Investigating the Empirical Existence of Static User Equilibrium

J. Raimbault[1,2]

juste.raimbault@parisgeo.cnrs.fr

[1]UMR CNRS 8504 Géographie-cités
[2]UMR-T IFSTTAR 9403 LVMT

EWGT 2016

Session Transportation Modeling

5th September 2016

Traffic Modeling : User Equilibrium Frameworks

Equilibrium frameworks central in Transportation Research since Wardrop [Wardrop, 1952]

Recent Developments :

→ Dynamic Stochastic User Equilibrium [Han, 2003]

→ Restricted Stochastic User Equilibrium [Rasmussen et al., 2015] more realistic in alternatives

→ Boundedly User Equilibrium [Mahmassani and Chang, 1987]

→ Assignment techniques inspired from other fields such as Network Science [Puzis et al., 2013]

Validation and Practical Use

Static User Equilibrium lacks emirical validation in the literature
Behavioral study of route choices in [Zhu and Levinson, 2010]
[Leurent and Boujnah, 2014]

Empirical Investigation of SUE Existence

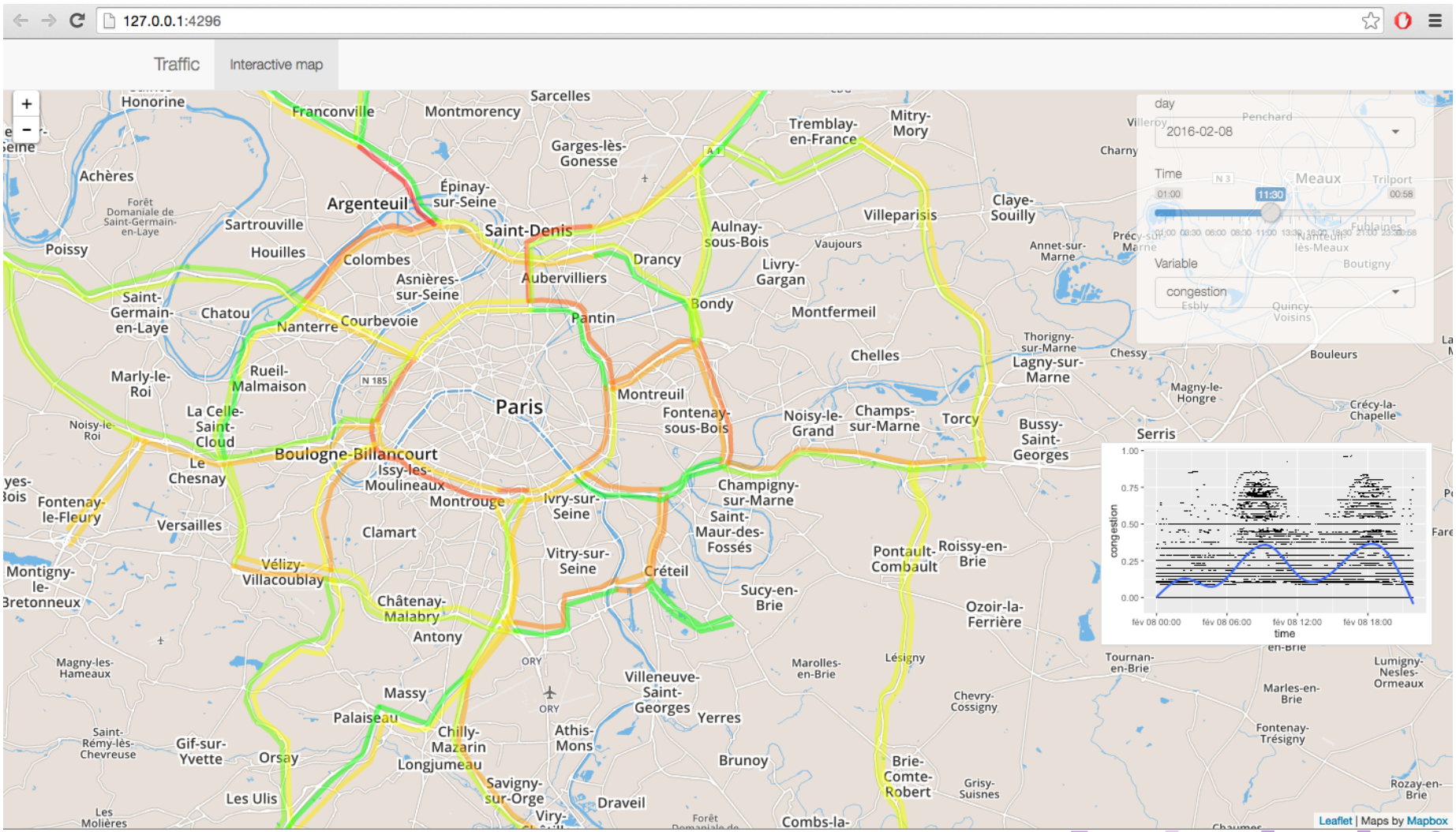
Research Objective : *Investigate empirically the spatio-temporal stationarity of flows, combining different quantitative approaches*

Data Collection

Difficulty to find Open Data on Transportation Systems
[Bouteiller and Berjoan, 2013]
$\rightarrow$ Construction of an open historical travel time dataset for major links in the region of Paris, collecting in real time public data from

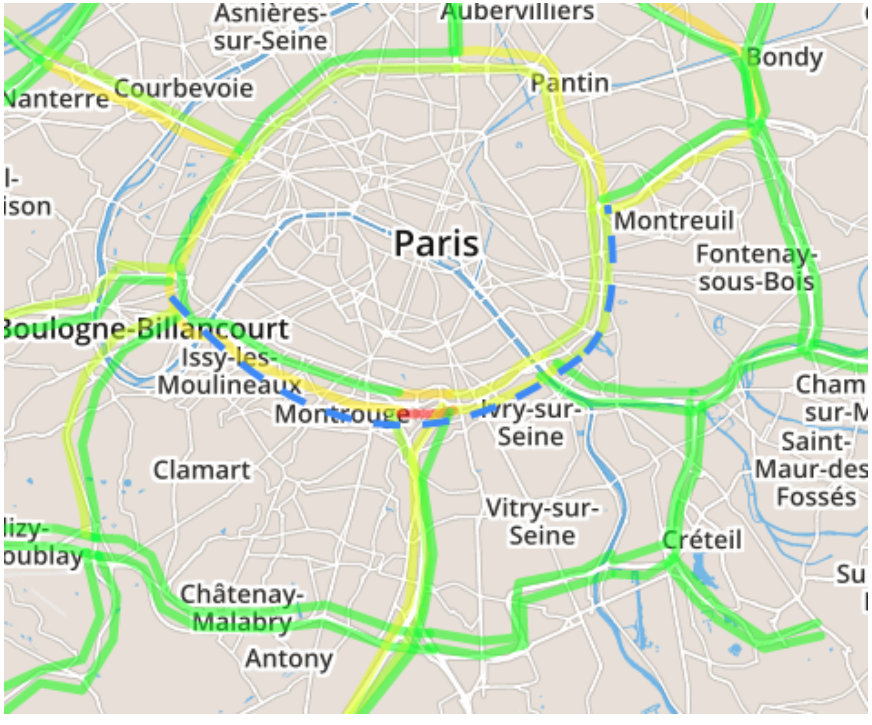
Interactive Data Visualization

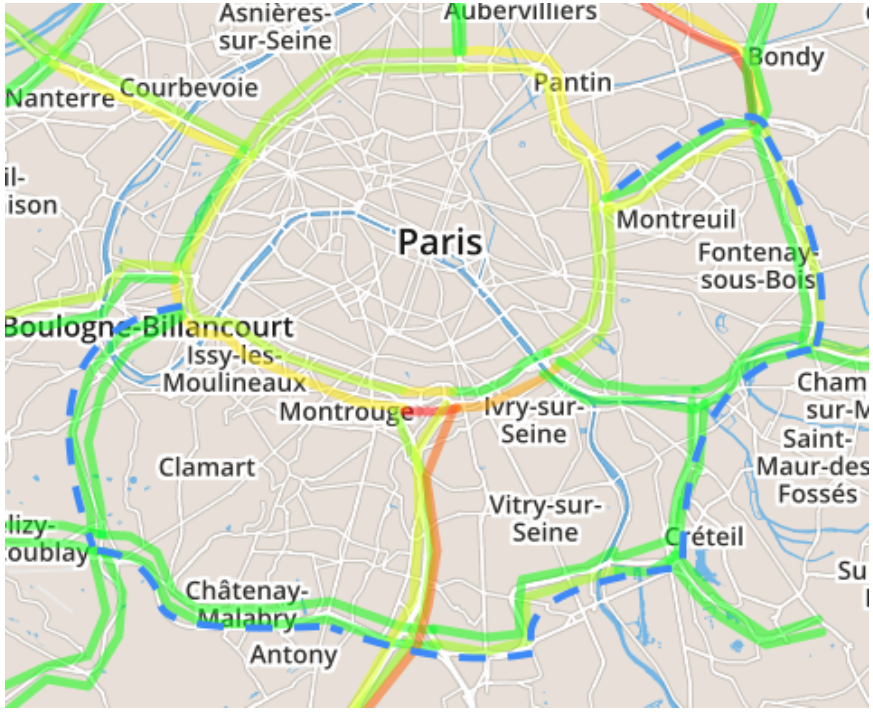
Interactive web-application for spatio-temporal exploration



Spatio-temporal Variability : Example

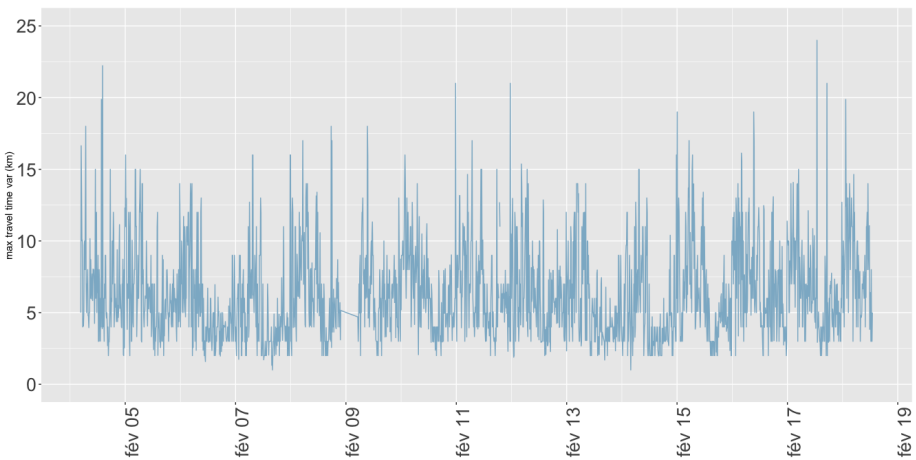
Very high spatial variability on 10min time interval

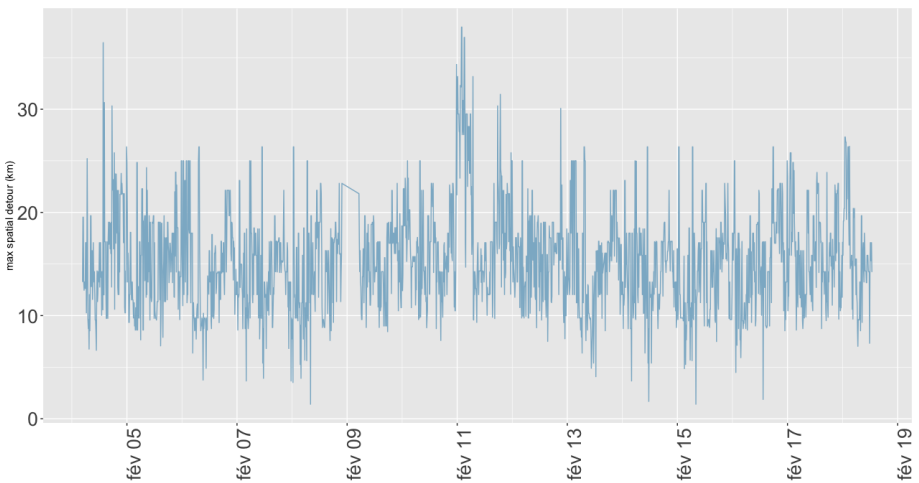




Spatio-temporal Variability

Maximal travel time and spatial variabilities





Stability of Network Measures

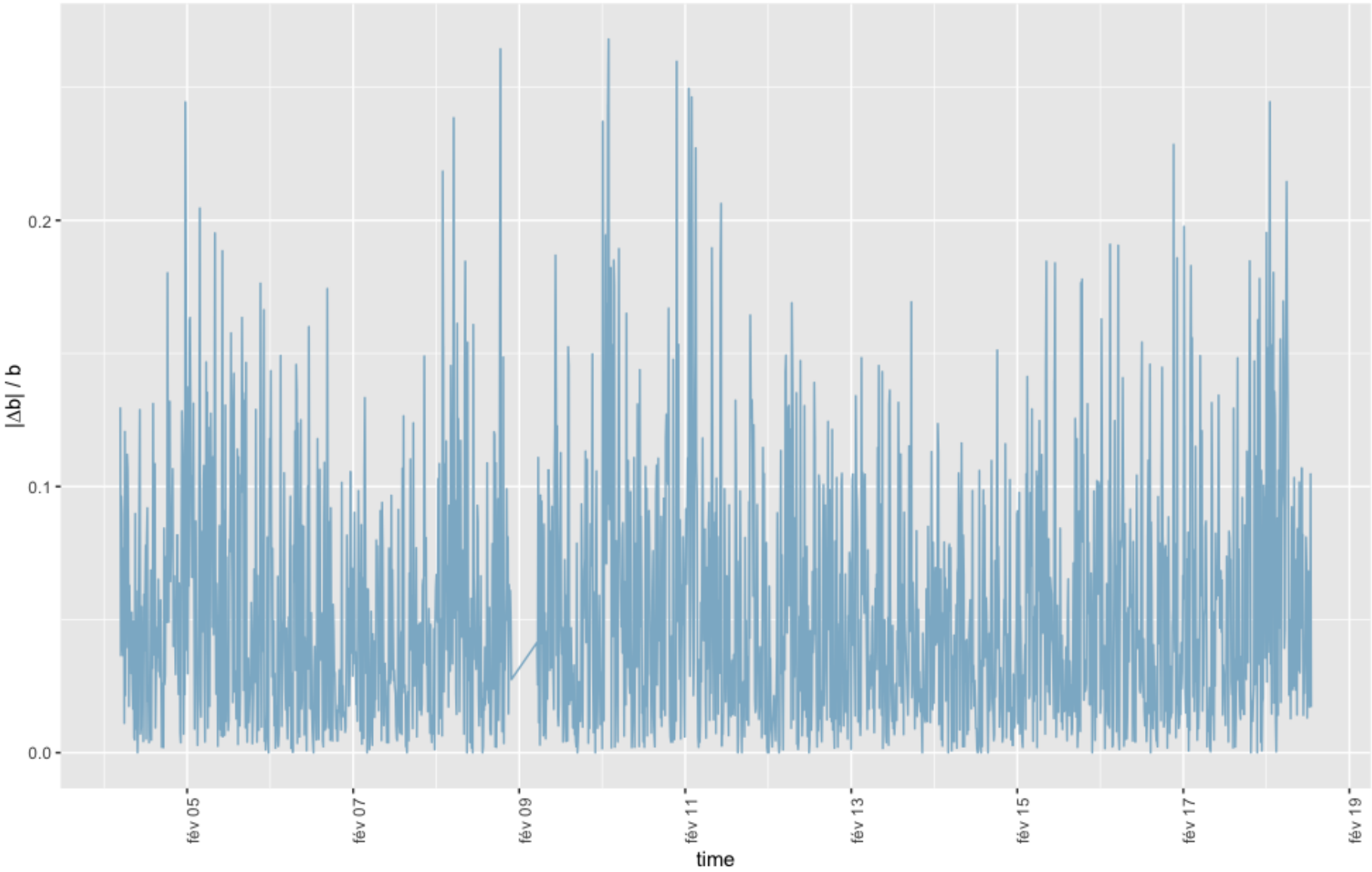
Network Betweenness Centrality

$$b_i = \frac{1}{N(N-1)} \cdot \sum_{o \neq d \in V} \mathbb{1}_{i \in p(o \to d)} \tag{1}$$

Variability

$$\Delta b(t) = \frac{|\max_i(b_i(t + \Delta t)) - \max_i(b_i(t))|}{\max_i(b_i(t))} \tag{2}$$

Stability of Network Measures



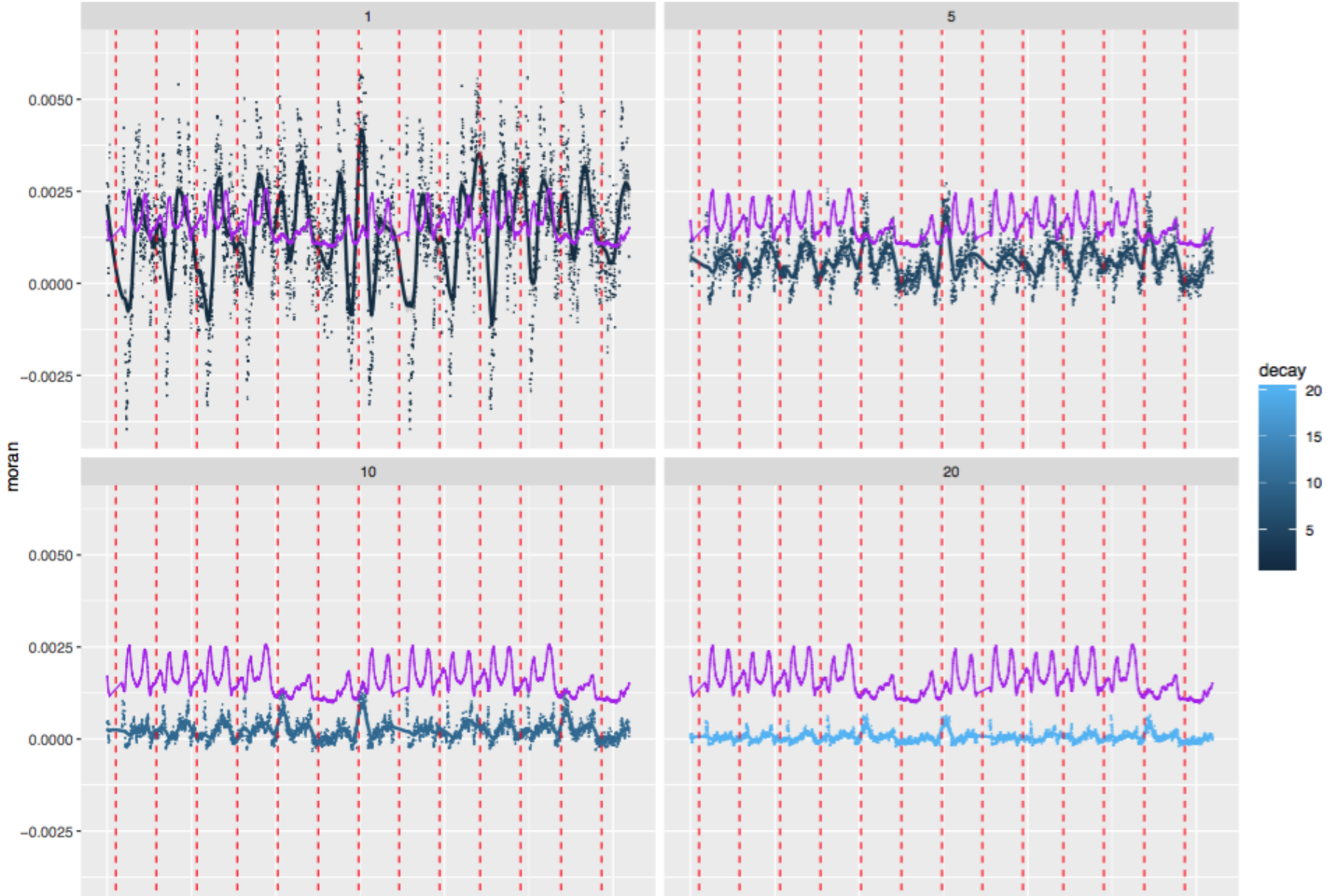
Spatial Heterogeneity

Spatial Autocorrelation as an index of spatial variability

$$\rho_i = \frac{1}{K} \cdot \sum_{i \neq j} w_{ij} \cdot (c_i - \bar{c})(c_j - \bar{c}) \tag{3}$$

with weights $w_{ij} = \exp\left(\frac{-d_{ij}}{d_0}\right)$

Spatial Heterogeneity



Theoretical and Practical Implications

Theoretical Implications

$\rightarrow$ Need for more systematic comparison of framework validity : multi-modeling. [Kryvobokov et al., 2013] compares two LUTI models

$\rightarrow$ Can still be used e.g. for integration within more complex models

Practical Implications

$\rightarrow$

Explanative Interpretations

Possible Developments

Conclusion

References I

Bouteiller, C. and Berjoan, S. (2013).
Open data en transport urbain: quelles sont les données mises à disposition? quelles sont les stratégies des autorités organisatrices?

Han, S. (2003).
Dynamic traffic modelling and dynamic stochastic user equilibrium assignment for general road networks.
Transportation Research Part B: Methodological, 37(3):225–249.

Kryvobokov, M., Chesneau, J.-B., Bonnafous, A., Delons, J., and Piron, V. (2013).
Comparison of static and dynamic land use-transport interaction models.
Transportation Research Record: Journal of the Transportation Research Board, 2344(1):49–58.

References II

Leurent, F. and Boujnah, H. (2014).
A user equilibrium, traffic assignment model of network route and parking lot choice, with search circuits and cruising flows.
Transportation Research Part C: Emerging Technologies, 47:28–46.

Mahmassani, H. S. and Chang, G.-L. (1987).
On boundedly rational user equilibrium in transportation systems.
Transportation science, 21(2):89–99.

Puzis, R., Altshuler, Y., Elovici, Y., Bekhor, S., Shiftan, Y., and Pentland, A. (2013).
Augmented betweenness centrality for environmentally aware traffic monitoring in transportation networks.
Journal of Intelligent Transportation Systems, 17(1):91–105.

References III

Rasmussen, T. K., Watling, D. P., Prato, C. G., and Nielsen, O. A. (2015).
Stochastic user equilibrium with equilibrated choice sets: Part ii–solving the restricted sue for the logit family.
Transportation Research Part B: Methodological, 77:146–165.

Wardrop, J. G. (1952).
Some theoretical aspects of road traffic research.
Proceedings of the institution of civil engineers, 1(3):325–362.

Zhu, S. and Levinson, D. (2010).
Do people use the shortest path? an empirical test of wardrop's first principle.
In *91th annual meeting of the Transportation Research Board, Washington*, volume 8. Citeseer.