Calibrating Speed-Density Functions for Mesoscopic Traffic Simulation

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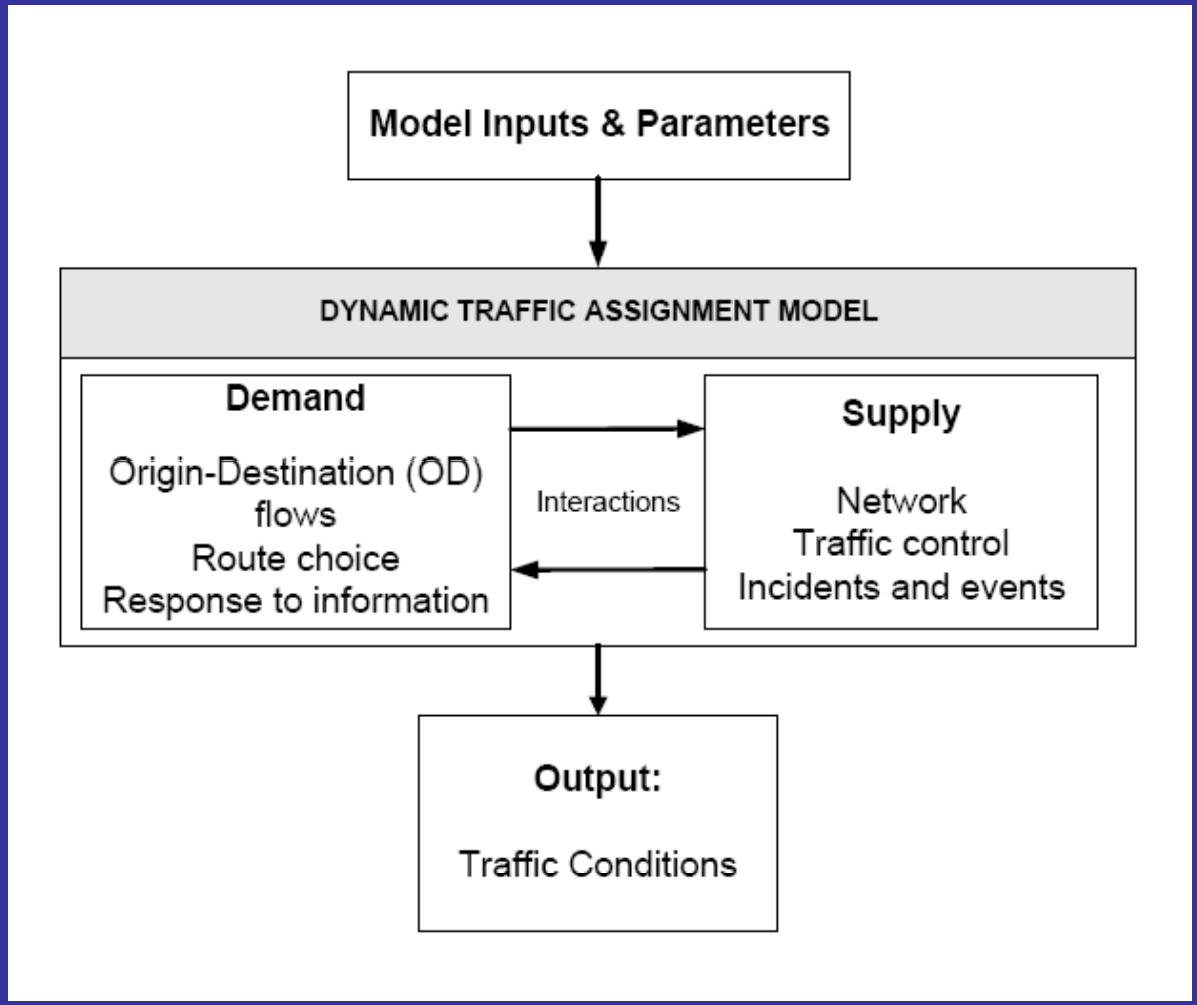
Motivation



- Key supply input: speed-density functions for all road segments

Literature Review

- Off-line
  - Curve-fitting
    - *Leclercq (2005), Van Aerde & Rakha (1995)*
  - Parameter subsets
    - *Munoz et al. (2004)*
  - Freeway corridors and sections
    - *Ngoduy & Hoogendoorn (2003), Ngoduy et al. (2006)*
  - General networks
    - *Park et al. (2006), Kunde (2002), Balakrishna et al. (2007)*
- On-line
  - Adjustments in response to real-time data
    - *Doan et al. (1999), Tavana & Mahmassani (2000), Wang & Papageorgiou (2005), Antoniou et al. (2007)*

Case Studies

(I) Los Angeles, CA (off-line)

(II) Lower Westchester County, NY (off-line)

(III) Southampton, UK (on-line)

- DynaMIT: Mesoscopic model to be calibrated
  - Disaggregate (microscopic) demand
  - Aggregate (macroscopic) supply

Case Studies (contd.)

- DynaMIT speed-density function form

$$v = v_{max}\left[1 - \left(\frac{k - k_{min}}{k_{jam}}\right)^{\beta}\right]^{\alpha}$$

- Performance measures

$$RMSN = \frac{\sqrt{S\sum_{i=1}^{S}(y_i - \hat{y}_i)^2}}{\sum_{i=1}^{S} y_i}$$

y_i : observed (count, speed)

$\hat{y}_i$: simulated (count, speed)

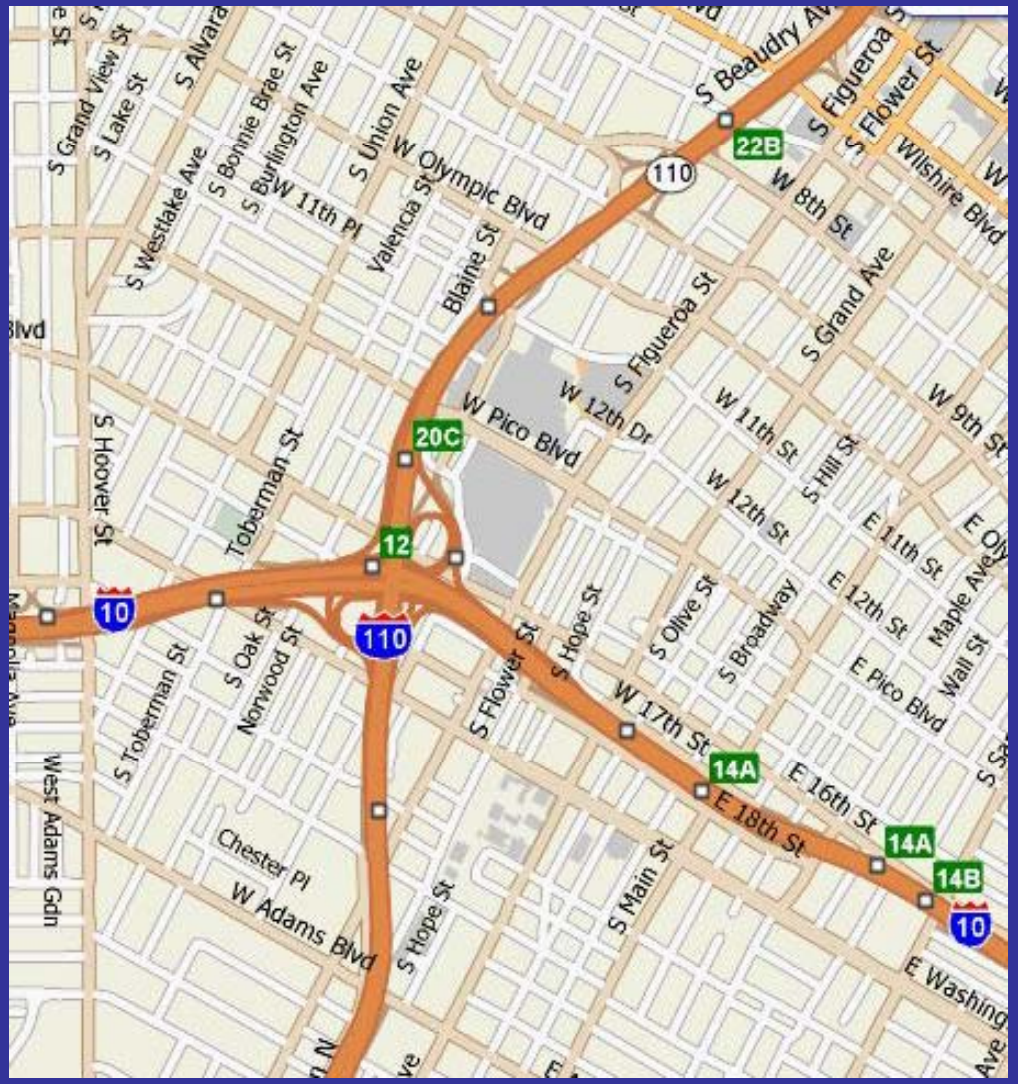
S : number of data points

Case Studies (contd.)

- Methodology
  - Large-scale optimization
    - Match DTA outputs to data
  - Highly non-linear
  - Solution algorithms
    - SPSA, Kalman Filter
- Data issues
  - Very sparse sensor coverage
  - Measurement errors
  - Spatial inconsistencies

Case Study I: Los Angeles, CA

- 740 segments
- Freeways, arterials
- Heavy congestion
  - Staples Center
  - Conventions
- Loop data
  - Counts, occupancies



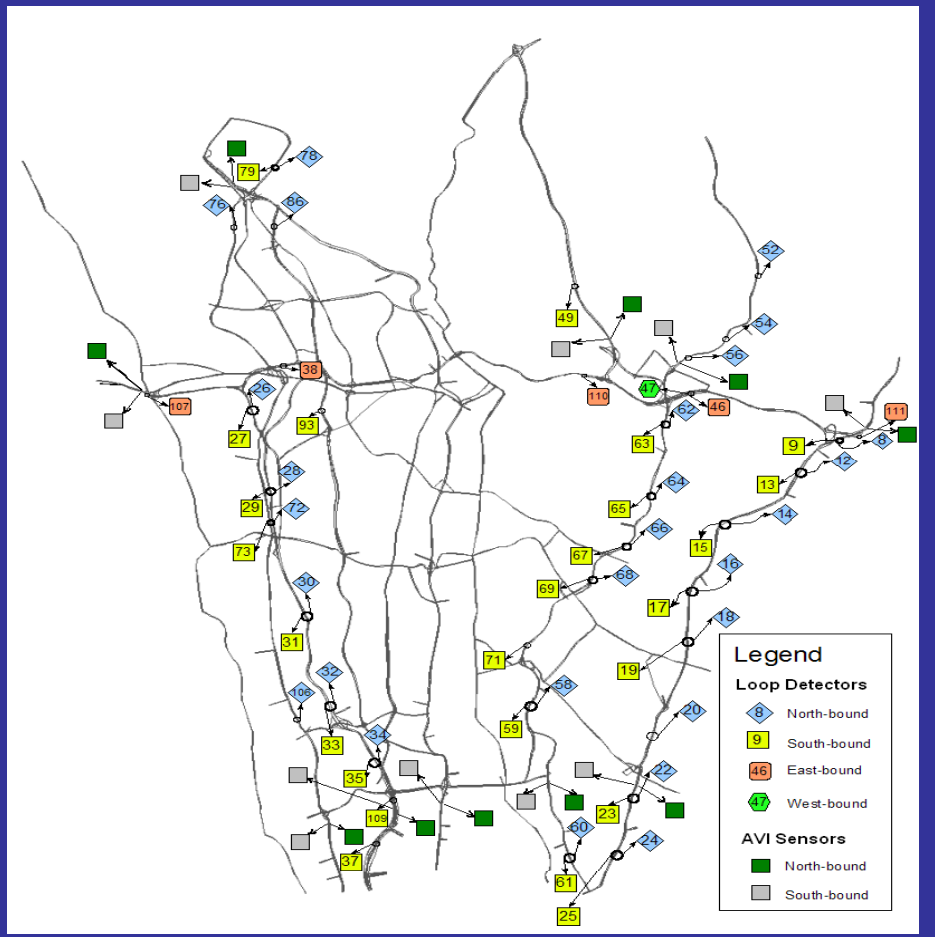
Case Study I: Results

Estimator	Fit to Counts ($RMSN^c$)		Fit to Speeds ($RMSN^s$)	
	Freeway	Arterial	Freeway	Arterial
Ref	0.218	0.239	0.181	0.203
S(c)	0.149	0.178	0.119	0.131

- Ref
  - Local fitting of speed-density functions
- S(c)
  - Network-level supply calibration with counts
  - Demand same as Ref

Case Study II: Lower Westchester County, NY

- Freeways
- 8 time intervals
- Data
  - Loop counts, speeds
  - AVI (Automatic Vehicle ID)

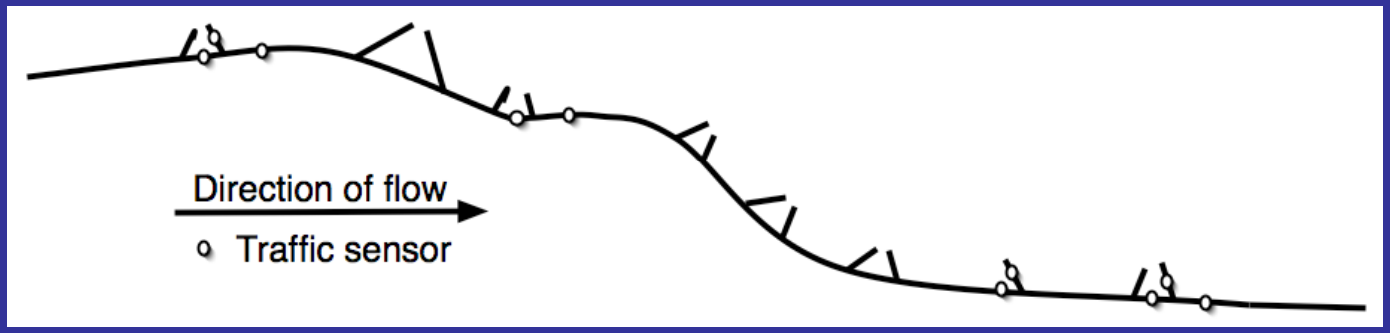


Case Study II: Results

- Calibration variables
  - Dynamic OD flows
  - Speed-density parameters
  - Capacities

	Fit to counts ($RMSN^c$)	Fit to speed ($RMSN^s$)
A priori	0.253	0.291
Count data	0.200	0.222
Count+AVI data	0.182	0.212

Case Study III: Southampton, UK

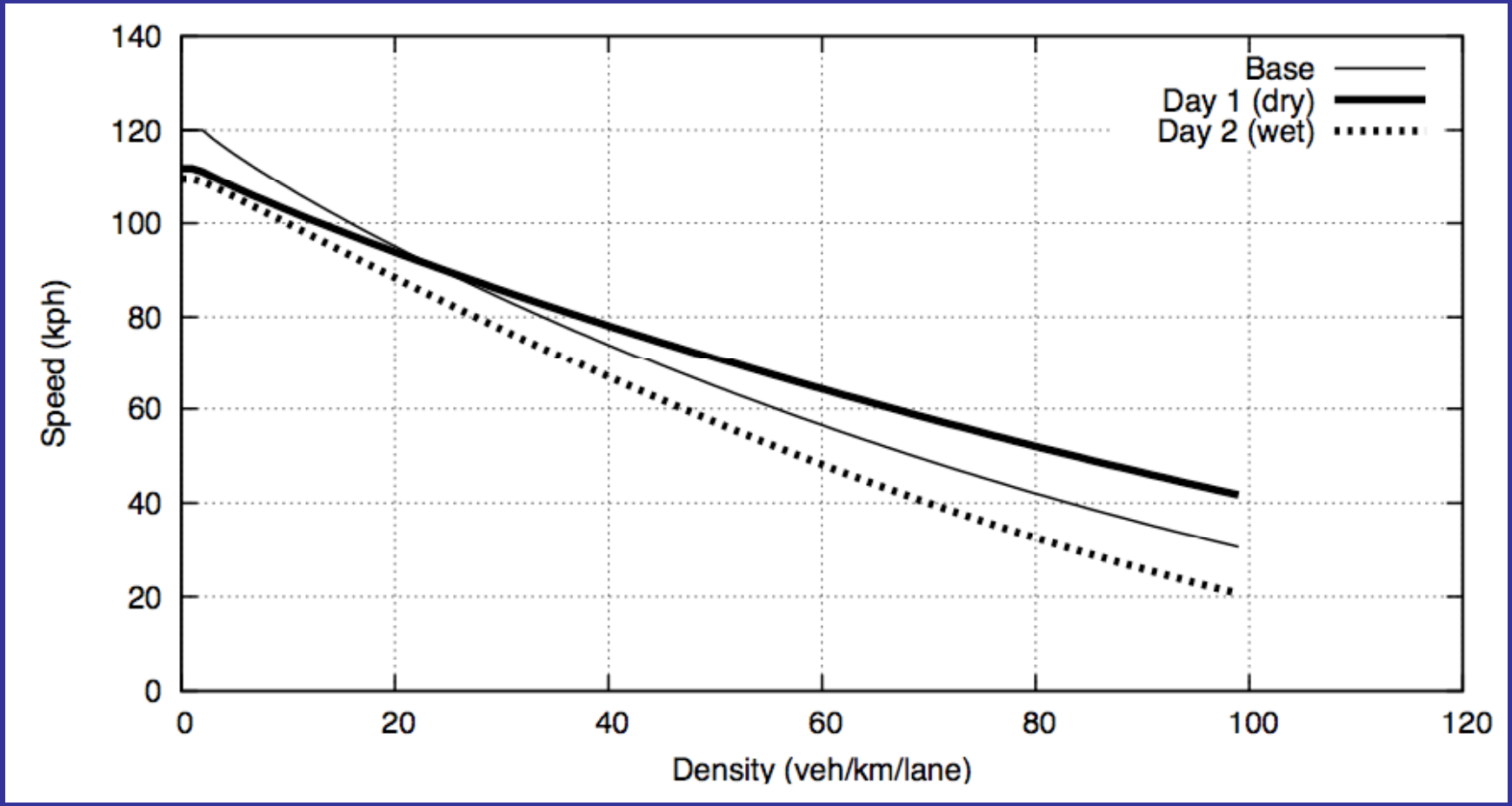


- On-line
  - Demand calibration only (base)
  - Demand + supply calibration
    - Dry weather
    - Wet weather

Case Study III: Results

	Demand-only		Demand and supply	
	Fit to counts ($RMSN^c$)	Fit to speeds ($RMSN^s$)	Fit to counts ($RMSN^c$)	Fit to speeds ($RMSN^s$)
Dry weather	0.128	0.126	0.109	0.112
Wet weather	0.115	0.131	0.102	0.117

Case Study III: Results (contd.)



- Re-calibrated speeds lower for wet day

Conclusion

- Speed-density functions
  - Capture traffic dynamics in many DTA models
  - Have several parameters for each segment
  - Require calibration against real traffic data
- DynaMIT applications
  - Network-wide calibration
  - Off-line, on-line
  - Replicates counts and speeds
  - Adjusts parameters for conditions on given day