FAIRMODE

2023-2025 roadmap

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Introduction

The Forum for Air Quality Modelling (FAIRMODE) was launched in 2007 as a joint initiative of the European Environment Agency (EEA) and the European Commission Joint Research Centre (JRC). Its aim is to bring together air quality modellers and users in order to promote and support the harmonized use of models by EU Member States, with emphasis on model application under the European Ambient Air Quality Directives (AAQDs). The AAQDs are currently under revision, and the European Commission published a proposal in October 2022. FAIRMODE is currently chaired by the Joint Research Centre of the European Commission.

This document summarizes the FAIRMODE work-plan for the years 2023-2025. It is a transition workplan that keeps the same structure of work as in the previous roadmap but recognizes the need for further cohesion between the different cross-activities in order to better respond to the requirements under the revised Ambient Air Quality Directives (AAQDs). FAIRMODE provided recommendations to support that revision and will keep on its support during the upcoming phases, what can influence the development of this roadmap.

The terms of reference and users of the network are first recalled, before introducing the structure and work-plan and expected deliverables. The connections between FAIRMODE and other European-wide networks and activities are finally discussed to provide a view of the network in a broader context.

Terms of reference

FAIRMODE is a Forum for Air Quality Modelling created for exchanging experiences and results from air quality modelling in the context of the Ambient Air Quality Directives (AAQDs) and for promoting the use of modelling for air quality assessment and planning in a harmonized manner within and among Member States. Its main objectives are:

- To provide a permanent European Forum for air quality modellers and users of models results, to address air quality modelling issues
- To study and set-up a system (protocols and tools) on the quality assurance and the continuous improvement of air quality models and input data operating at different spatial scales from national to regional[1], urban and local.
- To provide guidance, support the standardization and evaluate the fitness-for-purpose of air quality models and input data, for assessing current and future air quality within the framework of implementing the EU's Ambient Air Quality Directives.
- To support air quality management (at the national, regional and local level) in developing and implementing plans and measures to improve air quality with efficient modelling tools.
- To promote capacity building activities aiming at ensuring an optimum use of the proposed common methodologies and guidance and to promote good modelling practices among the EU Member States.

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[1] Regional is intended here as sub-national

- To make recommendations on future priorities, research activities and other relevant initiatives to secure Air Quality improvements.

While we will keep these terms of reference for the period 2023-2025, a process should be initiated during this period in order to identify possible necessary changes to these terms of reference derived from the final form of the revised AAQDs.

Participants in the network

The FAIRMODE network intends to support model users at all administrative levels (national, regional urban and local) in their policy-related model applications. The network aims at establishing tools and mechanisms to enhance communication and promote good modelling practice. The network provides a framework for exchanging experience at all levels of application, including electronic interfaces, databases and tools as well as workshops, seminars and common projects and activities.

In addition to its national contact points, FAIRMODE is also open to the participation and contribution of regional and local air quality managers and air quality modelling groups in order to cover a wider range of model applications, in particular to cover the urban and regional scales.

Organisation of the work

FAIRMODE priorities and working groups

The current structure of FAIRMODE intrinsically reflects the main recommendations on the use of models identified by the forum back in 2011[2]. The priority lines of work are set according to the major applications of models within the Ambient Air Quality Directives, that are grouped into two main categories: assessment and planning.

Figure 1 provides an overview of the organization of the work and proposed FAIRMODE structure for the next road map period. Within the framework provided by the two main pillars: assessment and planning, the work is structured according to three years priorities established in dialogue with Member States and consolidated at the last technical meeting in 2022 in Oslo. The introduction of these two pillars in the 2023-2025 work plan aims at securing better cohesion between the activities in the different working groups. The priority activities identified for the period 2023-2025 respond to the current scientific advances and needs for guidance, expressed by MS in various fora, in particular the Ambient Air Quality Expert Group. Activities are organized through the following 9 working groups (WG). Some working groups cover both pillars, partly or entirely.

1. Source apportionment to support air quality management
2. Quality assurance, quality check and fitness for purpose of AQ assessment modelling applications
3. Quality control indicators for air quality forecast
4. Microscale assessment

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[2] http://www.eea.europa.eu/publications/fairmode

5. Towards efficient and robust air quality measures
6. Sensors and data fusion
7. Compilation of high resolution emission inventories
8. Exceedance Situation indicators and Spatial representativeness
9. Quality assurance, quality check and fitness for purpose of AQ planning modelling applications
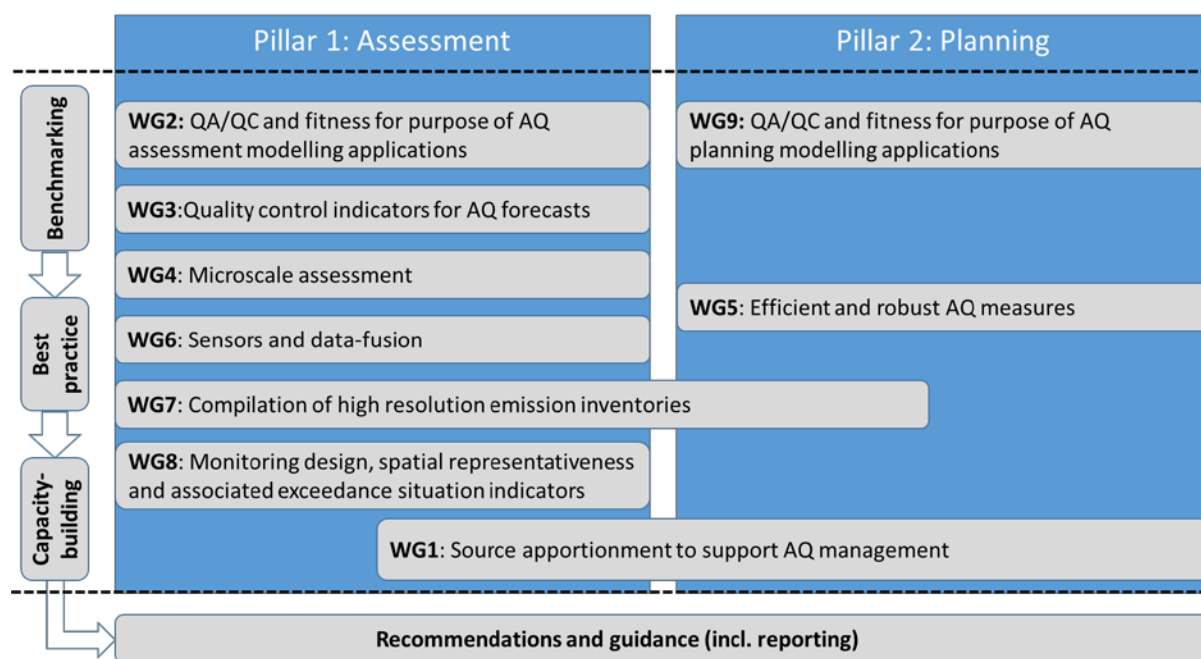

Figure 1: Overview of FAIRMODE's activities for 2023-2025. Working groups are defined within the framework of two main priority pillars. Work in the working groups and pillars is implemented following FAIRMODE's four-steps approach (on the left, for details see next section).

FAIRMODE's implementation plan

The priority activities under FAIRMODE's are to be carried out following a common implementation plan. The implementation process is similar in each working group (WG) and is highlighted in the left side of Figure 1. It secures a chronological four-steps working process.

- Benchmarking is intended as a first step that aims at exploring and comparing results from different approaches. The goal is to understand the strengths and weaknesses of the different approaches. This stage also requires developing and testing a standardized evaluation or inter-comparison methodology (possibly supported by common tools and common datasets) for collecting and reporting model inputs and outputs in a way that enables relevant comparisons.

- Best practices: Benchmarking, intercomparing and flagging strengths and weaknesses allows to identify best practices among (modelling) applications. FAIRMODE second step in the implementations of its activities is to identify best practices.

- Capacity-building is the third step in the FAIRMODE implementation plan where best practices are used with the overall objective of promoting good modelling practices among and within Member States. Capacity building activities include workshops, hackathons and training activities.

- Recommendations, guidance (incl. on reporting): is the fourth step in the FAIRMODE implementation plan. Based on the experience from the previous three steps, we elaborate first recommendations on which approaches are better suited for different applications and then general guidance documents or publications. Recommendations constitute a necessary step before reaching the level of the guidance documents/publications. They include the list of actions and tests necessary before compiling the final guidance. Guidance documents and publications is the last and more effort- and-resource demanding step of the FAIRMODE implementation process. Guidance is usually compiled in an evolving document that includes a detailed description of all steps required to choose and apply a fit-for-purpose approach for a given modelling application.

Recommendations and guidance should be performed at pillar level to be consistent across working groups. One advantage of the proposed 2023-2025 structure is that it leads to guidance being produced within the FAIRMODE network at pillar level. It also emphasizes as a key task the communication of good practices as identified by expert groups to the broader FAIRMODE community, including national and local authorities applying models for regulatory purposes.

FAIRMODE annual meetings

The network is based on communications between experts. Such communication is structured around two annual meetings. The FAIRMODE annual meetings include a *plenary meeting and a technical meeting.* The *plenary meeting* is addressed to national contact points and local policy makers, where the main focus is to review the progress made by experts in the network, review recommendations, discuss strategic options and endorse the workplan. The *technical meeting* is dedicated in contrast to model experts with the purpose to develop and agree on common methodologies, carry out benchmarking and establish good practices, contribute to capacity building, and develop guidance. Independently of these two general meetings, dedicated capacity-building workshops are organized on specific issues, tools and guidance (e.g. DELTA[3], SHERPA[4]…) as well as progress meetings to cover specific issues (e.g., past hackathons on forecast indicators). The scope of the two main types of meetings is further explained below..

Plenary meeting: This meeting focuses on policy aspects with the following objectives:

- Report on outcomes and review the progress made in each WG
- Interact with national contact points
- Communicate experiences, e.g. challenges and good practices, for each of the existing applications

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[3] DELTA: tool to support the evaluation of modelling results
[4] SHERPA: tool to support the design of local and regional air quality plans

- Review and endorse recommendations
- Discuss strategic options
- Endorse the work-plan for further developments related to all WGs
- Gather information from related projects
- Discuss the most efficient way to support DG ENV (e.g. implementing provision on reporting of the AAQD, INSPIRE, etc.)
- Explore potential collaborations and funding mechanisms

Technical meeting: This meeting focuses on technical discussions on benchmarking as well as on the drafting of recommendations and guidance documents. The main purpose of this expert meeting is to:

- Identify expert approaches to the activities related to each WG
- Report on progress of benchmarking activities, incl. development of methodologies and indicators
- Identify and discuss best practices
- Plan and discuss progress on the preparation of recommendations and guidance
- Discuss possible collaborations and integrations at pillar level
- Report the feedback of the Plenary meeting to the experts

FAIRMODE governance

1) The Ambient Air Quality Expert Group supports the participation of relevant national/regional representatives to achieve the FAIRMODE work plan goals.

2) FAIRMODE is chaired by the JRC with the support of DG ENV and EEA. Representatives of these three Institutions form the FAIRMODE Steering Group (SG) together with 5 thematic experts with experience chairing FAIRMODES activities. If a current SG member steps down, substitute candidates are proposed for nomination to the SG by their members and should be approved unanimously. The SG has the mandate to define and implement the FAIRMODE strategy, communicate to the broader community and contribute to the organization of the FAIRMODE meetings. The SG also secures that activities in the different working groups are coordinated, now in 20223-2025 , this coordination is essential also across pillars. Within the SG, DG ENV ensures that the topics identified in need for further research are included in the priorities of its non-regulatory support actions (e.g. LIFE+ program) and further set-up the frame for relations with the Ambient Air Quality Expert group. EEA supports networking, connects to the e-reporting activities and ensures that experiences and results gained from work within the EIONET network are conveyed to the FAIRMODE community, and vice versa. Both EEA and DG ENV supports FAIRMODE by actively contributing to the review of guidance documents with the focus of strengthening and emphasizing policy relevant aspects of FAIRMODE products. Thematic experts share their experience and discuss the most effective way of fostering the activities within the working groups.

3) Working groups (WG) are chaired by experts. Candidates for the chairs and co-chairs of each WG are proposed for nomination to the SG by their members for a period of 3 years. The SG can do so at any

time either because a current member steps down or because the composition of the team needs to be adapted to the objectives. After their term ends, they may decide to continue as chair/co-chair or they may step down. They are welcome to continue for additional 3-year terms as long as their participation contributes to fulfill FAIRMODE's goals. The WG chairs and co-chairs have the mandate to:

- Coordinate the work of the WG by promoting the participation of the experts and distributing relevant information to the group members
- Participate to the FAIRMODE plenary and technical meetings, serving as chairs, organizing, coordinating and providing session summaries
- Continuously monitor the status of the WG activities to ensure high quality meetings and products
- Contribute to focusing the WG on relevant activities and making recommendations on best practices
- Link to activities and projects that can be relevant to FAIRMODE
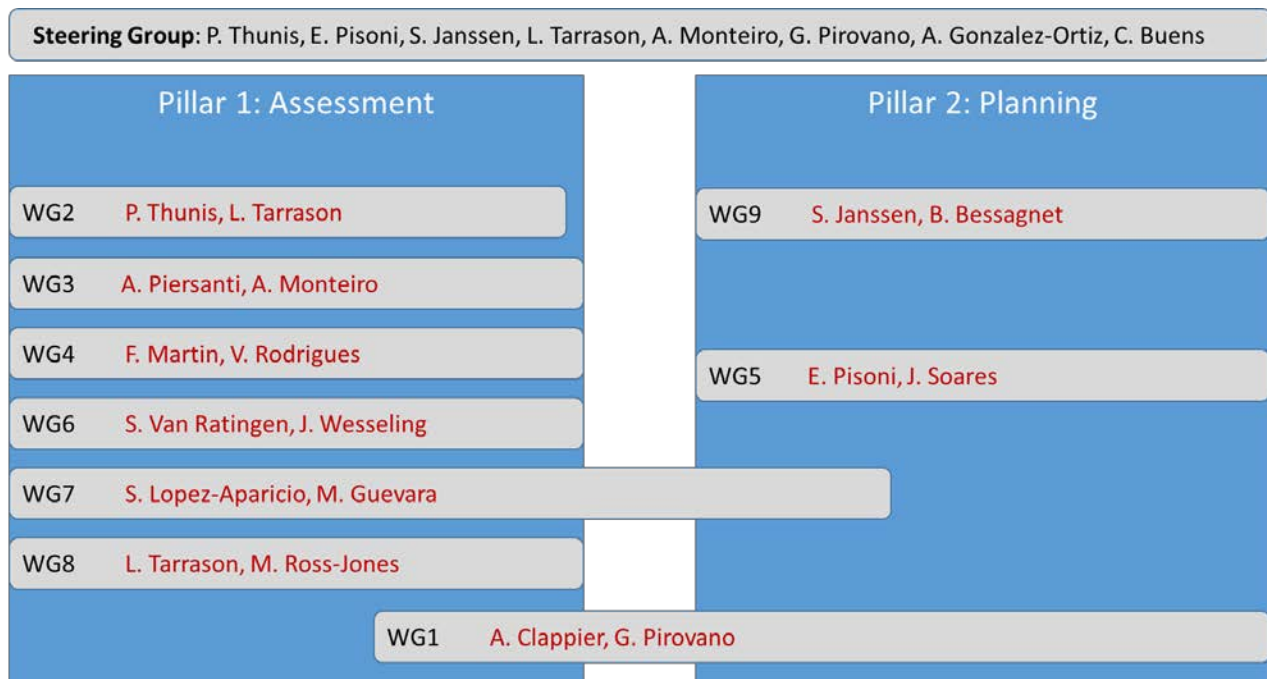- Identify future needs and organize responses to tackle them

Steering Group: P. Thunis, E. Pisoni, S. Janssen, L. Tarrason, A. Monteiro, G. Pirovano, A. Gonzalez-Ortiz, C. Buens

Pillar 1: Assessment	
WG2	P. Thunis, L. Tarrason
WG3	A. Piersanti, A. Monteiro
WG4	F. Martin, V. Rodrigues
WG6	S. Van Ratingen, J. Wesseling
WG7	S. Lopez-Aparicio, M. Guevara
WG8	L. Tarrason, M. Ross-Jones

Pillar 2: Planning	
WG9	S. Janssen, B. Bessagnet
WG5	E. Pisoni, J. Soares

| WG1 | A. Clappier, G. Pirovano |

Figure 2: Overview of the composition of the current steering group and working group chairs/co-chairs.

Activities and deliverables for 2023-2025

For the roadmap for 2023-2025, activities are organized across working groups (WG) with specific deliverables. The identified WGs above are in different stages of maturity. Some WGs may therefore devote more time to the development of benchmarking methodologies while others will mostly focus on

the drafting of recommendations or guidance. This is reflected in the detailed work-plan for each WG proposed below.

WG1 – Source apportionment to support AQ management

The main aim of WG1 is to deliver guidance on the fitness for purpose of different source apportionment approaches in the overall context of air quality management practices. Future WG1 activities will focus on:

- Consolidating the fitness for purpose source apportionment (SA) guide, in particular with the following topics: complementarity of SA approaches, receptor modelling, extension to O_3, NO_2, PM coarse...
- Supporting the reporting of SA results and update of documentation
- Developing a SA protocol in support to planning (key components, sequence, purpose, complementarity…).
- Interacting with CEN, in particular in relation to the foreseen Technical Specifications on source oriented SA.
- Provide guidance on the use of the CAMS policy products related to source apportionment and source-receptor relationships.

WG2 – Quality assurance, quality check and fitness for purpose of AQ assessment modelling applications

WG2 is an activity whose importance is expected to increase in relation to the enhanced role of modelling and official status of the FAIRMODE network in the revised AAQD. While WG2 activities have so far focused on developing a methodology to benchmark model performance (Modelling Quality Objective (MQO), QA/QC protocol), future WG2 activities will focus on regular inter-comparison exercises based on the Composite Mapping platform and use of the MQO indicators:

- Regular inter-comparisons and targeted analysis of key reported assessment data (modelling air concentrations & emissions aggregated data)
  - Targeted analysis of the Modelling Quality Indicator (MQI) across Europe (based on the comparison of on-the-fly and reported MQI)
  - Targeted study of the underlying emission data (Emission Dashboard – link to WG7)
  - Testing usability and usefulness of modelling metadata
  - Consequences for e-reporting of modelling data
- Guidance on model application, documentation and validation
  - Update of the 2011 Fairmode guide on model application
  - Support to AAQD guidance on model use
  - Support to CEN WG43 (MQO) on the implementation of MQI

WG3 – Quality control indicators for AQ forecasts

This activity aims at providing a specific benchmarking framework for modelled air quality forecasts. Performance indicators have been developed to provide additional information about the capability of

the forecasting system to detect and anticipate regulatory threshold exceedances and to check its ability to provide accurate forecasts (benchmarked against the 'persistence model'). Future WG3 activities will focus on:

- Assessing the clarity of the output of the forecast evaluation and discussing a possible tiered approach
- Developing the AQI plots (multicategory contingency table, …) in view of improving the communication of results to non-experts
- Documenting the procedure for experts (slideshow, video, training sessions)
- Developing an open and user-friendly software platform
- Further testing of the indicators

WG4 – Microscale assessment

Microscale air quality modelling refers to air quality modelling at high spatial resolution (typically down to a scale in the order of one meter), usually focused on urban environments. This type of modelling applications is more and more used in the AAQD policy context, driven by the fact that more and more exceedances occur at local hotspots which require high spatial resolution for understanding their causes and setting up specific and localized measures to mitigate the problem. The focus points of this WG4 are thus:

- Testing the robustness of approaches to retrieve annual averaged concentrations (and other AAQD statistics such as percentiles), in particular by assessing the importance of meteorology: e.g. understanding differences between unsteady full year simulations vs scenario (wind sector) approach.
- Specifying simulation requirements in terms of input data (e.g., microscale emission inventories, meteorological data) and observation datasets for validation.
- Providing guidance for microscale model applications in the context of the AAQD, e.g. derivation of exceedance situation indicators, spatial representativeness area of monitoring stations.,… (link with WG8)

WG5 – Efficient and robust AQ measures

Work will continue to elaborate recommendations to support local, regional and national authorities in designing efficient and coherent measures. It will also support the reporting of those measures to ensure comparability and exchange of good practices.

The idea of this WG is to look for a more comprehensive approach, that strengthens the interactions with other WGs, to build an 'air quality management process' to support authorities. To achieve this aim, WG5 will develop a 'checklist / guidance', to help preparing/reporting a plan. The checklist's ingredients will originate from links with other WGs, i.e. with WG1 (to understand the main sources of pollution), WG7 (to analyse and evaluate emissions), WG8 (to evaluate exposure to air pollutants), WG9 (to deal with scenarios and assess the impact of measures on air quality).

The aim of the WG5 'checklist' is also to 'distillate' FAIRMODE technical contents (from other WGs) in a simplified way, so that these messages can reach policy makers. A holistic approach will be used to built the 'checklist', looking (among others) at ways to:

- Improve the coordination with other geographical (EU, country, regional, …) and sectoral (energy, transport, agricultural, …) policies,
- Involve cities (i.e. Eurocities or other relevant city networks).

The last step of the work will be to test the 'checklist' with partner cities.

WG6 –Sensors and data-fusion

Low-cost sensors can be very relevant for FAIRMODE, especially concerning methodologies to combine sensor networks with modelled data and official measurements. Present experiences suggest important roles for data fusion/assimilation approaches, and possibly other techniques with similar scopes. WG6 activities will focus on discussing and understanding the strengths and weaknesses of the different ways low-cost sensors can be used in conjunction to modelling. The focus points for WG6 are:

- Exchanging best practices about the calibration and subsequent integration of sensor network data in air quality mapping methods (data fusion) and demonstrating the use of sensors in different areas/countries with national models to fuse
- Providing guidance and recommendations on the use of sensors (e.g. citizen science projects), both in terms of calibration, data fusion or communication about related uncertainties
- Exploring how exploitation and validation of an air quality sensor network can contribute to improved air quality modelling, with a focus on city applications.

WG7 – Compilation of high resolution emission inventories

The focus of this WG is on the compilation of high resolution emissions to be used as basis for air quality modelling applications at urban/local scales. This is because such compilation is not fully covered by the EMEP/EEA emission inventory guidebook, which focus on national emission totals, and therefore follows uneven practices across Europe, sometimes following approaches that are systematically different from those of emission compilation at national level. One of the main aims is to provide recommendations on the necessary steps to document and compile these emission inventories to support air quality assessments and the elaboration of national and local plans and programmes under EU legislation. Future WG7 activities will focus on:

- Identifying best practices through QA/QC approaches and drafting recommendations for the compilation of sectorial high resolution emission inventories that are relevant at the urban scale.
- Elaborating recommendations for a common system to document the use of ancillary data and define the relevant meta-data that support each emission inventory at the urban scale. The metadata recommendations will provide a common documentation framework to better understand the differences between inventories. Tests will be performed to assess the feasibility of reporting emission metadata for assessment and planning based on a simpler approach.
- Benchmarking and creating an emission dashboard (based on available downscaled EU inventories; e.g. CAMS, and bottom-up national and local inventories) to monitor progress and identify inconsistencies among inventories. Regular inter-comparisons will be carried out to support this objective.

- Using the Composite Mapping platform (1) as spatial information support to evaluate specific sectors/ topics identified as inconsistency by the dashboard and (2) to carry out emission evaluation in relation with activities of the composite mapping for assessment purposes
- Providing relevant feedback to improve European inventories used for regulatory purposes in the context of EMEP, CAMS-REG and/or European research projects (e.g. RI-URBANS).

WG8 – Monitoring design, spatial representativeness and associated exceedance situation indicators

The AAQD offers the opportunity for MS to use model applications (alone or as supplementary information of measurements) to assess the air quality. The Implementing Provision on Reporting (IPR) and related e-Reporting process have defined how to report these model applications. As a result, an increasing number of MS are reporting modelling data and model based indicators requested by the IPR. However, there is still a clear lack of guidance on the use of model results for assessment and planning purposes and, therefore, in the formal reporting cycle (e.g. estimation of exceedances, exposure in given areas or spatial representativeness of the monitoring station). Based on the work carried out in the past years, future WG8 activities will focus on:

- Best practice identification - Fine-tuning and further testing spatial representativeness methods
- Best practice identification - Fit-for-purpose modelling approaches to assess Exceedance Situation Indicator
- Benchmarking - Better describing the details of implementation of the Exceedance Flagging Indicator
- Benchmarking - Compiling experience from the Intercomparison exercise on monitoring network design
- Benchmarking – Intercomparison exercise in cooperation with CAMS on the contribution of natural sources to exceedances
- Competence Building - Providing recommendations on monitoring network design and consequences for e-reporting
- Guidance - Elaboration of guidance document on spatial representativeness and monitoring design
- Guidance – Elaboration of guidance document for use of models for exceedance situations

WG9 – Quality assurance, quality check and fitness for purpose of AQ planning modelling applications

The aim of this WG is to deliver recommendations on QA/QC methods to assess the quality of models used for planning purposes. The WG9 activities will focus on:

- Assessing the sensitivity of the model responses to emission reductions when input data (emissions, meteorology…) or the model itself is changed, with a focus on short-term model responses.
- Assessing the influence of various processes (e.g. meteorology, emissions, resolution…) in the observed differences
- Providing recommendations on the combined use of models and observations for planning purposes

- Evaluate consequences for e-reporting of planning data
- Providing overall support to model users (SHERPA, air quality models…) in their planning activities (measures, emission and model scenarios)

FAIRMODE in the broader context

This section details the interactions between FAIRMODE and other networks and projects. A good communication is secured by the participation of key scientists in both FAIRMODE and the other groups.

FAIRMODE and CAMS

Since the FAIRMODE launch, searching for possible synergies with the Copernicus Atmosphere Monitoring Service, CAMS, has been a key priority. While CAMS contributes with a series of products and information that may be relevant for all activities under FAIRMODE (e.g., CAMS-REG emission inventory), it is not always clear how these products can be directly used for the assessment of air quality levels to establish the extent of exceedances, the forecasting of urban air quality levels for short term mitigation and public information and warning, determining the origin of exceedances or providing a knowledge basis for national planning strategies. FAIRMODE, through its guidance and benchmarking activities can play an essential facilitator role providing feedback for suitable applications of the CAMS products. Experiences of use of CAMS products compiled under the technical FAIRMODE working group activities are to be communicated to the CAMS steering group and effectively contribute to improve the CAMS policy products. Both expert networks cooperate and benefit from each other.

FAIRMODE and EMEP Task Forces (TF)

EMEP has a long support record of cooperation with FAIRMODE. EMEP helps identifying key problematic areas for which developments in terms of benchmarking are needed. In return the available FAIRMODE methodologies can be used in support to the QA/QC process of EMEP work, in particular related to assessment (TFMM), emissions (TFEIP) and planning (TFIAM). As a result of its benchmarking activities, FAIRMODE contributes to EMEP by identifying the main reasons driving inconsistencies and differences between national scale assessment versus regional and local assessment.

FAIRMODE and AQUILA

Some topics are recognized of being of common interest to both the FAIRMODE and AQUILA community (e.g. spatial representativeness, network design, detection of outlying measurements, measurement uncertainty, assimilation of monitoring data with modelling studies, use of low-cost sensors...). Ad-hoc workshops or common sessions on one of these specific themes took place in past meetings and will continue in future.

FAIRMODE and EIONET

The European Environment Information and Observation Network (EIONET) brings together some of the main potential users of modelling results (AQ managers and EEA) with some of the model developers and modelling groups (for instance national groups and some of the partners in the European Topic Centre on Human health and the Environment (ETC HE)).

AQ managers can be supported in both their assessment and their management practices using the modelling applications identified in the WGs, and in the subsequent reporting obligations. At the same time their feedback and their specific needs are drivers for future FAIRMODE work.

With the enhanced role of modelling in the revised AAQDs, e-reporting of modelling data will become more relevant. Cooperation with EIONET and the EEA on e-reporting will become a key activity within FAIRMODE activities.

FAIRMODE and CEN

The harmonization in the methodologies to assess model performance developed in FAIRMODE are being used in the standardization process started in 2015 with the creation of WG 43 on Model Quality Objectives and WG 44 on Source apportionment. The close collaboration between these two working groups and FAIRMODE is essential to increase the efficiency of the work and to ensure full coherence between guidance and CEN standards for a better support to the environmental policy.

Contact points

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WG5 – Efficient and robust AQ measures

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