























1 time traveler near free flow speed (22.4% vs. 20.9% for unmanaged case). This can also be seen in Table  
 2 2 which shows the hours and miles traveled, average speeds and experienced delay for the unmanaged  
 3 and managed cases for affected travelers and for the system as a whole. The results show a statistically  
 4 significant increase in average travel speed in the managed case of 4.5%, and a decrease in hours  
 5 traveled of 6.3% and delay of 9.3%.

6

**Table 2. Aggregate Travel Characteristics for Affected Travelers and All Travelers**

	Affected travelers			All travelers		
	No ATIS	ATIS	% change	No ATIS	ATIS	% change
VHT	8,189	7,673	-6.3%*	198,892	198,287	-0.3%*
VMT	108,229	107,852	-0.3%	5,451,218	5,450,853	0.0%
Avg. speed (by time)	18.1	18.9	4.5%*	31.8	31.9	0.3%*
Delay	5,567	5,049	-9.3%*	67,010	66,383	-0.9%*

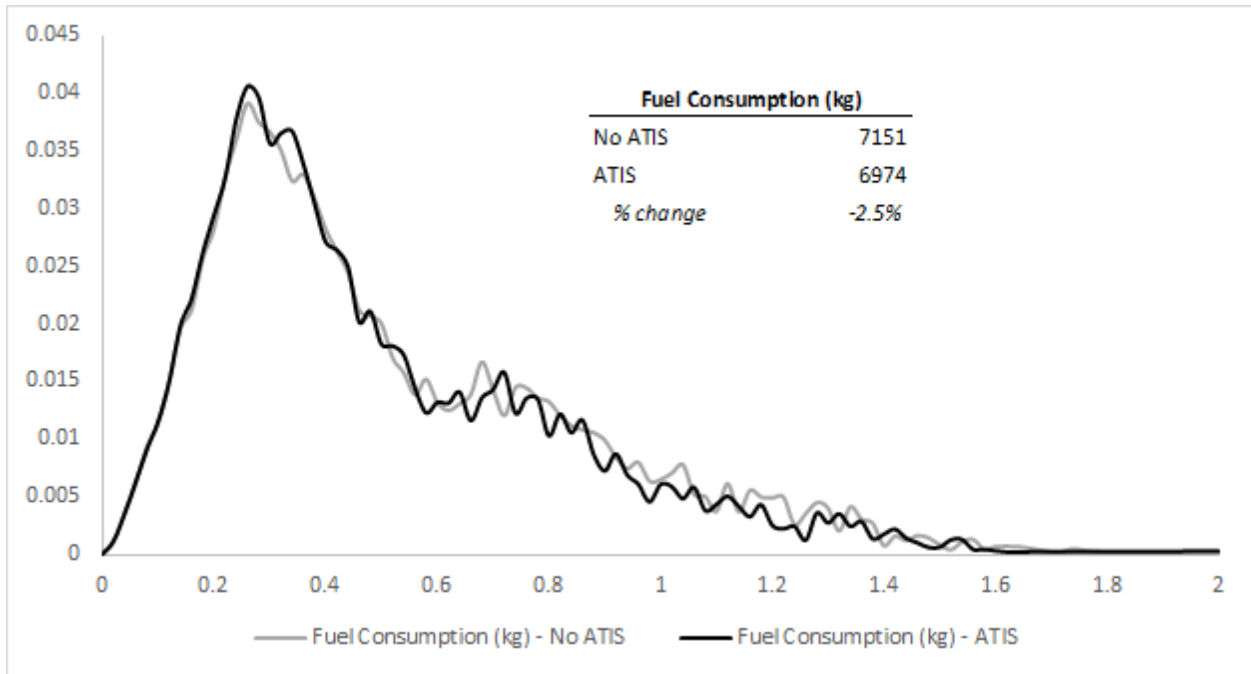
\* differences statistically significant at  $p=0.05$

7

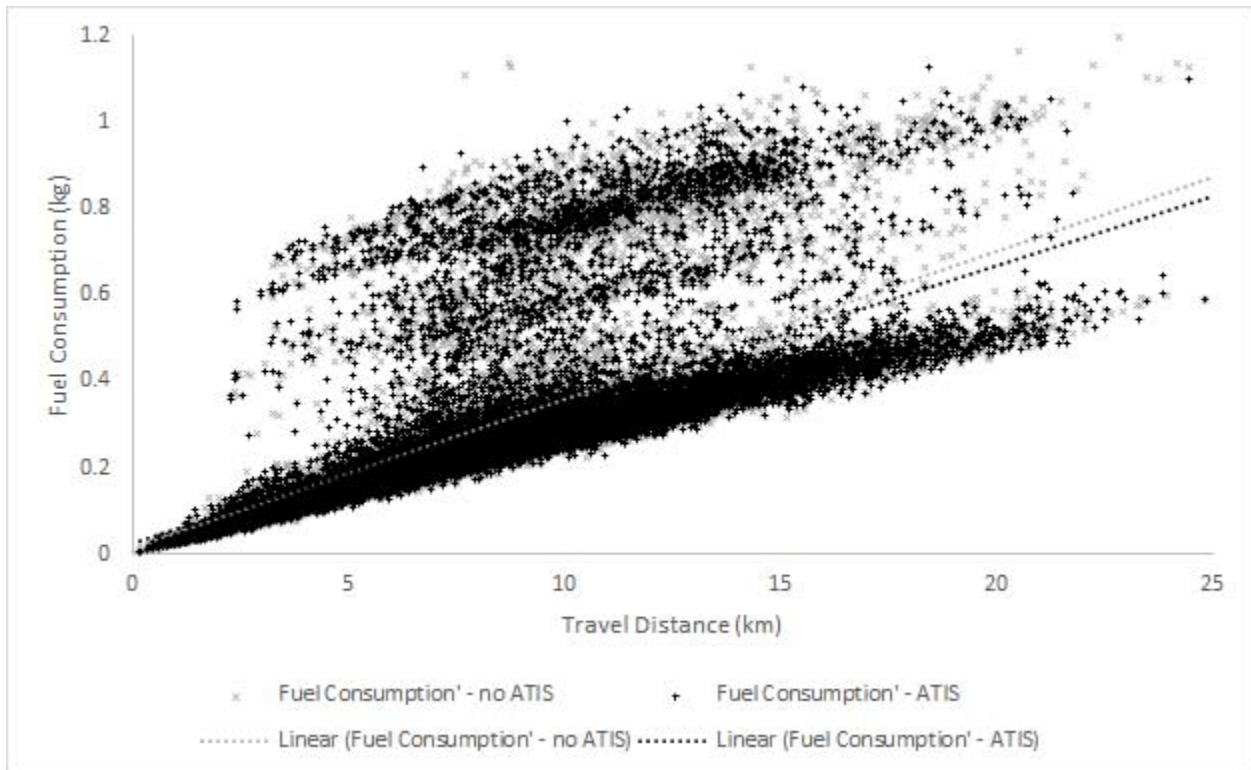
8 The impacts shown above can also be seen at the overall system level, which is important as it is  
 9 possible that improving the situation for informed travelers could be detrimental to the system as a  
 10 whole, for example by pushing more travelers onto congested arterial streets when routing around  
 11 incidents. However, the results in Table 2 show this to not be the case. In fact, there is minor, though  
 12 significant, improvement at the system-wide level, with the delay reduced approximately 100 hours  
 13 beyond the reduction for affected travelers alone, and average speed increasing from 31.8 to 31.9 mph,  
 14 which affects the overall energy consumption, and no significant change in the miles traveled.

15

16 The primary purpose of the proposed modeling effort is on estimating the energy impacts of  
 17 transportation policies and system investments (i.e. ATIS deployment in this case) as these policies  
 18 interact with various vehicle technologies. Previous research has shown that there are complex  
 19 interaction effects between transportation policies and vehicle powertrain technologies which can  
 20 either multiply or inhibit the expected benefits from either in isolation, as in the case of heavy vehicle  
 21 hybridization and managed lane deployment (Sokolov et al 2014). The results of the vehicle simulation  
 22 using the generated speed profiles demonstrate this to an extent. The overall distribution of fuel  
 23 consumption for affected travelers in each case is shown in Figure 3, where fuel consumption is  
 24 measured in kilograms of gasoline. The results show that the deployment of ATIS to travelers does  
 25 result in a fuel consumption savings of approximately 2.5% in terms of the overall weight of fuel used by  
 26 affected travelers. There is a clear reduction in trips using more than 0.6 kg of fuel, which are shifted  
 27 closer to the 0.2-0.4 kg range in the managed case. This is likely due to improved performance in long-  
 28 distance, highway trips coming into the CBD, which subsequently route around the traffic incidents  
 29 using local streets.



1  
 2 *Figure 3. Plot of fuel consumption distribution shows managed case reduce energy use by 2.5% for*  
 3 *affected travelers*  
 4



5  
 6 *Figure 4. Fuel consumption by travel distance*  
 7

1 This result can clearly be seen in Figure 4. There is very little difference in fuel consumption between the  
2 managed and unmanaged cases for short distance trips (0-5 km) as the local trips in the CBD largely  
3 avoid the affected highway segments. However, in the unmanaged case there is a large cluster of trips  
4 in the 5-15 km range which have very high fuel usage, in the 0.6-1.6 kg range, which are largely reduced,  
5 as previously observed. The trend lines in the figure clearly show the improvement in fuel consumption  
6 with increasing distance as expected. The variability in fuel consumption for a given distance is a result  
7 of the combination of various vehicle technologies as specified by the fleet mix and differing drive  
8 patterns (i.e. highway vs. arterial where variability due to traffic signals is introduced. However, it is  
9 clear that this variability is reduced in the managed case, where highly congested travel segments are  
10 mostly eliminated.

11

## 12 5. DISCUSSION AND CONCLUSIONS

13 This case study has demonstrated how multiple levels of model integration, i.e. connection between  
14 travel demand, traffic flow and network operations for POLARIS, and between POLARIS outputs and  
15 Autonomie, can be leveraged to assess the energy use impacts of transportation system policies and  
16 operations. The model process made use of a new methodology for extracting detailed second-by-  
17 second speed profiles from aggregated link performance measures which are generated by the POLARIS  
18 model. The speed profile generation process is guided by the constraints imposed by the POLARIS link  
19 performance measures, but is estimated using real-world travel data obtained from the Chicago GPS  
20 travel tracker survey. In other words, the speed profiles are synthesized statistically, but in such a way  
21 that the replicate observed driving cycles and behavior to an acceptable degree (Karbowski et al. 2014).  
22 The process stands in for detailed traffic flow microsimulation when such is either infeasible due to  
23 scale, data limitations, etc., or when such detail is unnecessary.

24

25 The ATIS deployment analyzed in this case was a fairly simplistic example, but a clear benefit was  
26 identified, both in terms of mobility and energy use. Users who are affected by the traffic incidents save  
27 approximately 500 hours of excess delay when they are informed of incidents via the ATIS system as  
28 compared to the case where they are not informed. Their average travel speed increases from 18.1 to  
29 18.9 mph, primarily due to a reduction in time spent in highly congested links. The results in terms of  
30 energy usage are more mixed. While there was a reduction in overall fuel consumed of 2.5%, which is  
31 smaller than the travel time savings and speed increase. This is most likely due to increases in non-  
32 highway driving, stopping at intersections, and interfering with existing surface street traffic. This result,  
33 however, is clearly dependent on context, i.e. the mix of long-distance vs. local trips, the time of day, the  
34 location of the ATIS infrastructure, and the availability of suitable alternatives. The availability of such a  
35 wide range of complex and interacting effects indicates the importance of this type of integrated  
36 modeling when planning for such deployment scenarios.

37

38 The process demonstrated in this work is extensible to more complex scenarios, especially those  
39 pertaining to future connected and autonomous vehicle technologies and the intersection with such  
40 technologies with advanced vehicle powertrains (Sokolov et al 2014), which complicates the analysis  
41 even further. Future work in this area will include more detailed analysis of fleet characteristics and

1 forecasting of fleet vehicle technology market penetration. The addition of individual level vehicle  
2 choice models, rather than assigning vehicle technologies randomly to trajectories, will add another  
3 dimension of interest to the work. Finally, comparisons of the speed profile disaggregation approach  
4 with both real world data on speed and energy use, as well as alternative traffic microsimulation  
5 approaches will be undertaken.

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