

HTAP spring meeting report 2025

To review progress and organize additional efforts on its workplan, the CLRTAP Task Force on Hemispheric Transport of Air Pollution (TFHTAP) held a hybrid (in-person and online) meeting in Potsdam, Germany from May 7-9, 2025. The first session of the meeting was held jointly with the CLRTAP Task Force on Measurements and Modelling (TFMM).

Overall, the meeting was well attended, with up to 40 participants present in Potsdam and 100 online participants for some sessions. A major focus of the meeting was the final planning of activities for the exercise HTAP3-OPNS (modelling of Ozone, Particles, and the deposition of Nitrogen and Sulfur in support of the revision of the CLRTAP Gothenburg Protocol). Sessions were also held on the planned activity HTAP3-Fires (multi-pollutant impacts of wildfires), MCHgMAP (simulation of trends and attribution of Mercury to inform the Air Convention and effectiveness evaluation of the Minamata Convention on Mercury), and for scoping a potential new activity on PFAS.

The meeting agenda and presentations can be found on the [HTAP website](#) and details of the discussions and conclusions on each topic are given below.

HTAP3-OPNS: modelling of Ozone, Particles, and the deposition of Nitrogen and Sulfur in support of the revision of the CLRTAP Gothenburg Protocol (May 7 and 8)

Sessions under this topic included presentations from TFHTAP co-chairs on current plans (available in the online [white paper](#)), the emission datasets to be used in the exercise, preliminary work, and planned and potential analyses for the exercise.

The discussions in the two sessions on this topic revealed the need to clarify certain aspects of the modelling plans and resulted in a small number of changes to the experiment descriptions (already taken up in changes to the online white paper). Progress was made on finalizing the two remaining unfinished emission datasets (current and future biomass burning, also relevant for HTAP3-Fires), and on estimating the timeline for completion of the work. Initial analyses of early global model runs can be expected as early as Spring 2026, regional model runs by mid-2026, with a preliminary report on the work for CLRTAP expected by September 2026. Most scientific publications from the exercise will likely be submitted before or during 2027, with a final report for CLRTAP expected by Summer 2027. A representative of the CLRTAP Working Group on Strategies and Review indicated that this timeline for this work is compatible with the timeline for the revision of the CLRTAP Gothenburg Protocol.

Global to regional downscaling (morning of May 7, held jointly with TFMM)

Presentations were given on the lessons learnt from previous regional modelling work conducted under TFHTAP, the anthropogenic emission scenarios to be used in the current exercise, the design of regional modelling experiments for the current exercise, and preliminary regional modelling work already conducted using these emission

scenarios by the EMEP MSC-W (Meteorological Synthesizing Centre – West) based at Met.Norway using the EMEP model.

It was clarified that the main policy aim of the global to regional downscaling work under HTAP3-OPNS is to increase the robustness of the scenario assessment results from MSC-W for pollutants covered by the Gothenburg Protocol through the use of an ensemble of regional models for Europe including the EMEP model. Scientific aims of the exercise include understanding the inter-model differences between the full set of global and regional models contributing to HTAP3-OPNS.

Given that the global and regional runs under HTAP3-OPNS are listed in the CLRTAP work plan with TFHTAP as the lead body, TFHTAP will be responsible for overall coordination of the model runs, model evaluation, and analyses. TFMM as a contributing body will help to facilitate the participation of regional modelling groups in the exercise. During the session five Europe-based regional modelling centers indicated an interest in the exercise. Modelling centers welcomed the possibility of a letter of support from EMEP indicating the importance of the exercise for the revision of the Gothenburg Protocol.

An important aspect of the exercise is a low barrier to entry for regional modelling centers. The only mandatory requirements are the use of a common meteorological year, specified emission datasets for anthropogenic and biomass burning emissions, and boundary conditions from global runs done under HTAP3-OPNS over a minimum common geographical area (as specified in the online white paper). It was clarified that simulations are welcome for either the CAMS regional modelling domain or the larger EMEP domain, but that groups using the CAMS domain must simulate the entirety of this domain. Boundary conditions from global models should be provided with at least 6 hourly temporal resolution. It was further decided that regional models should not run with methane emissions inside their domain but rather treat methane as a background tracer with only input from the lateral boundary conditions.

While the online white paper contains all of the necessary information required to perform the simulations, the need was also identified for a shorter technical guidance document for modelers.

Global model simulations (morning/afternoon of May 8)

After an introductory presentation from a TFHTAP co-chair on the design of the global model experiments based on the online [white paper](#), several presentations were given on planned and potential analyses which will or could be carried out on the model results. Discussion focused on the suitability of the experiment design for the planned and potential analyses. While the experiment design was found to be generally suitable, several points for clarification in the white paper were identified, as well as some additional model diagnostics to be added to the data request.

An important point of clarification was that for all model experiments in the future transient work stream, methane emissions (or concentrations) should always follow the

transient methane from the relevant GAINS scenario. For the runs with fixed 2015 climate forcing, it was also clarified that radiative forcing in models should be fully decoupled from climate variables (eg. concentrations of methane, ozone, and aerosols, and aerosol-cloud interactions). For the future transient runs, it was decided that modeling centers only need to deliver hourly surface output for the first 10 and last 10 years of their simulations (2010-2019 and 2040-2049).

For the calculation of ozone impacts on vegetation (all work streams), it was clarified that TFHTAP would calculate daily values of the POD3IAM metric from hourly model output and provide this to ICP Vegetation. Ozone should be provided at the lowest model level and will be scaled by TFHTAP to the canopy top based on guidance from ICP Vegetation.

For human health impacts (all work streams) it was clarified that hourly model output for ozone at the lowest model level is necessary, and that hourly output for PM2.5 and NO2 will also be useful.

For the construction of an ensemble emulator from the perturbation model runs, it was emphasized that all groups should aim to complete at least all of the runs marked as priority 1 and 2 in the white paper.

For the analysis of chemistry-climate interactions from future transient runs, it was suggested that climate modelers contributing to the future transient work stream should try to harmonize their radiation double-calls. This will be discussed further by the relevant modelling centers.

For the analysis of tropospheric ozone budgets (all work streams), it was noted that the experiment design including two distinct future emission pathways will provide a good test of the model responses to changing emissions. Modeling centers were asked to make sure their online tropopause definition follows the thermal tropopause definition from the WMO and that tropospheric ozone columns are reported using this definition. Several additional model diagnostics were identified as being useful: do3chm and tropdo3chm (change in ozone across the chemical timestep); production of Ox from photolysis of molecular oxygen; and secondary production of CO.

For the provision of total deposition model output for the WMO MMF-GTAD exercise (historical transient run), it was clarified that all available model years will be useful, but that the most recent years will be the most useful.

For model evaluation (all work streams) it was confirmed that the existing data request is adequate. The addition of vertical profiles of ozone at ozonesonde sites would also be useful.

HTAP3-Fires: multi-pollutant impacts of wildfires (May 8 and 9)

The Fires session started with an overview of the status of the HTAP3-Fires project. The white paper was accepted at the time, and was fully published a few weeks later (<https://gmd.copernicus.org/articles/18/3265/2025/>). HTAP3-Fires has 8 experiments designed to answer science policy questions related to open biomass burning emissions and how they impact air quality, health, and climate, as well as improving representation of biomass burning in models. There are 8 source regions defined that cover the globe, which are different from the OPNS project, as they are more focused on fire regimes, in addition to political boundaries. As model simulations get started, a technical guidance document is available for additional details and FAQs that run beyond the white paper. The prescribed emissions for HTAP3-Fires are the same as those for OPNS.

HTAP3-Fires for Short-Lived Climate Forcers (afternoon of May 8)

An initial assessment of the HTAP3-Fires emissions (biomass burning and anthropogenic) for aerosol species, BC, OC, and SO₂ was presented during the overview, as they compare to CMIP6 and CMIP7 emissions. While there are differences, the HTAP emissions are reasonable and more up to date.

For short-lived climate forcers (SLCFs), the HTAP3-Fires project is aiming to deliver model output that will be used for a fires-focused Arctic Monitoring and Assessment Programme (AMAP) report – ideally to be published in spring 2027, but possibly in 2028. An overview of the science-policy questions, sub-experiments, and timelines of interest to AMAP SLCF were presented. An [inter-journal special issue](#) for HTAP3-Fires is already open for submissions, and will be until December 2027. We expect most HTAP3-Fires publications to occur towards the end of this special issue's timeline.

There was a presentation on the HTAPv3.1 emissions dataset, which provided details on how this emissions mosaic was created. Some discussion about whether methane emissions could be included occurred, and it was determined that it could not be provided in a timely manner, though there is still interest.

Similarly, there was a presentation on the GFAS4HTAPv1.2.1 emissions, including methods and recent developments towards VOC species and injection heights.

Following the meeting, steps were taken to finalize the emission factors for remaining missing species for HTAP Fires.

Finally, there was a presentation on future fire emissions, in which the methodology was discussed. It was noted that future fire projections that are sensitive to climate increase in the future, however, by 2050, which is the end year for HTAP3-Fires future simulations, the fires have not yet changed much from present day. The future fire emissions also don't include peat fires. Discussion included sending the final set of emission factors so that this emissions dataset can be completed and published, as well as to what level the bias correction would need to be done, given the large uncertainties in fire emission datasets in general.

There were two additional presentations in this session, one on the uncertainty in biomass burning emissions, with a focus on CO and satellite measurements, and the second on the recent results from the AeroCom multi-model biomass burning study, focused on aerosol species. This project included multi-model evaluation of AOD, the intermodal diversity, despite all being driven by the same set of emissions, and assessment of fire plume injection height.

Discussions after the presentations included on the topic of OC-BC ratios, and MISR-derived plume injections.

HTAP3-Fires for Hg, PAH, PCDD/Fs (afternoon of May 9)

Presentations and discussions in this session focused primarily on the choice of pollutants to include in this work, and how they can be included in the emission inventory. The session was informed that a parallel activity of the Arctic Monitoring Assessment Program on POPs/CEAC Trends is collecting observation data that will be useful for model evaluation and can be made directly available to the HTAP working group.

HTAP Emission factors are available for Hg and several PAH and dioxin species, and these are included in the GFAS4HTAP inventory which will be used in the HTAP3-Fires exercise. Global modelling of PAHs and dioxin from fires have begun. These emissions factors have a high level of uncertainty. Intercomparison modelling result evaluation with observations of major fire events can help identify modelling bias and quantify and reduce emission factor uncertainty. Backward trajectory and high resolution dispersion modeling of these major fire events detected in observations can contribute to the evaluation of the proposed Hg, PAH and PCDD/F global modelling exercises.

For species which are not included in the inventory due to a lack of emission factor estimates, it may be possible to estimate the emission factors using inverse modelling based on observations of fire plumes.

It was suggested to encourage and support the addition of PCB modelling of fires to the HTAP exercises due to the advantage of PCB's wide range of chemical properties, greater availability of observation data and past experience modelling (including with HTAP earlier intercomparison modelling). This would aid in relating results to other POPs/CEC species with similar physical-chemical properties. But at this stage, those capable of global modelling do not have the funding to do so. It is possible in the HTAP exercise to begin the foundation of these efforts to model PCB and other POPS/CEC fire emissions with Lagrangian and hybrid Lagrangian-Eulerian models which use less computational resources and can build from the POLARCAT collaboration with extensive data following and observed wildfire plume for the International Polar Year.

The next steps will be to map out existing activities related to modelling and estimating emissions factors for toxic chemicals, and to draft a model intercomparison plan coordinated with the existing HTAP3-Fires activities.

MCHgMAP (morning of May 9)

The Multi-Compartment Mercury Modelling and Analysis Project (MCHgMAP) is an international scientific initiative originally designed under TF HTAP to inform the effectiveness evaluation of both the Air Convention and the Minamata Convention on Mercury through multi-model assessment and attribution of geospatial variation and temporal trends in mercury pollution. MCHgMAP combines models of the atmosphere, oceans, land, and global mercury budgets, and promotes collaboration between emissions reporting, monitoring, and modelling communities to improve data and inform global policy decisions. A comprehensive description of the multi-model experiment programme was recently published in the white paper (<https://gmd.copernicus.org/articles/18/2747/2025/gmd-18-2747-2025.html>).

Presentations and discussions in this session focused on available emissions and monitoring data, the status and preliminary results of ongoing model experiments, and plans for future simulation and analysis.

An overview of the project design and experiments was presented at the beginning of the session, highlighting the complex nature of mercury cycling in the environment, which requires coupling atmospheric, oceanic, terrestrial, and mass balance models for multi-compartment simulations of Hg dispersion. This was followed by several presentations that provided an overview of the global mercury emissions inventory (EDGAR v8.1) covering the period 1970–2022, compiled data on geogenic emissions and their uncertainties, as well as the latest emissions inventory and future scenarios from IIASA.

The second part of the session addressed preliminary results from the first phase of the project, which aimed to simulate and analyse the spatial distribution and temporal trends of mercury levels in both the atmosphere and the ocean. Atmospheric model experiments for the baseline case have been completed, and a preliminary evaluation shows that the model ensemble generally reproduces observed patterns of atmospheric mercury concentration and deposition well but does not reproduce the observed declining trend observed in the Northern Hemisphere. This may be due to missing sources such as emissions overlooked in the inventories or re-emission from legacy contaminated sites. To analyse this discrepancy, a number of additional emission scenarios were developed and included in the model experiments. The ocean simulations showed reasonable consistency among the models and with observations. However, evaluation of ocean model experiments is challenging due to the sparse temporal and spatial coverage of available measurements and is ongoing.

The key focus of the Hg work will be to inform the effectiveness evaluation for the Minamata Convention, with discussions on application of the Hg work to CLRTAP priorities to occur after delivery of results to the Minamata Convention.

PFAS (afternoon of May 7)

This session brought together leading experts in PFAS modeling and measurements. The workshop marked an important step toward a coordinated international effort to coordinate emission inventories, modeling approaches, and observational data for PFAS.

Participants discussed current challenges and opportunities in modeling the global distribution and impacts of PFAS and initiated work on a joint white paper to support future comparative assessments. The workshop was organized by Dr. Johannes Bieser and Dr. Martin Otto Paul Ramacher (Helmholtz-Zentrum Hereon, Germany). Parties interested in participating in the upcoming PFAS modelling initiative can register under: <https://coastalpollutiontoolbox.org/117872/index.php.en>