DY 64: Traffic Dynamics, Urban and Regional Systems (joint session SOE/DY)

Time: Thursday 15:00–16:15 Location: MA 001

DY 64.1 Thu 15:00 MA 001

A planar growing network model for urban street network evolution — •Oliver Weisse and Reik V. Donner — Potsdam Insitute for Climate Impact Research, Potsdam, Germany

Historically grown cities can be at least partially understood as the result of self-organization principles without central planning authority. In order to understand the associated spatial settlement patterns, it is convenient to analyze the associated urban road networks providing the backbone of such cities. Recent work has demonstrated that the topological and geometric properties of such networks exhibit a surprising degree of universality, suggesting that the corresponding structure formation has been governed by relatively general principles.

Here, we propose an evolving planar network model based on a small set of simple rules that model stochastic network growth under local optimization of construction costs and travel efficiency. Specifically, we assume that the growth of cities follows a probability distribution of nodes in a two-dimensional Euclidean space with higher probability in areas where infrastructure already exists. In contrast to other existing models of urban road networks, this growth is recursive and depends on the existing city. Nevertheless, the geometric characteristics of the generated planar networks are statistically similar for sufficiently large cities, implying that they are largely independent of the specific evolution path. Moreover, the observed properties agree well with those of real-world cities.

DY 64.2 Thu 15:15 MA 001

Dynamics of cities' population: relating Zipf's law and urban scaling — •José M. Miotto — LIACS, Universiteit Leiden, Netherlands

The distribution of city sizes in a country is characterized by having a power-law tail (Pareto), a common feature of large social systems. Proportional effect -each city grows with the same rate- is a well-accepted growth model for cities that explains the emergence of this feature (Gabaix); however, data from cities gathered in historical scale (Italy, 1861-2011) shows important features that cannot be explained by this model. I will introduce a modified growth model where the growth rate of cities scales with city size, and show that this model can (a) reproduce quantitatively the cities' size distribution evolution in time, (b) provide a better null model for the time evolution of the population of single cities and (c) reveal patterns in the dynamics of internal migration.

DY 64.3 Thu 15:30 MA 001

Urban Kaya relation: understanding urban CO2 emissions — Ramana Gudipudi[1], •Diego Rybski[1], Matthias K. B. Lüdeke[1], Bin Zhou[1], Zhu Liu[2,3,4], and Jürgen P. Kropp[1,5] — [1]Potsdam Institute for Climate Impact Research, 14473, Potsdam, Germany — [2]John F. Kennedy School of Government, Harvard University, Cambridge, Massachusetts 02138, USA — [3]Resnick Sustainability Institute, California Institute of Technology, Pasadena, California 91125, USA — [4]Cambridge Centre for Climate Change Mitigation Research, Department of Land Economy, University of Cambridge, 19 Silver Street, Cambridge CB3 9EP, UK — [5]Dept. of Geo- and Environmental Sciences, University of Potsdam, 14476, Potsdam, Germany

Given the strong global urbanization trend, it is crucial to understand whether large urban areas are more emission efficient in comparison to smaller ones. Recent literature on urban scaling properties of emissions as a function of population size led to contradicting results and more importantly lacked an in-depth investigation of the factors leading to such scaling properties. Therefore, in analogy to the well-established Kaya Identity, we developed an urban Kaya relation to investigate different scaling properties of the indicators within the Kaya Identity. Contrary to traditional urban scaling studies which use ordinary least squares regression, we show that orthogonal regression is necessary when complex relations among scaling exponents are to be investigated.

DY 64.4 Thu 15:45 MA 001

The Urban form, quantifying population spatial distribution in cities — •Valerio Volpati and Marc Barthelemy — IPhT, Universite' Paris Saclay, France

In Urban Economics, the different forces playing a role in the development of a city have been described, leading to idealized models of cities such as the von Thunen monocentric model. In real data, the spatial distribution of activities inside cities is often more complicated and non monocentric. Here we study the population spatial distribution inside french cities, and we introduce measures to quantify how much each city is monocentric, polycentric or homogenous. We classify cities according to such measures and discuss how we can revisit classical models of Urban Economics in light of the empirical analysis.

DY 64.5 Thu 16:00 MA 001

Antipersistence of traffic flow explains congestion durations — •Sebastian M. Krause, Lars Habel, Thomas Guhr, and Michael Schreckenberg — Faculty of Physics, University of Duisburg-Essen, Lotharstr. 1, 47048 Duisburg, Germany

Many highways are running above their capacity and therefore suffer congested traffic. The traffic breakdown from free flow becomes increasingly likely around a critical flow, a critical number of vehicles per minute. Here we discuss congestion durations which are distributed with a power law over three decades, from minutes to hours [1]. This finding suggests a robust mechanism behind it. Using antipersistent stochastic modeling of the traffic flow, we are able to explain the distribution of congestion durations: The traffic flow shows large fluctuations on short time scales which quickly trend back to the mean value. Consequently, it exceeds the critical flow for time spans which are power law distributed.

[1] S. M. Krause, L. Habel, T. Guhr and M. Schreckenberg, 'The importance of antipersistence for traffic jams', EPL 118, 38005 (2017).