Design Project - SIE 2013

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Developing an Environmental Field Layer for an Integrated Mobile Sensor Network Simulation

CONTEXT

- The OpenSense Project is looking into enabling an air quality monitoring using mobile sensing platform anchored on buses provided by the public transports of Lausanne.
- An environmental field layer is needed for the integrated simulation framework.

OBJECTIVE

Using concentration measurements together with additional available sources of information (e.g. vehicle mobility data, weather data), the goal of this Design Project is to derive a simple data driven, statistical model for the pollution field in the central area of Lausanne.

METHODOLOGY

Raw Data

Environmental Filtering

Filtered Data

- wind speed < 2 km/h
- solar radiation < 500 W/m^2

Filtered Data

Large scale analysis

- Daily mean interpolation based on seasonal variations

Daily average modelling

- Seasonal variations removal from filtered data by subtraction of the daily average concentration

Detrended Data

Local scale analysis

- Spatial selection algorithm and statistical analysis of daily variation

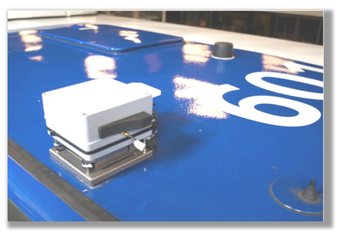
Spatial variations modelling

Combination of both models

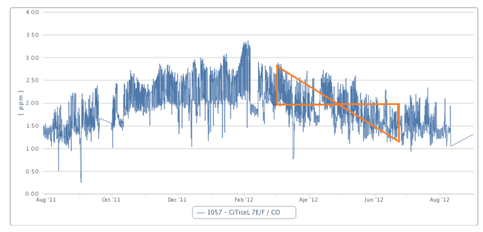
PREDICTION TOOL

CO concentration estimation : ***f*(date,time,position)**

DATA DESCRIPTION



SOURCE - Climaps platform - mobile station 1057
VALIDATION - Statistical comparison with reference station
SELECTION - CO as main parameter for the model building
SPATIAL SCOPE - Public Transport Bus Network
TEMPORAL SCOPE - About one year of measurements



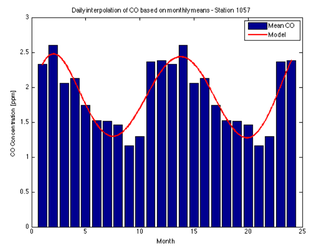
Raw Data - Seasonal trend highlighting

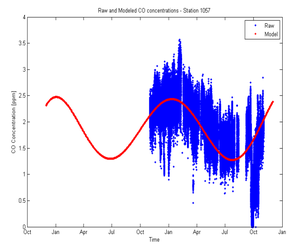
MODEL BUILDING

Daily average model

Large scale model building

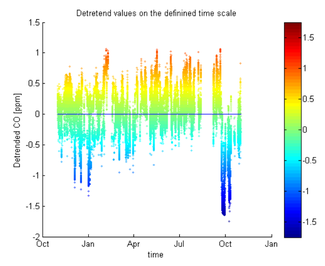
- Seasonal trend interpolation
- Aim : Remove the variability at a large time scale
- Method : Sinusoidal interpolation of CO monthly means



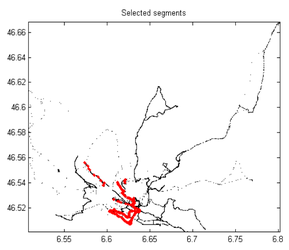


Result : Dentrended concentration measurements

- Variations around the daily mean of carbon monoxide concentration
- Aim : Study these variations locally in order to build a spatio-temporal model
- Localized variations around the daily average are modelled and added to the large scale model in order to set-up the environmental field layer

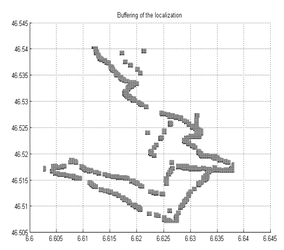


Spatial variations model



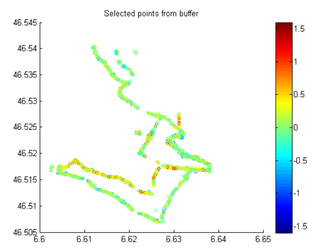
Selection of one segment

Computational simplification



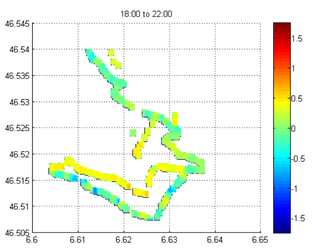
Buffering on a meshed grid

Extract all measurements on that segment



Gathering of all detrended data located in the buffer

Study the local variations on a daily basis

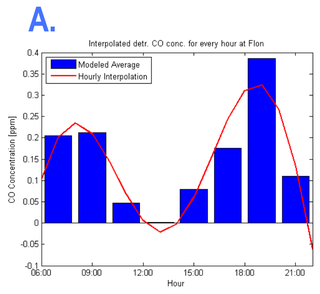


Moving window average processing

Measurements smoothing

OUTPUT EXAMPLE – LE FLON

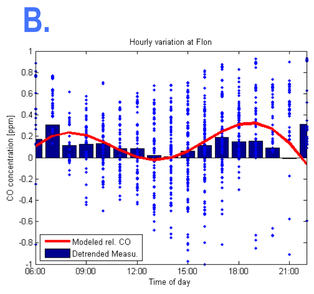
A.



Predicted local variation with a resolution of 2 hours
Hourly interpolation

Note that concentrations are generally above the daily mean.

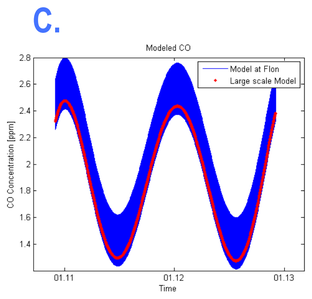
B.



Comparison between the hourly interpolation and the filtered measurements [•] at Le Flon, bars are observed hourly means

A good fit of the detrended data by the daily variation model is observed.

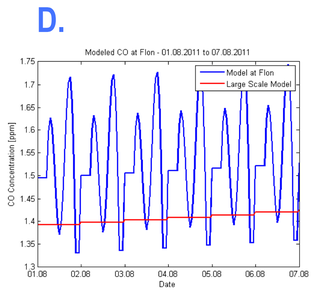
C.



Combination of the large scale model & the hourly CO variations at (Le Flon)

This graph represent the final CO concentration prediction tool for one location.

D.



One week zoom-in on graph C

Daily variations between 6am and 10pm as it appears in the model.

LIMITS & PERSPECTIVES

- The model is: - build on data covering a limited **period of time**
  - only valid for the specified **weather conditions**
  - better fitted for **daytime**
- **Interactions** of carbon monoxide with other particles and secondary phenomena taking place in the atmosphere have been omitted in the present attempt to build the model
- CO concentration **general trend** is significantly **correlated** with seasonal **temperature** variations and could therefore be incorporated into the daily average model.

CONCLUSION

Statistical analysis is necessary in order to support further improvements of the model. Generalization of the model would also need longer period of measurements in order to improve the prediction tool for certain specific locations and time intervals.

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