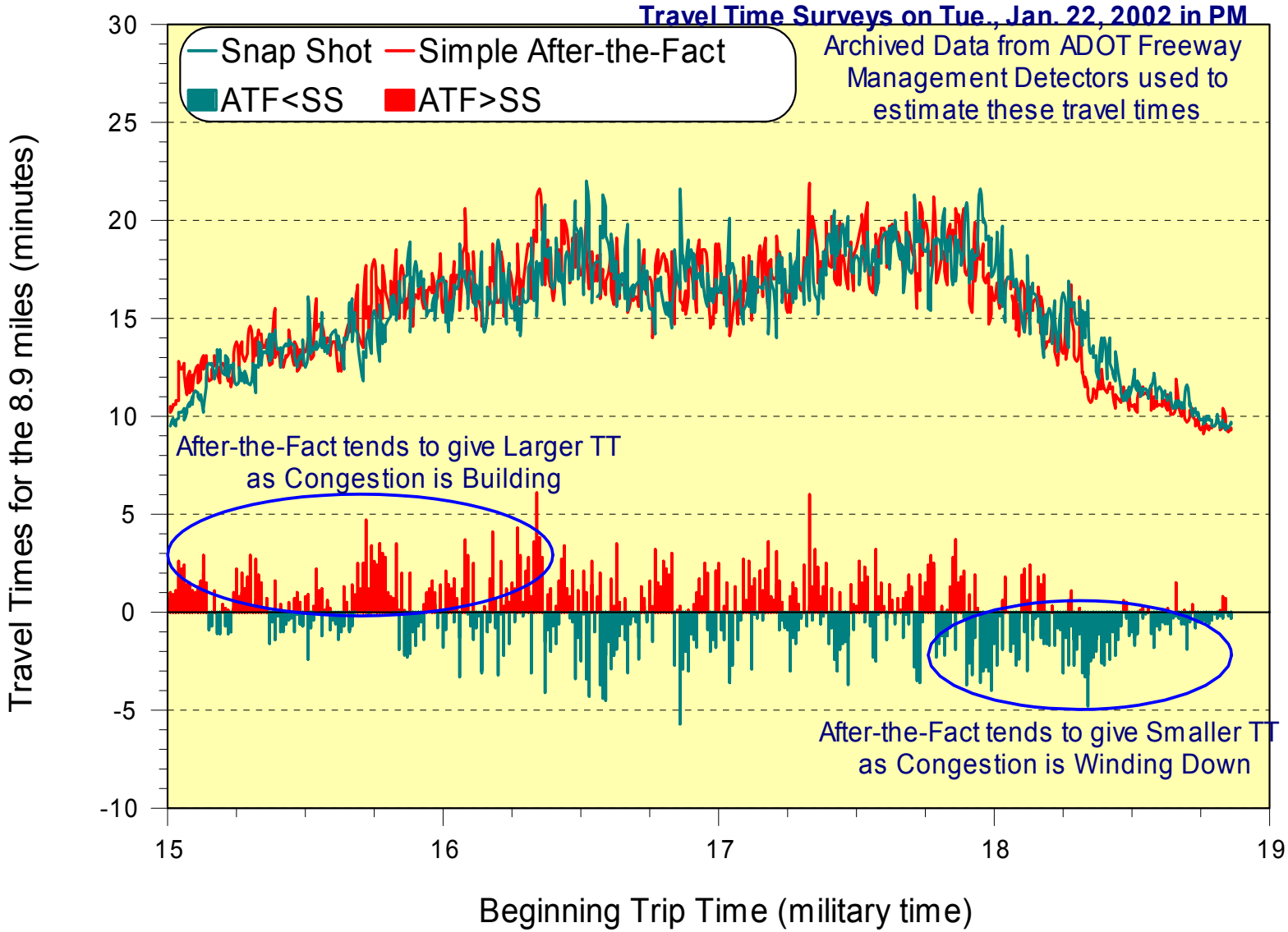

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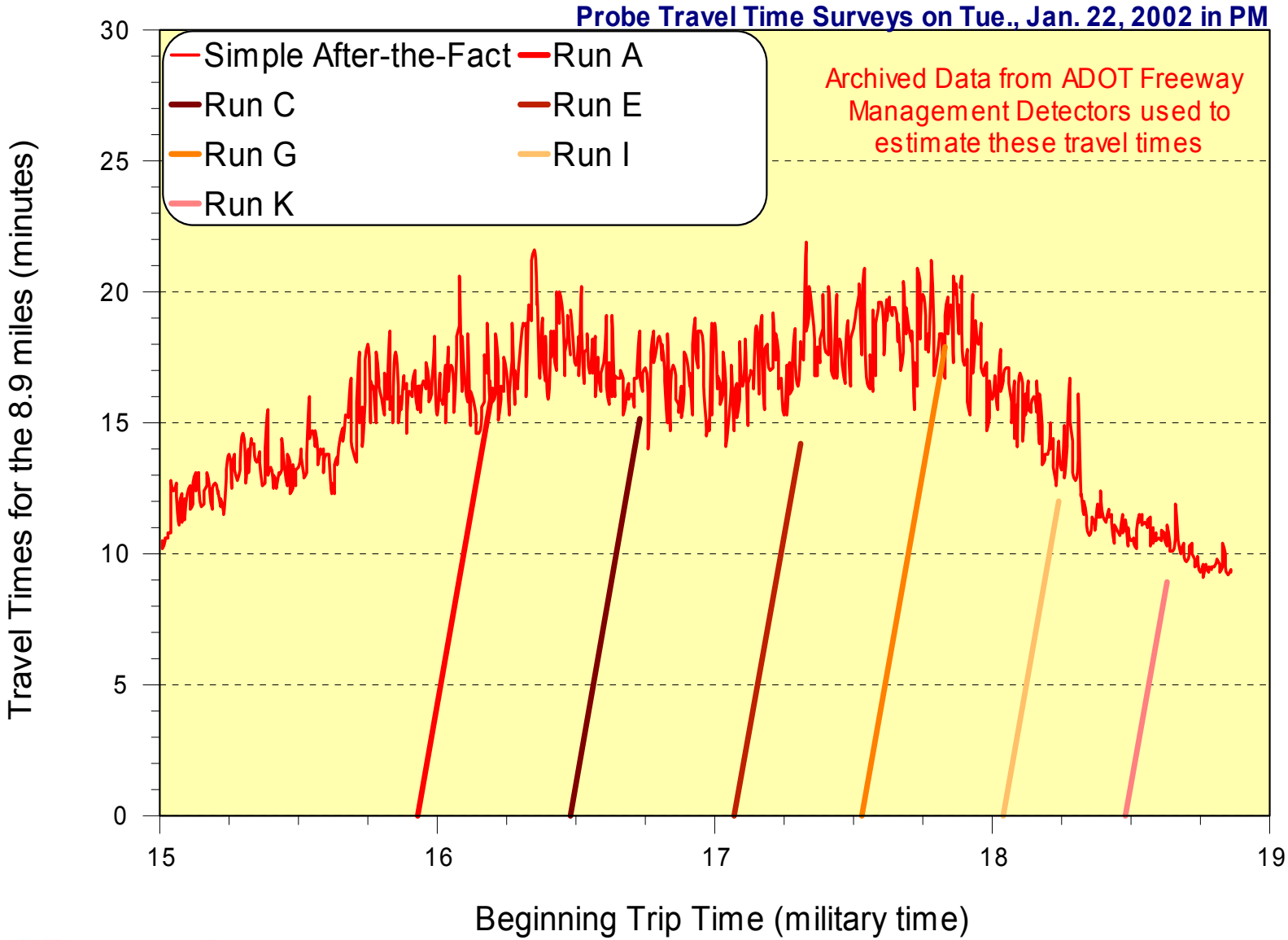
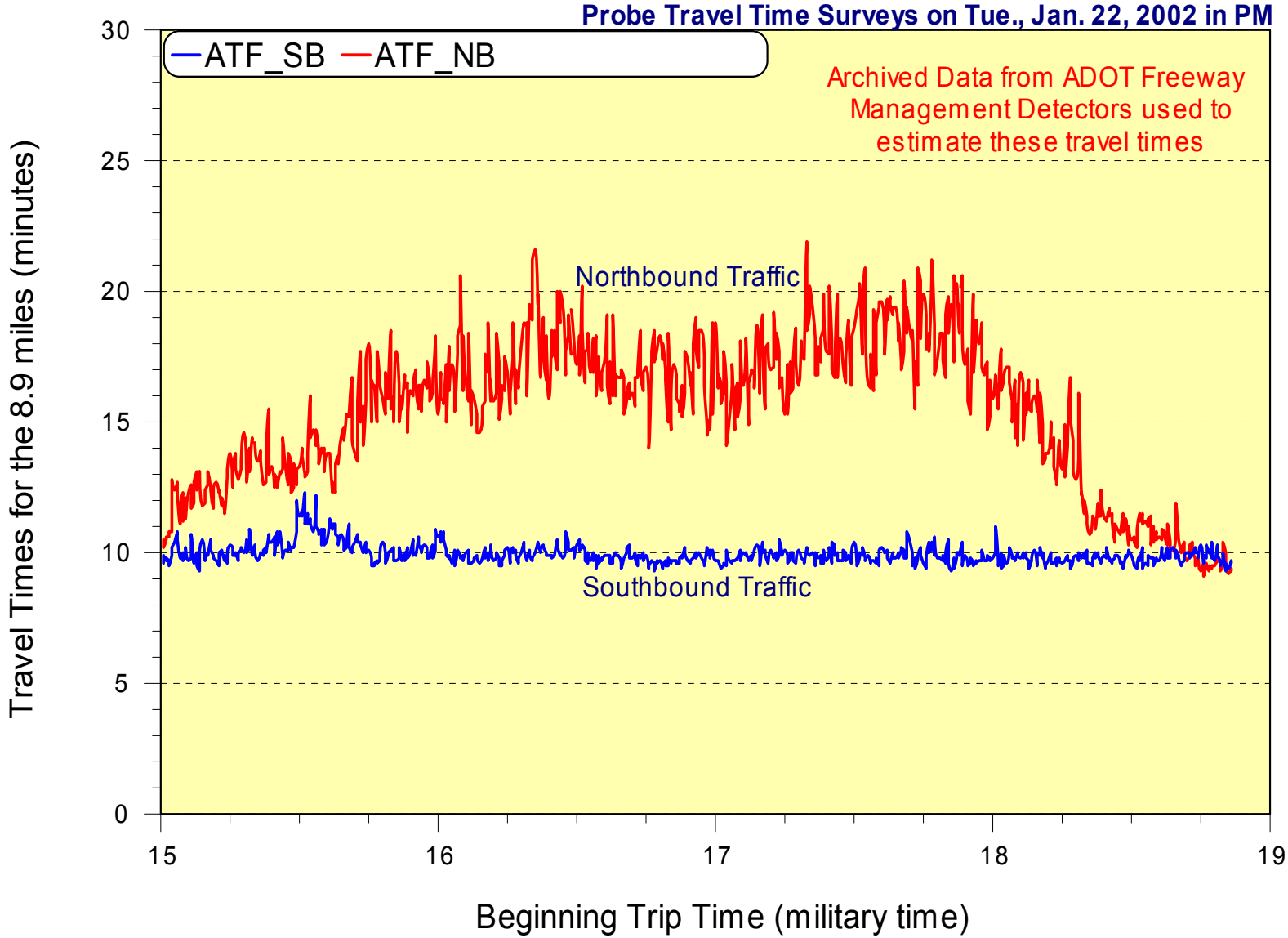


Comparison of Travel Time Estimates for I-17: NB: Adams St. to Peoria Ave./ SB: Peoria Ave. to Grant St.



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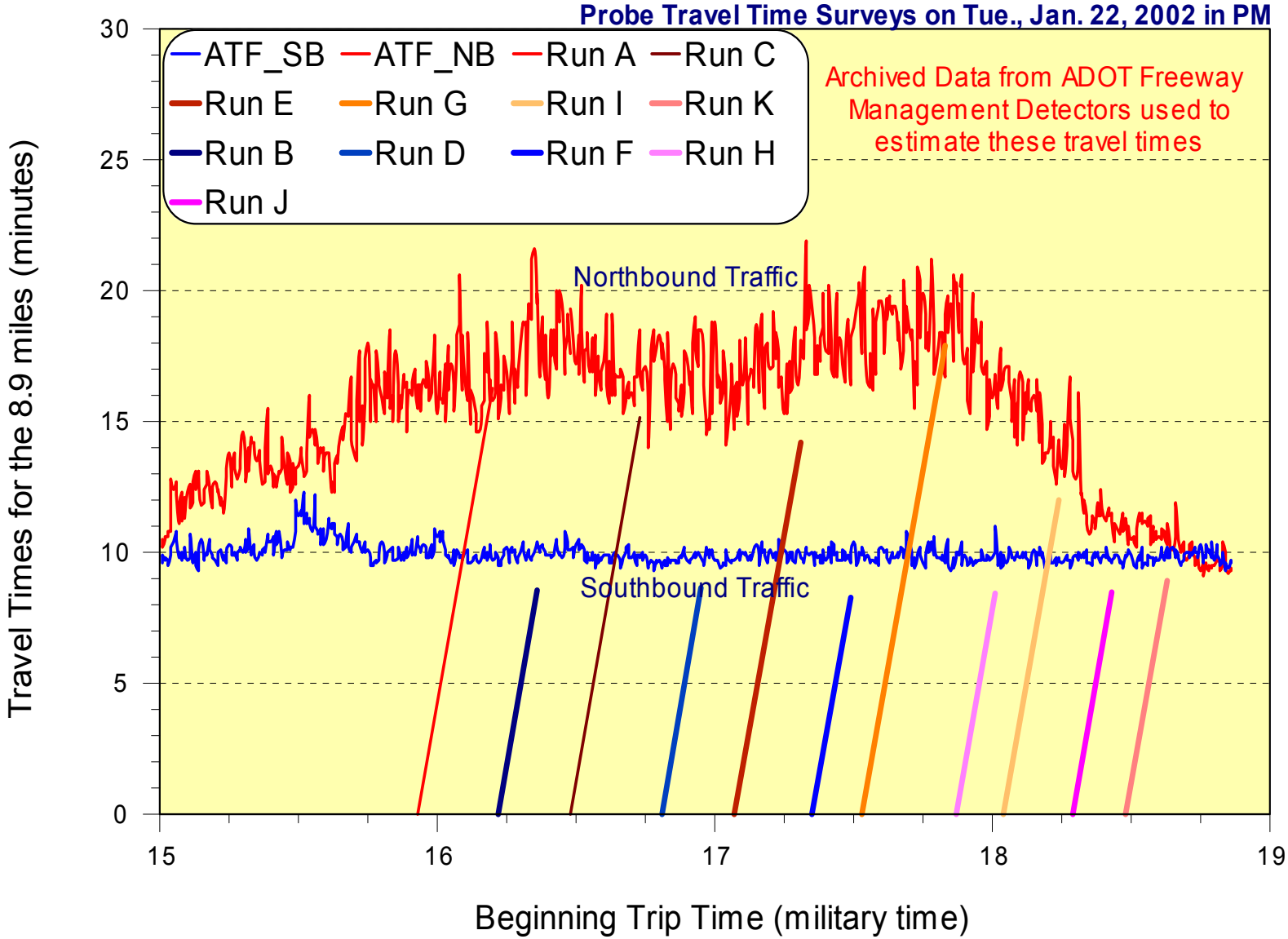

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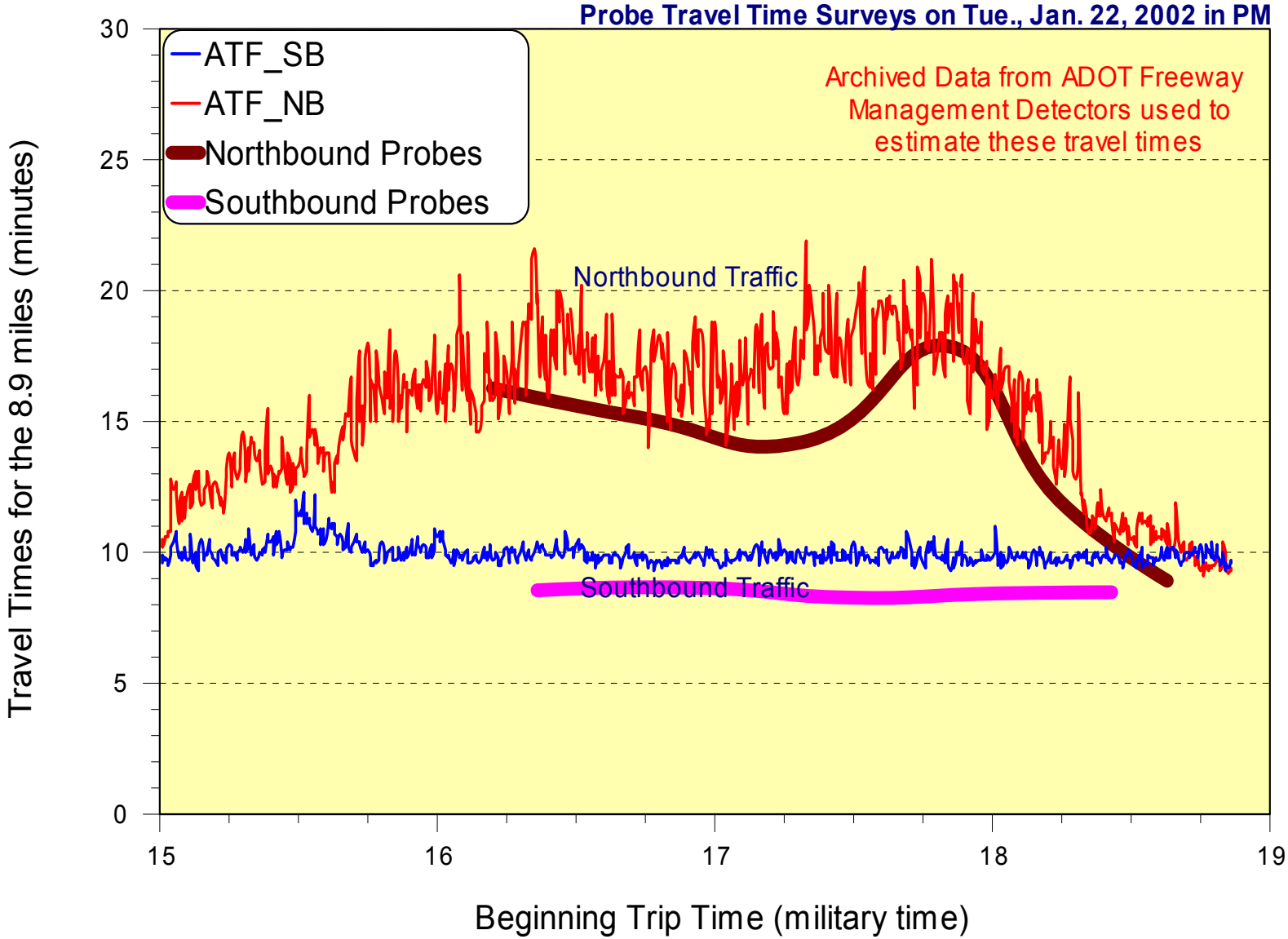
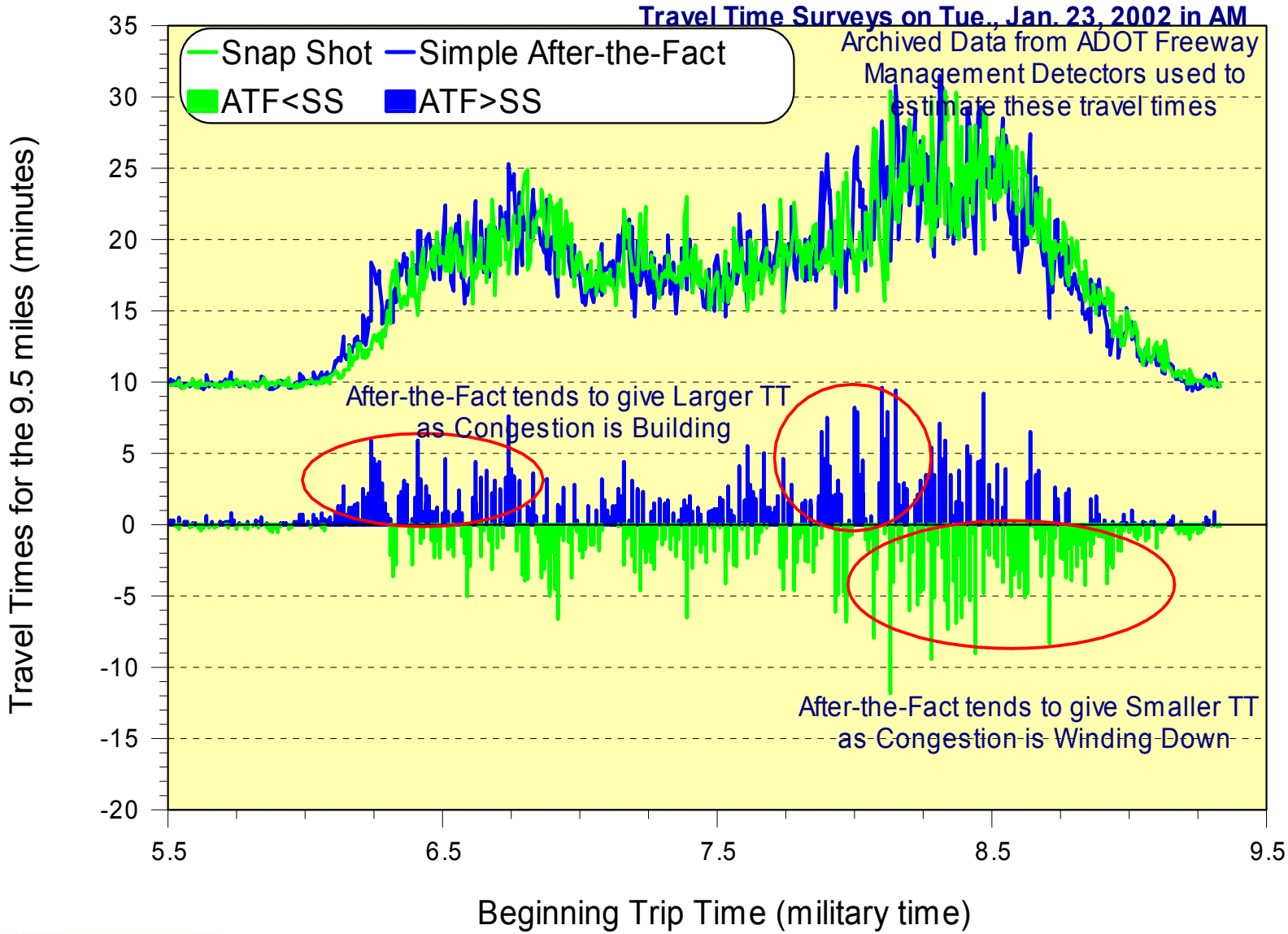


Comparison of Travel Time Estimates for I-17: Southbound: Peoria Ave. To Grant St.



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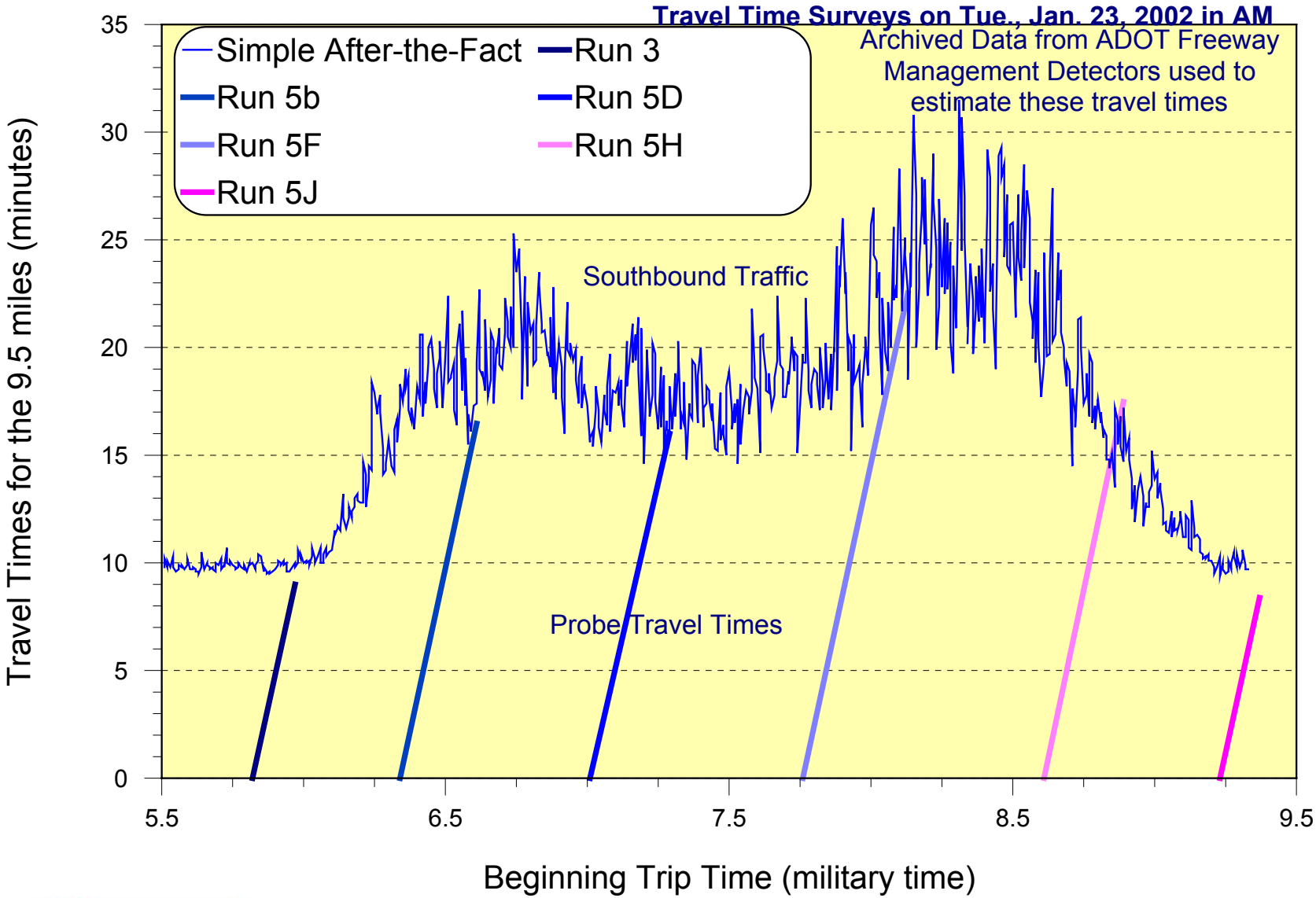

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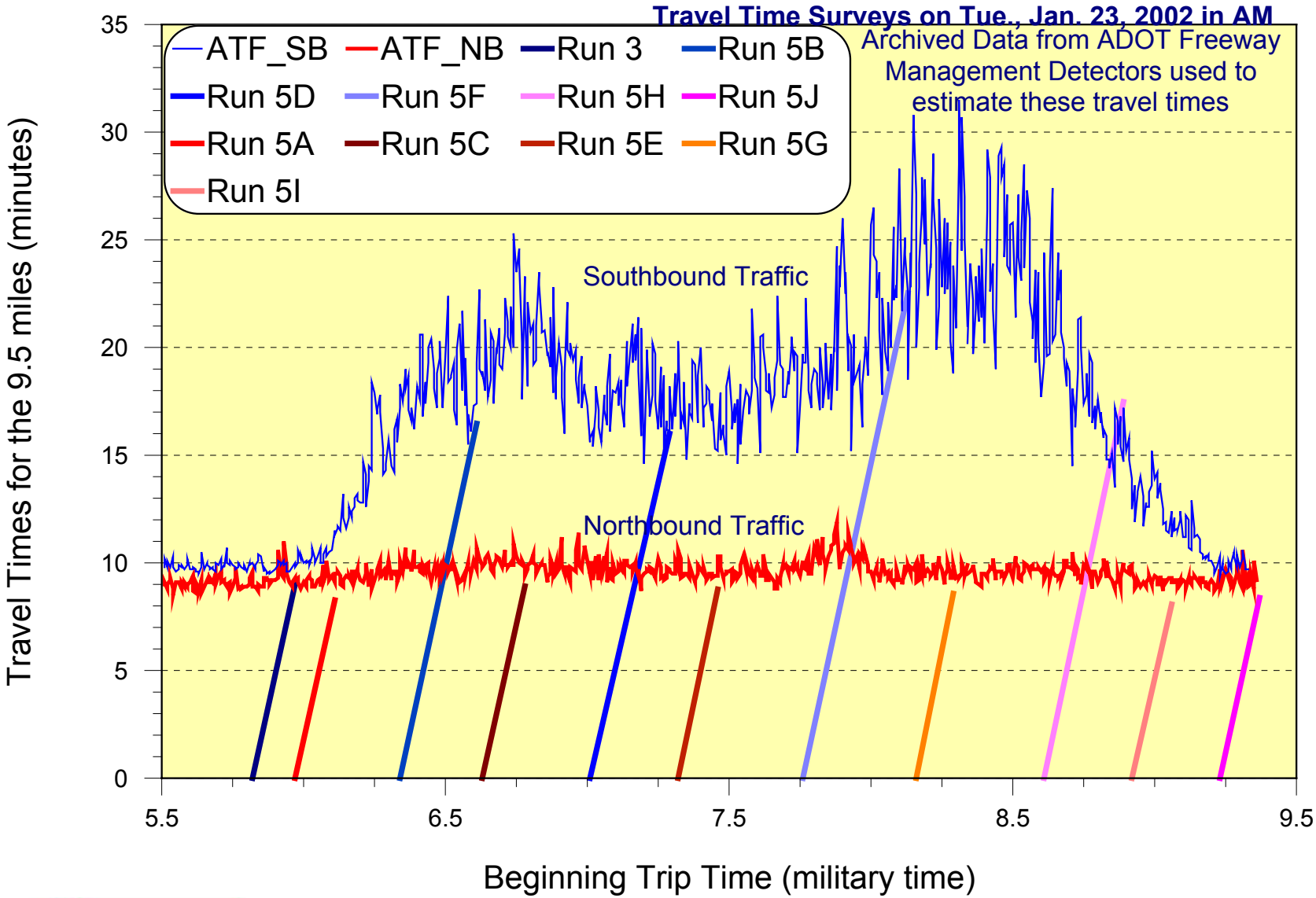

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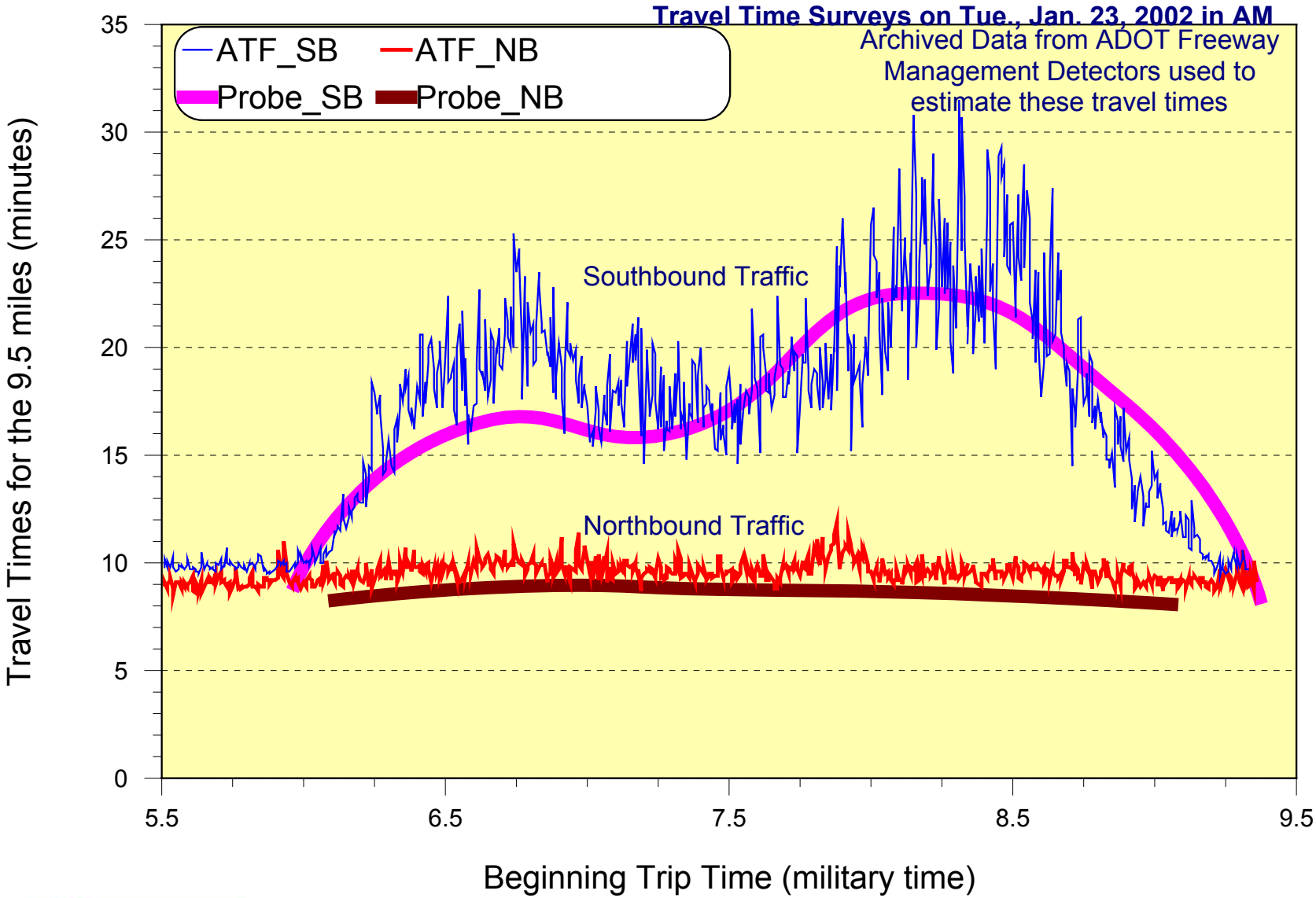
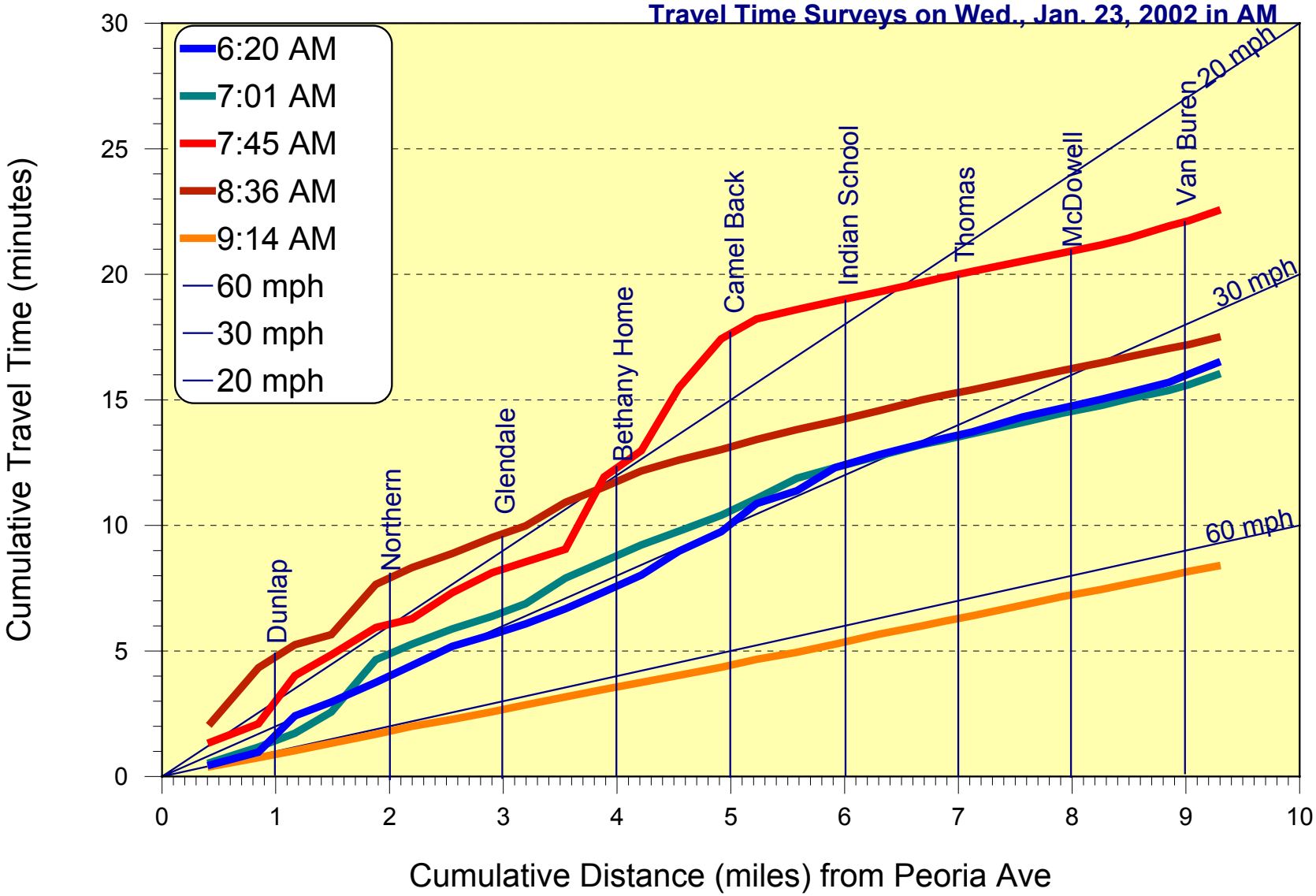


Cumulative Travel Time Southbound for I-17: Peoria Ave. to Grant St. AM Peak Period



Expected Project Results

- Use GPS probes to sample travel times every 5 minutes, every 10 in the HOV lane
- Expect to find that ATF_TT compares well to probe travel times for a six-day period
- Archived data to be used for a longer period to have a wider set of conditions
- A set of algorithms will be developed for predictive travel times for the test corridor that will rely in part on the FMS archived data

Conclusions

- Travelers want accurate estimates of the time it will actually take to get to a destination or check point, and providers want to supply such information
- Preliminary data shows that after-the-fact calculations of travel time from archived data differ from calculated snap shot travel times
- ATF_TT, compared to SS_TT gives longer times as congestion is building and shorter travel times as congestion is waning
- ATF_TT compare well to the limited sample of probe travel times under a limited range of conditions
- More conclusions need to await the actual project