CT6 Benchmarking

Status

Plenary Meeting March, 2023

Practical work and results

- In the first two years, many subjects and issues were discussed.
- Over the last year, INERIS, ISSeP and RIVM use the available data to (further) develop/test their **selection** and **calibration** methods and, later, for data fusion/assimilation.
- The first comparison of benchmark results became available this year …

INERIS

- Categories of sensor observations: clustering based on distance between sensors, their typology and season.
- Estimate local correction factor and interpolation by kriging.
- Later: Apply SESAM (data fusion with **SE**n**S**ors for **A**ir quality **M**apping) tool: fusion of sensor data and official map considering data variability.

ISSeP

- Measurements from reference stations are used to produce interpolated [PM_{xx}] fields for the studied area. Interpolations are done using the DIVA tool.
- Selected sensor measurements are compared to co-located interpolated reference values
- Sensor values are corrected using linear parameters.

National Institute for Public Health and the Environment
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- Outliers detection methodology based on lowest/highest sensors.
- Look for sensors in the vicinity of the reference stations, then estimate local correction factor and interpolation correction field.
- Later: Apply data fusion by Bayesian weighing of sensor data and official map considering data uncertainties in both.

Issue: validation data

- So, we have many results from different analyses, what now?

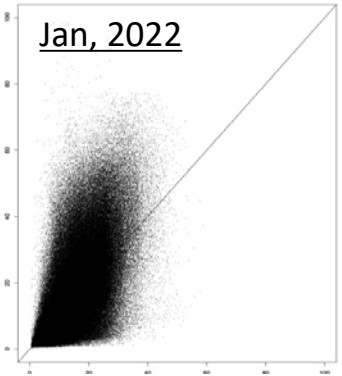
- We do not know the actual “real” concentrations at the (majority of the) ~2500 locations of the sensors, so we cannot test the quality of different algorithm’s in a simple way.
- Knowing the “real” concentrations would make it possible to:
  - Compare results from different calibration methods to real values;
  - Objectively test the effects of variations in calibration strategies.

- Alternatively, we can generate **synthetic sensor data** to test different algorithm’s.
  - It is essential to take all the (seemingly) chaotic aspects of sensors into account.
  - We used behaviour of actual sensors to create synthetic sensor data.
- A **data set** with **synthetic data** was created for **January, 2022**, using 50% of the random uncertainty.

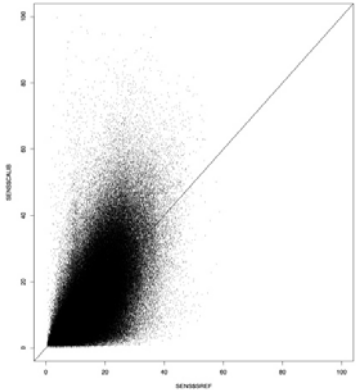
Issue: Analysis/visualization

How to visualize/test/compare the results of the calibration of the sensors?

Raw sensor concs.

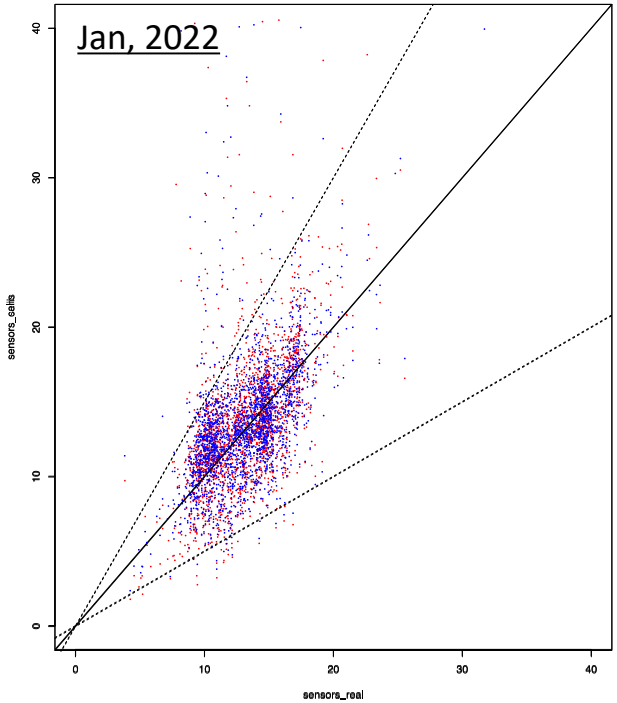


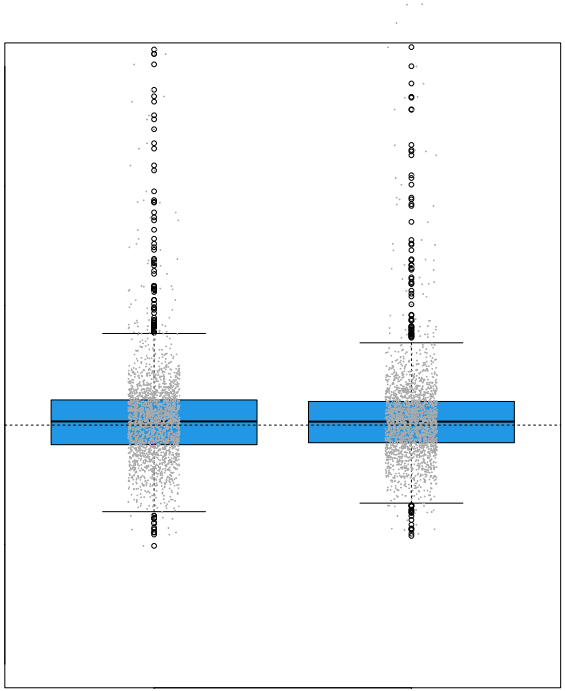
Calibrated sensor concs.



Synth real concs.

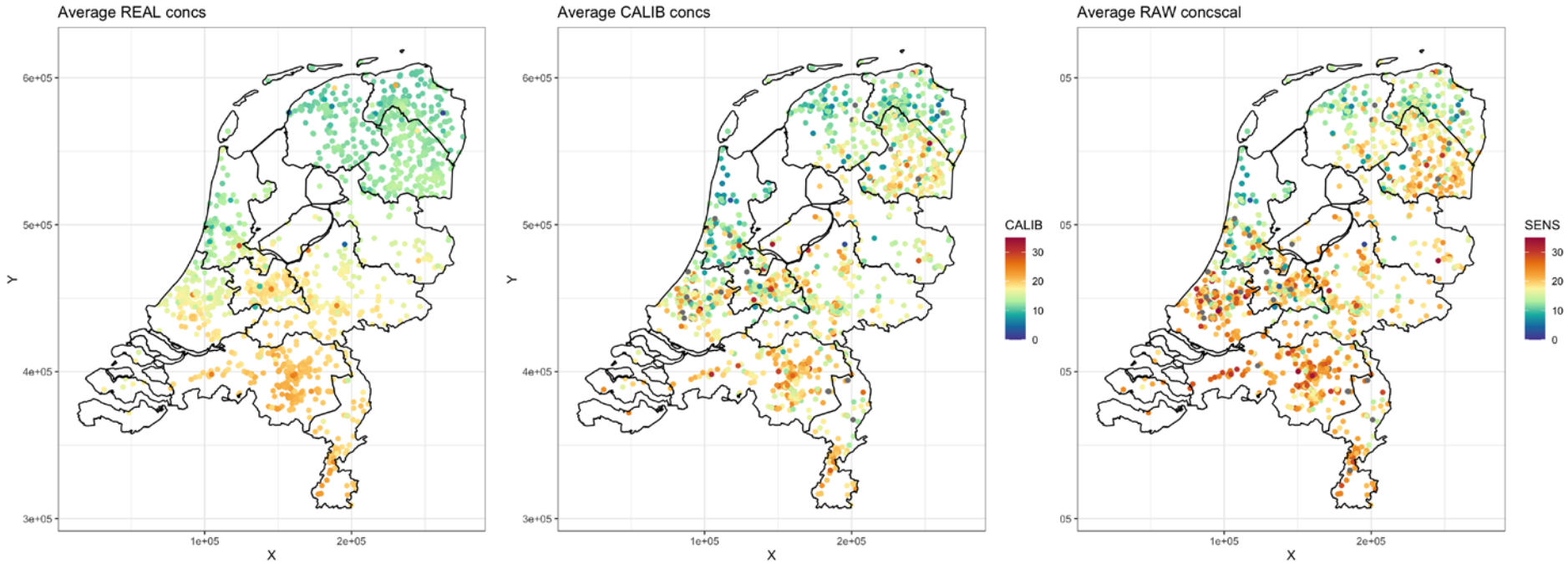
Average values of sensors





Analysis/visualization ...

- **Spatial** effect of calibration in the sub-period <u>10-19 Jan, 2022</u>



Analysis/visualization

Period Jan 01-31, 2022

Biases of the **monthly averaged** raw PM2.5 data and the averaged calibrated data versus the averaged synthetic real data.

Over the full month, the raw and calibrated concentrations do not differ much.

Analysis/visualization

Period Jan 01-31, 2022

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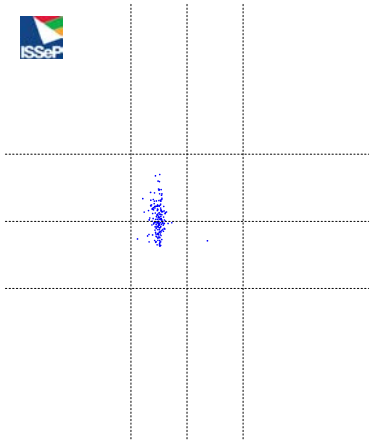
RAW

Analysis/visualization



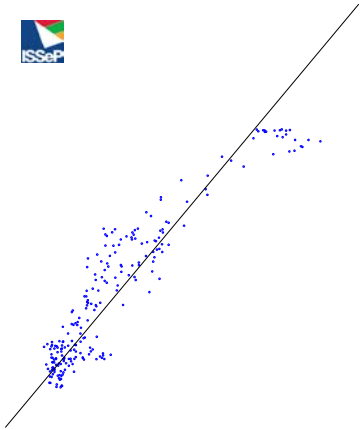
Period Jan 01-31, 2022

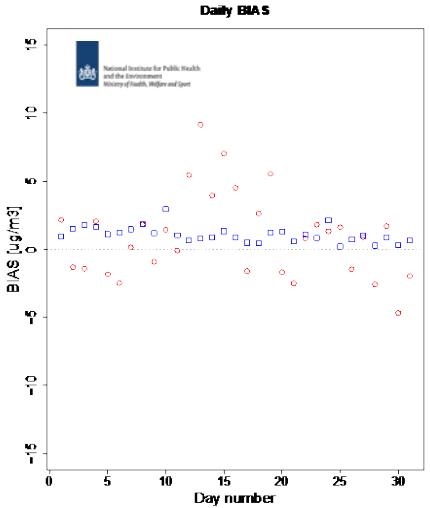
Target plots of the monthly averaged raw data and the averaged calibrated data.

The raw and calibrated data differ in the CRMSE's.

The BIAS and CRMSE are <u>not</u> normalised using the uncertainty of reference PM2.5 measurements.

Analysis/visualization





Period Jan 01-31, 2022

Hourly averaged raw data and the averaged calibrated data.

The **daily** average concentrations show that there were several days in the middle of the month with substantial over-estimation by the sensors.

Conclusions so far ...

- Benchmarking is an important process.
- The importance of data cleaning, handling of uncertainty, interpolation and calibration of low-cost sensors is demonstrated and investigated.
- Sufficiently realistic synthetic sensor data can be constructed and these are valuable for an objective test of sensor-processing algorithms.
- The algorithms applied in the benchmark for network-calibration can, to a large extent, correct for the influence of environmental conditions on the performance of the SDS011 PM2.5 sensors.

- The SDS011 sensor has a large random uncertainty that can not be corrected for by network calibration → limits individual use.

What did CT6 achieve (2020-2022)?

- Exchanging potential concepts and best practices about the integration of sensor network data in air quality mapping methods (Calibration vs DF).

- Exploring how air quality modelling can contribute to the exploitation and validation of an air quality sensor network.

Additional (Not in previous ROADMAP…)

- Created real as well as synthetic data sets and benchmark data set.

Questions ?

CT6 Benchmarking
Outlook

Plenary Meeting March, 2023

Priorities WG6 for 2023-2025

- Exchanging **best practices** about the calibration and subsequent integration of sensor network data in **air quality mapping methods** (data fusion) and demonstrating the use of sensors in **different areas/countries** with national models to fuse.
- So, less focus on the generation of synthetic data and on the calibration.
- More focus on data fusion and combination with existing maps.
- Less focuss on the Dutch sensor data, more on the rest of the world.

- Providing **guidance and recommendations** on the use of sensors (e.g. citizen science projects), both in terms of **calibration**, **data fusion** or communication about related **uncertainties**.
- What is the quality of both individual sensors in a network and what is the use of data derived from networks of sensors, before/after data fusion.

Priorities WG6 for 2023-2025

- Exploring how exploitation and validation of an air quality sensor network can contribute to **improved air quality modelling**, with a focus on city applications.
- Project running in the EU would like to apply low-cost sensors on the scale of (part of) a city.
- Is the same calibration possible?
- What is the lowest amount of sensors to be usefull in a network approach?

- At the start of WG6 - Sjoerd van Ratingen (RIVM) primary contact.

Time scale in practice:

- Finish/submit article (Before summer 2023)
- Data fusion, assimilation, sensitivities (All of 2023)
- Smaller region/city (Antwerp, Paris, Berlin, Milano, …) (2023)

- Other sensors/networks (Sensirion, Purple Air …) (2023/2024)
- Other substances (NO2, …) (2024?)

Interest in sensors and/or data fusion? Join us !

FAIRMODE

Questions ?

Interest in sensors and/or data fusion? Join us !