United Nations ECE/EB.AIR/GE.1−WG.1/2024/INF.20

Distr.: General
7 August 2024

Original: English

Economic Commission for Europe

Executive Body for the Convention on Long-range Transboundary Air Pollution

Steering Body to the Cooperative Programme for Monitoring and Evaluation of the Long-range Transmission of Air Pollutants in Europe

Working Group on Effects

Tenth joint session
Geneva, 9-13 September 2024
Item 5 (a) of the provisional agenda
Progress in activities of the Cooperative Programme for Monitoring and Evaluation of the Long-range Transmission of Air Pollutants in Europe in 2024 and future work: Improvement and reporting of emission data and adjustments under the Protocol to Abate Acidification, Eutrophication and Ground-level Ozone

TFEIP 2024 Meeting Paper

Condensable PM emissions: Reviewing the progress made against user needs, and identifying improvement priorities

Authors: TFEIP Co-Chairs, CEIP, and the TFEIP's Ad Hoc group on User's needs regarding condensable PM.

Date: 31/05/2024

Reference & version: 2514/2024/CD9150

Summary

The TFEIP have been asked by the EMEP Steering Body to provide guidance on reporting condensable PM emissions, and consequently there is a corresponding item in the TFEIP's workplan: 1.1.2.3 Guidance on reporting condensable PM. At their 2024 annual meeting (14-16th May), the TFEIP agreed to form an ad hoc group to consult with emission inventory users in the Convention, to identify their needs relating to condensable PM, and then draft this "needs and improvement priorities" paper for the tenth joint session of EMEP Steering Body and Working Group on Effects (Geneva, 9-13 September 2024).

I. Introduction and Context

1. The TFEIP have been asked by the EMEP Steering Body to provide guidance on reporting condensable PM emissions, and consequently there is a corresponding item in the TFEIP's workplan: 1.1.2.3 Guidance on reporting condensable PM.

2. After some discussion, the co-Chairs agreed to approach this as two specific items:

1.1.2.3 Guidance on reporting condensable PM (Pt 1/2) – reviewing the needs of emissions inventory users and improvement priorities

3. The EMEP/EEA Guidebook currently provides methodologies that, to the extent possible, include the condensable component of PM for small-scale residential/domestic combustion, road transport, and non-road mobile machinery, but not other sources. In addition, Parties are required to provide information with their emissions estimates that explains which sources include condensable PM.

4. Before being able to propose changes to the current guidance and reporting requirements, it is necessary to consider what the current reporting is not delivering to the users of the emissions data.

5. At their 2024 annual meeting (14-16th May), the TFEIP agreed to form an ad hoc group to consult with emission inventory users in the Convention, to identify their needs relating to condensable PM, and then draft this "needs and improvement priorities" paper for the tenth joint session of EMEP Steering Body and Working Group on Effects (Geneva, 9-13 September 2024).

1.1.2.3 Develop guidance on reporting condensable PM (Part 2/2) – proposals for developing the current emissions inventory reporting

6. Following the "needs and improvement priorities" paper, it will be possible to do a more detailed gap analysis, and then draft a paper of "proposals" regarding improved emission estimation methodologies, potential future PM metrics, and potential emissions reporting structures.

7. The timeline for this work plan item is to have a draft paper for discussion at the 2025 annual meeting of the TFEIP. The finalised paper can then be submitted to the 2025 joint session of EMEP Steering Body and Working Group on Effects for consideration.

II. Reviewing the needs of emissions inventory users

A. Background and context

8. MSC-West indicated that the findings of the EMEP technical report MSC-W 4/2020, titled "How should condensables be included in PM emission inventories reported to EMEP/CLRTAP?" (Simpson et al, December 2020) are still relevant, because there have not been any significant developments in the understanding of condensable PM since the report was published. The report proposes the following as a road map:

(a) In year 1 the TNO Ref2 data is used in an initial estimate for residential combustion emissions, with modellers making educated choices about SVOC emissions and the VBS framework.

(b) In subsequent years these top-down estimates should be increasingly replaced by national estimates once procedures for quantifying condensables in a more harmonised way are agreed on and implemented.

(c) Approach/updates should be tied to EMEP TFEIP meetings, with successive improvement of the reporting and transparency of the activity data and emission factors used.

(d) This process needs guidance and support. Voluntary contributions will lead to new mixtures of inconsistent assumptions.

9. Since 2021 the number of Parties where the data for GNFR sector C is replaced by TNO Ref2 data before it is used for modelling activities has consistently decreased. In 2024, data reported by Parties was used unamended for 32 Parties (out of 48). TNO Ref2 data was used for 11 Parties (two of these Parties did not provide a PM emission inventory). For five Parties, the inventory including GNFR sector C had to be gap-filled by CEIP due to quality issues of the inventory or missing submissions.

10. Some progress has been made, in that emission methodologies presented in the EMEP/EEA Guidebook have been developed to include condensables from small-scale combustion (including residential) and road transport, and is excluded from other sources. An increased number of Parties follow this approach, primarily because this is the information included in the EMEP/EEA Guidebook. However, a significant amount of progress is still required to:

(a) **Develop the transparency and accuracy of data included in the EMEP/EEA Guidebook:** It is important to not only improve data in the EMEP/EEA Guidebook based on the latest scientific understanding, but also to more clearly define the way the condensable component has been quantified and included.

(b) **Ensure that Parties have sufficiently detailed and accurate activity data:** This is so that they can use more sophisticated higher Tier methodologies, which give more accurate emission estimates.

11. There is a window of opportunity, to undertake development work across the next two years, so that updated information can be included in the next edition of the EMEP/EEA Guidebook (to be published in 2027). But this will only be possible with funding which has, to date, not been forthcoming.

B. Needs relating to improved quantification of emission estimates

12. In addition to the recommendations made in Simpson et al (2020) and comments received from MSC-West, CIAM also provided the TFEIP with thoughts on specific sources which should be priority for development. These have been combined to give the observations below, which are ordered from high to low priority.

(a) High priority

1A2gvii, 1A4aii, 1A4bii, 1A4cii Off-road diesel engines in non-road mobile machinery

13. Off-road diesel engines are used in a number of sectors (industry, construction, agriculture etc.), and can also be a large source of primary organic aerosol (POA) and condensable POA. McDonald et al. (2015), note that the less efficient off-road diesel engines may be the primary source of mobile POA in Los Angeles.

Thoughts from the TFEIP:

For both Tier 1 and Tier 2 methodologies, the PM EFs in the 2023 EMEP/EEA Emissions Inventory Guidebook are presented as including the condensable component. So the vast majority of Parties are likely to be reporting emissions that include the condensable component of PM.

However, many Parties do not have sufficiently resolved activity data to allow accurate emission estimates to be included in their national inventories, and importantly are not able to represent emissions resolved by equipment age, emissions control, engine capacity etc. This severely limits the resulting accuracy of the emission estimates.

Supporting Parties to make better emission estimates from these sources has been flagged by the TFEIP as a priority for several years, but little progress has been made due to the lack of resources.

1A3di, 1A3dii National and international shipping

14. Some studies of the IVOC (and SVOC) emissions from shipping and ship engines have been published in recent years, including those which suggest that the total IVOC emissions were better correlated with POA emissions than with "total hydrocarbon" emissions.

Thoughts from the TFEIP:

The 2023 EMEP/EEA Emissions Inventory Guidebook contains no information on whether the condensable component is included in the reported PM emission factors. Improvements to this chapter in general is a TFEIP priority, but it is not yet clear what improvements the existing literature can support. In addition to compiling emission estimates with more transparency regarding the inclusion/exclusion of the condensables component, improvements could also target supporting Parties to provide better data to the modelling community, such as resolving emissions into in-port emissions, emissions that are close to the coastline e.g. in territorial waters, and emissions that are further away from the coastline.

(b) Medium priority

1A3a Aviation

15. Landing and take-off emissions from aviation do not make a particularly large contribution to national totals of PM, but are usually significant in the context of local air quality.

Thoughts from the TFEIP:

The 2023 EMEP/EEA Emissions Inventory Guidebook contains no information on whether the condensable component is included in the reported PM emission factors. Addressing this is a priority, and there are now considerably more measurements of PM, including ultrafine PM, at airport locations. So it may be that the available literature has significantly increased in recent years, and can support improvements in methodologies.

3F Field burning, and other unregulated fires

16. Emissions from unregulated fires (e.g. wildfires, prescribed burns, agricultural fires): can be major sources of SVOC and IVOC, at least locally and during specific periods. In the USA measurements on these unregulated fire emissions are performed in both the lab and field. Extensive studies of US wildfire composition,

with detailed chemical analysis have been reported by for example Jen et al. (2019) and Hatch et al. (2018). In Europe the available data on chemical composition seems to be sparser, but there are also problems in the basic reporting of fire source PM emissions.

Thoughts from the TFEIP:

Open burning of agricultural residues is banned in the EU, and consequently some national inventories report the emission source as not occurring. However, satellite data indicates that in some countries it is an extensive practise, even if it is not legal. The current chapter of the EMEP/EEA Guidebook on the burning of agricultural residues does not specify whether the PM estimates include the condensable component, and there is a need to address this. In addition, there are now satellite-based emission estimates for fires, and whilst these data include all types of open burning and wildfires, it should be possible to use these data in verification studies to drive improvements in national emissions inventories.

(c) Low priority

1A1a, 1A2, 1A4ai, 1A4ci Combustion of gaseous fuels

17. Combustion of natural gas tends to be a low contributor to TSP, PM10, PM2.5 emission and emission factors in the EMEP/EEA Guidebook are generally for filterable PM. However, it is notable that US EPA emission factor guidance for external combustion sources burning natural gas1 includes emission factors for condensable emissions and the emission factor for the condensable fraction is about three times the filterable PM emission factor. US EPA also provides condensable PM emission factors for natural gas combustion in gas turbines2 and engines3.

Thoughts from the TFEIP:

The US EPA Emission Factor Handbook has condensable PM emission factors for a range of activities and fuels. However, emission factors tend to be relatively old and, for condensable emissions from natural gas, are likely to have high uncertainty as measurement methods may have relatively high detection limits. Work has been undertaken in the US since 2000 to investigate condensable PM and ultrafine PM from natural gas combustion with several publications in the literature[4].

1B2ai Oil sands operations

18. The relative distributions of SVOC and IVOC from the Oil Sands are uncertain, though IVOCs are likely the more important precursors for OA from the Oil Sands.

Thoughts from the TFEIP:

The TFEIP have not considered this source for inclusion in the EMEP/EEA Guidebook because it is thought to be specific to North America, and the USA and Canada typically use methodologies from USEPA AP42 rather than the EMEP/EEA Guidebook. But, if considered necessary, an AP42 based methodology could be added to the EMEP/EA Guidebook, with transparency regarding the inclusion/exclusion of condensable PM. .

[1] AP42 Chapter 1.4 https://www.epa.gov/sites/default/files/2020-09/documents/1.4_natural_gas_combustion.pdf Table 1.4-2

[2] Chapter 3.1 Table 3.1-2

[3] Chapter 3.2, Tables 3.2-1, 3.2-2, 3.2-3

[4] For example, see https://www.sciencedirect.com/science/article/pii/S1352231015305550

1B2aiv Petroleum refineries (fugitive and process emissions)

19. Refineries may also contribute to emissions of condensables and IVOC in Europe, but more data are needed.

Thoughts from the TFEIP:

To date, no effort has been made to ensure the inclusion of condensable PM in the EMEP/EEA Guidebook methodologies for large stationary combustion plant because these sources were considered to be far less important than e.g. small-scale combustion. Furthermore, for reporting emissions from large combustion plants, EU countries typically use plant/country specific measurement data which do not include condensable PM. If resources and high-quality data emissions and the knowledge about the removal efficiency of abatement techniques regarding condensable particles are available, then progress could be made in improving the methodologies presented in the EMEP/EEA Guidebook. But it would be challenging to transparently demonstrate consistency between these estimates (including condensable PM) and detailed reporting of PM emissions from large point sources (excluding condensable PM).

D Asphalt manufacture and application

20. Asphalt-based sources are considered to be a major source of S/IVOC in urban areas.

Thoughts from the TFEIP:

Methodologies for estimating the emissions of PM and NMVOC are included in the EMEP/EEA Guidebook, but condensable PM is likely to be excluded from the PM emission estimates. Asphalt mixing plants are usually equipped with filter systems for dust removal, therefore knowledge of the removal efficiency regarding PM emissions including condensable particles would be necessary in order to avoid overestimation when improving the existing emission methodologies presented in the EMEP/EEA Guidebook. To date this has not been considered a priority activity, but could be revised if considered necessary.

2H2 Food and drink

21. Emissions from food-related sources (the commercial and possibly residential cooking/frying/etc. of meat and other food types) may be significant sources of organic aerosol in urban locations. But, this source is not currently included in national emission inventories.

Thoughts from the TFEIP:

Newly available results from measurement campaigns are expected to allow a methodology to be added to the EMEP/EEA Guidebook. It is not yet clear to what extent condensables might be accounted for, but progress is expected ahead of the publication of the next version of the EMEP/EEA Guidebook in 2027.

C. Improved engagement with the Air Convention's emissions measurement community, and health impacts experts

22. The existing measurement data for condensable PM is not thought to be particularly robust, and the different approaches/methodologies for measurement give results that vary in their representation of condensable PM (created by e.g. temperature differences). There is therefore a need for better engagement with the Air Convention's measurement community, so that they can provide guidance on how emissions measurements should be interpreted for use in the development of emissions estimation methodologies.

23. Knowledge about the health impacts of the condensable fraction of PM thought to be limited. This is probably because constrained by the limited information on the chemical speciation of condensable PM, and PM more generally. The TFEIP is focused on support Parties with their emissions inventory reporting to the Air Convention, and hence there has been little effort to develop an understanding of the chemical speciation of PM. But it is clear that better information would support the work and aims of the Air Convention more generally.

III. Conclusions

A. Development of the EMEP/EEA Guidebook

24. The EMEP/EEA Guidebook contains information on condensables for a limited number of sources, and the focus of development work to date has been to provide improved transparency on what the methodologies represent, and to standardise on consistently reporting pm that includes condensables for a given list of emission sources. Further work is required to:

(a) Continue with this improved transparency, because there are still some sources in the EMEP/EEA Guidebook where it is not clear whether condensable PM is included or not in the current methodologies.

(b) Develop the accuracy of some of the sources that include condensable PM (such as non-road mobile machinery, shipping, and fires).

(c) Add new sources (such as commercial cooking) where measurements demonstrate that the sources makes a significant contribution to PM concentrations.

25. The TFEIP is developing the plan to secure funding that allows improvements to be delivered as part of the next Guidebook update, scheduled for publication in 2027. But, the TFEIP will explore whether is it possible to secure resources that allow improvement activities to be progressed earlier than this timeline.

B. Improving the quality of national emissions inventory submissions

26. The users of the emissions inventories have a general need for the national submissions to be of higher quality – although this is very variable from Party to Party, and therefore the need is better expressed as being relevant for certain specific Parties. CEIP currently undertake gap filling for several countries before passing emissions data to the Air Conventions modellers, and some of these Parties are not making progress in addressing shortcomings in the quality of their submissions.

27. So, it would be sensible to consider some hands-on targeted support for selected Parties. Previous experience suggests that the most effective approach would be to provide emissions inventory experts that can work in a very practical hands-on way with the national emissions inventory team. This gives the best chance of embedding improvements in the annual compilation processes so that the step-change up in quality remains in place for future submissions.

C. Potential revisions to the current approach used for reporting condensable PM

28. This has not been considered in this (Part 1), of the work plan item, but will be included in Part 2: Proposals for developing the current emissions inventory reporting.