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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**

**Working Group on Effects**

**Third joint session**
Geneva, 11–15 September 2017
Item 3 of the provisional agenda
**Progress in activities in 2017 and further development of effects-oriented activities**

# 2017 joint progress report on policy-relevant scientific findings

## Note prepared by the Chairs of the Steering Body to the Cooperative Programme for Monitoring and Evaluation of the Long-range Transmission of Air Pollutants in Europe and the Working Group on Effects, in cooperation with the secretariat

*Summary*

The present report was drafted by the Extended Bureau of the Working Group on Effects[1] and the Extended Bureau of the Steering Body to the Cooperative Programme for Monitoring and Evaluation of the Long-range Transmission of Air Pollutants in Europe (EMEP)[2] in cooperation with the secretariat to the Convention on Long-range

[1] Comprising the Bureau of the Working Group; the Chairs of the international cooperative programme task forces, the Joint Task Force on the Health Effects of Air Pollution and the Joint Expert Group on Dynamic Modelling; and representatives of the programme centres of the international cooperative programmes.

[2] Comprising the Bureau of the Steering Body, the Chairs of the EMEP task forces and representatives of EMEP centres.

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Transboundary Air Pollution. The review of recent scientific findings is based on the information provided by the lead countries and the programme centres of the international cooperative programmes, and is submitted in accordance with the 2016–2017 workplan for the implementation of the Convention (ECE/EB.AIR/133/Add.1) and the informal document approved by the Executive Body for the Convention at its thirty-fourth session, "Basic and multi-year activities in the 2016–2017 period"[3] (item 1.8.2).

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[3] Both documents are available on the web page for the Executive Body's thirty-fourth session: http://www.unece.org/index.php?id=38060#/.

# I. Introduction

1. The present report was compiled by the Chairs of the Steering Body to the Cooperative Programme for Monitoring and Evaluation of the Long-range Transmission of Air Pollutants in Europe (EMEP) and the Working Group on Effects in accordance with the 2016–2017 workplan for the Convention on Long-range Transboundary Air Pollution (ECE/EB.AIR/133/Add.1) and the informal document approved by the Executive Body for the Convention at its thirty-fourth session "Basic and multi-year activities in the 2016–2017 period"[4] (item 1.8.2). The report reflects achievements during 2016 and 2017 and was prepared with support from the scientific subsidiary bodies. The report is the second common report of the work under EMEP and the Working Group on Effects, reflecting the new organization of the two bodies with joint, integrated sessions based on a common agenda. These joint reports represent a further integration of the scientific work under the Convention and should be seen as a strengthening of the scientific basis for the Convention's policy development.

# II. Calls for data

## A. Inventory and condition of stock of materials at United Nations Educational, Scientific and Cultural Organization cultural World Heritage Sites

2. In late 2015, the International Cooperative Programme on Effects of Air Pollution on Materials, including Historic and Cultural Monuments (ICP Materials) launched a call for data on inventory and condition of stock of materials at United Nations Educational, Scientific and Cultural Organization (UNESCO) cultural World Heritage Sites. Six Parties to the Convention announced their intention to participate in the call: Croatia, Germany, Italy, Norway, Sweden and Switzerland. Of these, Croatia had previously not participated in the activities of ICP Materials and its contribution is therefore especially welcomed.

3. All documents provided by the call (the official letter disseminating the call for data, a template for submission of data, an explanatory note with instructions on the use of the reporting template and a brochure exemplifying the step-by-step approach for the previously assessed UNESCO sites) are available for downloading on a web page[5] dedicated to the call for data on the ICP Materials website. Some examples of the filled-in reporting template are also available for download from that web page.

4. So far, property and environmental data have been provided for eight outstanding monuments (Italy, Norway and Switzerland). In addition, three sites have been selected by Sweden to be studied in greater detail according to the relative risks of the sites for being affected by air pollution and climate degradation. Data on selected UNESCO sites in Germany are expected to be sent shortly. Submitted contributions are compiled in an interim report, currently dated January 2017, which is also available on the website for download. The delivery of a status report is expected in 2017.

[4] Ibid.
[5] See http://www.corr-institute.se/icp-materials/web/page.aspx?refid=20 (updated 31 January 2017).

## B. Critical loads for acidification, eutrophication and biodiversity

5. The workplan for 2015–2017 of the Coordination Centre for Effects (CCE) under the International Cooperative Programme on Modelling and Mapping of Critical Levels and Loads and Air Pollution Effects, Risks and Trends (ICP Modelling and Mapping) focused on the call for critical loads on acidification, eutrophication and biodiversity. This call enabled Parties to update their data in the European critical loads database, which can be used to support European air pollution abatement policies. New in this call was the agreed manner for compiling the critical loads for eutrophication, i.e., as the minimum of the empirical and nutrient-nitrogen critical load. The novel aspect of this call was the requirement to compute critical loads of biodiversity.

6. Fourteen Parties to the Convention, all European Union member States, submitted updated critical loads for acidification and eutrophication, while seven Parties embarked on the compilation and submission of critical loads of biodiversity. National focal centres provided most of the data for "Woodlands and Forests" (European Nature Information System class G) followed by "Grasslands, Forbs, Mosses and Lichens" (European Nature Information System class E). Using submitted critical loads and the European background database, a tentative analysis was conducted of exceedances in 2005 for the baseline emission scenario compiled to support the European Union Thematic Strategy on Air Pollution and deposition patterns of sulphur and nitrogen computed by EMEP. Results reveal that critical loads for acidification, eutrophication and biodiversity are exceeded in 11 per cent, 68 per cent and 27 per cent, respectively, of the ecosystem area within the EMEP domain. For the 28 European Union member States the percentages of the ecosystem area at risk are 13 per cent, 81 per cent and 28 per cent, respectively.

7. At the thirty-third meeting of the ICP Modelling and Mapping Task Force (Wallingford, United Kingdom of Great Britain and Northern Ireland, 4–6 April 2017), representatives of national focal centres emphasized that further work on biodiversity critical loads, in particular, was required. While the Task Force recommended that CCE and the Centre for Integrated Assessment Modelling should proceed with the implementation of the updated critical loads for acidification and eutrophication in the Greenhouse Gas Air Pollution Interactions and Synergies (GAINS) model for integrated assessment applications, it was noted that the use of critical loads of biodiversity should, for the time being, be restricted to scientific applications only.

# III. Air pollution effects on health

8. In 2016, the World Health Organization (WHO) released a new study, *Ambient Air Pollution: A Global Assessment of Exposure and Burden of Disease*.[6] According to this study, in the European region almost 290,000 were attributable to ambient air pollution in high-income countries and 190,000 deaths in middle- and low- income countries in 2012. WHO is updating its outdoor air pollution database with more recent estimates, including new cities and also developing methods to include data from rural areas.

9. In 2016, WHO launched AirQ+: a software tool that quantifies the health effects of exposure to air pollution, including estimates of the reduction in life expectancy. One year after its launch, AirQ+ has been downloaded from 290 cities in 70 countries. An online

[6] WHO, Geneva.

survey shows 92 per cent of users are interested in a user's forum. WHO has supported several member States to quantify effects of air pollution on human health. Two of those countries, Hungary and Serbia, reported case studies using AirQ+, and provided useful feedback on the future tool application during the twentieth meeting of the Joint Task Force on the Health Aspects of Air Pollution (Bonn, Germany, 16–17 May 2017). In order to further raise awareness of the adverse health effects of air pollution in the region, WHO is designing a capacity-building curriculum (including using AirQ+) targeting public health and environmental experts, policymakers and advocacy groups. WHO is currently updating AirQ+, including the new functionality –DALY (disability-adjusted life year).

10. The process of the update of global WHO global air quality guidelines, initiated in 2016, is ongoing. The project aims to provide updated numerical concentration limits and, where possible, an indication of the shape of the concentration-response function, for a number of ambient air pollutants, for relevant averaging times and in relation to critical health outcomes. The air pollutants included are: particulate matter and its fractions with a diameter less than 2.5 and 10 micrometres (PM, $PM_{2.5}$ and $PM_{10}$); nitrogen dioxide; ozone; sulphur dioxide; and carbon monoxide. The health outcomes to be systematically reviewed as part of the guidelines process were selected based on a framework for causality and severity of outcomes. They vary per pollutant and averaging time, but include mortality (all-cause and/or cause-specific) and emergency department visits or hospital admission due to asthma or ischemic heart disease. The development of the detailed methodology for guideline development and conduct of systematic reviews and meta-analyses is ongoing through 2017–2018.

# IV. Air pollution effects on terrestrial ecosystems: evidence of recovery but still threatened

## A. Forests

11. The International Cooperative Programme on Assessment and Monitoring of Air Pollution Effects on Forests (ICP Forests) long-term monitoring is a substantial option for effects-related studies, as evidenced by the fact that 24 scientific (International Scientific Indexing) papers were published between May 2016 and May 2017 based on ICP Forests data or with considerable use of the ICP Forests infrastructure. An ecosystem-related study underlines the high value of long data series by analysing soil, deposition, foliar and defoliation data from two plots in the Solling mountain ranges in Germany, where monitoring started in the 1960s. Generally higher inputs of air pollutants in spruce compared with beech stands under comparable natural conditions were found. The highest sulphur inputs occurred around 1980 and nitrogen inputs were also considerably higher in the 1970s and 1980s than today. As an indication of nitrogen saturation, considerable amounts of nitrate were leached in intervals from the spruce ecosystems since the 1970s, while nitrate has been leached from the beech stand only after 2000. Beech and spruce foliage revealed a significant decrease of potassium over the decades, whereas the foliar base cation to nitrogen ratio only declined in spruce. Defoliation, estimated since the 1980s, was constantly on a comparatively high level of circa 30 per cent for both tree species, while adjacent limed stands are less defoliated. The reduction of sulphur and to a lesser extent nitrogen deposition reflects efforts of international clean air policy under the Convention; however, critical loads for acidity and eutrophying nitrogen are still exceeded. Owing to the remobilization of sulphur from the soils, leaching of base cations is still

ongoing and only on the beech plot some indications of recovery from acidification are visible, rendering further monitoring indispensable.

12. The composition of ground vegetation and its change from European-wide ICP Forests Level II sites between 1995 and 2006 were analysed. Data on soil chemistry, climate, tree species composition, and stand age were used as explanatory variables along with interpolated deposition estimates of sulphate, nitrate and ammonia. Spatial variation is mainly determined by the traditional factors related to soil type and climate; however, a significant part of the floristic composition could be ascribed to atmospheric nitrate deposition. Interestingly, floristic changes in time were also correlated to nitrate deposition, but this could not be shown for any single species. In an approach used in Czechia, coincidences between the occurrence of selected nitrophilous species and mainly the carbon/nitrogen ratio in soil and — less obvious — total nitrogen concentration in upper mineral soil were detected.

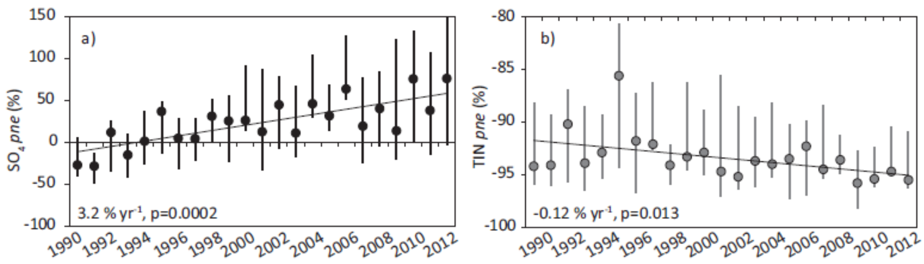
## B. Integrated monitoring in catchments

13. Site-specific annual input-output budgets for sulphate ($SO_4$) and total inorganic nitrogen (TIN) were calculated for 17 European sites of the International Cooperative Programme on Integrated Monitoring of Air Pollution Effects on Ecosystems (ICP Integrated Monitoring) in 1990–2012. Temporal trends for input (deposition) and output (run-off water) fluxes and the net retention/net release of $SO_4$ and TIN were also analysed. Large differences in the input and output fluxes of $SO_4$ and TIN reflect important gradients of air pollution effects in Europe, with the highest deposition and run-off water fluxes at ICP Integrated Monitoring sites located in southern Scandinavia and in parts of Central and Eastern Europe and the lowest fluxes at more remote sites in Northern European regions. A significant decrease in the total (wet + dry) deposition of non-marine $SO_4$ and bulk deposition of TIN was found at 90 per cent and 65 per cent of the sites, respectively.

14. Output fluxes of non-marine $SO_4$ in run-off decreased significantly at 65 per cent of the sites, indicating positive effects of the international emission abatement actions in Europe during the past 20 years. Catchments retained $SO_4$ in the early and mid-1990s, but this shifted towards a net release in the late 1990s, which may be due to the mobilization of legacy sulphur pools accumulated during times of high atmospheric $SO_4$ deposition (figure 1). Despite decreased deposition, TIN output fluxes and retention rates showed a mixed response with both decreasing (nine sites) and increasing (eight sites) trend slopes, and trends were rarely significant. In general, TIN was strongly retained in the catchments not affected by natural disturbances. The net release of $SO_4$ from forest soils may delay the recovery from acidification for surface waters and the continued enrichment of nitrogen in catchment soils poses a threat to terrestrial biodiversity and may ultimately lead to a higher TIN run-off through nitrogen saturation. Continued monitoring and further evaluations of mass balance budgets are thus needed.

Figure 1

**Annual percentiles (25 per cent, median 50 per cent, 75 per cent) of percent net export (pne, per cent) for $SO_4$ (a) and TIN (b) at the ICP Integrated Monitoring sites CZ01, CZ02, DE01, FI01, FI03, NO01, NO02 and SE04 in 1990–2012**




*Source*: Jussi Vuorenmaa and others, “Long-term sulphate and inorganic nitrogen mass balance budgets in European ICP Integrated Monitoring catchments (1990–2012)”, *Ecological Indicators*, vol. 76 (2017) pp. 15–29. DOI: http://dx.doi.org/10.1016/j.ecolind.2016.12.040.

# V. Air pollution effects on aquatic ecosystems

15. The International Cooperative Programme on Assessment and Monitoring of the Effects of Air Pollution on Rivers and Lakes (ICP Waters) monitoring network is tailored to document responses in water chemistry to changes in atmospheric loads of air pollution. New countries are starting to contribute (Republic of Moldova) while several countries have reinitiated their participation (Ireland and Poland). Collaboration within the Convention has intensified through organization of joint meetings with ICP Integrating Monitoring. Reports and results that are delivered continue to be of relevance under the Convention and outside, for instance for the European Union National Emission Ceilings Directive[7] or the Minamata Convention on Mercury.

16. As the emissions of the pollutant mercury (Hg) are regulated and included in old and new international legislation, conventions and agreements (e.g., the Arctic Monitoring and Assessment Programme, the Minamata Convention and the European Union Water Framework Directive[8]), documentation of spatial patterns and temporal trends in Hg levels in ecosystems is therefore highly opportune. The database on Hg in fish in Finland, Norway and Sweden, with some data from the Kola Peninsula, consists of over 50,000 observations of Hg in fish covering the period 1965 to 2015 (the most extensive database of its kind). More than 40 per cent of the almost 2,800 lakes in the database have fish Hg levels that exceed typical environmental quality standards (0.5 milligrams per kilogram) established as limits for human consumption. There were no uniform changes observed for temporal trends in fish Hg concentrations from lakes with sufficient historical records (less than five years of data). The respective report will be delivered by September 2017.

17. A study of high altitude lakes in the Southern Alps in Switzerland demonstrated that water chemistry (sulphate, nitrate) in most lakes reflects precipitation chemistry and show

[7] Directive 2001/81/EC of the European Parliament and of the Council of 23 October 2001 on national emission ceilings for certain atmospheric pollutants, 2001 O.J. (L 309).

[8] Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy, 2000 O.J. (L 327).

strong signs of chemical recovery. However, there were deviating patterns in the lakes at the highest elevation. Release of sulphur and base cations from melting permafrost appeared to be the best explanation for the deviating patterns. Similar observations have been done in high altitude lakes in North America, which were also explained by melting permafrost. High altitude lakes in permafrost areas function as early warning systems for ecosystem impacts of climate change.

# VI. Modelling critical levels and loads

## A. Flux-based critical levels of ozone pollution for vegetation

18. At the thirtieth meeting of the Task Force of the International Cooperative Programme on Effects of Air Pollution on Natural Vegetation and Crops (Poznan, Poland, 14–17 February 2017), the Task Force adopted 21 ozone stomatal flux-based critical levels for vegetation. A distinction was made between species (group)-specific critical levels ($POD_Y$SPEC) for detailed risk assessment, based on flux-effect relationships developed for specific plant species or a group of plant species, and vegetation type-specific critical levels for indicative risk assessment in large scale modelling, including integrated assessment modelling ($POD_Y$IAM). Sixteen $POD_Y$SPEC and five $POD_Y$IAM-based flux-effect relationships and derived critical levels are now available. The critical levels can be used for calculating critical level exceedances, both amount and area. Further details are available in the revised Chapter 3 (Mapping critical levels for vegetation) of the *Manual on Methodologies and Criteria for Modelling and Mapping Critical Loads and Levels and Air Pollution Effects, Risks and Trends*.[9]

19. $POD_Y$SPEC-based flux-effect relationships and critical levels can be applied at any geographical scale. For crops they can be used to quantify the potential negative impacts of ozone on the security of food supplies (yield losses) and associated economic losses. For forest trees they were derived from experiments with young trees, and can be used to quantify the potential negative impacts of ozone on the annual growth of the living biomass of trees. They can also be used as a starting point for assessing impacts on carbon sequestration in trees and impacts on tree diversity. Similarly, for (semi-)natural vegetation they can be used to quantify the risk of potential negative ozone impacts on annual biomass production and reproductive capacity, and also as a starting point for assessing impacts on carbon sequestration and plant biodiversity.

20. $POD_Y$IAM-based ozone flux models have a simpler form than $POD_Y$SPEC-based ones and have been developed specifically for use in large-scale integrated assessment modelling, including for scenario analysis and optimization runs. Different parameterizations are provided for Mediterranean and non-Mediterranean areas for application in risk assessments, and for forest trees and (semi-)natural vegetation also separate critical levels. The crops parameterizations can be used for potential maximum yield loss calculation and indicative economic losses. For forest trees and (semi-)natural vegetation they are indicative of the potential maximum risk for estimating environmental

[9] The 2004 version was published by the German Federal Environment Agency (Berlin). The 2004 version and further information about latest updates to the Manual, including updated chapters, are available on a web page of the ICP Modelling and Mapping website from http://www.icpmapping.org/Latest_update_Mapping_Manual (updated 1 February 2017).

cost, but not economic losses. For applications in a climate change context, the $POD_YSPEC$ method is recommended as key factors, such as phenology and soil moisture, are not included in the parameterization of $POD_YIAM$.

## B. Critical loads for eutrophication and biodiversity

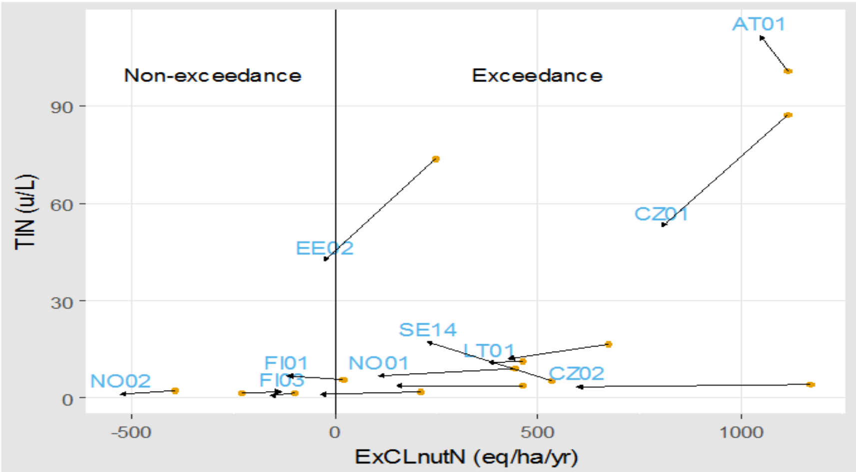
21. European databases and maps of critical loads have been instrumental in the negotiation of the effects-based Protocols to the Convention. For testing and validation of the key concepts in the critical load calculations, it is therefore important to study the link between critical thresholds of acidification and eutrophication and empirical impact indicators. Critical loads for eutrophication and their exceedances were determined for a selection of ICP Integrated Monitoring sites.[10] The exceedances ($ExCL_{nut}N$) were calculated as differences between the level of total nitrogen (N) deposition ($N_{tot} = NO_3 + NH_4$) and the mass balance critical loads of nitrogen ($CL_{nut}N$). Concentrations and fluxes of total inorganic nitrogen ($TIN = NO_3^- + NH_4^+$) in run-off were determined for the same sites, as empirical indicators of the level of eutrophication. As the deposition and the empirical indicators were previously determined for the year 2000, it was therefore decided to make an update using modelled deposition values for the year 2010 and empirical indicator values based on water quality observations for the years 2013-2015.

22. For most sites, there was an improvement visible as a shift towards less exceedance and lower concentrations of TIN in run-off (figure 2). At the majority of the sites both the input and the output flux of TIN decreased between the two observation periods 2000–2002 and 2013–2015. Data from ICP Integrated Monitoring thus provide evidence of the link between modelled critical thresholds and empirical monitoring results for fluxes of nutrient nitrogen. This increases the confidence in the European-scale critical loads mapping used in integrated assessment modelling. The results also indicate ecosystem recovery.

[10] M. Holmberg and others, “Relationship between critical load exceedances and empirical impact indicators at Integrated Monitoring sites across Europe”, *Ecological Indicators*, vol. 24 (2013), pp. 256–265.

Figure 2

**Observed concentration of TIN in run-off (y-axis) versus the calculated exceedance of critical loads of nutrient N (x-axis) at ICP Integrated Monitoring sites, using modelled deposition values**




*Note*: The arrows begin at the locations of the data points for the period 2000–2002 and end at the locations of the data points for the period 2013–2015.

23. The Joint Expert Group on Dynamic Modelling reviewed the progress in development and testing of terrestrial biodiversity models. Model development has continued within several research teams, including work on evaluating the models against very extensive and large data sets, as has been shown, in particular for the PROPS model. The use of the Habitat Suitability Index (HSI) the indicator agreed at the CCE meeting in Rome 2015 have been tested by increasing the number of modelling teams. Here the choice of species to be included in the index is important and affects the results. One remaining difficulty in plant species modelling is that the present-day species composition may reflect past (and unmeasured) soil conditions and thus past nitrogen and sulphur deposition. Other factors (such as light conditions) could explain the scatter between the observed and modelled Habitat Suitability Index and plant species occurrences.

24. There has also been a progress in calculating biodiversity critical loads in compliance with the procedure outlined by CCE. Since plant response to varying drivers often differs substantially among the models, resulting critical loads functions are only rarely compared. However, irrespective of the model, only protection levels above 80 per cent of HSImax led to a systematic lowering of critical load for sulphur (CLmaxS). For nitrogen critical load (CLmaxN), protection levels of 70 per cent of HSImax and higher are required to get a systematic reduction of CLmaxN. This work will gain robustness when models will be tested at an increasing number of sites covering a wider range of natural conditions and modelling methodologies.

# VII. Emissions

## A. Improvement of national emission inventories

25. The gridding system for 0.1° x 0.1° (longitude-latitude) for the new EMEP area is in place. The spatial distribution of emissions is harmonized with the Emission Database for Global Atmospheric Research (EDGAR) inventory from the European Commission Joint Research Centre. The first gridded emission data are expected from reporting in 2017. Parties were supposed to report by 15 May 2017, but some delays are expected for this first year. Evaluation of the quality and consistency of gridded emissions reported by the Parties or built up by the Centre on Emission Inventories and Projections to fill in the gaps are essential key activities. Emissions experts and modellers from the Meteorological Synthesizing Centre West will be involved in this work as a priority task in 2017. Therefore, the Meteorological Synthesizing Centre will not calculate new source-receptor matrices for integrated assessment modelling before the new gridded emissions have been correctly assessed, and will focus its work on the verification process, running the model with new gridded emission data sets. Redistribution of historical years in the new 0.1° x 0.1° resolution (requested by modellers) will be very challenging and considered in the second phase. Moreover, comparison of those official data with other emissions inventories built up in other scientific frameworks (Horizon 2020 of the European Union and the Copernicus Atmosphere Monitoring Service) will have to be developed in order to guarantee consistency of reported emissions with the scientific state of the art.

26. It should be noted that the reporting of inventories to EMEP has slightly improved, particularly among countries in Eastern Europe, the Caucasus and Central Asia. The capacity-building activities organized by the ECE secretariat seems to have motivated countries to improve their data. Continuation of such activities would be welcomed.

27. A new sensitive topic requires joint activities from both the emission and modelling communities. It relates to the treatment of condensable and semi-volatile organic compounds in emission inventories that could impact the amount of particulate matter emissions and ambient air concentrations. Recent scientific studies prove the major role of semi-volatile organic species in the formation of secondary aerosols, and possible underestimation of particulate matter concentrations modelled by current chemistry transport models because of lacking emission data (semi-volatile organic compounds), and inappropriate process parameterizations in the model. Following a recommendation from a joint workshop of the Task Force on Emission Inventories and Projections and the Task Force on Measurements and Modelling held in Zagreb in May 2016, it was decided to elaborate and send out a questionnaire to Parties to get more detailed information about the way they report particulate matter emissions (with or without the condensable part for various sectors). Forty-four Parties answered this questionnaire managed by the Task Force on Emission Inventories and Projections and the synthesis of their answers will help in defining a strategy between the emissions and modelling communities to account for this important issue.

28. Black carbon emission data are gathered on a voluntary basis from the Parties following the reporting process. This is a successful initiative that should be developed and shared with other organizations also interested in the methodologies developed under the Convention and its database on black carbon emissions. In particular the Clean Air and Climate Coalition and the Arctic Monitoring and Assessment Programme expressed interest in building up cooperation with the Convention and EMEP on this topic.

### B. Applications for adjustments to emission inventories

29. For the year 2017, one new application (Spain) for adjustments to emission inventories in the agriculture sector have been confirmed by the Centre on Emission Inventories and Projections. Furthermore, the reviewers are supposed to check also adjustments approved in the years 2014, 2015 and 2016. To make the procedure more efficient, the Centre developed an online database system[11] that allows online calculation of differences between emission data already approved and the latest reporting in 2017. Moreover, countries are invited to declare in a one-page Word document that there are no significant changes in criteria or methods and respectively explain reasons if there are minor differences in calculated emissions. If all countries provide the requested information the review of adjustments previously approved should be significantly less resource demanding. This process produced successful results in 2016.

## VIII. Hemispheric transport of air pollution

30. The work of the Task Force on Hemispheric Transport of Air Pollution aims at developing international cooperation for global scale assessment of air pollution patterns. It established a set-up for a model intercomparison experiment that should provide outputs that will update the findings of the first hemispheric transport of air pollution (HTAP1) exercise in 2010, and also allow new analysis of impacts (e.g., ozone fluxes, higher resolution results). Currently, approximately 20 global and 15 regional models run coordinated experiments evaluating the impacts on ozone and aerosol of emission reductions of air pollutants in various world regions. The results are now available but, because of the lack of consistency between the multiple runs provided by research teams, they are very difficult to analyse. It is essential that beyond the large number of scientific papers published by the scientific teams involved in the second experiment (HTAP2), the results could be digested and made available for policymakers. They should be integrated in the FAst Scenario Screening Tool (FASST tool) developed and maintained by the Joint Research Centre of the European Commission to present the global source-receptor relationships and play with various emission scenario results. According to current policy processes, there is specific interest in investigating the effects of methane emissions reduction on ozone concentrations.

## IX. Towards the urban scale

31. With a view to the more efficient implementation of the Convention, the 2016 scientific assessment of the Convention[12] and the ad hoc policy response group that analysed this report recommended to take better account of the urban scale in the future Convention strategy. Most of the world’s population live in cities, which are the first target of air pollution, and have the highest exposure. It is also important to consider that urban air pollution is influenced not only by local sources but also by long-range transport of

[11] See webdab.umweltbundesamt.at/adjustments.

[12] See Rob Maas and Peringe Grennfelt, eds., *Towards Cleaner Air: Scientific Assessment Report 2016* (Oslo, 2016) and United States Environmental Protection Agency and Environment and Climate Change Canada, *Towards Cleaner Air: Scientific Assessment Report 2016 – North America* (2016, online report).

pollutants. In February 2017, the Task Force on Integrated Assessment Modelling organized a workshop on local-scale air pollution issues in Utrecht, the Netherlands, back to back to a European Union (FAIRMODE) project meeting. Several Parties presented projects and results related to their countries and cities that demonstrated the need to establish linkages between the urban and regional scale to deal with air pollution.

32. In that perspective, a modelling methodology that bridges the regional to urban scales in the EMEP model, the urban (uEMEP) methodology, was presented and discussed at the eighteenth meeting of the Task Force on Measurements and Modelling (Prague, 3–5 May 2017). An important part of this methodology is the ability to calculate the amount of air pollution of local origin in each EMEP grid cell. Proxy data of emissions and a Gaussian model is used to redistribute the local part of the pollution in a subsequent step. The methodology opens new possibilities for consistent regional-to-urban modelling and the assessment of the importance of long-range transported air pollution in cities.

33. The Task Force on Measurement and Modelling also initiated a new activity with the use of triples of urban-suburban-background monitoring sites to assess the contribution of long-range transport of air pollution to urban air quality (the Twin Sites project). The work relies on chemically speciated observations of particulate matter, and will be accompanied by dedicated modelling assessments.

34. Activities related to linkages with the urban scale should be included in the 2018-2019 workplan of several EMEP bodies.