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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

Ninth joint session
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Item 5 (b) 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 and its workplan for 2024–2025: measurements and modelling**
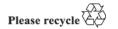
Measurements and modelling

Report of the Task Force on Measurements and Modelling on its twenty-third meeting

Summary

The present document contains the annual report of the Task Force on Measurements and Modelling under the Steering Body to the Cooperative Programme for Monitoring and Evaluation of the Long-range Transmission of Air Pollutants in Europe, in accordance with the 2022–2023 workplan for the implementation of the Convention on Long-range Transboundary Air Pollution (ECE/EB.AIR/148/Add.1), and in line with the revised mandate of the Task Force (Executive Body decision 2019/8).[a] The present report summarizes the discussion at and the outcomes of the Task Force's twenty-fourth meeting (Warsaw, 10-12 May 2023).

An important focus this year is on the first analysis of results collected during the EMEP Intensive Measurement Period of the summer 2022. After several years focusing on particulate matter, it was the first time a comprehensive experiment was devoted to improving the understanding of ozone. And in the context of enhanced scrutiny of methane mitigation, it is also very timely to consider how the scientific basis of volatile organic compounds had evolved in recent years. An unprecedented setup allowed the collection of 4755 datasets for 146 chemical components in 27 stations across 13 State Parties during a 10 day period which corresponded to an intense heat-wave in mid-July 2022 in Europe. The first results show insight into the relative role of biogenic and anthropogenic sources in the formation of ozone and secondary organic aerosols. These datasets will further be used to strengthen modelling and measurement practices. A multi-model experiment is being designed, and lessons to reinforce the long-term EMEP monitoring will be drawn.

The work is also progressing for BaP modelling with a State Party maintaining the leadership in coordinating the multi-model Eurodelta-BaP exercise. A workshop devoted to the monitoring of Chemicals of Emerging Concerns will be organised in the autumn of 2023, and we also had presentations on the modelling of pesticides and monitoring of microplastics in atmospheric deposition fluxes.

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Several presentations focused on past and future ozone evolution, allowing to put in perspective the recent trends - which are widely different depending on the metrics and area considered – with the expected impact of either climate change, NO_x and VOC mitigation, or CH_4 mitigation.

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a All Executive Body decisions referred to in the present document are available at www.unece.org/env/lrtap/executivebody/eb_decision.html.

I. Introduction

1.   The present report contains the outcomes of the twenty-fourth meeting of the Task Force on Measurements and Modelling (Warsaw, Poland, and also some remote participation, 10–12 May 2023), including the presentation of activities undertaken since its previous meeting (online, 3–5 May 2022). It describes progress on the implementation of the monitoring strategy of the Cooperative Programme for Monitoring and Evaluation of the Long-range Transmission of Air Pollutants in Europe (EMEP) for the period 2020–2029 (Executive Body decision 2019/1) and on the development of modelling tools and specific ongoing assessments, as well as current and potential collaborative activities with other bodies of the Convention on Long-range Transboundary Air Pollution.

2.   In all, 57 experts from the following Parties to the Convention attended the meeting: Austria, Belgium, Canada, Croatia, Cyprus, Czechia, Denmark, Estonia, Finland, France, Germany, Hungary, Italy, Latvia, Netherlands, Norway, Poland, Russian Federation, Slovakia, Spain, Sweden, Switzerland, Turkey, the United Kingdom of Great Britain and Northern Ireland and the United States of America. Also present were representatives of the Chemical Coordinating Centre; the Meteorological Synthesizing Centre-West (MSC-West); the Centre for Integrated Assessment Modelling; the EMEP Steering Body; the European Environment Agency; the European Commission; the Task Force on Integrated Assessment Modelling; the Task Force on Hemispheric Transport of Air Pollution; and the World Meteorological Organization (WMO).

3. The meeting was opened by the host institutions with opening addresses by Krystian Szczepanski, Director of the Institute of Environmental Protection – National Research Institute, and Barbara Toczko, Deputy Director for air quality from the Department of Environmental Monitoring, Chief Inspectorate of Environmental Protection (Poland). They informed on the activities of Poland with regards to environmental protection in general and in particular support of UNFCCC and LRTAP conventions and activities related to relevant European Directives.

4. An expert from Poland provided a detailed overview of activities in relation to air pollution modelling. This work included short-term forecast at European (contributing to the Copernicus Atmosphere Monitoring Service) and national level, source apportionment of particulate matter, mapping exposure to ambient Arsenic, long-term, past and future projections.

II. Updates from the Convention and EMEP Centers

5. Mr. Augustin Colette (France) started the meeting and introduced Mr Lorenzo Labrador (WMO) taking for the first time the role of co-chair of the Task Force. They presented the agenda of the meeting and highlighted the main areas of work. Referring to the expectations of the LRTAP Executive Body in a presentation provided by the EMEP Chair, they pointed out the relevance of TFMM to produce scientific evidence on the efficiency of the Gothenburg protocol to mitigate air pollution in the UNECE region. To achieve this, long term trends are instrumental to assess potential discrepancies between reported emissions, model results and observations. Specific examples such as underestimation of organic carbon

downward trends compared to measurements were highlighted as a possible indication of remaining challenges in relation to the modelling of condensables in the residential sector. The need to better link hemispheric and European scale to understand ozone trends was also pointed out. The relevance of EMEP activities in developing monitoring at supersites was emphasized in the context of the proposed recast of the European Ambient Air Quality Directive. Possible items for the future Task Force workplan over the 2024-2025 biennium were introduced prior to further discussion during the meeting. They included following-up on the EMEP Intensive Measurement Campaign held in the summer 2022 and linking temporal and spatial scales in order to understand high ozone episodes, making use of models and observations to consolidate condensable reporting, and the preparation of a workshop on the monitoring of Chemicals of Emerging Concern. The situation of the Meteorological Synthesizing Centre East was also mentioned, emphasising the need for State Parties to highlight their previous use of MSC-East's models and data, and considerations they may have about options to maintain MSC-East activities in the future as it would be further presented to the next Executive Body meeting in December 2024. This introductory talk was concluded with the announcement that France would discontinue its involvement as TFMM co-chair as of 2024.

6. An expert from Sweden presented the Conclusions and recommendations of the Saltsjöbaden VII Workshop. The workshop was held on 13-15 March 2023 and gathered 180 scientists, policymakers, non-governmental organisations and other stakeholders. Future challenges and opinion on international air pollution management were discussed in six working groups: Attain good air quality in airsheds (city areas) at risk, Achieve policy-relevant understanding of air pollution effects on health, Fulfil Air Convention objectives, Transform nitrogen waste into nitro-resources & flourishing ecosystems, Integrate policies and research on air pollution, climate and biodiversity, Accomplish significant air quality improvements through international cooperation. An overarching recommendation was related to reducing impacts of air pollution on health and ecosystems by 50% in 2035. Several recommendations were directed to TFMM: actions to address CH_4 and NH_3 emissions, contributing to the UNEP Science and Policy Panel on Chemicals, initiating an IPCC Special Report on air pollution and climate, or reviewing evidence for the use of low-cost sensors to monitor air pollution in low-income countries.

7. A representative of CCC provided an update from the Centre. He started by informing on the establishment of ACTRIS as a European Research Infrastructure, recalling that the EMEP Monitoring Strategy recommended, but did not require, aligning with ACTRIS's practices which would be accessible for a fee for the countries not contributing in kind through national facilities or calibration centres. Recent software developments in support of data reporting to EMEP were presented. The Copernicus Atmosphere Monitoring Service started supporting a project to improve the use of Near Real Time observations from EMEP, in particular for high quality NO_2 and O_3 measurements. A revision of the ozone absorption cross section is being undertaken and will need to be tracked in meta-data reported to EBAS to ensure continuity of the long-term trends. The recast of the European Directive on Ambient Air Quality proposed at the end of 2022 was welcomed since it stresses the need to monitor air quality at supersites, which correspond to the EMEP Level 1 stations. There remained some discrepancies, in particular those related to the position of EMEP to monitor aerosol composition in the PM_{10} fraction instead of only focusing on $PM_{2.5}$. A workshop is in preparation for the autumn of 2023 to review practices in monitoring Chemicals of Emerging Concerns, including microplastics.

8. A representative of MSC-West presented on the progress of the Centre's activities. These activities included future model simulations which test the stringency of attaining the new WHO guidelines for $PM_{2.5}$, NO_2 and O_3. For exposure to PM2.5, a spatial downscaling at 250 m is achieved. The expected improvement is larger over Western Europe compared to Balkan and EECCA countries. The WHO guidelines values will likely not be reached for $PM_{2.5}$ and ozone peaks anywhere in the region. It is also unlikely for EECCA countries for NO_2, although the most ambitious scenarios foresee reaching the objective over the Balkans and west European countries. An innovative method for source apportionment of ozone was introduced in the EMEP model and offers promising perspectives.

9.   A representative of WMO presented the Implementation Plan of the Global Atmosphere Watch Programme (GAW) for the 2024-2027 period, which was expected to be approved by the WMO Congress in May 2023. The GAW bodies work on the development of GAW's workplan. He outlined the organization of the program and alignment of activities with WMO's strategic plan. This is referred to as an integrated topical value chain and it is supported by, among others, capacity development activities. He updated on the support to the environmental policy, including bulletins (Greenhouse Gas Bulletin and Air Quality and Climate Change Bulletin). The 2022 meeting on Carbon Dioxide, Other Greenhouse Gases and Related Measurement Techniques provided recommendations on GHG observations. The Integrated Global Greenhouse Gas Information System Initiative (IG3IS) hosted the second user summit and produced recommendations on urban GHG emissions good practices. WMO also produced, together with UNEP, the 2022 Scientific Assessment of Ozone Depletion report. The Group of Experts on the Scientific Aspects of Marine Environmental Protection's (GESAMP), Working Group 38 on the Atmospheric Inputs to the Ocean, sponsored by WMO, held a workshop on the impacts of atmospheric deposition on ocean productivity in the western Indian Ocean and linked it with the stakeholders' practices by including the attendance local fisheries' mangers. Direct engagement with user community is an important element when providing particular scientific advice to resolve specific environmental problem on a relevant scale. The WMO representative further reflected on the activities related to establishment of the new WMO GHG monitoring infrastructure and its elements. The support to the health and ecosystem sector is provided through the publication of the annual Air Quality and Climate Bulletin and Sand and Dust Bulletin. A new working group on the linkages of air pollution, climate change and health was established. WMO hosted the integrated urban workshop across all WMO activities. Three urban reports were launched in June 2022. It is planned to review guidance on the use of low-cost sensors to monitor air quality in 2024 and TFMM could be associated to this work.

III.   Thematic Session: EMEP Intensive Measurement Period 2022

10.   A representative of CCC presented the Status and first results from the O_3/VOC/SOA EMEP Intensive Measurement Period of 2022. The objective of the campaign was to better understand: (i) why are ozone episode levels typically underpredicted by atmospheric transport models, (ii) how the reductions in NMVOC and NO_x emissions affect the summer episodes, (iii) how EMEP VOC monitoring data could be used, (iv) what is the level of secondary organic aerosol (SOA), especially from biogenic VOCs, during high ozone events. An unprecedented monitoring effort was deployed thanks to the involvement of State Parties, centralised analysis laboratory and financial support from the European Solvent Industry Group. The forecasting of the campaign was conducted in collaboration with the Copernicus Atmosphere Monitoring Service and led to the collection of 4755 datasets for 146 components in 27 stations distributed over 13 countries. The comparison between different monitoring approaches allowed highlighting the metrological challenges in documenting Volatile Organic Compounds. A synthesis is in preparation and will pave the way for further analyses, including by involving modellers to take stock of this vast amount of data.

11. An expert from France presented the activities related to analyzing biogenic tracers and other chemical species in PM during the EMEP campaign. It was highlighted how individual markers of VOC markers, potentially leading to the formation of secondary organic aerosols, could allow identifying the main anthropogenic and biogenic sources of air pollution, also by involving machine-learning decomposition of the sources. The importance of meteorology and the potential future enhancement of such intense heatwaves in the future were also discussed.

12. An expert from Finland presented the centralized analysis of biogenic VOCs and hydrocarbons in passive tube sampling during the campaign. She compared their respective chemical reactivity and pointed out the major role of biogenic VOCs, although indications of anthropogenic volatile chemical products in urban areas were also identified.

13. An expert from France presented the centralized analysis of oxygenated VOCs on the basis of hundreds of samples collected during the campaign. The relative role of propanone and acetaldehyde were discussed as they presented a similar variability to the ozone episode. Field data for glyoxal were also collected which could also be relevant for comparison with satellite observation. The data is now becoming available for public use through the EBAS database.

14. An expert from Germany presented the centralized analysis of canister analysis which were deployed at a less numerous set of sites, but offer a more detailed view in terms of number of VOC species analysed. These data allow for an analysis of the ozone chemical regime depending on the usual framework of comparing ozone production depending on VOC or NO_x mitigation strategies. Using that framework, it was pointed out that for some sites, ozone production might already have attained the low NO_x regime, which was earlier than originally planned.

15. An expert from MSC-West presented how the field campaign data could be used for comparison with modelled results. To achieve this, 11 new VOC species were introduced in the EMEP Chemical Mechanism in addition to the already existing 14 species. The speciation of anthropogenic VOCs in the emission inventories was obtained from the United Kingdom National Inventory. It was concluded that hydrocarbon VOCs were modelled better than Oxygenated VOCs. These results confirmed the relevance of collecting VOC observations in the field to validate models, calling for more systematic and long-term monitoring of VOCs.

16. The session was concluded by a general discussion highlighting the need to consolidate the analysis and initiate a modelling exercise to better answer policy questions such as (i) do biogenic emissions dominate ozone formation processes, (ii) what is the scope of mitigation of anthropogenic VOCs, (iii) what is the relative importance of VOC and methane, (iv) how can monitoring data be used to not only understand formation of secondary pollutants but also track sources and validate emission inventories.

IV. Thematic Session: General Country Updates

17. An expert from the Netherlands presented how the EMEP model and subsequent spatial downscaling with the OPS model could be compared to observations of deposition . They were also integrated in the SHERPA surrogate modelling framework developed by JRC to assess the impact of multiple scenarios in improving nitrogen deposition.

18. An expert from the United Kingdom explained how the EMEP model had been adapted to assess PM mitigation options over India, with a specific focus on particulate chloride. The availability of the generator of chemical mechanisms GenChem provided by MSC-West experts was acknowledged to facilitate the addition of new model species. He also presented a case study to apply the uEMEP over the United Kingdom and generate ozone and NO_2 maps at 50m resolution.

19. An expert from Norway presented how the EMEP model was used by the Copernicus Atmosphere Monitoring Service to better understand air pollution episode and assess the relative importance of local and transboundary air pollution, including natural sources such as desert dust or wildfires.

20. An expert from Italy presented various modelling activities including source apportionment of NO_2 and PM_{10}, refining wood burning emissions in the cooking sector, assessing the degraded visibility attributed to air pollution in national parks, forecasting sea-salt outbreaks and assessing soiling and corrosion of materials over cultural heritage sites.

21. A representative from Spain presented the advances in a BaP modelling intercomparison exercise (Eurodelta-BaP). The progress was impaired by the discontinued communication with MSC-East over the past year, but the work could nevertheless continue on the basis of available results with the GLEMOS, CHIMERE, MINNI and SILAM models. The modelling uncertainties highlighted the sensitivity of gas/particulate partitioning processes, evaluation of deposition fluxes, and the need to revise the spatial distribution of BaP emissions which were overestimated over densely populated areas in Spain.

22. An expert from Poland presented how the EMEP model had been adapted to model BaP concentrations, compare it with measurements and derive associated health impact as part of the European twining project. Ongoing and follow-up work included downscaling at high resolution for $PM_{2.5}$ and in the future for BaP.

23. A representative from Switzerland presented how wet and dry deposition of microplastics could be monitored. The approach highlighted the need to design consistent methods to strengthen the monitoring reliability and potentially inform epidemiological studies in the future.

24. An expert from France presented how the Chemical-Transport model CHIMERE was adapted to also include pesticides. A specific work was required to include volatilization processes during land/surface exchanges. The model could be compared with in-situ data for S-metolachlor exhibiting satisfactory spatial correlation.

V. Thematic Session: Interlinkages between air pollution, climate change and biodiversity

25. An expert from the United Kingdom presented a study aimed at disentangling the factors contributing to long terms changes in peak ozone levels in Europe between 1989 and 2018. He concluded on the need for concerted policy action to reduce baseline ozone transported at hemispheric scale. He pointed out that regional photochemical enhancement had been efficiently reduced in the past, but this decline was slowing down because of the lack of ambition in diesel NO_x emission controls.

26. An expert from Sweden presented a recently finished research project entitled BioDiv-Support which consisted of assessing the relative role of climate change and air pollutant emission reductions on biodiversity in mountain areas in the Scandes, the Pyreneans and the central Spanish mountain system. The added value of very high-resolution climate projections to assess precipitations, and in turn wet deposition, was highlighted. The results were coupled to an ecology model to infer potential shifts of vegetation zones. A decision support online tool was made available to the public.

27. An expert from MSC-West presented a modelling study of the impact of methane and global emission reductions on European surface ozone concentrations relying on future emission projections established by CIAM. He concluded that when comparing 2015 and 2050, it appeared that NO_x and VOC mitigation would give more efficient results than targeting CH_4. But when considering different scenarios for the year 2050, it appeared that CH_4 could bring a comparable benefit to those of either European or Hemispheric emission reductions.

28. A representative from France discussed short- and long-term mitigation strategies for ozone. Ozone trends are widely different when considering various metrics, nevertheless it is possible to put into perspective the approximate order of magnitude for summertime average daily peaks. Over the past 15 years, such peaks have decreased by about $10\mu g/m^3$. Future climate change constitutes a significant risk as a median scenario would increase those peaks by 2 to $6\mu g/m^3$ by 2050. Methane mitigation in line with the global methane pledges could deliver a $6\mu g/m^3$ benefit. And targeting methane as well as other precursors, as in a maximum feasible reduction scenario, could help mitigate $20\mu g/m^3$ of peak ozone. These numbers highlight that none of these factors are negligible and future action should account for a diversity of mitigation options.

29. A representative of the Task Force on Hemispheric Transport of Air Pollution presented the outcome of a recent workshop on methane and source apportionment of ozone. He recalled the main results of a past HTAP assessment demonstrating that future CH_4 increases could potentially offset the benefit of current legislation scenarios, emphasizing the need to engage into maximum feasible emission reductions. Further work is being planned to potentially revisit these estimates in the short term. An innovative source apportionment tagging approach was also introduced.

30. A representative from Spain presented the scientific basis of the Spanish Ozone Mitigation Plan. He presented recent trends and, by pointing out the covid/lockdown years,

he illustrated how shipping was supposed to contribute to ozone levels in Barcelona. He then presented how the VOC speciation in the emission inventories could be compared to field measurement by also considering their respective ozone formation potential.

31. An expert from Spain presented on the modelling strategy to assess ozone abatement scenarios in the framework of the Spanish Ozone Mitigation Plan. The planned emissions scenario was expected to reduce daily exceedances by 37%, mainly through actions in the road and maritime sectors. The project was also an opportunity to further validate the models in their ability to reproduce VOC concentrations.

32. A representative from Spain presented an analysis of the effect of the covid-19 lockdowns on air quality in Spain using either observations corrected from any meteorological factors or air quality models.

VI. Conclusions

33. In the conclusion of the meeting, the Task Force reviewed potential items for the next biannual workplan covering the period 2024-2025. An important focus will be given to the interpretation of the 2022 VOC/SOA EMEP Intensive Measurement Campaign to improve model and measurement, but also to better link with emissions by identifying VOC sources. Modellers of several State Parties already raised their willingness to join a multi-model exercise. Monitoring experts were also committed to taking stock of the campaign's results in order to chart the way forward to reinforce VOC monitoring in EMEP activities. A review will be undertaken to better understand the level of refinement in aerosol modelling in the various groups contributing to TFMM. The Eurodelta-BaP exercise will continue under the leadership of Spain, possibly also better connecting to TF-Health in order to derive potential impacts of BaP exposure. The effect of methane on ozone mitigation at the European scale is also an important topic in the context of the possible revision of the Gothenburg Protocol, and it also raises important scientific challenges in linking spatial and temporal scales. The roadmap for monitoring of Chemical of Emerging Concern will be further consolidated after the workshop scheduled in the autumn of 2023. TFMM will also be invited to contribute to the revision of WMO/GAW guidance on the use of low-cost sensors.

34. Co-chairs of the TFMM, Mr Augustin Colette (France) and Mr Lorenzo Labrador (WMO), closed out the meeting by thanking participants for joining the meeting and gratefully acknowledging the organising institution Institute of Environmental Protection – National Research Institute and Poland for hosting the meeting.