



CONVENTION ON LONG-RANGE TRANSBOUNDARY AIR POLLUTION

WORKING GROUP ON EFFECTS

INTERNATIONAL COOPERATIVE PROGRAMME ON EFFECTS OF AIR POLLUTION ON NATURAL VEGETATION AND CROPS (ICP VEGETATION)

Minutes of the 25th Task Force Meeting

The twenty-fifth meeting of the Programme Task Force was held from 31 January – 2 February, 2012 in Brescia, Italy and hosted by the Ecophysiology and Environmental Physics Laboratory - Mathematics and Physics Department, Università Cattolica del Sacro Cuore.

1. The meeting was attended by 73 experts from 21 countries, including 19 Parties to the LTRAP Convention: Albania, Belgium, Croatia, France, FYR of Macedonia, Germany, Greece, Italy, Latvia, Norway, Poland, Russian Federation, Slovakia, Slovenia, Spain, Sweden, Switzerland, United Kingdom and USA. Participation included two guests from Egypt and South-Africa.
2. The Programme Task Force adopted the agenda of the meeting.
3. Welcome addresses were given by Mr Antonio Ballarin Denti (Director of the Department of Mathematics and Physics, Università Cattolica del Sacro Cuore), Mr Gian Luca Gurrieri (Lombardy region, Directorate Environment, Energy and Networks) and Mr Francesco Lechi (Chamber of Commerce of Brescia).
4. Mrs Gudrun Schütze (Germany), vice-chair of the Working Group on Effects (WGE), gave an overview of the current status of the Gothenburg, Heavy Metals and POPs Protocols and the action plan of the LRTAP Convention to implement its new long-term strategy (ECE/EB.AIR/106/Add.1). She highlighted the conclusions of the draft of the 'Impacts report', prepared by the WGE in collaboration with the Task Force on Integrated Assessment Modelling and EMEP Centres to support the Revision of the Gothenburg Protocol, stating that more ambitious emission abatement scenarios will lead to a better improvement of human health and the environment. She drew attention to the Guidance Document VII and acknowledged with appreciation the important contributions of the ICP Vegetation to the work plan items of the WGE to support policy development within the Convention.
5. Mr Harmens (UK) gave an overview of the activities and achievements of the ICP Vegetation in 2011. An important deliverable was the report and a summary brochure for policy makers on 'Ozone pollution: A hidden thread to food security'. The report contains the first flux-based quantification of crop yield and economic losses due to ozone in the EU27 + Norway + Switzerland (see also paragraph 12). A review of the impacts of black carbon on vegetation had shown that little data is available on its direct impacts and high uncertainties are associated with the indirect impacts. Based on a review on the application of mosses as biomonitors of atmospheric deposition of persistent organic pollutants (POPs), it was concluded that mosses are suitable biomonitors for certain

POPs, polycyclic aromatic hydrocarbons (PAHs) in particular. Further details can be found in the annual ICP Vegetation report for 2010/11 and/or in the separate reports published on these items (<http://icpvegetation.ceh.ac.uk>).

6. Mr Harmens continued with reporting on progress made with the ICP Vegetation work plan items for 2012 (see ECE/EB.AIR/109/Add.2), which will be reported to and presented at the 30th session of the WGE, 20 - 21 September, 2012 in Geneva:
 - *Annual report on supporting evidence for ozone impacts on vegetation.* Although a stomatal flux model was developed for bean, a robust flux-effect relationship could not be established so far based on data collated between 2008 and 2011 (see also paragraph 13).
 - *Report on ozone, carbon sequestration, and linkages between ozone and climate change.* This report is scheduled for publication by April 2012. It will include: a review on the deposition of ozone to vegetation and its impact on carbon sequestration; modelling case studies on the impacts of ozone on carbon storage in forests; ozone effects in a changing climate (elevated carbon dioxide, global warming, changing nitrogen deposition, enhanced drought frequency); conclusions and recommendations.
 - *Progress report on European heavy metals and nitrogen in mosses survey 2010/11.* Twenty seven countries will submit data on the 2010/11 European moss survey, including three EECCA countries and nine countries from southern-eastern Europe (SEE). Fourteen of the 27 countries will also determine the nitrogen concentration in mosses and six countries will submit data on concentrations of selected POPs in mosses.
 - *Report on the relationship between (i) heavy metal and (ii) nitrogen concentrations in mosses and their impacts on ecosystems.* During the first half of 2012 the Programme Coordination Centre will, in collaboration with selected experts, review this theme. The availability of relevant impacts data from other ICPs (Forests and Integrated Monitoring in particular) for this study will be investigated.

Common work plan items for all ICPs, Task Force on Health and Joint Expert Group on Dynamic modelling:

- *Final version of the report on impact analysis by the Working Group on Effects.* The ICP Vegetation has submitted contributions to the final report, to be published in time for the 30th meeting of the Executive Body of the LRTAP Convention, 30 April – 4 May, 2012, Geneva. Risk assessments applying the stomatal ozone flux methodology have shown that although the areas intensely and adversely impacted by ozone are predicted to decline by 2020, large areas of crops and forests remain at risk from ozone pollution, even under the maximum technically feasible emission reduction scenario. The ICP Vegetation will coordinate the printing of a short glossy summary brochure of the ‘Impacts report’ for policy makers and the general public.
- *Report on the further implementation of Guidelines on reporting of monitoring and modelling of air pollution effects.*
- *Report on ideas and actions to enhance the involvement of EECCA/SEE countries in the Eastern Europe, the Caucasus and Central Asia and on cooperation with activities outside the Air convention.*

The Programme Coordination Centre will summarise progress with the latter two items in reporting to the WGE in September 2012 and will include further details in the annual report for 2011/12, to be published in August 2012.

Finally, Mr Harmens proposed work plan items for 2014 – 2015 (see Annex I), bearing in mind the action plan for the implementation of the new long-term strategy of the LRTAP Convention, and encouraged the Task Force to consider these during discussions on the future work of the ICP Vegetation. After summarising the outputs from the ICP Vegetation in 2011, he thanked the Parties for their invaluable contributions to the ICP Vegetation and noted with appreciation the continuing increase in the number of Parties and experts attending the annual Task Force meetings over the last 25 years (see Annex IV).

7. On behalf of the ICP Forests, Mr Schaub (Switzerland), co-chair of the Expert Panel on Ambient Air Quality, gave an update of the work conducted by the ICP Forests. The ICP Forests Manual was revised and updated in 2011 and a procedure has been put in place for data requests to ICP Forests. Mr Schaub encouraged the ICP Vegetation Task Force to make more use of ICP Forests data in the future and to enhance collaboration where possible.
8. Mr Büker (UK) gave an update on general outreach activities of interest to the ICP Vegetation. He highlighted the work of the Global Air Pollution (GAP) Forum. The GAP Forum brings together regional intergovernmental networks and other governmental and non-governmental bodies concerned with co-operation on air pollution at the regional, hemispheric and global scales. Its aim is to promote cooperative action among them, and more generally to enhance capacity and strengthening cooperation to address air pollution issues (see http://www.unece.org/fileadmin/DAM/env/documents/2011/eb/eb/n_12.pdf).
9. Mr Gerosa (Italy) gave an overview of ten years ozone research at the Catholic University of Brescia. He highlighted achievements regarding i) micrometeorological measurement campaigns, ii) ozone exposure facilities for vegetation, and iii) mapping ozone risk at the regional scale.
10. Three presentations followed on the impacts of ozone on carbon sequestration by vegetation in the current and future climate. Mr Harmens (UK) gave a more detailed presentation on the ICP Vegetation study on the effects of ozone on carbon sequestration in Europe (see paragraph 6). Mr Karlsson (Sweden) presented a case-study on the impacts of ozone carbon sequestration in northern and central European Forests and estimated that current ambient ozone concentrations had reduced the carbon stock in the living tree biomass by 10% since the industrial revolution. Mr Pleijel (Sweden) concluded that the stomatal flux-based methodology would indicate central Europe to be at highest risk from adverse impacts of ozone on crops and trees, whereas southern Europe would be at highest risk when applying the concentration-based methodology. A predicted rise in stomatal ozone flux in the future (2021- 2050 and 2071 - 2100) may be counteracted by a rise in atmospheric carbon dioxide concentrations.
11. For most of the meeting there were two parallel sessions considering the ozone and heavy metals (HM)/nitrogen (N)/persistent organic pollutants (POPs) sub-programmes. The topics of oral presentations and discussions in the parallel sessions are provided below. For further details on the content of oral presentations and posters we refer to the book of abstracts and powerpoint files, both available on the ICP Vegetation web site (<http://icpvegetation.ceh.ac.uk>). The posters covered similar topics as discussed during the oral presentations and provided valuable additional information. Posters were on display throughout the meeting.

12. In the first ozone session on food security, Ms Mills (Head Programme Coordination Centre, UK) described in more depth the results, conclusions and recommendations presented in the report 'Ozone pollution: A hidden threat to food security'. In 2000, ozone caused an economic loss of wheat and tomato yield worth Euro 3.2 and 1.02 billion respectively, with losses predicted to be Euro 1.96 and 0.63 billion in 2020 respectively. In a subsequent presentation, Mr Gerosa (Italy) showed that durum wheat in contrast to bread wheat is not sensitive to ozone and concluded that the critical level based on dose-response relationships for bread wheat should not be applied in Mediterranean areas such as Italy where durum wheat is intensely cultivated. Mr Berner (South Africa) described in detail how ozone negatively affects photosynthesis in wheat and maize, with the magnitude of effects being cultivar-dependent.
13. In the second ozone session the suitability of snap bean as a biomonitor for ozone pollution was discussed. Firstly, Mr Burkey (USA) showed how the snap bean biomonitoring system performed under different management regimes. Secondly, Ms Hayes (Programme Coordination Centre, UK) presented an overview of the performance of snap bean as biomonitor for ozone pollution between 2008 and 2011. Although an ozone flux model had been developed for snap bean, no robust flux-effect relationship was observed for bean yield ratios between the ozone-sensitive and resistant genotype. Ms Salvatori (Italy) showed how the snap bean biomonitoring worked well in chamber experiments under Mediterranean climatic conditions, but she recommended that the complexity of ecophysiological responses must be unraveled before applying the snap bean biomonitoring system in the field. In the ensuing discussion it was recommended to continue ozone biomonitoring with snap bean based on an improved phenology-based protocol for 2012, as the occurrence of ozone-induced visible leaf injury in ambient air conveys a valuable political message.
14. The third ozone session focussed on the response of grasslands to ozone. Mr Volk (Switzerland) reported on the responsiveness of subalpine grassland productivity under increased nitrogen and ozone deposition determined by carry-over effects and climate impacts of extreme years. Subsequently, Ms Bassin (Switzerland) described the effects of elevated ozone and nitrogen deposition on ecosystem nitrogen pools and the fate of a ¹⁵N isotope tracer. Mr Calvete (Spain) discussed the responses of Mediterranean annual pasture sown in natural soil to ozone and nitrogen. Finally, Mr Callaghan (UK) reported on the combined effects of ozone and drought on model grassland communities.
15. In the final ozone session, progress reports from the ozone experts groups established in 2011 (see Annex II) and the conclusions and recommendations from the one-day ozone workshop, held on 31st January, 2012, were presented (see Annex III). Finally, the future work plan items on ozone were proposed as presented in Annex I.
16. In the first moss survey session (heavy metals, nitrogen and POPs), Mr Steinnes (Norway) gave an overview of the trends of three decades of atmospheric metal deposition in Norway as evident from analysis of moss samples. Ms Frontasyeva (Russian Federation) continued with an overview of past, present and planned for the future moss biomonitoring activities in the Russian Federation. Ms Phil Karlsson showed that the metal concentration in mosses continued to decline in Sweden. In addition, the content of posters was briefly described by participants.
17. In second moss survey session Mr Harmens (UK) described the progress with data submission for the 2010/11 European moss survey, discussed the outline of reporting on the 2010/11 survey in 2013, and described in more detail the application of mosses as

biomonitors of POPs. He recommended conducting more studies to investigate the relationship between air concentrations/deposition fluxes and concentrations in mosses of POPs (see also paragraph 5). In a discussion on the future of the European moss survey it was recommended to conduct the next survey in 2015 (see Annex I). Subsequently, Mr Schröder (Germany) reported on progress with the development of an online sampling protocol for the European moss survey; a prototype is now available and participants can import and access their own password-protected metadata. Mr Santamaria (Spain) described preliminary results of ^{15}N analysis in mosses to assess the attribution of pollution sources. He suggested to write up the results for publication in the summer of 2012.

18. In the third moss survey session, Ms Foan (France) reported on the spatial trends of PAH concentrations in mosses from France, Switzerland and Spain and compared these with heavy metal concentrations, carbon and nitrogen content and their stable isotope signatures ($\delta^{13}\text{C}$ and $\delta^{15}\text{N}$). Mr De Temmerman (Belgium) concluded that there is a direct uptake and translocation (although limited) of some air borne trace elements to the edible parts of root (arsenic and cadmium) and legume vegetables (arsenic, cadmium and lead). Ms Izquieta (Spain) described how *Pleurochaete squarrosa* (Brid.) Lindb is a good alternative for heavy metals and nitrogen monitoring in southern Europe compared to the moss species normally recommended for inclusion in the European moss survey.
19. The fourth moss survey session focussed on presentations from participants from southern-eastern European countries. First of all, Mr Spiric (Croatia) described progress with the moss survey in Croatia in 2010, followed by a presentation from Mr Stafilov (FYR of Macedonia) on the application of mosses as biomonitors of atmospheric heavy metal pollution in the Republic of Macedonia, and finally Ms Lazo reported on the preliminary results of moss biomonitoring activities in Albania in 2010/11 and made recommendations for the future.
20. In the final plenary session, Mr Bender (Germany) gave an overview of presentations, conclusions and recommendations from the ozone sub-group, followed by a summary from Mr De Temmerman (Belgium) on the presentations and the outcome of discussions in the moss survey sub-group. The Task Force took note of the conclusions and recommendations of both sub-groups (as described above and Annex I, II) and those agreed at the one-day ozone workshop (see Annex III). The Task Force discussed and adopted the medium-term (2014 – 2015) work plan of the ICP Vegetation as described in Annex I.
21. The Task Force encouraged the continuation of collaboration with other bodies within the LRTAP Convention such as the WGE subsidiary bodies, EMEP Centres, Task Force on Integrated Assessment. In addition, a closer collaboration with the European Commission was encouraged, in particular regarding support for the ongoing review of the Thematic Strategy on Air Pollution and associated policies. The Programme Coordination Centre will inform the relevant EU bodies about the current status of ozone risk assessment for vegetation and will recommend the inclusion of the ozone stomatal flux-based method (as adopted by the Executive Body of the LRTAP Convention in 2008). The ICP Vegetation is also actively taking part in the European Framework Programme 7 project ECLAIRE (Effects of Climate Change on Air Pollution and Response Strategies for European Ecosystems; see <http://www.eclair-fp7.eu/>). The Task Force encouraged further participation of EECCA and SEE countries and further development of outreach activities and collaboration with regions and countries outside the ECE region.

22. Finally, Mr Harmens (UK) drew attention to forthcoming meetings and workshops and noted with appreciation the offers from France and Italy to explore opportunities to organise the 27th ICP Vegetation Task Force meeting in 2014. The 26th ICP Vegetation Task Force meeting will be held in Sweden, tentatively scheduled for 28th – 31st January 2013.

23. On behalf of the Task Force, Mr Harmens (UK) closed the meeting by thanking Mr Gerosa (Italy) and his colleagues at the Ecophysiology and Environmental Physics Laboratory - Mathematics and Physics Department, Università Cattolica del Sacro Cuore for hosting and financially supporting the meeting. Mr Harmens acknowledged the UK Department for Environment, Food and Rural Affairs (Defra), the United Nations Economic Commission for Europe (UNECE) and the Natural Environment Research Council (NERC) for their continuous financial support of the ICP Vegetation Programme Coordination Centre. Last but not least Mr Harmens thanked his colleagues at the Programme Coordination Centre and the participants of the ICP Vegetation for their continuing support of the programme.

Annex I. Medium-term workplan of the ICP Vegetation (updated on 2 February, 2012).

2012-2013: Biannual workplan as approved at 29th session of the Executive Body, 12-16 December 2011, Geneva (see ECE/EB.AIR.109/Add.2):

Common items of the Working Group on Effects:

- i) Report on the further implementation of the Guidelines on Reporting of Monitoring and Modelling of Air Pollution Effects;
- ii) Final version of the report on impact analysis by the Working Group on Effects (**2012**);
- iii) Report on ideas and actions to enhance the involvement of EECCA/SEE countries in the Eastern Europe, the Caucasus and Central Asia and on cooperation with activities outside the Air convention;
- iv) Report on impacts on biodiversity and ecosystems services (**2013**).

ICP Vegetation-specific items:

Ongoing activities:

- a. Annual report on supporting evidence for ozone impacts on vegetation;
- b. Annual progress report on the European heavy metals and nitrogen in mosses survey 2010/11 (**final report: 2013**);
- c. Report on the relationship between (i) heavy metal and (ii) nitrogen concentrations in mosses and their impacts on ecosystems (**2012**).

New activities:

- a. Report on ozone, carbon sequestration, and linkages between ozone and climate change (**2012**);
- b. Report on ozone impacts on biodiversity and ecosystem services (**2013**);
- c. Report on the pilot study of mosses as biomonitors of POPs (**2013**);
- d. Conduct work pursuant to decision 2010/2.

2014:

- Report on supporting evidence for ozone impacts on vegetation;
- Update of chapter 3 of the Modelling and Mapping Manual by inclusion of a new annex describing further technical developments;
- Report on ozone impacts on vegetation in a changing climate;
- Report on heavy metal and nitrogen concentrations in mosses in EECCA/SEE countries;
- Report on preparations for the moss survey 2015/16.

2015:

- Report on supporting evidence for ozone impacts on vegetation;
- Report on air pollution impacts on vegetation in EECCA/SEE countries;
- Report on interacting effects of co-occurring ozone and nitrogen pollutants on vegetation;
- Report on progress with the moss survey 2015/16.

Annex II. Activities of ozone expert groups (see minutes of 24th ICP Vegetation Task Force meeting)

1. *Ozone and climate change interactions (including interaction with nitrogen):*

- Contribute to IUFRO meetings in Lithuania 2012 and Brazil 2013;
- Start preparations for glossy reports in 2014 and 2015.

2. *Ongoing flux model development and AOT40 and flux map validation:*

- Scientific report on progress – summary in annual report;
- Information sharing area on the ICP Vegetation web-page;
- One day workshop in 2013 with new technical annex for Modelling and Mapping Manual as output;
- Further epidemiological studies to assess ozone impacts on trees (make use of ICP Forests data in Spain and Italy, Norway spruce in Sweden, Norway spruce and oak in Switzerland);
- Make better use of existing eddy covariance data;
- Further collaboration with EMEP regarding discrepancies in AOT40 and/or POD_Y maps and with ICP Forests for data sharing;
- To influence EU policy, better inform the European Commission about the current status of the flux-based risk assessment for impacts of ozone on vegetation (possibly submit a COST action application in 2013 on epidemiological work).

3. *Outreach activities:*

- Continue ongoing reporting and consider publication of a position paper;
- Linking of scientists in Mediterranean Basin countries in north Africa with scientist in southern Europe (1) via GAP forum, (2) possible COST action (to develop now and apply in 2013), with a focus on ozone effects on crops.

4. *Ozone impacts on C sequestration:*

- Complete report in April 2012 and write scientific papers.

New expert group established on:

5. *Ozone impacts on ecosystem services and biodiversity:*

- Report on this theme in 2013, including:
 - C sequestration (see 4);
 - Food security (see report published in 2011);
 - Water control by plants (with contributions from Spain, Italy, UK);
 - Pollutant removal potential (with contributions from Italy, Spain, UK);
 - Economics (UK, in collaboration with the chair of NEBEI).

Annex III. Presentations, new scientific developments, conclusions and recommendations from the ozone workshop (31st January, 2012, Brescia)

The following **presentations** were given at the workshop:

Theme 1: Quantifying ozone impacts on Mediterranean Forests:

- Ms Mircea (Italy) – Ozone simulations over Italy with the atmospheric modelling system of the Minni project: evaluation and perspectives for vegetation.
- Mr Finco (Italy) – When stomatal flux is predictable from AOT40. Results of a 13 years stomatal flux calculation exercise at an Alpine spruce forest with the DO₃SE model.
- Ms De Marco (Italy) – FO₃REST project - First application of DO₃SE model on French and Italian Forests: Comparison of risk indicators for Mediterranean trees.
- Mr Fares (Italy) – Measured and modelled stomatal and non-stomatal ozone fluxes in a mixed Mediterranean forest.
- Ms Alonso (Spain) – Ozone critical levels for Mediterranean forests.

Theme 2: Mapping vegetation at risk from ozone at the national scale

- Mr Karlsson (Sweden) – Introduction of Environmental Objectives for ozone impacts on vegetation in Sweden based on ozone flux.
- Mr B ker (UK) – Applying flux based ozone risk assessment methods in the UK.
- Mr Rihm (Switzerland) – Mapping ozone fluxes for Switzerland: comparison with EMEP-maps.
- Ms Braun (Switzerland) – Flux-response relationship of *Fagus sylvatica*: what does the epidemiological data analysis tell us?

New scientific developments:

- New flux-based dose-response functions have been derived for Mediterranean evergreen trees and a new critical level tentatively suggested. It should be noted that Mediterranean evergreen trees are less sensitive than Mediterranean deciduous trees;
- Simplified flux methods are being developed for use at national level in Sweden. If applied in other areas, the soil moisture deficit should be included as a modifier;
- Methods are being developed for modelling ozone flux from passive sampler data;
- The DO₃SE (Deposition of Ozone for Stomatal Exchange) model is being used extensively at the national level for mapping impacts, but in some cases flux-based values (but also concentration-based values) calculated with the EMEP model are different from those calculated with national models (e.g. Switzerland). The development of a lower grid size by EMEP might be helpful, especially for countries with large topographical variation within a grid square.

Conclusions:

- New scientific developments support the current text and conclusions in the Modelling and Mapping Manual, i.e. the flux-based method is better than the concentration-based method for ozone impact assessments on vegetation;
- Current flux-based critical levels for beech/birch were validated by epidemiological studies on mature trees in Switzerland.

Recommendations (see also annex II):

- Further field-based validation of ozone dose-response functions and critical levels for vegetation is required via epidemiological studies;
- Validation of DO₃SE with eddy covariance flux data would make a valuable contribution;
- Further develop the ozone flux-based method by:
 - Expanding the number of species with flux-effect relationships;
 - Standardising the method of up-scaling for mature trees;
 - Further qualifying and quantifying uncertainties;
 - Developing a protocol for estimating the maximal stomatal conductance (g_{max});
 - Including effects of biogenic volatile organic compounds (BVOC);
 - Further developing the Ball –Berry photosynthesis model in DO₃SE;
 - Further stimulating the cooperation with ICP Forests and make more use of their data;
 - Adding a new technical annex to chapter 3 of the Modelling and Mapping Manual.

Annex IV. Participation in the ICP Vegetation Task Force meetings (1987-2012)

