

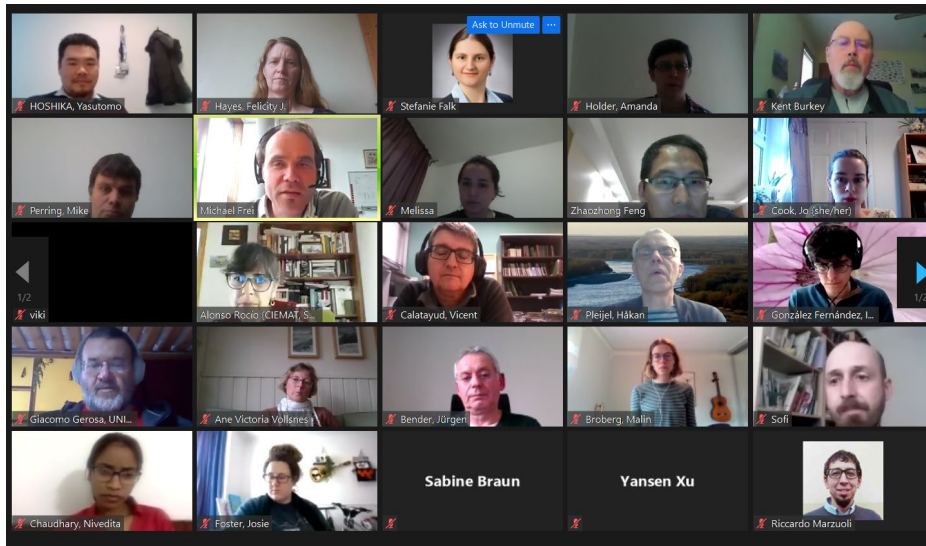


Achievements of the ICP Vegetation and future work plan

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Task Force Meeting 2021



22-24 February 2021

125 participants from 35 countries, by Zoom

Condensed programme, including separate moss and ozone specific sessions, plenary session, and breakout discussion/poster/informal sessions

(2022 meeting planned to be in Kaunas, Lithuania)

Mapping Manual – Annexes Added

SBD-B (Scientific Background Document)

Gap-filling (for flux-effect modelling) - added

Interactions between ozone exposure and N application in crops – added

Workplan item 1.1.1.9

Preparing for the Review of the Gothenburg Protocol –
parameterisations for (semi-)natural vegetation, and for upscaling to the
whole canopy for large-scale modelling – *with EMEP*

Workplan item 1.4.1

New DO₃SE model parameterisations

Tropical Crops

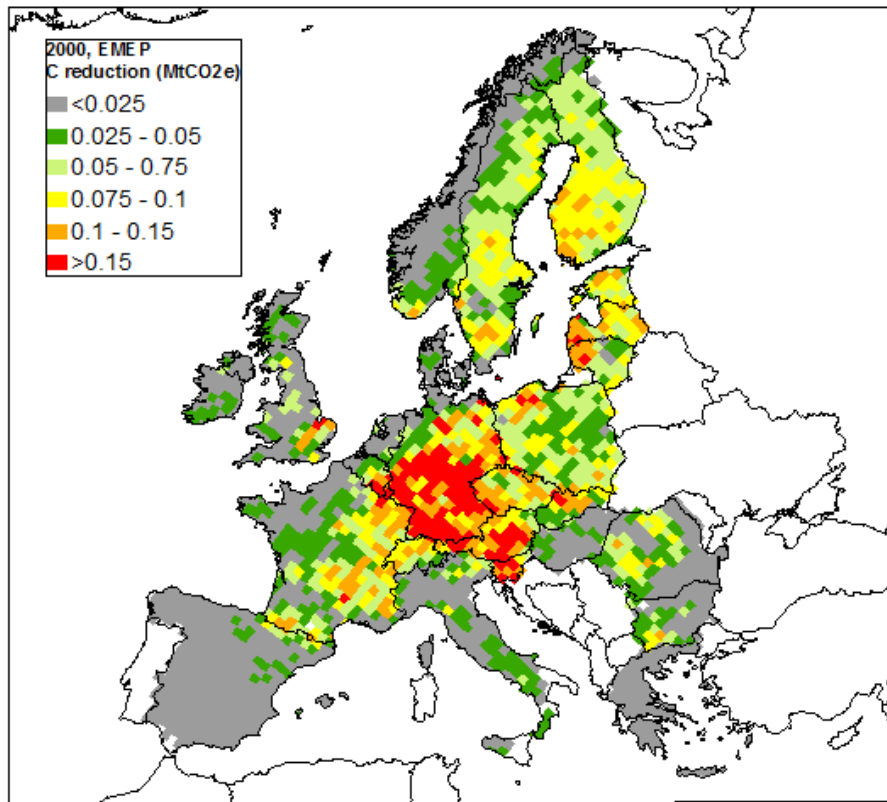
Parameterisations developed for bean, sweet potato and finger millet

Allowing improved risk assessment in tropical areas – particularly relevant as temperate crops e.g. wheat are not commonly grown in all regions

Sweet potato and bean are ozone-sensitive, showing yield reductions

Effect of ozone on living biomass (carbon sequestration) of sensitive trees

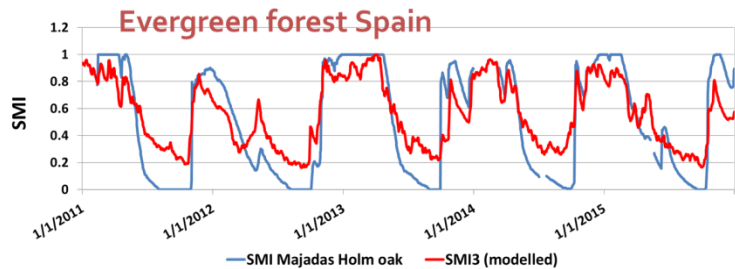
Lisa Emberson, Sabine Braun et al.



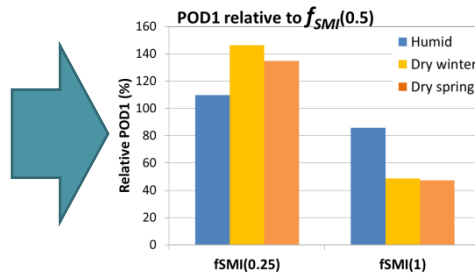
- ❑ Based on gross annual increment
- ❑ Using dose-response relationships for 12 species / species groups
- ❑ Weighted by the presence of each species/species group in each gridcell
- ❑ Ozone fluxes in 2000 reduced the increase in C storage by 12.6% (EMEP model) to 17.7% (Rossby Centre Regional Climate (RCA3) model)
- ❑ Also affected by soil moisture – particularly in the Mediterranean region

Ozone risk assessment in soil moisture limited areas

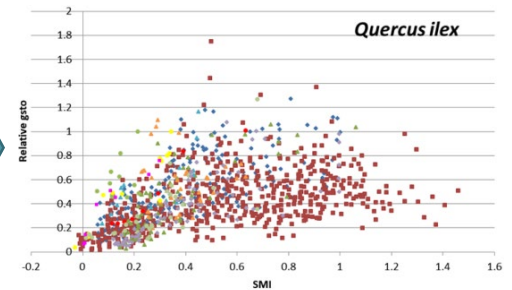
- Objective: improving POD-based O₃ risk assessment in soil moisture limited areas (and under future climatic conditions)
- Participants: ICP-Vegetation (Spain and Italy + Switzerland + Sweden + UK) in collaboration with EMEP MSC-W



Test Soil Moisture Index at monitoring sites: tend to overestimate soil moisture



Sensitivity analysis: depth and species-specific parameters important for POD estimation

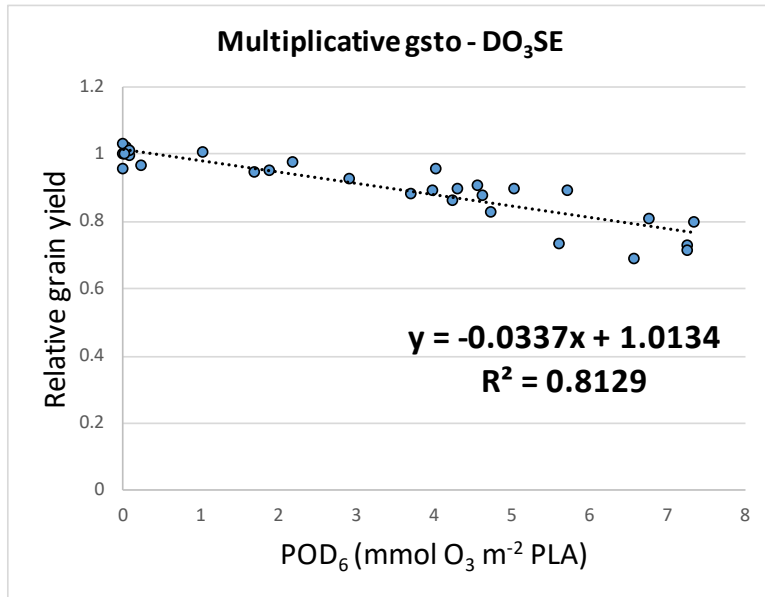


New species-specific parameters into EMEP model

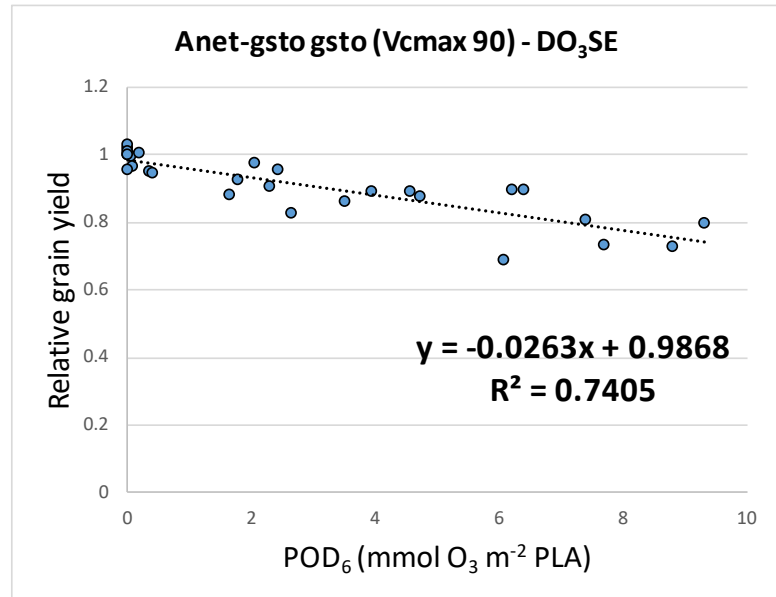
- Next steps (2022-2023): further development of soil moisture parameters and assessment of effects of drought on POD estimation across Europe

Development of coupled gsto-An model

i. Multiplicative stomatal conductance (gsto) model



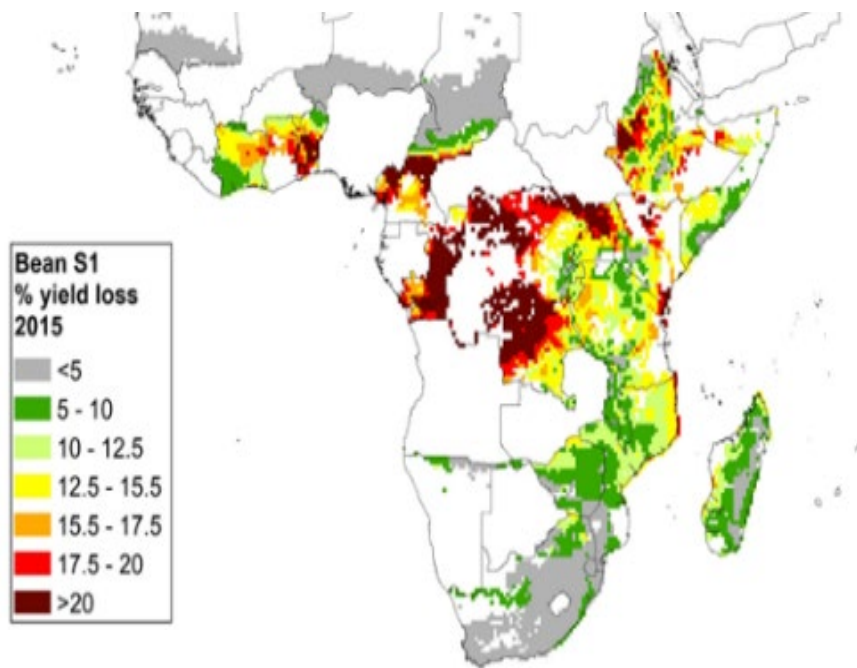
ii. 'New' coupled photosynthesis-stomatal conductance (Anet-gsto) model



Next steps:

- Add new datasets to flux-response relationships (Europe & India)
- Explore parameterisation according to Vcmax term (by cultivar), and sensitivity of senescence to ozone

Outreach - maps of predicted impacts on yield



Sharps et al., (2021)

- % yield loss for common beans
- Modelled ozone flux data (for 2015) from EMEP MSC-W.
- >20% estimated yield loss for some areas.
- Ozone diffusion tubes deployed in: DRC, Ethiopia, India, Kenya, Sri Lanka, Malaysia, Rwanda, Uganda, United Republic of Tanzania, Zambia
- Variable ozone concentrations, up to monthly average concentrations of 36 ppb in some parts of Uganda

Outreach – Information sharing

- ❑ Webinar – to Tanzania (virtual)
- ❑ Youtube video – ozone impacts on agriculture
<https://youtu.be/OBEJB-60jQU>
- ❑ Ad-hoc advice – including to India
- ❑ Information leaflets – including to Plantwise Knowledgebank

Ozone impacts: legumes

Legumes, including beans, are very sensitive to ozone pollution and other stressors. Ozone pollution causes symptoms of damage. The leaves become discolored and injury often occurs within 24 hours of exposure to the ozone. The leaf veins contain green chlorophyll and the leaf will stay green for a while, but the leaf will eventually turn brown and die.

Ground-level ozone leaf injury

Ground-level ozone injury on crops

Ozone formation

At the upper levels of the atmosphere ozone is beneficial and protects us from harmful UV light from the sun. It is also formed in sunlight from precursors. These are released from various sources, including industry, industry, and vehicles. Ozone formation can occur far away from where the precursors were released. Ozone then travels thousands of miles so that increased ozone formation can occur far away from where the precursors were released.

Other crops

Highly sensitive

Medium sensitive

Low sensitive

Not sensitive

Ozone visible leaf injury on tropical crops

At ground level, ozone is a damaging pollutant. It is formed from reactions in sunlight involving oxides of nitrogen, carbon monoxide and non-methane volatile organic compounds released mainly from vehicle and industrial sources. The pre-cursor molecules can travel on the wind for thousands of miles so that increased ozone formation can occur far away from where the precursors were released.

Amaranth (pygmy torch)

Finger millet **bean** **Pearl millet**

chickpea **Mandarin orange** **peanut**

pea

When ozone enters a leaf, it is transformed into cell-damaging compounds that cause localized cell death. This becomes visible on the leaf as small spots. In severe cases, these spots can join together to cover large areas of the leaf surface.

Ground-level ozone: Damaging crop production

In the upper levels of the atmosphere ozone is beneficial because it protects us from harmful UV light from the sun. At ground level, ozone is a harmful pollutant. It is formed from reactions in sunlight involving oxides of nitrogen, carbon monoxide and non-methane volatile organic compounds released mainly from vehicle and industrial sources. The pre-cursor molecules can travel on the wind for thousands of miles so that increased ozone formation can occur far away from where the precursors were released. Ozone then travels thousands of miles so that increased ozone formation can occur far away from where the precursors were released. Ozone concentrations tend to be highest in urban areas where there is more traffic and industry.

Ozone levels are increasing rapidly in developing regions due to increasing emissions of precursor pollutants. There is evidence of crop damage in some developing regions in South East Asia, and visible ozone damage in Africa.

Identified ozone hotspots for crops in crop growing areas are used to predict where ozone damage is likely. These are large regions in crop growing areas where ozone damage is likely to occur. These include Africa, Asia, and South America.

Estimated ozone damage to crops in crop growing areas is shown in the map. The map shows that ozone damage is likely to occur in large areas of the world.

Options for mitigating ozone pollution impacts on crop yield

At ground level, ozone is a damaging pollutant. It is formed from reactions in sunlight involving oxides of nitrogen, carbon monoxide and non-methane volatile organic compounds released mainly from vehicle and industrial sources. The pre-cursor molecules can travel on the wind for thousands of miles so that increased ozone formation can occur far away from where the precursors were released. Ozone then travels thousands of miles so that increased ozone formation can occur far away from where the precursors were released. Ozone concentrations tend to be highest in urban areas where there is more traffic and industry.

Micro-climate environments of hotspots and growth. Ozone damage to crops is most likely to occur in hotspots and growth. The magnitude of the negative impacts of ozone on crop yield is determined by the cumulative impact. For many crops, ozone damage reduces their productivity and crop yield and reduces crop yield and productivity.

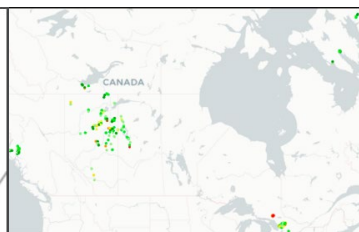
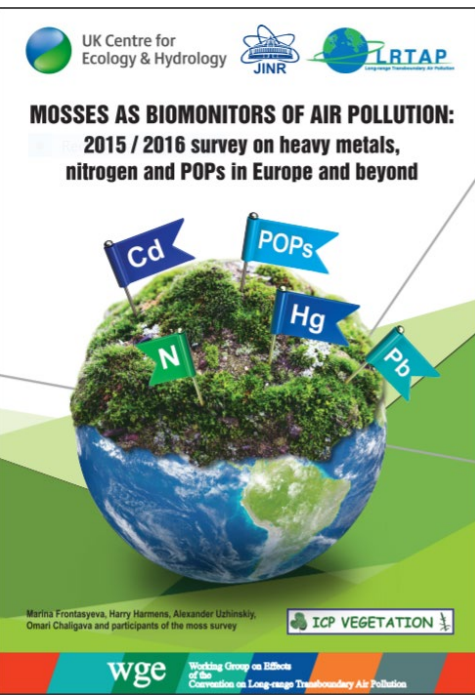
Options for mitigating ozone pollution impacts on crop yield

Highly sensitive	Medium sensitive	Low sensitive	Not sensitive
Amorpha fruticosa	Amorpha fruticosa	Amorpha fruticosa	Amorpha fruticosa
Amorpha fruticosa	Amorpha fruticosa	Amorpha fruticosa	Amorpha fruticosa
Amorpha fruticosa	Amorpha fruticosa	Amorpha fruticosa	Amorpha fruticosa
Amorpha fruticosa	Amorpha fruticosa	Amorpha fruticosa	Amorpha fruticosa
Amorpha fruticosa	Amorpha fruticosa	Amorpha fruticosa	Amorpha fruticosa
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Amorpha fruticosa	Amorpha fruticosa	Amorpha fruticosa	Amorpha fruticosa
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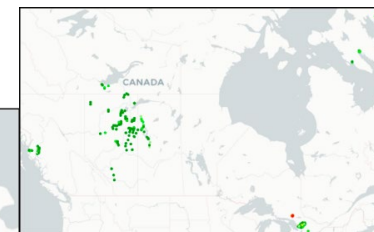
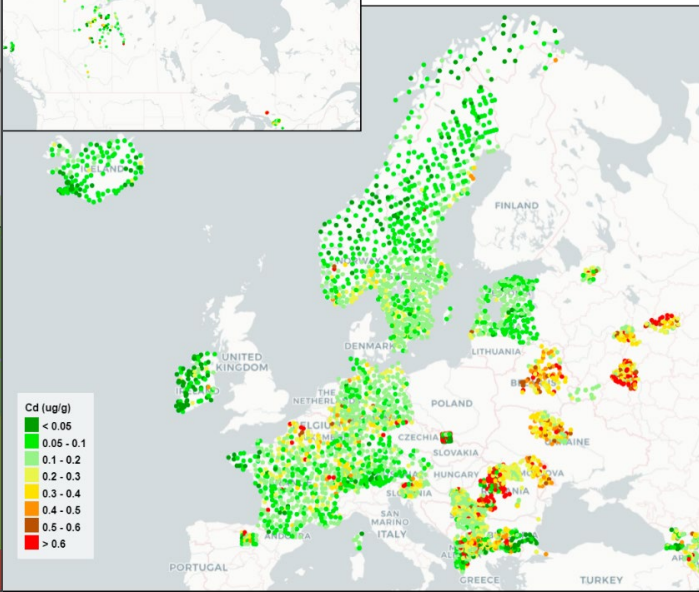
CP V

Moss survey 2015/16

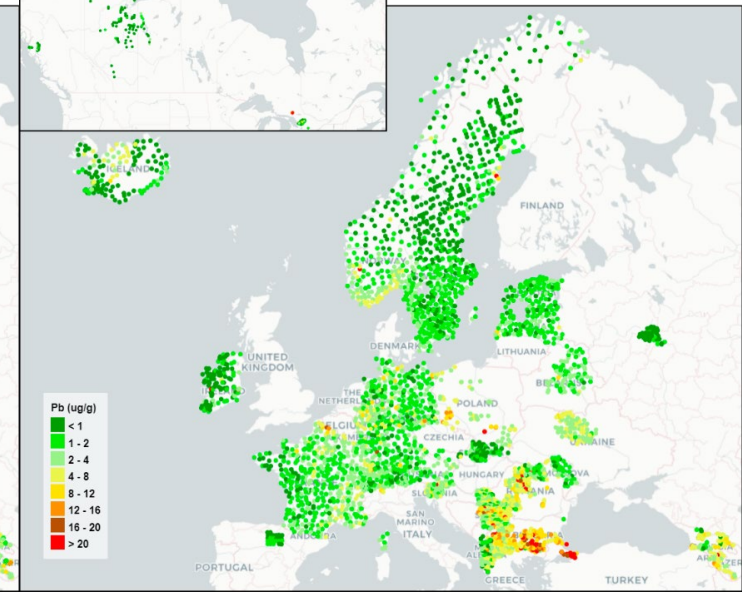
- ❑ North-West to South-East gradient in Europe
- ❑ High concentrations in (south-)east due to anthropogenic sources and high wind-resuspension?
- ❑ Final report for 2015/2016 now available



Cadmium

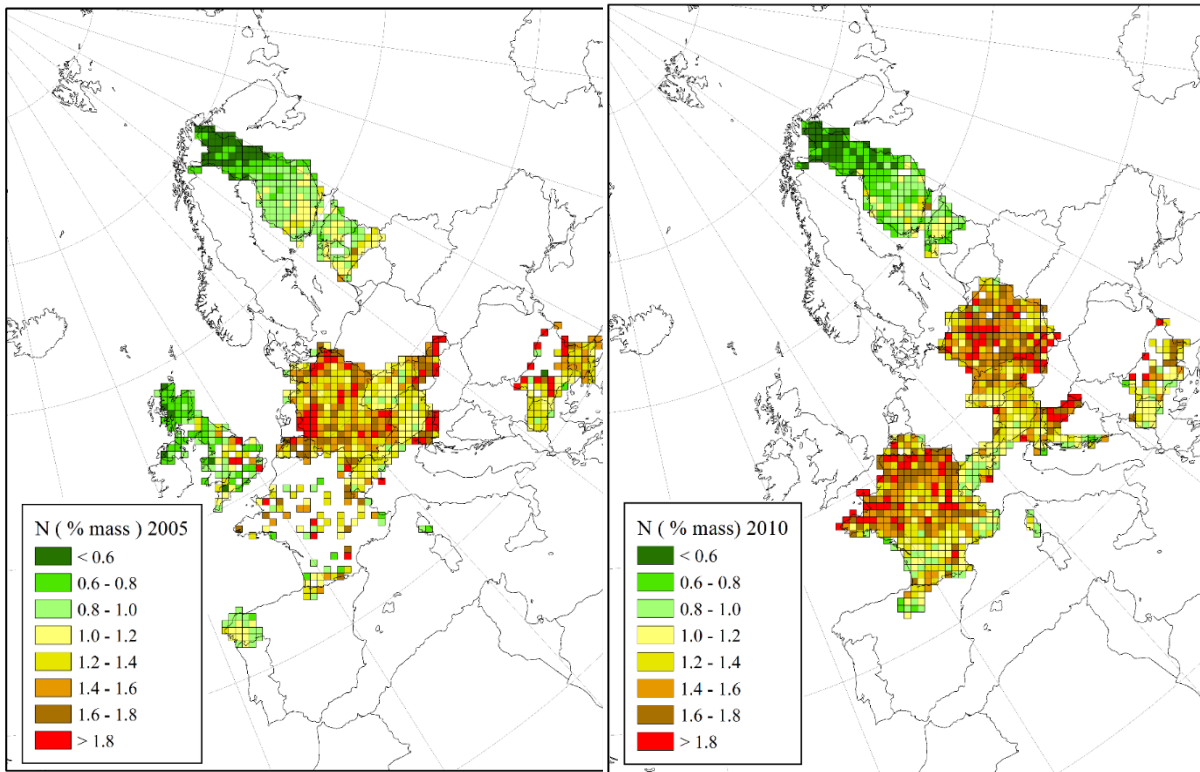


Lead

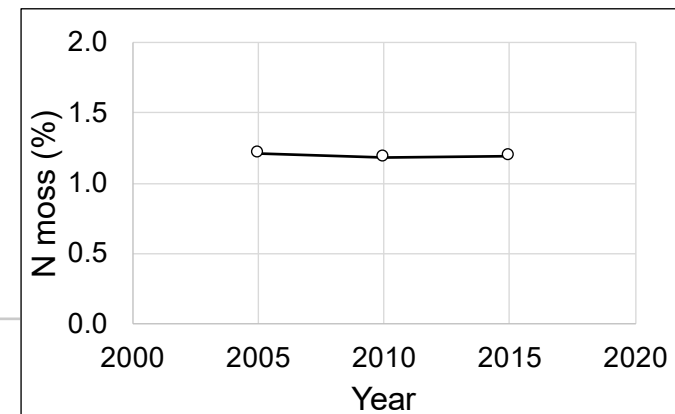
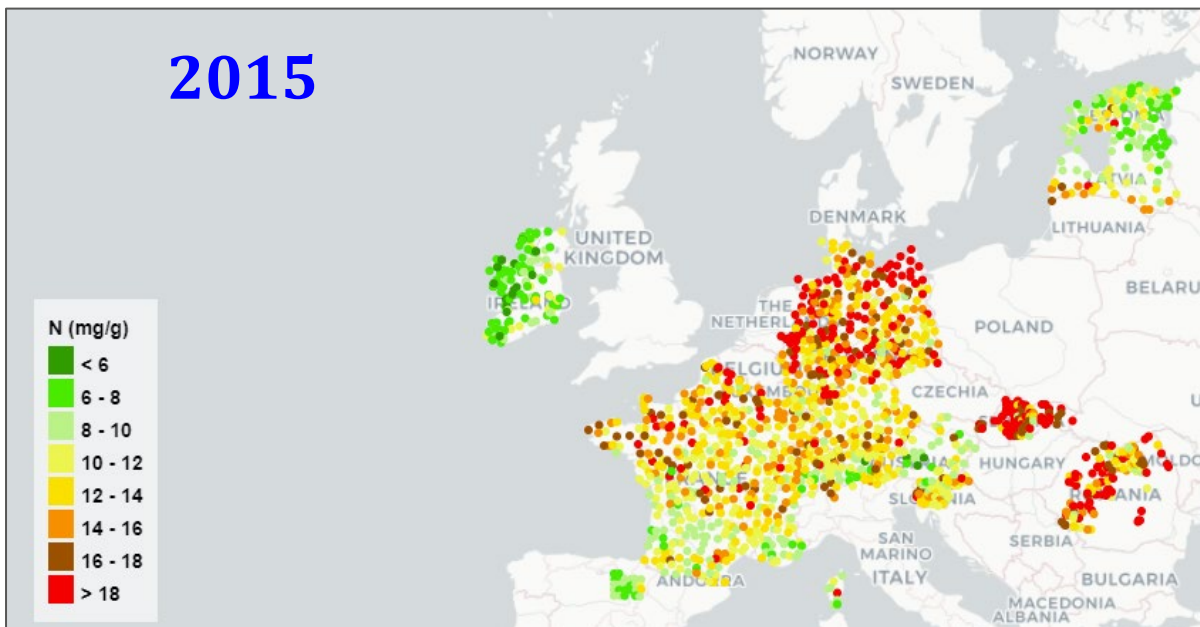


N in moss

- ☐ Every 5 years since 2005
- ☐ Concentrations lowest in northern/western Europe, highest in Central Europe
- ☐ No significant decline between 2005 - 2015



2015



Next survey 2020-2022:

Call for data issued (HM, N, POPs) (approximately 1500 sites sampled already)

Include pilot study on mosses as biomonitors of microplastics as indication of atmospheric deposition rates

Monitoring manual: **English and Russian**

<https://icpvegetation.ceh.ac.uk/get-involved/manuals/moss-survey>

Countries already participating in moss survey 2020-2022

Albania	Germany	Kazakhstan	Russia	Vietnam
Armenia	Greece	Latvia	Slovakia	Switzerland
Georgia	Italy	North Macedonia	Sweden	UK
Netherlands				

Current ICP Vegetation Workplan

2021 delivery:

Call for data for moss survey 2020-22 (collection extended due to Coronavirus)

Ozone flux-based risk maps for soil moisture limited areas (with EMEP/MSC-West)

Ozone flux-based risk assessment for vegetation at various air pollution scenarios (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 N (with CCE, ICP Modelling and Mapping)

ICP Vegetation - Draft Future Workplan

2022 delivery:

Call for data for moss survey 2020-22 (collection extended due to Coronavirus).
Final report 2024.

2022/2023.

Ozone flux-based risk assessment for vegetation at various air pollution scenarios.
Maps and reports 2023

- (GP, also methane precursors) (with EMEP/MSC-West, HTAP)
- Further development and applications of ozone modified photosynthesis-based flux-response models (with EMEP/MSC-West)
- *the effects of drought under present and future climatic conditions (with EMEP/MSC-West, and in-kind contributions from participating countries).*

2022/2023

Review of air pollution and climate change impacts on vegetation – focus on implications for calculation and application of flux-based Critical Levels and risk assessment.

2022/2023

State of knowledge report: Genetics of crop resilience to ozone and potential for improved crop breeding.

ICP Vegetation Workplan – other items

Ongoing Annual Activities

Review and update Scientific Background Document B for Chapter 3 of Modelling and Mapping Manual

Outreach and networking activities in developing regions (e.g. ICP Vegetation-Asia); linking with other networks

Additional (unofficial) items

???? delivery:

Comparison of spatial patterns and temporal trends of heavy metals in mosses and EMEP-modelled deposition (with EMEP/MSC-East)

2021 delivery: *Joint workshop with other working groups (e.g. ICP Waters) on latest developments in analysis of environmental microplastics*

2022 delivery: *Review metals and pollutants of focus, including emerging pollutants*

2022 delivery: *Pilot studies on use of mosses as bioindicators of airborne microplastics*

Thank you

Notes for minutes:

ICP Vegetation have continued to prepare for the upcoming review of the Gothenburg Protocol by reviewing and re-introducing parameterisations to allow large scale modelling of impacts of ozone on crops and semi-natural vegetation.

Progress presented with improving ozone risk assessment in soil moisture limited areas – this work will continue

Progress with flux-effect models for some tropical crops – to improve global risk assessments.

Assessment of the effect of ozone on living biomass of sensitive trees showed that ozone decreased carbon sequestration in many parts of Europe.

Development of a coupled photosynthesis-based flux model is ongoing.

Heavy metals in mosses report from 2015/16 survey is published. 2020/21 survey is underway (extended to 2022). Approximately 1500 samples collected already. The survey will include a pilot study on microplastics content of mosses. Outreach activities continue, to raise awareness and to share skills and expertise.