Space mean speed and time mean speed
Empirical differences

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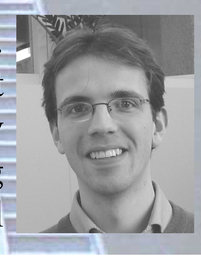
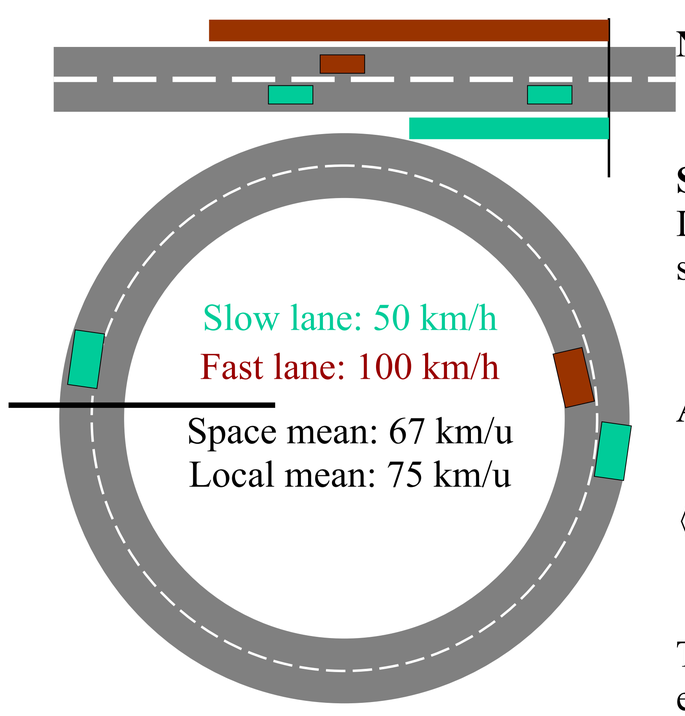


Abstract

Loop detectors provide a large part of traffic information. They log usually the time mean average speed. It is well known that a time mean average is higher than a space mean average (see figure aside). A database gives the passing time and the speed of individual vehicles. From this local data, one can estimate the space mean speed. We compare the time mean speed with the estimated time mean speed. The difference is big: in the lower speed regime on average almost a factor 2, and up to a factor 4 in individual cases. A flow-density diagram fits the data much better if constructed using a space mean speed; it also predicts the propagation speed of density waves more accurately.



Normal, time mean average speed:

$$\langle v \rangle_T = \frac{1}{n}\sum_{i=1}^{n} v_i$$

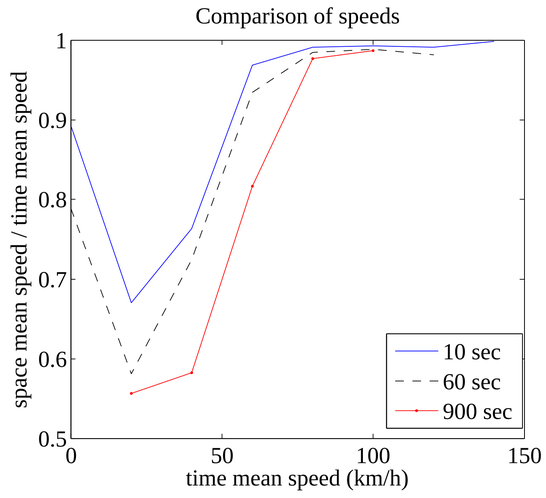
Space mean speed
Influence length proportional to speed. Correct with weight factor:

$$W_i = \frac{1}{v_i}$$

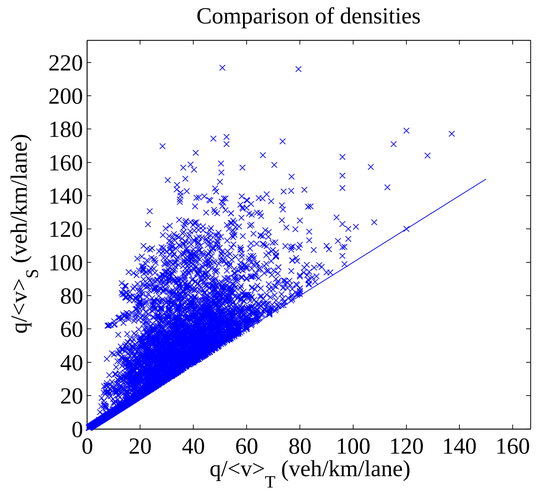
Average the weighted speeds:

$$\langle v \rangle_S = \frac{\sum_{i=1}^{n} W_i v_i}{\sum_{i=1}^{n} W_i} = \frac{\sum_{i=1}^{n} \frac{1}{v_i} v_i}{\sum_{i=1}^{n} \frac{1}{v_i}} = \frac{1}{\frac{1}{n}\sum_{i=1}^{n} \frac{1}{v_i}} = \left\langle \frac{1}{v} \right\rangle_T$$

Thus, the space mean of speed equals the time mean of slowness.



The average difference of time mean speed and space mean speed is bigger for larger times and with lower speeds.



Densities computed as q/v, 10 seconds aggregation interval; every dot is a measurement. Densities computed with space mean speed are (up to 4 times) higher

Differences in mean speeds

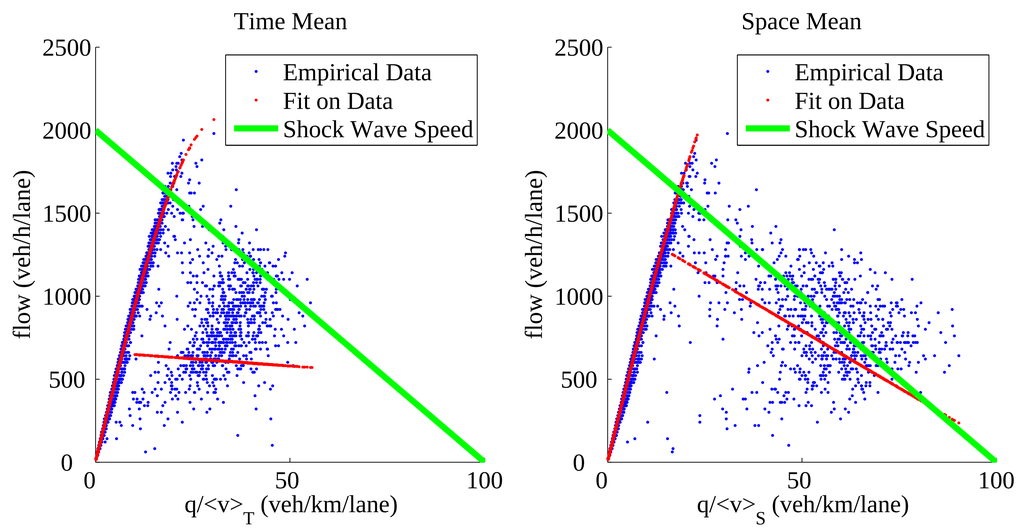
Differences time mean speed and space mean speed:

- caused by differences in speed of individual cars;
- Average in speed class:
  - in congestion larger than in free flow;
  - larger in large aggregation times;
- Differences in low speeds most important for inverse of speed (density, travel times)
- In one aggregation time, difference can be factor 4
  - short aggregation time shows bigger differences

Fit of fundamental diagram

The flow is plotted versus the density, determined by ρ=q/v. Using the space mean speed in this equation gives a better fit. Data from more detectors provide the speed at which a density wave travels upstream (20 km/h). The diagram with time mean speed represents this better. The fit of the congested branch gives the jam density.
Using a time mean speed shock wave speed and jam density are derived more accurately. These values can improve macroscopic traffic simulators.

Flow-density diagrams based on time mean speed and space mean speed



The density is approximated by q/v. Using the space mean speed, one gets a better fit. This data is aggregated over 1 minute.

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