AIR CONVENTION
(CONVENTION ON LONG-RANGE TRANSBOUNDARY AIR POLLUTION)

Cooperative Programme for Monitoring and Evaluation of the Long-range Transmission of Air Pollutants in Europe (EMEP)

TASK FORCE ON INTEGRATED ASSESSMENT MODELLING (TFIAM)
with a special session of the
TASK FORCE ON HEMISPHERIC TRANSPORT OF AIR POLLUTION (TFHTAP)

46th session, 2 - 3 May 2017
Paris, France

Chairs report

I. INTRODUCTION

1. This report describes the results of the 46th session of TFIAM, held from the 2nd to the 3rd of May 2017 in Paris, France. The presentations made during the meeting and the reports presented are available at: http://www.iiasa.ac.at/web/home/research/researchPrograms/air/policy/past_meetings.html.

2. 46 experts attended, representing the following Parties to the Convention: Belarus, Denmark, European Commission, Finland, France, Germany, Ireland, the Netherlands, Norway, Portugal, Sweden, Switzerland, United Kingdom of Great Britain and Northern Ireland, and the United States of America. Other bodies represented were the EMEP Centre for Integrated Assessment Modelling (CIAM), the EMEP Steering Body, the EMEP Meteorological Synthesizing Centre-west, ICP Vegetation, the Coordination Centre for Effects, the Task Force on Techno-Economic Issues (TFTEI), Airclim/the European Environment Bureau (EEB), CONCAWE, the Climate and Clean Air Coalition (CCAC), the Arctic Monitoring and Assessment Program (AMAP), the OECD and the International Council on Clean Transport (ICCT).

3. Mr. R. Maas (Netherlands), Mr. S. Åström (Sweden), Mr. F. Dentener (JRC), and Mr. T. Keating (United States) chaired the meeting.

4. The chair of the EMEP Steering Body, Ms. Laurence Rouil, welcomed TFIAM to Paris and opened the meeting. Ms. Rouil presented the current developments following the CLRTAP Assessment Report, including the work of the Ad Hoc Policy Review Group of Experts on the 2016 Scientific Assessment of the Convention. The group will present their policy proposals at the WGSR meeting in May-June 2017.

II. OBJECTIVES OF THE MEETING AND NEWS FROM OTHER BODIES

5. Mr. Maas presented the latest developments within the CLRTAP and defined the purposes of the 46th TFIAM meeting (TFIAM 46). The purposes of TFIAM 46 were to:

- assess the status of models,
- assess available scenarios,
- define policy packages or measures to be explored further,
- learn from national/regional/sectoral analysis, and
- define further cooperation of TFIAM and TFHTAP

6. The main focus of TFIAM is to enable development of cost effective policy strategies for the Air Convention and to highlight links with other policy processes, such as the implementation of the UN Sustainable Development Goals.

7. In the current work plan TFIAM focuses on integration across scales: a) the cost-effectiveness of regional versus local measures (see the main conclusions of the workshop on local measures held in Utrecht 14-15 February in the annex to this report) and b) the effectiveness of regional versus global measures, which includes linkages to global issues such as the increase of background ozone, the role of short lived climate pollutants and the accumulation of heavy metals and POPs. For the latter, cooperation between TFIAM and TFHTAP seems sensible.

III. TFHTAP SPECIAL SESSION

8. The co-Chair of TFHTAP, Mr. Dentener opened the TFHTAP special session. TFHTAP started in 2005 and is now completing a second round of cooperative experiments referred to as HTAP2. HTAP2 is focused on quantifying intercontinental influences on regional air quality to evaluate air pollution control potentials and their impacts. TFHTAP seeks to identify relevant policy scenarios at the continental and global scales as a basis for such analyses.

9. Tentative conclusions from HTAP2 are that the findings of the first phase of cooperative experiments (HTAP1) on the near-linear relationship between emissions of ozone precursors in the northern hemisphere and background ozone (O_3) levels are still valid. Methane is important drive of future ozone trends. Ozone peaks however seem more related to local sources in a non-linear way. Exposure of the population to high levels of particulate matter and nitrogen dioxide (NO_2) is predominantly caused by local sources, but forms a universal phenomenon in urbanised areas that could be tackled with internationally coordinated action. The experience from TFHTAP is that international collaboration is important for driving knowledge development. Regular workshops and meetings help align the research of different research groups, but are increasingly difficult to organize when connecting to multiple global actors.

10. CIAM presented recent GAINS model developments. One part of the work has been to assess air pollution projections of the Shared Socio-economic Pathways (SSP) developed under the Intergovernmental Panel on Climate Change. The range of the SSP emission projections is larger than in the previous RCPs used for IPCC AR5 report. HTAP2 was using the ECLIPSEv5a scenarios with several policy assumptions (GAINS HTAP CLE & MTFR in this report). Further climate policy assumptions were based on IEA projections (GAINS IEA-NPS). The GAINS HTAP-MTFR scenario leads to lower emissions than the SSP scenario with lowest emissions. The

SSP3 scenario is the SSP with highest emissions of sulphur dioxide (SO_2) and nitrogen oxides (NO_x) for 2050 as it is based on increased use of fossil fuels and modest autonomous development in air pollution control. However the SSP3 emissions for 2050 are lower than the GAINS HTAP-CLE projections (GAINS HTAP-CLE assumes no further steps than current legislation). A GAINS IEA-NPS scenario developed for the IEA in 2016 –assuming full implementation of the pledges under the Paris Agreement- showed a significant decline in emissions of SO_2 and Black Carbon, especially in Asia.

11. Recent review of emission scenarios in Asia made during the last 20 years shows the importance of what is assumed regarding the timing of air and energy policy implementation as well as the level of enforcement. Analysis also shows that dedicated air pollution control has been important for the control of SO_2 and NO_x emissions in China and India, but demographic trends (aging population), rising energy use, and urbanization counteract health benefits of air pollution control.

12. TFIAM noted the recent work with TM5-FASST model on ozone by the European Commission's Joint Research Centre. TM5-FASST calculates ozone and PM concentrations and impacts based on air pollution emissions from 56 regions over the world and for different emission control scenarios; results were largely coherent with HTAP scenarios used for the CLRTAP Assessment report, but provided larger regional details for e.g. Europe.

13. Analyses using TM5-FASST showed that ozone levels will increase over Europe if no further control is implemented. Tentative results also show that winter and summer ozone concentrations react differently to emission reductions. Air pollution control and methane control will help to reduce ozone concentrations. TM5-FASST is freely available to use and can be found at: http://tm5-fasst.jrc.ec.europa.eu/ .

14. Current outlook activities include development of an EMEP-FASST model using European-scale source-receptor relationships and further efforts to address non-linear ozone responses at the regional scale. The development of a version of FASST based on the HTAP2 source-receptor relationships is under discussion.

15. TFIAM acknowledged the presentation by CCE. The 2015 call for critical load data has now (2017) been reported by 13 national focal points and the data reported is currently under review. Tentative analyses show relatively small differences between the old and new data for eutrophication critical load, but (relatively) larger differences for acidification critical loads. CCE have produced also critical loads for biodiversity impacts from sulphur and nitrogen deposition, which would lead to stricter limits for sulphur. The main areas where exceedance is virtually certain are located in Western & Central Europe. CCE, in collaboration with EMEP/MSC-E, has done CL and exceedance calculations also for mercury for the (northern) Northern Hemisphere, indicating the opportunities to reduce exceedances, if dedicated emission controls were implemented.

16. In view of the uncertain future of the CCE, TFIAM recommends to the WGE that it requests the ICP M&M National Focal Centres (NFC) to continue their work into 2018 for the CCE call for data on biodiversity critical loads; to report these results to the 34th session of the Task Force on M&M in April 2018 for review by the 4th joint meeting of the EMEP-SB and WGE in September 2018; and to maintain and digitally safeguard the NFC-data on critical loads of biodiversity until these can be

submitted to a new Programme Centre of the ICP M&M to be established by the EB for the coming work plan period of the Convention.

17. TFIAM recognised that the Arctic Council AMAP work plan offers opportunities for increased cooperation in general and cooperation on joint thematic assessment reports in particular. One of the recent developments is a proposed Black Carbon project sponsored by the European Commission. AMAP will take the role as coordinating agency. Other issues for cooperation could be related to SLCP emissions (including ozone), shipping, domestic wood burning, or nitrogen. Specification of the issues will depend on LRTAP decisions on priorities inter alia on the basis of the recommendations by the Ad hoc Policy Review Group of Experts.

18. TFIAM took note of the presentation of the PACES initiative. PACES is focused on identifying remote and local sources of arctic air pollution and interactions with other environmental issues. Two main elements of the PACES activities are to improve the predictive capabilities of models and to improve knowledge on the societal impacts of arctic air pollution.

19. TFIAM also noted the presentation by OECD on the future global economic costs from emissions of air pollutants if no action is taken. The analysis included not only the economic values of health endpoints but also the impacts on economic growth from reduced labour productivity, additional health expenditures and reduced crop yields. These market costs constitute up to 5 – 30% of the total welfare costs of air pollution and are growing significantly over time if no further action is taken.

20. TFIAM acknowledged the presentation from the consultant Environmental Health Analytics on emissions from the global transport sector. Recent analysis shows that the difference between real-life emission factors and test cycle emission factors for cars, buses, and trucks occurs in all world regions and is estimated to be responsible for 38 000 cases of premature deaths related to secondary PM and ozone. A new generation real driving NO_x-emission standards could avoid 174 000 cases of premature death by 2040.

21. TFIAM appreciated the presentation by the Pacific Northwest National Laboratory on the assumptions behind the air pollution emission projections in the recently developed SSP scenarios. The historical emissions data used in this effort are available for review by interested experts and comments are welcome online at: http://www.geosci-model-dev-discuss.net/gmd-2017-43/ .

22. The CCAC presented an overview of objectives and ongoing activities, e.g. on black carbon and the development of national actions plans. The CCAC seeks cooperation with CLRTAP and the scientific expertise available within CLRTAP to improve emission inventories and impact assessments.

23. CIAM presented recent developments in estimating current and future methane emissions. The importance of methane for global warming has increased. Concentrations are up 144% from pre-industrial levels, and the climate metric for methane (GWP100) has been re-evaluated from IPCC AR4 to AR5 (last 10 years) from 21 to 32 times more potent than carbon dioxide (CO_2) per kg emission. Globally there is a fairly large amount of control options with negative costs. Examples of non-conventional options to reduce methane emissions include converting methane currently flared into liquid methanol, reducing the use of antibiotics for animals, as well as changing human diets. These options need follow-up and cost information prior to analysis with IAM.

24. MSC-West updated the TFIAM on differences between the HTAP1 and HTAP2 results for ozone import into Europe. Due to differences in the definition of source regions in HTAP1 (large squares including oceans) and HTAP2 (following geo-political boundaries), the important role of shipping emissions for ozone formation over Europe can be seen more explicitly in HTAP2. Furthermore, for European ozone concentration (background levels) it is more important to implement all available technical control of NO_x and non-methane volatile organic compounds (NMVOC) emissions in areas outside Europe and to implement European and global reductions of methane than to implement further European controls on NO_x and NMVOC. Due to global warming, the lifetime of ozone and its precursors is expected to decrease, which may reduce the relative importance of ozone transport into Europe. However, further analysis is needed to consider simultaneous changes to climate, emissions in Europe, and emissions in the rest of the world. Efforts being planned under the ACCMIP experiments may provide insights (https://www.giss.nasa.gov/projects/accmip/).

25. Regarding the development of national/regional/hemispheric emission scenarios of ozone precursors TFIAM 46 can confirm that several parties to the Convention develop ozone precursor emission scenarios and that MSC-West and ICP Vegetation have developed several scenarios on future ozone levels and ozone impacts on regional and global levels. MSC-West found that methane reduction and non-European emission reductions outside Europe is most important for European (background) ozone concentrations.

26. ICP Vegetation had updated the ozone critical levels -and stressed the importance of the flux based approach to assess ozone impacts. Global model calculations showed that more than 9% of the global wheat production was lost due to ozone damage and that especially biodiversity in global biodiversity hot spot areas were at risk from ozone. ICP Vegetation is also engaged in outreach activities, including the Tropospheric Ozone Assessment Report, which is expected to be published this year.

27. TFIAM noted the presentation from the Netherlands on national methane emission projections. Reported reductions in methane emission from the Netherlands seemed to be higher than estimated from measurements and inverse modelling. The decrease in reported emissions is largely due to methane recovery from landfills. Emissions from gas and oil recovery are already low. However, methane emissions per cow have increased. Future reduction options such as changes in cattle feed and anaerobic digestion of manure might increase ammonia emissions.

Summary of TFIAM / TFHTAP discussion

28. During TFIAM 46 there were several discussions about future TFHTAP and TFIAM activities. This section summarizes some of the elements discussed.

29. The discussion was framed around two policy questions:

- Do sources outside the UNECE region contribute to problems within the region and is it more cost effective to reduce emissions in other regions?
- Which are the universal or common regional problems that can more cost-effectively be tackled with the same technological solutions or policy tools that can be transferred between regions?

30. TFHTAP can confirm that ozone precursors (mainly affecting background ozone levels), mercury, and some POPs, are transported between regions at intercontinental scales. Anthropogenic PM2.5 and other pollutants are transported to a lesser extent between regions, with most of the intercontinental PM2.5 transport associated with dust and fires. However, important contributions of similar magnitude from both ozone and PM on health impacts have been calculated.

31. A number of questions that were brought up in the discussion are currently being addressed as part of TFHTAP's ongoing work program. These include the need for an improved understanding of the heterogeneity in global model estimates of long-range transport, the linearity (or nonlinearity) of source/receptor relationships at different spatial and temporal scales, and the appropriate spatial resolution for estimating exposures and impacts.

32. The special session confirmed the need for TFHTAP to complete its current work plan by:

- Summarizing the current performance of global and regional models and the response of regional models to boundary conditions.
- Completing the estimation of global and nested source/receptor relationships and provide corroborating evidence of these.
- Exploring the implications of the CLE revisions and the methane scenarios and cost estimates.
- Evaluating the capabilities to address sectoral control measures, particularly for shipping, aviation, and agriculture.

33. With respect to the directions of future work under TFHTAP, several topics were discussed including

- cooperation with ICP Vegetation, AMAP, and other groups
- inclusion in TM-FASST of the same ozone metrics that are used in GAINS
- an assessment of deposition and the integration of ozone, nitrogen, mercury, POPs and climate change.

34. To address specific policy-relevant questions identified in the context of the Convention (such as the potential benefits of mitigating sources in a particular sector), it was suggested that focused reports or papers could be developed by small teams of experts drawn from TFHTAP, TFIAM, and other relevant bodies.

IV. UPDATES ON EUROPEAN SCIENTIFIC RESEARCH

35. TFIAM noted the latest CIAM developments of the GAINS model. Current focus lies on updating emission projections with respect to base year values and key (PRIMES model) scenarios. A recent review showed that emission inventories reported by the parties to the Convention for past years are still varying between submission years. These variations imply difficulties in the GAINS modelling for base years and for scenarios.

36. EMRC presented recent developments of air pollution cost-benefit analysis. Recent environmental economic studies of chemicals give values of statistical lives in

the same range as is currently used in air pollution Cost-Benefit studies. There is now a growing amount of literature on human health impacts from NO2 exposure. In the United Kingdom, the COMEAP is currently studying health impacts from air pollution. In contrast to HRAPIE, COMEAP is uncertain of the overlap between NO2 and PM health impacts but recommends using a lower risk factor for NO2 than recommended by HRAPIE while not using a safe threshold. For the economic valuation of air pollution, it is important to recognise that real numbers of fatalities linked to air pollution might be higher than estimates from quantitative analysis, although not visible on average.

V. NATIONAL EXPERIENCES

37. TFIAM appreciated the presentation from Belarus. In Belarus recent scenario analysis has been made for future emissions of NO_x and SO_2, including its control costs. The impact part of the integrated analysis showed a limited impact of national measures in Belarus due to large transboundary contributions.

38. TFIAM took note of the presentation on the Irish national mitigation plan for greenhouse gases and air pollution. The final plan will be published in June 2017. The policymeasures.com database will be available as support to the implementation of the plan. Current policies under investigation are the "smoky coal" ban, remote working, and car purchase modelling (to be used to analyse impacts of car purchase subsidies etc.).

39. TFIAM appreciated the presentation by the UCL from the United Kingdom on a hypothetical British energy system dominated by renewable energy. Renewable energy will lead to lower emissions, but the higher variability of production requires a storage capacity of 10% of total annual electricity demand. Another option instead of storage is to strengthen the European electricity transmission grids. Currently UCL is analysing the best balance between storage, transmission, and trade.

40. TFIAM noted a presentation ICL from the United Kingdom. The diesel car exhaust gas problems appear to have started a shift in the vehicle purchase patterns in the UK back towards petrol. Vehicle emission studies confirm the problem with super-emitting cars shifting the average NO_x emissions from Euro 5 and Euro 6 diesel cars, but also illustrate the higher real-world emissions of CO_2 from petrol cars. An air emissions index (www.equaindex.com) has been developed by Emissions Analytics for consumers to use when considering car purchases.

41. TFIAM acknowledged the presentation from Germany, one of the countries in the EU with frequent exceedances of NO_2 air quality limit values and therefore high interest in long term control of NO_2 emissions. Germany had increased its vehicle emission factors for Euro 4, 5 and 6 vehicles that take into account that exhaust gas recirculation is switched off at low temperatures. Analysis of scenarios for alternative transport measures that can improve the urban air quality in Munich showed that of the analysed measures, the only measure that can achieve air quality levels by 2020 is a ban of diesel personal cars. Low emission zones (enabling a fast penetration of euro-6 vehicles) would be sufficient if the limit value would have to be achieved by 2025. Also modal shifts was analysed but with lower impact.

42. TFIAM noted the presentation by IER on behavioural change measures to reduce transport emissions by shifting transport modes. From a specific case study, the policy recommendations were that the use of public transport should be promoted via less

expensive and more attractive public transport, rather than punish the use of private transport.

43. TFIAM appreciated the presentation from the French representatives. A coupled model multi-criteria analysis had been used to analyse inter alia cost effectiveness, cost-benefit and public acceptance of the measures studied. The results were based on a pre-Paris Agreement energy scenario and showed that the 2020 NEC targets are achievable, but that the 2030 targets for SO_2 and NMVOC are problematic. According to air quality scenarios, ozone concentrations in the north of France are expected to increase with reduced NO_x emissions from transport, due to the so-called "titration effect".

VI. FURTHER WORK

44. The 47th session of TFIAM will take place in Brescia Italy sometime during the period 7-11 May 2018. The TFIAM 47 is planned to be arranged as a back to back meeting with the International Federation of Automatic Control (IFAC).

VII. ANY OTHER BUSINESS

45. Several parties highlighted the need to add analysis of heavy metals mitigation options, abatement costs, and benefits to ecosystems and human health into the work of TFIAM.

46. The amount of freely available tools for air pollution policy analysis is increasing. Recently a web-version of the TM5-FASST model has been made available on http://tm5-fasst.jrc.ec.europa.eu/ and can be accessed and run upon registration. Earlier, the SHERPA model (http://aqm.jrc.ec.europa.eu/sherpa.aspx) and the GAINS online scenario analysis models (http://gains.iiasa.ac.at/models/index.html) are available.

ANNEX: TFIAM/FAIRMODE WORKSHOP ON MODELLING URBAN AND REGIONALMEASURES FOR IMPROVED AIR QUALITY

1. This annex describes the main conclusions of the TFIAM/FAIRMODE workshop on modelling urban and regional measures for improved air quality, held from the 15th to the 16th of February 2017 in Utrecht, the Netherlands. The presentations made during the meeting and the reports presented are available at: http://www.iiasa.ac.at/TFIAM-FAIRMODE.html

2. 60 experts attended the workshop. The following countries and parties to the Convention were represented: Belgium, Croatia, Czech Republic, Cyprus, Denmark, European Commission, Finland, France, Germany, Ireland, Italy, The Netherlands, Norway, Portugal, Slovakia, Slovenia, Spain, Sweden, and United Kingdom. Other bodies represented were: Airclim, the EMEP Centre for Integrated Assessment Modelling (CIAM), CONCAWE, the European Environment Bureau (EEB) and JRC.

3. The findings from the workshop are:
   a. There are no effective local measures to reduce particulate matter concentrations during episodes (with the exception of cities that are not substantially affected by surrounding sources).
   b. Regional and transboundary policy coordination remain needed.
   c. Low emission zones and traffic management were local measures that most often applied. Promotion of cycling, the use of public transport and shore-side electricity for ships seem to be cost-effective local measures. Control of domestic wood burning and combining urban energy policy with air pollution policy seem promising. At the national and international level measures to reduce ship emissions are cost-effective. Fewer restrictions on the use of economic instruments could enlarge the choice of policy instruments at the local level.
   d. Photocatalytic paint does not seem to be effective. Scrubs could form barriers between car exhausts and pedestrians. Street trees reduce dispersion of pollution.
   e. Reduction of agricultural emissions and reduction of tyre wear are a blind spot in many local air quality plans.
   f. Health is currently not a central issue in local air quality plans. Now that air quality limit values are met for most of the European population, and acknowledging that still substantial health benefits can be gained, the focus of local modelling and measurements should shift towards assessment of the impact of measures on average population exposure.
   g. By calculating the costs per life years gained the effectiveness of local, national and European wide measures can be compared. It remains important to assess co-benefits of air pollution abatement on climate, noise and nature, to assess who will pay for or gain from measures, and to what extent inequality issues (e.g. the accumulation of energy poverty, unequal exposure to air pollution and noise) can be addressed jointly.

4. The workshop participants advise to further develop a methodology to include the cost-effectiveness of local and regional measures in developing future air quality strategies aimed at long term targets for health and nature. It is recommended to include more local knowledge in international networks that support air policy formulation. National and international authorities are called upon to stimulate (and fund) a larger involvement of local experts.