FAIRMODE WG2 MQI Mapping Exercise
Contribution from Germany

Technical Meeting Dublin

“on-going work”

WG2 - Data Used in the exercise

Model used: REM-CALGRID (RCG) in 2x2km² (we used the raw model to investigate the stringency of the MQI)

Main uses of the modelling system under the AAQD: Assessment of national/regional air quality, scenario analysis (e. g. national air pollution control program for NEC-directive)

Monitoring Stations data used: fixed monitoring background stations ((sub)urban, rural) in Germany

Emissions: GRETA (2018 Sub 2020, Germany), CAMS (Europe)

Pollutant: all

Area used for the MQI evaluation: Germany

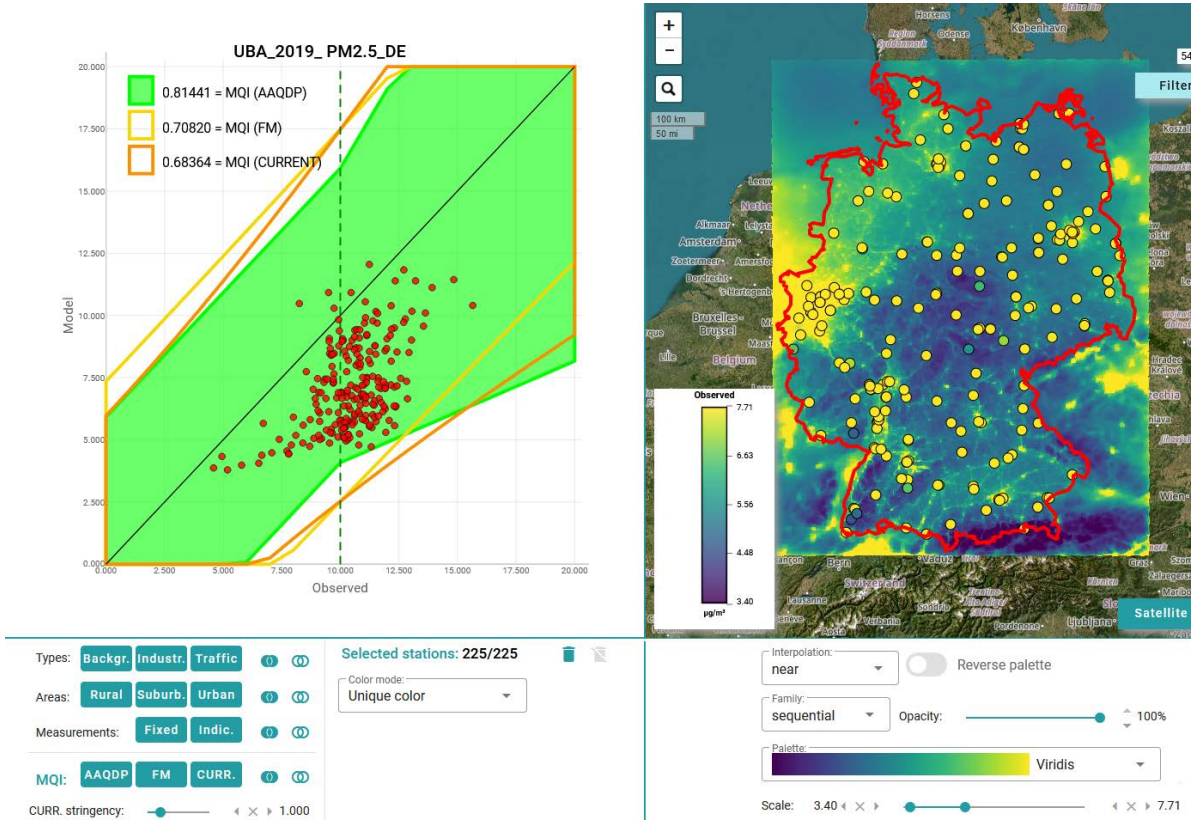
Meteorological year used: 2019

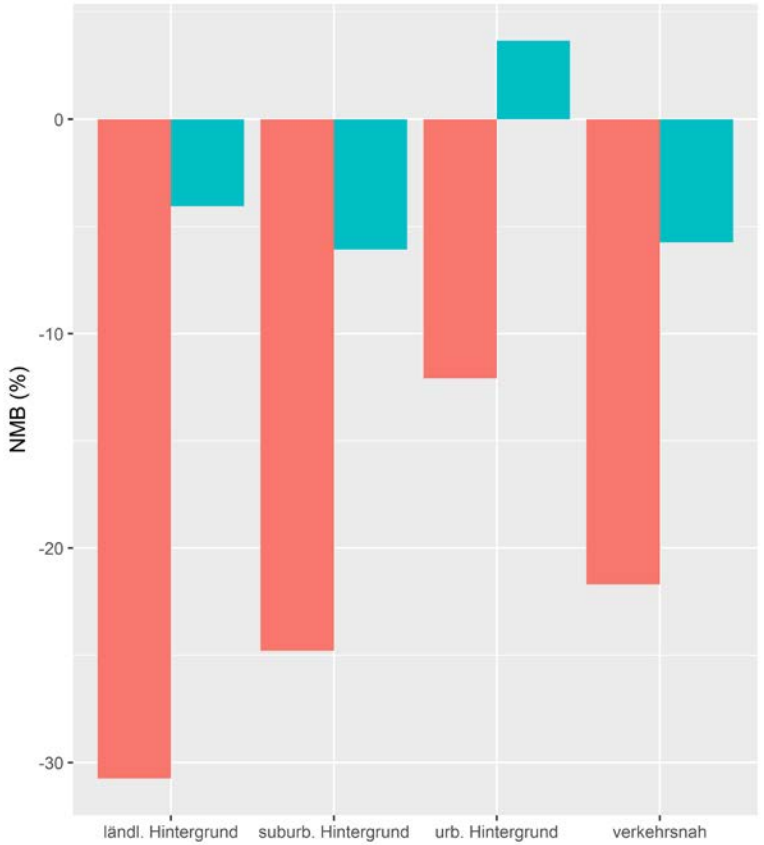
Selected MQI/Stringency level: default

Questions / tests to be addressed

- **Q2 - Are the MQI stringent enough and consistent among pollutants?**

Example PM2.5





European Commission

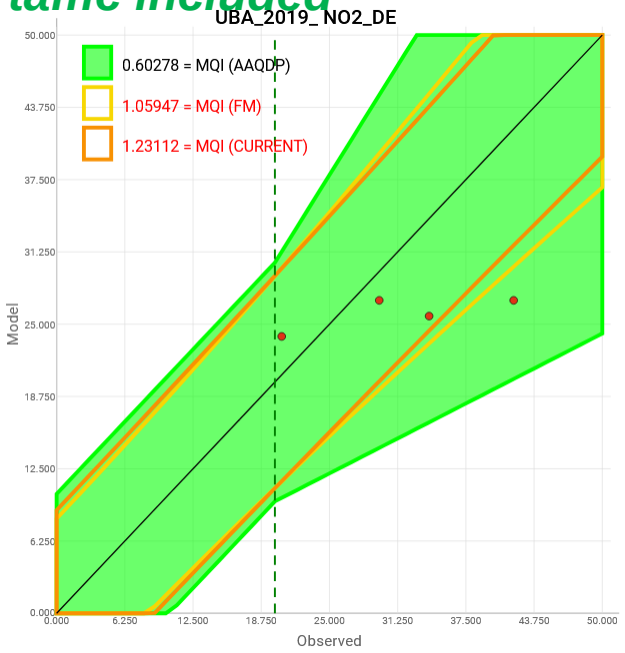
Questions / tests to be addressed

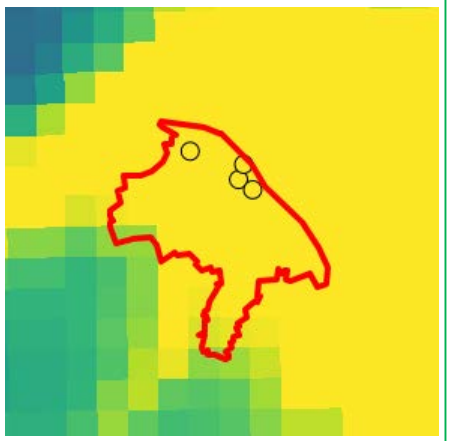
- **Q2 - Are the MQI stringent enough and consistent among pollutants?**

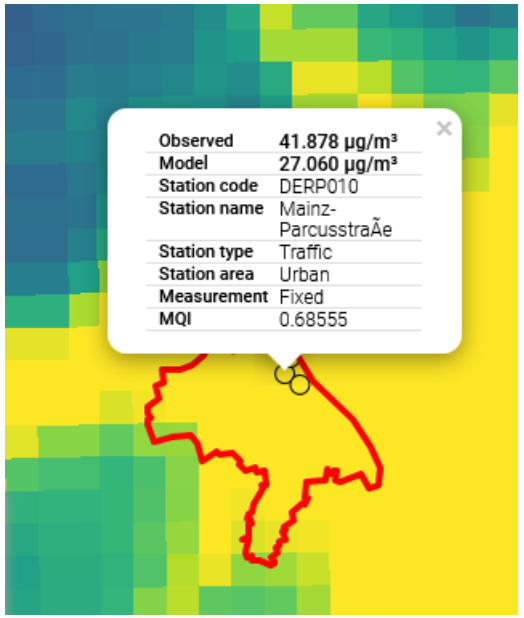
Example NO2

NO_2 raw model – Mainz (DEZKXX0006S)

taffic included







Exceedance in 2019 → model 40% below measurement, but AAQD-MQI fulfiled

European Commission

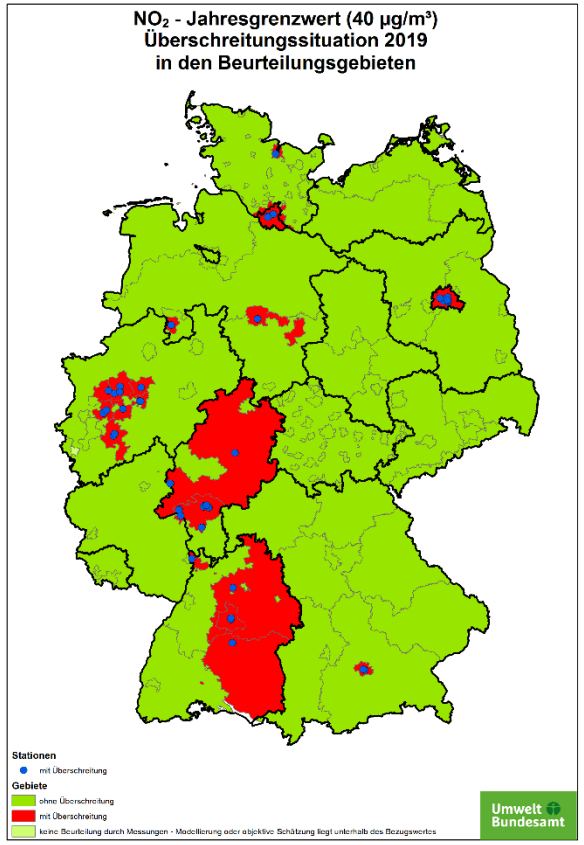
Questions / tests to be addressed

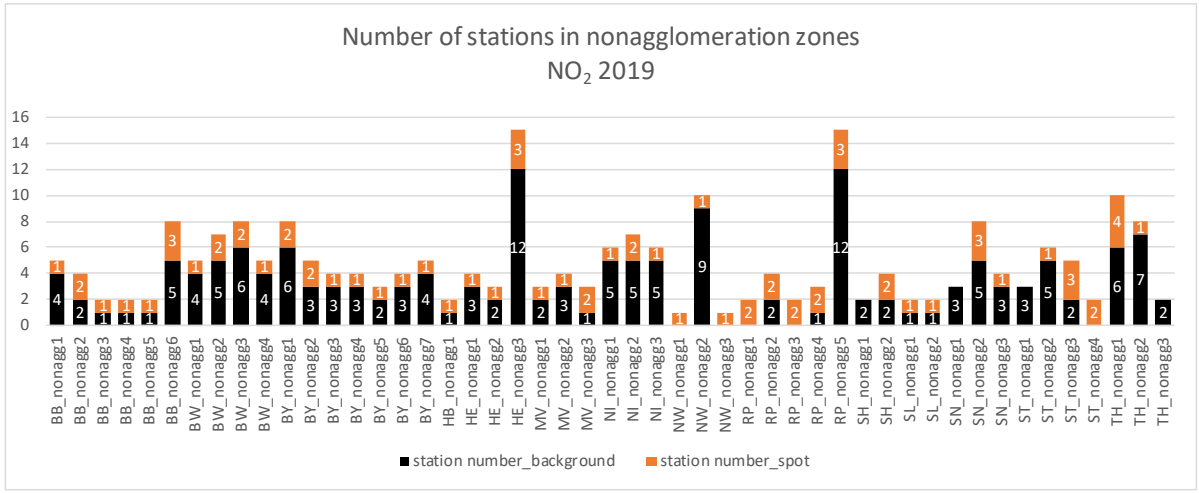
- **Q2 - Are the MQI stringent enough and consistent among pollutants?**
  - Not stringent enough for PM2.5 (considering all station categories and the raw model, but the model fulfil the MQI for all stations)
  - AAQD-MQI might be fulfilled for traffic sites using a regional model although there is a large deviation between model and observation at the limit value. NO_2 MQI stringent enough around the limit value?
  - Use other metric (peak season?) for ozone (annual at the moment)?

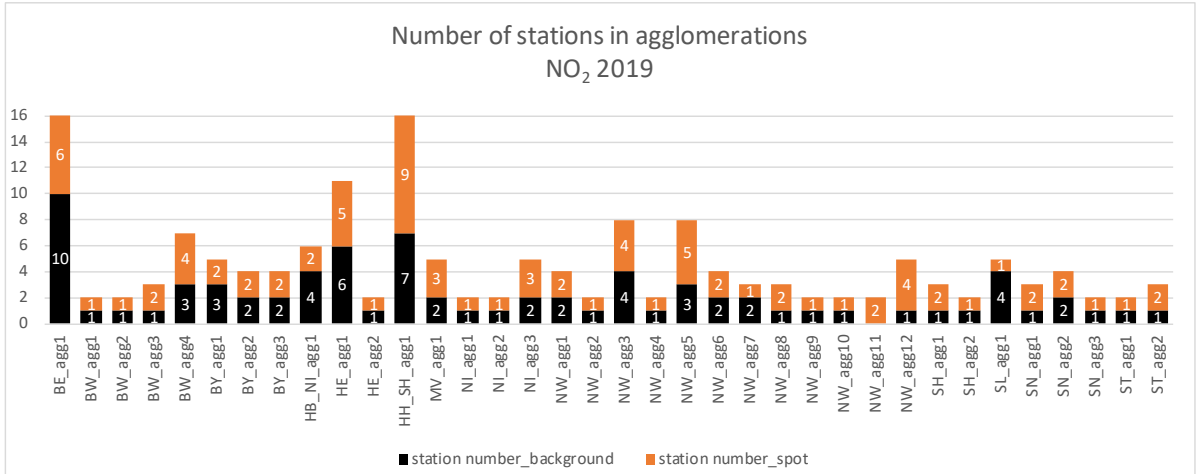
Questions / tests to be addressed

- **Q1 – Is the MQI robust?**
  - **Check robustness of your MQI with respect to the number of stations and aggregation area (zone vs. NUTS1)**

86 air quality zones







Mostly less than 10 stations in a zone for NO2

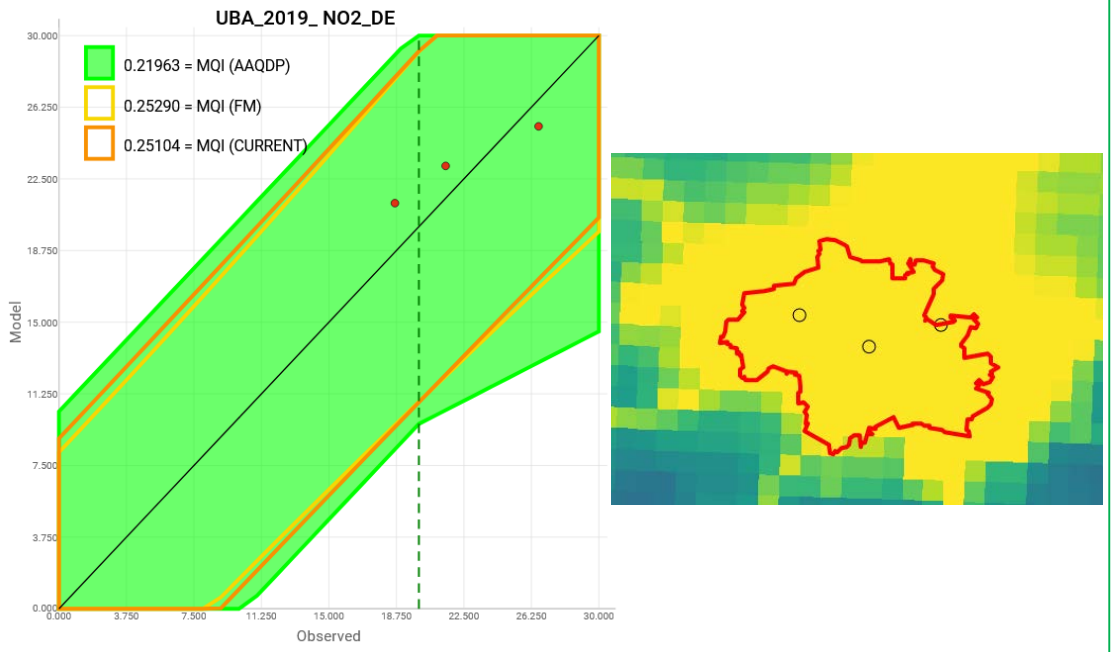
European Commission

WG2 MQI robustness – Analysis

Robustness test I – MQI with respect to aggregation area (zone level vs. NUTS1)

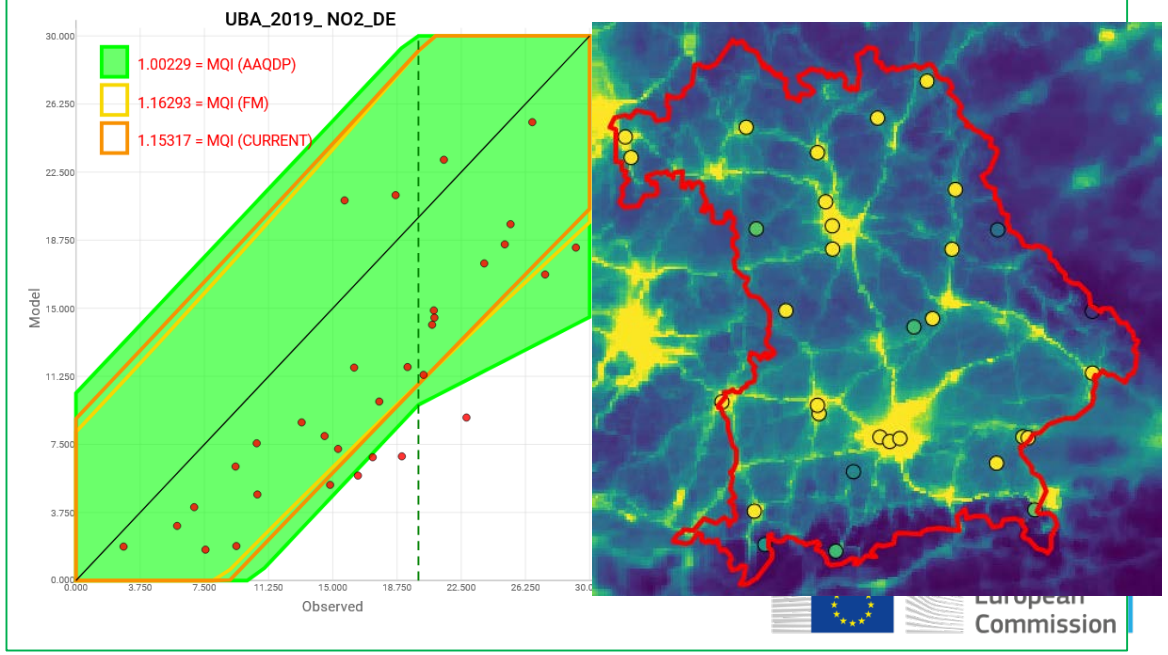
NO_2 raw model – Munich (DEZDXX0001A)

No traffic stations



NO_2 raw model – NUTS1 (Bavaria) – 32 SPOs

No traffic stations



European Commission

WG2 Questions & suggestions

- **Is the MQI robust?**
  - Number of observation sites on zone level mostly below 10 → MQI < 1 at all stations according to Guidance document
  - Geographical extent may influence the MQI result → fulfilled on zone level but not fulfilled on NUTS1 (Bavaria example) or other way around

WG2 Questions & suggestions

- Shall we calculate the MQI for each single air quality zone? Or shall we do it on NUTS1 level due to the number of SPOs?
- Shall we use all stations (including traffic / industry) if the number of SPOs is < 10? (2x2km² model results vs. traffic stations) → please be clear in the guidance
  - Please consider CEN-approach (WG43) → responsible authority can apply further methods for model validation tests (based on national standards)
- Is NO_2 AAQD-MQI stringent enough around the limit value?
- $PM_{2.5}$ and O_3 “always” fulfilled? → further checks for other pollutants and regions necessary

Thank-you

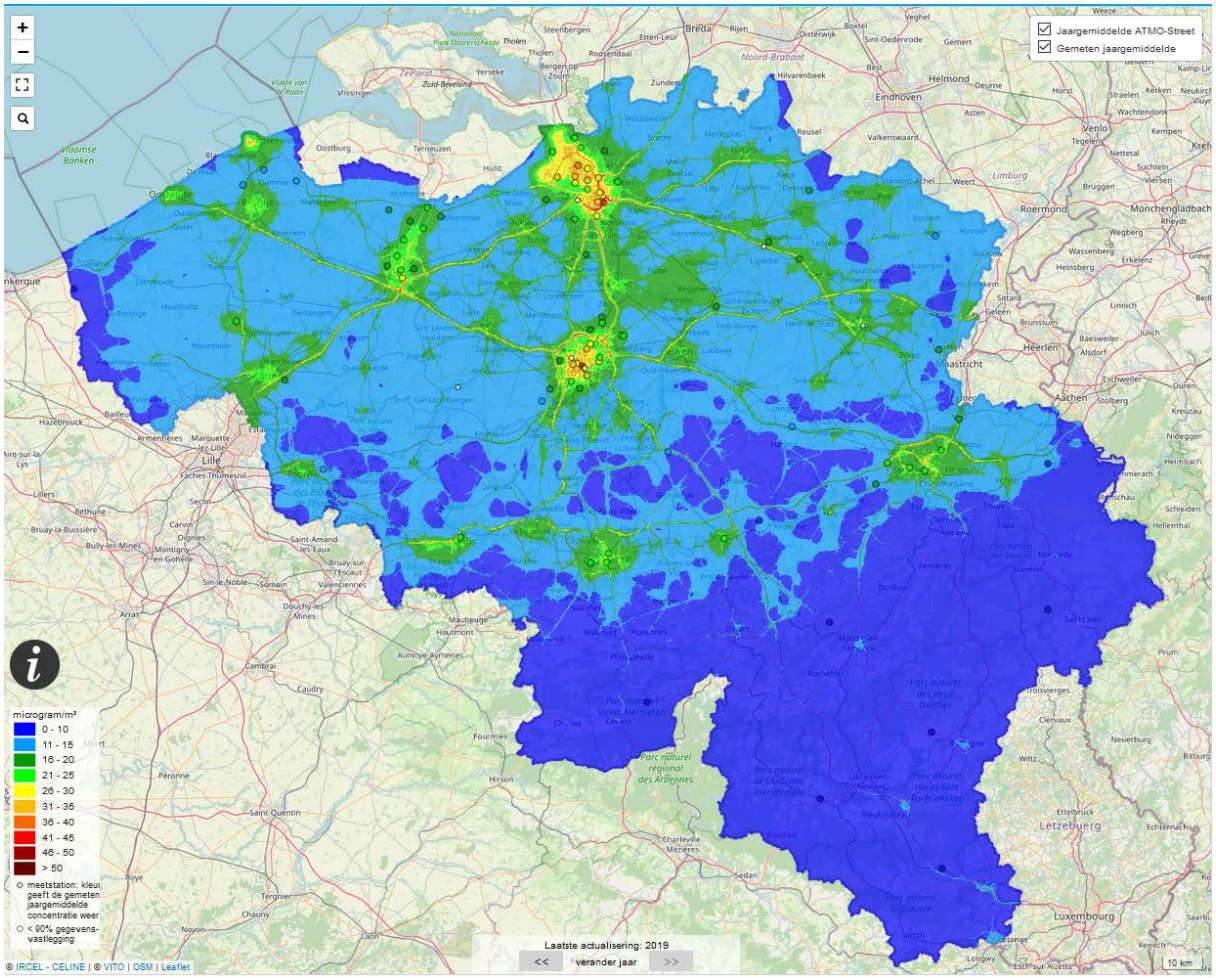
European Commission

IRCEL-CELINE
Belgian Interregional Environment Agency

vito

Result in cooperation with VITO (Peter Viaene) in the framework of the Reference Tasks for IRCEL.

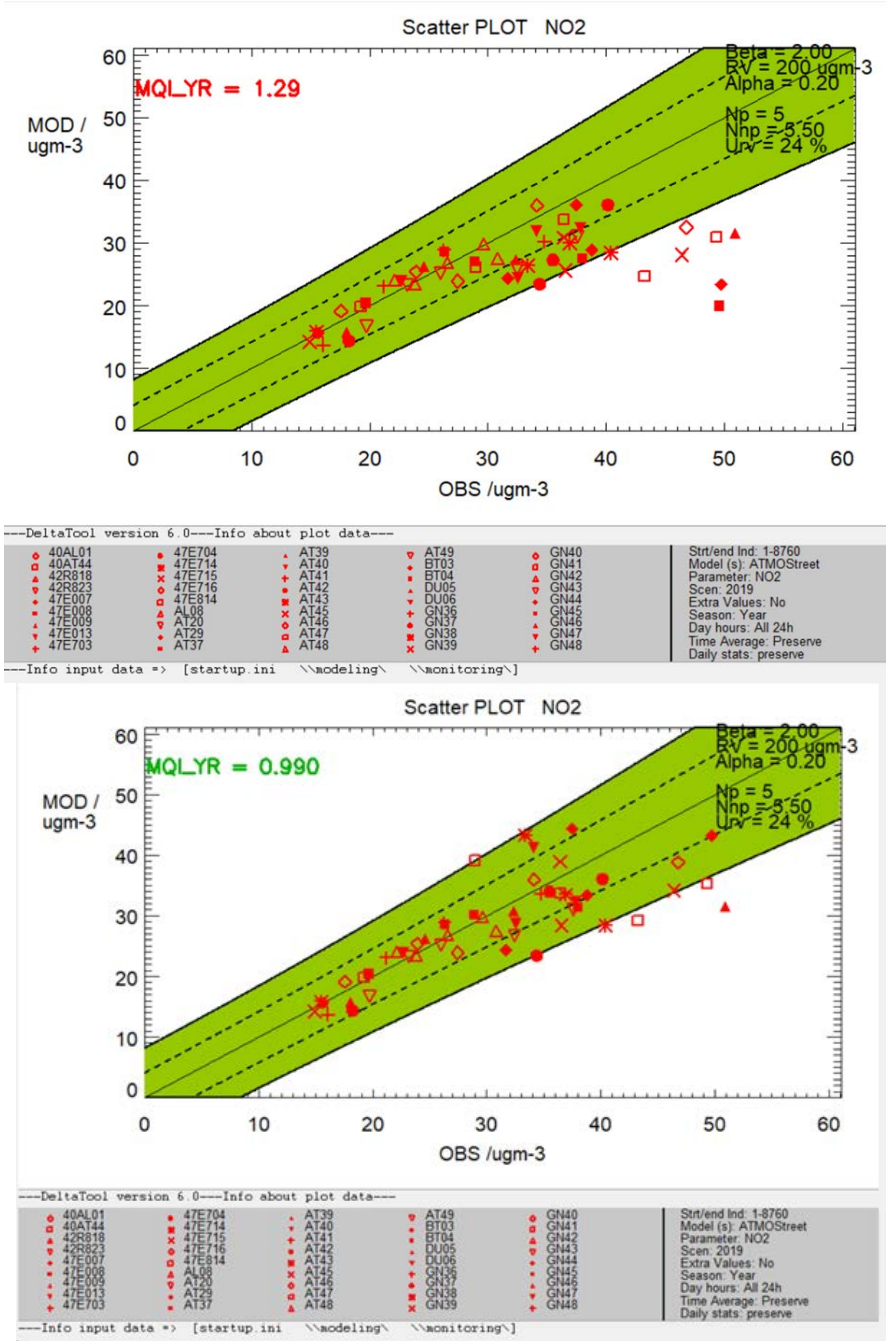
NO2 : open roads and street canyons included in ATMOstreet model



Validation : need for ‘fit for purpose measurements’

- independent telemetric measurements
- independent continuous annual PS – campaigns

Total of 54 independent measurements



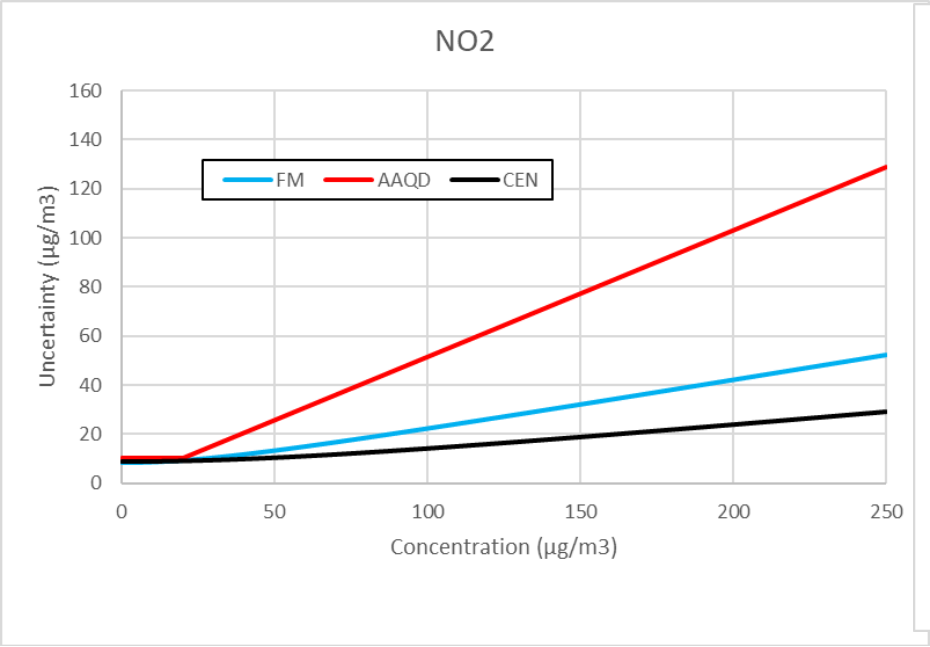
MQI 2019 without street canyon effects

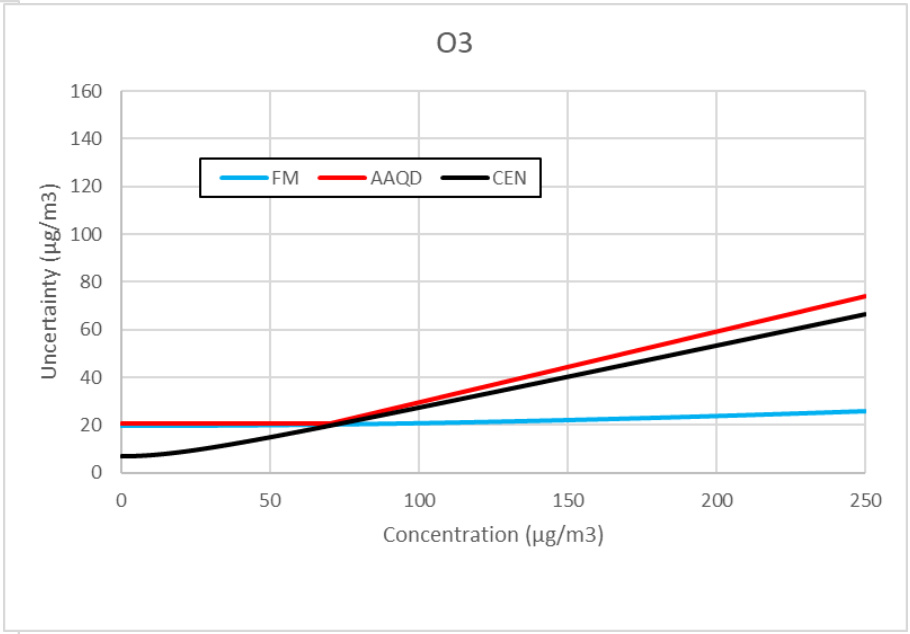
MQI 2019 with street canyon effects (OSPM – model included)

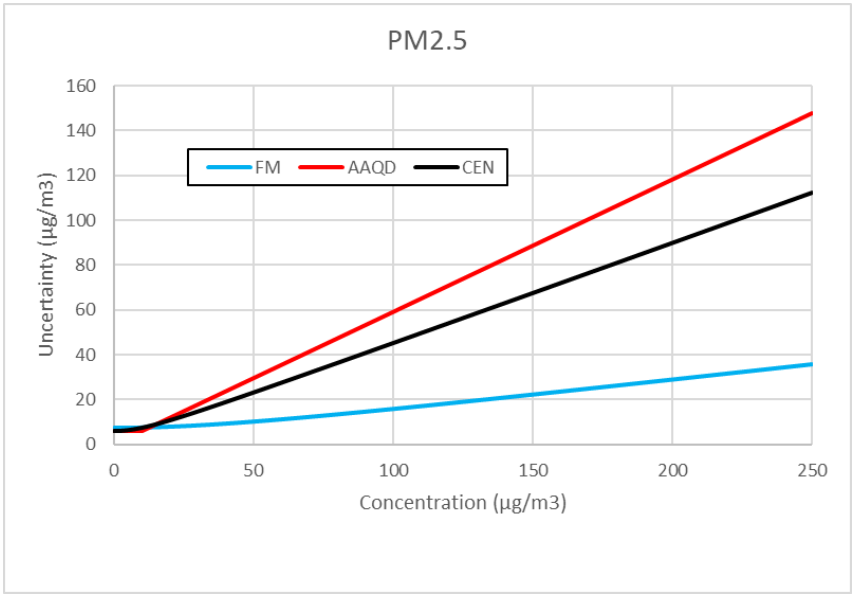
FAIRMODE MQO valid distinction between fit/non fit for purpose for NO2

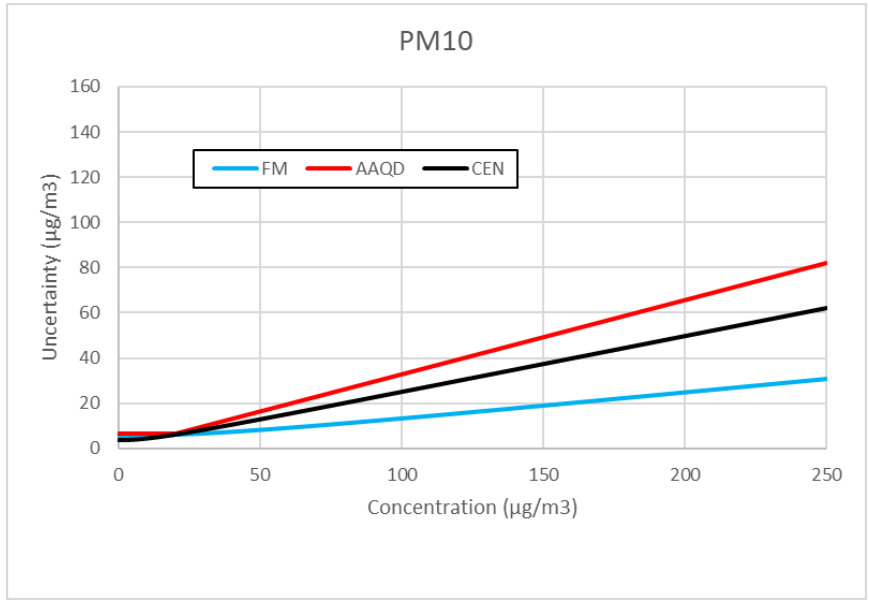
irCELine

Uncertainties MQI: Fairmode – CEN – AAQD









Comparison MQI NO2 2019
different calculation methods

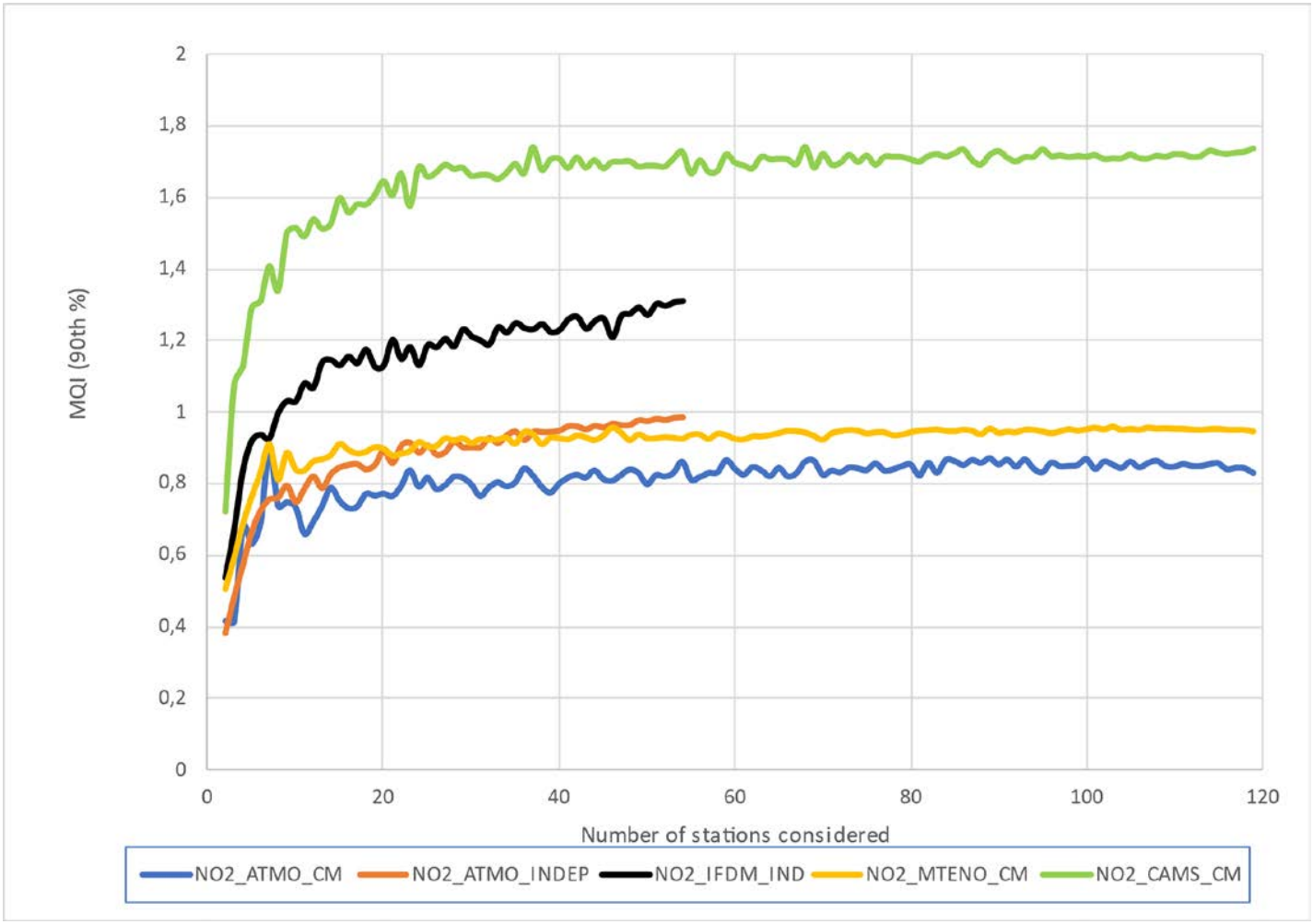
MQI	Without street canyon	With street canyons
Fairmode	1.29	0.99
AAQD	0.68	0.56
CEN	1.6	1.1

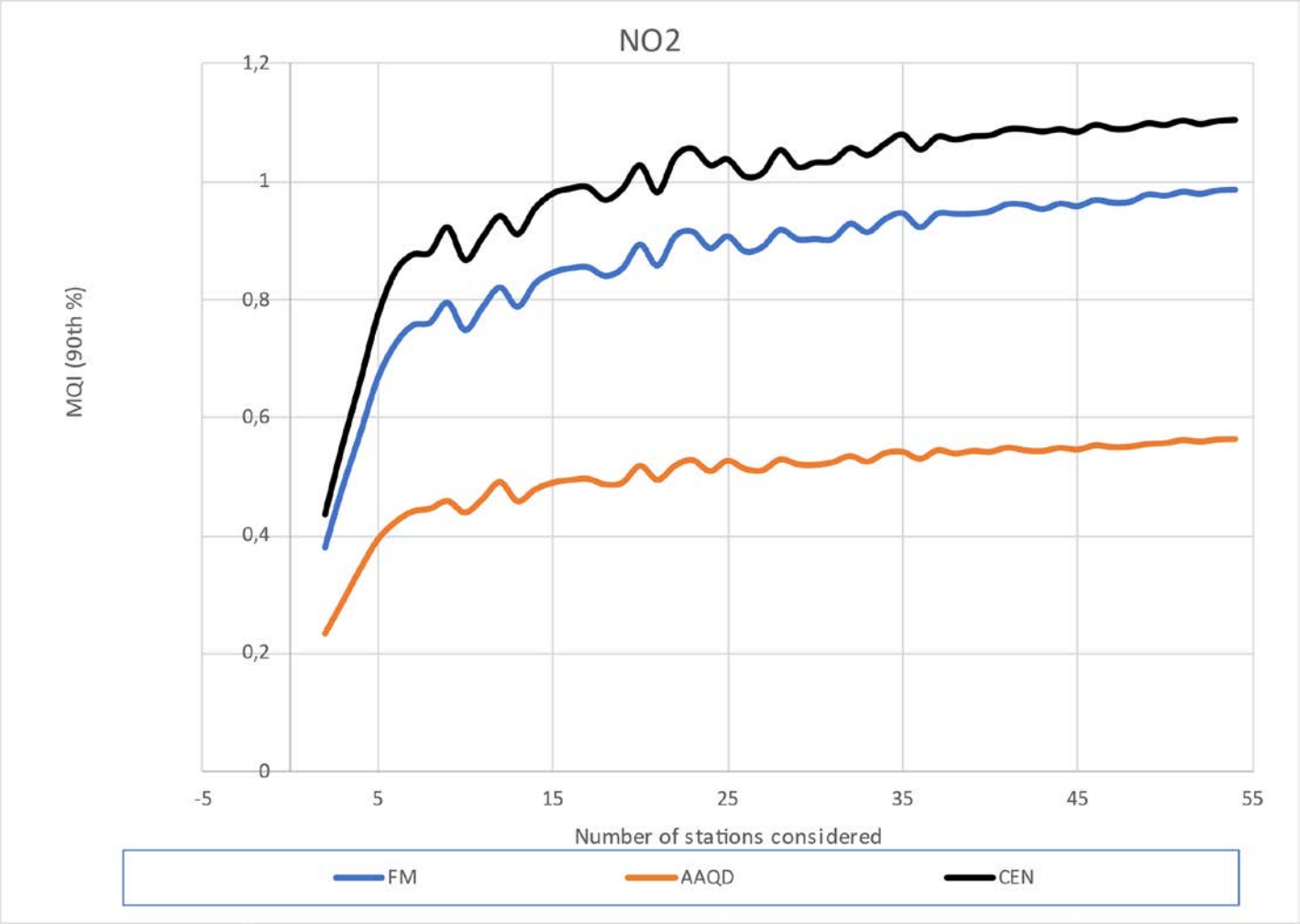
MQI's AAQD and CEN also fit for purpose ?

- MQI AAQD : seems not to be fit for purpose
  (open street model for street canyons passes MQI)
- MQI CEN: stringent: lower uncertainties

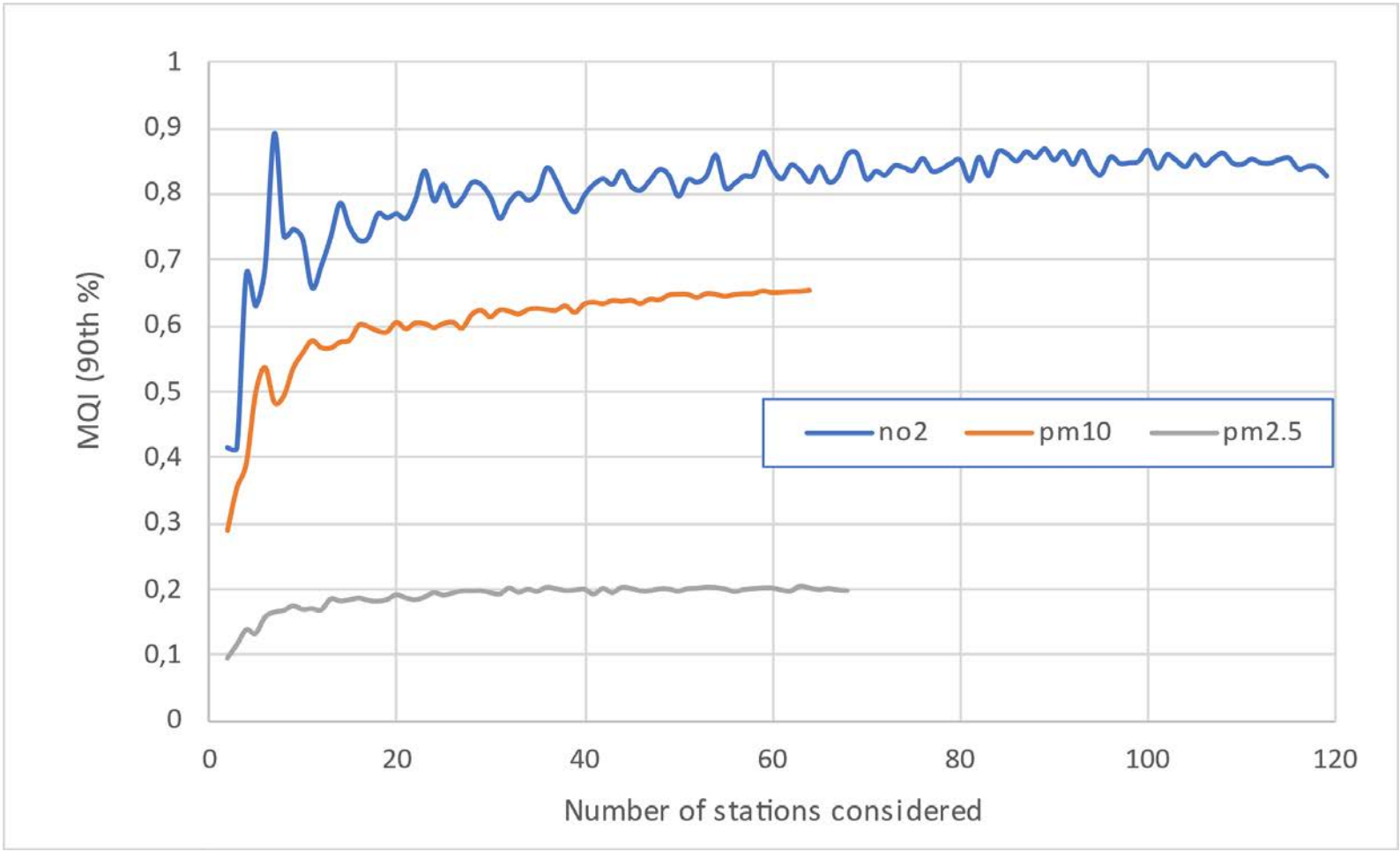
MQI for different stations and models

- stations Composite Mapper and Independent
- ATMO-Street, IFDM, METNO and CAMS





- MQI decreases if the number of stations considered decreases
- minimum 20 ?
- argument to not assess MQI per zone



- CAMS stations BE

Thank you !

Additional assessment indicators, relevance and usefulness in the context of FAIRMODE.

Alexander de Meij, Kees Cuvelier, Philippe Thunis, Enrico Pisoni.

Air quality modelling
Directorate C: Energy, Transport and Climate
Unit C.5: Clean Air and Climate Unit

Alexander de Meij
MetClim
www.metclim.com

History

Time….

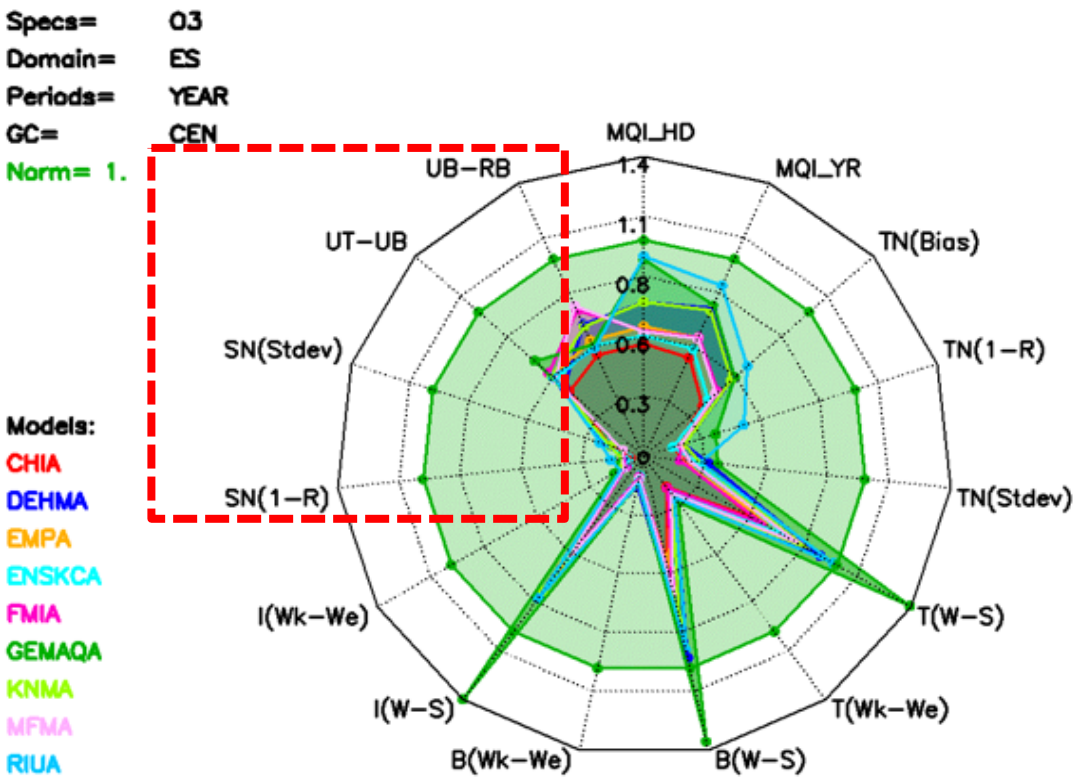
Oct. 2024

MQI/MQO:
Mean bias between model & observations.

Summary Report Indicators:
Temporal and spatial correlation & STDEV.

Dynamic evaluation Indicators:
Concentration gradients between rural & urban or between traffic & urban stations.

Additional assessment indicators, relevance and usefulness



T = Traffic
B = Background
I = Industry

W-S: Winter- Summer
Wk-We: Weekend-Week

Temporal, spatial gradients

Temporal and spatial correlation and standard deviation.

European Commission

Thank you

MetClim

www.metclim.com

European Commission

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

FAIRMODE

Testing the MQO
With few stations

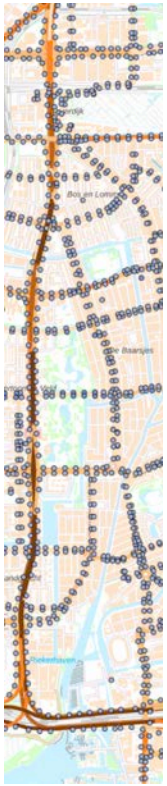
Evaluating the MQO

- Fulfillment of the MQO requires that 90% of the MQI has a value less than (or equal to) 1.0.
- We always take a sample of all the locations that we model to compare to measurements.
- Often, many measurements are available to compare to model results.
- Situations with few datapoints (i.e. MQI) are not an air-quality issue, but a statistical sample-issue.

Example Amsterdam

- In the city of Amsterdam, we model air quality at many locations.
- At which locations do we want to compare model results to observations?

Example Amsterdam



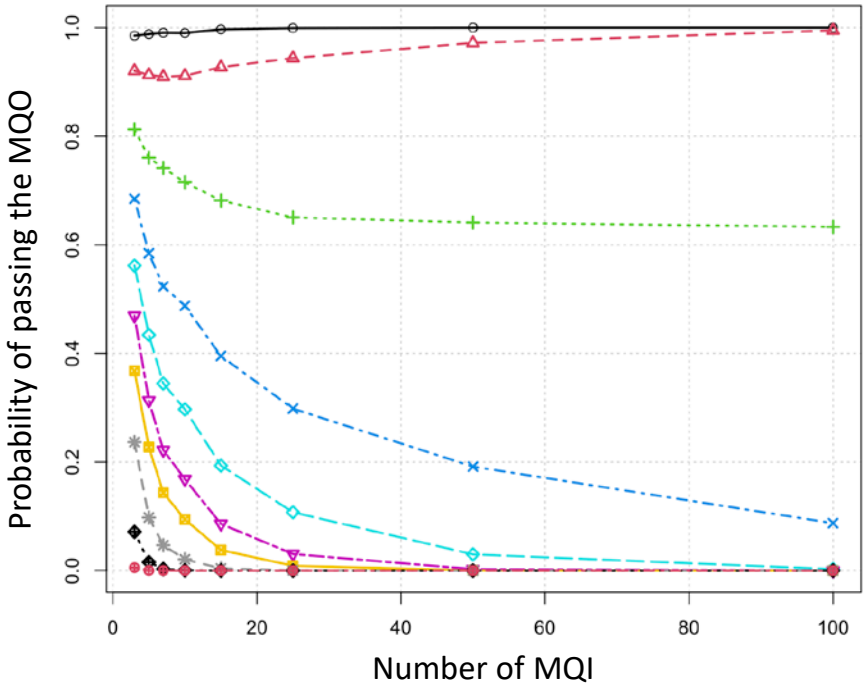
- Assume the 90-percentile of the MQI is 0.7 → model fails MQO!
- Assume the model quality is roughly similar at all locations.
- For all locations, there is 70% probability of finding a MQI < 1.
- If we sample 100 locations, on average, 70 locations will have a MQI<1 → model fails MQO.

- If we sample 3 locations, there is a 0.7 x 0.7 x 0.7 = 0.34 probability of finding MQI<1 → model passes MQO.

- If we calculate the 90-percentile of 3 draws, the probability of passing the MQO is even larger.

Numerical simulations

Perform simulations to estimate the effect of number of stations using actual data.
Different colours represent different model qualities.



These (good) models pass the MQO, regardless of the number of stations in the MQI.

This model just passes the MQO.

The other (not so good) models *may* pass the MQO in a small sample, but will fail (>50% probability) with 10+ values for the MQI.

Correct evaluation of the MQO

- A correct evaluation of the MQO means that the result of the evaluation is not (very) dependent on the number of MQI.
- Correct evaluation of the MQO requires **at least 10 representative values** for the MQI, the probability of correct pass/fail larger than 50%.
- When not enough MQI are available:
  - Add measurement stations, either reference or indicative.
  - Increase the area with measurements (include other cities/regions/…).
  - Explain the proper authorities why you cannot do one of the above ☹
  - Other?

Thank You !

FAIRMODE WG2 MQI Mapping Exercise
Contribution from MET Norway
Europe and Norway

Second interpretation webinar - 3rd September 2024

Q1 + Q2+ Q3 evaluation of on-the-fly MQI

WG2: Evaluation of the MQI - Europe

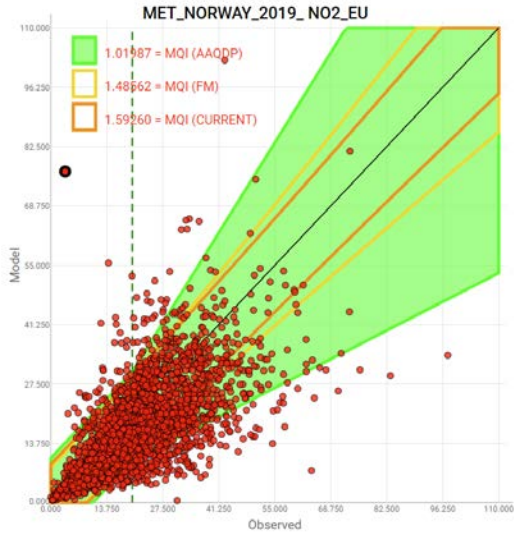
Does the MQI reflect the expected model results for European models?

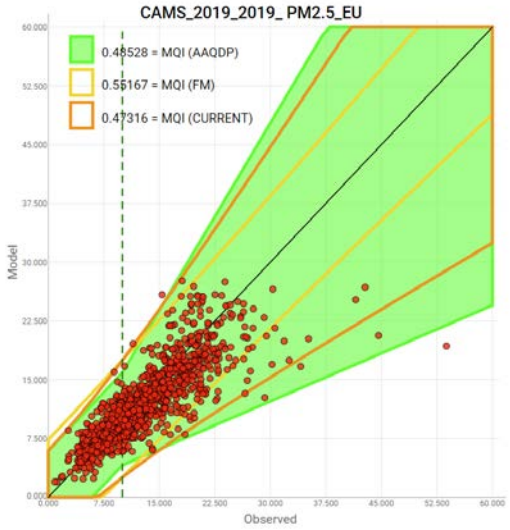
Comparison in Europe of CAMS, EMEP and uEMEP-EU, MQI (AAQDP)

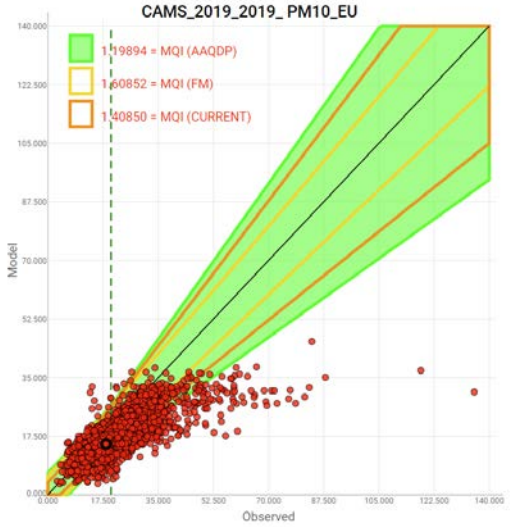
NO_2	All	BG
CAMS	1.38	1.05
EMEP	1.44	1.17
uEMEP-EU	1.02	0.84

$PM_{2.5}$	All	BG
CAMS	0.48	0.46
EMEP	0.76	0.72
uEMEP-EU	0.66	0.62

PM_{10}	All	BG
CAMS	1.12	1.05
EMEP	2.03	1.92
uEMEP-EU	1.44	1.33







European Commission

WG2: Evaluation of the MQI - Norway

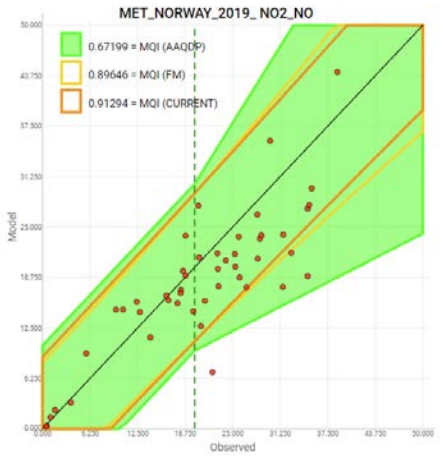
European models in Norway and local bottom-up modelling

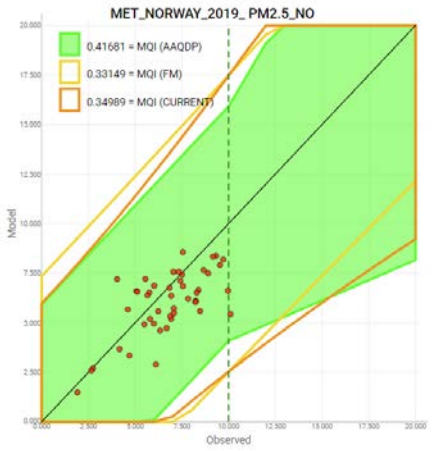
Comparison in Norway of CAMS, EMEP, uEMEP-EU and uEMEP-NO MQI (AAQDP)

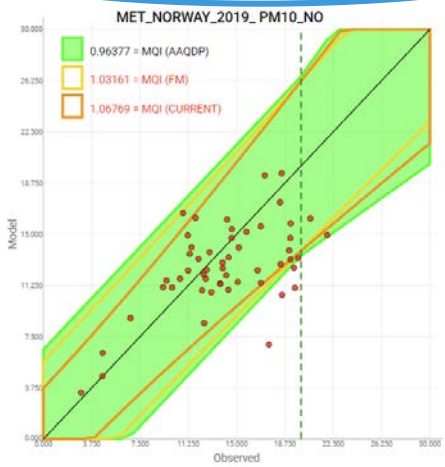
NO_2	All	BG
CAMS	1.62	1.06
EMEP	1.75	1.45
uEMEP-EU	1.16	0.69
uEMEP-NO	0.67	0.47

$PM_{2.5}$	All	BG
CAMS	0.52	0.31
EMEP	0.86	0.57
uEMEP-EU	0.51	0.35
uEMEP-NO	0.42	0.21

PM_{10}	All	BG
CAMS	1.51	0.75
EMEP	2.32	1.68
uEMEP-EU	1.67	1.15
uEMEP-NO	0.96	0.45







European Commission

Questions answered

- **Q1 – Is the MQI robust?**
  - ***MQI seems to be indicative of general model uncertainty, no surprises found***
- **Q2 - Are the MQI stringent enough and consistent among pollutants?**
  - **It is not stringent enough for PM2.5**
- **Q3 – Does the fail/pass MQO test ensure a valid distinction between Fit/non-Fit-for-purpose modelling applications ?**
  - **For PM10 and NO2 it seems to be strict enough, with most models failing without data assimilation. A single number will never answer the fit-for-purpose question.**
  - **MQO test is not very useful for PM2.5, as it is now.**

FAIRMODE WG2 MQI Mapping Exercise Contribution from Sweden

Maria Grundström, Air quality unit, SMHI

FAIRMODE Technical meeting - 8th October 2024

WG2 Data Used in the exercise

Model used: MATCH+CLAIR/NG2M, regional and urban scales (Eularian, Gaussian)

Main uses of the modelling system under the AAQD: Assess air quality nationwide, down to street-level.

Monitoring Stations data used: Urban background stations (low number of stations)

Emissions: SMED (Swedish environmental emission data)

Pollutant: NO2, PM10 and PM2.5

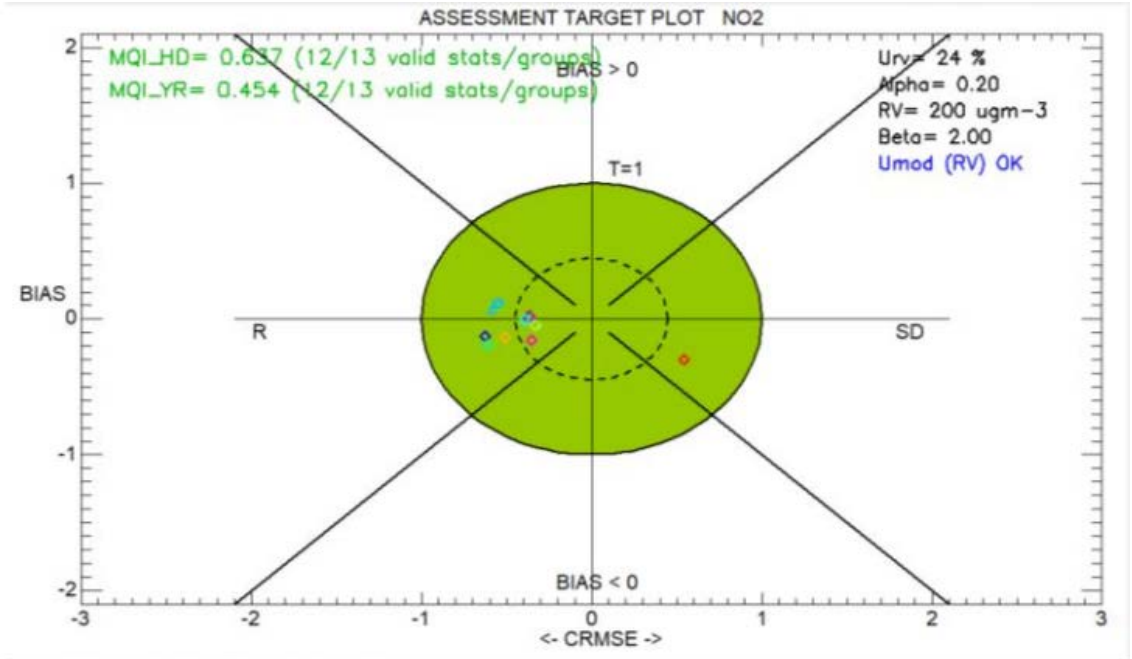
Area used for the MQI evaluation: Sweden

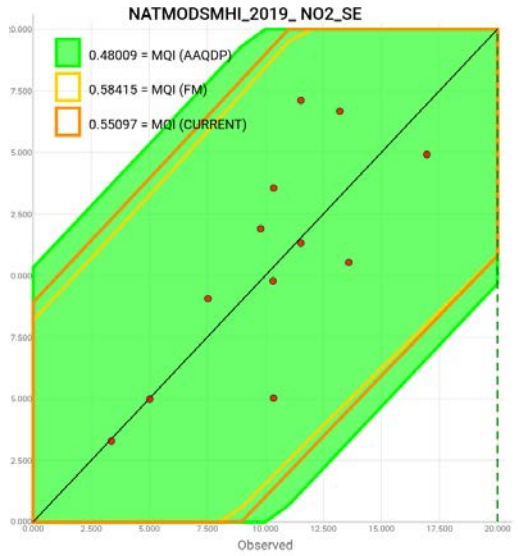
Meteorological year used: 2019

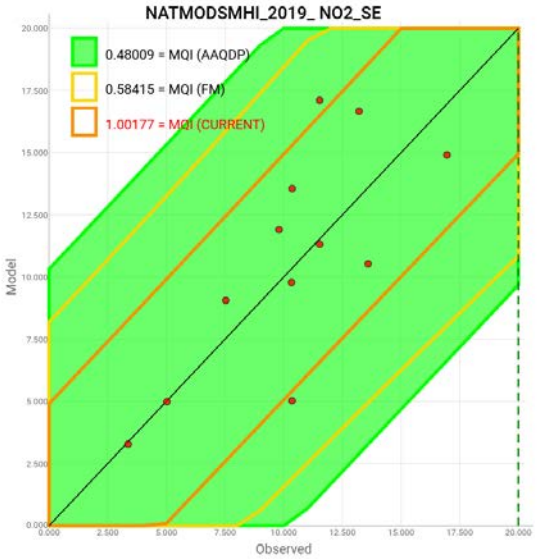
Selected MQI/Stringency level: default 1 and lower

WG2 Evaluation of the FAIRMODE MQI

Comparison of the MQO from FAIRMODE and at home – building trust and understanding differences *- Analysis for **NO2** at urban background stations (non-assimilated)*

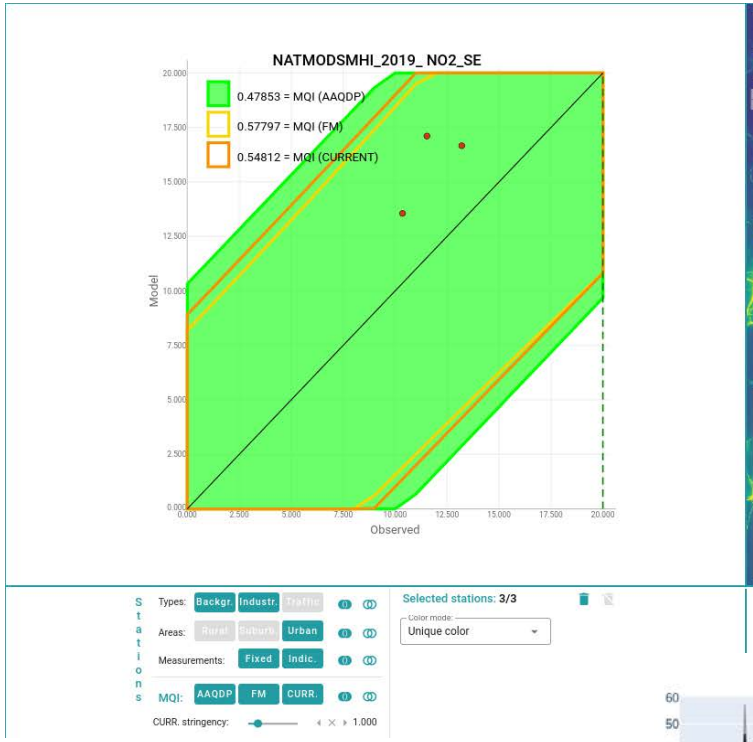


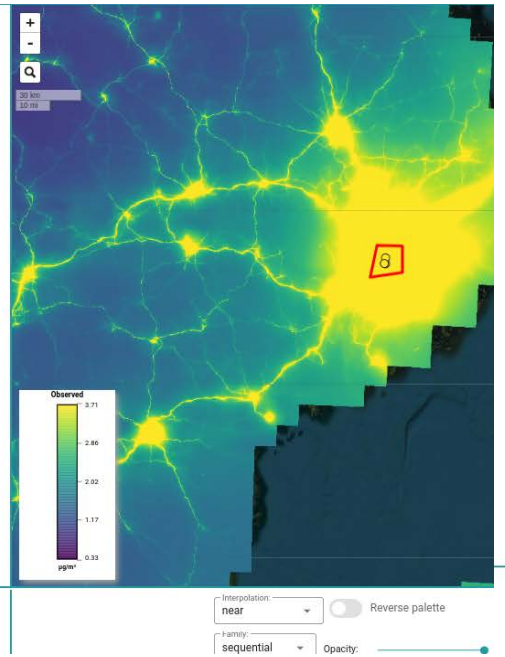


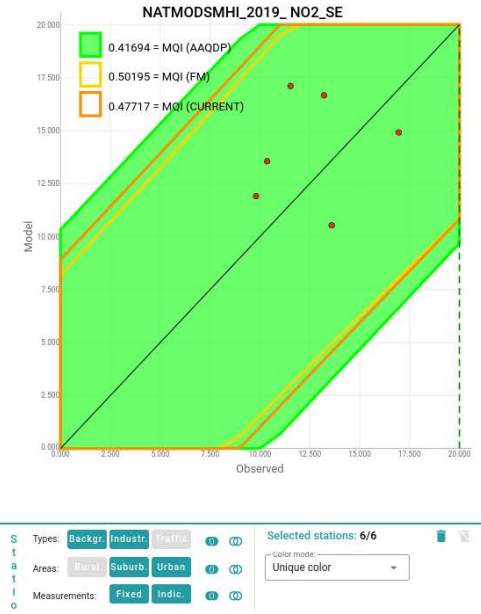


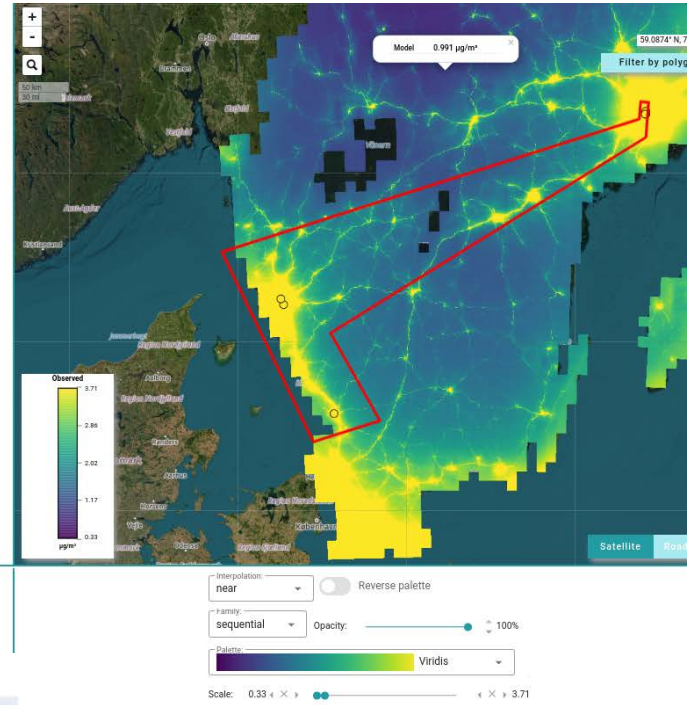
WG2 Evaluation of the MQI robustness - Results

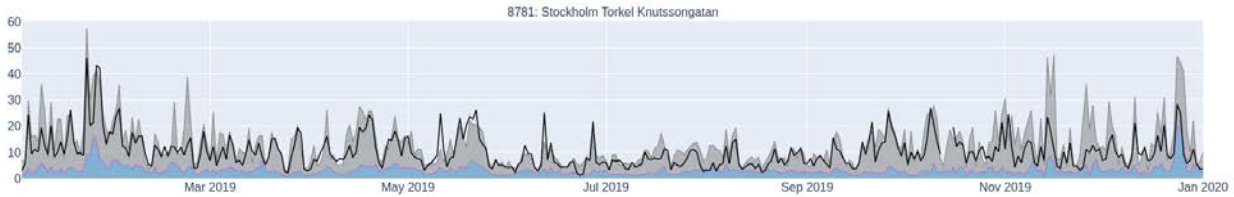
Test number of stations < 10, for NO2, MQO passed at default stringency







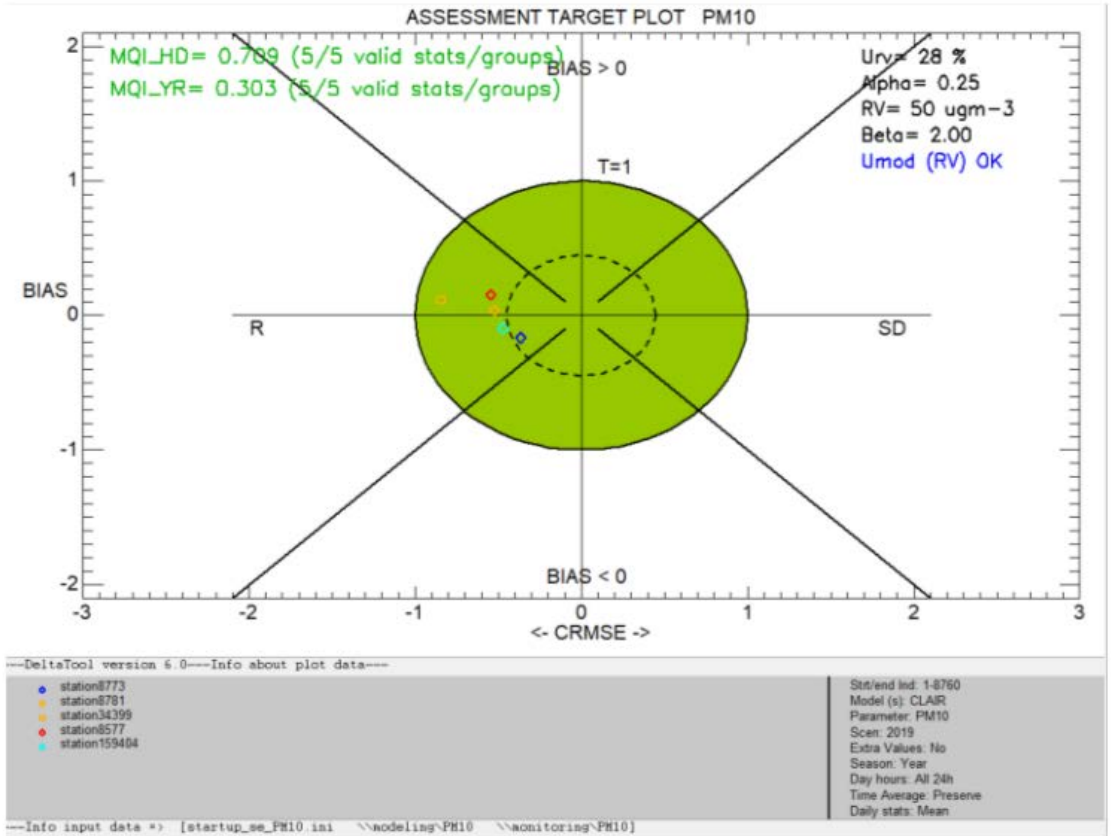


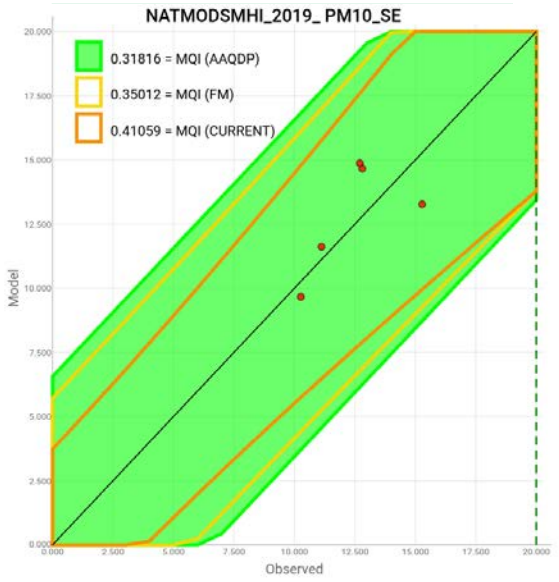


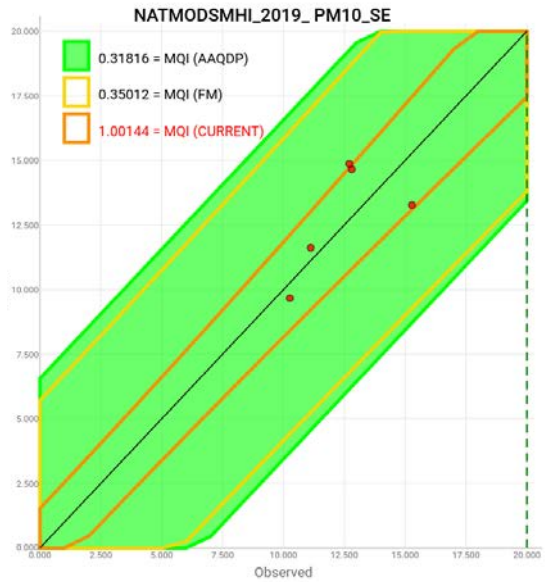
European Commission

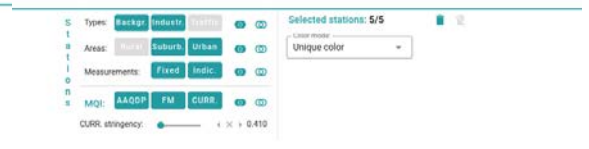
WG2 Evaluation of the FAIRMODE MQI

Comparison of the MQO from FAIRMODE and at home – building trust and understanding differences *- Analysis for **PM10** at urban background stations (non-assimilated, n stations < 10)*



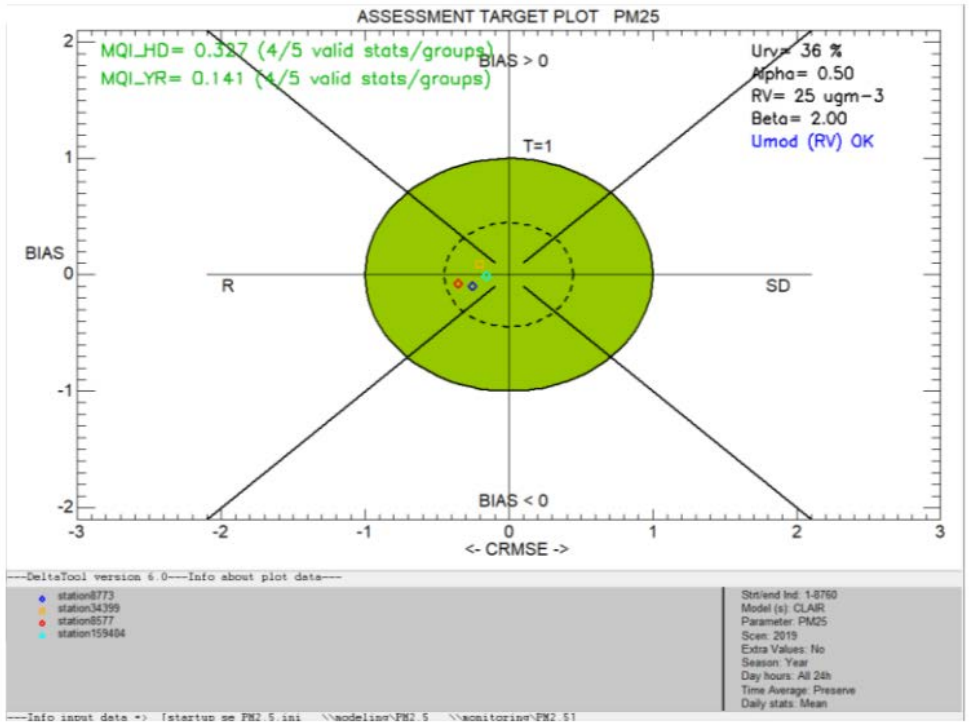


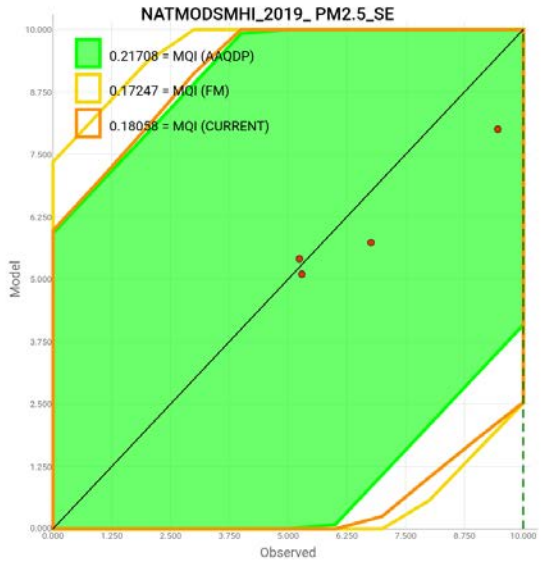


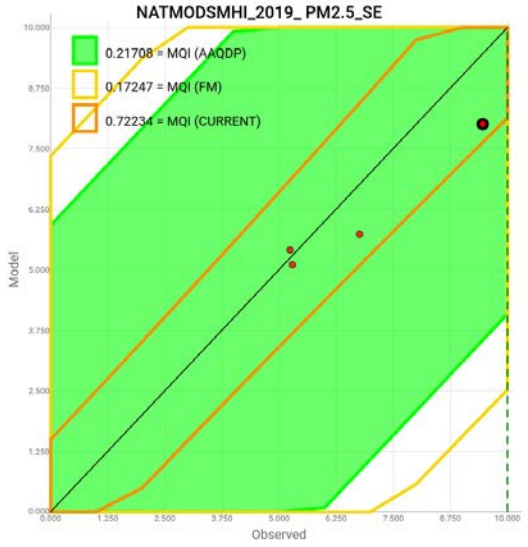


WG2 Evaluation of the FAIRMODE MQI

Comparison of the MQO from FAIRMODE and at home – building trust and understanding differences *- Analysis for **PM2.5** at urban background stations (non-assimilated)*

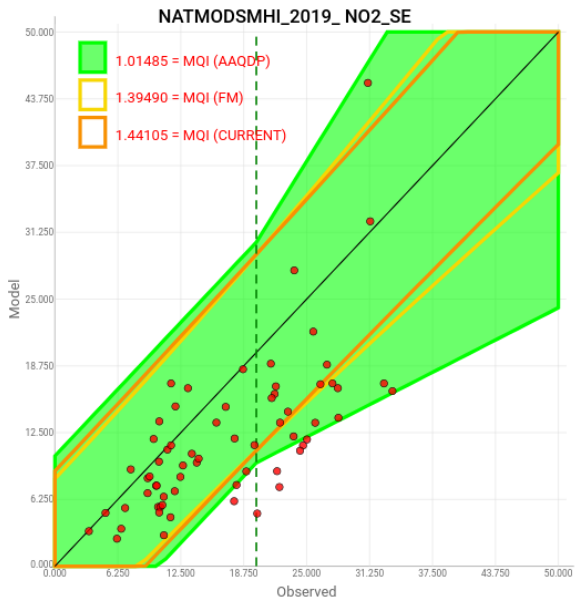


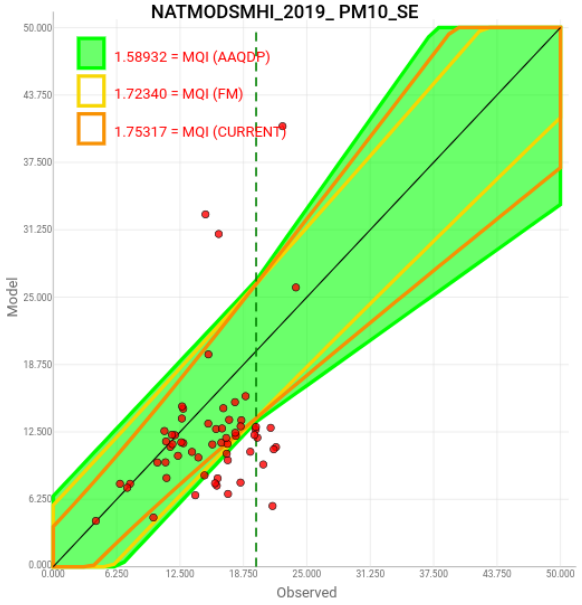


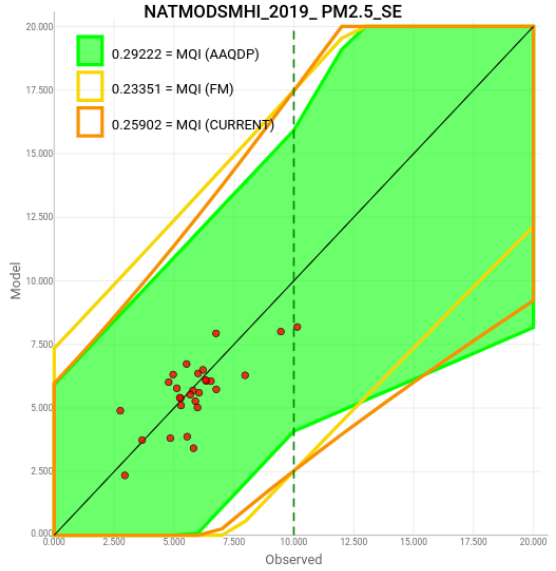


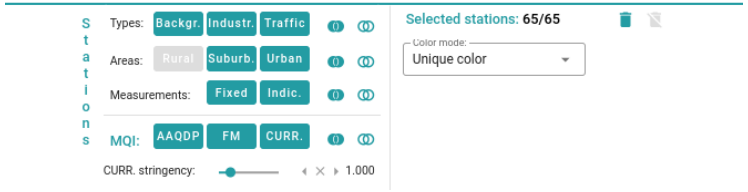
WG2 Evaluation of the MQI robustness - Results

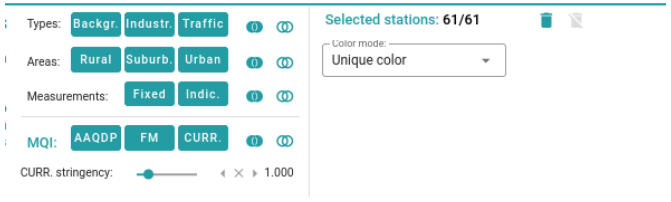
Robustness test I – when including traffic stations the MQO fails for NO2 and PM10, but not for PM2.5

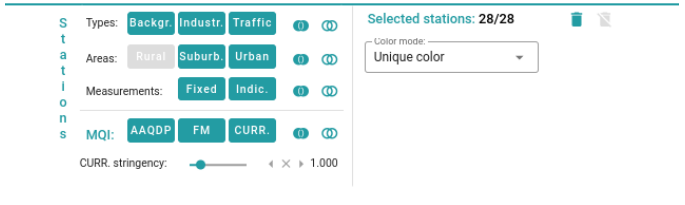












WG2 MQI robustness – Analysis

Main conclusions and further testing

- ***MQO was fulfilled with default stringency even when using a low number of stations***
- ***The MQO failed for NO2 when increasing the stringency.***
- ***Some differences observed in the MQI value between DeltaTool and MQI-on-the-fly***
- ***Further testing of MQI-on-the-fly of street-canyon model.***

Thank-you

European Commission