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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

First joint session*
Geneva, 14–18 September 2015
Item 15 of the provisional agenda
Progress in activities in 2015 and further development of effects-oriented activities

Effects of air pollution on natural vegetation and crops**

Report by the Programme Coordinating Centre of the International Cooperative Programme on Effects of Air Pollution on Natural Vegetation and Crops

Summary

The present report is being submitted for consideration by the first joint session 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 accordance with the request of the Executive Body for the Convention on Long-range Transboundary Air Pollution in the 2014–2015 workplan for the implementation of the Convention (ECE/EB.AIR/122/Add.2 items 1.1.10 and 1.1.17–1.1.19).

* The Executive Body to the Convention agreed that, as of 2015, the Working Group on Effects and the Steering Body to the Cooperative Programme for Monitoring and Evaluation of the Long-range Transmission of Air Pollutants in Europe should meet jointly, to achieve enhanced integration and cooperation between the Convention's two scientific subsidiary bodies (ECE/EB.AIR/122, para. 47 (b)).

** The present document is being issued without formal editing.

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The report of the International Cooperative Programme on Effects of Air Pollution on Natural Vegetation and Crops presents the results of an evaluation of effects of air pollutants on (semi-)natural vegetation and crops, further development of the flux-based approach for setting critical levels of ground-level ozone for vegetation and progress with the European moss survey 2015/16 on heavy metals, nitrogen and persistent organic pollutants. The report also presents the results of the twenty-eighth meeting of the Programme Task Force held in Rome, Italy from 2 to 5 February 2015

Contents

I. Introduction

1. The present report of the International Cooperative Programme on Effects of Air Pollution on Natural Vegetation and Crops (ICP Vegetation) is being submitted for the consideration 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 request of the Executive Body for the Convention on Long-range Transboundary Air Pollution in the 2014–2015 workplan for the implementation of the Convention (ECE/EB.AIR/122/Add.2 items 1.1.10 and 1.1.17–1.1.19). The report presents the results of an evaluation of effects of air pollutants on (semi-)natural vegetation and crops, further development of the flux-based approach for setting critical levels of ground-level ozone for vegetation and progress in the preparations for the European moss survey 2015–2016 on heavy metals, nitrogen and persistent organic pollutants). The results of the workplan items common to all the International Cooperative Programmes (ICPs) under the Convention are also presented. The lead country for ICP Vegetation is the United Kingdom of Great Britain and Northern Ireland, with the Programme Coordination Centre at the Centre for Ecology and Hydrology in Bangor. ICP Vegetation has over 200 participants in more than 40 countries, including outreach to countries that are not Parties to the Convention.

II. Workplan items common to all International Cooperative Programmes

A. Further implementation of the Guidelines for Reporting on the Monitoring and Modelling of Air Pollution Effects (workplan item 1.1.10 (a))

2. An overview of the monitoring and modelling effects reported by ICP Vegetation, according to the Guidelines for Reporting on the Monitoring and Modelling of Air Pollution Effects (ECE/EB.AIR/2008/11),[1] was provided in ECE/EB.AIR/2014/8.

B. Enhanced involvement of countries in Eastern and South-Eastern Europe, the Caucasus and Central Asia (workplan item 1.1.10 (b))

3. The Moss Survey Coordination Centre, at the Institute for Joint Nuclear Research in Dubna, has reached agreement on the participation of countries in Eastern Europe, the Caucasus and Central Asia (including Azerbaijan, Belarus, Georgia, Kazakhstan, the Republic of Moldova, Russian Federation and Uzbekistan) and selected Asian countries (China, India, Mongolia, Republic of Korea, Thailand and Vietnam) for the moss survey in 2015–2016. Collaborations are also ongoing with China, India, Japan and Pakistan regarding research on ozone impacts on vegetation.

[1] The Guidelines were adopted by the Executive Body at its twenty-sixth session (ECE/EB.AIR/96/Add.1–ECE/EB.AIR/WG.1/2008/16/Rev.1, decision 2008/1).

C. Cooperation with programmes and activities outside the region (workplan item 1.1.10 (c))

4. ICP Vegetation will participate in the first Asian Air Pollution workshop in Tokyo, Japan on 31 October – 2 November 2015. Members of the Chinese Academy of Sciences contribute to the ozone biomonitoring programme of the ICP Vegetation and selected Asian countries (see paragraph 3) take part in the moss survey in 2015–2016.

5. ICP Vegetation contributes to the 'Tropospheric Ozone Assessment Report (TOAR): Global metrics for climate change, human health and crop/ecosystem research'. This is a new activity of the International Global Atmospheric Chemistry Project (IGAC).[2] TOAR's mission is to provide the research community with an up-to-date global assessment of tropospheric ozone's distribution and trends from the surface to the tropopause. TOAR has two primary goals:

(a) Produce the first tropospheric ozone assessment report based on the peer-reviewed literature and new analyses conducted by TOAR;

(b) At hundreds of measurement sites around the world (urban and non-urban), generate freely accessible ozone metrics for global-scale impact studies of ozone on human health and crop/ecosystem productivity, and generate diagnostics relevant to climate forcing by tropospheric ozone.

D. Contribution to the 2015 joint progress report on policy-relevant scientific findings for consideration by the Executive Body (workplan item 1.1.12)

6. ICP Vegetation contributed to the 2015 joint progress report on policy-relevant scientific findings with clear policy-relevant messages and recommendations to the Working Group on Strategies and Review and to the Executive Body (see ECE/EB.AIR/GE.1/2015/3–ECE/EB.AIR/WG.1/2015/3).

III. Workplan items specific to the International Cooperative Programme on Effects of Air Pollution on Natural Vegetation and Crops

A. Evaluation of effects on (semi-)natural vegetation and crops due to air pollution (workplan item 1.1.17)

7. A web-based smart-phone application (App)[3] was applied and tested for the recording of visible leaf injury on vegetation caused by ambient ozone. Together with data from the literature and from ICP Vegetation biomonitoring experiments, this data was added to the ICP Vegetation database providing field-based evidence for impacts of ambient ozone on vegetation (workplan item 1.1.17 (a)). Figure 1 shows the locations were

[2] See www.igacproject.org.

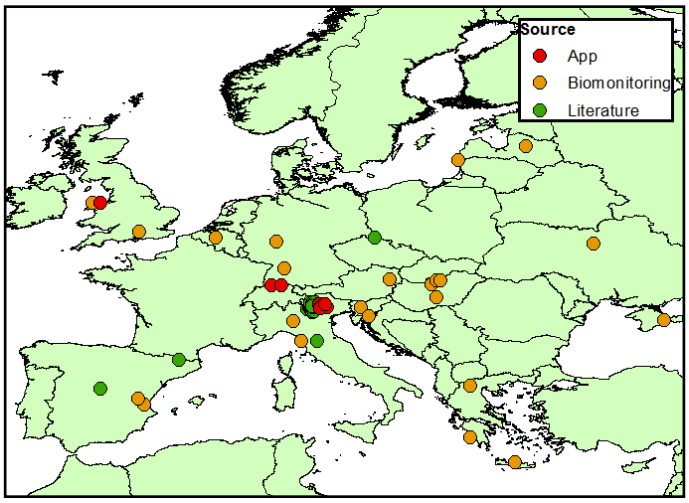
[3] See http://icpvegetation.ceh.ac.uk/record/index.

ozone-induced leaf injury on crops and (semi-)natural vegetation was reported since 2007 in Europe. Data until 2006 was reported previously.[4]

8. A brochure[5] was produced on "Climate change and reactive nitrogen as modifiers of vegetation responses to ozone" (workplan item 1.1.17 (b)). As well as directly affecting plant growth, crop production and ecosystem services, these modifiers affect vegetation indirectly by modifying the phytotoxic ozone dose. Experimental and modelling evidence indicates that responses of vegetation to a combination of changing environmental drivers such as elevated ground-level ozone and carbon dioxide concentrations, enhanced nitrogen deposition, warming, and drought are non-linear, variable, and difficult to predict. Responses of vegetation to a combination of changing environmental drivers cannot simply be extrapolated from responses to single drivers.

Figure

Locations in Europe were ozone-induced leaf injury was reported since 2007 (at ICP Vegetation biomonitoring sites or in the literature) and in 2014 during the test-phase of the App for recording incidences of ozone-induced leaf injury. App data were also submitted for two locations in the USA and for Beijing (China) in 2014



9. Despite a more than 30 per cent reduction in European emissions of ozone precursors during the last two decades, a decline in mean ozone concentrations is generally not seen at EMEP and ICP Vegetation ozone monitoring sites. However, the ozone profile in Europe has changed: background concentrations have generally risen until the end of the 20th century, with some levelling off occurring since then, whilst peak concentration have declined in several parts of Europe since 2000. Averaged for seven ICP Vegetation monitoring sites in Europe between 1999 and 2010, for the months of June, July and August, the proportion of hourly ozone concentration in the lowest (0-19 parts per billion (ppb)) and highest (> 60 ppb) ranges decreased whilst that in the mid ranges increased (20 – 39 ppb) or didn't change (40 – 59 ppb). Between 1999 and 2010, the risk of ozone impacts on vegetation has generally not changed at ICP Vegetation monitoring sites. Ozone

[4] Hayes, F., Mills, G., Harmens, H., Norris, D. (2007). Evidence of widespread ozone damage to vegetation in Europe (1990 – 2006). ICP Vegetation Programme Coordination Centre, CEH Bangor, UK.

[5] http://icpvegetation.ceh.ac.uk/publications/documents/Brochureozonenitrogenandclimatechange.pdf.

abatement policies require global actions as emissions of ozone precursors in fast developing countries contribute to background ozone concentrations in Europe.

B. Further development of the flux-based approach for setting critical levels of ground-level ozone for vegetation (workplan item 1.1.18)

10. 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[6] (Modelling and Mapping Manual) was updated to include a slightly modified ozone critical for tomato yield and a new ozone critical level for tomato quality. A reference to the inclusion of a simple soil moisture index in the EMEP model was also included.

C. Progress in preparations for the European moss survey 2015–2016 on heavy metals, nitrogen and persistent organic pollutants (workplan item 1.1.19)

11. Following the establishment of the new Moss survey Coordination Centre in the Russian Federation, the moss survey for 2015–2016 has now started. Thirty five and twenty seven countries have confirmed to determine heavy metal and nitrogen concentrations in mosses respectively, including the countries of Eastern Europe, the Caucasus and Central Asia and other Asian countries listed paragraph 3. Three countries will determine persistent organic pollutant concentrations in mosses.

IV. Expected outcomes and deliverables over the next period and in the longer term

12. Over the next period and in the longer term, ICP Vegetation will report on: (a) Field-based evidence for ozone impacts on vegetation; (b) Ozone impacts on biodiversity; (c) Revised ozone risk assessment methods; (d) Revision of Chapter 3 of the Manual on Methodologies and Criteria for Modelling and Mapping Critical Loads and Levels and Air Pollution Effects, Risks and Trends; and (e) The 2015–2016 European moss survey on heavy metals, nitrogen and persistent organic pollutants. ICP Vegetation will organise the next ozone critical level workshop in the autumn of 2016 in Spain.

V. Policy-relevant issues, findings and recommendations

13. Climate change and nitrogen modify the response of vegetation to ozone pollution. Experimental and modelling evidence indicates that responses of vegetation to a combination of changing environmental drivers cannot simply be extrapolated from responses to single drivers (see also paragraph 8). Two types of interactions need to be considered differently: (a) responses to gradual long-term changes in background ozone, reactive nitrogen and climate; (b) responses to extreme pollution and climate events, likely to become more frequent in the coming decades.

[6] Germany, Federal Environmental Agency (Berlin: December 2004). Available from http://www.icpmapping.org/Mapping_Manual.

14. Despite a more than 30 per cent reduction in European emissions of ozone precursors during the last two decades, a decline in mean ozone concentrations is generally not seen at EMEP and ICP Vegetation ozone monitoring sites. However, the ozone profile in Europe has changed at some sites in Europe but not at others. Between 1999 and 2010, the risk of ozone impacts on vegetation has not changed at ICP Vegetation monitoring sites (see also paragraph 9).

15. Transfer of the coordination of the moss survey to the Russian Federation has enhanced participation by countries in Eastern Europe, the Caucasus and Central Asia, and potentially other Asian countries.

VI. Issues for the attention and advice of other groups, task forces or subsidiary bodies, notably with regard to synergies and possible joint approaches or activities

16. Many of the issues that were identified in 2014 for the attention and advice of other groups, task forces and subsidiary bodies (see ECE/EB.AIR/WG.1/2014/8) are still valid for the near future. Of particular importance are:

(a) The assessment of temporal trends and spatial patterns in past and predicted future ground-level ozone concentrations in a changing climate, and associated (risk of) impacts on vegetation (including crops) at the European and global scale, in collaboration with EMEP/Meteorological Synthesizing Centre-West, Task Force on Measurements and Modelling, Task Force on Hemispheric Transport of Air Pollution, and ICP on Assessment and Monitoring of Air Pollution Effects on Forests (ICP Forests). There is a need to apply the ozone flux-based risk assessment methodology globally;

(b) Assessment of the interactive (risk of) impacts of ozone and nitrogen pollution on vegetation and ecosystem services (including valuation) in a changing climate (i.e. warmer and dryer climate, enhanced carbon dioxide concentration, more extreme events) in collaboration with ICP Modelling and Mapping of Critical Levels and Loads and Air Pollution Effects, Risks and Trends, ICP Forests, the Task Force on Integrated Assessment Modelling/Centre for Integrated Assessment Modelling, EMEP/Meteorological Synthesizing Centre-West, and the Task Force on Reactive Nitrogen;

(c) Assessment of future temporal trends and changes in spatial patterns in heavy metal deposition in collaboration with EMEP/ Meteorological Synthesizing Centre-East.

VII. Recommendations to further strengthen implementation and ratification of the Protocols in Eastern Europe, the Caucasus and Central Asia, as well as South-Eastern Europe

17. To further strengthen implementation and ratification of the protocols to the Convention in Eastern Europe, the Caucasus and Central Asia, as well as South-Eastern Europe, further evidence of air pollution deposition to and impacts on vegetation in countries of the sub-region should be sought through increased participation in the work of ICP Vegetation. The latter is promoted by:

(a) The Moss Survey Coordination Centre in the Russian Federation;

(b) Knowledge transfer through the publication of reports, the Modelling and Mapping Manual and leaflets in Russian;

(c) Organization of the twenty-ninth ICP Vegetation Task Force meeting in the Russian Federation in 2016;

(d) Encouraging countries of the sub-region to identify and support the participation of ozone experts in ICP Vegetation.

VIII. Scientific and technical cooperation with relevant international bodies

18. The ICP Vegetation will continue collaboration with Asian countries (in particular China, India and Japan) by contributing to the first Asian Air Pollution workshop in Tokyo, 31 October–2 November 2015. In addition, the ICP Vegetation also contributes to the "Tropospheric Ozone Assessment Report (TOAR): Global metrics for climate change, human health and crop/ecosystem research". This is a new activity of the International Global Atmospheric Chemistry Project (IGAC; http://www.igacproject.org; see also paragraph 5).

IX. Scientific findings: highlights

19. Highlights of scientific findings of ICP Vegetation are summarized in document ECE/EB.AIR/GE.1/2015/3–ECE/EB.AIR/WG.1/2015/3 and in section V above.

X. Meetings

20. The twenty-eighth meeting of the Programme Task Force was held in Rome, Italy from 2–5 February 2015. The meeting was hosted by the Department of Environmental Biology, Sapienza University, Rome, with support from 'Corpo Forestale dello Stato' (National Forest Service) and "Accademia Nazionale Delle Scienze Detta Del XL" (National Academy of Sciences). The meeting was attended by 80 experts from 22 countries, including 20 Parties to the Convention and guests from China and Egypt.

21. ICP Vegetation organised a joint session with the Coordination Centre for Effects/ICP Modelling and Mapping at their twenty-fifth workshop/thirty-first Task Force meeting, Zagreb, Croatia, 20–23 April 2015. The theme of the session was interactive impacts of ozone and nitrogen on vegetation, including impacts on biodiversity (see ECE/EB.AIR/GE.1/2015/17–ECE/EB.AIR/WG.1/2015/10 for further details).

22. An expert workshop on 'Epidemiological Analysis of Air Pollution Effects on Vegetation', was held in Basel, Switzerland, from 16–17 September 2014. The workshop was organised by the Institute of Applied Plant Biology in cooperation with the Swiss Federal Office for the Environment as a contribution in kind. Epidemiological methodologies to analyse air pollution effects were discussed, especially ozone effects on growth of mature trees, considering simultaneously modifying factors such as climate and nitrogen. For detailed conclusions and recommendations, we refer to the workshop report, available from the ICP Vegetation website.[7]

[7] http://icpvegetation.ceh.ac.uk/.

XI. Additional comments and lessons learned

23. There is a need to: (a) continue and extend monitoring the impacts of ozone on vegetation, so that long-term trends (20 years or more) can be established; (b) collate further field-based evidence of ozone impacts on vegetation, especially for areas where information is scarce; (c) further assess the combined impacts of ozone and nitrogen on vegetation in a changing climate (i.e., interactions with elevated carbon dioxide and temperature, more drought events); and (d) continue to communicate the threat of ozone pollution to food production, carbon sequestration and other ecosystem services to stakeholders.

XII. Publications

24. For a list of ICP Vegetation publications and references for the present report, please visit the ICP Vegetation web site.[8]

[8] http://icpvegetation.ceh.ac.uk/publications/index.html.