United Nations ECE/EB.AIR/GE.1−WG.1/2023/INF.4

Distr.: General
8 July 2024

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

Tenth joint session Geneva
Geneva, 9-13 September 2024
Item 5 (d) 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 2024 and future work: 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 carries out the activities specified in its revised mandate (Executive Body decision 2019/9).[a] During the reporting period, it was also tasked with carrying out the activities assigned to it in the 2024–2025 workplan for the implementation of the Convention on Long-range Transboundary Air Pollution (ECE/EB.AIR/154/Add.1) approved by the Executive Body at its forty-third session (Geneva, 11-13 December 2023).

In accordance with the Convention workplan, the Task Force is requested to present an annual report on its work to the Steering Body of the Cooperative Programme for Monitoring and Evaluation of the Long-range Transmission of Air Pollutants in Europe. The present report details the progress made by the Task Force since its previous report and provides an overview of upcoming activities through 2025.

[a] Available at https//unece.org/decisions

I. Accomplishments under the 2024-2025 workplan

1. For the period 2024-2025, the Task Force's leadership team has organized its work around five interlinked activities:

(a) Continue development and refinement of the HTAPv3 global emissions mosaic, including extending the data set to other pollutants and incorporating information from additional regional-scale inventories (work plan item 1.1.2.7, 1.1.3.1).

(b) Conduct multi-model simulations of recent trends and future scenarios of ozone and other Gothenburg Protocol pollutants to inform future policy negotiations and impact assessments, including supporting World Meteorological Organization (WMO) Measurement-Model Fusion for Global Total Atmospheric Deposition (MMF-GTAD) activity, with a goal of providing initial results in 2025 (work plan items 1.1.1.5, 1.1.1.6, 1.1.1.7, 1.1.2.11, 1.1.2.12, 1.1.2.13, 1.1.2.15, 1.1.3.2).

(c) Conduct multi-model simulations of mercury trends by 2025 to inform the effectiveness evaluation of the Minamata Convention and continue simulations and analysis beyond 2025 to inform future reviews of the Heavy Metals Protocol (work plan item 1.1.2.16, 1.1.3.3).

(d) Plan and initiate multi-model simulations of the multi-pollutant impacts of wildfires and agricultural burning with a goal of providing results in 2026-2027 (work plan item 1.1.3.4).

(e) Continue to develop and produce emulators for the multi-model ensembles that can be incorporated into integrated assessment models and other decision support tools (work plan item 1.1.3.5).

2. Under the first theme, work is underway to extend the HTAPv3 global emissions mosaic from 2018 to 2020, and to address inconsistencies in the previous inventory. A new version of the global mosaic is expected late summer or early fall 2024.

3. Under the second theme, the Task Force is organizing a multi-model exercise in support of revisions to the Gothenburg Protocol, the HTAP3-OPNS project for ozone, PM, nitrogen and sulphur deposition. Extensive planning discussions were held in 2023 and 2024, with the project expected to be formally launched in July 2024, and initial results expected by the TFHTAP spring meeting in 2025.

4. Under the third theme, The Task Force has planned the Multi-Compartment Hg Modelling and Analysis Project (HTAP3-MCHgMAP), to model mercury trends and source attribution, to inform both the first Effectiveness Evaluation of the Minamata Convention and the evaluation of the Heavy Metals Protocol. Model simulations are already underway with results expected by early 2025.

5. Under the fourth theme, the Task Force is planning a multi-model, multi-pollutant exercise to examine the impacts of wildfires (HTAP3-Fires). Extensive planning discussions were held in 2023 and 2024, with a white paper developed describing the modelling plan. Model simulations are expected to begin in the fall of 2024, with model experiments to be completed by mid-2026.

6. Under the fifth theme, the Task Force had planned to hold a workshop on the development of reduced-form atmospheric models and ensemble emulators at an international environmental software conference in June 2024. Due to a lack of resources, the workshop had to be cancelled. However, the Task Force held a discussion at its 2024 meeting and decided to explore the organization of a future intercomparison of emulator methods that may use the results of the HTAP3 model experiments that are now getting underway.

II. 2023-2024 Task Force Meetings

7. To review progress and plan future work, the Task Force organized a number of virtual meetings since the last report: 10 October 2023; 7-9, 14 November 2023; 28

November and 1 December 2023; and 22-25 April 2024. The meetings in October through December 2023 contributed to the planning of the HTAP3-Fires and OPNS experiments. The April 2024 set of meetings served as the main task force meeting and was divided into four 4-hour-long online sessions. 160 individual experts from 21 countries participated in one or more of the April sessions. Agendas and presentation materials are available on the Task Force website.[1] The first meeting session focused on providing overviews of the five major threads of activity of the Task Force. The second and third sections were focused on the HTAP3-OPNS work and finalizing details around the multi-model exercise. The fourth session focused on the HTAP3-Fires multi-pollutant, multi-modelling exercise. The progress achieved and next steps in these areas of work are described below.

A. Multi-Pollutant Impacts of Fires

8. The 10 October, and 25 April sessions focused on the planning of a multi-pollutant, multi-impact study of the effects of wildfires and agricultural burning. This effort was launched 8 November 2022 with a goal of organizing a multi-model study of the health, ecosystem, and climate impacts associated with fine particles, ozone, mercury, other metals, and persistent organics emitted or mobilized by fires. Cynthia Whaley (Canada) is leading the development of a white paper describing the objectives and design of the study. The paper is expected to be completed in summer 2024. A multi-journal special issue is being planned for this white paper and subsequent science papers stemming from this exercise. Model simulations and analyses are expected to be conducted in the 2024-2027 period. The model activity will include both historical and future simulations. The historical simulations will include case studies, a medium run for the period of 2015-2019 and a long run for the period of 2003-2020. The future simulations will include a short run for the year 2050, and a medium run for the period of 2010-2050.

9. As part of this effort, the Task Force co-hosted a virtual workshop with the International Global Atmospheric Chemistry (IGAC) BBurned initiative on 7-9 and 14 November 2023. This workshop brought together the developers of the major global fire emissions inventories to hear about recent updates, understand their methods, discuss current intercomparison results and inventory disagreements, and determine which emissions (or combination of emissions) would be most useful for the HTAP fire modelling project. Historical fire emissions datasets were carefully considered at this meeting, and it was decided that GFAS 1.2 will be the recommended emissions as the inventory includes daily emissions, boreal peatland fires, and provide fire plume heights and speciation information. Future fire emissions will be provided by Hamilton and Kasoar, although these do not include any consideration of changes to fire management in the future.

10. The objective of the 25 April 2024 session was to present the model guidelines for the HTAP3-Fires project, and to ensure the modelling community is in agreement. Participants were asked to submit contributions to the white paper that discusses options and decisions for the multi-model experiments. The discussion focused on the following:

(a) The region definition for the HTAP3-Fires model runs. The group discussed using the HTAP2, HTAP3-OPNS regions, GFED regions, as well as IPCC regions.

(b) The potential for involvement from regional modelling groups, and the need to then provide boundary conditions for regional domains.

(c) Other model input besides biomass burning emissions that will come from GFAS v1.2, for example agricultural burning, illegal burning. The team also discussed other model factors, such as meteorology, plume injection heights, etc.

(d) The time period of simulation was discussed, including the availability of emissions information, and meteorological factors impacting on fires (e.g., El Nino years, etc). The long historical run will begin in 2003 as the GFAS inventory being used in the study does not start until 2003, with a short option centered around the years of 2015-2019. Modelling groups also had the option to look at specific case studies, with data that will be

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

made available to the teams. For the future simulations, it was agreed at the TF HTAP meeting that the short runs will focus on 2050, with a medium run over the period of 2010-2055. After the WGSR meeting in May, the target year was subsequently changed from 2050 to 2040, and hence a change in in the end date of the medium run to 2050 rather than 2055.

(e) Different case studies that could be modelled as part of the historical simulations.

B. Mercury

11. At the 22 April session, Ashu Dastoor (Canada) and key collaborators provided an update on the Multi-Compartment Hg Modeling and Analysis Project (HTAP3-MCHgMAP). The project intends to mechanistically link primary emissions and releases of mercury to levels in large-scale global environments to detect and analyse the spatial patterns and temporal trends of mercury. A total of nine models are participating in this exercise, with model simulations expected to be completed by early 2025.

(a) The MCHgMAP overview paper has been submitted to the journal Geoscientific Model Development (GMD), as part of a special issue.

(b) The project will make use of the Emissions Database for Global Atmospheric Research (EDGAR) v8.1 for the period of 1970-2022, with key improvements to emissions distribution and to emissions from the power generation sector. Biomass burning emissions will use FINN2.5 for standard simulations, and GFED4s for sensitivity simulations.

(c) The atmospheric model results will be evaluated following a two-step process: comparison of modelled year 2015 against observations, and comparison of the modelled 2010-2020 time series against observed trends. Work is already underway to compile observational datasets of ambient air concentrations of gaseous elemental mercury and of wet deposition fluxes. Due to the paucity of observational data, there are challenges with the evaluation of air-land elemental mercury exchange fluxes; as a result, the approach will focus on statistics over regions and land types, rather than focusing on evaluation against individual studies.

(d) The ocean model results will be evaluated against two unique datasets: mercury depth profile dataset for the period of 2006-2023 with approximately 40 water column profile datasets and more than 18,000 unique observations, and an elemental mercury air-sea exchange dataset for the period of 2006-2023 with approximately 15 surface ocean datasets and marine atmospheric Hg0 data and surface ocean Hg0 data.

(e) In the absence of long-term direct observations, dated natural archives provide a means of reconstructing trends in atmospheric mercury concentrations and deposition. Sources include lake sediment cores, ice cores, and tree ring records for both the pre-impact (~pre-1500), pre-industrial (~pre-1850), and post-industrial periods.

C. Ozone and other Gothenburg Protocol Pollutants

12. The modelling experiments that will be undertaken in support of ozone and other Gothenburg Protocol pollutants is referred to as HTAP3-OPNS (Ozone, Particulate matter, Nitrogen, Sulphur). The HTAP3-OPNS experiments is divided into three work streams:

(a) Future scenario simulations – transient global climate-chemistry simulations using GAINS LRTAP future scenarios for the period of 2010-2050.

(b) Source/receptor (perturbation simulations) – global chemical transport model simulations generating source-receptor relationships based on GAINS LRTAP scenarios using target year 2040. The results will also inform the development of an ensemble emulator for rapid scenario assessment.

(c) Historical transient simulations – specified dynamics simulations for the period of 2003-2020 with standardized emissions inventories for anthropogenic and biomass burning emissions. The results of this work will be provided to the WMO for use in the MMF-

GTAD project, and will provide a baseline for additional experiments in the related HTAP3-Fires work.

13. Virtual meetings were held 28 November and 1 December 2023 to discuss the modelling plan. The decisions are all documented in a white paper. The intention of the Task Force is to submit a revised version of the white paper for publication as part of a special issue that will be set up for HTAP3-OPNS. The HTAP3-OPNS work will be launched officially in July 2024, with initial results expected in spring 2025, and final results and analyses delivered by spring 2026. The Task Force is also considering a special session on HTAP3-OPNS results at the 2025 Fall Meeting of the American Geophysical Union (AGU).

14. The objective of the 28 November 2023 discussion was to outline the role of coupled chemistry-climate models in HTAP3-OPNS in order to address the question of relative contributions of intra- and extra-regional sources to air pollution and how these would change under different possible future emissions and future climate change, and to design the chemistry-climate model simulations. The discussion is summarized below.

(a) In addition to quantifying the effects of climate change on long-range transport of air pollution, the future scenario experiments would also provide a direct assessment of the GAINS LRTAP scenarios, as well as provide a check on the ensemble emulator produced under a separate stream of the HTAP3-OPNS work.

(b) The difference between time slice and transient runs was discussed. The latter would provide information on the evolution of model response to changes in climate but would require a longer run period so that there is sufficient length of time at both ends (10 years) to generate robust statistics for comparisons between present and future states. Originally, it was decided that the transient period would be 2010-2054 using GAINS LRTAP future anthropogenic emission scenarios and future fire emissions. After the WGSR meeting in May 2024, the target year was changed subsequently from 2050 to 2040, and hence a change in in the end date of the medium run to 2050 rather than 2054.

15. The objective of the 1 December 2023 meeting was to discuss the modelling plan for source perturbation runs and for the historical transient simulation stream using specified dynamics. One of the key outcomes of this stream of work is to provide hourly ozone concentration data to support the WMO MMF-GTAD project. The discussion and key decisions for the source perturbation runs are summarized below.

(a) A new set of source regions was presented to the participants. The source regions proposed are similar to those in HTAP2 experiments, with the EMEP region to be split into eastern and western parts approximately along the Ural Mountains.

(b) The list of proposed model runs was presented and discussed in further detail by attendees.

- A base simulation is requested from all groups participating in this work stream, using GAINS LRTAP CLE 2040 emissions, and a scenario run using GAINS LRTAP CLE 2015 emissions. The former is the base year for all perturbation runs, while the 2015 run will be used for model evaluation and for looking at the change in air quality.
- Global perturbation runs are performed by decreasing specified emissions or surface concentrations by 20% relative to the base run. The group agreed that a global perturbation run where all anthropogenic emissions are reduced by 20% globally (beyond just NOx-VOC-CO) is important to capture non-linearities in atmospheric chemistry (GLOALL run). A run where anthropogenic emissions are reduced by 20% as is the methane concentration boundary condition was also determined to be important and prioritised (GLOCH4, now the CH4ALL run).
- Aircraft emissions were discussed, and the HTAP team was asked to clarity whether aircraft emissions are included in the ALL scenario or not.

(c) The model output will be stored on the AeroCom server hosted by MetNo/MSC-W, with output format based on the AerChemMIP tables. The possibility of

calculating POD3IAM metrics was discussed, but further guidance from deposition experts was needed.

16. The objective of the 22 and 23 April 2024 sessions was to finalize the planning for the HTAP3-OPNS work. It was clarified that the future scenario and perturbation runs in the proposed list of model runs are prioritized as they are needed to inform the Gothenburg Protocol review. Key decisions from the discussion are as follows:

(a) For the future scenario transient simulations, while only data from 2010-2054 need to be reported, GAINS emissions can go back to 1990 to allow for spin-up. For the fixed climate runs, all conditions are fixed at 2015 except for anthropogenic emissions. After the WGSR meeting in May 2024, the target year was subsequently changed from 2050 to 2040, and hence a change in in the end date of the medium run to 2050 rather than 2054

(b) For the source/receptor perturbation runs:

- a CLE 2015 base year will be included as a priority 1 run. For these runs, models are to run with methane concentrations, not emissions-driven methane.
- Biomass burning emissions will use GFAS1.2+ with updated scenarios to become available in June.
- Methane values will be provided by MSC-W, and other long-lived greenhouse gases and ozone depleting substances will follow the SSP2-4.5 scenario.

(c) Data output should be provided on a uniform latitude/longitude grid with varying resolution, with a discussion on the priority variables that are requested from the modelling groups.

(d) Historical transient runs will now start from 2003 rather than 2000 due to the availability of the biomass burning emissions inventory.

(e) The possibility of providing boundary conditions for regional modelling and a section was added to the white paper to discuss this work.

(f) The attendees also discussed the need to spread awareness of the experiments and the availability of input and output data sets, in order to raise interest in analysing the extensive dataset that will be assembled from this experiment.

17. An online meeting is being planned by the Task Force for 10 July 2024 to officially launch the HTAP3-OPNS project.

III. Activities during the remainder of the 2024-2025 workplan

18. By the next report for the EMEP Steering Body in 2025, the Task Force hopes to have achieved a number of ambitious milestones:

(a) Released an update to the global emissions mosaic (HTAPv3.1) that can be used by the global and regional modelling community, including those engaged in the HTAP3 exercises.

(b) Presented initial results from the HTAP3-OPNS multi-model simulations of future scenarios of ozone and other Gothenburg Protocol pollutants to inform future policy negotiations and impact assessments.

(c) Presented initial results from the HTAP3-MCHgMAP multi-model simulations of mercury trends to inform the first effectiveness evaluation of the Minamata Convention.

(d) Launched HTAP3-Fire multi-model simulations of the multi-pollutant impacts of wildfires and agricultural burning.

19. The Task Force will continue to coordinate its work with the other subsidiary bodies of the Air Convention and to reach out to coordinate with a wide variety of relevant international cooperative scientific efforts.