FAIRMODE
Forum for air quality modelling in Europe

WG1 ASSESSMENT: KEY TOPICS & RECOMMENDATIONS

STIJN JANSSEN & JOOST WESSELING

CONTENT

- » Fitness for purpose and quality objectives in assessment modelling → **WG1 recommendation**
- » **Spatial representativeness** of monitoring stations: From chaos to …?
- » **CFD** Modelling: a real need in FAIRMODE?
- » Modeling quality objectives for **forecast**: nice to have or real need?
- » Collaboration FAIRMODE-**CAMS**: how and what?
- » Guidance from FAIRMODE WG1 to **IPR**: What should be included?
- » **Sensors**: what's next?

Fitness for purpose and quality objectives in assessment modelling

→ WG1 recommendation

AQ Directive & model applications

» AQD: *"The uncertainty of modelling estimation is defined as the maximum deviation between the measured and calculated concentration levels for 90 % of individual monitoring points, without taking into account the timing of the events."*

→ "RPE" and "RDE" objectives are vague and under debate since the AQD publication

AQ Directive & model applications

» AQD Annex I: *"The fixed measurements that are selected for comparison with modelling results shall be representative of the scale covered by the model"*

→ The model choice defines the spatial scale of the assessment

→ We need a good understanding of spatial representativeness

WG1 RECOMMENDATION I

» The **Modelling Quality Objective** (MQO), as defined by FAIRMODE and CEN, **should be used** to assess how well the model application and observations are in agreement, thus defining if a **model is good enough** for assessment purposes.

WG1 RECOMMENDATION II

» Any modelling application for formal assessment, as described in the AQD, should (by definition) be able to meaningfully **reproduce what is observed in ambient atmosphere**, regardless of the spatial scale and within the tolerance margins of the Modelling Quality Objective.

IMPLICATIONS

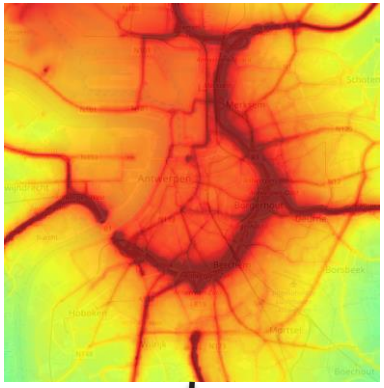
Some non-trivial consequences

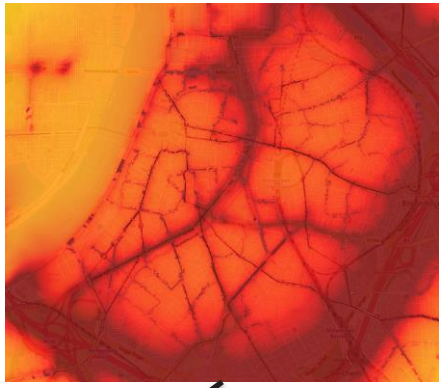
- » In **urban environment** assessment should go down to **street level** and a chain of models would probably be required to achieve this goal
- » Concept of **spatial representativeness** for model validation (cfr definition in AQD) **is circumvented**
- » Only in very specific situation, stations could be **left out** → no assessment possible
- » MQO should be **supported** by the whole AQ modelling community

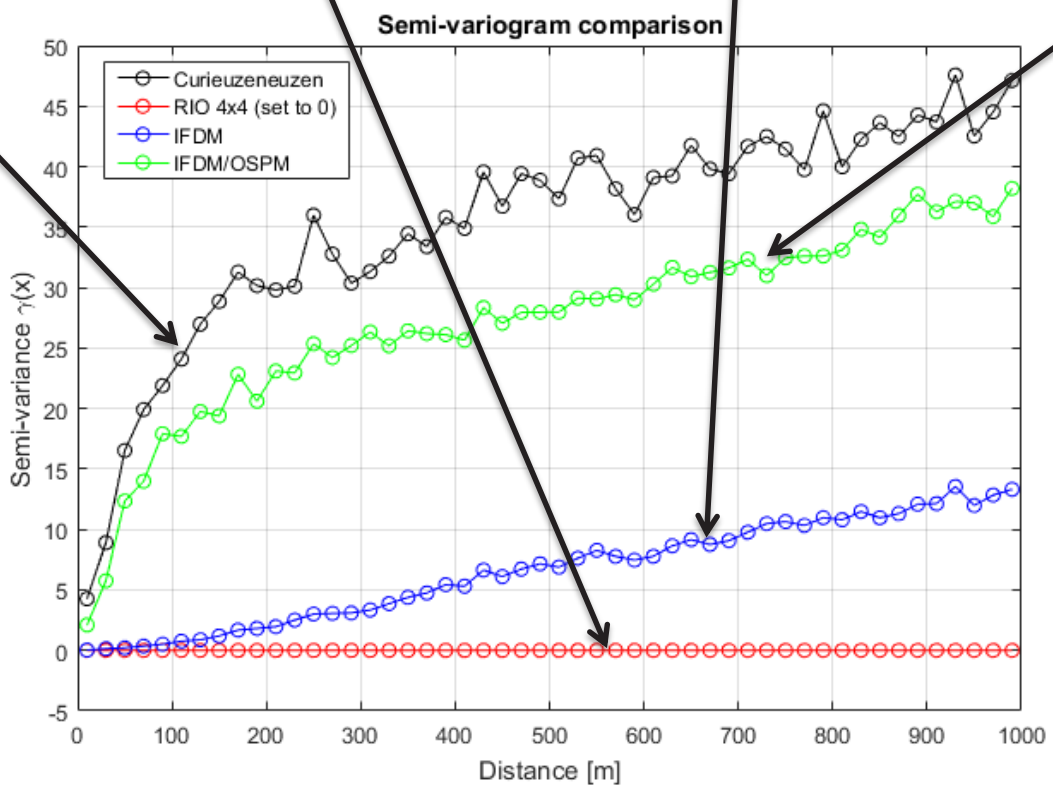
DISCUSSION TOPICS

- Do we agree that **observations** of ambient atmosphere should be the starting point to define fit-for-purpose?
- How realistic is **street level** modelling everywhere in Europe? What kind of **obstacles** (input data, resources…) do you observe?
- Various models in a model chain still need validation. Can we rely on **station type** for this purpose (as we do now?!) and skip spatial representativeness of stations?
- CEN is evolving towards **consensus** on the MQO → France recently expressed some concerns
- …

THE CHALLENGE…







FAIRM
Forum for air

CEN WG43 : French Proposal

1) Current project:

Elaborating a European Standard that specifies the requirements, in the form of Modelling Quality Objectives (MQO) mainly based on Delta Tool metrics.

2) Observation:

As National Reference Laboratory, LCSQA is responsible for carrying out technical audits of the regional implementation of air quality assessment in relation to European and national requirements. A recurrent observation is that statistical performance of the modelling and communication aspects tend to be favoured to the detriment of the understanding and rigourous accounting of physical and chemical processes.

2) New French proposal:

Ambitious definition of MQO including both quality assurance and quality control aspects.

CEN WG43 : French Proposal

Quality Assurance

should ensure that all steps of the modelling process are well performed thanks to:

- the definition of European reference dedicated guidelines,
- the realization of technical audits concerning air quality modelling in the member states,
- the participation to intercomparison exercises.

Quality Control

- Based on Current Delta Tool metrics and MQO definition.
- minimum number of stations used for evaluation is proposed to be set in coherence with the Directive as the minimum number of sampling points per zone.
- Regular field campaigns could also be requested for validation.
- Abandonment of the concept of demonstration of equivalence.

These points are also proposed to be added as additional Work Packages in the TS/Project.

WG1 PAPER ON MQO ACCEPTED!

FW: Decision on your manuscript #AIRQ-D-17-00266R1 - Message (Plain Text)

You replied to this message on 6/02/2018 12:28.

From: Alexandra Monteiro <alexandra.monteiro@ua.pt> Sent: di 6/02/2018 11:15

To: Laure.MALHERBE@ineris.fr; Cristina Guerreiro (Cristina.Guerreiro@nilu.no); Paweł Durka <pawel.durka13@gmail.com> (pawel.durka13@gmail.com); Joost Wesseling <joost.wesseling@rivm.nl> (joost.wesseling@rivm.nl); Maiheu Bino; Ana Miranda; Gabriela Sousa Santos (Gabriela.Sousa.Santos@nilu.no); 'Flandorfer Claudia'; 'Emilia Georgieva'; Elke (trimpeneers@irceline.be); Jonilda Kushta <j.kushta@cyi.ac.cy> (j.kushta@cyi.ac.cy); Frederic TOGNET (Frederic.TOGNET@ineris.fr); Jenny Stocker (Jenny.stocker@cerc.co.uk); Michele Stortini (mstortini@arpae.it)

Cc: Philippe.THUNIS@ec.europa.eu; Janssen Stijn

Subject: FW: Decision on your manuscript #AIRQ-D-17-00266R1

Good news!
We did it :-)

Thank you all!
Alexandra

-----Original Message-----
From: em.airq.73.5911fa.bf9c0ed6@editorialmanager.com [mailto:em.airq.73.5911fa.bf9c0ed6@editorialmanager.com] On Behalf Of Yong S. Chung
Sent: terça-feira, 6 de fevereiro de 2018 06:56
To: Alexandra Monteiro
Subject: Decision on your manuscript #AIRQ-D-17-00266R1

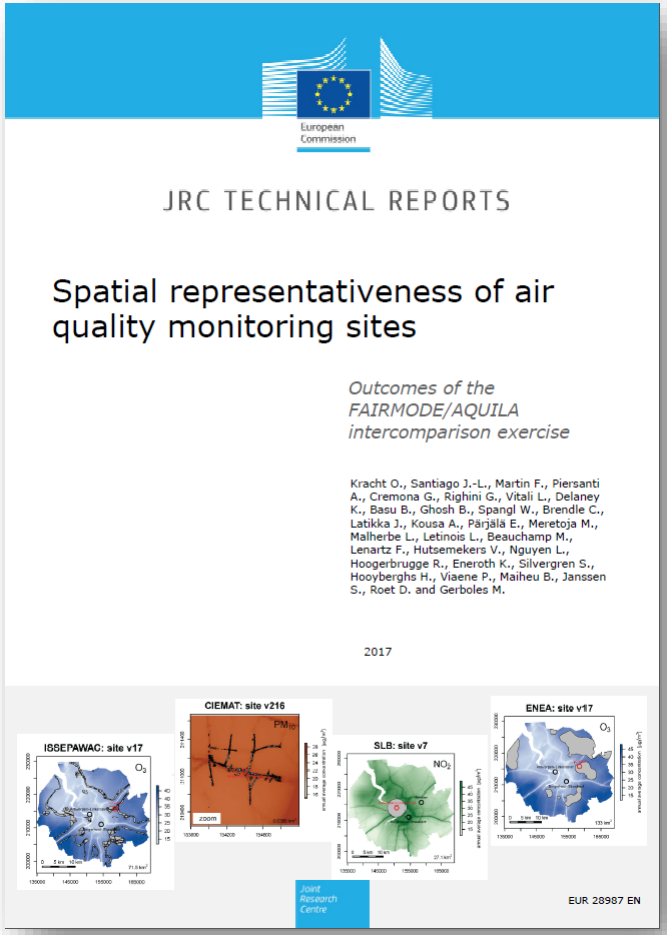
Dear Dr Monteiro:

We are pleased to inform you that your manuscript, "Strengths and weaknesses of the FAIRMODE benchmarking methodology for the evaluation of air quality models", has been accepted for publication in Air Quality, Atmosphere & Health.

Spatial Representativeness of monitoring stations: From chaos to …?

SR INTER-COMPARISON EXERCISE SUCCESSFULLY FINALIZED

- » SR inter-comparison exercise with 11 teams (2015 – 2017)
- » Under supervision of Oliver Kracht (JRC) → unfortunately left the JRC!
- » Final report available at FAIRMODE website



European Commission

JRC TECHNICAL REPORTS

Spatial representativeness of air quality monitoring sites

Outcomes of the FAIRMODE/AQUILA intercomparison exercise

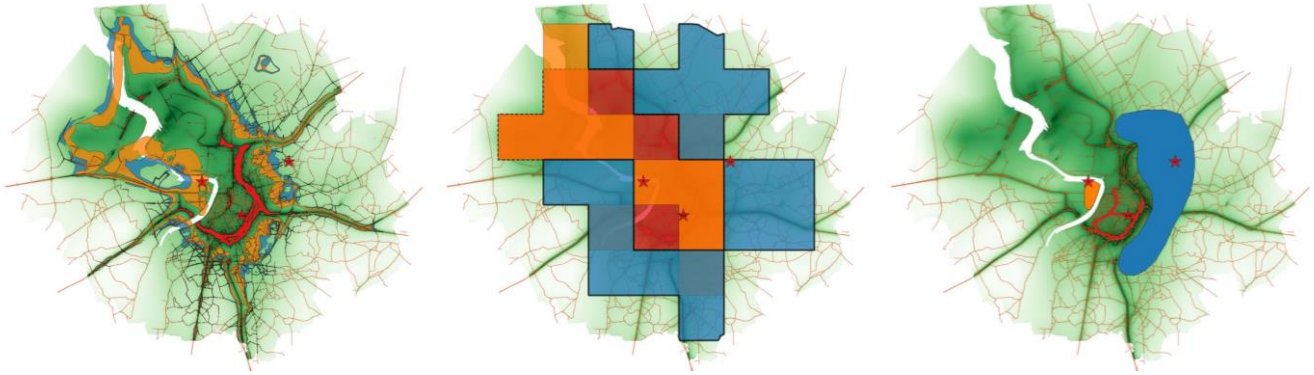
Kracht O., Santiago J.-L., Martin F., Piersanti A., Cremona G., Righini G., Vitali L., Delaney K., Basu B., Ghosh B., Spangl W., Brendle C., Latikka J., Kousa A., Pärjälä E., Meretoja M., Malherbe L., Letinois L., Beauchamp M., Lenartz F., Hutsemekers V., Nguyen L., Hoogerbrugge R., Eneroth K., Silvergren S., Hooyberghs H., Viaene P., Maiheu B., Janssen S., Roet D. and Gerboles M.

2017

SPATIAL REPRESENTATIVENESS: LESSONS LEARNT

» **Area of SR** → seemed to work well as general concept

» Considerable range of **dissimilarity in results** due to differences in **definition** and **methodology**



SPATIAL REPRESENTATIVENESS: RECOMMENDATION

- Need for a better definition of SR
  - Consistent and transparent **criteria** for e.g. the tolerance level
  - A **purpose base metric** (model validation, network design, population exposure,…) might solve some of the confusion

SPATIAL REPRESENTATIVENESS: RECOMMENDATION

- Technical methods available to assess the SR area:
  - **Proxy data** based methods → try to mimic emission or dispersion characteristics

  - **Model based** methods → our best understanding of emissions and dispersion characteristics

DISCUSSION TOPICS

- How could the purpose of SR impact its definition
  - model validation → only rely on station type?
  - network design
  - population exposure

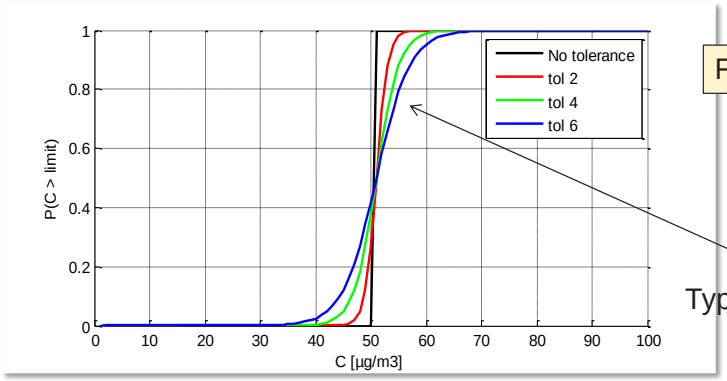
- Do you agree that model based approaches are more promising than proxy data ones?

- How to continue this work in FAIRMODE?
  - Work on a better definition / metrics of SR?
  - Repeat (part) of the exercise with a better definition?
  - …

Modeling quality objectives for forecast: nice to have or real need?

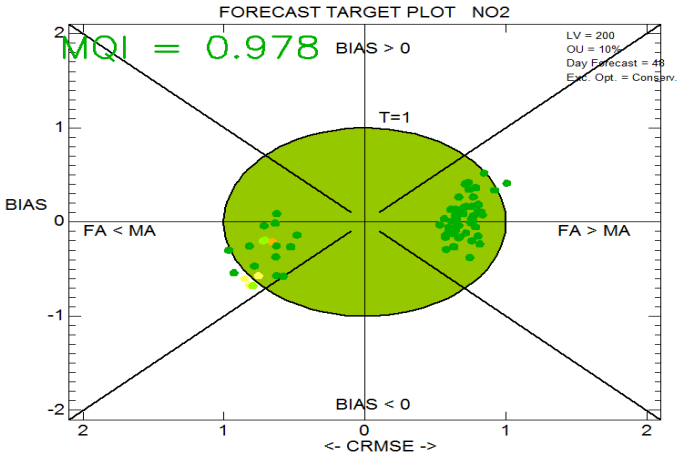
MQO FOR FORECAST

» New probabilistic approach to deal with exceedances



For model as well as obs. !

Typical tanh – like shape



» Implemented in DELTA but still some issues to solve

DISCUSSION TOPICS

- How to make progress: a 2 day hackathon at Ispra to jointly work on the definitions, DELTA implementation, testing and documentation?
- Who is interested?

Collaboration FAIRMODE-CAMS: how and what?

Guidance from FAIRMODE WG1 to IPR: What should be included?

Alberto González Ortiz | 26 February 2018 | Fairmode plenary meeting, Baveno, Italy

E-reporting of models:
Possible guidance to the IPR

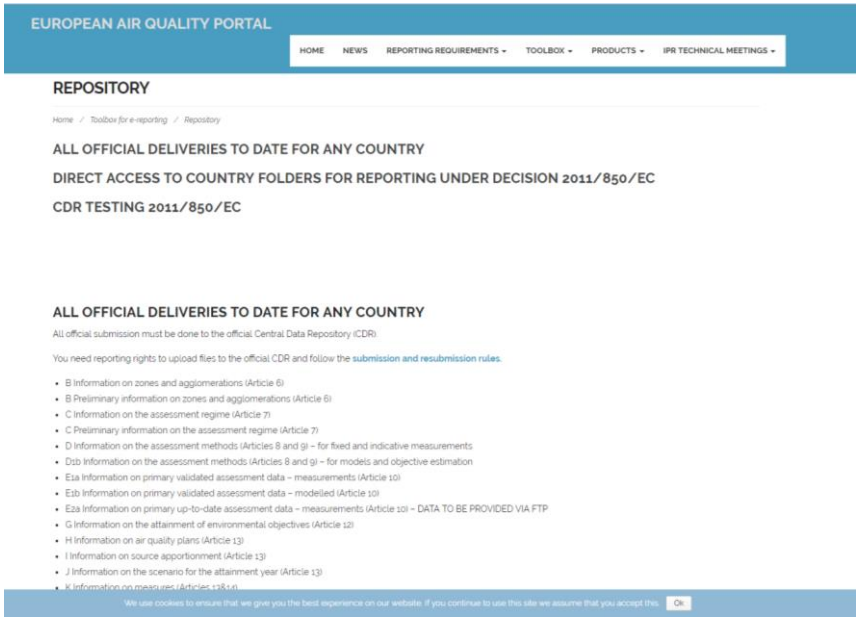
E-reporting of models: current state

- Dataflows D1b (metadata) and E1b (model results)

- User guide to XML & Data model → formats
- Data base schema
- Concept paper for the processing of model datasets (E1b)

- Stored in CDR. Countries reporting models in 2017

Denmark
Germany
Netherlands
Poland
Portugal
Romania
Spain
United Kingdom



Croatia
Greece
Italy
Malta
Norway

European Environment Agency

E-reporting of models: possible ways ahead

- Define functionalities
  - Visualization and analysis
  - Links to compliance (dataflow G)
  - Adjustments

- Identified common activities e-reporting/Fairmode
  - Visualization ←→ composite map
  - Delta tool as possible data quality objective
  - Assessment activities

- Which functionalities would you like to have in the e-reporting?

- Which kind of guidance for reporting models would you like to have in the IPR Guidance document?

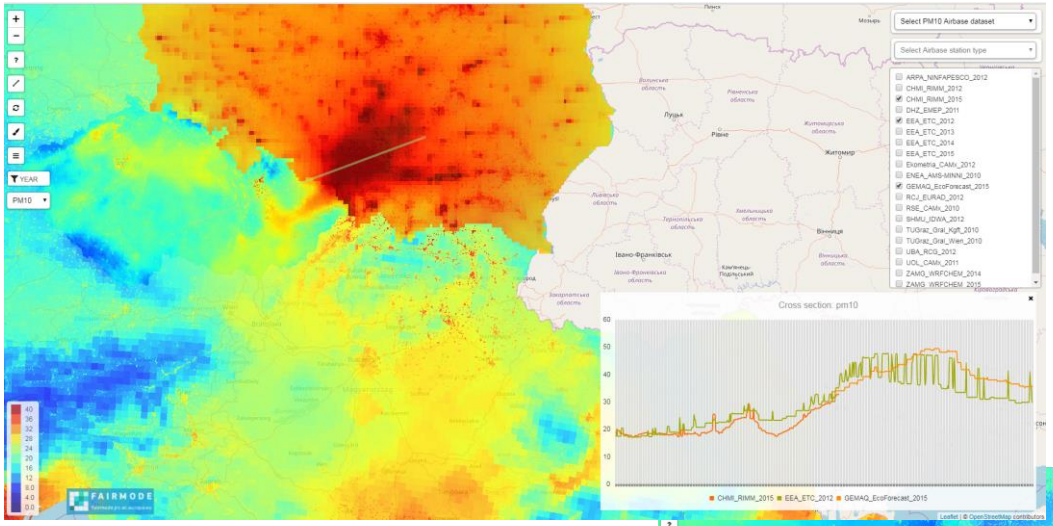
GUIDANCE FROM FAIRMODE ON IPR

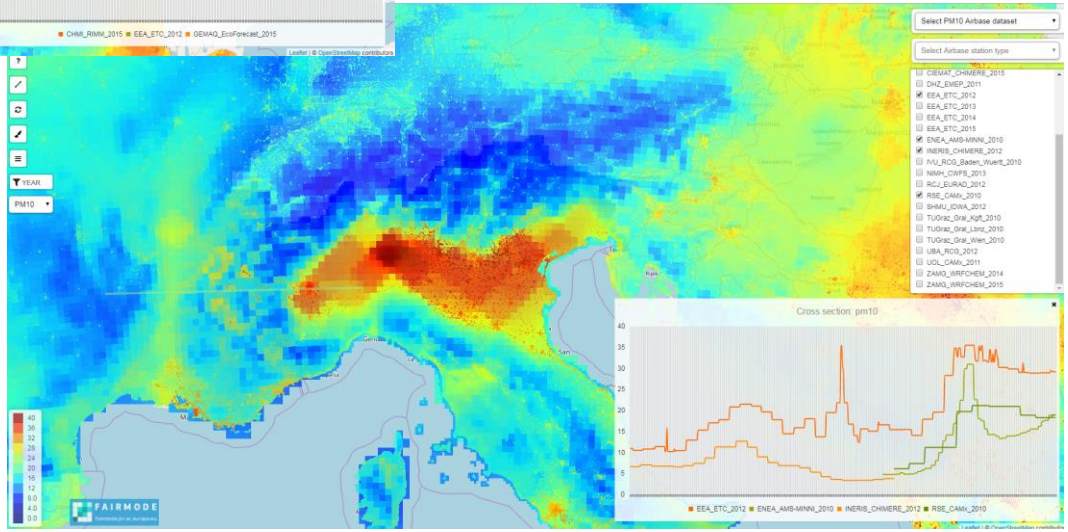
The FAIRMODE perspective

» Additional download functionality in DELTA tool to produce MQO summary statistics in XML format “readable” by the CDR data flows

» Establish a link between the CDR and the Composite Mapping Platform so that data only has to be submitted once → mentioned before but not yet implemented due to lack of resources

EEA-ETC MAP AVAILABEL FOR BENCHMARKING IN COMPOSITE MAPPING





DISCUSSION TOPICS

» Which functionalities would you like to have in the e-reporting?

» Which kind of guidance for reporting models would you like to have in the IPR Guidance document?

Sensors: what’s next?

INDICATIVE MEASUREMENTS AND AQ MODELS

Extensive indicative NO_2 measurements are (becoming) available in several countries. Can this data be used in model quality assessment?

- » In several countries relatively large numbers of indicative measurements are (becoming) available, i.e results of Palmes tubes for NO_2.
- » The uncertainty of yearly average NO_2 concentrations is slightly larger than the requirements for reference measurements.
- » The sheer number of indicative measurements may compensate for the relative large random uncertainty.

- » Can indicative measurements be used in defining/testing a MQO?

DEVELOPMENTS WITH SENSORS

Some developments and projects using sensors for Air Quality, running project:

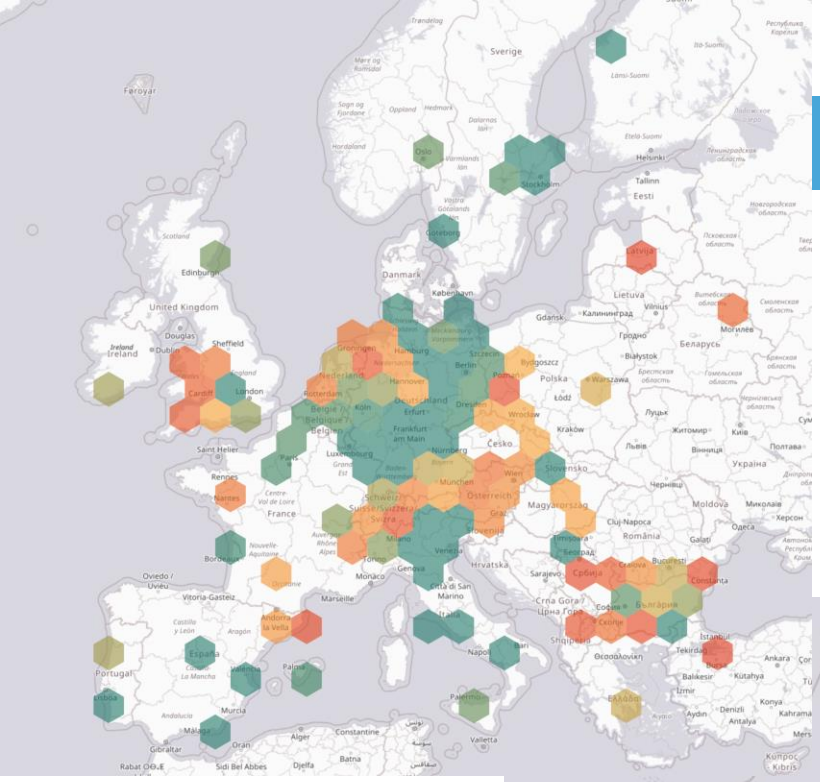
- Universidad Politécnica de Madrid (Rafael Borge)
  - LIFE-PHOTOSCALING: aims to demonstrate the validity of the photocatalytic technology in cities, measurements using AQmesh sensors. The sensors needed additional calibration and the data obtained was treated with machine learning algorithms to improve the accuracy of the measures.
  - TECNAIRE-CM: Eight kits of low-cost sensors measuring NO2, O3, PM10 and T, RH developed in collaboration with private company. Presently collocated in the UPM facilities, later to be collocated in a reference Air Quality Station with the objective of calibrating them, by means of machine learning algorithms.
- VMM/ECN/RIVM (Christophe Stroobants, Ernie Weijers)
  - LIFE VAQUUMS: Focus on sensors for PM, NO2, O3. presently looking at literature, selecting sensors for actual (field) testing.
- VMM (Christophe Stroobants
  - DenCity: Establish a network of sensors in the SmartCity-zone of Antwerp, check calibration.
  - CurieuzeNeuzen: 20000 Palmes tubes (NO2) during 1 month.
- RIVM
  - Extensive testing an calibration of Nove SDS011 dust sensor and Aphasense B43F NO2 sensor.

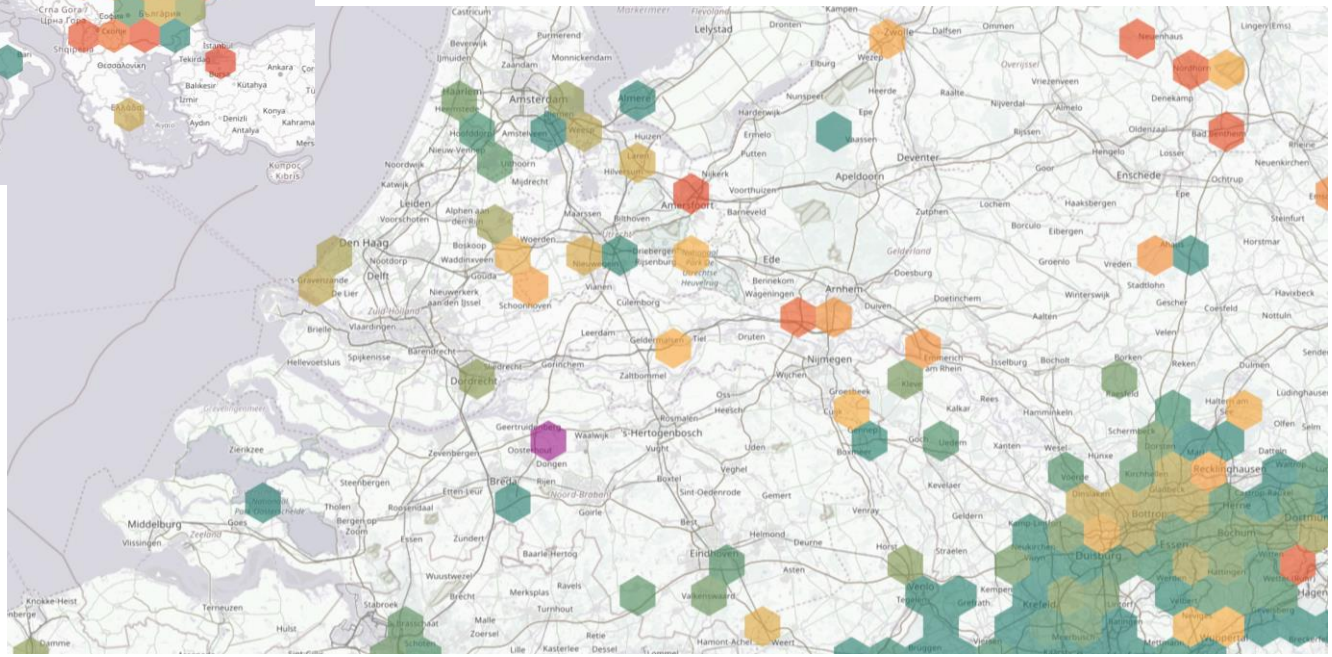
SENSORS AND AQ MODELS

*The German Luftdaten project is developing into a *large* network of citizens performing $PM_{10}/PM_{2.5}$ measurements.*

- An example of a successful Citizen Science (CS) sensor network is the German "Luftdaten" project (plus spin-offs).
- PM10/PM2,5 sensors, Shinyei/Nova, many countries in the EU, some **3700** unique measurement locations.
- The large number of sensors in some countries is interesting for model tests / validations.
- However, the results of the sensors are very sensitive to moisture.
- Assuming a correction for moisture (and other sensitivities) is possible and there are, on average, no systematic differences, the sheer number of sensors may compensate for the relative large random uncertainty.

- When can sensor measurements be used in defining a MQO?

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Deventer
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Nijmegen
Ede
Zwolle
Lelystad
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Breda
Tilburg
Middelburg
Vlissingen
Terneuzen
Roosendaal
Zierikzee
Hellevoetsluis
Spijkenisse
Gouda
Alphen aan den Rijn
Veenendaal
Ede
Wageningen
Doetinchem
Winterswijk
Oldenzaal
Hengelo
Almelo
Emmen
Assen
Leeuwarden
Sneek
Heerenveen
Drachten
Harlingen
Terschelling
Vlieland
Texel
Den Helder
Alkmaar
Zaandam
Hoofddorp
Amstelveen
Haarlemmermeer
Noordwijk
Katwijk
Voorschoten
Zoetermeer
Rijswijk
Vlaardingen
Schiedam
Rotterdam
Maassluis
Spijkenisse
Hellevoetsluis
Brielle
Goes
Zierikzee
Oostende
Knokke-Heist
Brugge
Gent
Antwerpen
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Hasselt
Genk
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Eindhoven
Helmond
Deurne
Asten
Someren
Veldhoven
Waalwijk
Oosterhout
Dongen
Geertruidenberg
Zevenbergen
Etten-Leur
Roosendaal
Bergen op Zoom
Tholen
Steenbergen
Zundert
Essen
Baarle-Hertog
Wuustwezel
Brecht
Merksplas
Ravels
Turnhout
Malle
Zoersel
Retie
Mol
Dessel
Hamont-Achel
Lille
Kasterlee
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Kempen
Grefrath
Krefeld
Meerbusch
Neuss
Düsseldorf
Duisburg
Essen
Mülheim
Oberhausen
Recklinghaus

DISCUSSION

Sensor networks pop up everywhere. How to deal with this new data?
Use of indicative measurements and / or sensors

» Assuming that measurements like, for example, NO2 Palmes have random uncertainties that are below the requirements for indicative measurements, can they be used in evaluating the MQO?

» How about the case were no /too few reference measurements are available for evaluating the MQO?

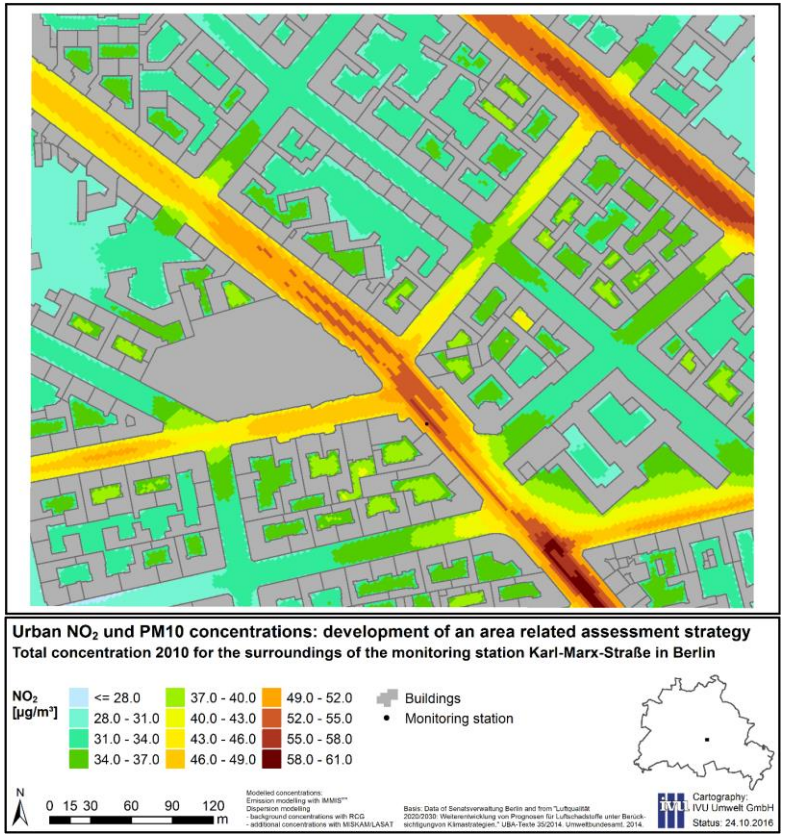
» Same questions for sensors.

» Same questions for large numbers of sensors that may (individually) perform worse than indicative measurements, although the average values may compare quite well to reference measurements.

CFD Modelling: a real need in FAIRMODE?

CFD AND THE AQ DIRECTIVE

Hot spots more and more occur at local level → need for obstacle resolving policy tools



Additional issues for CFD models

- The complexity of CFD models compared to more traditional (Gaussian) dispersion models leads to a number of additional challenges in case of regulatory applications:
  - CFD models require more information on the situation to be modelled, for instance spatial and temporal boundary conditions;
  - CFD models rely in part on internal sub models for which the best setting / choice may not be evident, i.e. turbulence models;
  - The application of CFD models requires much more expertise than using other types of models → increased change of human error in setting up the modelling;

CFD IN FAIRMODE

FAIRMODE could offer a platform to:

- Collect feedback on application of CFD in ADQ context
- Compare modelling methodologies,
  - ways to produce annual statistics
  - Validations strategies,
  - calibration with measurements/other well-validated model results
- Compare modelled effects of complex canyons, vegetation, screens…,
  - possibly formulate consensus on effects of screens, vegetation
- Exchange experience on strategies for dealing with complex geometries (e.g. road tunnels), meshing,…
- ….

DISCUSSION TOPICS

- Do you recognize the need for obstacle resolving tools to support AQD policy?
- Do we expect that the additional challenges for CFD models can be met, now / in the near future?
- Is FAIRMODE the right platform to deal with this CFD challenges?
- How to organize this subtask?