ADVANCE VERSION

United Nations

ECE/EB.AIR/GE.1/2017/8–ECE/EB.AIR/WG.1/2017/18

Economic and Social Council

Distr.: General
3 July 2017

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

Third joint session
Geneva, 11–15 September 2017
Item 11 (a) of the provisional agenda
Outreach efforts, information sharing and cooperation with other organizations and programmes: hemispheric transport of air pollution

Hemispheric transport of air pollution

Report prepared by the Co-Chairs of the Task Force on Hemispheric Transport of Air Pollution

Summary

The Task Force on Hemispheric Transport of Air Pollution under the Cooperative Programme for Monitoring and Evaluation of the Long-range Transmission of Air Pollutants in Europe (EMEP) carries out the tasks specified in its mandate (ECE/EB.AIR/106/Add.1, decision 2010/1). In the reporting period, it was also tasked with implementing the activities attributed to it in the 2016-2017 workplan for implementation of the Convention on Long-range Transboundary Air Pollution (ECE/EB.AIR/133/Add.1, items 1.1.3.2, 1.1.4.1-1.1.4.4 and 1.3.1) and those set out in the informal document submitted to the Executive Body for the Convention at its thirty-fourth session, “basic and multi-year activities in the 2016-2017 period” (items 1.5.2, 1.5.3, 1.6.1 and 1.6.2). In line with these mandates, the Task Force continued to develop and implement a multi-year workplan to improve scientific understanding of the intercontinental transport of air pollution in the Northern Hemisphere and to evaluate the availability of mitigation strategies inside and outside the geographic scope of the Convention.

In accordance with the Convention workplan, the Task Force is requested to present an annual report on its work to the EMEP Steering Body. The present report details the progress made by the Task Force since its previous report and provides an overview of upcoming activities through 2017.

I. Progress in implementation of the 2016-2017 workplan

1. The Task Force on Hemispheric Transport of Air Pollution under the Cooperative Programme for Monitoring and Evaluation of the Long-range Transmission of Air Pollutants in Europe (EMEP) is continuing to implement a multi-year plan that was begun in 2012. This multi-year plan is outlined on the Task Force website[1] and encompasses activities in six areas: (a) emissions inventories and projections; (b) global and regional modelling of source-receptor relationships; (c) model-to-observation evaluation and process studies; (d) impacts on health, ecosystems and climate change; (e) impacts of climate change on air pollution transport; and (f) data networks and tools.

2. Consistent with guidance provided through the biennial workplans for the Convention on Long-range Transboundary Air Pollution, the work of the Task Force has evolved to focus on two main themes:

(a) **The quantification of global influences on regional air quality**. Through global and regional modelling and model evaluation, this thematic area directly informs the atmospheric and integrated assessment modelling performed at the regional scale by other EMEP bodies. This theme has been the focus of most of the Task Force's activities since 2012 and encompasses tasks 1.1.4.1, 1.1.4.4 and 1.5.2 of the 2016-2017 workplan for the implementation of the Convention (ECE/EB.AIR/133/Add.1);

(b) **The evaluation of air pollution control opportunities and their impacts at intercontinental to global scales**. Work under this thematic area is performed in conjunction with other EMEP and Working Group on Effects bodies, and encompasses tasks 1.1.3.2, 1.1.4.2, 1.1.4.3, and 1.3.1 set out in the 2016–2017 workplan. Over the course of 2017 and into the near future, this theme will become a larger focus of the Task Force's activities.

3. The Task Force took stock of current efforts under the first theme (quantifying global influences) during the "Air Quality in a Changing World" workshop held in North Carolina, United States of America, from 3 to 6 April 2017. The workshop was hosted by the United States Environmental Protection Agency and was attended by 95 individuals in person and an additional 80 individuals by web conferencing over the course of the four-day event. Forty-eight scientific presentations were made, copies of which are available on the Task Force website. The workshop was divided into three parts focused on:

(a) Analyses of the Task Force's coordinated global and regional modelling experiments for 2008–2010 (task 1.1.4.1), referred to as the "HTAP2 experiments";

(b) A review of recent research regarding the impact of climate change on air pollution (task 1.1.4.4);

(c) An initial meeting for a set of 13 research projects funded by the United States Environmental Protection Agency on the topic of "Particulate Matter and Related Pollutants in a Changing World", with participation of the Task Force participants.

4. The discussion of results from the HTAP2 experiments led to the following conclusions:

[1] See http://www.htap.org.

(a) The HTAP2 experiment results presented in April are similar to the results of the HTAP1 experiments, which were conducted for the year 2001 and reported in the Task Force's 2010 assessment report.[2] The HTAP2 results for base case monthly average ozone values show a similarly wide spread between global models as seen in the HTAP1 results. For particulate matter, the spread between global models is lower in HTAP2 than in HTAP1, but still quite significant. At the regional scale, the performance of regional models contributing to HTAP2 (simulations for 2010 as part of the Air Quality Model Evaluation International Initiative Phase 3 (AQMEII3)) did not improve over the performance in AQMEII Phase 1 (simulations for 2006);

(b) More work is needed to understand the biases in the global model simulations as compared with observations. Initial analyses of the regional model results from AQMEII3 suggest that the regional models tend to underpredict concentrations of carbon monoxide, nitrogen oxides and particulate matter. A significant fraction of this bias may be owing to errors in the emissions estimates. For ozone, however, the regional models tend to overpredict observed ozone, which appears to be driven by uncertainties in ozone deposition, boundary conditions (from the global models) and the overall magnitude of precursor emissions. It was suggested that future work by the Task Force and AQMEII focus on evaluating deposition processes in the global and regional models;

(c) The patterns of extraregional source-receptor relationships (i.e., the influence of one continental region on another) appear to be similar in the HTAP2 and HTAP1 global model emission perturbation simulations. The HTAP2 results also include information from a tagged species model and an adjoint model, both of which seem to confirm the general patterns of extraregional source-receptor relationships seen in the emission perturbation simulations. Moreover, the results presented in April 2017 suggest that the global models respond linearly to changes in emissions in other regions, changes in multiple pollutant emissions across whole sectors and with respect to longer concentration averaging times, such as seasonal or annual averages. The linearity decreases in the global model responses for emission changes within a given region or for a single pollutant and with respect to short averaging periods or peak metrics. These findings suggest that parameterized source-receptor relationships from the global models may be useful in evaluating some of the benefits of international cooperation, but may not be appropriate for assessing the ability of emission control policies within a region to attain specific peak-related objectives.

5. The review of recent research results on climate change impacts on air pollution at the April 2017 workshop added to the discussion of the topic at the second joint session of EMEP Steering Body and the Working Group on Effects in 2016. The discussions at the April workshop led to the following conclusions:

(a) Climate change affects meteorology, emissions, chemistry and deposition, all of which have impacts on air pollution concentrations. The magnitude of this effect is often

[2] See Hemispheric Transport of Air Pollution 2010 Executive Summary (ECE/EB.AIR/2010/10 and Corr.1 and 2) and the four related reports: *Hemispheric Transport of Air Pollution 2010, Part A: Ozone and Particulate Matter*, Air Pollution Studies No. 17 (United Nations publication, Sales No. E.11.II.E.7); *Hemispheric Transport of Air Pollution 2010, Part B: Mercury*, Air Pollution Studies No. 18 (United Nations publication, Sales No. E.11.II.E.8); *Hemispheric Transport of Air Pollution 2010, Part C: Persistent Organic Pollutants*, Air Pollution Studies No. 19 (United Nations publication, Sales No. E.11.II.E.9); and *Hemispheric Transport of Air Pollution 2010, Part D: Answers to Policy-Relevant Science Questions*, Air Pollution Studies No. 20 (United Nations publication, Sales No. E.11.II.E.10).

referred to as the “climate change penalty” (i.e., the additional amount of ozone that must be decreased by emission mitigation measures to achieve a specific air quality target under a changed climate). In the near term, projected changes in air pollution because of changes in emissions (owing to economics, technology and policy) are generally larger than changes owing to climate change, but the climate penalty is large enough to be policy relevant;

(b) Estimates of the climate change penalty for average summer mean daily maximum eight-hour average ozone over the United States varies from a two to eight parts per billion (ppb) increase by 2050. However, models differ on how that climate penalty is distributed regionally and even the sign of the penalty within regions. The sensitivity of ozone to increasing temperature decreases with decreasing nitrogen oxides emissions, partially offsetting the climate penalty. Rising global methane levels may exacerbate the climate penalty, making local or regional emission controls less effective at decreasing local or regional ozone levels;

(c) Models differ more in their estimates of a climate penalty for particulate matter than for ozone. The penalty could be as high as an increase of 1.5 micrograms per cubic metre ($\mu g/m^3$) in the annual mean concentration of particles with an aerodynamic diameter equal to or less than 2.5 micrometre ($PM_{2.5}$) in the eastern United States by 2050 owing to faster oxidation rates, more biogenic emissions and more stagnation. In western North America, climate change is expected have the additional impact of increasing wildfires, smoke emissions and harmful exposures;

(d) Climate variability, which differs by region and season, can confound the detection of anthropogenic climate change and its influence on air pollution. Patterns of climate variability, such as the El Niño-Southern Oscillation (ENSO), or the North Atlantic Oscillation (NAO), are known to be influenced by climate change and, in turn, have an influence on air pollution. For example, the La Niña phase of ENSO increases the frequency of deep stratospheric intrusions of ozone over the western United States. However, if large-scale circulation shifts occur, then historical air pollution-temperature relationships may not hold. There is an increasing trend in both North America and Europe to study the impacts of pattern shifts in climate variability;

(e) Analysis of global model simulations of a carbon monoxide-like tracer suggests that climate change is likely to lead to a weakening of the Hadley cell circulation, decreasing the movement of air pollutants from the tropics into the upper troposphere and poleward, as well as shifting mid-latitude jets further poleward, confirming previous analyses.

6. To encourage and organize the publication of scientific products from the HTAP2 experiments, the Task Force launched a special issue of the open-access journal *Atmospheric Chemistry and Physics*, entitled “Global and regional assessment of intercontinental transport of air pollution: results from HTAP,[3] AQMEII and MICS[4]”.[5] The special issue is open to all papers related to the intercontinental transport of air pollution and addressing the following policy-relevant science questions identified by the Task Force:

(a) What fraction of air pollution can be attributed to contemporary anthropogenic regional emissions sources versus extraregional, non-anthropogenic, or legacy sources of pollution?;

[3] I.e., the Task Force on “Hemispheric Transport of Air Pollution “ (HTAP).
[4] Model Intercomparison Study-Asia.
[5] F. Dentener and others, eds. See http://www.atmos-chem-phys-discuss.net/special_issue257.html.

(b) What is the contribution of each fraction to impacts on human health, ecosystems and climate change?;

(c) How sensitive are regional pollution levels and related impacts to changes in regional versus extraregional emission sources?;

(d) How will the contributions of the fractions and their sensitivities change in the future as a result of expected air pollution abatement efforts or climate change?;

(e) How do the availability, costs and impacts of additional emission abatement options compare across different regions?

7. As of early June 2017, 12 articles have been published in the special issue and 8 more are undergoing public and peer review through *Atmospheric Chemistry and Physics* discussions.[6] At the April meeting, the Task Force decided to extend the submission deadline for the special issue until December 2017 to allow additional analyses to be included. Approximately 10 more papers are under development and expected to be submitted.

8. The Task Force took stock of ongoing efforts under the second theme of its work, joining with the Task Force on Integrated Assessment Modelling for a special joint session as part of forty-sixth session of the Task Force on Integrated Assessment Modelling (Paris, 2–3 May 2017), hosted by L'Institut National de l'Environnement Industriel et des Risques (INERIS). The presentations from the special session are available on the websites for both Task Forces and are described in a separate report submitted jointly by the Co-Chairs of the two task forces.

9. As reported in previous annual reports, the Center for Integrated Assessment Modelling (CIAM), with funding from the European project, Evaluating the Climate and Air Quality Impacts of Short-Lived Pollutants (ECLIPSE), has developed global air pollution emissions scenarios to guide the Task Force's exploration of emission mitigation opportunities inside and outside the Economic Commission for Europe region (tasks 1.1.3.2 and 1.1.4.2). The emissions scenarios are referred to here as the Greenhouse Gas Air Pollution Interactions and Synergies (GAINS)-Task Force on Hemispheric Transport of Air Pollution (GAINS-HTAP)) scenarios, but are also known as the ECLIPSE v5a scenarios. At the Paris meeting, the GAINS-HTAP scenarios were compared with: (a) the air pollution projections of the Shared Socio-economic Pathways (SSP) developed for the Intergovernmental Panel on Climate Change; and (b) work by CIAM, funded by the International Energy Agency, to account for the Intended National Determined Contributions agreed to under the Paris Agreement on climate change (IEA-New Policy Scenario (NPS)). The range of the SSP emission projections is larger than in the previous Reference Concentration Pathways used for the Intergovernmental Panel on Climate Change Fifth Assessment Report, but the range of scenarios is not as large as the range of the GAINS-HTAP scenarios. The GAINS-HTAP maximum technologically feasible reduction (MTFR) scenario generally leads to lower emissions than the SSP scenario with lowest emissions. The new GAINS IEA-NPS shows a significant decline in emissions of sulphur dioxide and black carbon, especially in Asia, taking into account the newest mitigation policies in China.

10. At the May 2017 joint session the task forces considered the potential to incorporate the results of the HTAP2 experiments into the FAst Scenario Screening Tool (FASST)

6 See http://www.atmos-chem-phys-discuss.net/discussion_papers.html (accessed on 21 June 2017).

model developed by the European Commission's Joint Research Centre to create a user-friendly tool for exploring global air pollution scenarios and impacts (task 1.1.4.3). The current version, TM5-FASST,[7] calculates concentrations of ozone and particulate matter and their impacts based on source-receptor relationships between 56 world regions derived from a simulation of 2001 using the TM5 global model. TM5-FASST is freely available to use by means of a web interface. A version of the FASST model incorporating the European source-receptor relationships produced by the regional EMEP model is being developed. Currently, HTAP2 model output is being prepared for use in FASST.

11. With representatives of the Arctic Monitoring and Assessment Programme and the "Air Pollution in the Arctic: Climate, Environment and Societies (PACES)" initiative, the joint session explored opportunities for increased cooperation with the work of the Arctic Council and others (task 1.3.1). Topics for potential collaboration that were identified include black carbon emissions and mitigation strategies, shipping impacts, and nitrogen impacts.

12. The Task Forces also took note of recent and ongoing work of the International Cooperative Programme on Effects of Air Pollution on Natural Vegetation and Crops (ICP Vegetation) and the Coordination Centre for Effects, and also of the Climate and Clean Air Coalition, the International Council on Clean Transportation and the Organization for Economic Cooperation and Development.

13. The joint session confirmed the need for the Task Force to complete its current workplan by:

(a) Summarizing the current performance of global and regional models and the response of regional models to boundary conditions;

(b) Completing the estimation of global and nested source-receptor relationships and providing corroborating evidence for them;

(c) Exploring the implications of the current legislation scenario (CLE) revisions and the methane scenarios and cost estimates;

(d) Evaluating the capabilities to address sectoral control measures, particularly for agriculture, aviation and shipping.

14. With respect to the directions of future work under the Task Force, participants at the joint session recommended further exploration of:

(a) Cooperation with the Arctic Monitoring and Assessment Programme, ICP Vegetation and other groups;

(b) Inclusion in TM-FASST of the same ozone metrics that are used in the GAINS model;

(c) An assessment of deposition and the integration of nitrogen, mercury, ozone, persistent organic pollutants and climate change.

[7] See European Commission, FASST – FAst Scenario Screening Tool, 24 March 2017. Available from http://tm5-fasst.jrc.ec.europa.eu/.

II. Activities during the remainder of 2017

15. During the remainder of 2017, the Task Force expects to:

(a) Hold several web conferences to check progress on contributions to the special issue of *Atmospheric Chemistry and Physics* mentioned above;

(b) Make progress in the development of an HTAP-FASST tool that will allow Convention experts to explore the implications of the HTAP2 results for future global emissions scenarios and their associated impacts;

(c) Summarize policy-relevant results from the scientific publications in the special issue of *Atmospheric Chemistry and Physics*.

III. Activities in 2018–2019

16. In the 2018–2019 period, it is expected that the work of the Task Force will focus on the second theme of its recent work: the evaluation of air pollution control opportunities and their impacts at intercontinental to global scales. This work is expected to be guided by the recommendations emanating from the work of the ad hoc policy review group of experts established by the Executive Body to respond to the Convention’s 2016 assessment report.

17. The Task Force will also emphasize outreach and collaboration with other bodies within the Convention and with other international forums where the data and tools developed by the Task Force may inform the evaluation of future air pollution control efforts.

18. To the extent resources allow, the Task Force will continue to pursue cooperative model intercomparison and evaluation efforts at the regional and global scales, building upon the relationships with AQMEII and MICS. Future efforts in this area are likely to focus on evaluation of deposition and other atmosphere-surface exchange processes.