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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

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Item 12 (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 in 2020 and future work: measurements and modelling

Measurements and modelling

Report of the Task Force on Measurements and Modelling on its twenty-first 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 2020–2021 workplan for the implementation of the Convention on Long-range Transboundary Air Pollution (ECE/EB.AIR/144/Add.2), and in line with the revised mandate of the Task Force (Executive Body decision 2019/8.[1] The present report summarizes the discussion at and the outcomes of the Task Force's twenty-first meeting (online, 11–13 May 2020).

[1] Available at www.unece.org/env/lrtap/executivebody/eb_decision.html.

I. Introduction

1. The present report contains the outcome of the twenty-first meeting of the Task Force on Measurements and Modelling (online, 11–13 May 2020), including the presentation of activities undertaken since its previous meeting (Madrid, 7–9 May 2019). It describes progress in 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)[2] and in 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, 80 experts from the following Parties to the Convention attended the meeting: Austria; Canada; Croatia; Czechia; Denmark; France; Germany; Hungary; Italy; Netherlands; Norway; Poland; Russian Federation; Slovakia; Spain; Sweden; Switzerland; United Kingdom of Great Britain and Northern Ireland; and United States of America. Also present were representatives from: four EMEP centres – the Chemical Coordinating Centre, the Meteorological Synthesizing Centre-East, the Meteorological Synthesizing Centre-West and 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. Mr. Augustin Colette (France) and Ms. Oksana Tarasova (WMO) co-chaired the meeting. They presented the agenda, highlighted the progress on the 2020–2021 workplan for the implementation of the Convention on Long-range Transboundary Air Pollution, (ECE/EB.AIR/144/Add.2) outlined the expected input from the Task Force to the review of the Protocol to Abate Acidification, Eutrophication and Ground-level Ozone (Gothenburg Protocol), as amended in 2012 (Executive Body decision 2019/4) and to the update of the revised strategy for EMEP for 2010-2019[3], involvement of Parties and broader international community in coronavirus disease (COVID-19)-related studies, as well as further planning of the activities for the second year under the 2020–2021 workplan, which was subsequently discussed during the meeting.

4. The Chair of the EMEP Steering Body provided an update on the Convention and EMEP activities. She presented the outcomes of the fortieth anniversary of the Convention that had been celebrated during the thirty-ninth session of the Executive Body (Geneva, 9–13 December 2019) and the Draft Declaration on Clean Air for 2020–2030 and beyond (ECE/EB.AIR/2019/6). She updated the meeting on the launch of the forum for international cooperation on air pollution, which aimed to provide a shared response to help address the threat to human health and ecosystems from air pollution. She stressed the need to prioritize support for the Gothenburg Protocol review process and described a new steering structure for the Task Force on Hemispheric Transport of Air Pollution. She mentioned that the issue of condensables in particulate matter (PM) was considered a priority for the Executive Body, especially from the perspective of the Gothenburg Protocol review process. The Executive Body was considering the possibility of basing the modelling in support of the Convention on gap-filled emission inventories using a “science-based” approach that included condensable PM in the residential sector, provided that such an approach was documented and assessed for and by the Parties. She mentioned that the revised strategy for EMEP for 2010–2019 and the revised long-term strategy of the effects-oriented activities[4] should be revised for the period 2020–2029. They would be merged into a single document to highlight linkages and facilitate development of joint

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[2] Available at www.unece.org/env/lrtap/executivebody/eb_decision.html.

[3] Available at http://www.unece.org/fileadmin/DAM/env/documents/2012/EB/Informal_document_no_20_Revised_Strategy_for_EMEP_for_2010-2019_clean_text.pdf.

[4] Available at www.unece.org/fileadmin/DAM/env/documents/2012/EB/Informal_document_no_18_Revised_Long-term_Strategy_of_the_effects-oriented_activities_clean_text.pdf.

actions. The draft document would be discussed at the sixth joint session of the EMEP Steering Body and the Working Group on Effects (Geneva, 14–18 September 2020) and was expected to be adopted by the Executive Body at its fortieth session (Geneva, 17 and 18 December 2020).

II. Modelling activities

5. A representative of the Meteorological Synthesizing Centre-West described the development of the EMEP model, with a particular focus on elemental carbon (EC) verification. The EMEP model had been evaluated utilizing data from the EMEP/Aerosols, Clouds, and Trace gases Research InfraStructure Network (ACTRIS)/Chemical On-Line cOmpoSition and Source Apportionment of fine aerosoL (COLOSSAL) Intensive Measurement Period winter 2017/18. The model simulations had been conducted using the elemental carbon (EC) emissions reported by 38 Parties for 2017. That comparison demonstrated that EMEP EC emissions were low in winter, or possibly that the spatial distributions were erroneous, but the ratio of biomass burning to fossil fuel emissions in EMEP EC was quite satisfactory. It was noted that correct spatial distribution/gridding was extremely important. A new method called “Local fractions” implemented in the EMEP model by the Meteorological Synthesizing Centre-West provided detailed source maps for any point. Several new features had been implemented:

(a) Tracking sources from far away (fine resolution in a large surrounding region, coarser resolution further away);

(b) A source could be defined as a country and many countries could be tracked simultaneously in a single model simulation; and

(c) Sulphur dioxide/sulphate (SO_2/SO_4) chemistry. EMEP-Meteorological Synthesizing Centre-West model calculations for the current year would be based on gap-filled emission inventories using a “science based” approach that included condensable PM in the residential sector. The model evaluation report would be replaced by a model evaluation web interface to the extent possible.

6. Another representative of the Meteorological Synthesizing Centre-West described the development of the EMEP model with a particular focus on spatial downscaling. Starting from EMEP chemical transport model calculations over Europe at 15 x 15 km^2, urban EMEP (uEMEP) had further refined the concentration maps up to 25m resolution. Model validation demonstrated that downscaled nitrogen oxide (NO_2) and fine particulate matter ($PM_{2.5}$) concentrations were generally notably improved. Spatial correlation was always significantly improved with downscaling. Generally, the bias in EMEP was reduced by 1/3 to 1/2 when downscaling to 250 m, and by 1/2 to 2/3 when downscaling to 25 m. All results relied heavily on regional emission data sets. Downscaling had an extremely important impact for exposure and health impact calculations. Increased exposure to $PM_{2.5}$ had been calculated when downscaling from 15 km to 250 m. That ranged from a 5 to 40 per cent increase in population attributable fraction that reflected health outcomes such as “years of life lost” or “premature deaths”.

7. A representative of the Meteorological Synthesizing Centre-East described national-scale case studies on heavy metals. He described the evaluation of heavy metal (lead: Pb, cadmium: Cd, and mercury: Hg) pollution on a country scale for Germany. He highlighted significant contribution of global sources and transboundary transport for Hg, with seasonality characterized by the maximum in summer and minimum in winter. For Pb, significant contribution was made by national emission sources and resuspension. Pb concentrations exhibited distinct seasonality, with maximum in winter and minimum in summer (opposite to Hg). Fine resolution modelling on a country scale provided detailed patterns of heavy metal pollution and reasonably reproduced background EMEP measurements. The national monitoring network had provided significantly improved coverage of heavy metal observational data in the country and additional information for evaluation of the modelling results. The refined national emission inventory for heavy metals favoured general improvement of the model assessment and led to better agreement

with observations. The modelling results based on emission scenarios indicated possible overestimation of emissions in some provinces of the country.

8. Another representative of the Meteorological Synthesizing Centre-East gave an overview of progress in persistent organic pollutant modelling in the EMEP domain. He recalled that the largest contribution to total toxicity of 16 polycyclic aromatic hydrocarbons (PAHs) was made by dibenzo(a,h)anthracene (D(ah)A), benzo(b)fluoranthene (B(b)F) and benzo(a)pyrene (B(a)P), and that defined the focus of the modelling. Long-term changes of modelled B(a)P concentrations generally agreed with measurements at EMEP monitoring sites. Modelling results and measurements did not indicate significant decrease of B(a)P air concentrations. Efforts to improve B(a)P pollution assessment included multimodel study in Spain and France and analysis and improvement of B(a)P emissions from key sectors (agriculture, domestic heating). A new case study had been initiated for Poland. New process description/parameterizations had also been introduced in the model.

9. An expert from the Centre for Integrated Assessment Modelling described the utilization of the Greenhouse Gas Air Pollution Interactions and Synergies model for source contributions to ambient $PM_{2.5}$, with focus on Asia. A combination of traditional transfer coefficients with grid-to-grid tracking allowed for improved ambient PM source apportionment in the model. He noted that expected sources like brick kilns provided much less contribution than initially thought for regional air pollution. In India, there were multiple contributions from burning of traditional fuels and waste. The study concluded that about half of the PM mass was missed when only primary $PM_{2.5}$ was taken into consideration. Improved inventories of ammonia emissions were required to improve knowledge of secondary aerosol formation in India.

III. Monitoring activities and monitoring methods

10. A representative of the Chemical Coordinating Centre presented an update on the Centre’s work, with focus on improvements and developments regarding data submission, storage and dissemination, quality assurance activity, use of EMEP data and work on source allocation. The Centre was working on improved data traceability and data correction through the improved web interface. The improved data curation tools and routines allowed for improved testing of spikes in the records (outlier check), flag consistency, metadata and version tracking. Some delays had been noted with data submission, and special data collection had been organized for the COVID-19 pandemic period. The Centre was working on digital object identifier implementation. The representative described the results of the annual intercalibration of heavy metals and inorganic components, with most laboratories performing within agreed data quality objectives. The Centre provided online training opportunities. EMEP data were widely used by the community, with about 300,000 annual data sets accessed every year. The Centre was involved in an increasing number of studies related to source apportionment, which helped to improve/evaluate both emissions and model parameterization – especially for organic aerosols.

11. Another representative of the Chemical Coordinating Centre presented an update on the measurements of contaminants of emerging concern, which were increasing in number, and represented complex mixtures that were very mobile and that found their way to the environment and humans. The Norwegian Institute for Air Research (the Centre’s host) had developed new analytical equipment that allowed for measurement of two-dimensional chromatograms to perform non-target screening and suspect characterization of organic contaminants in Arctic air. The methodology had been published in the peer-review literature. The representative noted that further method development was necessary and that new methods could not replace target methods. He also recommended that digital sample freezing be used at all monitoring stations as of the current time to allow for future analysis. Further international collaboration should be fostered on the topic, for instance by liaising between EMEP and the Network of reference laboratories, research centres and related organizations for monitoring of emerging environmental substances (NORMAN network).

12. An expert from Norway presented a long-term experience of monitoring of emerging chemicals in Norway. The monitoring had begun in 2013 and was currently at the second stage. The non-target screening performed at Mount Zeppelin (on the Svalbard Archipelago, Norway) demonstrated that samples contained only a small portion of regulated persistent organic pollutants and high concentrations of the new compounds. Source attribution represented a challenge, as constituents detected in the Arctic were brought there by long- range transport but there were also local sources (in particular from indoor air pollutants). She stressed that passive air sampling campaigns were a useful tool for identifying contaminants of emerging concern and were important for EMEP. She also recalled that the earlier sampling was initiated the better, although it required guidance and intercalibration to ensure comparable data.

13. An expert from France presented the evolution of the measurement programme and quality assurance of the EMEP French monitoring network. She described the measurement programme at 12 operational sites. The PM monitors had been substituted by optical spectrometers and focused analysis had been performed on the multiannual chemical composition of $PM_{2.5}$. Substantial differences had been found between the sites with dominant organic aerosol contribution at the south and non-organic contributions at the north. The main drivers of $PM_{2.5}$ chemical composition changes were the variability of sources and transport of air masses and meteorological conditions. Additional focus was on the oxygenated volatile organic compounds (VOCs) measured with the online analyser and organic part of PM. Ammonia was an important precursor of secondary organic aerosols and was measured with online analysers with high temporal resolution at 5 sites.

IV. Thematic session on ozone

14. A representative of Spain presented an analysis of ozone episodes formation in Barcelona, Spain. It was based on the results of measurement campaigns conducted in areas of high ozone. There was a combination of chemical and dynamical processes that contributed to the episodes with the formation of multi-layered structure. Precursors of agriculture-related biomass burning produced ozone in the midday, while the other source was associated with the plume of a petrochemical plant in Huelva, Spain. Modelling analysis further demonstrated that both local and regional contributions of ozone might be very relevant in the pollution episodes. The study also demonstrated that agricultural biomass burning emissions were not fully reflected in emission databases. Detailed analysis of precursors demonstrated that some critical VOCs responsible for ozone production were not reported, leading to the fact that the inventory did not adequately reflect the current atmospheric mixture of VOC species.

15. Another representative of Spain presented an analysis of the impact of decreasing emissions of nitrogen oxides on ozone. Using a modelling framework, the contribution of different processes in ozone formation had been studied. She demonstrated that reduction of nitrogen oxides (NO_x) could have different impacts on ozone concentration depending on the time of day and NO_x levels. The net effect also depended on the choice of ozone metric. Maximum hourly ozone benefited the most from the reduction of NO_x emissions, whereas the annual mean was the metric most affected by NO_x titration. Studies were ongoing to see potential effects of methane on ozone using two different chemical mechanisms. A sensitivity test of the contribution from methane demonstrated impact on O_3 levels in summer.

16. An expert from France presented an analysis of the global scale methane abatements and their impacts on regional ozone. Several global methane emission trajectories were evaluated and the impact on different ozone metrics was evaluated. For all scenarios, a positive trend was calculated for all ozone indicators. In the discussion that followed, the need to look at the role of methane in future ozone levels in Europe for a range of metrics, including peak values, was stressed. Whereas global models generally assessed methane impact on average ozone levels (as done, for instance, in the activities of the Task Force on Hemispheric Transport of Air Pollution), those findings underlined that methane was also very important for ozone hot spots.

V. Thematic session on carbonaceous aerosols

17. A representative of the Chemical Coordinating Centre gave a presentation on the results from the 2017/18 winter field campaign. The estimates of BC obtained using Positive Matrix Factorization (PMF) methodology and the Aethalometer model were presented for different measurement sites. The main focus was on the separation of fossil fuel and biomass fractions. Analysis demonstrated that diurnal patterns were found close to roads or urban sites, while at the background sites less of a diurnal cycle was present. For all sites analysed by PMF for two factors data were currently available. Aethalometer model source apportionment had also been done for those sites. PMF yielded information on both the time series and the Ångström exponents compared favourably to the Aethalometer model, which needed a priori Ångströms. PMF produced quite different splits between fossil fuel and biomass burning contributions from the Aethalometer model (though uncertainty was very high in the Aethalometer model). A collaboration with the modelling community was foreseen at the next step, as well as considerations for advanced analysis using three factor solutions, combined site PMF and longer time series for seasonal variability.

18. The Co-Chair of the Task Force presented an overview of a new model intercomparison exercise entitled EuroDelta-Carb and organized jointly by EMEP/the Task Force and the Copernicus Atmosphere Monitoring Service, devoted to the 2017/18 winter field campaign. Fourteen models had been registered for participation in the exercise. The scope was to test: the model performance including or excluding condensables in PM; and the Convention-reported BC emission inventories. The first results demonstrated substantial discrepancies in the reported emissions. Sharp gradients were simulated between the countries, which did not look realistic and indicated different strategies in emission reporting. Inclusion of condensables led to an increase in simulated $PM_{2.5}$ levels in most countries and improved model performance by reducing bias by 18 per cent on average over Europe and up to 50 per cent over some countries. More detailed analysis was planned for the next steps of comparison.

19. An expert from the Netherlands presented an in-depth assessment of Copernicus Atmospheric Monitoring Services regional forecasting. Specific attention in the assessment had been paid to episodes with high air pollution, including high ozone in Southern and Central Europe (due to meteorological conditions and/or stagnant high pressure systems), dust aerosol contribution in Southern Europe, PM episodes in late winter/early spring in Central Europe (due to agricultural ammonia emissions) and PM and nitrogen dioxide episodes in winter (due to stagnant air, inversions and enhanced use of wood burning for residential heating). The presentation was partly based on a preliminary analysis of the EuroDelta-Carb model intercomparison. The first results demonstrated that Eastern Europe had strongly underestimated $PM_{2.5}$ in winter due to missing contribution from the residential wood combustion and from not reporting condensables. Inclusion of condensables led to increased simulated levels of $PM_{2.5}$ and particles with an aerodynamic diameter equal to or less than 10 micrometres (PM_{10}). Winter underestimation of PM would be studied in more detail and the observational data from the EMEP winter campaign would be used for comparison with modelled EC (and its biomass burning and fossil fuel fractions).

20. An expert from the Meteorological Synthesizing Centre-West presented the findings from a workshop on condensable organics held under the auspices of the Nordic Council of Ministers (online, 17–19 March 2020). He stressed the differences in emission reporting between countries. The issue with the condensables was that different emission factors were used inconsistently by various countries and did not reflect the multiple processes that occurred within the emission plume. The workshop concluded that the current situation was untenable and unfair, as inventory by countries was incompatible and produced very different PM emissions in national reporting. The workshop confirmed the importance of condensables and agreed that residential wood combustion was a priority source, but that it was also important to reflect on other sources that might prove to be important. Assumptions behind national emissions were not documented, and methods could change from year to year. The workshop participants agreed that condensables should be included

in future emission inventories and modelling, although it was not obvious how they should be included. As an alternative, using gap-filled emission inventories based on a consistent science-based approach that included condensable PM in the residential sector was a good first no-regret step for describing condensable emissions from residential wood combustion in emission dispersion modelling. It needed to be further documented and evaluated against national emission and International Institute for Applied Systems Analysis estimates. The need for more detailed emission reporting should be communicated clearly to Parties. That could, for example, entail requests for types of wood stoves or exhaust standards on road transport. The issue was difficult and made policymaking even more complicated.

21. An expert from Italy presented an analysis of biomass burning contribution to PM_{10} in southern Italy. PMF with nine factors and macrotracer based on Levoglucosan concentrations had been used for analysis. Twenty-nine parameters had been quantified in 24-hourly samples of PM_{10}. The PMF/macrotracer approach had resulted in good agreement, as confirmed by the correlation coefficient (to 0.85) and the slope close to 1. The good agreement of the two methods had allowed for the exclusion of an underestimation of the biomass burning contribution in the macrotracer approach due to Levoglucosan degradation. The integrated use of those two independent methods had allowed for a robust quantification of biomass burning contribution to PM. Biomass burning had been confirmed as one of the most significant sources of PM_{10} in the study area, with an average contribution of slightly less than 30 per cent, a maximum of 50 per cent and a minimum of 10 per cent.

22. An expert from Switzerland presented a European overview of source apportionment of organic aerosol. He articulated the limitations of the traditional PMF approach and proposed a rolling PMF approach. The first results of source apportionment using that methodology from eight sites were presented. Oxygenated organic aerosol represented the largest contributor over Europe. Biomass burning was a considerable source in most of the stations, especially during the cold period. Further analysis would allow for provision of a comprehensive overview of the temporal/spatial variabilities of the organic aerosol sources in Europe and determine the origin of long-range transported aerosols.

VI. General country updates

23. A representative of the United Kingdom of Great Britain and Northern Ireland presented a study dedicated to the analysis of ammonia in South Asia. The EMEP model had been used to simulate PM in India. The higher resolution model was capable of reproducing hot spots; for example, it could reproduce magnitude and time of aerosol peaks in evaluation with hourly data in New Delhi. Model limitations were related to the use of the emissions from 2010, and they were required with a higher resolution. Simulations demonstrated that a 100 per cent reduction in ammonia anthropogenic emissions would lead to up to a 10 per cent reduction of $PM_{2.5}$ in New Delhi. The simulations showed that primary $PM_{2.5}$ was a large proportion of the total $PM_{2.5}$ in New Delhi. In terms of policy, primary emissions seemed to be the dominant fraction that had an impact on $PM_{2.5}$ concentration levels.

24. A representative of WMO gave an update on recent developments within WMO and its Global Atmosphere Watch Programme. She described the process of reform of the constituent bodies that had begun in June 2019 and the process of the Programme’s alignment with the new WMO organization. She described: the task of the new technical commissions and the research board; the organization of the Global Atmosphere Watch Programme infrastructure-related activities; the strengthening of the science focus and partnership in the Scientific Advisory Groups and Science-for-Services initiatives – the Integrated Global Greenhouse Gas Information System, the Measurement–Model Fusion for Global Total Atmospheric Deposition and the Global Air Quality Forecasting and

Information System; and cooperation with the Commission on Services on the topics of integrated urban and integrated health services.[5]

25. An expert from Canada gave a presentation on the WMO Measurement–Model Fusion for Global Total Atmospheric Deposition initiative. She described the impacts of atmospheric deposition with focus on ozone and nitrogen. The initiative had started by comparing global measurements with model results of atmospheric deposition. The Measurement-Model Fusion approach brought together the best available data and modelling results on precipitation chemistry, precipitation depth, air concentrations and dry deposition velocities to estimate wet, dry and total deposition. Regional deposition maps from North America and Sweden using that approach were shown, and the way forward of the initiative was presented. The initiative would pay particular attention to consistency between regional and global fused maps.

VII. Planning of activities within the workplan for 2020–2021

26. The Co-Chairs summarized the discussion held during the meeting in relation to the future activities under the workplan for 2020–2021. Continued efforts would be made regarding the model intercomparison exercise (EuroDelta-Carb) in collaboration with the Copernicus Atmosphere Monitoring Service to take stock of the EMEP/ACTRIS/COLOSSAL winter 2017/18 field campaign (see paras. 5, 18 and 19 above). The focus of the model intercomparison was mainly on carbonaceous aerosol but B(a)P was also an important topic in relation to residential emissions. That work would also build support for the need to improve the reporting and representation of condensables in collaboration with the Task Force on Emission Inventories and Projections (see para. 20 above); strengthening bilateral collaboration between Parties and modelling centres (investigation of emission spatialization for the main pollutants in Poland (see para. 8 above) and heavy metal case studies in Germany (see para. 7 above)). The following new topics were identified: ozone studies in the context of the connection between the scales were identified as a critical element for review of the Gothenburg Protocol; monitoring, emission reporting and modelling of VOCs was becoming increasing important as NO_x started to decrease (as well as in the context of understanding condensables); consolidated efforts should be made to understand the effects of pandemic lockdown measures on air quality and comparison of the effect with the long-term Convention efforts (a dedicated publication and a session during the next meeting of the Task Force on Measurements and Modelling would be planned following a proposal formulated by the Chemical Coordinating Centre); and the need to pay more attention to contaminants of emerging concern and the processes leading to resuspension of heavy metals.

[5] See https://public.wmo.int/en/governance-reform/services-commission.