



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

### WORKING GROUP ON EFFECTS (WGE)

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

#### Minutes of the 34<sup>th</sup> Task Force Meeting

The 34<sup>th</sup> meeting of the Programme Task Force was held online from 22-24 February, and hosted by the Coordination Centre, at the UK Centre for Ecology & Hydrology.

1. The meeting was attended by 125 participants from 35 countries. Participation included representatives of EMEP/MSC-West and the Coordination Centre for Effects (CCE) of the ICP Modelling and Mapping, in addition to the Chair of the Working Group on Effects.
2. A brief welcome address was given by Ms. Felicity Hayes (UK), Chair of ICP Vegetation, noting that this online meeting gave opportunities for attendance by representatives of countries participating in outreach work of the ICP Vegetation, in addition to those participating as representatives of countries covered by the UNECE region.
3. Ms. Isaura Rabago (Spain), Chair of WGE, gave an overview of recent developments in the Air Convention, and reported on the process for the amended Gothenburg Protocol Review, the next steps for the update of the scientific strategy for Effects-related activities and EMEP, and an overview of ecosystems monitoring under the NEC Directive. The ICP Vegetation will be contributing directly to the amended Gothenburg Protocol Review, to the specific questions 'Progress made towards achieving the environmental and health objectives' and 'Adequacy of obligations in attaining the environmental and health objectives'.
4. Ms. Alice James Casas (Chair of ICP Modelling and Mapping) and Ms. Christin Loran (CCE) gave an update on the on-going activities under the Programme on Modelling and Mapping of Critical Levels and Loads and Air Pollution Effects, Risks and Trends. This included the expected timeframe of the various activities, including progress made on the review and revision of the empirical critical loads for nitrogen for natural and near-natural ecosystems. An opportunity for collaboration with the newly formed Centre for Dynamic Modelling (CDM) was identified, particularly for analysis of time-series data. Other topics including the proposed harmonisation of the receptor map for Europe were also presented.
5. Ms. Felicity Hayes (UK), Chair of ICP Vegetation, gave an overview of the activities and achievements of the ICP Vegetation in 2020 and reported on progress with items included in the biannual workplan of the LRTAP Convention for 2020 and 2021. Important activities and deliverables included:
  - Additional chapters to Scientific Background Document B were published on 'Interactions between ozone exposure and N application in crops' and 'Guidelines

for gap filling in data required for flux modelling'. Progress with other chapters was presented later in the meeting.

- Development of a coupled photosynthesis-stomatal conductance model for wheat has shown a similar prediction of relative yield compared to the existing multiplicative stomatal conductance model. Additional datasets will be included for the new model, which will ultimately allow linkages to crop growth models and land-atmosphere interaction models.
  - Potential collaborations with HTAP to estimate the environmental benefits of decreasing ozone through mitigation of methane emissions.
  - Contributions of ICP Vegetation participants to the Revision of Empirical Critical Loads for Nitrogen (led by the CCE).
  - Progress with calculation of the effect of ozone on the carbon sequestration of living biomass of forest trees in Europe.
  - Outreach activities beyond the UNECE region, including: maps of predicted impacts on crop yield in sub-Saharan Africa, where it was estimated that yield losses in excess of 20% were predicted in some regions for ozone-sensitive crops; measurements of ozone concentration in some countries outside the UNECE region, which included 28-day mean ozone concentrations of up to 53 ppb in some parts of Rwanda; results of a literature study into the yield benefits of air filtration, which showed yield increases of 2-60% depending on the country and crop.
  - The final report of the 2015 moss survey was published and is available from the Coordination Centre Website. The next survey is from 2020-2022 (extended for 1 year due to Covid-19 restrictions on fieldwork in some countries) and includes a pilot study on mosses as biomonitors of microplastics as an indication of atmospheric deposition, in addition to content of metals, N and POPs. Further details of progress with the 2020-2022 survey were given later by Ms. Marina Frontasyeva (Russian Federation).
  - Update of the ICP Vegetation website (<https://icpvegetation.ceh.ac.uk>).
6. Mr. Ignacio González-Fernández (Spain) reported on progress with modelling phytotoxic ozone doses for risk assessment at European and plot scales using the soil moisture index (SMI). Modelled and observed time series of SMI at six sites in Italy and Spain covering cropland, forest and pastures have been compared as work is continuing with EMEP MSC-W to improve modelling of SMI in dry regions.
  7. Ms. Marina Frontasyeva (Russian Federation) gave an overview of the moss sampling campaign from countries that had collected samples in 2020. The first European moss survey was conducted in 1990 and has been repeated every five years since. >1500 moss samples were already collected in 2020 (compared to the ~5000 samples of the 2015/16 campaign), from a total of 14 countries. Additional countries will collect their samples in 2021 and 2022, including from south-eastern Europe (SEE) and Eastern Europe, Caucasus and Central Asia (EECCA region).
  8. Mr. Stefano Loppi (Italy) presented results from a detailed study in a city in Italy using lichens as biomonitors of trace elements. There was a clear trend of increasing air pollution from the periphery to the city centre, however, the pollution pattern was more related to the street size and characteristics rather than to the socioeconomic status of the neighbourhoods.
  9. Mr. Julian Aherne (Canada) gave a brief overview of microplastics as an airborne pollutant. A methodology for active sampling of microplastics using mosses was presented, showing

how carefully designed moss bags could be deployed across an urban transect. A pilot study showed that microplastics were found in all moss bags across the urban transect, with approximately 51% of the total being microfibers.

10. The following four sessions considered the ozone and moss survey sub-programmes. The topics of the oral presentations are provided in Annex III. For further details of the content of the oral presentations we refer to the book of abstracts and copies of the presentations available on the ICP Vegetation web site (<http://icpvegetation.ceh.ac.uk>). In addition, 15 posters were presented during the meeting, covering similar topics as the oral presentations.
11. At the end of the ozone and moss survey specific sessions, conclusions and recommendations were presented, discussed and adopted by the Task Force as described in Annex I. An updated medium-term workplan was agreed and adopted by the Task Force (see Annex II). Ms. Hayes (UK) drew attention to various workshops and conferences in 2021. The Task Force took note of the offer from Lithuania to host the 35<sup>th</sup> Task Force Meeting at the Institute of Forestry, Lithuanian Research Centre for Agriculture and Forestry in Girionys (Kaunas district), provisionally 21-24 February 2022. The Task Force took note of a provisional offer from Albania to host the meeting in 2023.
12. On behalf of the Task Force, Ms. Hayes (UK) closed the meeting by thanking the colleagues at the PCC for supporting and hosting the meeting. Ms. Hayes acknowledged the UK Department for Environment, Food and Rural Affairs (Defra) and the United Nations Economic Commission for Europe (UNECE) for their continuous financial support of the ICP Vegetation Coordination Centre. Ms. Hayes thanked the participants of the ICP Vegetation for their valuable contributions to the programme.

**Annex I. Decisions and recommendations by the Task Force of the ICP Vegetation at its 34<sup>th</sup> meeting, 22-24 February 2021, Online, PCC. Workplan items for 2021-2024 are included in Annex II.**

**OZONE RELATED ACTIVITIES:**

- The Task Force (TF) took note of progress with the workplan item on ‘Improving and validating soil moisture index in the EMEP model’ and acknowledged the efforts of CIEMAT (Madrid, Spain) to coordinate this work in collaboration with EMEP/MSC-West.
- The TF took note of progress with the development of new chapters for Scientific Background Document B (SBD-B), associated with Chapter 3 of the Modelling and Mapping Manual of the LRTAP Convention. The table below provides an overview of the topics proposed for inclusion, who is taking the lead and who is going to contribute (subject to available funding).

<b>Topic</b>	<b>Lead</b>	<b>Contributions</b>
<i>Guidelines for assessing ozone-induced foliar damage and yield loss of horticultural crops</i>	Ignacio González Fernández and Victoria Bermejo (Spain)	Vicent Calatayud (Spain), Giacomo Gerosa and Riccardo Marzuoli (Italy)
<i>Impacts of ozone on pasture quality</i>	Felicity Hayes (Coordination Centre, UK), Ignacio González Fernández (Spain)	
<i>Ozone flux-effect relationships and methodology for net annual increment (NAI) of trees</i>	Lisa Emberson (UK)	Sabine Braun (Switzerland), Per Erik Karlsson (Sweden)
<i>Ozone removal by vegetation in urban areas</i>	Lina Fusaro and Fausto Manes (Italy)	Rocio Alonso (Spain), Pierre Sicard (France), Giacomo Gerosa (Italy)
<i>Validation of soil moisture index used in EMEP model</i>	Ignacio González Fernández (Spain)	Sabine Braun (Switzerland), Vicent Calatayud and Arnaud Carrara (Spain), Giacomo Gerosa and Riccardo Marzuoli (Italy), Lisa Emberson (UK), Per Erik Karlsson (Sweden), David Simpson (Sweden, EMEP/MSC-West)
<i>Ozone-induced injury guidance for educational and awareness raising purposes</i>	Klaudia Borowiak (Poland)	Felicity Hayes (UK), Felix Leung (Hong Kong, China), Vicent Calatayud and Victoria Bermejo (Spain)
<i>Critical levels for ozone-sensitive clones of poplar</i>	Yasutomo Hoshika (Italy)	Vicent Calatayud (Spain), Riccardo Marzuoli (Italy), Pierre Sicard (France)
<i>Ozone impacts on insects</i>	Valda Araminiene (Lithuania)	Coordination Centre (UK)
<i>Improved phenology for ozone flux modelling in trees</i>	Sabine Braun (Switzerland)	Per Erik Karlsson (Sweden)
<i>Interactive impacts of ozone and nitrogen on (semi-)natural vegetation</i>	Felicity Hayes (Coordination Centre, UK),	

- The TF took note of the roadmap for the review and revision of the empirical critical loads for nitrogen, presented by the Coordination Centre for Effects (CCE) of the ICP Modelling and Mapping. The TF welcomed the opportunity for experts within the ICP Vegetation to contribute to the review. A thematic session on empirical studies about nitrogen effects on vegetation was proposed for the next TF meeting.
- The TF took note of the ongoing collaboration between ICP Vegetation and EMEP Task Forces and Centres and encouraged to continue such collaboration as described in further detail of the workplan of the ICP Vegetation (Annex II).

- The TF took note of the outreach activities of the ICP Vegetation and encouraged to continue such activities, especially in developing regions. The TF encouraged further collaboration with international scientific networks at the global scale.

#### **MOSS SURVEY RELATED ACTIVITIES:**

- The TF reiterated the importance to participants of the 2020-22 moss survey to:
  - Sample mosses in agreement with the monitoring manual and recommended sampling in areas with a defined humus layer (where possible);
  - Conduct quality checks of data before submitting the final data to data management system (DMS), including data on moss reference material;
  - Make use of the many functionalities of the Data Management System, such as link to an App to upload metadata, conduct simple summary statistics and mapping of the data.
  - Remember that the focus of the LRTAP Convention is at rural sites, rather than at local point sources.
- The TF reiterated that quality checks of submitted data are responsibility of the data provider. Subsequently, the Moss Survey Coordination Centre is tasked to check data for outliers, discuss any country border effects with respective data providers and agree with the data providers on the final data to be included in the DMS.
- The TF took note of the suggestion that mapped values of metal content should be supplemented by a classification based on percentiles of the measurement values to give spatial differentiation of low element inputs and accumulations.
- The TF recommended the formation of a sub-group to review the metals and pollutants of focus for the 2025/6 survey, bearing in mind potential emerging pollutants, and to report back to the TF at the next meeting. The TF noted the following recommendations:
  - Heavy metals accumulation in mosses should continue to be measured, even though they have been decreasing since 1990. The decreases are not continuous for all elements, it is important to report stagnations and renewed increase, and even low accumulation can cause critical concentrations in ecosystems to be reached or exceeded.
  - Nitrogen must also continue to be measured, because in many countries nitrogen emission and related accumulation in mosses has been monitored at unchanged high levels since 2005, exceeding critical effect thresholds.
  - POP measurements started since 2010 should be continued and could be part of the standard measurement program.
  - Microplastics should be considered after the results of the pilot studies are known.
- The following countries plan to take part in the pilot study on microplastics: Ireland, Switzerland, Germany, Italy (Toscana region), UK. It was recommended to have a joint workshop with other working groups to discuss the latest developments in analysis of microplastics.
- The TF recommended to continue to compare moss survey results with other environmental and surrounding vegetation data to assess factors affecting element concentrations in mosses.

**Annex II. Medium-term workplan (2020 – 2021) ICP Vegetation** (updated February 2021), and proposed items for 2022-23

Workplan items in *italics* are not specifically included in the biannual workplan ([http://www.unece.org/fileadmin/DAM/env/documents/2019/AIR/EB/ECE\\_EB.AIR\\_2019\\_1-1916514E.pdf](http://www.unece.org/fileadmin/DAM/env/documents/2019/AIR/EB/ECE_EB.AIR_2019_1-1916514E.pdf)) of the LRTAP Convention for 2020 and 2021.

**2020:**

- Ozone flux-based risk maps adapted for soil moisture limited areas (with EMEP/MSC-West);
- Review on interactive impacts of ozone and nitrogen on crops
- Contribution to improve estimation of environmental benefits from decreasing ozone through mitigation of methane emissions (in collaboration with various Convention bodies; HTAP workshop: 22-24 April 2020, Edinburgh, UK)
- Call for data for moss survey 2020-21 on heavy metals, nitrogen and POPs
- *Review leaf area index and total surface area parameterisations in ozone flux-based modelling for upscaling from leaf to canopy level (with EMEP/MSC-West)*
- *Report on ozone impacts on crops in developing regions*
- *Joint workshop with Agricultural Model Intercomparison and Improvement Project (AgMIP) on inclusion of ozone damage functions in crop growth models*
- *Comparison of spatial patterns and temporal trends of heavy metals in mosses and EMEP-modelled deposition (with EMEP/MSC-East)*

**2021:**

- Review on interactive impacts of ozone and nitrogen on vegetation (excluding crops)
- Ozone flux-based risk assessment for vegetation at various air pollution scenarios (to support review of Gothenburg Protocol, with EMEP/MSC-West, TFIAM, CIAM)
- Test development and applications of photosynthesis-based flux-response models (with EMEP/MSC-West)
- Contribution to validation and revision of empirical critical loads for nitrogen (with CCE, ICP Modelling and Mapping)
- Call for data for moss survey 2020-21 on heavy metals, nitrogen and POPs
- *Workshop on epidemiological analysis of ozone and nitrogen impacts on forests (with ICP Forests)*
- *Development of ozone critical levels for forest trees based on the net annual increment (NAI)*

**2022 (provisional):**

- Ozone flux-based risk assessment for vegetation at various air pollution scenarios (for Review of the Gothenburg Protocol) (with EMEP MSC-W)
- Review of ozone pollution and climate change impacts on vegetation – focus on implications for calculation and application of flux-based Critical Levels and risk assessment
- Further development and application of ozone modified photosynthesis-based flux-response models (with EMEP MSC-W)
- *Joint workshop with ecosystem and crop modellers on inclusion of ozone impacts*

**2023 (provisional):**

- Ozone flux-based risk assessment for vegetation at various air pollution scenarios (methane precursors) (with EMEP MSC-W and HTAP)
- State of knowledge report on ‘genetics of crop resilience to ozone and potential for crop breeding’.

**2024 (provisional)**

- Review critical levels for NO<sub>x</sub>

**Selected ongoing annual activities:**

- *Review and update Scientific Background Document B for Chapter 3 of Modelling and Mapping Manual of LRTAP Convention*
- *Outreach and networking activities in developing regions, linking with other international networks*

## **Annex III. Programme of the 34<sup>th</sup> Task Force Meeting of the ICP Vegetation**

### **Monday 22<sup>nd</sup> February, 2021**

**Session: Plenary Chair: Felicity Hayes**

14:00 Welcome address

14:15 *Isaura Rabago (Chair WGE)* - Recent developments in the Air Convention: Challenges, critical factors and opportunities for action.

14:45 *Alice James Casas and Christin Loran* - Update on the process "Review and revision of the empirical critical loads for nitrogen for natural and near-natural ecosystems".

15:05 *Felicity Hayes et al.* - Overview of activities and achievements of the ICP Vegetation.

15:30 ***Comfort break***

15:40 *Ignacio González-Fernández et al.* – Modelling of phytotoxic ozone doses for risk assessment at European and plot scales using the soil moisture index.

16:00 *Marina Frontasyeva et al.* - Moss survey 2020-2021-2022. Sampling in COVID year of 2020.

16:20 *Stefano Loppi et al.* - Lichen biomonitoring and environmental justice. A case study from Milan, Italy.

16:40 *Carter Bertrim & Julian Aherne* - Active moss biomonitoring of microplastic deposition in urban environments.

17:00 ***General Discussion***

17:30 ***Session End***

### **Tuesday 23<sup>rd</sup> February, 2021**

**Session: Moss 1 Chair: Konstantin Vergel**

10:00 *Nikita Yushin et al.* - Mosses as Bioindicators of Heavy Metal Air Pollution in the Lockdown Period Adopted to Cope with the COVID-19 Pandemic.

10:20 *Biljana Balabanova et al.* - An effective tool for monitoring the deposition of surface dust in the cross-bio-indication process of metals in moss tissue.

10:40 *Mira Aničić Urošević et al.* – Moss bag biomonitoring of polycyclic aromatic hydrocarbons in urban areas during winter season.

11:00 ***Comfort break***

11:10 *Stefan Nickel & Winfried Schröder* - Pilot Studies on the Suitability of Bioindication with Mosses for the Detection of Atmospheric Deposition of Persistent Organic Pollutants and Microplastics in Germany: Measurement Network Planning and Implementation.

11:30 *Carmen Wolf et al.* – Pilot studies on the suitability of bioindication with mosses for the detection of atmospheric deposition of persistent organic pollutants and microplastics in Germany: Method development, sample preparation, and preliminary investigation on microplastics.

11:50 *Arlinda Cakaj et al.* – Accumulation of Platinum elements in *Taraxacum officinale* collected in urban areas of Pristina (Kosovo) and Poznan (Poland).

12:10 ***General discussion, including questions about posters.***

13:00 ***Session End.***



13:30 **Breakout rooms open (aimed at moss survey participants, but others can join too).**

14:00 **Session End.**

**Session: Ozone 1 Chair: Håkan Pleijel**

14:00 *Kent O. Burkey & Thomas E. Carter, Jr.* - Progress in breeding to improve the ozone tolerance of crops.

14:20 *Cristina Sausor Carmona et al.* – Effect of tropospheric ozone and water stress on spring wheat biomass and soil microbial communities under Mediterranean conditions.

14:40 *Melissa Chang Espino et al.* – Ozone response of a Mediterranean bread wheat under different nitrogen fertilization levels.

15:00 *Yanru Feng et al.* - Genetic variation of wheat responses to ozone treatment.

15:20 **Comfort break**

15:40 *Pritha Pande* – Developing Ozone Flux-Response Relationships for wheat using different stomatal conductance (gsto) models.

16:00 *Jo Cook* – Incorporation of a nitrogen dynamics module into the DO<sub>3</sub>SE model to simulate wheat grain quality parameters.

16:10 *Malin Broberg et al.* – Harvest index and remobilization of 13 elements during wheat grain filling: Experiences from ozone experiments in China and Sweden.

16:30 **General discussion, including questions about posters.**

17:30 **Session End.**

### **Wednesday 24<sup>th</sup> February, 2021**

**Session: Moss 2 Chair: Inga Zinicovscaia**

10:00 *Pranvera Lazo et al.* – Study of air quality by moss biomonitoring and trace elements content.

10:20 *Guntis Tabors et al.* - Results of moss biomonitoring of atmospheric deposition in Latvia in 2020.

10:30 *Sebastien Leblond & Caroline Meyer* – Spatial distribution of platinum group elements in French mosses.

10:50 *Alexander Uzhinskiy et al.* - Prediction of air pollution by potentially toxic elements by combining satellite imagery, Moss Biomonitoring Data and Machine Learning: Limitation and Perspectives.

11:10 *Camiel Aggenbach et al.* – Moss survey 2020-2021 in The Netherlands.

11:30 *Ayse Nur Esen et al.* - Review of moss biomonitoring in Turkey.

11:40 **General discussion and future workplan, AOB.**

12:30 **Session End.**

12:30 **Breakout rooms open (aimed at ozone session participants, but others can join too).**

13:30 **Session End.**

**Session: Ozone 2 Chair: Rocio Alonso**

- 14:00 *Zhaozhong Feng et al.* - Introduction on new Ozone-FACE system in China.
- 14:20 *Raquel Ruiz-Checa et al.* – Current studies on atmospheric nitrogen deposition and effects in Spain.
- 14:40 *Samuel Prieto-Benítez et al.* – Ozone effects on visual pollinator attraction flower traits of the Spanish endemism *Erodium paularense*.
- 15:00 *Yasutomo Hoshika & E. Paoletti* - Comparison of sensitivity to O<sub>3</sub> between native poplars and poplar clones -Working Progress.
- 15:10 *Muhammad Adrees et al.* - Efficacy of silicon nanoparticles for wheat growth under combined effect of ozone and salinity.
- 15:30 *Amanda Holder & Felicity Hayes* - Impact of tropospheric ozone on sweet potato.
- 15:50 **General discussion and future workplan, AOB.**
- 17:00 **Session End.**

## LIST OF POSTERS

### OZONE

Author(s)	Title	Break-out Room
Ueno Andrea C. et al.	Maternal ozone increases survival of the progeny depending on plant symbiotic status and current environmental condition.	1
Durgesh Singh Yadav et al.	Diurnal variations in physiological characteristics, photo assimilates, and total ascorbate in early and late sown Indian wheat cultivars under exposure to elevated ozone.	1
Felix Leung et al.	Evidence of Ozone-Induced Visible Foliar Injury in Hong Kong using <i>Phaseolus vulgaris</i> as a Bioindicator.	2
Li Li et al.	Response of gas exchange, biomass and nonstructural carbohydrates (NSC) allocation in <i>Indocalamus decorus</i> to experimental atmospheric O <sub>3</sub> enrichment in a suburb of Beijing, China.	2
Falk S. et al.	Characterizing subarctic biomes for land surface modeling of pollution and climate risk.	2

### MOSS SURVEY

Author(s)	Title	Break-out Room
Mehrabova M.A. et al.	Moss biomonitoring of air pollution with heavy metals and radionuclides.	1
Koroleva Yulia et al.	Features of the trace element composition of bryophytes in coastal landscapes (southern Curonian Spit, Russia).	1
Ramazanov Bakhruz et al.	Using of Mosses <i>Hylocomium splendens</i> and <i>Pleurozium schreberi</i> for assessment of atmospheric deposition of PAH in the Kaliningrad region.	2

Trajče Stafilov et al.	Atmoferic mercury deposition in Macedonia from 2002 to 2015 determined using the moss biomonitoring technique.	2
Lisiak-Zielińska Marta et al.	Comparison of rare earth elements content in <i>Taraxacum officinale</i> collected in urban areas of Poznan (Poland) and Brno (Czech Republic).	3
Borovská Jana et al.	Atmospheric deposition of Heavy metals in Slovakia.	3
Shaniko Allajbeu et al.	Temporal trend of sea spray elements in two different periods survey 2010 and 2015 in Albania by moss samples growing in natural condition.	4
Ilić M. et al.	Can <i>Hypnum cupressiforme</i> be easily found within urban areas? – a case study in Serbia.	4
Stihi C. et al.	Moss surveys in Romania: 2010/2011, 2015/2016, 2020/2022. Results and perspectives.	5
Saxena D.K. & Saxena A.	Atmospheric Metal Load By Mosses During Pre-Lockdown And Lockdown Pandemic Period.	5