



CT2: QA/QC protocol

P. Thunis
October 2022

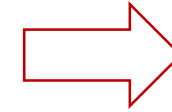
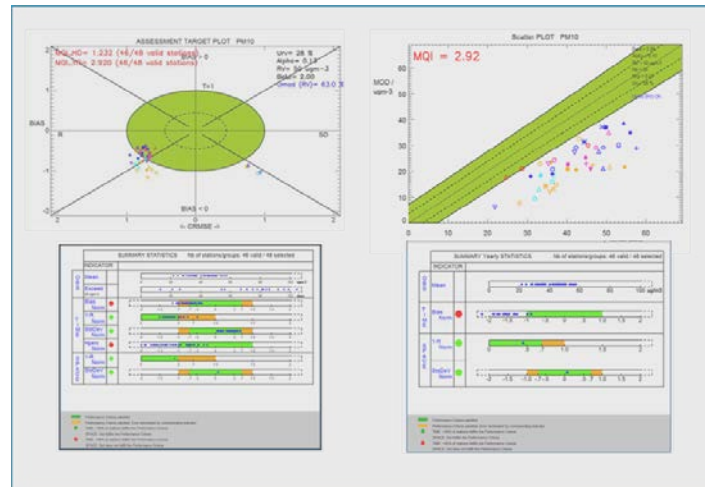
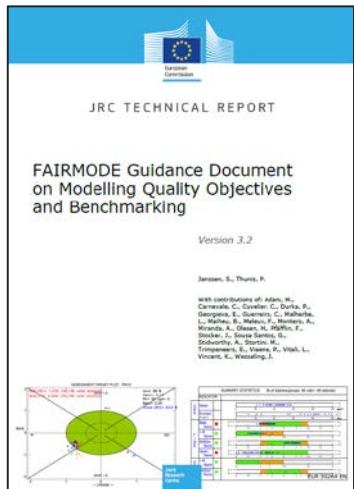
AQ/QC Protocol (CT2)

15:00 – 15:10	P. Thunis	What have we achieved
15:10 – 15:25	M. Stortini	Return on experience with QA/QC protocol
15:25 – 15:50	L. Tarrason	MQO & MQI
15:50 – 16:15	P. Thunis	Composite mapping
16:15 – 16:30	P. Thunis L. Tarrason	Discussion on the 2023-2025 Road-map

What have we achieved in CT2?

Where do we stand with the *linkage between emission and concentration* QA/QC (indicators, meta-data...)?

Background



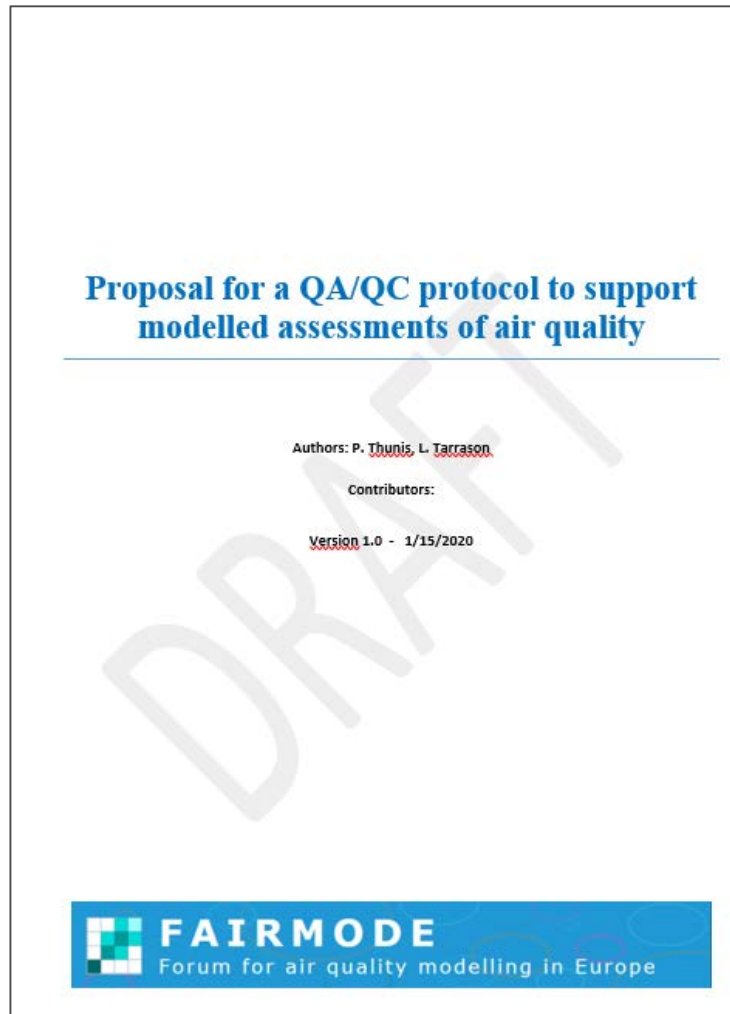
Is this sufficient to ensure quality of modelling applications?

The main drawback of the MQOs is that they provide a **single summary pass/fail** information.

It provides limited information on the capability of the model to reproduce **hot spot areas** (spatial variability) or the timing of the **pollution peaks** (temporal variability).

This key information for the AAQD is only partially addressed with the current MQO proposal.

Proposal for a QA/QC protocol (2020)



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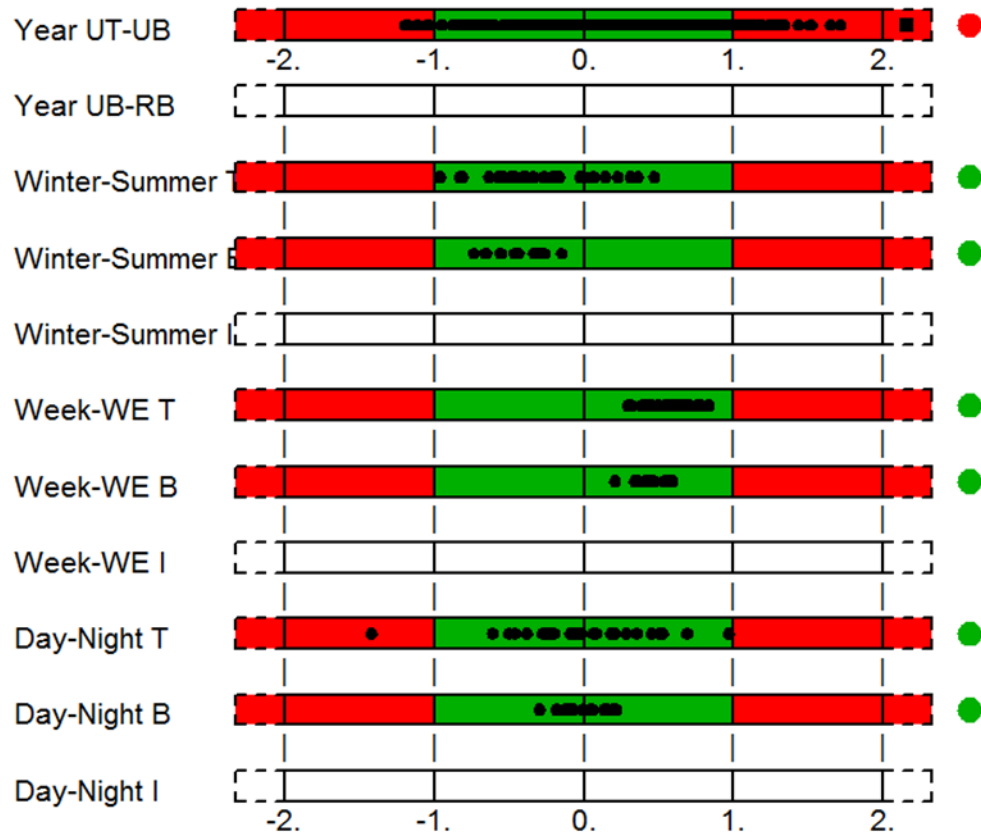
FAIRMODE QA/QC evaluation (indicators)

	Model Performance Indicator (MPI) (to be implemented)	Model Performance Criteria (MPC)
Urban - rural	$\text{MPI} = \frac{INC_{urb}^{model} - INC_{observed}}{\beta RMS_{\sigma}}$ <p>Urban – rural gradients</p>	
traffic - urban	$\text{MPI} = \frac{INC_t}{\beta RMS_{\sigma}}$ <p>Urban – Traffic gradients</p>	

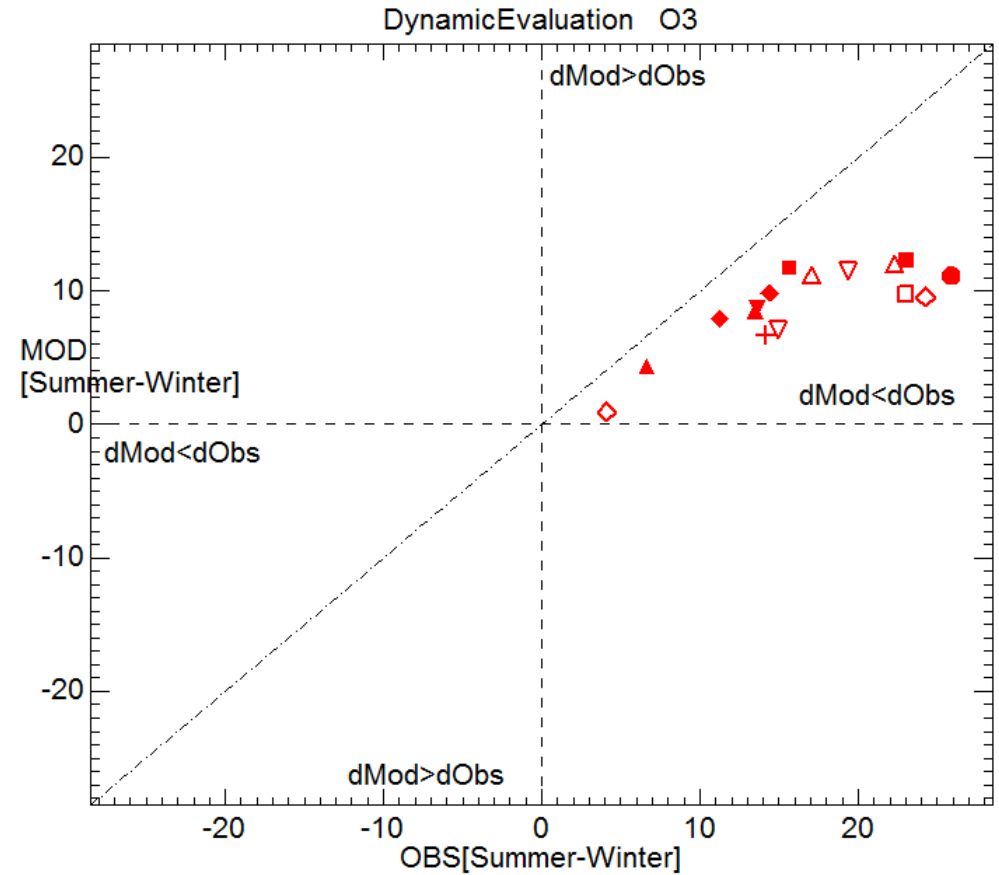
Spatial indicators, normalised by measurement uncertainty

	Model Performance Indicator (MPI) (to be implemented)	Model Perf. Criteria (MPC)
Urban	$\text{MPI} = \frac{SeasDiff_{urban}^{mod} - SeasDiff_{urban}^{obs}}{\beta RMS_{\sigma}}$	
Seasonal	$\text{MPI} = \frac{SeasL}{\beta RMS_{\sigma}}$ <p>Seasonal variability</p>	
Rural	$\text{MPI} = \frac{SeasDiff_{rural}^{mod} - SeasDiff_{rural}^{obs}}{\beta RMS_{\sigma}}$	
Urban	$\text{MPI} = \frac{WeekDiff_{urban}^{mod} - WeekDiff_{urban}^{obs}}{\beta RMS_{\sigma}}$	
Week / weekend	<p>Week-week-end variability</p>	
Rural	$\text{MPI} = \frac{WeekDiff_{rural}^{mod} - WeekDiff_{rural}^{obs}}{\beta RMS_{\sigma}}$	
Urban	$\text{MPI} = \frac{DayDiff_{urban}^{mod} - DayDiff_{urban}^{obs}}{\beta RMS_{\sigma}}$	
Day/night	<p>Day-night variability</p>	
Rural	$\text{MPI} = \frac{DayDiff_{rural}^{mod} - DayDiff_{rural}^{obs}}{\beta RMS_{\sigma}}$	

Temporal indicators, normalised by measurement uncertainty



Strt/end Ind: 1-8784
 Model (s): ADMS2012
 Parameter: NO2
 Scen: 2012
 Extra Values: 12
 Season: Year
 Day hours: All 24h
 Time Average: Preserve
 Daily stats: preserve



- ◇ BL0
- △ BX1
- ▽ GB6
- ◆ GN3
- GR4
- ▲ GR8
- ▼ GR9
- + HK6
- KC1

- ◇ MY1
- NM2
- △ NM3
- ▽ RB1
- ◆ ST3
- TH1
- ▲ TH4

Strt/end Ind: 1-8784
 Model (s): ADMS2012
 Parameter: O3
 Scen: 2012
 Extra Values: No
 Season: Summer-Winter
 Day hours: All 24h
 Time Average: 8h
 Daily stats: Max

Comments (detailed at previous TM) from

- Met.No
- IRCEL
- CERC
- ENEA
- Others

All accounted for in DELTA V7.0
released in June 2022



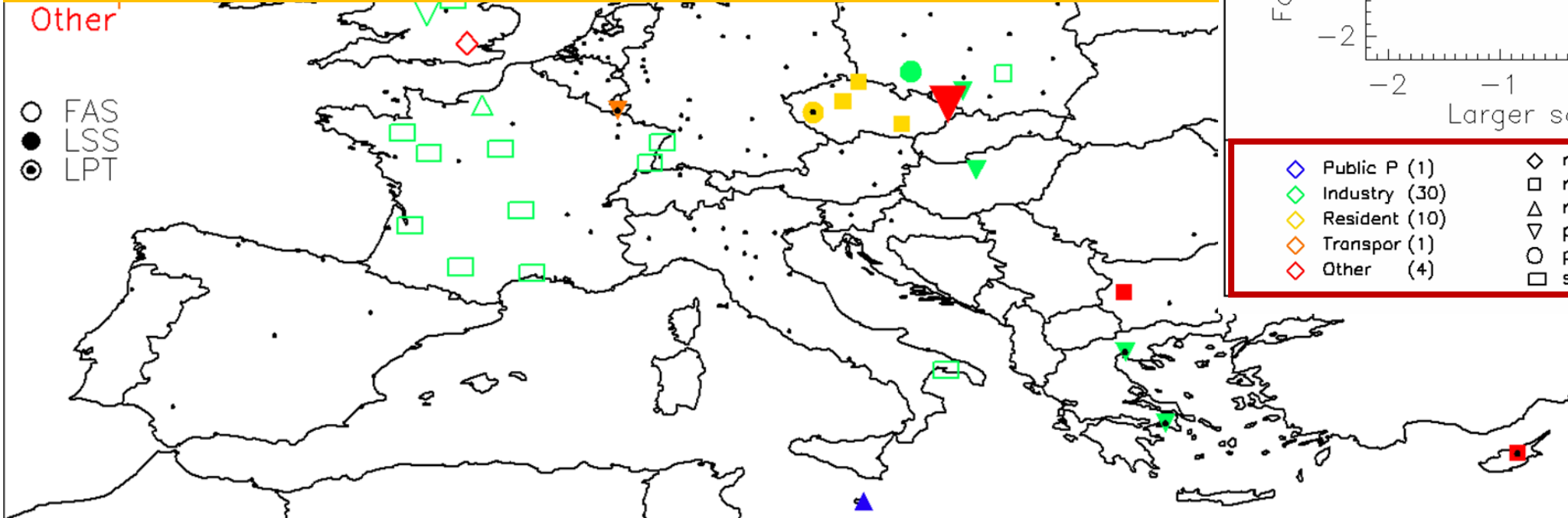
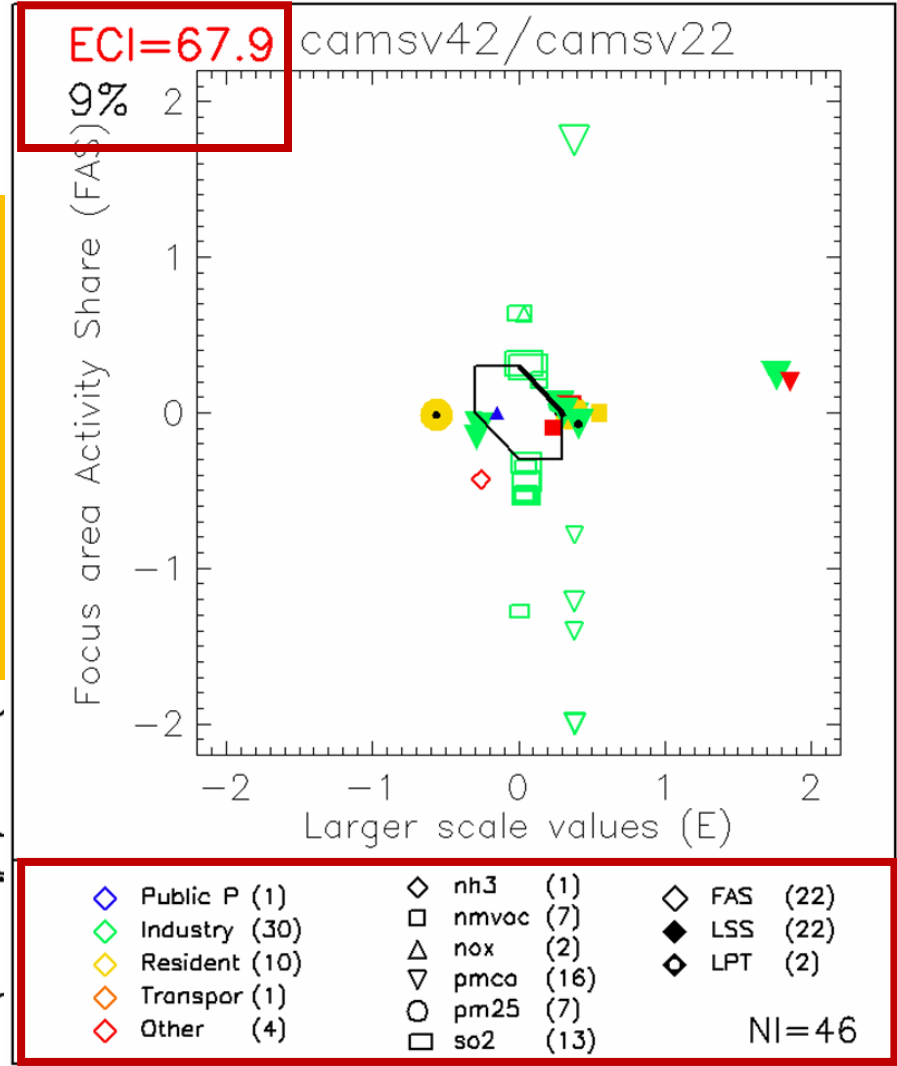
- Need for further testing! The JRC will test them on CAMS `data (2023)
- Need for guidance on application (definition of season, selection of stations...)
- When mature enough → Include into Fairmode guidance on benchmarking

Input Consistency (emissions)

5 sectors x 6 pollutants x 150 cities = 4500 values

NI = 46 = Number of inconsistencies (= 9%)

ECI = 68: Inconsistencies are up to 68 times the assumed level of uncertainty

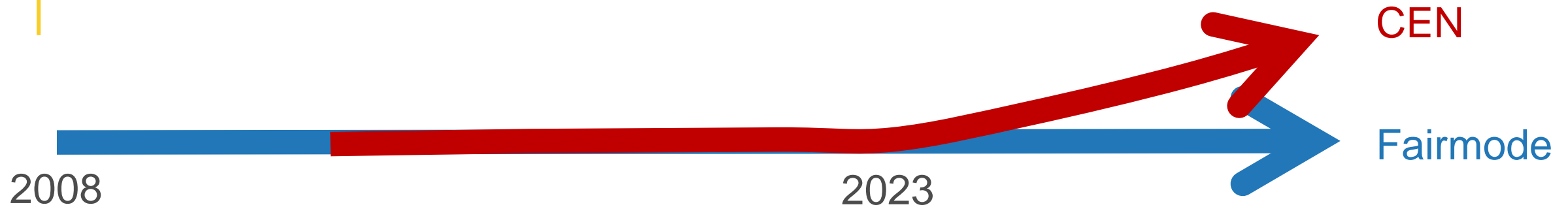


MQI – MQO

How to support the CEN WG43 process?

What will be the role of CEN guidance vs FAIRMODE guidance in the revised AAQDS?

CEN 43 (MQO) vs FAIRMODE



- What CEN does:

- Formalization (mathematical formulation, MQO parameters...)
- Data requirements (e.g. min number of stations)

- What CEN does not do:

- What to do if stations are not enough? Enlarge the domain? Equivalence?
- How can we check the capacity of the model wrt. high percentiles

One example

In general, the resolution of the modelling system results should be such that measurements of environmental indicators within the scope of the application can be reproduced, irrespective of the spatial representativeness or classification of the monitoring locations.

- How do we make sure that the MQO is fulfilled for the right reason?
- Can we advice on best-practice (e.g. resolution)?
- Can we advice on fit-for-purpose modelling (e.g. Gaussian, Eulerian, microscale modelling...)?

Need for FAIRMODE complementary guidance

Support to AAQD guidance

Air quality monitoring, modelling, plans

In addition: Support study on (a) scoping, mapping and analysis related to the before-mentioned issues, (b) assessing the technical suggestions to address issues identified

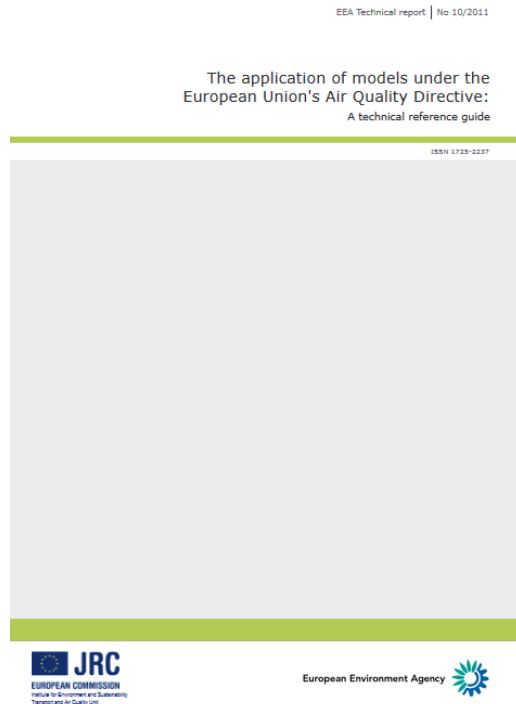
Outcome: Study suggests to develop new technical guidance (for non-legislative solutions):

- A. Guidance on air quality assessment in air quality zones
- B. **Guidance on exceedance and exposure indicators.**
- C. Guidance on reference methods and DQO for new pollutants.
- D. Guidance on use of indicative measurements/low cost sensors.
- E. **Guidance on the Tiered approach of assessment methods.**
- F. **Guidance on the use of models.**
- G. **Guidance on preparing air quality plans.**
- H. Guidance on AQ Management Best Practice (Governance and Communication)

TENTATIVE (!)

Support to AAQD guidance

“Guide on the use of models”



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Should we update the 2011 FAIRMODE guide to support both the AAQD and CEN process?

MQI – MQO

How to improve the current scheme for reporting the MQI?

What recommendations do we have for e-reporting of MQIs (eg. Metadata)?

MQI and MPC in e-reporting - metadata

- It is expected that the revision of the AAQDs will enable an **enhanced use of modelling** data for assessment, source allocation, forecasting and planning purposes
- This imposes further documentation requirements on modelling applications and their QA/QC
- ... and needs to be linked to e-reporting



Following the Covid-19 virus outbreak, we are working remotely. We are doing our best to be operational and carry out our work as before.

This portal contains technical details and services that facilitate the reporting of official air quality information from EU Member States and other EEA member and co-operating countries. This information is submitted according to Directives 2004/107/EC and 2008/50/EC of the European Parliament and of the Council. The rules for this exchange are set out in the [Commission implementing decision 2012/850/EU](#). The portal is maintained by the European Environment Agency (EEA).

Officially published air quality information is available through the [website of the EEA](#).
Comments and suggestions on this website should be addressed to the [AQ IPR helpdesk](#).

<https://aqportal.discomap.eea.europa.eu/>

MQI and MPI in e-reporting

- E-reporting Air Quality Models – Data flows D1b and E1b

Air Quality Models and Objective Estimations (data flows D1b/E1b)

This viewer shows information on Air Quality Models and Objective Estimations reported within AQ e-Reporting

Linked tables [Share](#) [Download CSV](#)

Country	B-G Namespace	Year	AQ Model Id	Model Process Id
Spain	ES.BDCA.AQD	2019	OBE_ES_SEASALT_NS_PM10_H_LV_daysAbove_2019	OBP_ES_SEASALT_NS_PM10_H_LV_c
Greece	GR.MINNENV.AQ	2019	MDL-CAMx_05012	MDP-CAMx

Showing 1-30 of 603

<< < 1 2 3 4 .. > >>

Filters
Country: [all]
Year: 2019 (603)
AQ Model Id:
Assessment Type:
 Modelling (302)
 Objective estimation (301)
Air Pollutant Description: [all]
Data Aggregation Process: [all]
Result Encoding:
 external (284)
 inline (319)

D1b
assessment
methods –
modelling
Metadata

E1b modelling
results and
actual MQI

<https://discomap.eea.europa.eu/App/AirQualityModels/index.html#.eu/>

E-reporting of model quality E1b - FAIRMODE

E1b – Modelling data – “NEW SECTION”

Results quality Updated

As for fixed and indicative observations information on the quality of results is required, however, the level of information that is applicable to models and objective estimation and therefore required is different:

- | | |
|---|--|
| • om:resultQuality (Time coverage) | Not required by definition it is expected to be 100% |
| • om:resultQuality (Data capture) | Not required by definition it is expected to be 100% |
| • om:resultQuality (Uncertainty estimation) | Conditional, mandatory if yearly reporting (E.7.3) |

EEA/ETC-ACM and FAIRMODE are working together to find best solutions for e-Reporting of data from air quality models. A decision has been adopted to recommend a harmonised methodology based on [FAIRMODE's Delta Tool](#) for e-Reporting on data quality objectives for AQ models ([link now E1b](#)).

The FAIRMODE's Delta Tool generates the following files as an output:

- ASCII and/or csv file with data quality check results summarized per measurement location, pdf (or PNG) files with graphic representation of the results (summary diagram) including
- the overall quality score called 'Modelling Quality Indicator' (MQI, <1 for modelling results of good quality).

More details on the outputs of the Delta Tool can be found in "[Delta User Guide](#)".

EEA/ETC-ACM and FAIRMODE agreed that the optimal solution in the case of Delta Tool output(s) would be a combination of encoding and xlink such as:

- Encoding MQI value in the XML, which delivers the final and most important information about data quality to the AQ e-Reporting system (even in absence of additional, linked files),
- Linking in the XML report to external file(s) generated by the Delta Tool, using relative path, which gives more detailed information about data quality and allows generating summary diagram.

MQI in e-reporting - Few reports

Note that EEA also estimates its own

Air Quality Models and Objective Estimations (data flows D1b/E1b)

This viewer shows information on Air Quality Models and Objective Estimations reported within AQ e-Reporting

Linked tables

id	Boundary Conditions	Scaling	Projection (SRID)	Model Description	Time Of Result	EEA's estimation of MQI	Data Quality Description	Data Quality Report URL	Model Reference Title
		None applicable		Roadside concentrations calculated using the PCM-Roads Kernel Model (PCM-RKM) dispersion modelling approach to represent the roadside increment, calibrated with monitoring. The	2020-09-22T12:00:00		The AQD sets data quality objectives (DQOs) for modelling uncertainty, within supplementary assessment under the AQD. AQDD4 sets DQOs in terms of uncertainty, which acts as a guide for	https://uk-air.defra.gov.uk/library/reports?report_id=1007	Technical report on supplementary assessment under the Quality Directive (2008/50/EC) the Air Quality Framework Directive (96/62/EC) Fourth Daughter Directive (2004/107/EC)

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Filters

Country: [all]

Year: 2019 (302)

AQ Model Id: []

Assessment Type:
 Modelling (302)
 Objective estimation (301)

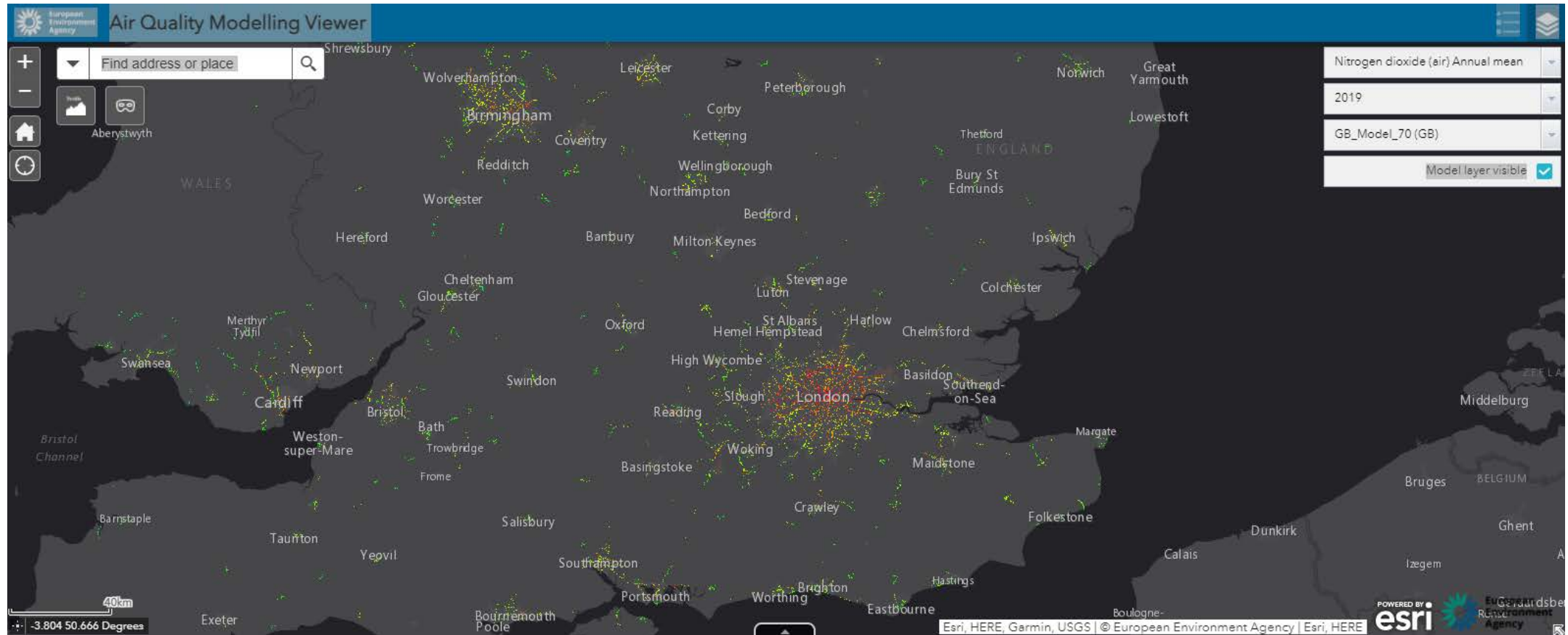
Air Pollutant Description: [all]

Data Aggregation Process: [all]

Result Encoding:
 external (260)
 inline (42)

<https://discomap.eea.europa.eu/App/AirQualityModels/index.html#.eu/>

EEAs data viewer for model data reported



Has a different purpose & functionality than FAIRMODEs composite mapping platform – no integrated views

<https://maps.eea.europa.eu/AirQualityModellingViewer/>

Modelled metadata in e-reporting – D1b

Air quality model configuration - <aqd:AQD_Model>	221
AQD Model identifier - <ef:inspireId>	224
Model name <ef:name>	225
Responsible party <ef:responsibleParty>	225
Air quality assessment type <aqd:assessmentType>	226
Air quality zone <aqd:zone>	226
Model observing capability <ef:observingCapability>	227
Predicted environmental objectives <aqd:environmentalObjective>	234
Data reported to <aqd:reportingDB> & <aqd:reportingDBOther>	235
Organisational level <ef:organisationalLevel>	236
Media monitored / predicted <ef:mediaMonitored>	236
Flagging a technique for AEI, NS / WSS assessment <ef:involvedIn>	237
aqd:assessmentMethodWSS	237
aqd:assessmentMethodNS	238
Model configuration - <AQD_ModelProcess>	239
Model configuration identifier <ompr:inspireId>	242
Model configuration name <ompr:name>	243
Model configuration description <aqd:description>	243
Model configuration documentation <ompr:documentation>	244
Responsible party for the model configuration <ompr:ResponsibleParty>	245
Process type <ompr:Type>	247
Model configuration parameters <ompr:processParameter>	247
Model time resolution <aqd:temporalResolution>	256
Spatial resolution <aqd:spatialResolution>	257
Model data quality uncertainty evaluation description <aqd:dataQualityDescription>	257
Model data quality uncertainty evaluation URL <aqd:dataQualityReport>	259
Model domain - <AQD_ModelArea>	260
Model domain identifier <aqd:inspireId>	262
Geographical extent of the model domain <sams:shape>	263



Proposed metadata for modelling

Basic information	Model name	
	Version	
	Contact information	
	Model type	Eulerian, Gaussian..
	Model documentation	Schemes, parametrizations
Coverage & Resolution	Model domain/ spatial coverage	Geographical extent
	Year	
	Temporal resolution	
	Spatial resolution	
Input data	Emissions	Do we need more than just the name ?
	Meteorology	
	Initial & boundary conditions	
	Data assimilation / fusion	Requested by FAIRMODE, currently not required
	Data Quality – MQI and MPI	Actual values FAIRMODE methodology
	Observations - measurements	Basis for MQI calculations / ASCII or CSV

Simplified proposal for metadata request in ECM

Field	Contents- Proposed revised metadata
Code	A descriptive label for the data chosen by the user
Participant	Account owner, user that is logged in to upload the maps
Affiliation	Details on the Account owner (e.g. Institute)
Emission Model Name	Name of the emission model - common to e-Reporting request
Emission Model Version	Version of the emission model - common to e-Reporting request
Year	Year of the emission data – common to e-Reporting request
Sector	Sector code based on the SNAP nomenclature (S1 – S10) or GNFR nomenclature (Gnfr_A – Gnfr_N)
Emission Estimation approach	Methodology used to estimate/model the emissions: per sector “Bottom-Up”, “Top-Down”, Inverse Modelling
Spatial distribution approach	Methodology used to spatially distribute emissions: “Bottom-Up”, Downscaling
Documentation	Link to publications/references
Pollutant	CO, NH ₃ , NMVOC, NO _x , PM ₁₀ , PM _{2.5} , SO ₂
Country	Name of the country selected from a drop down list
Area	In case the map refers to a part of a country: city, region, ...
EPSG code	EPSG code for the map projection system

Discussion

- Is the current MQI reporting demand with both information on the measurement stations and on the aggregated situation appropriate ?
- Do we need to add/remove information to the modelled proposed metadata?
- Do we need to include more detail emission information as proposed in CT7 for assessment purposes?

Composite Mapping

Background

Current status: a nice tool...

- Many options to inter-compare results, incl. off-line MQI
- Comparison with airbase measurements
- 158 air concentration maps and 456 emission maps, 22 countries

BUT

- a number of gaps in the current datasets
- Need to trigger discussions amongst the FAIRMODE community

Background

During the 2021 technical meetings, proposals were made to develop further the composite mapping platform by developing

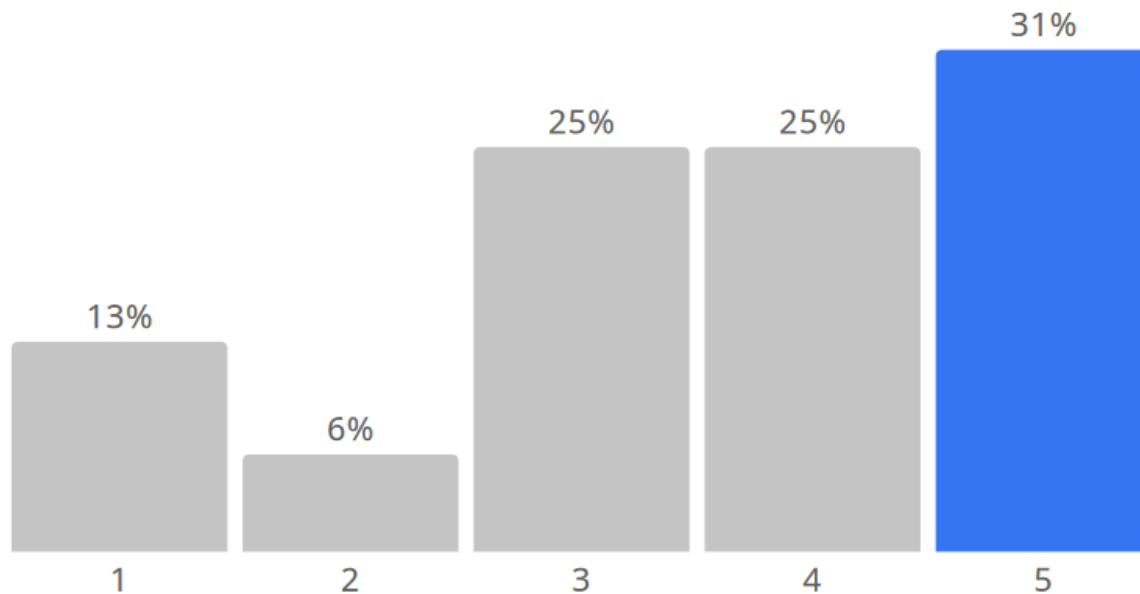
- An **online MQI/MQO**
- A **benchmark EU map**
- Ensemble **emission benchmark** for QA/QC
- Structured and regular **inter-comparisons**

Step 1: On-the-fly MQI

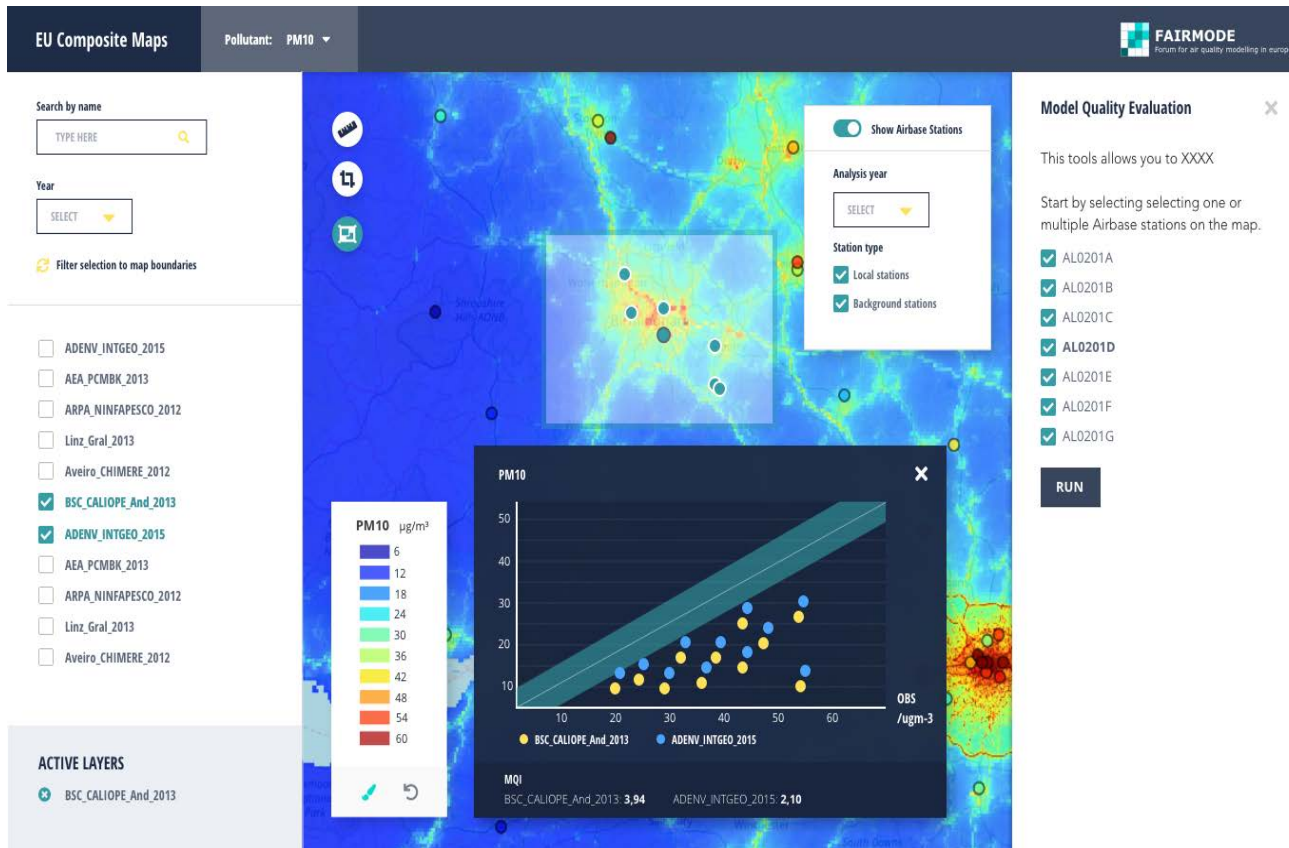
Rate the following change: An online dynamic MQI/MQO

0 1 6

Score: 3.6



Step 1: On-the-fly MQI

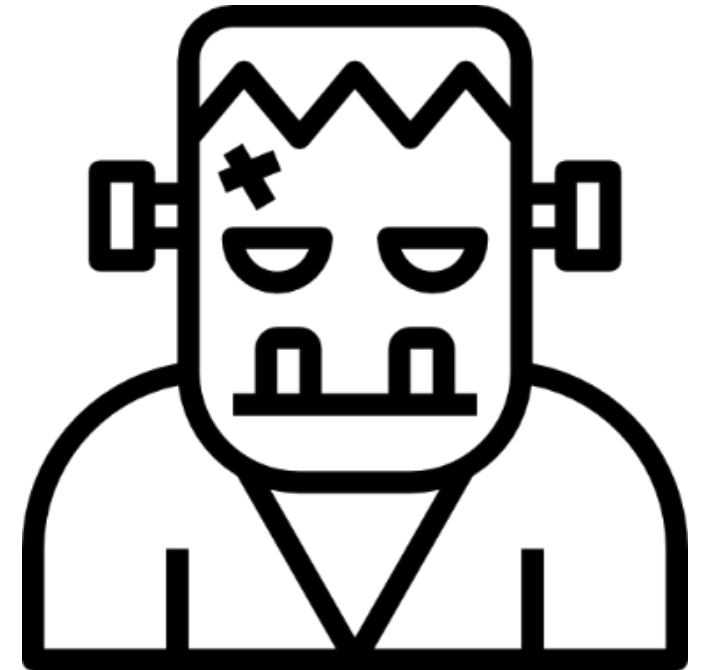
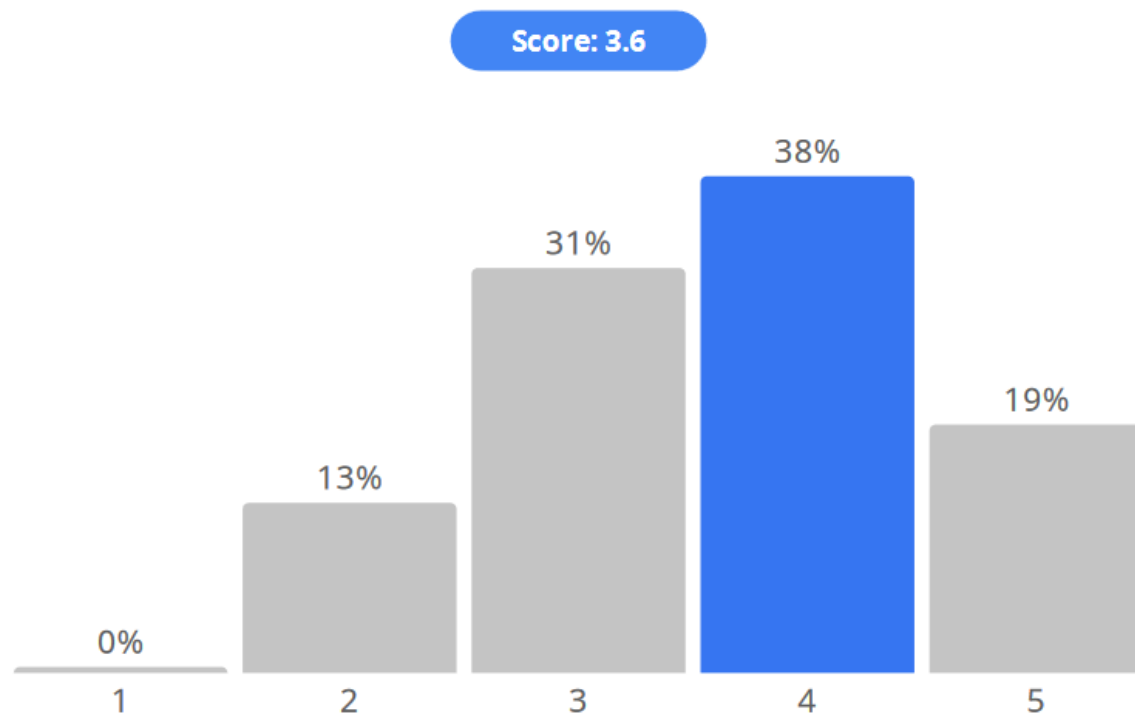


- ❖ User-defined set of AIRBASE stations for the MQI calculation
- ❖ Available for NO_2 , PM_{10} , $\text{PM}_{2.5}$ and O_3
- ❖ Only possible for the annual MQI

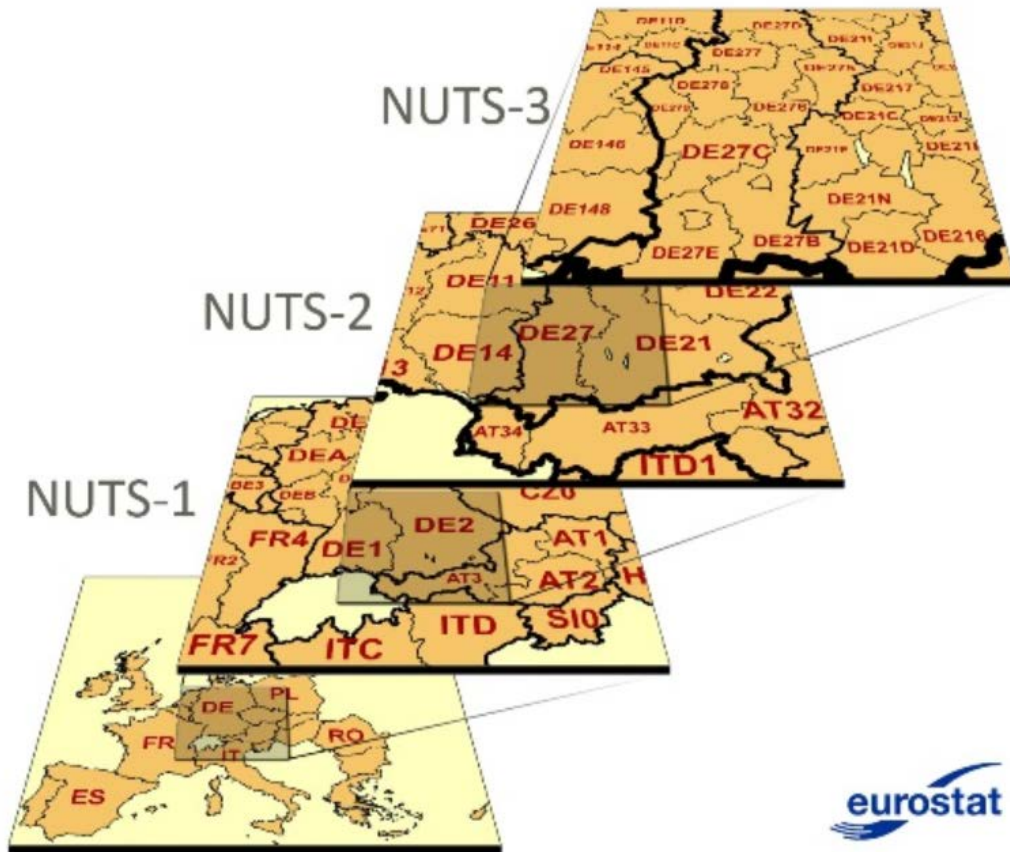
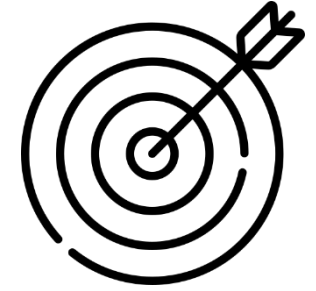
STEP 2: Frankenstein assessment map

Rate the following change: A benchmark EU map

016

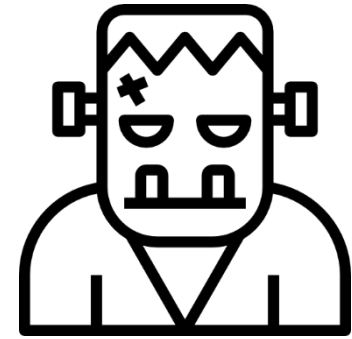


STEP 2: Frankenstein assessment map: Constrained MQI calculation

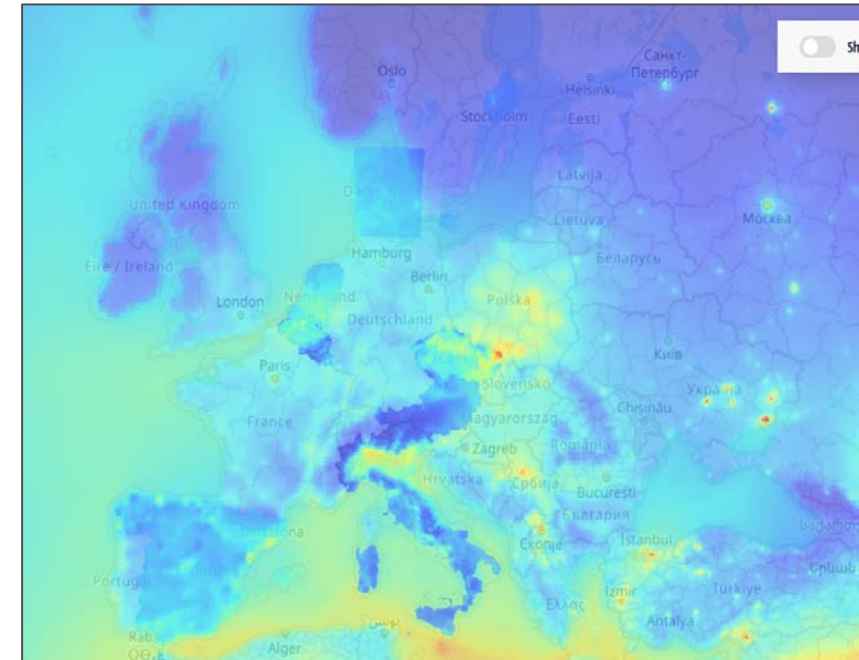


- ❖ From EU to NUTS3 (AQ zone?) and where possible (minimum monitoring station) and available (modelling) to city scale
- ❖ Based on all available AIRBASE stations (regardless of classification)
- ❖ For NO_2 , PM_{10} , $\text{PM}_{2.5}$ and O_3
- ❖ Only possible for the annual MQI

STEP 2: Frankenstein assessment map: Generation of the benchmark map



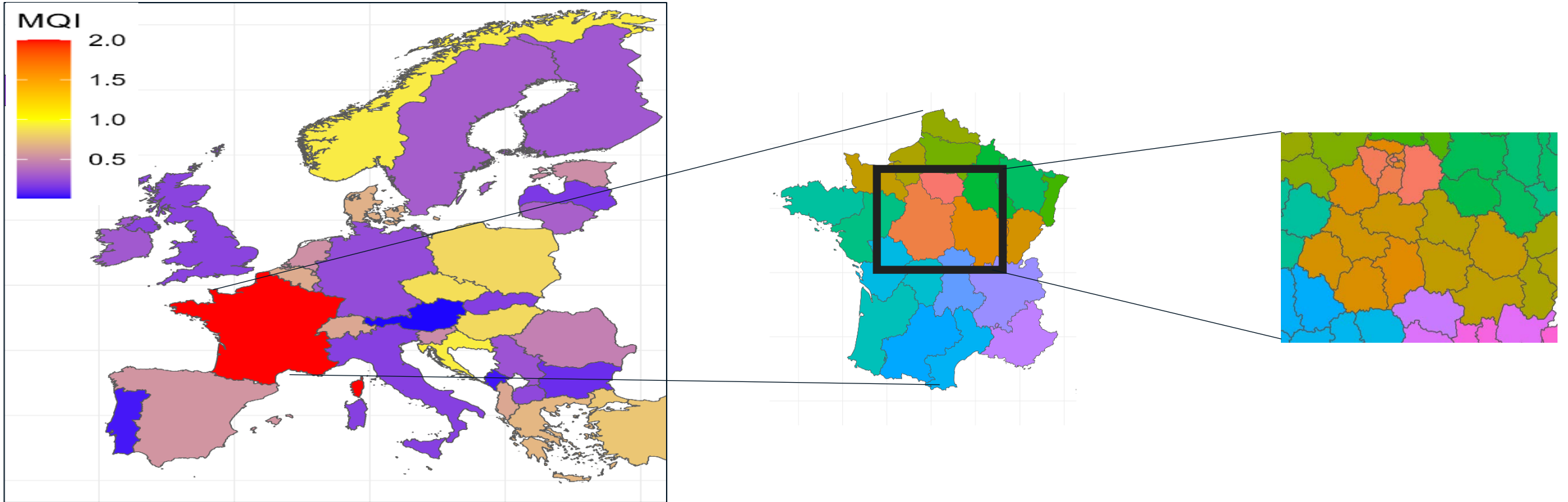
- ❖ From larger (country - NUTS0) to smaller scale (NUTS3 – city), compare MQI for all available EU maps at a given spatial scale.
- ❖ Best MQI map gets selected!
- ❖ Side products:
 - ❖ Frankenstein map can serve as benchmark for testing other parameters than MQI: exposure, station representativeness, design of monitoring networks, evaluation of data-assimilation...
 - ❖ Associated MQI map to be developed to steer discussions and improvements



- ❖ For $PM_{2.5}$, PM_{10} , NO_2 and O_3
- ❖ Unique fixed year

STEP 2: Frankenstein assessment map

MQI map



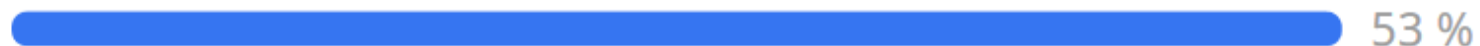
Associated MQI map to steer discussions and improvements

STEP 3: Emissions dashboard

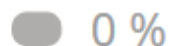
Do you see the implementation of QA/QC process based on an ensemble benchmark inventory as a positive step to improve emissions?

0 1 7

Yes



No



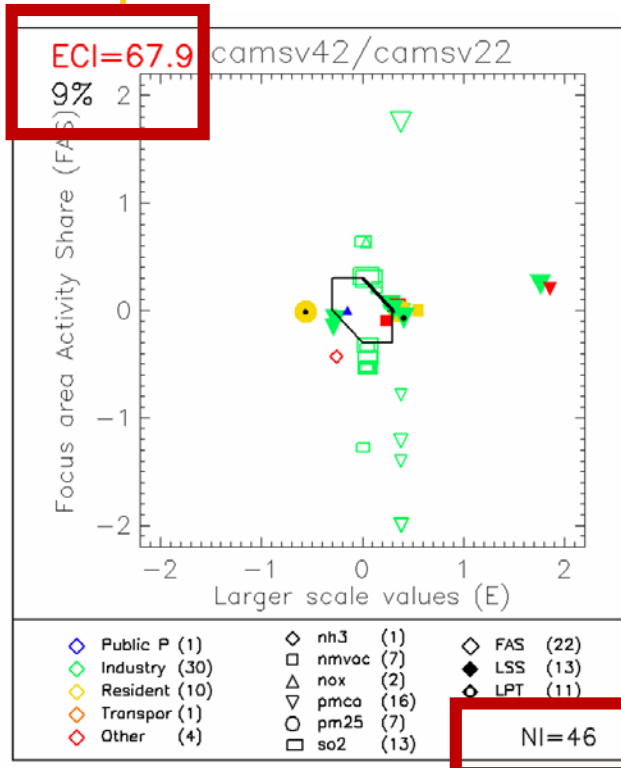
Maybe



I'm not sure to have understood the full potential of the method



STEP 3: Screening emissions: The method



❖ INPUT (NO gridded data necessary)

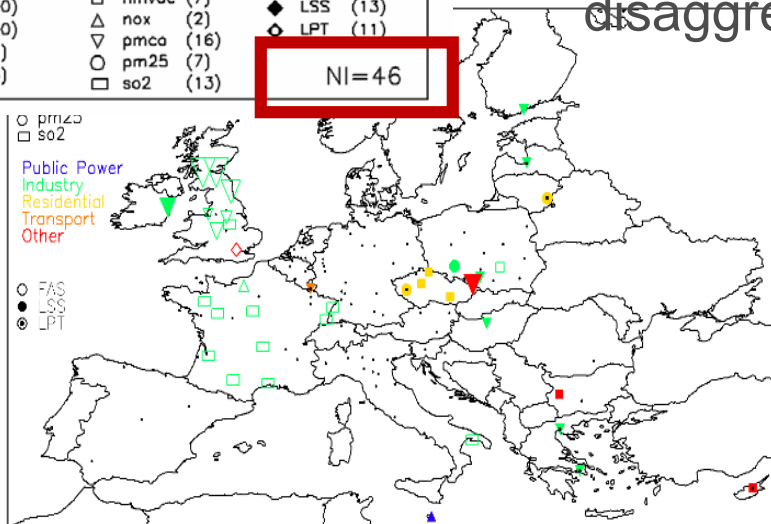
- sector/pollutant totals for the larger NUTs covered
- Sector/pollutant totals over a series of pre-fixed urban (or other) areas of interest
- Should be associated to assessment maps!

❖ The screening method identifies inconsistencies (in terms of Large Scale pollutant total, Large Scale sectorial share and Fine Scale spatial disaggregation)

5 sectors x 6 pollutants x 150 cities = 4500 values

NI = 46 = Number of inconsistencies (= 9%)

ECI = 68: Inconsistencies are up to 68 times the assumed level of uncertainty



STEP 3: Screening emissions: The top-down ensemble

CAMS (p, s, city)

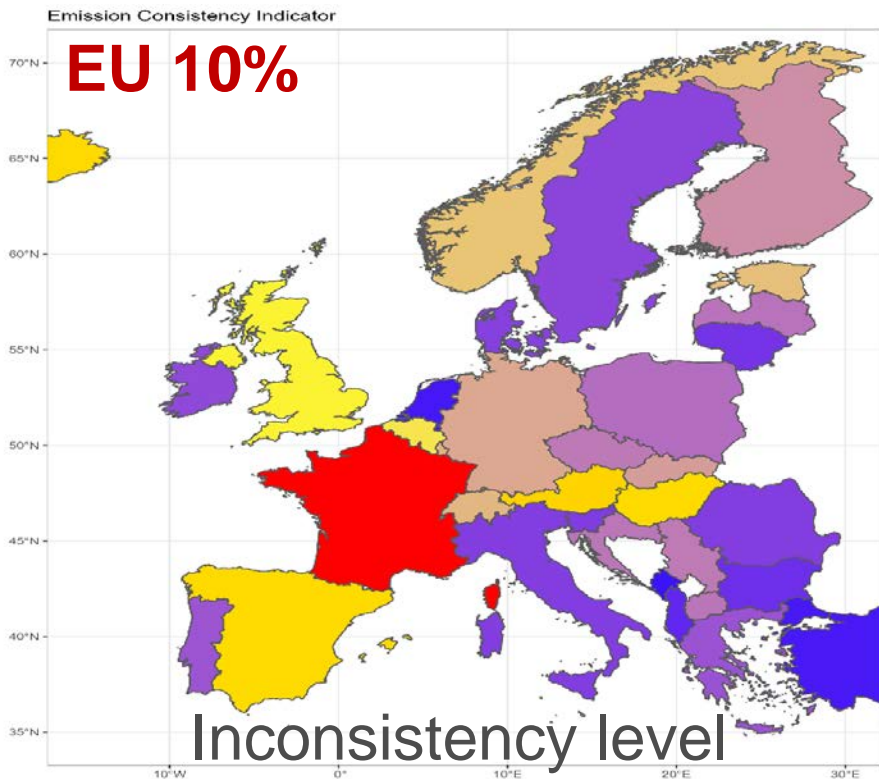
EMEP (p, s, city)

EDGAR (p, s, city)

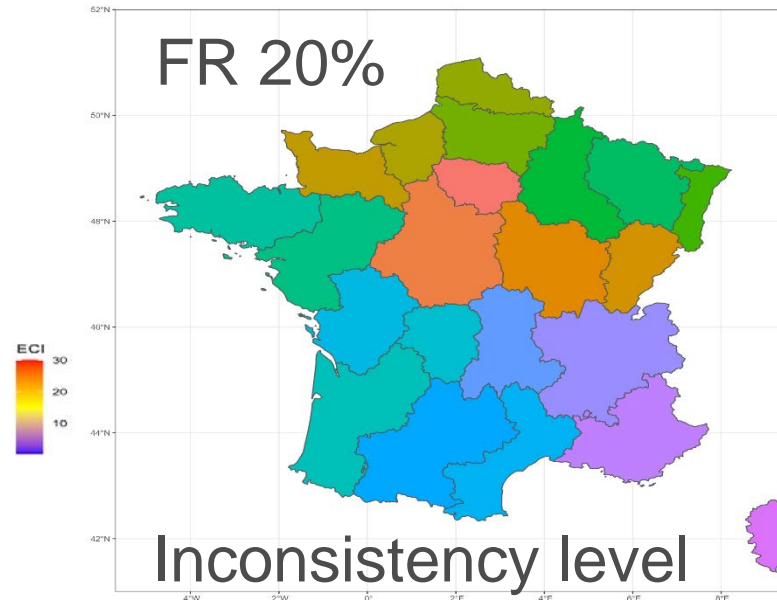
Median

- ❖ Monitor the variability of the ensemble
- ❖ Steer discussion around major inconsistencies towards potential improvements
 - ❖ Comparisons top-down vs. EU ensemble (median)
 - ❖ Comparisons bottom-up vs. EU ensemble (median)
- ❖ Side products (maps)
 - ❖ Monitoring indicator based on number of inconsistencies.
 - ❖ Main sectors/pollutants concerned by inconsistencies

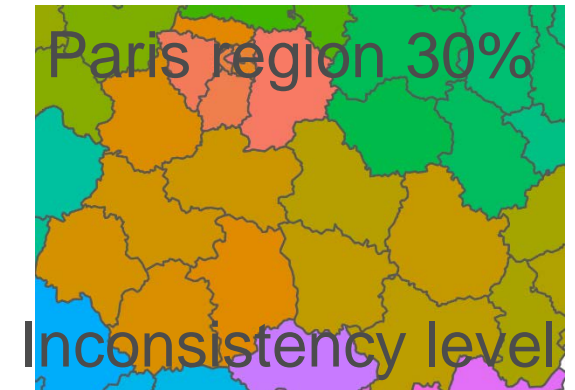
STEP 3: Screening emissions: Top-down emission consistency dashboard



Public P	9	NH3	0	LPT	40
Industry	30	NMVOC	6	LSS	10
Residential	10	NOx	10	FAS	20
Transport	3	PMCO	30		
Other	18	PM25	5		
		SO2	19		NI=70



Public P	0	NH3	0	LPT	5
Industry	20	NMVOC	6	LSS	10
Residential	0	NOx	12	FAS	5
Transport	0	PMCO	0		
Other	0	PM25	0		
		SO2	2		NI=20

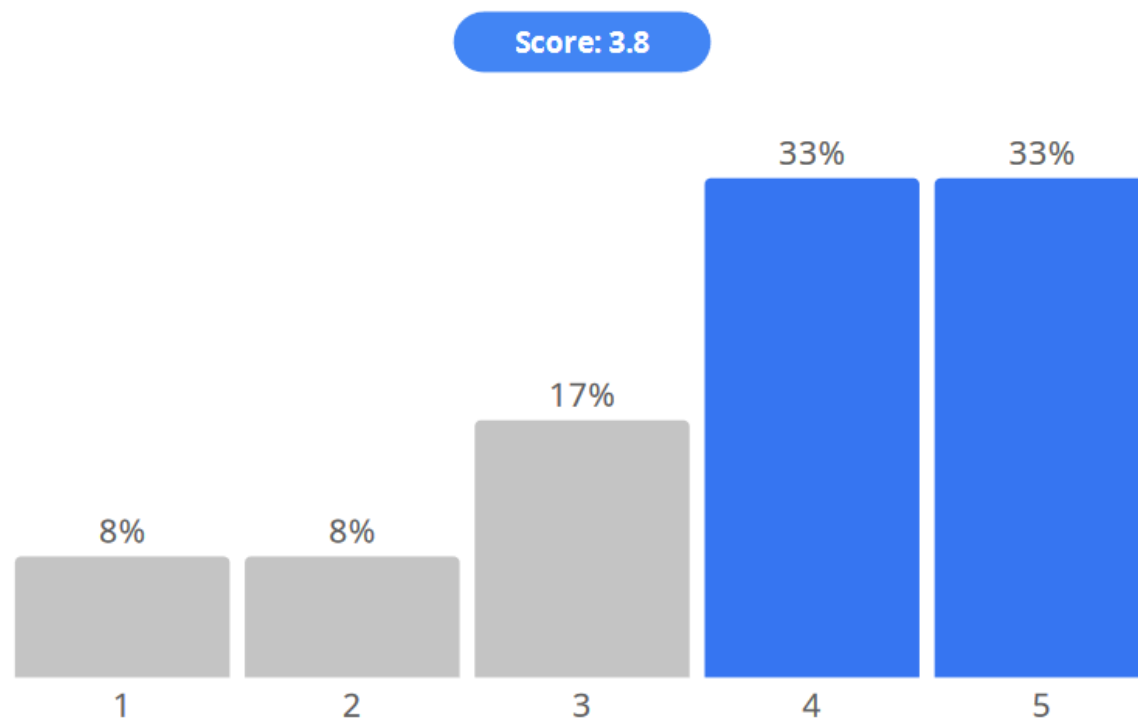


Public P	0	NH3	0	LPT	2
Industry	10	NMVOC	1	LSS	6
Residential	0	NOx	8	FAS	2
Transport	0	PMCO	0		
Other	0	PM25	0		
		SO2	1		NI=10

STEP 4: Structured inter-comparison exercises

Rate the following change: towards structured inter-comparisons

0 1 2



- ❖ Repeat steps 1 to 4 every X years
- ❖ For benchmarking, NOT for compliance!

Time schedule

- On the fly MQI/MQO
- Frankenstein Map
- QA/QC aggregated emissions



Summer 2023

- Delivery of results for inter-comparisons
- Required input

Before summer 2023?

- Best map at EU, country, regional or urban scale for NO₂, PM₁₀, PM_{2.5} or/and O₃
- Sector/pollutants emission totals (over largest administrative area and a set of defined smaller areas)
- For one specific fixed year
- Meta data (to be agreed)

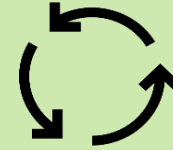
CT2 Roadmap

What did we achieve (2020-2022)?

- Elaborating recommendations to set up an overall QA/QC protocol for air quality modelling purposes.
 - Proposal for a QA/QC protocol published in 2020
 - Testing of the new indicators by several groups (spatial and temporal MPI)
 - Updated Delta tool (2022) – MPIs in the delta tool
- Following up and further developing of the EU Composite Mapping Platform.
 - JRC technical report on the evolution of the CM and ECM platforms
 - with on –the fly- QA/QC
 - Assembling of Frankenstein Maps
 - Emission Dashboard (conceptual paper)
- Following up and contributing to the consolidation of the MQO, together with CEN TC264/WG43 working group.
 - Proposal for a fitness-for-purpose criteria related to spatial resolution
 - Yet missing components (e.g. high percentile indicator)



Priorities for 2023-2025



Go for another round



Rename

CT2 is an essential activity of FAIRMODE in the **expected** result of the revision of AAQDs wrt enhanced role of modelling and official status of the network

- Regular inter-comparisons and targeted analysis of key reported assessment data (modelling air concentrations & emissions aggregated data)
 - Targetted analysis of the MQI across Europe (based on the comparison of on-the-fly and reported MQI)
 - Targetted study of the underlying emission data (Emission Dashboard – CT7 link)
 - Testing usability and usefulness of modelling metadata
- Guidance on model application, documentation and validation
 - Update of 2011 Fairmode guide on model application
 - Support to AAQD guidance on model use
 - Support to CEN WG43 (MQO) on the equivalence and the implementation of MQI

Thank-you