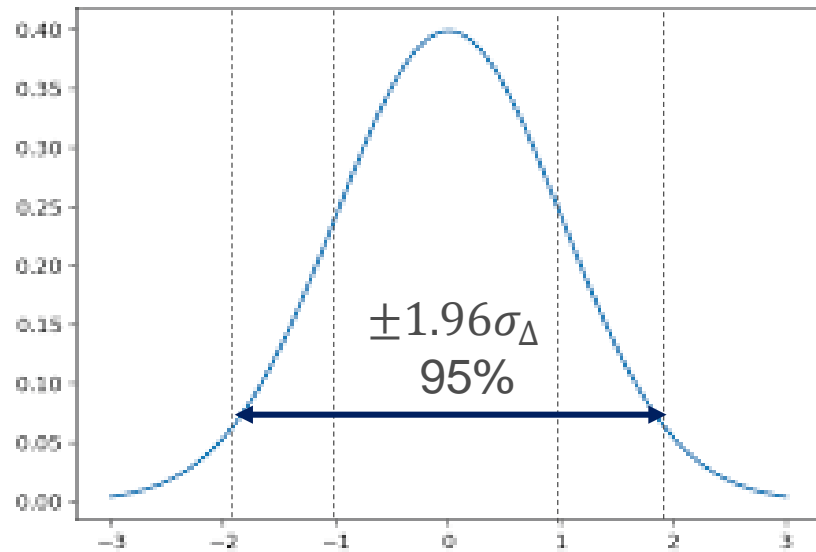# Modelling quality objectives & AAQD 2022

Background

- FAIRMODE recommendations included a proposal for MQI

- But NO reference document we can refer to (e.g. CEN)

- Specific constraints apply
  - Need to explicitly refer to a modelling uncertainty

  - Need to link to AAQD 2022 Data Quality Objectives for measurements
    - In terms of absolute levels
    - In terms of their dependency on concentration level
    - In terms of their time aggregation
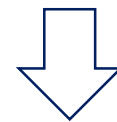
  - Be general for all pollutants
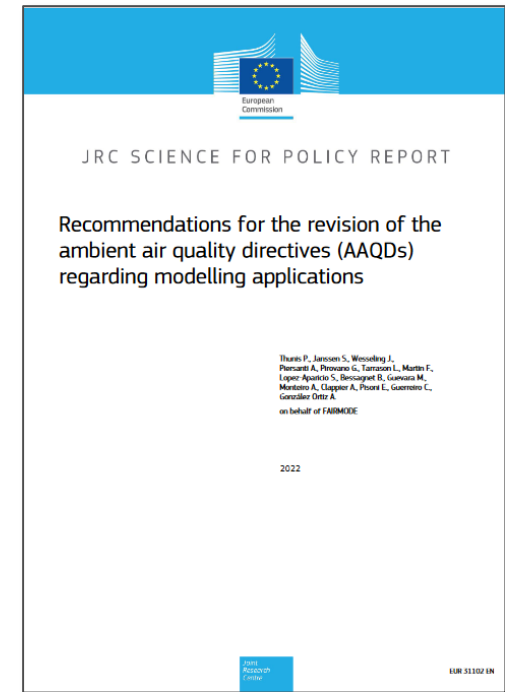
Concept

$$-z.\sqrt{{\sigma_O}^2 + {\sigma_M}^2} < M - O < z.\sqrt{{\sigma_O}^2 + {\sigma_M}^2}$$

Mod-Obs differences (M-O) follow a normal distribution centered on zero with standard deviation $\sigma_\Delta = \sqrt{{\sigma_O}^2 + {\sigma_M}^2}$

$$|M - O| < z.\sqrt{{\sigma_O}^2 + {\sigma_M}^2}$$

$$z = 1.96$$
Coverage factor

$$|M - O| < \sqrt{{U_O}^2 + {U_M}^2}$$

Exp. Meas. uncertainty   Exp. Mod. uncertainty

$\pm 1.96\sigma_\Delta$
95%

$$MQI = \frac{|M - O|}{\sqrt{{U_O}^2 + {U_M}^2}}$$

AAQD 22 vs. FAIRMODE formulations

$$MQI = \frac{|M - O|}{\sqrt{U_O{}^2 + U_M{}^2}}$$

AAQD 22

The measurement and modelling uncertainties are required to remain below given threshold values:

$$U_O \leq DQO_{OF\_22}$$

$$U_M \leq \gamma DQO_{OF\_22}$$

γ is the maximum ratio for modelling uncertainty (Annex V)

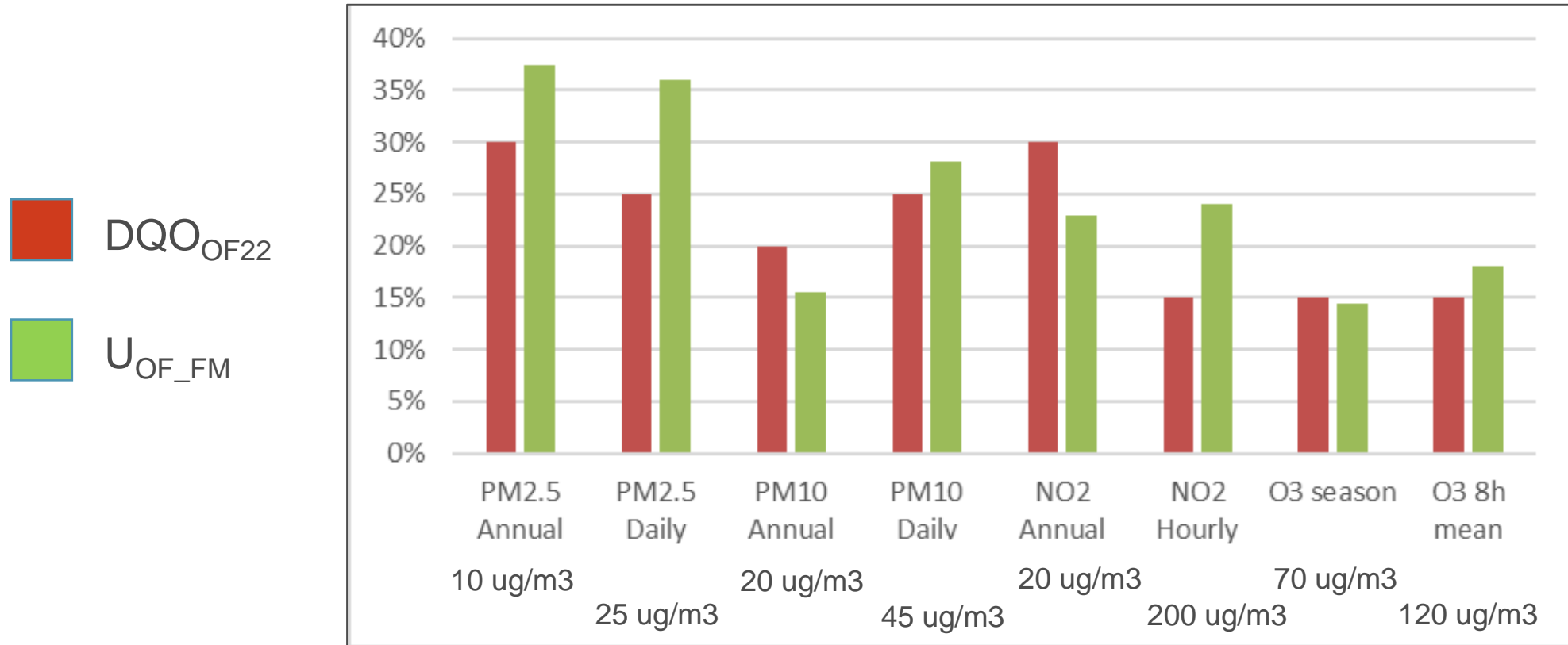$$\frac{|M - O|}{\sqrt{1 + \gamma^2} DQO_{OF\_22}}$$

FAIRMODE

The measurement uncertainty of fixed measurements estimated from data and inter-comparison exercises available before 2010

For historical reasons, a factor 2 is used to scale model-observed differences

$$\frac{|M - O|}{\beta U_{OF\_FM}} \; with \; \beta = 2$$

Fairmode uncertainties and AAQD's DQO at LV

DQO$_{OF22}$

U$_{OF\_FM}$

Differences are sometimes important between fixed measurement uncertainties used in FAIRMODE (prior to 2010) and their actual values set in the AAQD proposal.

Maximum ratio for modelling uncertainty

$$\frac{|M - O|}{\sqrt{1 + \gamma^2}U_{OF\_22}}$$

$$\frac{|M - O|}{2U_{OF\_FM}}$$

1. Uncertainty for measurement and modelling of long-term mean concentrations (annual mean)

Air pollutant	Maximum uncertainty of fixed measurements		Maximum uncertainty of indicative measurements [1]		Maximum ratio of uncertainty of modelling and objective estimation over uncertainty of fixed measurements
	Absolute value	Relative value	Absolute value	Relative value	Maximum ratio
PM$_{2.5}$	3,0 µg/m^3	30 %	4,0 µg/m^3	40 %	1,7
PM$_{10}$	4,0 µg/m^3	20 %	6,0 µg/m^3	30 %	1,3
NO$_2$ / NO$_x$	6,0 µg/m^3	30 %	8,0 µg/m^3	40 %	1,4
Benzene	0,75 µg/m^3	25 %	1,2 µg/m^3	35 %	1,7
Lead	0,125 µg/m^3	25 %	0,175 µg/m^3	35 %	1,7
Arsenic	2,4 ng/m^3	40 %	3,0 ng/m^3	50 %	1,1
Cadmium	2,0 ng/m^3	40 %	2,5 ng/m^3	50 %	1,1

γ

The proposed value for γ is set to ensure that the level of stringency of the MQO remains similar to the FAIRMODE formulation. In other words:
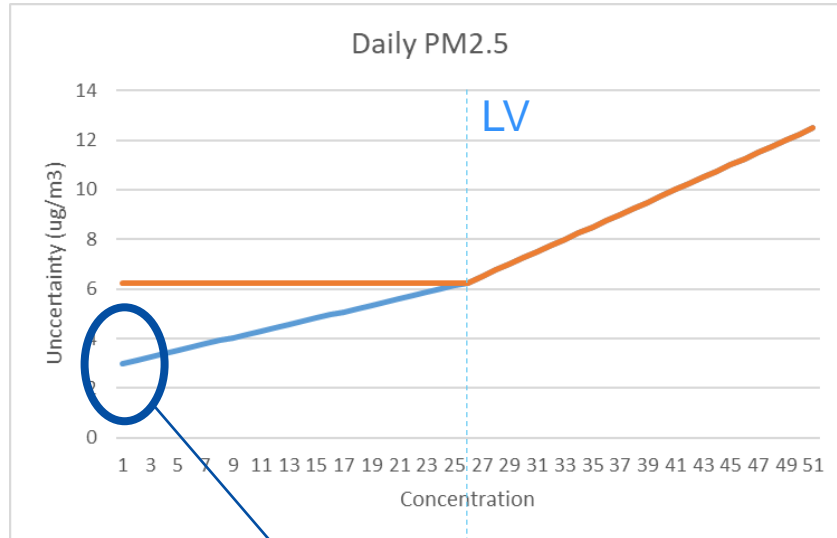
$$2U_{OF\_FM} \sim \sqrt{1 + \gamma^2}DQO_{OF\_22}$$

or

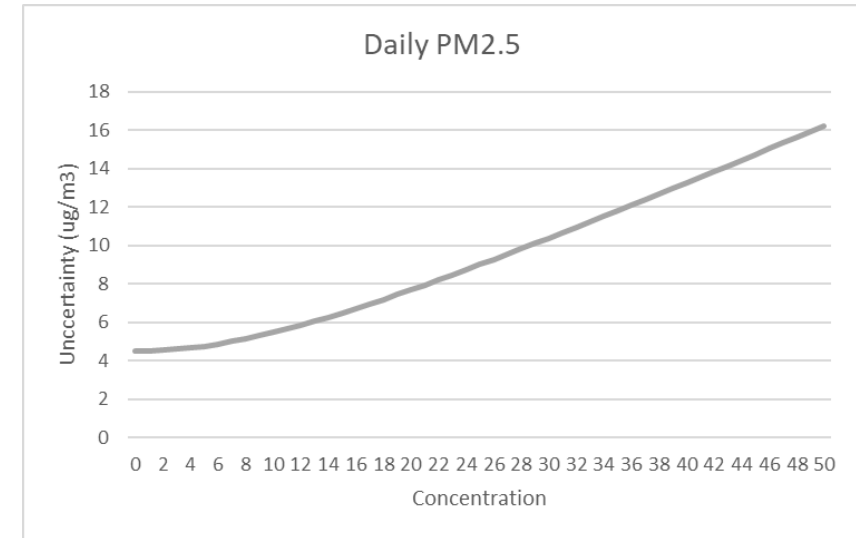$$\gamma \sim \sqrt{\left(\frac{2U_{OF\_FM}}{DQO_{OF\_22}}\right)^2 - 1}$$

Dependency on concentration level

AAQD Proposal
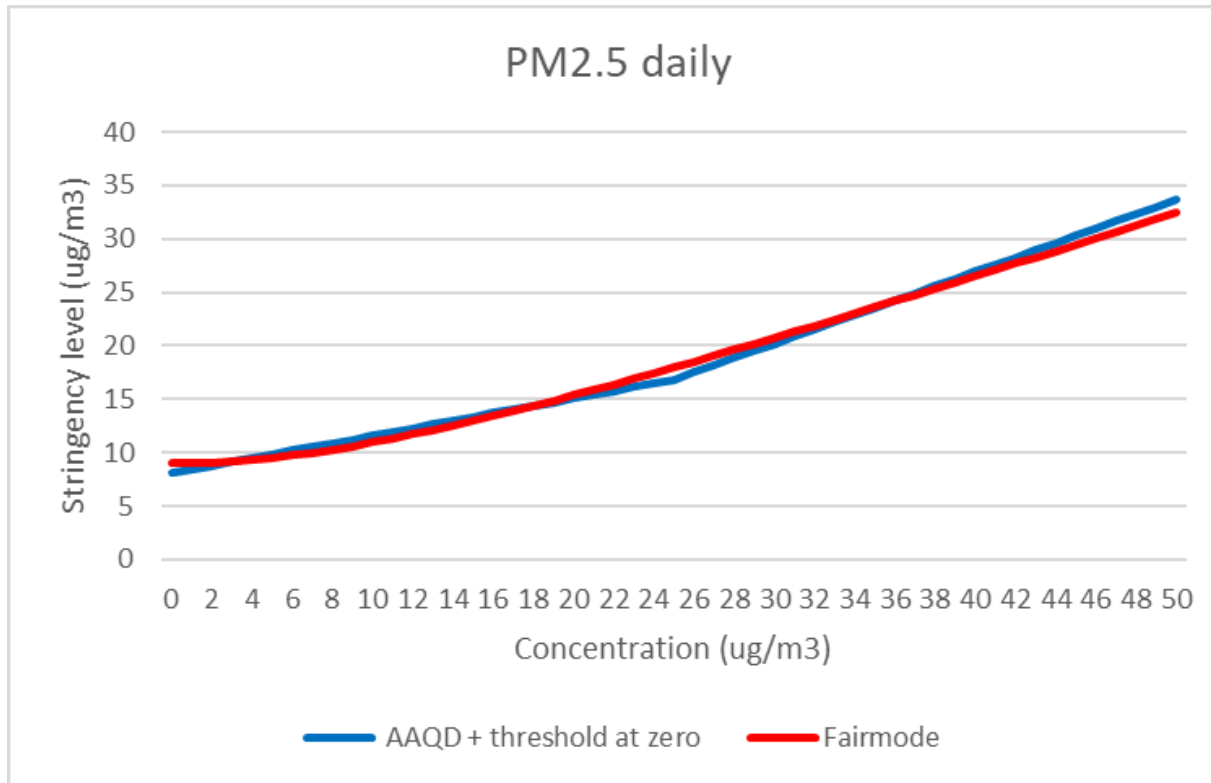

Threshold at zero concentration

FAIRMODE

$$U_O = \frac{U_{OF\_FM}(LV)}{LV}\sqrt{(1-\alpha^2)O^2 + \alpha^2 LV^2}$$

The threshold at zero concentration is set to a value that ensures matching with the uncertainty curves as formulated in FAIRMODE
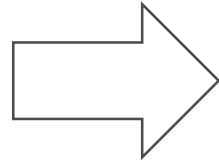
MQO stringency: AAQD22 vs. Fairmode

The same process applies to annual averages

Generalization to time series

$$\frac{|M - O|}{\sqrt{1 + \gamma^2} DQO_{OF\_22}}$$

$$\Rightarrow$$

$$\frac{\sqrt{\frac{1}{N}\sum(M_i - O_i)^2}}{\sqrt{1 + \gamma^2}\sqrt{\frac{1}{N}\sum DQO_{Of}^2\,(i)}}$$

AAQD2022 (Annex V): At a given monitoring point, the modelling quality indicator shall be calculated as the ratio of the root mean square error(s) between modelling results and measurements over the square root of the quadratic sum(s) of the modelling and measurement uncertainties, over an entire assessment period. Note that the sum will reduce to a single value when annual means are considered.

Conclusions & next steps

- Although the match with the FAIRMODE formulation is not perfect for all pollutants and time averages, the values set in the AAQD proposal are such than the MQO is close or less strict than FAIRMODE current requirements

- AAQD2022 (Annex V) points to the responsibility of the European network of air quality modelling for the periodic review of the modelling uncertainties and subsequent proposal of any necessary changes to the Commission".

- The AAQD formulation of the MQI will be implemented in the Delta tool for comparison

- Need for guidance on MQI application (number of stations…) → guidance on modelling

Thank-you