FAIRMODE 2025 plenary meeting: Prague, 05-06 March 2025

The meeting was organized in Prague and was hosted by the Czech Hydrometeorological Institute. About 150 participants (86 in presence, 64 from remote) attended. The initial speech was given by Vendula Breburdová (Ministry of Environment), that welcomed the participants, and discussed about how air quality models are used in Czech Republic, and how they are contributing to better air quality in the context of the revised Ambient Air Quality Directive (AAQD). The meeting was organized as follows.

First day:

- A series of "general presentation", from ENV and EEA, to set the scene;
- A discussion on how the different Working Groups (WGs) contributed to better modelling for assessment and planning, in the current roadmap (2023-2025).

Second day:

- Reflection on the 2026-2028 roadmap, starting with a short summary of the "TAIEX" workshop outcome (organized in January), by ENV and JRC.
- A discussion on the main challenges that FAIRMODE "National Contact Points" foresee in the future in terms of air quality modelling, to implement the revised directive (collected via a survey launched before the meeting). Seven breakout groups were organised to brainstorm on how FAIRMODE can help to overcome these challenges in practice.
- Discussion of the results of the breakout groups in plenary.
- Discussion on the "Guidance status and needs", for each FAIRMODE WG.
- Presentations by external network and projects (AQUILA, CAMS, RI-URBANS, …) on how they plan to contribute in the future to better modelling for assessment and planning, in the context of the AAQD.

Below we summarize these items, looking at the "general presentation", the "situation of the WGs" (looking at the current work, guidance status and future roadmap plans), and the "feedback from external networks".

General presentations

T. Henrichs (DG ENV) informed on the revised Ambient Air Quality Directive, and its implications for FAIRMODE. We discussed the specific role of modelling (and of modelling applications) in the context of the revised AAQD (focusing on assessment, spatial representativeness, forecast, source apportionment, planning). The presentation also highlighted the differences between air quality plans and roadmaps, the role of the new EU network of air quality modellers, and on future compulsory tasks for competent authorities (as defined by the revised AAQD).

A. Gsella (EEA) informed on the new EEA reporting scheme for air quality, called ReportNet3. He showed how this simplifies the current approach, and also on EEA plans to use a common grid to report air quality model results.

WG situation: current work, guidance status, future roadmap plans
WG1: Source apportionment (SA)

Current work: G. Pirovano presented the current work done in the WG, and how it contributed to better modelling for source apportionment (SA). He briefly summarized the main outcomes of the

activities carried out in 2023-24 including: a) an update of the Intercomparison Exercise (IE) on NO2 source apportionment; b) the interactions with the CAMS community, c) the contribution to the drafting of the Technical support document for the application of the new AAQD and to the activities of CEN/WG44; d) the current status of the Source Apportionment intercomparison based on the application of the available EU tools. Priorities for 2025 will be the conclusion of the IE exercise and the update of the SA guidance.

Guidance status: plan is to update the WG1 guidance document by December 2025. The update could concern: a) the chapters on SA definition and properties; b) a new section on a first version of SA protocol; c) the section on the support to the implementation of the new AAQD; d) the section on NO2 intercomparison. First step will be to organize a meeting to discuss priorities and define resources (Apr 2025). Text should be revised by September 2025 and finalised by December 2025.

Future roadmap plans: among the topics discussed during the breakout groups and in plenary, there are ideas to develop methods to quantify transboundary and natural contribution, to perform SA at different scales, to evaluate SA results, to analyse the importance of uncertainty in SA, to understand the complementarity use of tagging and brute-force methods and to improve the support to CEN/WG44 activities

WG2: MQO, composite mapping exercise: next steps

Current work: L. Tarrason presented the work of WG2, in particular the ongoing intercomparisons based on the composite mapping platform. She highlighted the remaining open issues (stringency of certain pollutants, minimum number of stations, data assimilation...) and detailed the foreseen steps. Since these issues are common to FAIRMODE and CEN WG43, a strategy needs to be elaborated to ensure complementarity between the two communities.

Guidance status: The plan is to update the WG2 FAIRMODE guidance and align it to the revised AAQD and associated support document by December 2025.

Future roadmap plans: the first reflections on the future roadmap produced the following list of topics: (1) need to strengthen the relation between WG2 and CEN, (2) need to work on other pollutants than O3, PM and NO2, especially for those characterised by low concentration, (3) need to develop indicators for short-term air quality modelling and (4) need to develop specific guidance to deal with situations where few measurement points are available.

WG3: Quality assurance for air quality forecast

Current work: A. Piersanti described the current situation of WG3. In particular, he reported about the invitation to talk about forecast evaluation at a recent (19th February) CAMS global workshop, and summarized the activities of 2024 on the comparison with the persistence model (hackathon in May 2024, test of the new CEN/AQUILA uncertainty parameters and new open issues) and the capability in predicting exceedances (recent analysis of CAMS 2021 and FORAIR-IT 2022 data searching for reference criteria). Plans for 2025 include a survey on the actual use of Forecast MQI, continuing searching criteria for exceedance indicators and implementation of correct timing of AQI forecast in the Delta tool.

Guidance status: there is no need for a specific guidance document for WG3, as WG3 guidance is part of the WG2 one and is updated to the stable version of the model quality indicators.

Future roadmap plans: the future roadmap for WG3 was not discussed during the meeting, as forecast was not mentioned as a main challenge in the survey sent to the NCP. However, discussion on this

point will continue during a dedicated online session in April-May and the next Technical Meeting, given the role foreseen for forecasting systems by the European Commission in the new AAQD.

WG4: Microscale assessment

Current work: F. Martin presented the situation of the WG4. Most of the activities outlined in the 2023-2025 roadmap have been completed. The first microscale modeling intercomparison exercise for a hot spot in Antwerp has been finalized, leading to valuable conclusions about the ability of different types of modeling systems to estimate the high-resolution spatial distribution of long-term average NO_2 concentrations, as well as the areas of limit value exceedances and the spatial representativeness of air quality stations.

This work has resulted in the publication of one scientific paper, with another currently under review, and the preparation of the first draft of a guidance document for microscale modeling in air quality assessment within the context of the AAQD.

A second intercomparison exercise, focusing on an urban hot spot in Madrid, has been agreed upon and is set to begin in spring 2025.

Additionally, a short study has been conducted on the number of sampling locations required for proper validation at the microscale (linked with WG2 and indirectly with CEN/TC 264/WG 43).

Guidance status: a guidance on the use of microscale modelling for assessment, in the context of the AAQD, is in preparation. It is expected to be finished and published (at least, in the FAIRMODE webpage) in 2025

Future roadmap plans: the following points were mentioned.

- Improve estimates of long-term concentrations (averages and percentiles), including bias correction methods.
- Expand the scope beyond NO_2 to include other pollutants, primarily $PM_{2.5}$ and PM_{10}.
- Evaluate estimates of limit value exceedance areas (LVEA) and spatial representativeness areas (SRA) of urban air quality (AQ) stations (linked to WG8).
- Explore the use of microscale modeling for designing air quality monitoring networks, particularly for optimizing AQ station locations (linked to WG8).
- Analyze the minimum number of stations required to comply with MQO in urban hot spots (linked to WG2).
- Investigate population exposure to air pollution (static vs. dynamic approaches) and its relationship with spatial resolution (CTM/microscale models).
- Assess the feasibility of using high-resolution street canyon modeling at a national scale.
- Develop guidance on model accuracy and computational feasibility, as well as extend modeling recommendations and best practices.
- Initiate the evaluation of microscale modeling systems for urban planning (linked to WG5).

A detailed analysis and discussion to prioritize these activities will be carried out within WG4 in next months.

WG5: Air quality planning

Current work: S. Jannsen and J. Soares presented the ongoing work in WG5. Two topics were discussed: (1) multi-level governance in air quality planning, and (2) the bias projection in future scenarios.

1. It was identified that many Member States are struggling with the multi-level governance in air quality planning. It remains a challenge to harmonize European, National and local air quality plans. Although the governance process might go beyond the responsibilities of the FAIRMODE modelling community, it is important that modelling teams are aware of these challenges and that they make suggestions to overcome the hurdles and harmonize at much as possible while supporting the design of air quality plans.
2. When developing air quality plans, there is a clear need to deal with biases observed in the reference case. However, today there is no uniform strategy to cope with the projection of the bias. To benchmark current methodologies, an exercise is designed based on a synthetic data set. This bias projection exercise will hopefully provide further common understanding about the pro's and con's of certain strategies. First results of the exercise are expected by the Summer.

Guidance status: there is already an existing Guidance document for this WG collecting several best practice case studies in air quality planning. At the time being, the idea is not to update it, but rather to finalise the intercomparison exercise for bias correction, and possibly to write a guidance based on the results of this intercomparison.

Future roadmap plans: few topics were proposed during the breakout groups as well as in plenary. It was agreed to continue the work on bias projection and multi-level governance, but complement this with work on meteorological variability in air quality plans, the assessment of worst/best case emission reduction scenarios and the design of short-term action plans. It was also highlighted that more focus should go to the percentile limit values since its compliance might become challenging with the new AAQD.

WG6: Low-cost sensors and data-fusion

Current work: S. Van Ratingen presented the current status of the WG. In particular, presenting the current intercomparison exercise. The current benchmark exercise aims to fuse sensor data and model calculations. Adopting the Netherlands as use case with > 1800 low-cost PM2.5 sensor measurements, four different models set ups with different predictive quality are being studied for different periods during the year. Six institutions have submitted preliminary results for their fusion models to RIVM who did a comparison of the data fusion results and a validation with reference data. The preliminary fusion results show a spread in capability to enhance the models result by fusing sensors into the model. An additional (coarser) model is currently used for a similar evaluation. The sensor fusion is expected, in this case, to show larger improvements, compared to the initial model results.

The WG6 contribution to better modelling can be summarized as follows:

- 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;
- Sensor data fusion methods are especially powerful when using larger numbers of sensors.

Guidance status: the plan is to publish a guidance document later during 2026, as this year the main focus is on a publication to present the results of the current intercomparison.

Future roadmap plans: the future roadmap for WG6 was not discussed during the meeting, as forecast was not mentioned as a main challenge, from the FAIRMODE National Contact Point perspective. However, sensors can help address different challenges. Model evaluation and microscale seem to be challenges where sensors can show added value. Additionally, well-embedded sensor data can

ultimately also help with "Spatial representativeness" and "Exceedances and exposure". Discussion on this point will continue during the next Technical Meeting.

WG7: High-resolution emissions

Current work: S. Lopez-Aparicio presented the activities carried out in WG7 up to date. The focus has been on benchmarking activities and the composite mapping. Within this activity, 2 webinars have been organized, and a 10-step protocol has been developed and distributed. The benchmarking has been scoped around detecting large inconsistencies between locally developed and regional emission inventories (CAMS, EMEP, EDGAR). This has facilitated discussions, investigation, explanation and problem resolutions across 8 teams.

Guidance status: In line with the "Technical support document on the use of modelling", we aim to align guidance contribution, with key aspects of emissions, on specific AQ modelling applications (i.e., assessment, forecasting, source contribution, planning) to other guidance documents. In the Technical meeting in Dublin, preliminary feedback was gathered regarding the different requirements or needs concerning emissions for the different AQ modelling applications. These needs go beyond sector specific guidance, which is covered in the EMEP/EEA Guidebook.

Future roadmap plans: the discussion in breakout groups and later in plenary highlighted the importance of establishing a catalogue or knowledge platform to facilitate the exchange of experiences across different teams and countries, and also training sessions were suggested. The general feedback indicated a preference for guidance focused on specific AQ modelling applications, such as planning and microscale modelling, rather than sector-based guidance. The breakout groups also identified key needs, such as temporal distribution for individual sector (e.g., splitting factors), speciation in the case of PM and VOCs, or high-resolution emission data from neighbouring countries. In general, the benchmarking tool and composite mapping received positive feedback. Participants suggested additional functionalities, such as incorporating gridded data, and the possibility of providing more methodological details behind the emissions data at the tool.

WG8: Exc. indicators, spatial representativeness and network design

Current work. M. Ross-Jones presented the current work of the WG. In particular an overview of the two key open issues that has been the focus of recent workshops and discussion relating to the issue of spatial representativeness of sampling points; criteria for limiting SRAs of rural / regional background stations and the use of source-related criteria. During 2024 and the beginning of 2025 a number of written contributions from testing and good practice examples have been received, which have been included as appendices to the FAIRMODE WG8 guidance document.

Guidance status: an updated guidance document on spatial representativeness has just been published on the FAIRMODE website: https://fairmode.jrc.ec.europa.eu/activity/ct8. Work is ongoing to finalise a guidance document on the use of MoNET to aid monitoring network design and a summary document on CAMS – FAIRMODE Natural dust exercise 2023-24.

Future roadmap plans: few topics were defined by the breakout groups and plenary. In particular, for the future, the idea will be to focus on modelling and reporting exceedances (link to Article 8.5 and 8.6 in the revised AAQD), use of SRAs to aid network design, further exploration of the use of source-related criteria, harmonisation of reporting and documentation of SRAs and an increased focus on testing the spatial representativeness methodology for pollutants that have received less focus so far (and in particular B(a)P.

WG0: General strategy

On top of the 8 WGs, an additional discussion item was on a "general strategy" topic, referring to more horizontal aspects (e.g. how to start from scratch to build air quality modelling capabilities, how to downscale national data to the local dimension, etc…). A. Piersanti led this WG.

Report from EU activities

The main objective of this session was to understand how external activities and projects could contribute to better modelling for assessment and planning in the future, and how these could interact with FAIRMODE.

E. Pisoni presented the "new EU modelling network" as defined by the revised AAQD. This new network, defined as a sub-group to the Ambient Air Quality Expert Group will gather the national competent authorities and bodies tasked to promote the accuracy or air quality modelling, in line with the tasks outlined in Annex V of the revised AAQD. It is the prerogative of Member States to nominate these competent authorities and bodies. This network is to be managed by the JRC. There will be some overlap and complementarity between this new sub-group/network and FAIRMODE, both in substance and in membership (e.g. one might reasonably expect that in many cases the competent authorities and bodies will also be the ones nominating the FAIRMODE National Contact Points) . FAIRMODE will continue working as it is doing now, i.e. based on its approved 3 years roadmaps.

M. Gerboles presented how AQUILA can interact and contribute to the work of FAIRMODE.

P. Thunis presented an update of the activities of the CEN, in relation to the Model Quality Objective (WG264/43) and to Source Apportionment (WG264/44).

A. Colette presented the CAMS and Ri-Urban projects, and highlighted how these projects can contribute to better modelling for assessment and planning.

R. Timmermans and B. Denby presented the CAMEO project, and highlighted how this project deals with source apportionment techniques, and emission inventory uncertainties.

Next meeting

The next technical meeting will be organized in Malta, from 8th to 10th October 2025.