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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 (EMEP)
(Twenty-ninth session, Geneva, 5-7 September 2005
Item 4(a)-(e) of the provisional agenda

MEASUREMENTS AND MODELLING

Progress report prepared by the Co-Chairs of the Task Force on Measurements and Modelling in collaboration with the secretariat

Introduction

1. This report presents the results of the sixth meeting of the Task Force on Measurements and Modelling, held in Zagreb (Croatia) from 4 to 7 April 2005. The Task Force discussed in particular the implementation of the EMEP monitoring strategy, the need for information on finer scales, model validation, analysis of uncertainties and source-receptor modelling. Minutes and presentations are available at: www.nilu.no/projects/ccc/tfmm/index.html.

2. Experts from the following Parties to the Convention participated in the meeting: Austria, Belarus, Bulgaria, Canada, Croatia, Czech Republic, Denmark, France, Germany, Hungary, Ireland, Italy, Latvia, Lithuania, Netherlands, Norway, Poland, Spain, Sweden, Switzerland, United Kingdom and the European Community (EC). Representatives from the Chemical Coordinating Centre (CCC), the Meteorological Synthesizing Centres-East and West (MSC-W, MSC-E), the World Meteorological Organization (WMO), the European Community's Joint Research Centre (JRC) and a member of the secretariat were present.

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3. Mr. D. Derwent (United Kingdom) and Ms. L. Jalkanen (WMO) co-chaired the meeting.

4. The meeting was hosted by the Meteorological and Hydrological Service of Croatia. The chairs opened the meeting, stressing the importance of moving forward on the implementation of the EMEP monitoring strategy and modelling of POPs and heavy metals, now that the 1998 Protocols on POPs and Heavy Metals had entered into force, as well as on implications for the review of the Gothenburg Protocol.

5. A member of the secretariat drew attention to relevant matters from the twenty-second session of the Executive Body noting the establishment of new bodies: the Task Force on Heavy Metals, the Task Force on Hemispheric Transport of Air Pollution and the Expert Group on Particulate Matter.

I. IMPLEMENTATION OF THE EMEP MONITORING STRATEGY

6. In accordance with the work-plan for the implementation of the Convention (ECE/EB.AIR/83/Add.2, annex XIII, item 2.2), the Task Force discussed the financial and structural obstacles to the implementation of the monitoring strategy.

7. Ms. W. Aas (CCC) drew attention to Executive Body decision 2004/1 calling on Parties and centres to make financial resources available for the implementation of the monitoring strategy. She noted that the UNECE project on Capacity-building for Air Quality Management and the Application of Clean-coal Combustion Technologies in Central Asia (CAPACT) would develop one level monitoring site in Central Asia. She stressed important aspects for further developing level 2 sites. She noted that research funding supporting level 3 was declining; securing long-term financing was important.

8. The Task Force considered the results of a workshop on the implementation of the monitoring strategy (November 2004, Oslo). The workshop had covered, inter alia, gas/particle distribution, size-segregated aerosol observations and volatile organic compounds (VOCs) and had discussed methodological and technical issues involved in the implementation of monitoring for each group of compounds. Further work was required by CCC. Conclusions of the workshop are available at: http://www.nilu.no/projects/ccc/tfmm/index.html.

9. The Task Force agreed to ask experts to present, at its seventh meeting, detailed plans for implementing the strategy in their countries. National implementation plans would allow the Task Force to identify common problems, taking into consideration numbers of stations and regional priorities.

10. Mr. M. Sutton (United Kingdom) noted the need to complement the continuous measurements of the EMEP programme with high-ambition intermittent measurements, particularly for level 2 and level 3 activities. Two kinds of intermittent measurements were defined: (a) measurement campaigns typically with intensive measurements involving several research teams, mainly relevant for level 3; (b) intensive periods of measurement represented a means of coordinating high-ambition measurements on a repeated basis. These linked closely to level 2 monitoring activities, where it was not feasible for all sites to operate fully continuous measurements.

11. A proposal was made to coordinate two intensive periods during 2006 with a focus on gas-aerosol distribution of inorganic and organic species, over as large an area of Europe as possible. Given the importance of automatic hourly measurements, the Task Force agreed to focus on two key months, one in summer and one in winter (provisionally June and November 2006). CCC would coordinate the effort and Parties were encouraged to indicate in their implementation plans their readiness to contribute to this work.

II. NEED FOR MODELLED INFORMATION ON FINER SCALES

12. Mr. T. Springer (Germany) informed the Task Force about critical load exceedances and the need for good spatial resolution in the evaluation of effects. Improved spatial resolution and landcover-specific modelling of deposition had improved the assessment of critical load exceedances.

13. Information was provided on the downscaling of the EMEP model for the United Kingdom to 5 km x 5 km resolution. Results of the European Commission's CITY-DELTA project, in particular regarding the urban contribution to particulate matter $(PM)_{2.5}$ were described.

14. The Task Force agreed that higher resolution modelling was important as it allowed for more realistic critical load exceedances. It allowed for spatial variability and made for better validation using total deposition. The Task Force concluded that downscaling was important for modelling. Policy requirements would have to focus more on this in future.

III. SCIENTIFIC AND TECHNICAL REVIEW OF MODELLING ACTIVITIES AT MSC-EAST

A. Model applications

15. MSC-E and others informed the Task Force on current modelling activities. Background information was given on the parameterizations used in various POPs and heavy metal models.

Two approaches to modelling of persistent organic pollutants (POPs) and heavy metals included: multi-compartmental mass balance models and atmospheric dispersion models. The multi-compartmental MSC-E POP model assessed environmental levels and transboundary fluxes for PAHs, dioxins/furans, PCBs, γ-HCH, HCB and some potential POPs.

16. Atmospheric dispersion models for heavy metals and POPs were adapted from classical air pollution dispersion models where the Earth's surface was a complex boundary. They often had higher spatial resolution but were limited to relatively short time frames. Low volatility POPs could be modelled as they behaved as classical air pollutants; their fate and behavior was dominated by particle-associated deposition, with minimal potential for volatilization from soils and vegetation. The Task Force welcomed the organization of a workshop on the review of the MSC-E model (October 2005, Moscow, see below) where these issues would be further explored.

B. Model uncertainties

17. Several speakers noted the incompleteness of officially submitted emission data for POPs and heavy metals, underlining the importance of emission data for modelling distribution at global and regional scales as well as for developing emission reduction strategies. The Task Force agreed that emission data quality was important and urged the revision of the Emission Reporting Guidelines, the updating of the EMEP CORINAIR Emission Inventory Guidebook and welcomed the development of an emission inventory review and improvement programme under the Task Force on Emission Inventories and Projections. Further cooperation between the two Task Forces was welcomed.

18. Ms. W. Aas informed the Task Force about the availability of monitoring data for heavy metals and POPs in EMEP databases. Quality control and assurance (QA/QC) was done through laboratory inter-comparisons for both POPs and heavy metals, though more campaign studies using passive samplers were needed for POPs. The Task Force agreed that work to monitor implementation of the Protocol on POPs and the Protocol on Heavy Metals would require significantly more monitoring data, in particular at supersites.

C. Model validation

19. Mr. A. Ryaboshapko (MSC-E) presented results of a 5-year programme of model inter-comparisons for mercury. The models tested were regional, continental and hemispheric in scale and all focused on the EMEP domain in order to test their applicability and reliability. The first approach to model validation was to compare model results with observations; the second approach was to compare a given model with other models. The study involved 9 modelling groups from Europe and North America that had models of mercury transport at regional and global levels.

20. The Task Force noted that comparison of modelling results with observation demonstrated that models could reproduce measurements of gaseous mercury with an uncertainty of a factor of 1.2 and of particulate/precipitation mercury within a factor of 1.5. Model-to-model comparison of trans-boundary mercury pollution for individual European countries could show variation up to a factor of 2. MSC-E models appear to provide results comparable to most other models.

21. The EMEP model inter-comparison study for POPs included 10 different models. It was planned in three stages, beginning in March 2002. In stage I, the focus was on the individual phase transfer processes; stage II involved mass balances, concentration and deposition fields and stage III, persistence and long-range transport potential. The Task Force noted that these studies showed improved understanding of individual environmental processes, more consistent sets of chemical property data and process descriptions and much greater understanding of the different models (box models as well as atmospheric dispersion models).

22. The main purpose of comparing model results and monitoring data was to validate models, to test and evaluate emission data and to select measurements for the comparison and evaluation of pollution levels in Europe. The Task Force recognized the work of MSC-E on the analysis of POP and heavy metal emission uncertainties and their effects on modelling results. It stressed the need to draw the attention of the EMEP Steering Body and the Task Force on Emission Inventories and Projections to the need for improving the quality of emission inventories for these pollutants. It also took note that official emission data for heavy metal and POPs were incomplete and that expert estimates were required to fill the gaps. Taking into account the good agreement between modelled lead and cadmium deposition fields based on expert emission estimates and observations, MSC-E would produce two sets of deposition maps for cadmium and lead for evaluating exceedances of critical loads: one calculated using official emission data, the other using expert estimates.

23. Mr. S. Dutchak (MSC-E) presented plans for a workshop under the Task Force on the review and evaluation of the MSC-E heavy metal and POP models (Moscow, 13-14 October 2005). The first half-day session would provide information on the MSC-E heavy metal and POP models and the current state of measurement and emission data. Details of the model parameterizations would be available on the MSC-E website in advance of the workshop. On the second day, two groups would consider the available model inter-comparison studies, comparisons between models and observations, and whether the models are fit for assessing the contribution of long-range transport to environmental impacts of heavy metals and POPs. A final session would agree conclusions on review and assessment as well as recommendations for future model developments and improvements to the MSC-E models.

24. The Task Force recommended that the MSC-E model review be considered by the EMEP Steering Body, the Task Force on Heavy Metals, the Task Force on POPs and the Working Group on Strategies and Review. These discussions would facilitate preparations for the workshop.

IV. PARTICULATE MATTER

25. Ms. L. Tarrason (MSC-West) informed the Task Force on recent work on trends, flux and process understanding, scenario analysis, source-receptor calculations and uncertainty analysis. The Task Force noted that trend studies from the period 1990-2002 showed an increase in winter ozone levels and a decrease in elevated summer levels. When co-deposition of SO_2 and NH_3 was included in the dry deposition parameterization, a clear relationship emerged between SO_2 and NH_3 that strongly influenced the trend in the ratio of SO_2 to particulate sulphate.

26. Process studies of levels of PM in urban background in Europe had focussed on natural sources of $PM_{2.5}$. Finer scale analysis of PM composition would require increased national cooperation. It was important to consider the extent to which particle-bound water could explain the model underestimation of observed PM. Including aerosol water could improve the correlation between modelled and observed PM levels.

27. For scenario analysis and source-receptor calculations, work was coordinated on country-to-grid allocated pollution levels for different years. For example, the French contribution to German $PM_{2.5}$ varied with scenario and meteorology. Evaluating robustness of model results with respect to meteorological variability was becoming more important.

28. MSC-W had modelled base cations in response to a request from the Working Group on Effects. The Task Force noted their main sources of wind-blown dust included the Sahara, agricultural and other bare soils as well as sea salt and anthropogenic sources. Wind-blown dust was a potentially large contributor to both PM and base cation deposition.

29. Ms. S. Tyro (MSC-West) explained that both anthropogenic and natural PM were included in the EMEP Unified Model because they both contributed significantly to PM_{10} and $PM_{2.5}$ levels. Progress in calculating anthropogenic PM was mostly a result of the revision of emission data. CIAM had revised its PM emission data based on bilateral discussions with emission experts. Revisions had addressed national totals, emission sector allocations and spatial distribution. Natural sources of mineral dust had been implemented in the EMEP Unified model. The first calculations gave encouraging results, but more measurements were needed for model testing and validation.

30. The Task Force appreciated the work of MSC-W on the modelling of man-made and natural sources of PM within the Unified EMEP model and its contribution to the improvement of model performance.

31. Mr. S. Reis (Germany) informed the Task Force about NATAIR (http://natair.ier.uni-stuttgart.de), a European Community project on natural emissions, including a synthesis and integration of source-specific methodology for natural emissions, such as wind-blown dust and sea salt. Related work was being done at JRC on forest fires. He described the ESPREME project on heavy metals and announced that it would hold a workshop on POPs and heavy metal emissions jointly with the Task Force on Emission Inventories and Projections in Rovaniemi (Finland) on 18 and 19 October 2005).

V. ANALYSIS OF UNCERTAINTIES IN AIR POLLUTION MODELLING

32. Mr. M. Krol (JRC) defined "inverse modelling" as the process by which, starting from observations, estimates are made of emissions. There were often problems with inverse modelling due to lack of measurement data and dependence on prior estimates of emissions. A further problem was the treatment of model errors. Model inputs such as transport, chemistry and wet and dry deposition were often highly uncertain.

33. Examples of inverse modelling within Europe included studies of methyl bromide in Crete, methane emissions from northwest Europe and black carbon emissions. It was difficult to determine from inverse modelling whether black carbon emission inventories were too high or too low because of the representation of the urban situation; data were sparse, from scattered campaigns in various years and with uncertain treatments of wet removal. Even if long-term data were available, it was still necessary to make a careful selection between stations and to take into account the treatment of model errors, before attempting inverse modelling.

34. The main reasons behind the underestimation of observed concentrations of lead in air and rain by the MSC-E model were uncertainties in observations, the model and lead emissions. Lead emission inventories appeared to be one of the main sources of uncertainty in the MSC-E modelling results; emissions of heavy metals appeared to be significantly underestimated. In this study, an optimization procedure was employed to refine lead emission data to produce better agreement between modelling and measurement results. The Task Force noted that increased lead emissions by factors of between 1.4 to 6 times were required to match observations with the MSC-E model. There was concern that lead emissions from the combustion of marine fuels had not been adequately taken into account.

VI. ANALYSIS OF UNCERTAINTIES AND SOURCE RECEPTOR MODELLING

35. Ms. L. Rouil (France) informed the Task Force about EURO-DELTA, a European Community project to evaluate uncertainties in model source-receptor relationships used in air quality policy. The project aimed to determine whether regional air quality models produced a consistent response to emission changes. Model scenarios for 2000, 2010, 2020 were consistent with the baseline scenarios defined in the European Commission's Clean Air for Europe (CAFE) programme and meteorological data from 1999. Although efforts had been made to agree on the baseline calculations, the models diverged because of differences in boundary conditions, vertical exchange and natural biogenic emissions. Model variability was high in the high NO_x areas of the Benelux countries, Eastern Europe and close to large population centres. Further work was required to understand how the variability between models could be incorporated into the integrated assessment framework for policy use.

36. The Task Force discussed three methods of understanding the importance of uncertainties in emissions in air pollution modelling: the sensitivity method, the application of inverse modelling and data assimilation. It was suggested the Task Force considered data assimilation at its next meeting together with satellite and other remote sensing techniques.

VII. INTERCONTINENTAL TRANSPORT OF POLLUTANTS

37. Ms. C. Forster (Norway) presented the meteorological and process descriptions that underpin the current scientific understanding of trans-Pacific and trans-Atlantic intercontinental transport of air pollutants.

38. The Chairman presented evidence for the transport of halocarbons from North America to Mace Head, Ireland, giving a clear validation of the accuracy of the calculated trajectories. He referred to Executive Body decision 2004/4 concerning the establishment of the Task Force on Hemispheric Transport of Air Pollution, to be chaired by Mr. T. Keating (United States) and Mr. A. Zuber (European Community). The new Task Force would address problems of intercontinental transport of ozone, particles, mercury and POPs. There could be some important overlap between the two Task Forces, since both had a commitment to modelling of ozone, particles, mercury and POPs in a hemispheric context. Close cooperation between the two groups was encouraged.

39. The secretariat clarified that Parties had been invited to nominate experts to the Task Force. Other experts wishing to participate would need to do so at the invitation of the Chairmen.

VIII. FURTHER WORK

40. The Chairman summarized strategic issues for MSC-E and MSC–W that had been discussed by the EMEP Bureau in February 2005. One concerned the unrestricted availability of the MSC-West Unified Model. Sharing the model with the scientific community could allow feedback to MSC-W and this could lead to new parameterization and approaches within the model. This was targeted for summer 2005. The code was not complete as it did not include a full meteorological driver. Each driver would have its own advantages, disadvantages and assumptions and these may clash with the EMEP Unified Model. The Task Force agreed it would cooperate with the EMEP centres and the national research communities in the application of the EMEP Unified Model, including on finer scales for urban- and ecosystem-scale effect studies.

41. The Task Force agreed that the following three concepts should be reflected in its work-plan for 2006:

(a) The preparation of a particle assessment report based on national activities;
(b) Cooperative work on urban-scale modelling of ozone and particles;
(c) Cooperative work on the implementation of fine-scale deposition models.

42. The Task Force discussed the possibility of holding its seventh meeting in spring 2006 (Finland) and proposed the following items for its agenda:

(a) Implementation of EMEP monitoring strategy by countries;
(b) Scientific work of CCC;
(c) Review and evaluation of the MSC-East model;
(d) Data assimilation;
(e) Status of particle assessment at the national level;
(f) Further results from CITY-DELTA and EURO-DELTA.

IX. CONCLUSIONS AND RECOMMENDATIONS

43. The Task Force:

(a) Agreed it would benefit from detailed material plans for implementation of the EMEP monitoring strategy and would ask experts to present these at its seventh meeting;

(b) Noted the analysis of air pollution on urban versus regional scale would be an important item in its long-term work-plan. It recognized the JRC and the modelling teams' work in the framework of CITY-DELTA in support of the estimation of urban levels of ozone and PM for integrated assessment modelling;

(c) Noted with appreciation the modelling work by MSC-E and other experts that provided background material to the review and evaluation of the MSC-E heavy metal and POPs models, dealing with model parameterizations, sensitivity studies, comparisons with observation and model intercomparisons;

(d) Agreed that the MSC-E model review should take place at a workshop to be held in Moscow, on 13 and 14 October 2005, and should be focused on comparison with observation and model intercomparisons. The Task Force requested that the information required for the review be placed on the MSC-E website in advance of the workshop. The Task Force approved the plans for the workshop and encouraged the full support and attendance from experts;

(e) Recognized the important strategic implications of the decision by MSC-W to make the Unified Model available to Parties. In this way it should be possible in future to generate national assessments of air pollution at finer scale for both ecosystem and health effects. This would be important in the long-term work-plan of the Task Force;

(f) Recognized the work of MSC-W on natural emissions and the contribution to improving model performance for particles. Further analysis of natural emissions would be important in the long-term work-plan of the Task Force;

(g) Believed model inter-comparisons were an important way to improve model performance in the long term. It appreciated the work of JRC in the context of EURO-DELTA on source-receptor relationships and the national support that had been given to modelling teams;

(h) Welcomed the formation of the newly-established Task Force on Hemispheric Transport of Air Pollution and looked forward to close cooperation in the areas of atmospheric transport and process understanding;

(i) Sought further cooperation with the Expert Group on Ammonia Abatement;

(j) Agreed to hold its seventh meeting in May 2006, to be hosted by the Finnish Meteorological Institute.

44. The Task Force invited the EMEP Steering Body to consider the following four additional tasks for its work-plan, recognizing that these would imply the allocation of national resources:

(a) To prepare urban fine-scale ozone and PM assessment tools by linking together national urban exposure assessments with national emission inventories and atmospheric models;

(b) To prepare a particle assessment report from national analyses of particle monitoring data (both national and EMEP) and from national and EMEP particle monitoring (CCC);

(c) To prepare ecosystem-scale deposition by linking national fine-scale models to the EMEP model; nesting to finer scales would be an important focus for the work of the Task Force;

(d) To consider inverse modelling and data assimilation to improve process understanding and to open communications with the satellite, light detection and ranging (LIDAR) and other remote sensing communities.