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National Institute for Public Health and the Environment
Ministry of Health, Welfare and Sport

WG6
Sensors and data fusion

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Need for sensor data fusion

Need for WG6 to look into sensors

- Increased use by citizen scientists, municipalities, lower governments.
- Often results and quality unclear (also for users)
  - What is the uncertainty of sensor networks ?
  - Can uncertainty be decreased by calibration ?
  - What is the added value of sensor networks (when e.g. used in data fusion approach.)
- These questions are being studied by WG6 (for PM2.5 sensors)
- Need for multiple calibration and fusion model approaches (benchmarking) to estimate results of different models and enhance exchange of knowledge

- Publication January 2024 on benchmark of different calibrations for PM2.5 sensors
- Decision to use calibrated sensor data as input for a new benchmark on **data fusion with sensors**
- Six organizations have been actively testing their fusion models using input data provided by RIVM.
- Preliminary results have been presented at technical meeting in October 2024. Demonstrated potential of data fusion to reduce uncertainty of model.
- Decision to look for data sets where effect of data fusion becomes more prominent.

sensor data fusion: Active partners

CERC *

INERIS *
maîtriser le risque pour un développement durable

Joint Research Centre JRC

ISSeP * Institut scientifique de service public

National Institute for Public Health and the Environment
Ministry of Health, Welfare and Sport *

Norwegian Meteorological Institute *

vito *

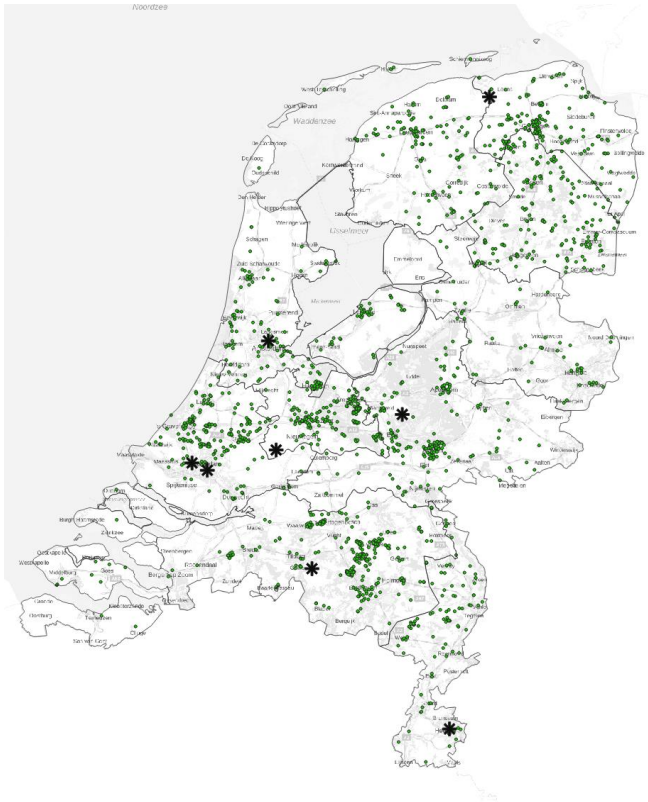
universidade de aveiro

*: has data fusion model

sensor data fusion: Use case

- Input data for the Netherlands
  - Sensors ●
  - Reference measurements ✱
  - Model results

- Experimentation with number of available reference measurement to study cases with **low information** density (Reference stations, bad model quality)



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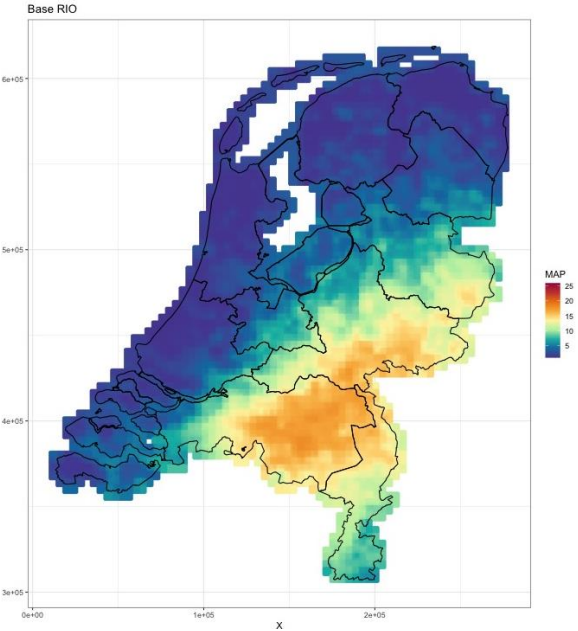
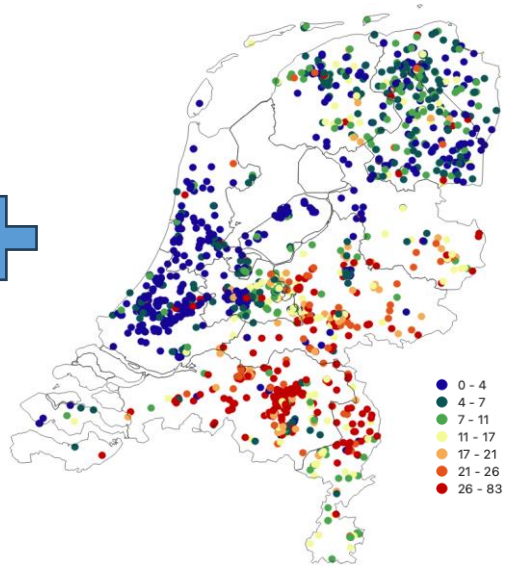
sensor data fusion: Idea

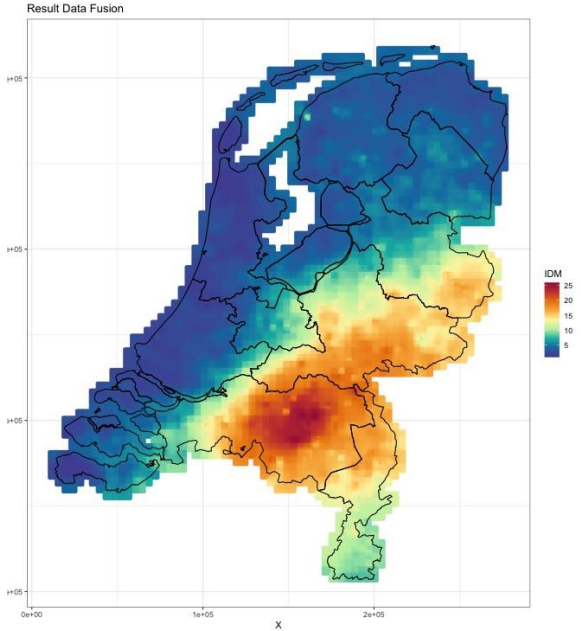
RIO model



Sensors



Data fusion



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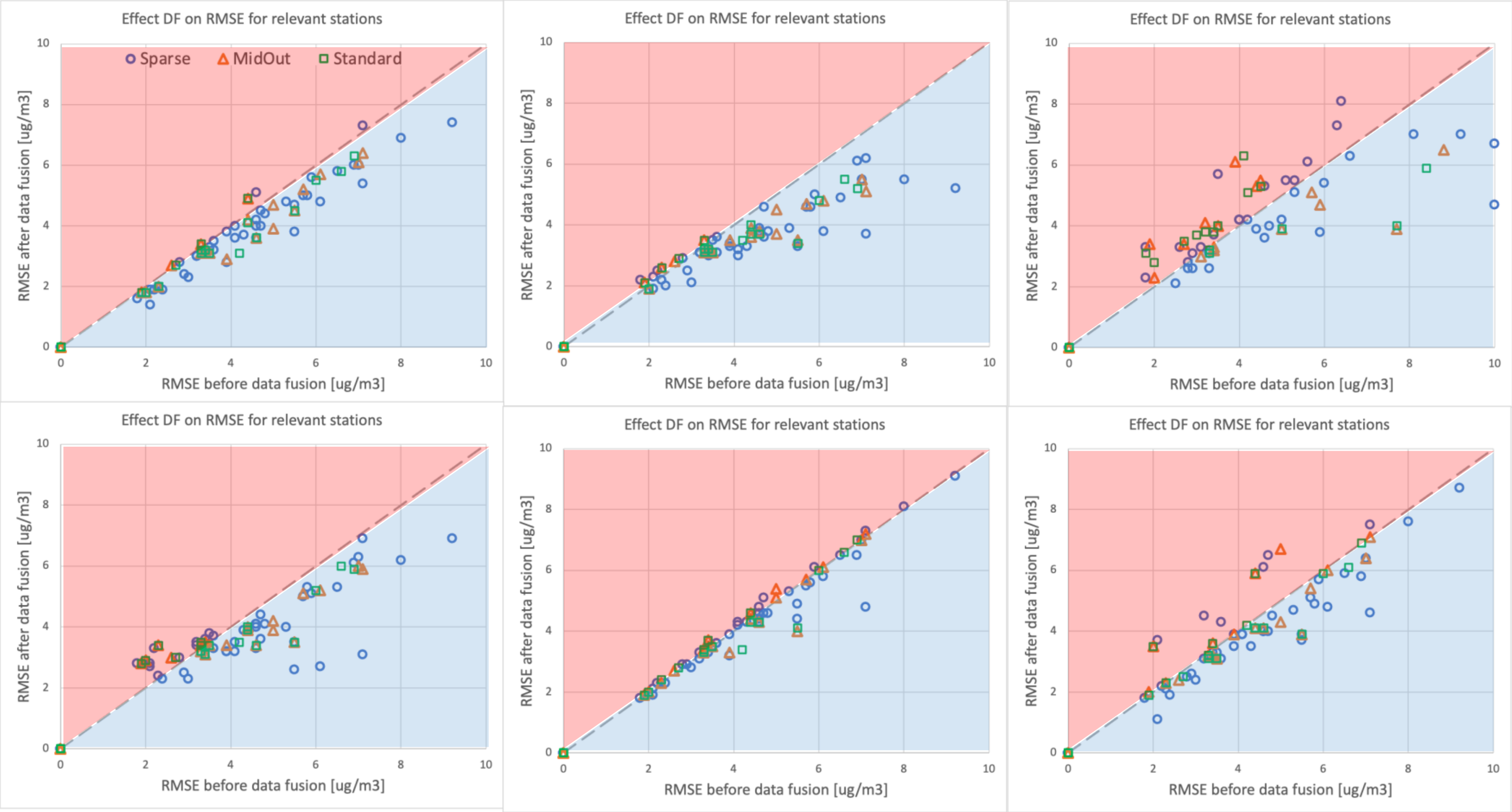
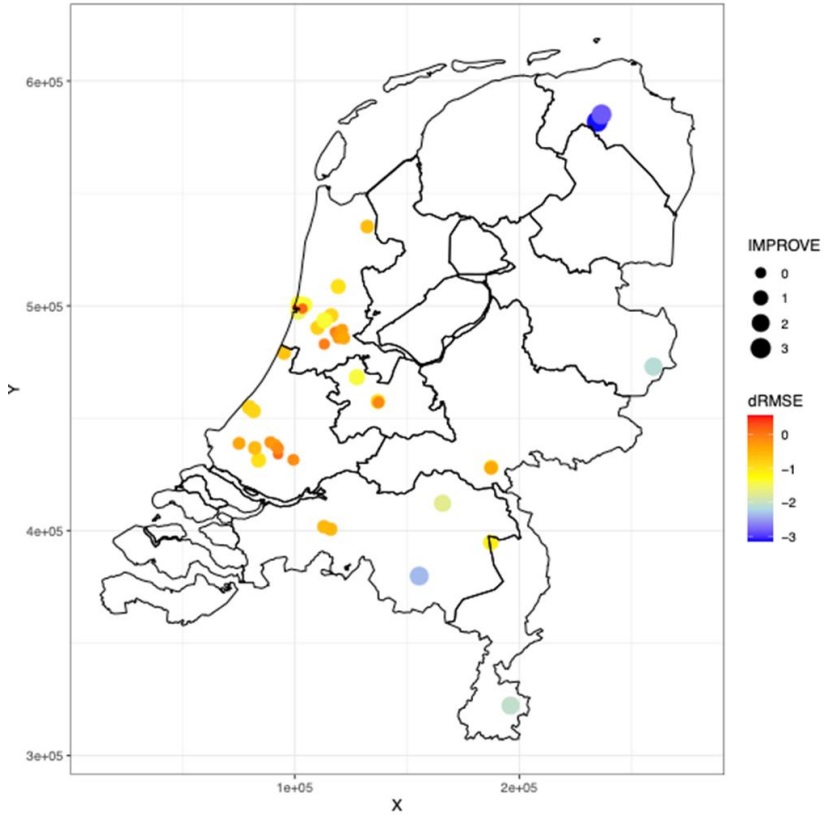
Comparison of fusion models



WG6 sensor data fusion: Results

How to further validate the sensor data fusion?

- Spatial representation of errors ?
- Identification of areas with more and less prominent effect of data fusion
- Discussing validation metrics and visualisations.

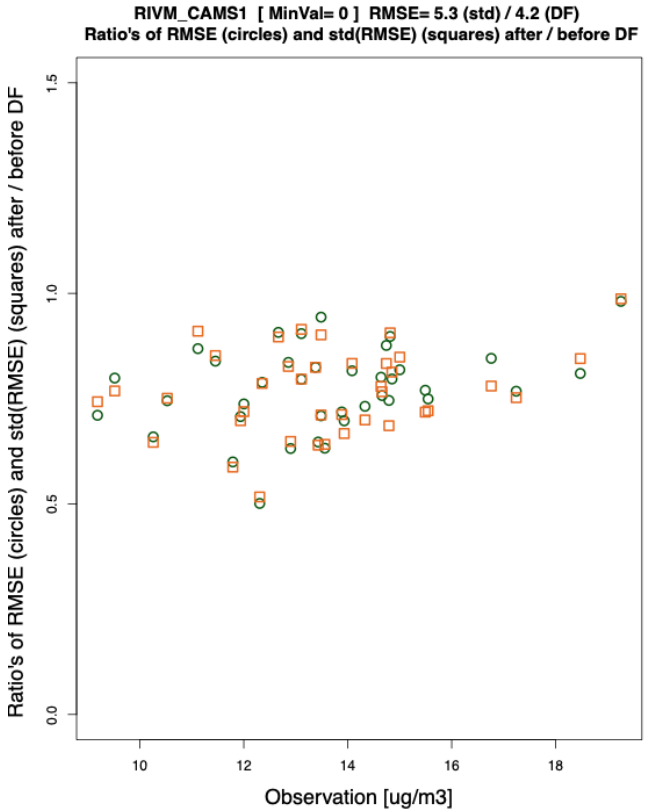


WG6 sensor data fusion: Results

How to further validate the sensor data fusion?

- Trying to improve on CAMS (no reanalyses) data using sensor data fusion.

- Look at normalized RMSE's
  - < 1 means that data fusion improves results.



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Contribution to better modelling

- Different calibration methods can substantially increase the quality of the PM2.5 sensors although for some sensors still a large intrinsic uncertainty remains

- First results with several sensor data fusion methods show improvements of the model when combined with sensor measurements using data fusion techniques.

- Especially powerful when using larger numbers of sensors

Discussion/Outlook

- **Next half year**
  - Aim to submit article on data fusion benchmark before summer.
  - Use RIO and CAMS models (no reanalyses) as model input.

- **Ideas for after data fusion benchmark**
  - Investigate added value of sensors measuring at high time (<< 1 hour) resolution.
    - Large variance within km cells could be indicative of local phenomena.
  - Use cases outside the Netherlands would be good to test.

Questions?