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Fachhochschule Nordwestschweiz

ETH Zürich

Modelling Ultrafine Particle Number Concentration in Zurich with High Spatio-Temporal Resolution

18th ETH-Conference on Combustion Generated Nanoparticles. June 24, 2014.

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[3]University of Applied Sciences and Arts Northwestern Switzerland, Windisch, Switzerland.

Ultrafine particle (UFP) number concentration in Zurich

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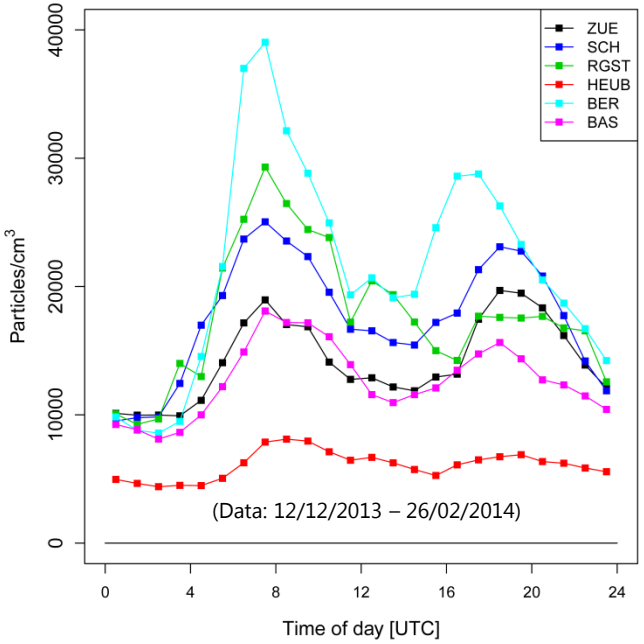
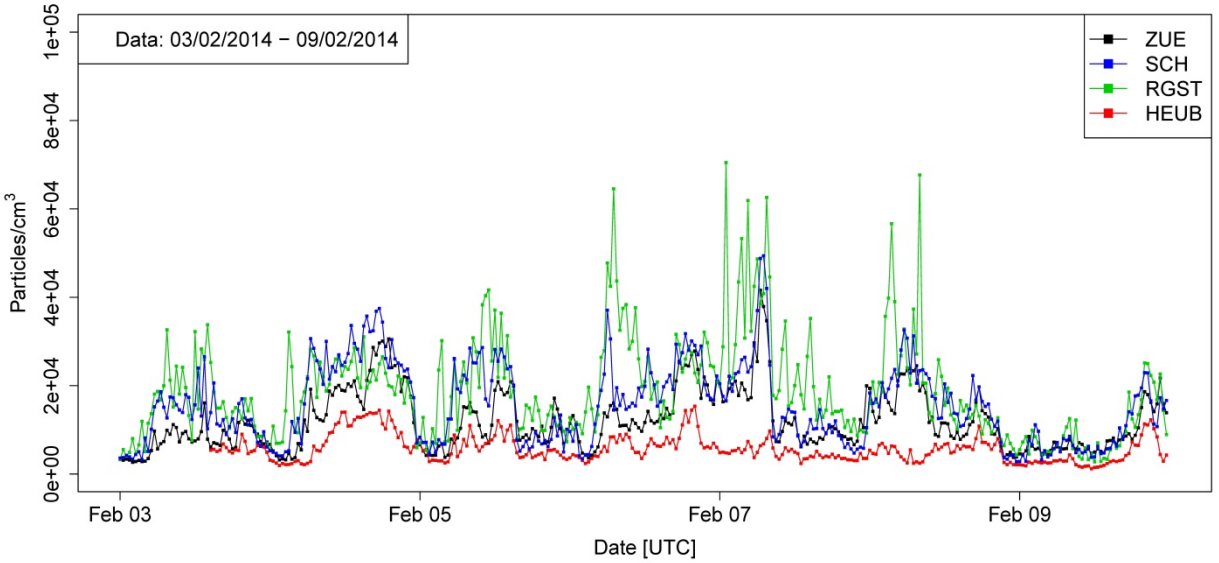
Averaged data, weekdays



30 minutes mean PNC



City of Zurich | **Bern-Bollwerk** | **Basel-Binningen**

(~1 month of data)

(UGZ)

(~1 month of data)

(NABEL)

(NABEL)

Ultrafine particles (UFP) concentration maps

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Ultrafine particles (UFP)

- Diameter < 0.1 µm
- Main emission source: road traffic (urban environments, Switzerland)
- UFP in ambient air are a potential risk to human health

Application fields of highly resolved pollutant concentration maps

- Investigation of health effects related to air pollutants
  - Improvement of the accuracy of personal exposure estimates
- Urban management and health protection
  - Impact assessment of traffic management on air quality
  - Settlement development, land-use planning

Statistical Modelling

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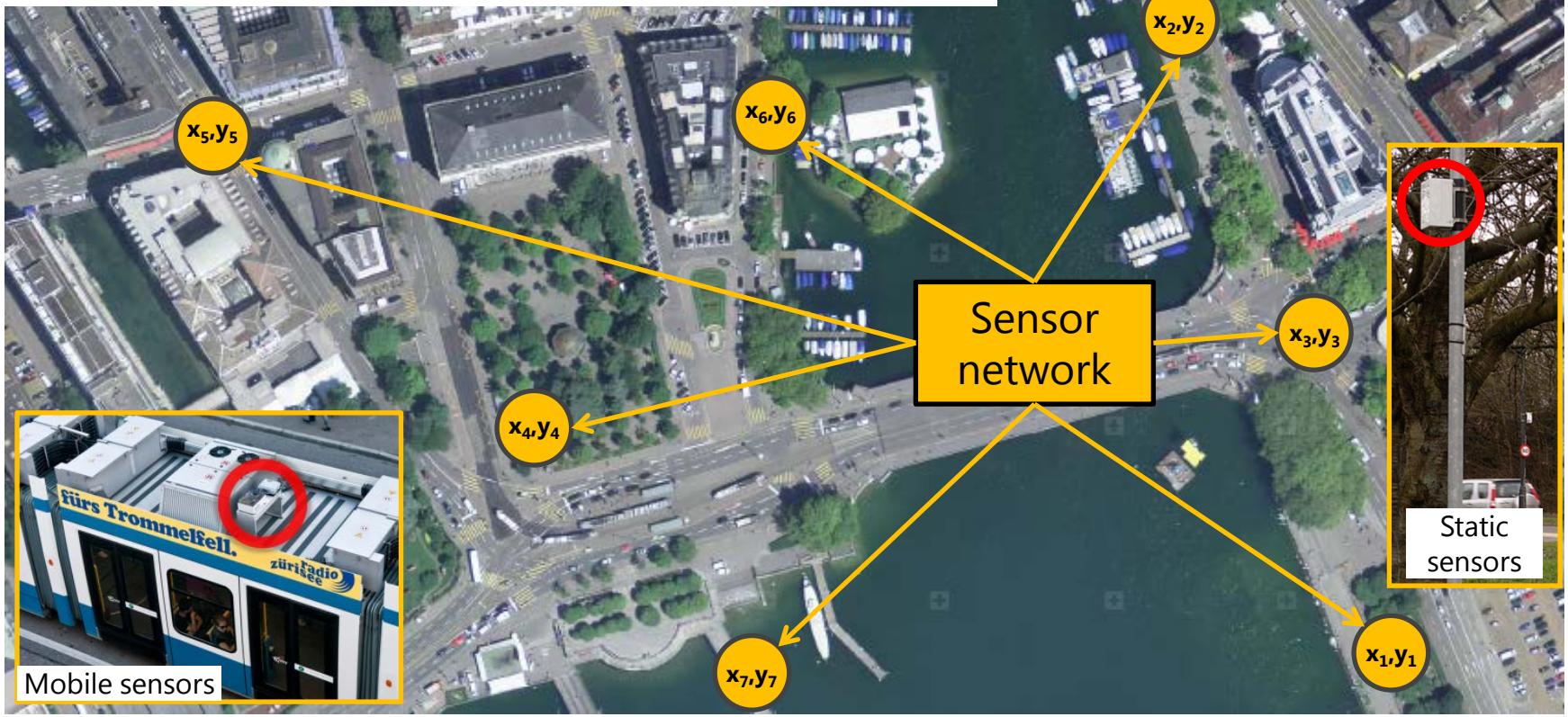
$$P(x,y) = s_1(geo_1(x,y)) + s_2(geo_2(x,y)) + \cdots + \varepsilon$$

P:	Pollutant concentration
s_i:	Smooth non-parametric functions (Generalized Additive Model, GAM)
geo_i:	Explanatory variables
ε:	Error
x, y:	Coordinates

Spatial information
- Traffic
- Building density
- Heating systems
- Elevation
- etc.



OpenSense Mobile Sensor Network

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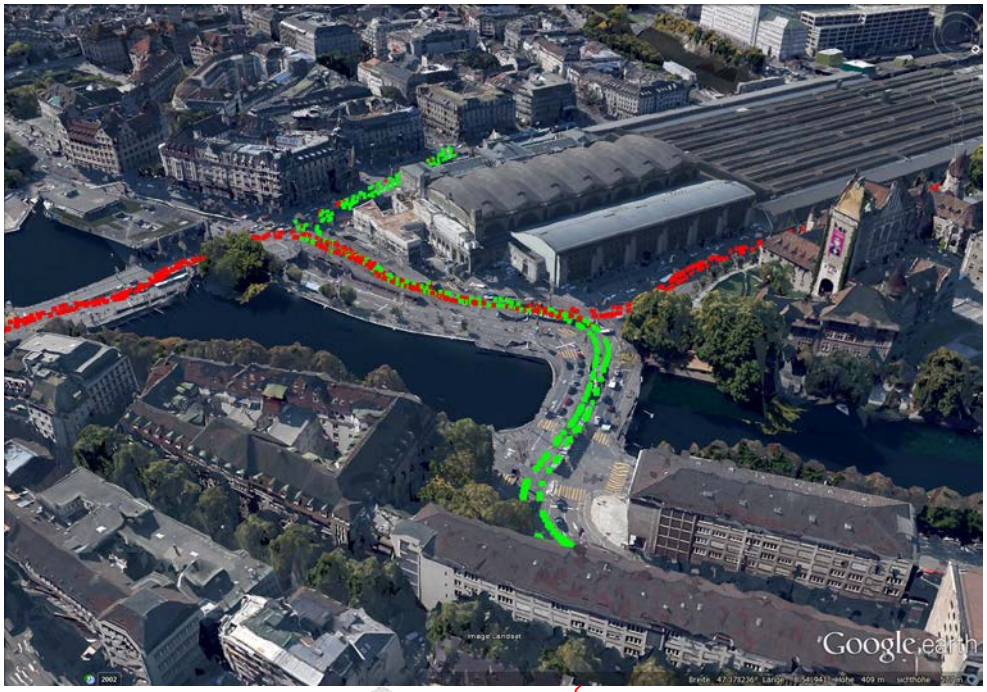
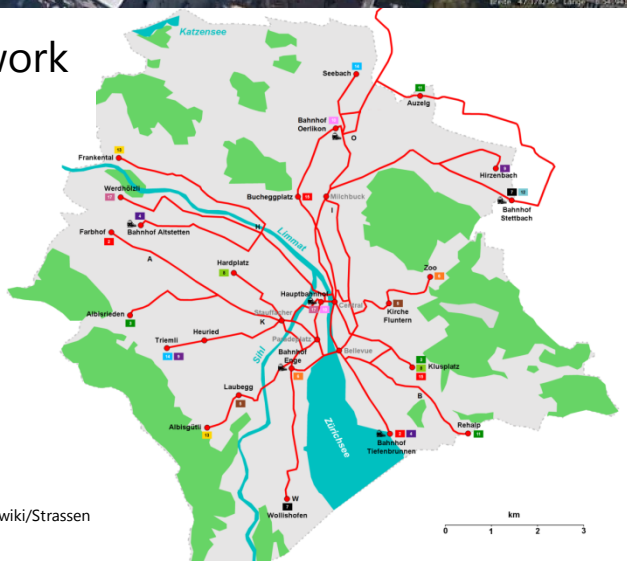


Tram network in Zurich



Source:
http://de.wikipedia.org/wiki/Strassenbahn_Z%C3%BCrich

Sensor boxes on top of 10 trams

- Particles number concentration
- Ozone
- Temperature
- Humidity
- Position (GPS)

MiniDiSC device

Representation of traffic

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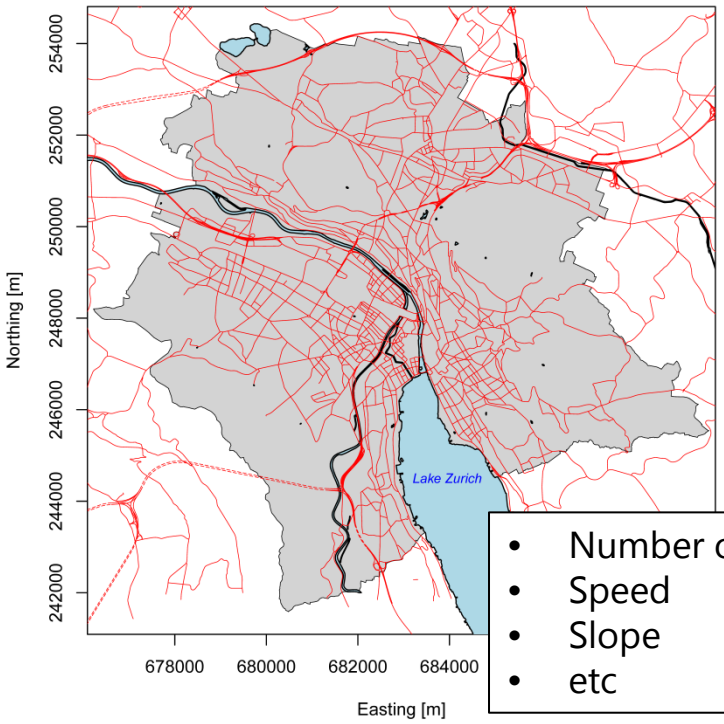
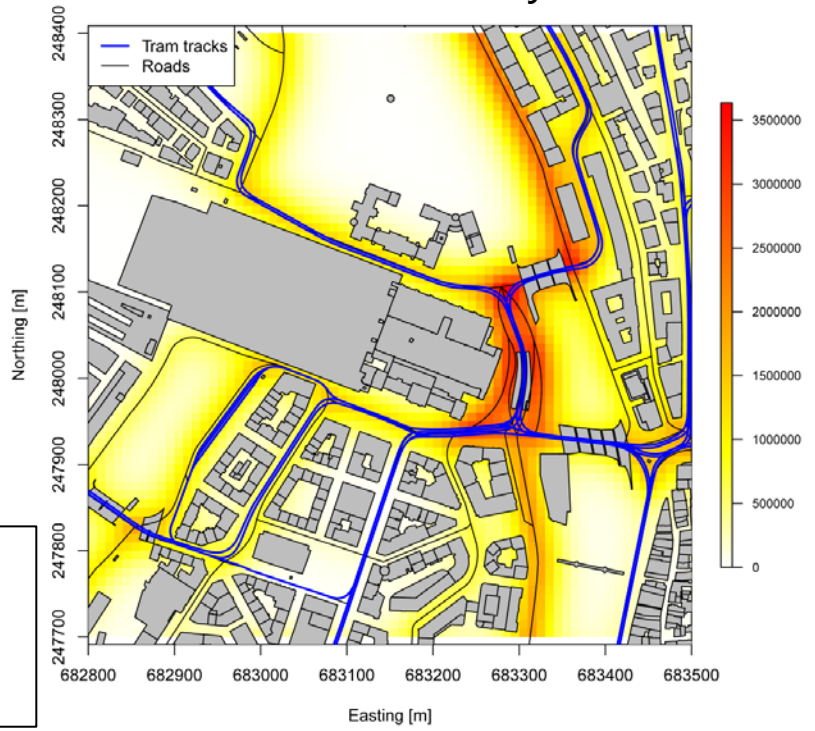
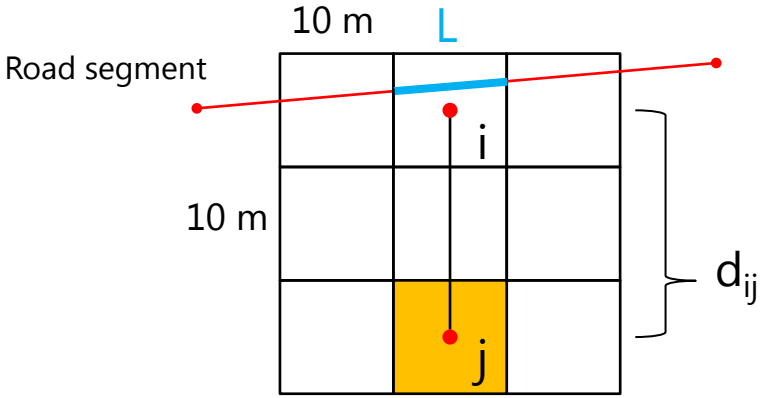
Road network



Traffic intensity



- Number of vehicles / day [**Q**]
- Speed
- Slope
- etc



Weighting function

$$T_j = \sum_{i=1}^{n} Q_i e^{\left(-\frac{d_{ij}}{d_0}\right)}$$

Representation of the built environment

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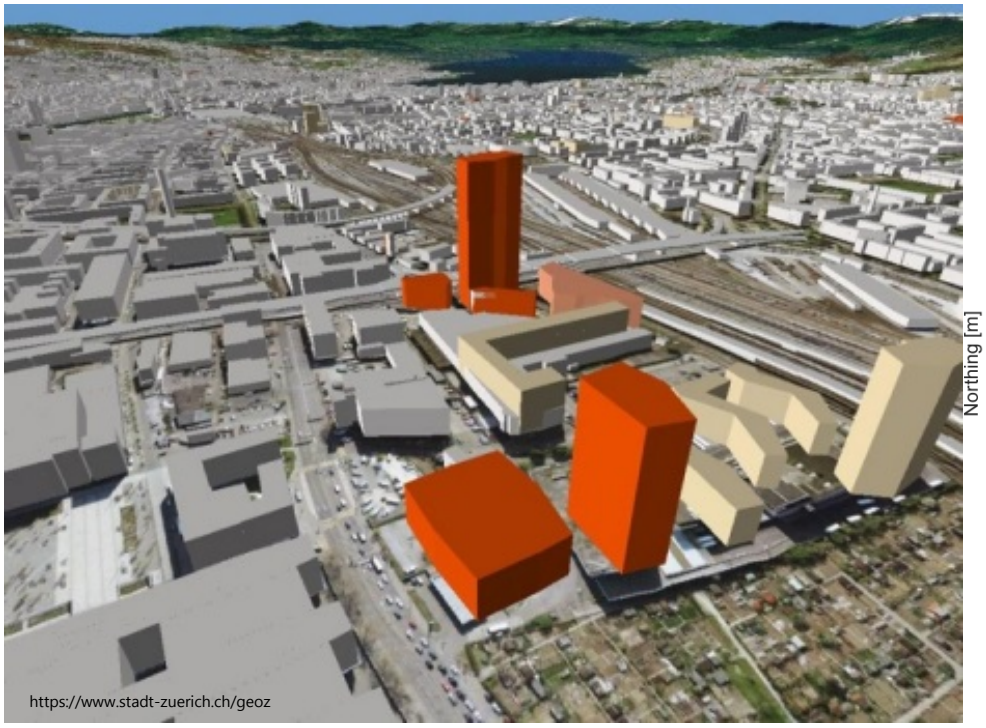
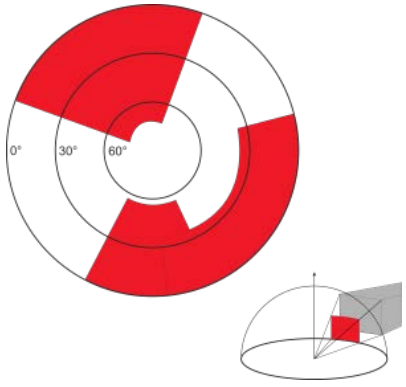


Sky view factors



UFP Maps

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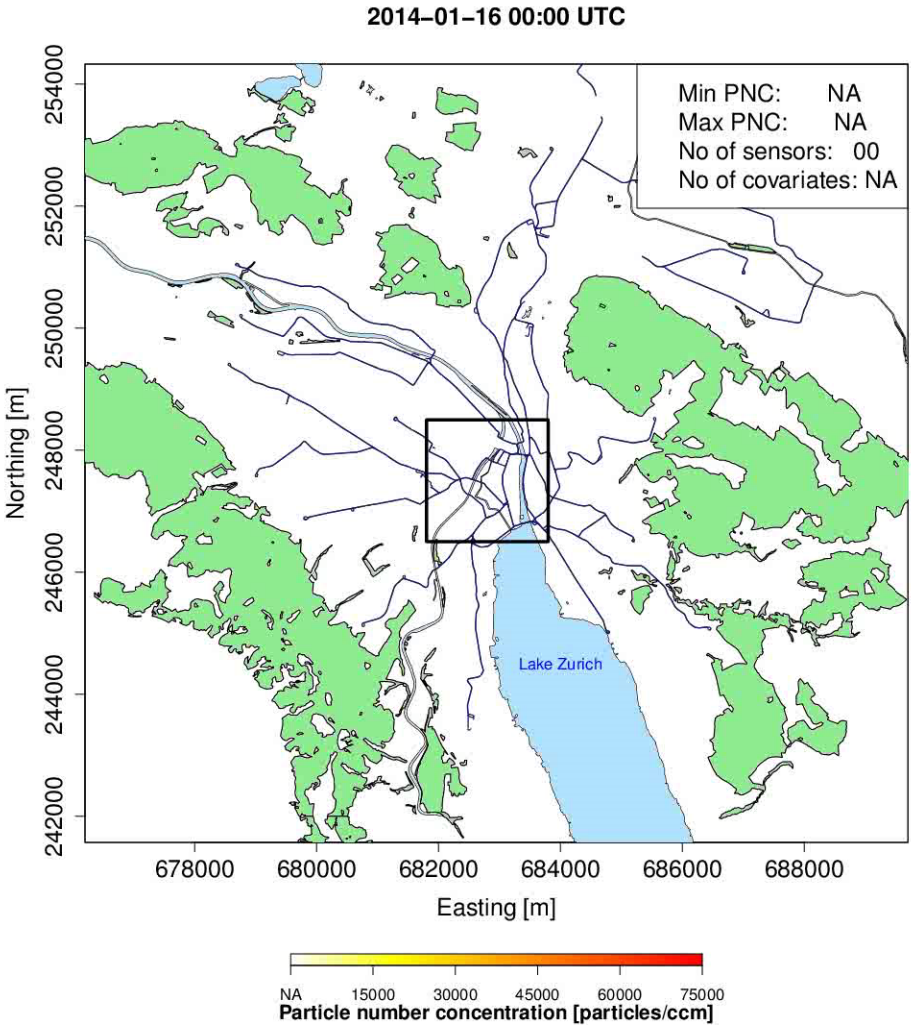
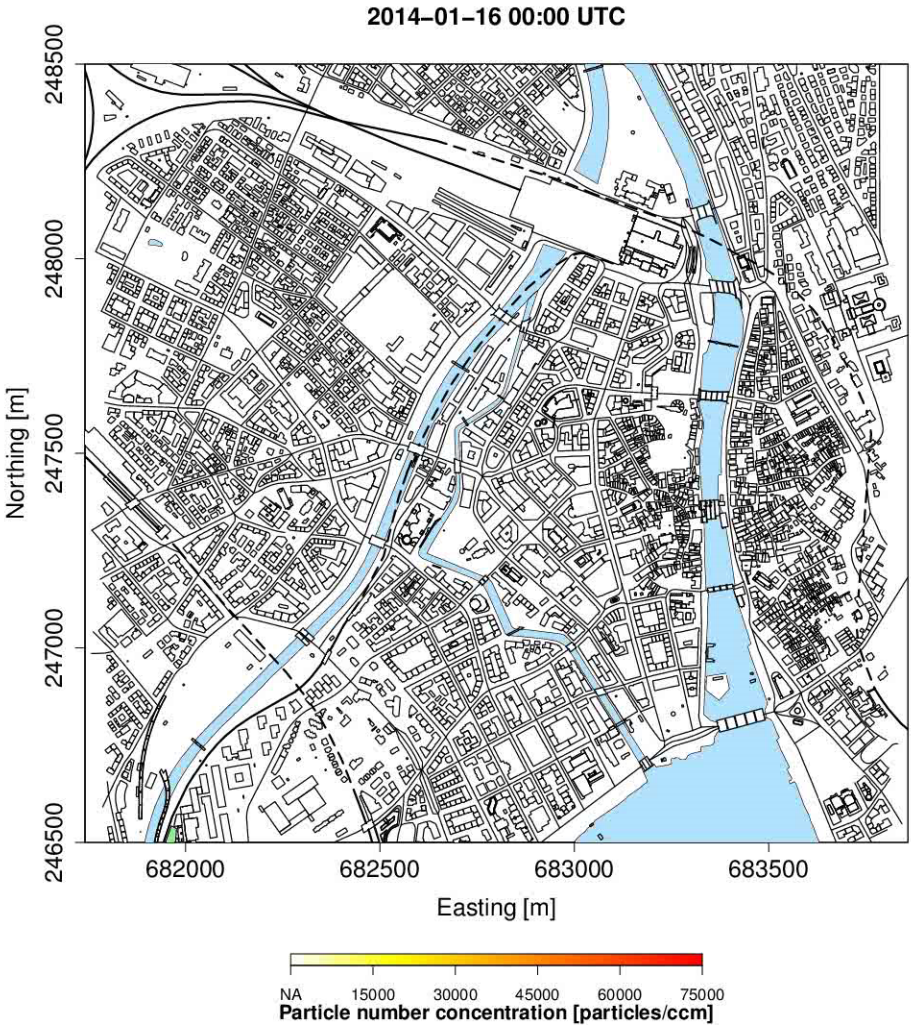
(Temporal resolution: 30 min)





Cross-validation («Leave-one-out»)

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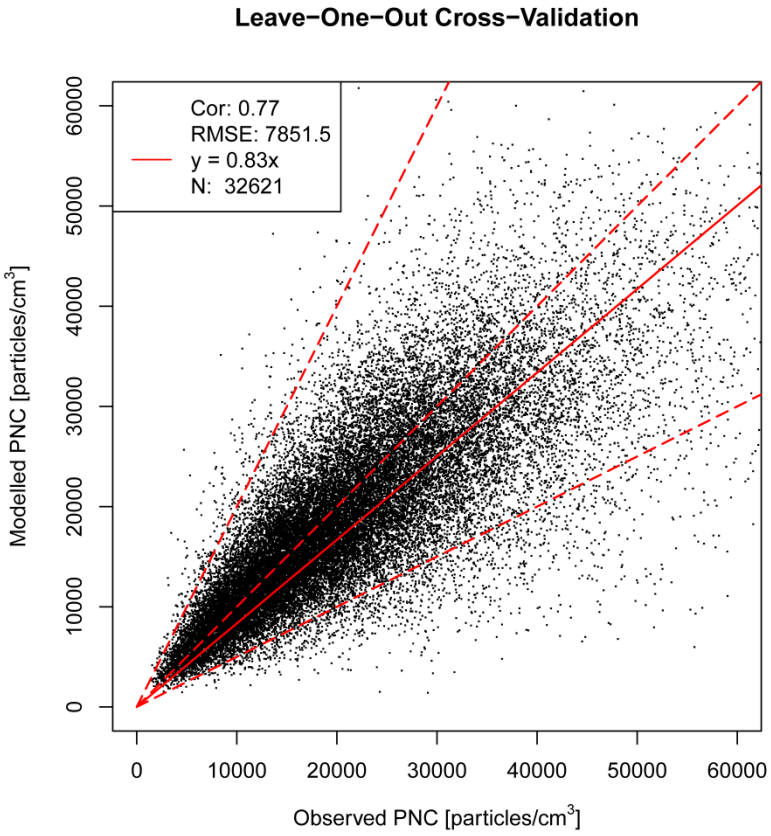

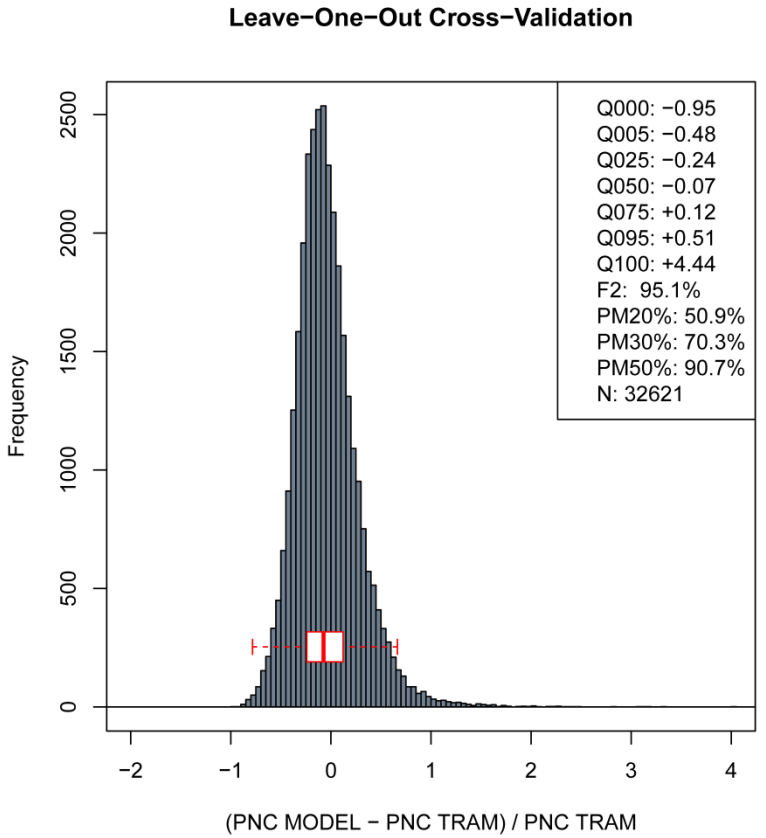

PNC: Mean PNC in a 15 min interval with at least 120 observations.

Comparison with measurements of permanent sites

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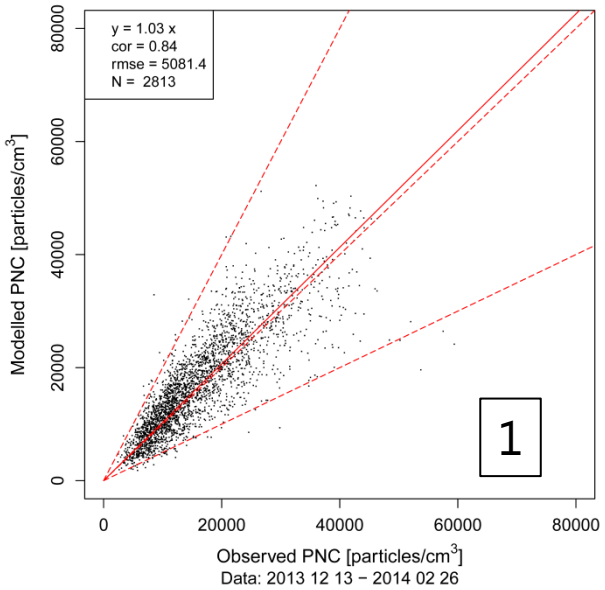
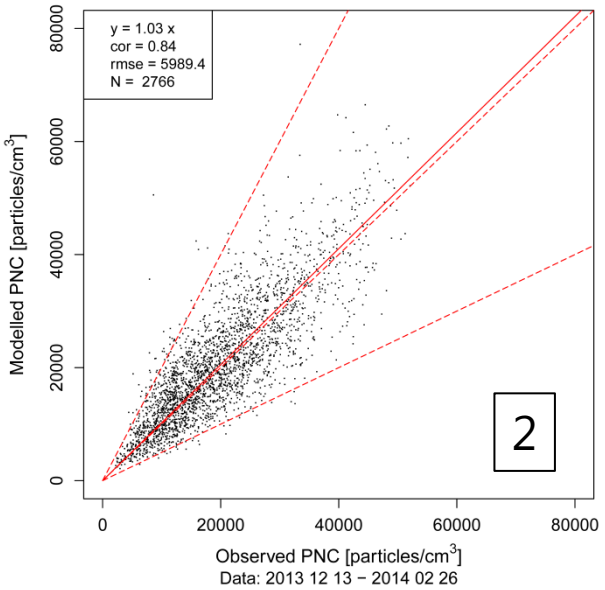
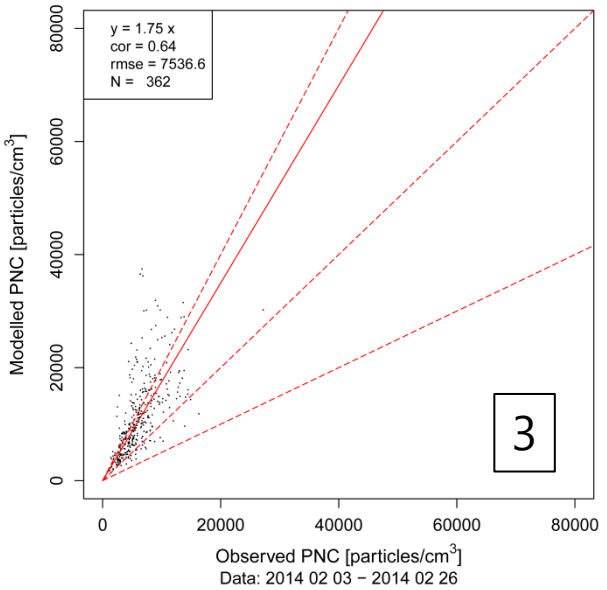
ZUE

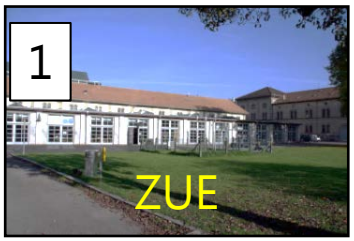


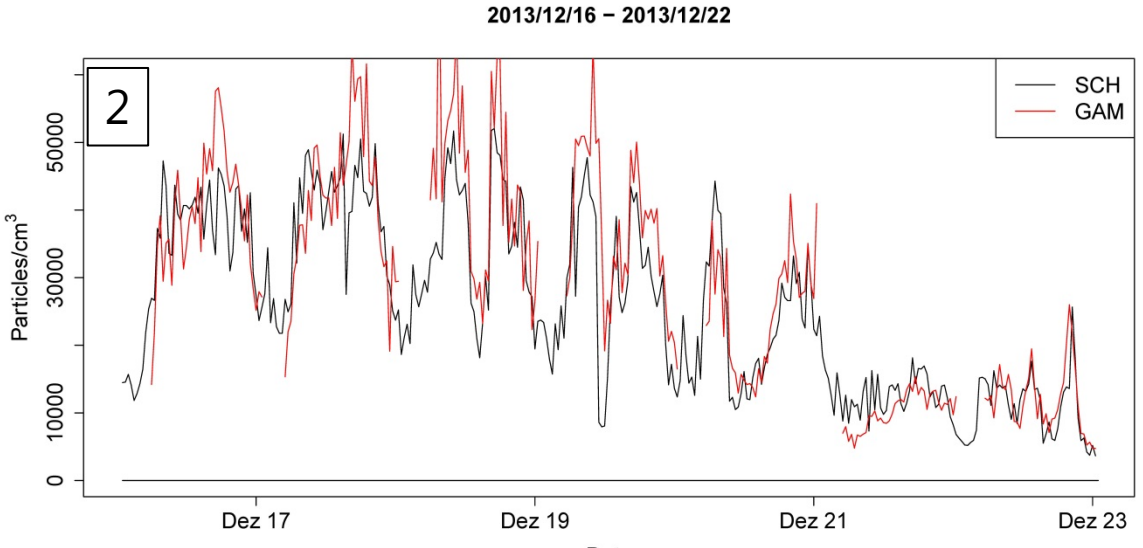
SCH



HEUB







Opensense network characteristics

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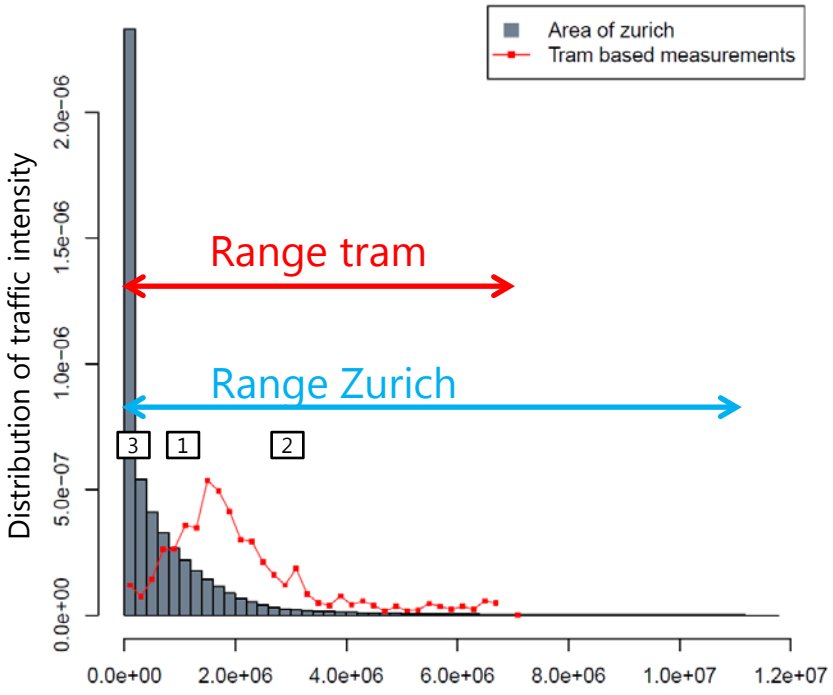
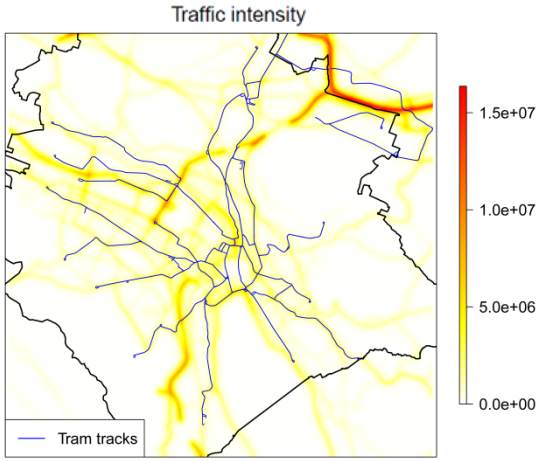
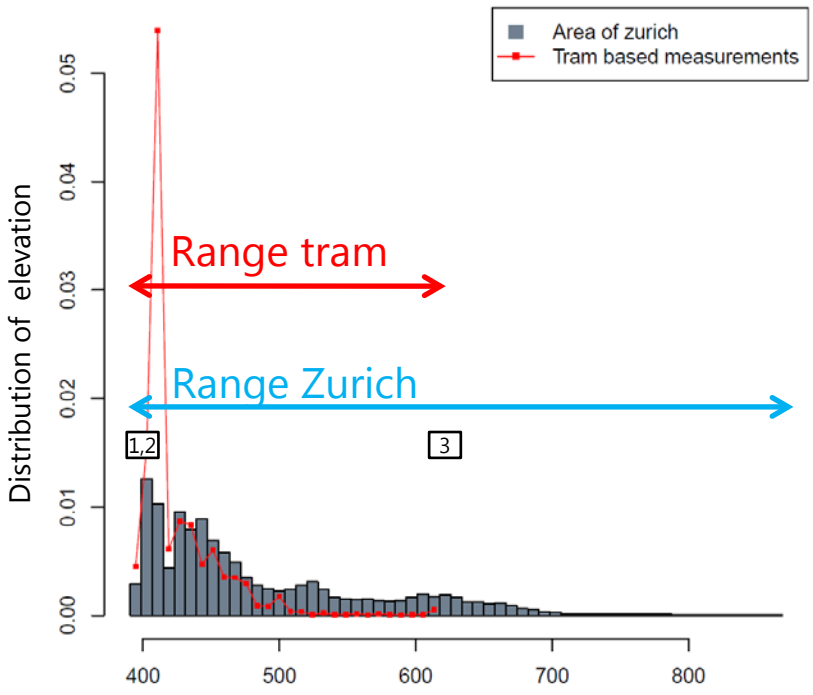
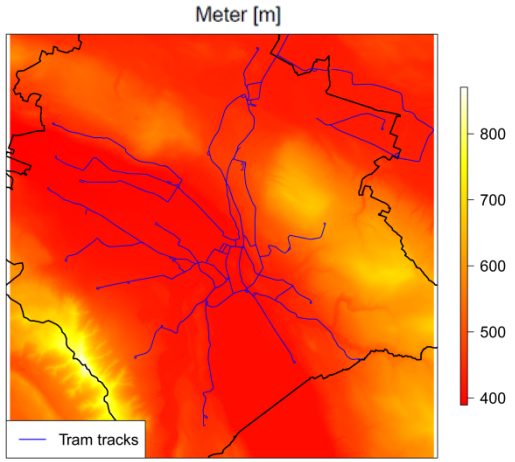
Traffic intensity





Elevation





UFP exposure measurements

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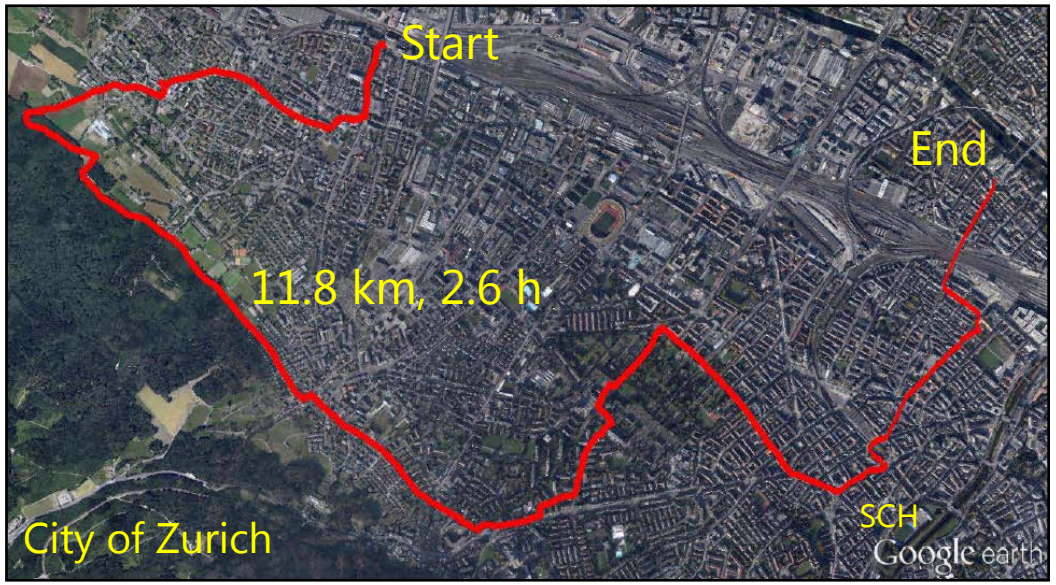

- 17 tours on 11 days in January 2014
- Duration (39 – 172 min)
- 113384 measurements (~1.3 days)

Exposure modelling and UFP map validation

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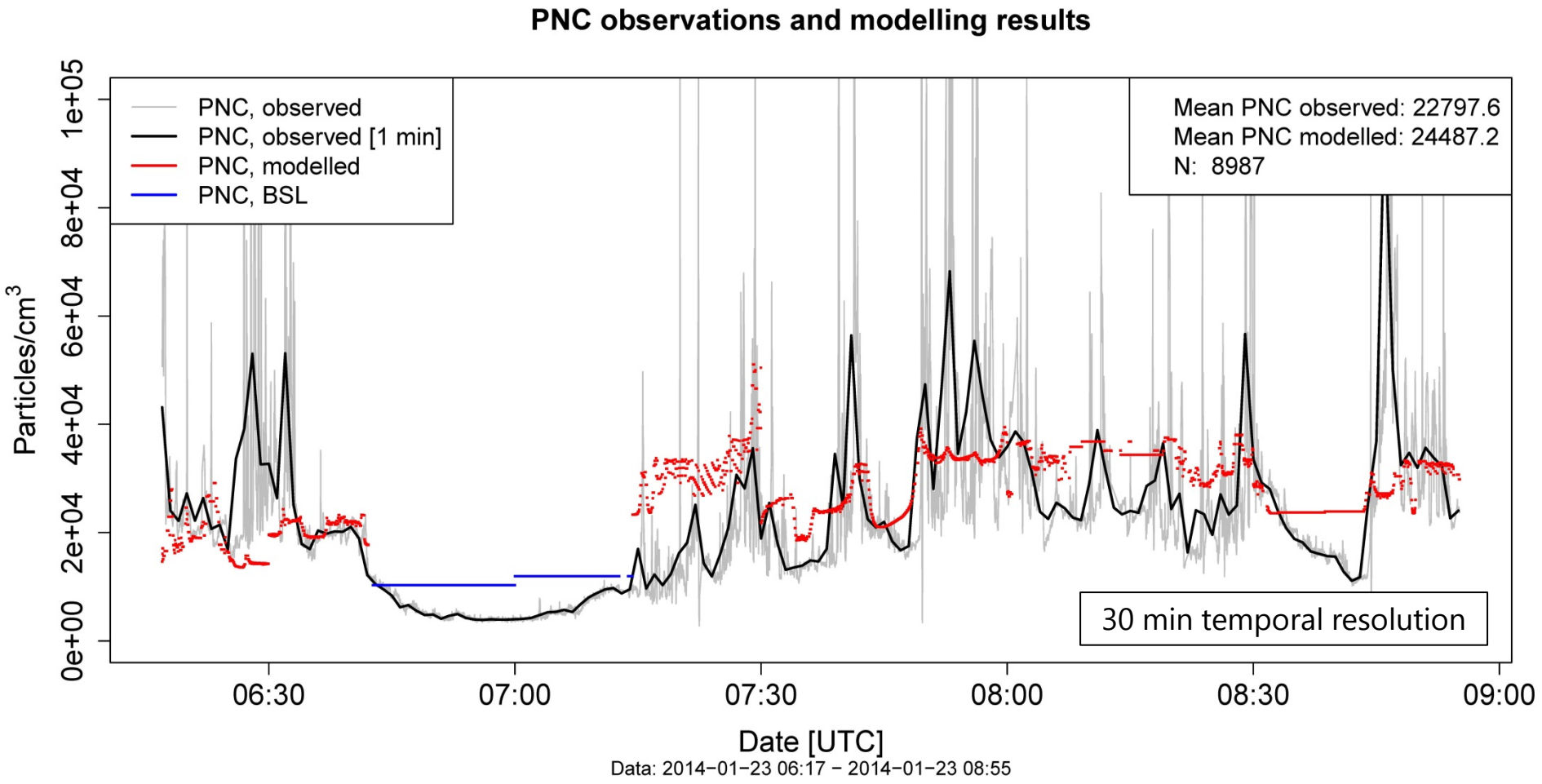

Exposure modelling and UFP map validation

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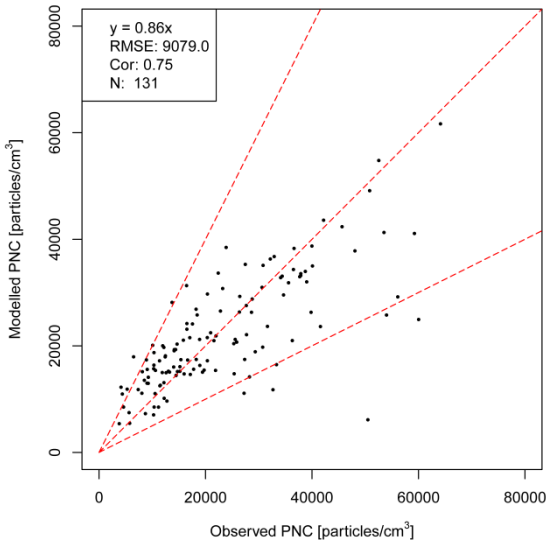
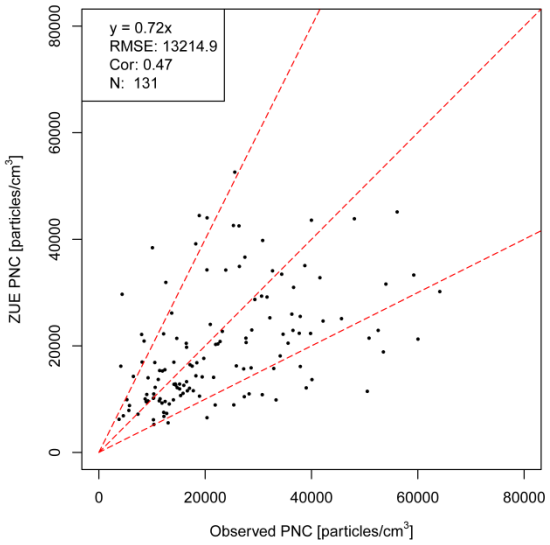
Model

15 minutes intervals



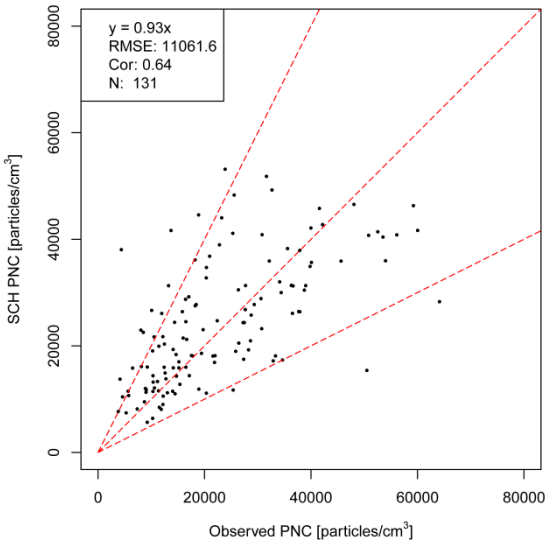
ZUE

15 minutes intervals



SCH

15 minutes intervals



Summary and conclusions

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- Opensense UFP data set of good quality
  - MiniDiSCs require periodical maintainance for 24/7 operation.
  - Only few QA/QC routines implemented in the network operation so far.

- Statistical modelling of UFP concentrations
  - Methodology of generating UFP maps developed
  - Further development of predictors ongoing
    - Traffic (e.g. time varying traffic patterns)
    - Improvement of three-dimensional building representation

- Opensense mobile sensor network
  - Uneven distribution of measurements w.r.t. location characteristics
  - Extension of the network by static sensors at distinct locations recommended (e.g. urban background, heavily congested environments)

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Thanks for your attention!

Acknowlegments

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- Nano-Tera.ch
  - Strategic action «InUse»
- COST
  - TD 1105 EuNetAir

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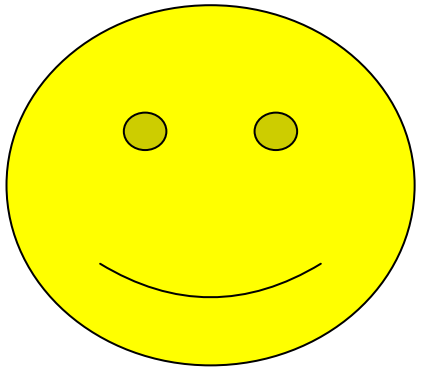

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