Analysis of Flow Features in Queued Traffic on a German Freeway

Prospectus for Dissertation Research

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Outline

- Introduction
- Background
- Preliminary Investigation
- Research Plan
- Concluding Remarks
- Questions

Introduction

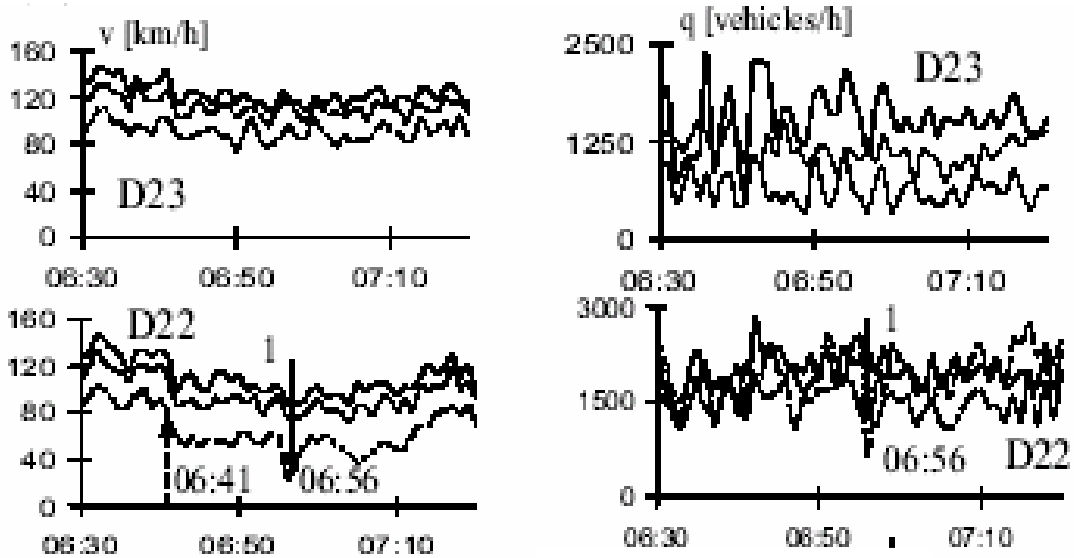
- The objective of this research is to study the evolution of traffic from freely flowing to congested conditions at freeway bottlenecks located near off-ramps.
- Preliminary investigations have found that a bottleneck is formed approximately 2000 m upstream of a freeway off-ramp at a location on a German Autobahn.
- This research will contribute to the understanding of congested traffic and may lead to enhanced models and effective real-time freeway management strategies

Background

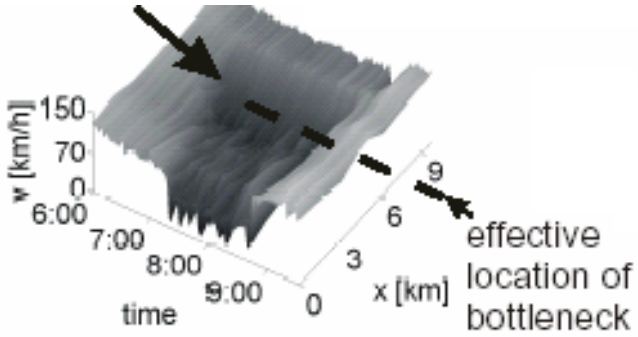
- 50 years of freeway bottleneck studies
  - Many studies were limited to manually collected data (direct observation, air photos) with short duration and limited length
  - Others studies were plagued by limitations of the data processing methods (flow vs. time and velocity vs. time plot)
  - Recently, there have been a limited number of successful studies of Canadian, British, and US freeways employing more robust data analysis methods – none on German freeways

Current German Freeway Analyses

- Measured variables (velocity and flow) exhibit statistical variations as well as time-dependant changes
- This plotting technique makes it difficult to distinguish between the two

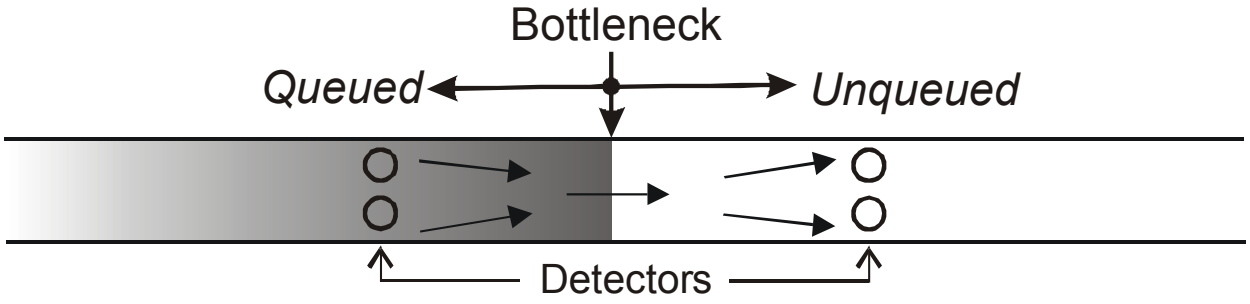


- 3-D plotting technique allows for coarse identification of flow features



Bottleneck

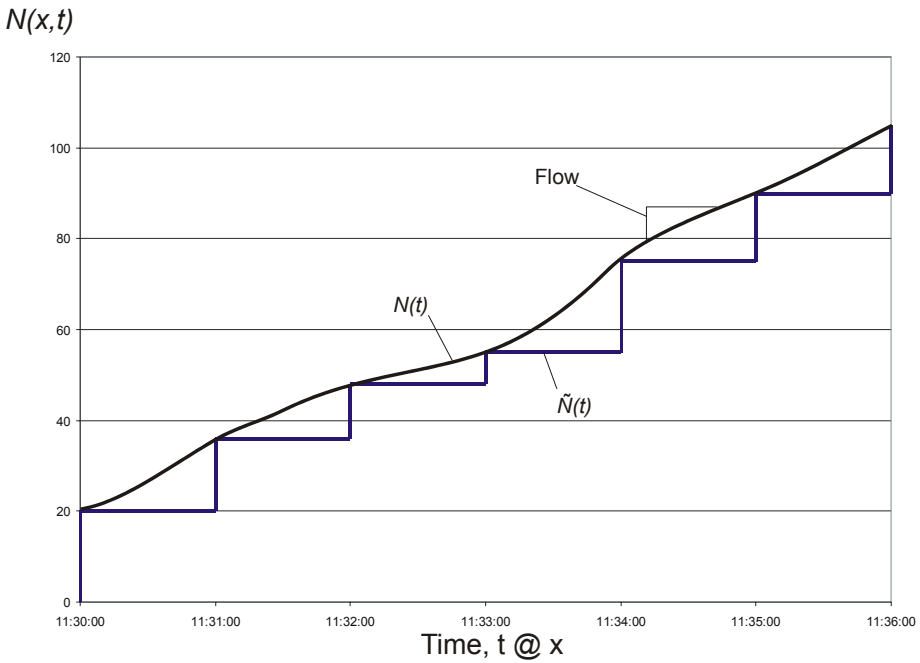
- Now, it turns out if the data are processed carefully and properly, key features related to a freeway bottleneck can be diagnosed
- An *active* bottleneck exists when upstream traffic is queued and downstream traffic unqueued
- Deactivated when there is either a decrease in flow or when a queue spills back from a downstream bottleneck



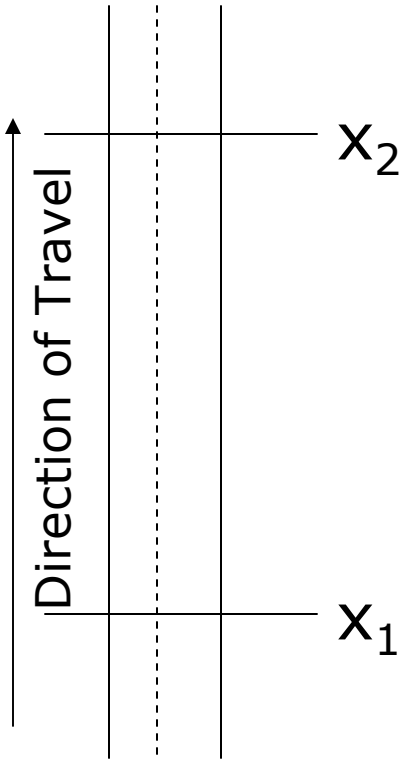
Methodology

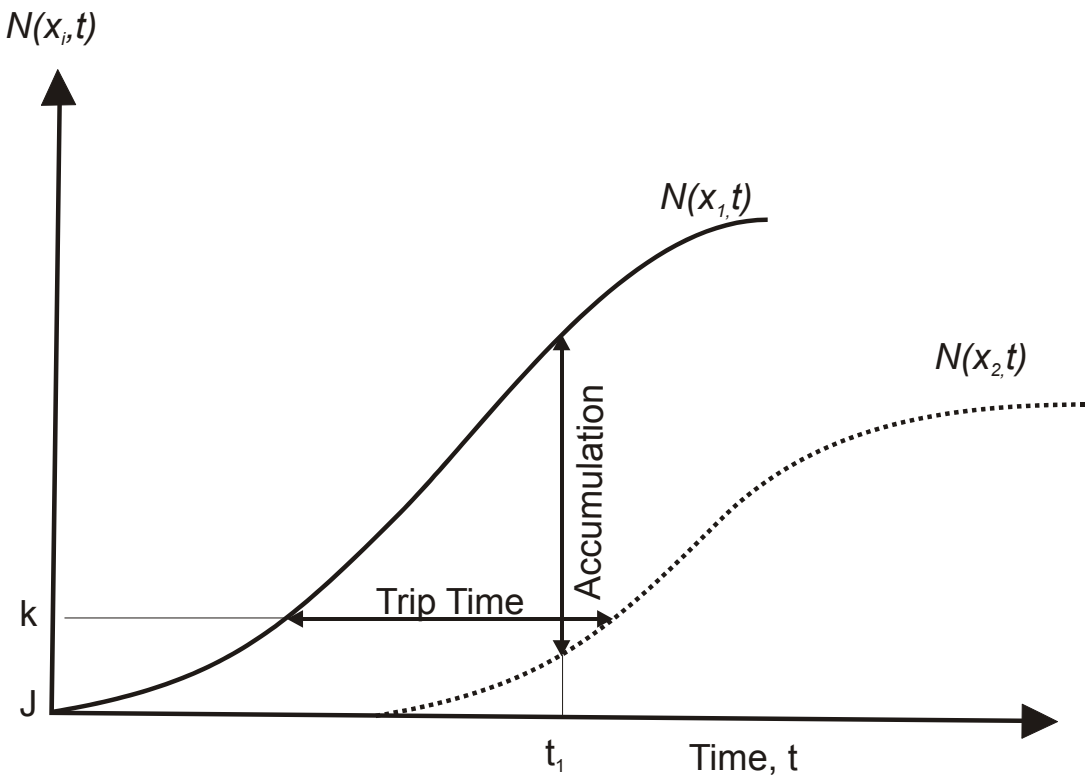
- Properly transformed curves of vehicle arrival number vs. time and time-averaged velocity vs. time provide the fidelity required to identify key time-dependent traffic features related to bottlenecks

Construction of cumulative count, *N(x,t)*, plots

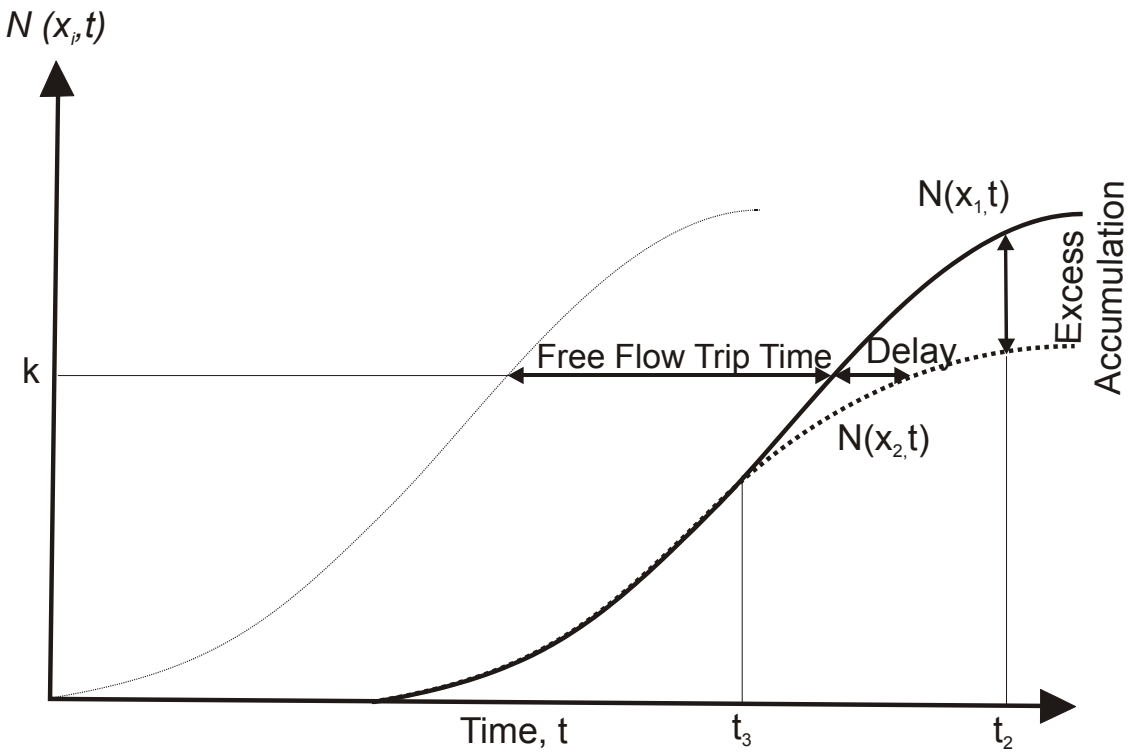


Shifted *N(x,t)*


Direction of Travel
x_2
x_1

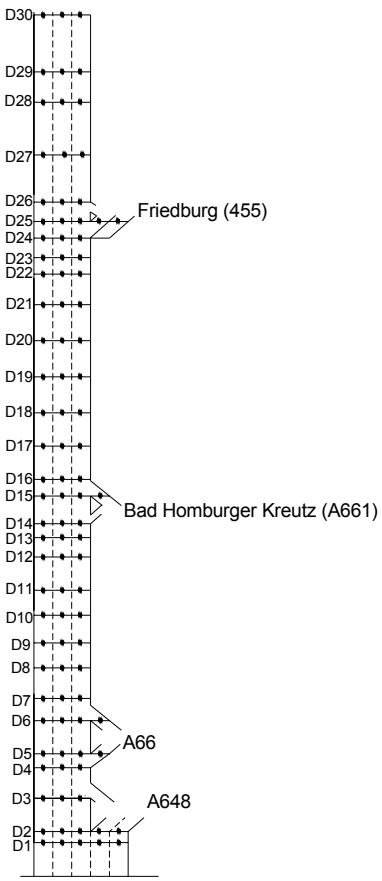

$N(x_i,t)$
$N(x_1,t)$
$N(x_2,t)$
Accumulation
Trip Time
k
J
t_1
Time, t

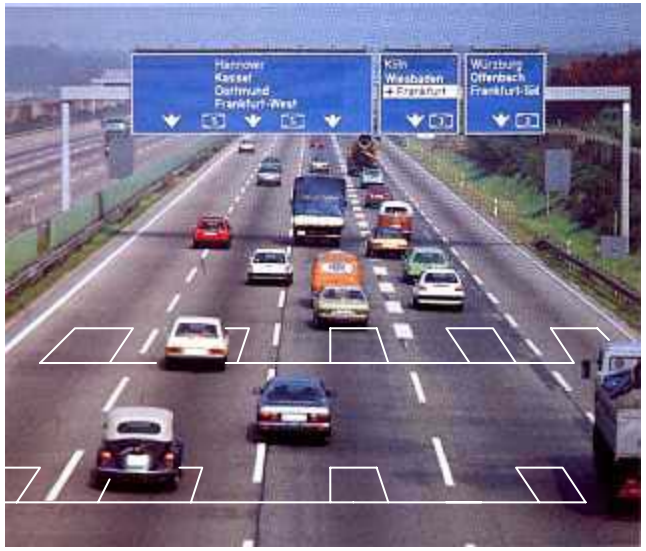
Data revealed from shifted *N(x,t)*



Study Site
Autobahn A5, Frankfurt am Main, Germany

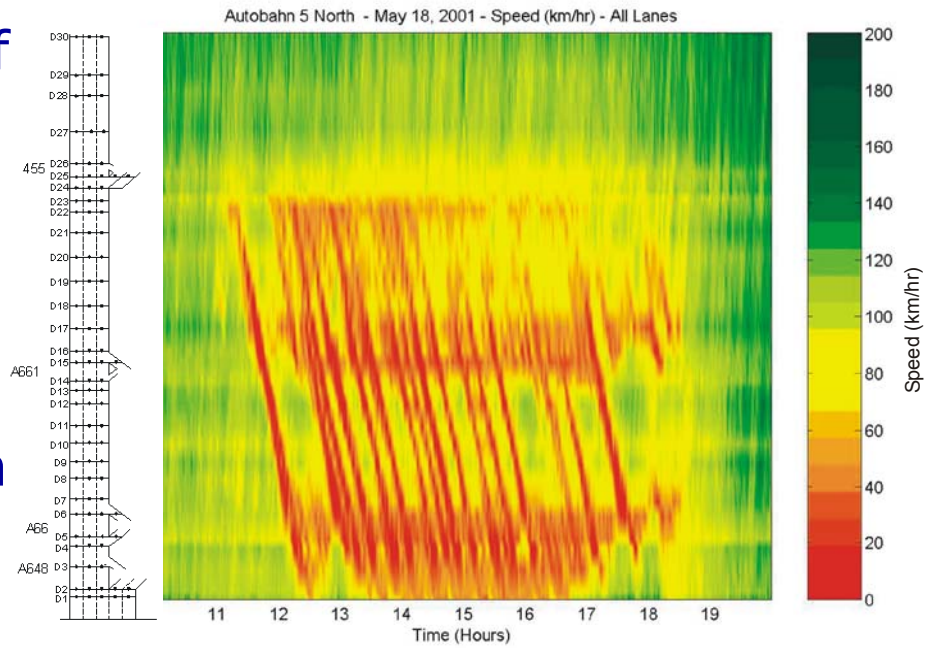
- A "speed trap" of two inductive loops gives vehicle counts, lengths and speeds
- The study site is a 30 km portion of the A5 north of Frankfurt am Main, Germany
- Research partnership with the Technical University at Dresden



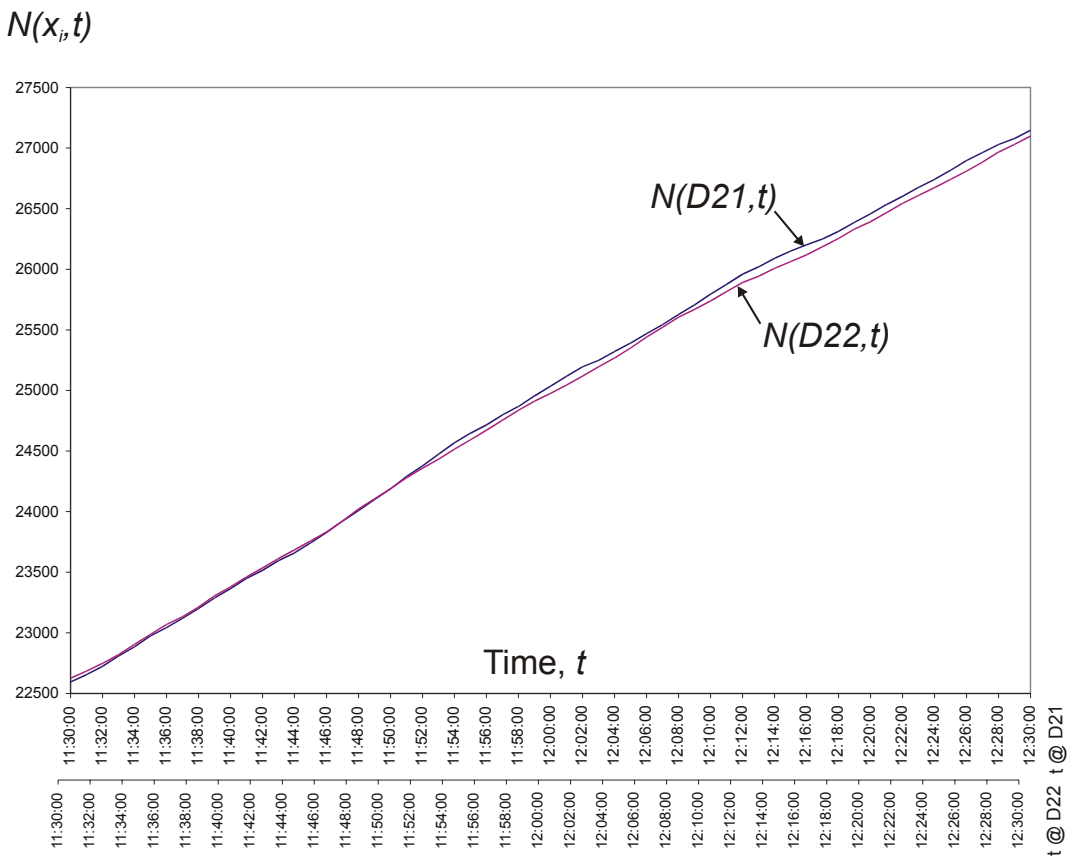


Speed Contour Plot

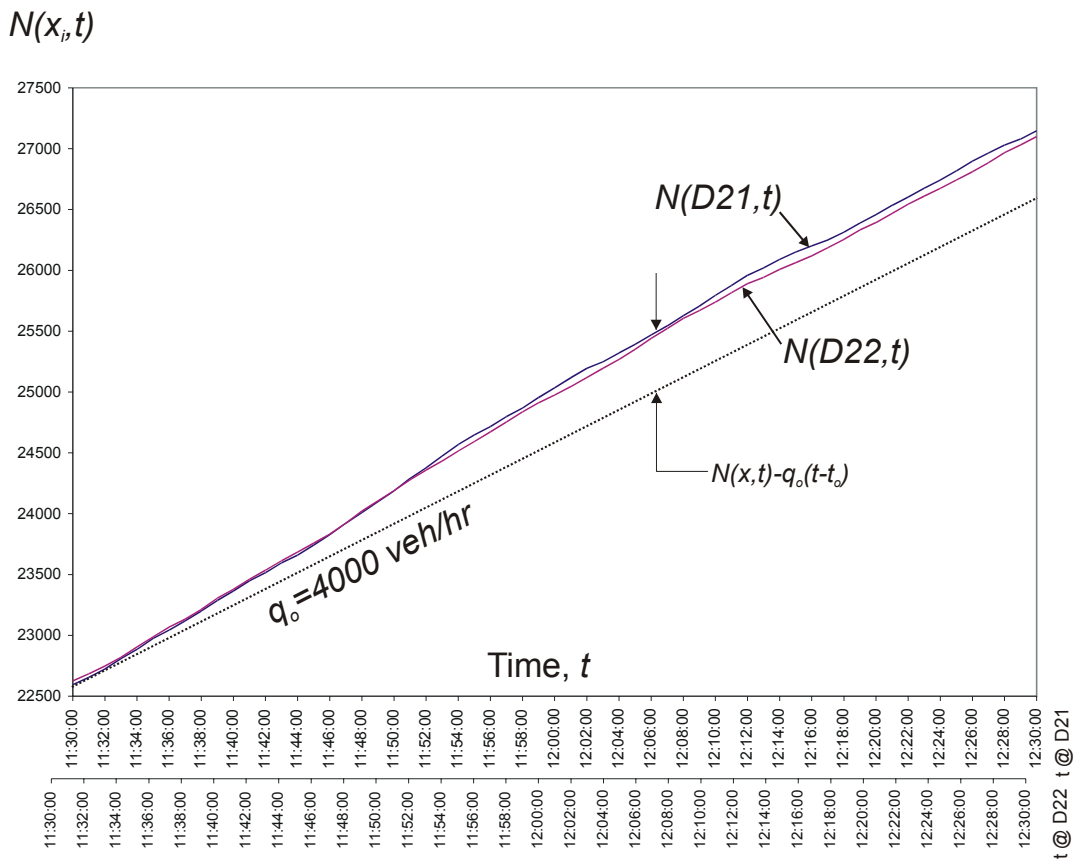
- Reveals the general location of the bottleneck
- Reveals approximate duration that the bottleneck remains active
- Resolution remains coarse, therefore useful only with a high-resolution technique such as cumulative plotting



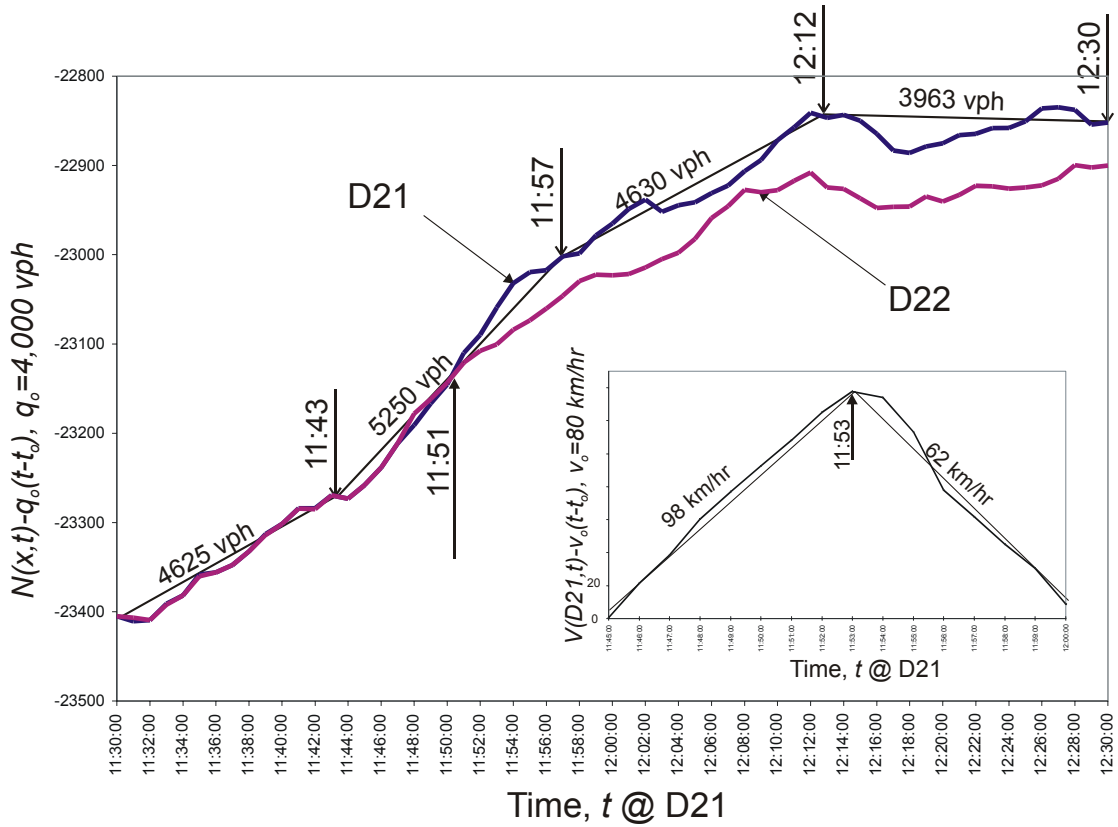
Shifted *N(x,t)* constructed from A5 data



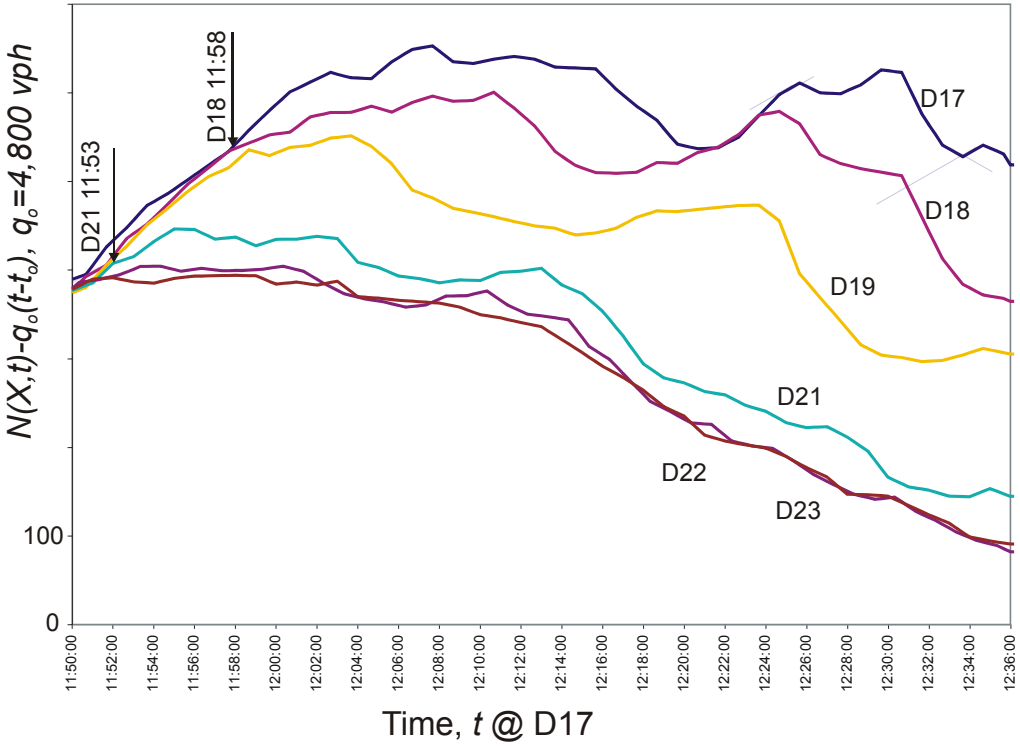
Shifted $N(x,t)$ with q_o



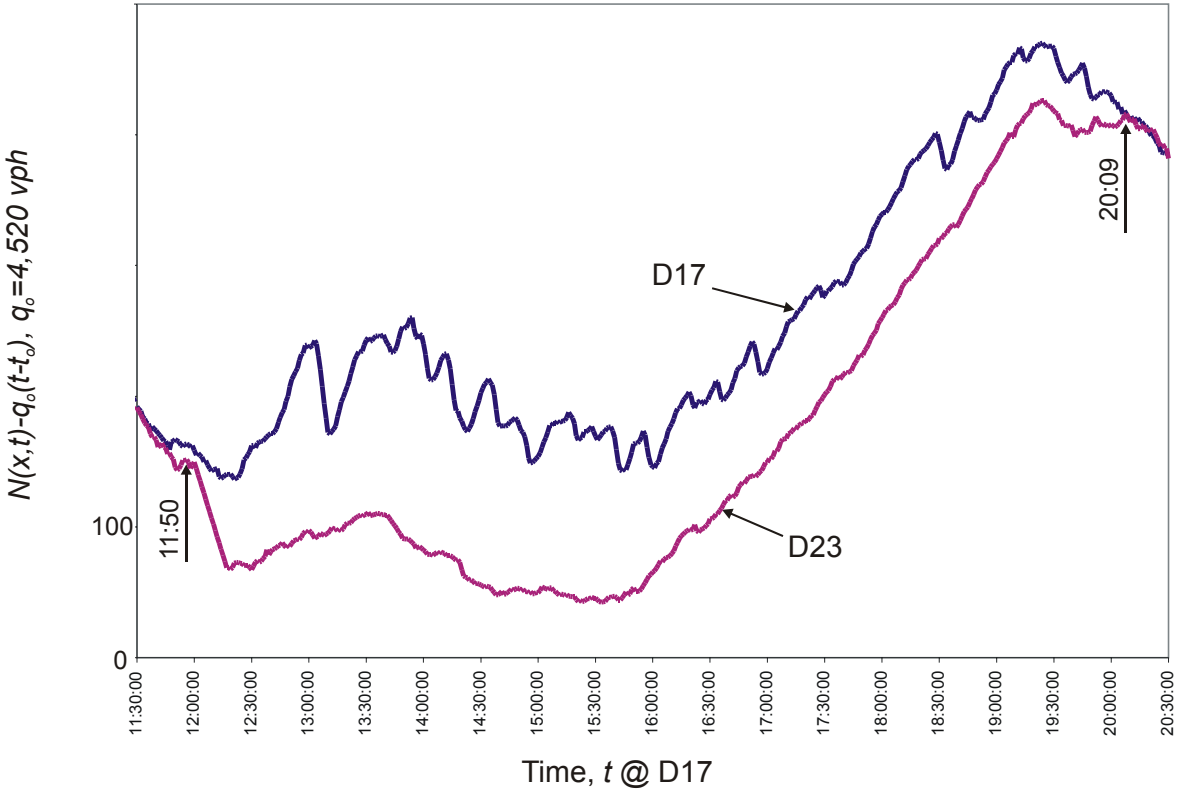
Oblique *N(x,t)* & *V(x,t)*



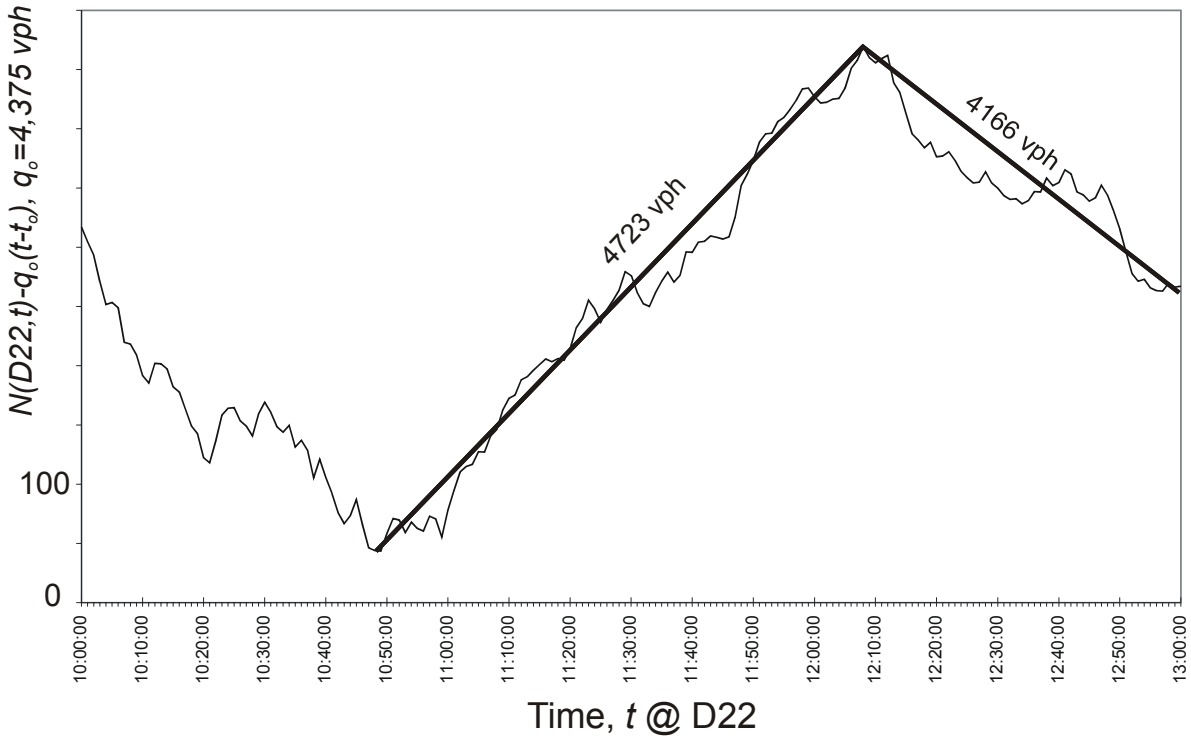
Tracing the queue



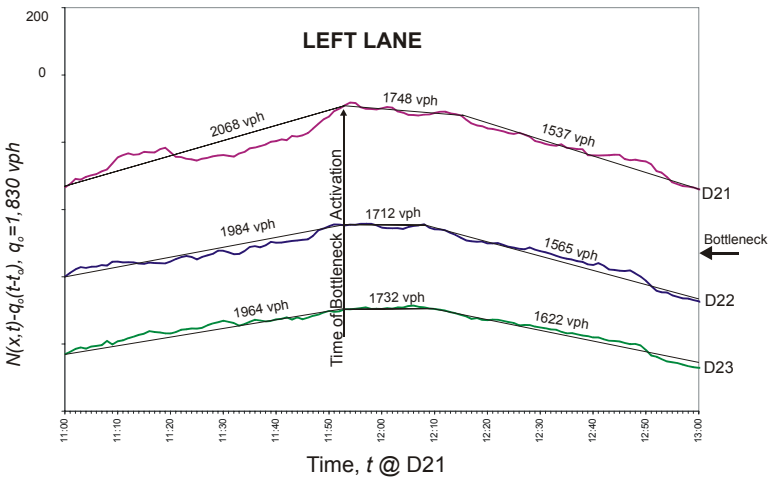
Extent of the queue

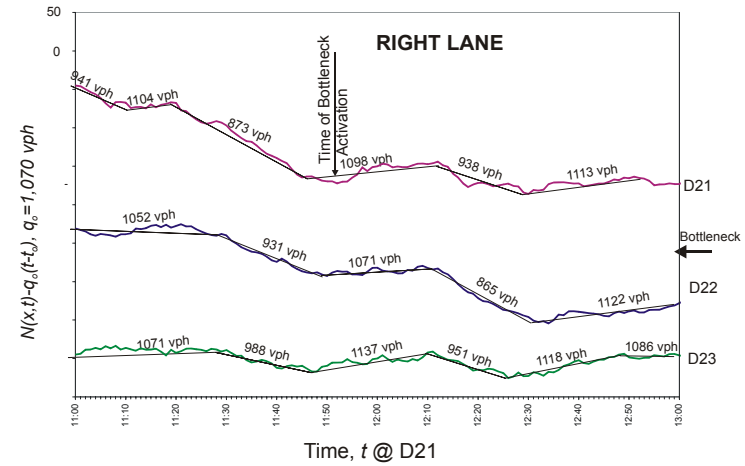


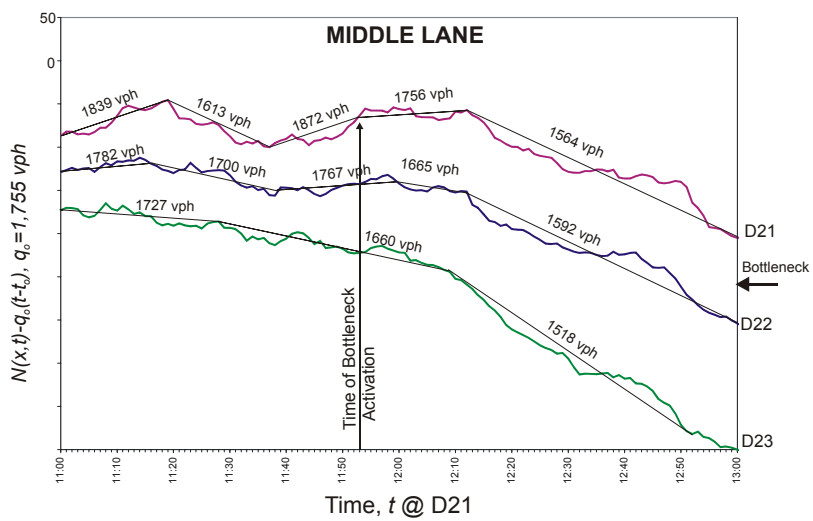
Queue discharge features



Lane-by-Lane Analysis







Research Schedule

MONTH	1	2	3	4	5	6	7	8	9	10	11	12
Literature Review												
Data Preparation												
Prelim. Data Analyses												
Final Data Analyses												
Dissertation												

Preliminary data analysis

- Examine the full 30 km data set
- Describe the evolution of traffic flow for a full day
- Examine the influence of ramp flows, lane-changing, and truck flows on bottleneck formation

Final data analysis

- Examine multiple days' data to check for reproducibility
- Compare results to Daganzo's behavioral traffic flow theory and Mauch's stop-and-go wave findings
- Model the freeway both microscopically and macroscopically and compare model results to empirical data
- Compare to other research findings
- Make data available for other researchers

Contributions

- Add to the understanding of bottleneck features
- Aid to freeway managers ability to predict and the formation of queues
- Allow for testing of traffic flow theories
- Provide an independent assessment of other research (Kerner)