Modelling long-distance travel and e-commerce as add-ons to an urban land use and transport interaction model

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SDS SIG Transport Workshop

"System Dynamics in Transportation Modelling"

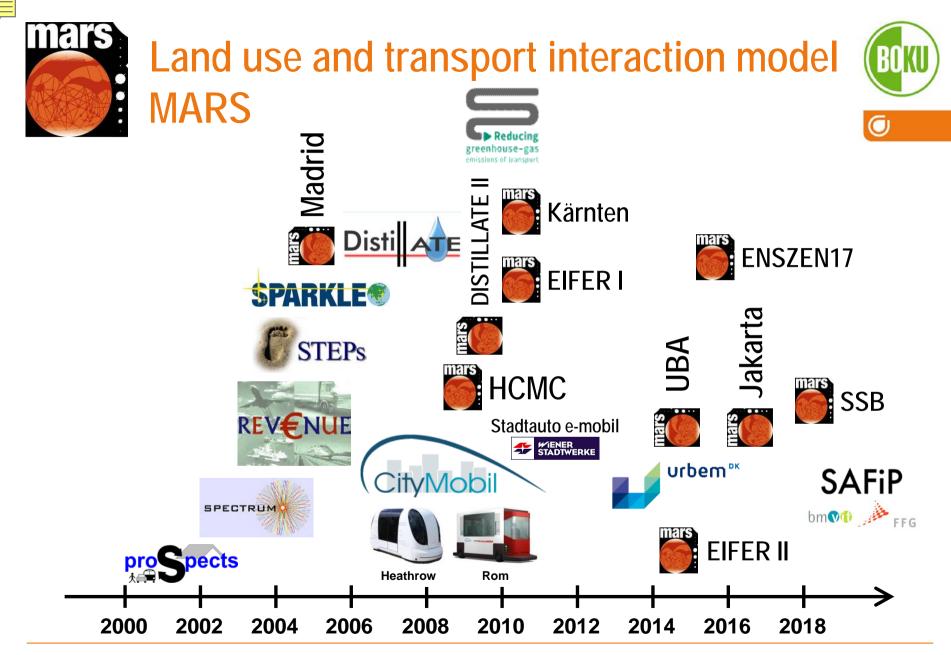Vienna, 23rd March 2018

Background and Rationale (1)

- Long-distance trips account for a small share of total trips but for a high share of distance travelled, energy consumed and pollutants emitted.

- E.g. long-distance travel by British residents accounts only for about 3% of their mechanised trips but for nearly a third of all distance travelled (Independent Transport Commission 2010).

- In Germany long-distance travel is responsible for about 34% of the transport related CO_2 emissions and 66% of transport related GWP20 (Reichert et al 2018).

- Furthermore long-distance travel is expected to continue to grow significantly in the future.
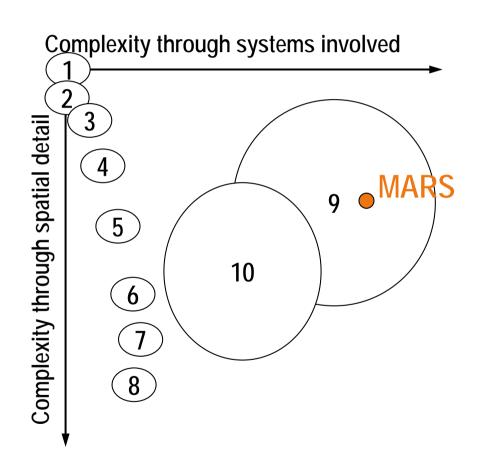
Background and Rationale (2)

- *Between 10 and 15% of all vehicle mileage driven in cities involves freight traffic* (Ploos van Amstel 2015).

- In Europe urban freight traffic grows with about 4-5% p.a., i.e. is doubling in about 15 years (Ploos van Amstel 2016).

- In Vienna urban freight is responsible for about 20-25% of the transport related CO_2 emissions and about 70% of the transport related NO_X emissions (Stadt Wien 2009).

- E-commerce is a major driver for urban freight and city logistics.

- In Austria the share of people shopping online increased from 11% in 2003 to 58% in 2016 and this trend continues (Statistik Austria 2016).

Land use and transport interaction model MARS

Modelling strategies to cope with the complexities of the real world

Complexity through systems involved

Complexity through spatial detail

1
2
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9 ● MARS
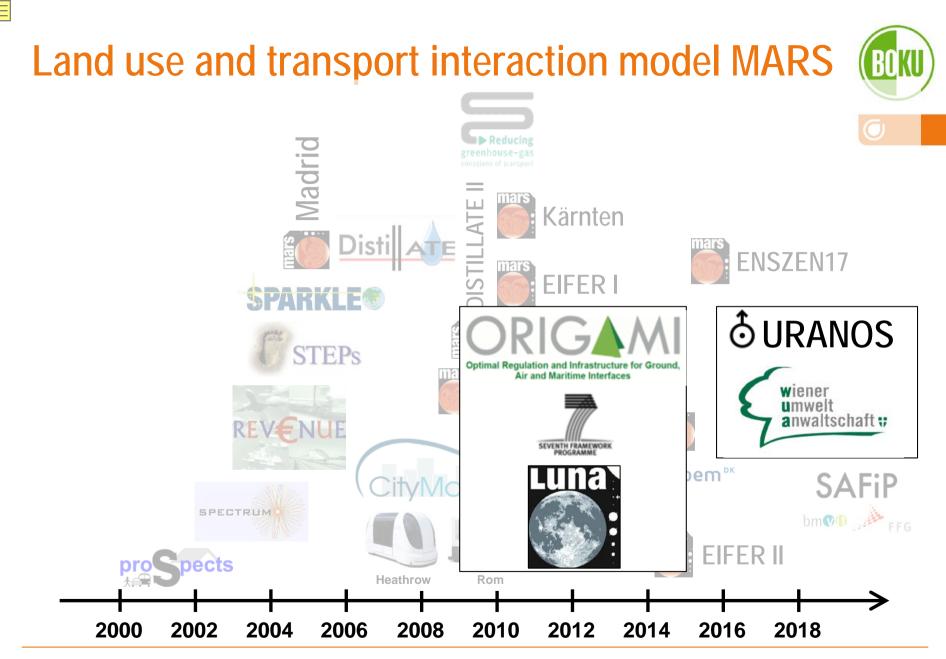
1. No model
2. Simple cost based
3. Spreadsheet model
4. Sketch planning model
5. Network assignment model without elastic assignment
6. Network assignment model with elastic assignment
7. Network assignment model in conjunction with external demand / mode-choice model
8. Four stage model
9. Land-use Transportation Interaction (LUTI) model
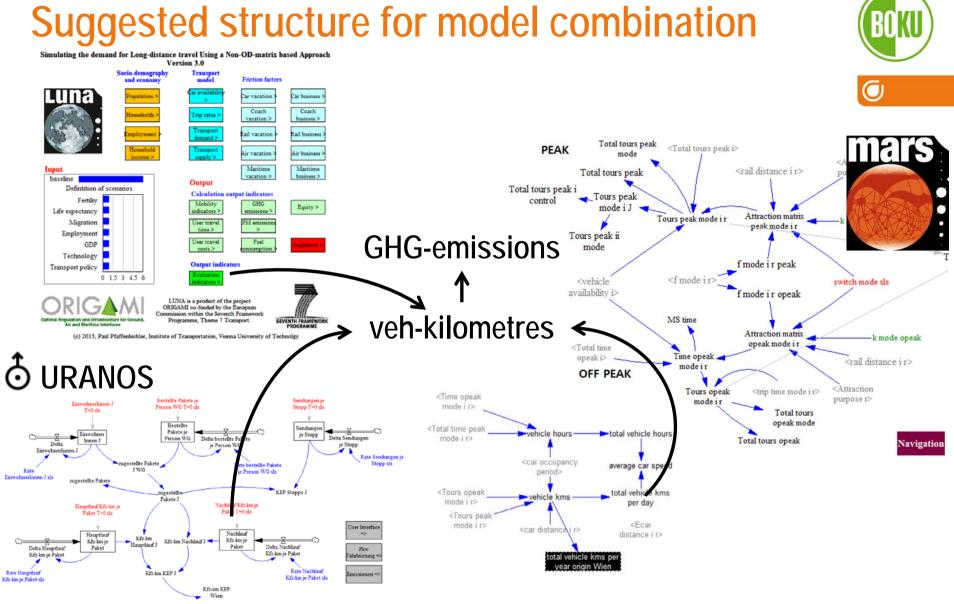10. Strategic Transport/ Environment Model

Main characteristics

- **Modes of transport**: Walking, Cycling, Motorcycle, Private car (ICE & BEV), Bus/coach, Railway, Informal PT (Tuk Tuk, etc.)
- **Trip purposes**: Commuting, Others
- **Main Sub-Models/Modules**:
  - a travel demand model,
  - a household location model,
  - a workplace location model,
  - a policy definition user interface and
  - a module calculating process and evaluation indicators.
- **Time horizon**: typically 30 years in steps of ¼ years

Land use and transport interaction model MARS

A timeline from 2000 to 2018 showing various projects: proSpects, Madrid, DistillATE, SPARKLE, STEPs, REVENUE, SPECTRUM, CityMobil, Heathrow, Rom, Reducing greenhouse-gas emissions of transport, DISTILLATE II, Kärnten, EIFER I, ENSZEN17, ORIGAMI (Optimal Regulation and Infrastructure for Ground, Air and Maritime Interfaces, Seventh Framework Programme), Luna, URANOS (wiener umwelt anwaltschaft), SAFiP, EIFER II

Suggested structure for model combination

GHG-emissions

veh-kilometres

URANOS

a non OD-matrix based long-distance travel model

- LUNA consists of seven sub-models and modules:
  - a population cohort model,
  - a household formation model,
  - an employment and household income model,
  - a car ownership model,
  - a non-OD-matrix based transport demand model,
  - an aggregate transport supply model and
  - a module calculating evaluation indicators.
- EU27 by country plus Norway and Switzerland
- Five modes of transport: private car, bus/coach, railway, air and maritime
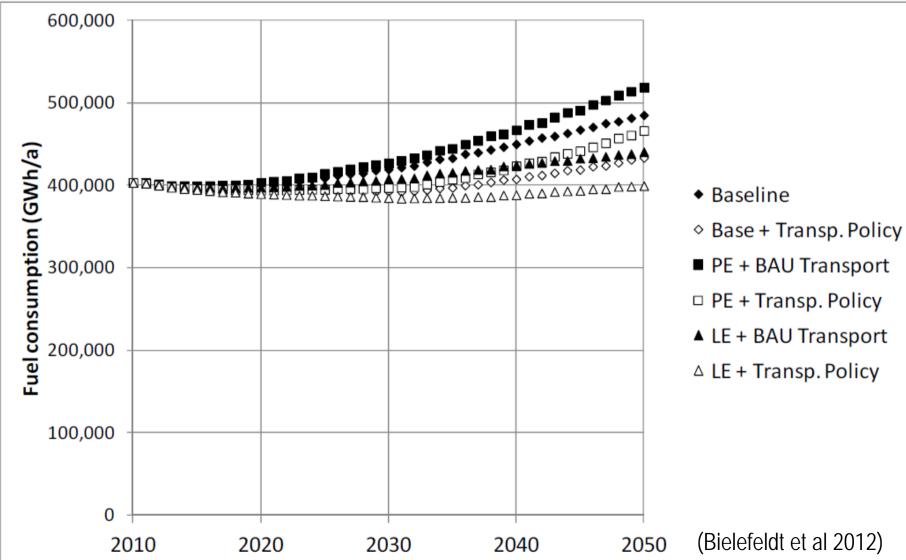
a non OD-matrix based long-distance travel model

- Population is subdivided into 18 age cohorts in five year time steps and distributed to ten different household types.

- Household income is calculated from scenario assumptions concerning GDP development and allocated to three income groups.

- Car availability is a function of household type and income.

- Trip rates are a function of household income and car availability (holidays) and GDP per employed (business).

- Simultaneous trip distribution to distance class and mode.

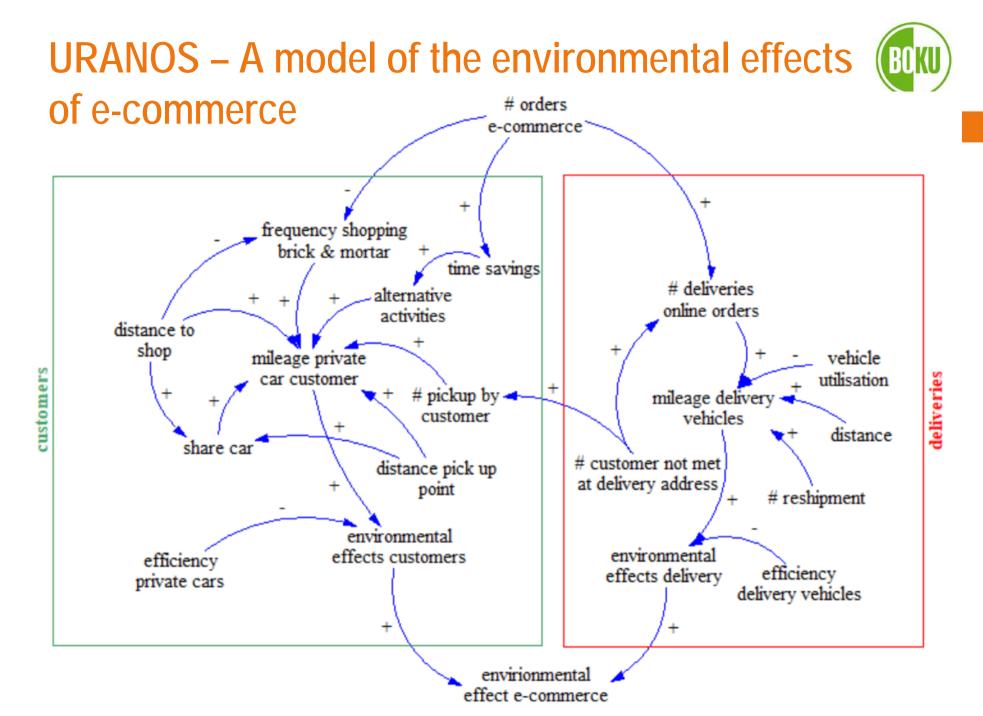- Utility is a function of weighted time and cost components of a journey.

a non OD-matrix based long-distance travel model - results

(Bielefeldt et al 2012)

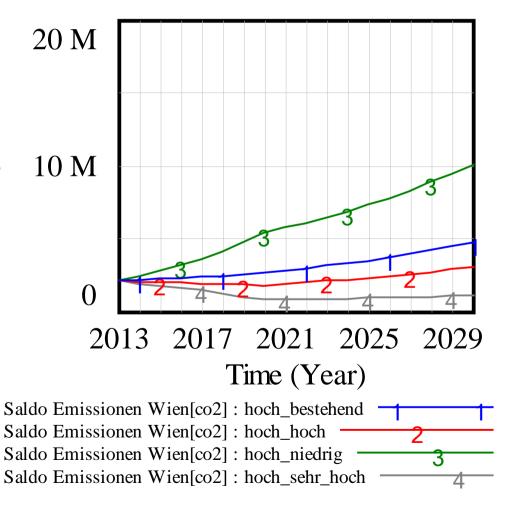# URANOS – A model of the environmental effects of e-commerce

- In a recent project a stock-flow model for the assessment of the environmental effects of e-commerce was developed on behalf of the Viennese Environmental Advocacy Office.

- The purpose is NOT to model the demand for e-commerce but the balance of transport related effects.

- The development of the total demand for e-commerce is a scenario variable.
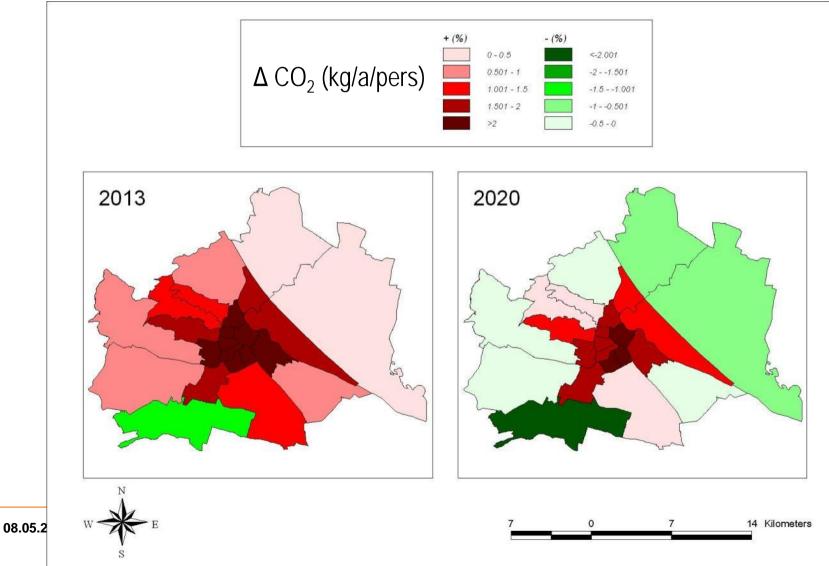
URANOS – Environmental effects of e-commerce First results

- Balance of CO_2 emissions per person and year

- Demand scenario „high"

- Delivery efficiency scenarios
  - "low"
  - "existing"
  - "high"
  - "very high"

Saldo Emissionen Wien

Saldo Emissionen Wien[co2] : hoch_bestehend

Saldo Emissionen Wien[co2] : hoch_hoch

Saldo Emissionen Wien[co2] : hoch_niedrig

Saldo Emissionen Wien[co2] : hoch_sehr_hoch

URANOS – Environmental effects of e-commerce
First results - scenario „high/very high"

Summary

- A significant share of transport related energy consumption and emissions is caused by long-distance travel and urban freight transport.

- Despite this fact, environmental assessment of scenarios and policies is typically based on urban transport models of workday trips.

- As a remedy a concept for the use of the long-distance transport model LUNA and the e-commerce model of the project URANOS as add-ons to the integrated land use and transport interaction model MARS is suggested.

- Open question to be discussed: full integration vs. iterative procedure of stand alone models?

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Most models and results presented here stem from work at:

Published versions of the models and could be found at:
www.fvv.tuwien.ac.at/forschung/mars-metropolitan-activity-relocation-simulator/overview/
http://www.fvv.tuwien.ac.at/forschung/projekte/international-projects/origami/origami-luna/