United Nations ECE/EB.AIR/GE.1/2019/4–ECE/EB.AIR/WG.1/2019/16

Economic and Social Council

Distr.: General
1 July 2019

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

Fifth joint session
Geneva, 9–13 September 2019
Item 3 (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 2019 and future work: measurements and modelling

Measurements and modelling

Report of the Task Force on Measurements and Modelling on its twentieth 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 2018–2019 workplan for the implementation of the Convention on Long-range Transboundary Air Pollution (ECE/EB.AIR/140/Add.1, items 1.1.1.1–1.1.1.4, 1.1.1.7, 1.1.2.1, 1.1.2.2, 1.1.3.2, 1.1.4.1, 1.2.1, 1.3.2 and 1.4.2), and activities set out in the document entitled "Revised mandates for the task forces under the Working Group on Strategies and Review and under the Steering Body to EMEP" (ECE/EB.AIR/2018/5), submitted to the Executive Body for the Convention at its thirty-eighth session (Geneva, Switzerland, 10–14 December 2018). The present report summarizes the discussion at and the outcomes of the Task Force's twentieth meeting (Madrid, 7–9 May 2019).

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I. Introduction

1. This report presents the outcome of the twentieth meeting of the Task Force on Measurements and Modelling (Madrid, 7–9 May 2019), including the presentation of activities undertaken since the previous Task Force meeting (Geneva, Switzerland, 2–4 May 2018). It describes progress in implementation of the current monitoring strategy of the Cooperative Programme for Monitoring and Evaluation of the Long-range Transmission of Air Pollutants in Europe (EMEP) (ECE/EB.AIR/2009/15), in its revision, 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.

2. In all, sixty-six experts from the following Parties to the Convention attended the meeting: Austria, Belarus, Belgium, Croatia, Cyprus, Czechia, Denmark, Estonia, France, Germany, Hungary, Italy, Latvia, Malta, Netherlands, Norway, Poland, Russian Federation, Slovakia, Spain, Sweden, Switzerland and United Kingdom of Great Britain and Northern Ireland. 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 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 activities carried out since the previous meeting, outlined the ongoing evolution of EMEP and drew attention to the Task Force's mandate and key elements of the workplan for 2018–2019, as well as the possible scope of the 2020–2021 workplan, which was subsequently discussed during the meeting.

4. The meeting was hosted by the Spanish Ministry of Ecological Transition. It was opened by Ms. Maj-Britt Larka Abellán, of the General Subdirectorate of Air Quality and Industrial Environment, who gave an overview of the activities of Spain with regard to air quality management, highlighting the significant involvement of Spain within the various bodies of the Convention. She discussed the achievements and challenges in meeting the objectives of the amended Protocol to Abate Acidification, Eutrophication and Ground-level Ozone (Gothenburg Protocol).

5. The Chair of the EMEP Steering Body provided an update on the Convention and EMEP activities. She highlighted the items of relevance to the Task Force on Measurements and Modelling in the Long-term strategy for the Convention on Long-range Transboundary Air Pollution for 2020−2030 and beyond (Executive Body decision 2018/5). She stressed the following issues in particular: ozone and its impacts on vegetation; nitrogen cycle; particulate matter and its impact on health; heavy metals and persistent organic pollutants; linkages between the geographical scales from urban to global (regional being at the intersection of both); and linkages of air pollution with climate change and biodiversity. The proposed mandate of the Task Force on Measurements and Modelling had been provisionally adopted by the Executive Body at its thirty-eighth session, pending minor editing before final adoption. The preparation of the forthcoming revision of the Gothenburg Protocol would be an important focus of the next biannual workplan, and the contribution of the Task Force was pending, especially on black carbon and condensables, spatial scales linkages and connections with the effect community (including health and ecosystems, but also biodiversity and climate). The recent work of the Task Force on trends would be of particular relevance for the review of policy efficiencies in the recent past. The Executive Body had given EMEP a mandate to propose a relevant and scientific approach to dealing with condensables in particulate matter, both in terms of emissions and modelling. The condensables should be taken into account in the national emission inventories used for modelling and assessment but the impact on compliance issues within the Gothenburg Protocol remained to be further investigated.

II. Modelling activities

6. Two representatives of the Meteorological Synthesizing Centre-West described the development of the EMEP model. The focus was on the use of 0.1 x 0.1 longitude-latitude degree resolution emission inventories submitted by Parties. A benefit in terms of model performance at both EMEP and urban monitoring stations had been found in most countries where high resolution emissions had been reported, in particular for nitrogen dioxide (NO_2) and ozone. There were exceptions for Bulgaria, Greece, Italy, Norway and Poland. Representatives of Italy and Poland agreed to liaise bilaterally with the Meteorological Synthesizing Centre-West to investigate further those differences. The impact of model resolution on source-receptor calculations was also presented, as well as a new tool for visualizing the contribution of long-range transported pollution (with the initial focus being on NO_2) to the observed pollution trend over the period 2000–2016 (available on the Meteorological Synthesizing Centre-West website).[1] The tool could, in the long term, replace the country factsheets. A successful training course on the EMEP Meteorological Synthesizing Centre-West model had been run in April 2019, involving 24 participants from Austria, China, Croatia, the European Commission Joint Research Centre, France, Germany, India, Malta, Norway, the Russian Federation and the United Kingdom of Great Britain and Northern Ireland. Recent developments regarding the model were also presented in relation to particulate matter thermodynamics and soil/atmosphere ammonia flux calculations.

7. A representative of the Meteorological Synthesizing Centre-East described recent developments in heavy metals modelling. For mercury, a new photo-reduction degradation mechanism had been introduced in the multimedia model that produced operational deposition and concentration maps. The results of an assessment of cadmium and lead modelling in Germany for 2014–2016 illustrated different performances when using various emission inventories concerning the spatial distribution for the three main heavy metals and agreement with the observations. Work was ongoing in collaboration with the Working Group on Effects to better represent the toxicity of particulate matter enriched with heavy metals and the effect of heavy metals on water ecosystems.

8. Another representative of the Meteorological Synthesizing Centre-East gave an overview of progress in persistent organic pollutant modelling in the EMEP domain. The discussion focused on benzo(a)pyrene (BaP) modelling, emphasizing the importance of processes such as gas-particle partitioning, degradation in gaseous phase, degradation due to heterogeneous reaction with ozone, nitrate and hydroxyl radicals and surface-atmosphere exchanges. The representative of France presented a comparison with BaP modelling in Europe. It would be followed up by national case studies involving Croatia and Poland and also by the participation of the Meteorological Synthesizing Centre-East in the model intercomparison being discussed for the winter field campaign.

III. Monitoring activities, including the revision of the monitoring strategy

9. A representative of the Chemical Coordinating Centre presented the outcome of the consultation on the revision of the EMEP monitoring strategy initiated in 2018. A proposal for the revision of the EMEP monitoring strategy had been circulated to the Task Force in advance of its nineteenth meeting (Geneva, Switzerland, 2–4 May 2018), allowing for a discussion during the previous meeting, at which it had been agreed that no major revision was expected, therefore excluding the option of organizing a dedicated workshop on the issue. Instead, national representatives had been encouraged to provide feedback in writing. A consolidated revision had thus been presented to the EMEP Steering Body in September 2018 and had brought marginal changes since then, accounting for the comments received in the interim. The technical specifications of the measurement programme had been agreed on, and a version that included all proposed changes had been made available on the Chemical Coordinating Centre website.[2] A number of national representatives present had expressed

[1] See www.emep.int/mscw.
[2] See https://projects.nilu.no//ccc/monitoring_strategy/index.html.

the need to further improve the text of the monitoring strategy in order to strengthen the language used therein. A drafting team had been set up to work on a revised draft to be submitted to the EMEP Bureau prior to its submission to the Steering Body in September 2019. The drafting team had accomplished its work within two weeks after the Task Force meeting.

10. A representative of the European Environment Agency spoke about the linkages between the EMEP monitoring strategy and the obligations of European Union Member States under the European Union Air Quality Directive.[3] There were substantial overlaps in the monitoring programmes and synergies to be sought between the Directive and EMEP, which shared several objectives and monitoring requirements. The Air Quality Directive directly referred to the need for coordination of work with EMEP.

11. A representative of the Chemical Coordinating Centre presented recent developments in the monitoring of persistent organic pollutants, including the required adaptation to new substances (contaminants of emerging concern), for example, through the use of non-target screening and liaison with a network of reference laboratories for the new substances.

12. An expert from Spain presented Global Harmonized Observational Surface Treatment; a new piece of database software designed to bring together observations from a wide range of networks worldwide, facilitate comparison with models by including additional metadata and homogenize quality checks.

IV. Thematic session on carbonaceous aerosols

13. A representative of the Chemical Coordinating Centre gave an overview of the joint EMEP/Aerosols, Clouds and Trace gases Research Infrastructure Network/Chemical On-Line cOmpoSition and Source Apportionment of fine aerosoL winter 2017/2018 field campaign. The focus had been on improving the characterization of fossil fuel and biomass burning contributions to observed black carbon concentrations throughout Europe. Reports of Parties' involvement had been encouraging, with 24 contributing countries and 59 sites, with a slight bias towards more urban sites. The vast database compiled was being used to reduce uncertainties in the assessment of the biomass burning fraction of black carbon, either using direct aethalometer observations (wavelength dependence of the absorption) or positive matrix factorizations, although the two approaches gave different outcome. The reasons for disagreement for specific locations would be further analysed.

14. An expert from Spain presented the European Cooperation in Science and Technology Action CA16109 Chemical On-Line cOmpoSition and Source Apportionment of fine aerosol, which consisted of an exchange of knowledge on source apportionment practices based on aerosol measurement by aethalometers or Aerosol Chemical Speciation Monitors. To date, the Action had only produced the data for the campaigns, but the aim was to deliver longer data sets. One of the elements of the Action was capacity development, which was done through schools, short duration scientific missions for the scientist exchange (29 grants awarded to date) and conference grants.

15. A representative of Estonia presented the results of a field campaign devoted to assessing the contribution of residential wood burning to black carbon air pollution, also including modelling work using a high-resolution inventory, modulated in time with high frequency observations. New instruments had been used to analyse filters with a high black carbon load. The contribution from the waste burning had been identified. Black carbon observations, ambient temperature and chimney temperature had been used to constrain the emissions. The condensable fraction would be included in the emission inventory in the future.

16. An expert from the Meteorological Synthesizing Centre-West presented the current status of secondary organic aerosol modelling. It was currently quite clear that organic aerosol formation was dominated by biogenic sources in summer and residential wood

[3] Directive 2008/50/EC of the European Parliament and of the Council of 21 May 2008 on ambient air quality and cleaner air for Europe, *Official Journal of the European Union*, L 152, 2008, pp. 1–44.

burning in winter, whereas a mix occurred during transition seasons. There were several models currently available in the literature that gave satisfactory performances, but the main source of uncertainty now resided in emission factors, which had not been homogenized in the EMEP reporting, pointing to a need for more guidance on the topic from the Task Force on Emission Inventories and Projections. A workshop involving key experts on the topics was scheduled for the autumn of 2019, but until homogenization was achieved, modellers favoured the option of using expert estimates of emissions.

17. A representative of France presented a recent development in secondary organic aerosol and wood burning tracer modelling, introducing new models and addressing the issue of how to better constrain emission inventories in terms of volatile organic compounds (VOCs), including their intermediate volatility fraction. The model demonstrated good results for the areas with strong biogenic emissions but underestimated concentrations for areas with strong anthropogenic emissions. The source of VOCs related to transport sector and solvents were considered to improve the agreement between simulated and observed secondary organic aerosols.

18. An expert from the Netherlands presented black carbon modelling results for Germany illustrating how model tagging could help diagnose deficiencies by comparison with observations. Tests performed with different black carbon emission inventories clearly illustrated the importance of and uncertainties related to residential wood burning emissions. Based on the work, Germany had made adjustments to the black carbon emission inventory and had carried out redistribution to the different sources, with a substantial shift to residential combustion emissions. With the new inventory, the agreement between modelling and observations was better at the urban sites and still showed a strong underestimate at rural sites. Comparisons to source speciated aethalometer data collected at a station in Berlin and observations from the 2017/2018 winter field campaign had been considered as a part of the work.

19. The Co-Chair of the Task Force presented a proposal for a new model intercomparison exercise entitled Eurodelta-Carb, devoted to the 2017/2018 winter field campaign. The main focus would be on the modelling of carbonaceous aerosols: black carbon and secondary organic aerosols. It was expected that the campaign would enable a better understanding of the relative contribution of fossil fuel and wood burning in the total aerosol concentration. The modelling exercise would be carried out jointly with the Copernicus Atmosphere Monitoring Service, which was also interested in modelling those fractions of elemental carbon. The exercise was also a good opportunity to liaise with the other bodies of the Convention, in particular the Task Force on Emission Inventories and Projections, on the issues of condensable reporting and validation of black carbon emission inventories. There was also scope for cooperation on the climate impact of black carbon through a better representation of its radiative properties in models. In addition to carbonaceous aerosol, it was proposed to also include BaP modelling in the scope of the exercise to strengthen collaboration with the Meteorological Synthesizing Centre-East. A workshop would be organized in the autumn of 2019 to further elaborate the experimental plan of the Eurodelta-Carb model intercomparison project.

V. Thematic session on long-range transport and urban air pollution

20. An expert from the Centre for Integrated Assessment Modelling described the global extension of the Greenhouse Gas-Air Pollution Interactions and Synergies model, which relied on additional source receptor calculation for particulate matter performed by the Meteorological Synthesizing Centre-West at the global scale, whereas the approach for the European domain version had not changed. The urban increment of primary and secondary particulate matter was discussed for various cities around the world. Such assessment was currently available for thousands of cities across the world and pointed to the fact that urban low-level emissions were generally responsible for less than 30 per cent of total fine particulate matter ($PM_{2.5}$) exposure.

21. An expert from the Meteorological Synthesizing Centre-West presented a downscaling technique for modelling nitrogen dioxides and particulate matter at very high resolution, keeping track of the local/non-local contribution to air pollution by using EMEP source-receptor matrices with subsequent spatial downscaling within the grid. The model was currently being used operationally in air quality forecasts.[4] The model could also be used in assessment mode, in particular to compare how population exposure estimates differed when increasing the model spatial resolution. Those differences could be important when calculating compliance with World Health Organization health regulations (for example, number of non-compliance days).

22. A representative of Spain presented the modelling work performed to assess the impact of the Spanish National Air Pollution Control Programme on air pollution levels. Compliance was expected to be achieved for particulate matters and NO_2, but exceedances would remain for ozone. The importance of VOC emission due to the use of solvent in the residential sector was pointed out, as well as the contribution of long-range transport for ozone background levels.

23. An expert from Spain presented the twin site methodology for assessing the local/non-local contribution of air pollution to urban air from observation and providing information on the main activity sectors. The approach relied on incremental decomposition (the so-called Lenschow approach) applied to the positive matrix factorization decomposition of fine chemical characterization of aerosols. It had been applied to observations at paired or tripled sites in France, Germany, the Netherlands, Spain and Switzerland. Overall, the urban increment ranged from 18 to 35 per cent, highlighting the substantial contribution of long-range air pollution even in urban areas.

24. An expert from Germany presented a method for tagging the various sources contributing to ozone at the global and European levels, putting those results into perspective with regard to the Task Force on Hemispheric Transport of Air Pollutants findings. Proximity sources had been found to be more important for high ozone concentrations in Europe (and related impact metrics), whereas hemispheric transport still contributed about 20–30 per cent to regional-scale impacts.

VI. General country updates

25. A representative of Croatia, also a former Chair of the EMEP Steering Body, gave a presentation on the evolution of measurement and modelling work within the Convention, both prior to and since the establishment of the Task Force on Measurements and Modelling. She pointed out the main achievements and the evolution in time towards more integration of measurement and modelling work, giving a posteriori support for the establishment of a joint task force addressing both issues.

26. A representative of Belarus presented the progress in modelling particulate matter in the area of Zhlobin, including a comparison with EMEP Meteorological Synthesizing Centre-West model results. The comparison did not exhibit significant discrepancies, but further improvements were expected as a result of work on the temporal variation of emissions and particulate matter speciation.

27. A representative of Denmark presented an overview of Danish activities in relation to EMEP (monitoring, modelling and emissions). Examples included an assessment of the benefit of the Sulphur Emission Control Area in the Baltic Sea and the North Sea, air pollution maps at very high resolution, nitrogen deposition and pesticides modelling.

28. A representative of the United Kingdom of Great Britain and Northern Ireland presented a detailed assessment of the relocation of an EMEP station from Harwell to Chilbolton (located about 50 km south of Harwell). Long-term data analysis, including by removing meteorological factors, indicated that both stations were similar in terms of particulate matter, sulphur dioxide and ozone evolution, but large discrepancies had been found for ammonia and NO_2.

[4] See https://luftkvalitet.miljostatus.no.

VII. Thematic session on links between the Cooperative Programme for Monitoring and Evaluation of the Long-range Transport of Air Pollutants in Europe and the Working Group on Effects

29. An expert from Sweden gave a presentation on how chemistry-climate models could be used to assess the climate impact of air pollution control strategies, including by differentiating the areas where emission reduction took place and where the greatest climate impact was expected. He highlighted the fact that the climate effect was not linear in response to the amount of sulphur dioxide emitted. The effect did not respond linearly as higher responses were observed at the smaller reductions than at the large reductions. The radiative forcing of various aerosol constituents varied greatly, so that the cooling effect lost by reducing 1 tonne of sulphur oxides emission could be compensated by the reduction of only 250 kg of black carbon, hence a climate neutral mix in controlling pollutant emissions was possible.

30. A representative of the Chemical Coordinating Centre presented a measurement-model fusion methodology to map sulphur and nitrogen deposition in Norway with a high resolution. It was emphasized that high resolution precipitation maps were required to perform such data fusion. Measurement-model fusion suggested higher dry deposition of sulphur dioxide compared to sulphate (SO_4) and large differences in the dry deposition velocity between the seasons. There were substantial differences between kriging and measurement-model fusion due to the distribution of the concentration fields and differences in emissions and dry deposition velocity. There was no effect on exceedance if one chose different methods. Measurement-model fusion improved the spatial deposition patter and gave more realistic deposition estimates.

31. A representative of WMO updated the Task Force on the progress of the Global Atmosphere Watch Workshop on Measurement-Model Fusion for Global Total Atmospheric Deposition. The most recent workshop had reviewed the available material to develop a proof of concept for global deposition maps taking the best models and observations. EMEP products had been identified as potential candidates (Meteorological Synthesizing Centre-West model results but also the Task Force on Hemispheric Transport of Air Pollutants and Task Force on Measurements and Modelling/ Eurodata model results). In the long run, WMO aimed to support the design of an operational product and to establish better connection with the user community, which stood to benefit from such a product.

32. A representative of Italy presented a research project devoted to the impact of urban vegetation and nature-based solutions regarding air quality.

VIII. Workplan for 2020–2021

33. The Co-Chairs summarized the discussion held during the meeting in relation to the forthcoming biennial workplan covering 2020–2021. The main identified tasks included: setting up a new model intercomparison exercise (Eurodelta-Carb) in collaboration with the Copernicus Atmosphere Monitoring Service to take stock of the winter 2017/2018 field campaign on black carbon and BaP (see paras. 8, 13, 16 and 19); improving the reporting and representation of condensables in collaboration with the Task Force on Emission Inventories and Projections (see paras 5, 16 and 19); strengthening bilateral collaboration between State Parties and modelling centres (investigation of emission spatialization for the main pollutants in Italy and Poland – para. 6, heavy metal case studies in Germany – para. 7); follow-up to the work on linking spatial scales through twin site and modelling approaches (para. 23); and taking stock of recent work on air quality trends to inform the review of the Gothenburg Protocol.