Update ozone critical levels for vegetation and other ICP Vegetation* activities

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* Supported by Defra (UK), NERC (UK) & UNECE

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46th session TFIAM, 2-3 May 2017, Paris

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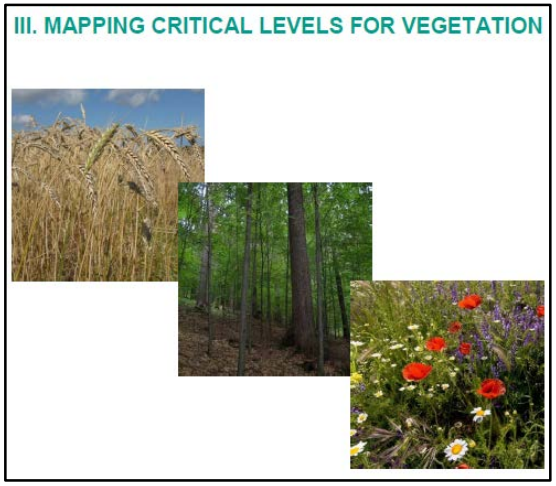
Ozone critical levels (CLs) for vegetation

Workshops:

- 23 – 25 Nov 2015: Critical Levels Methodology Workshops, Hindås, **Sweden***
- 7 – 9 June 2016: Workshop on deriving dose-response functions, Deganwy, UK **(with financial support from Switzerland*)**
- 7 – 9 November 2016: **UNECE Ozone Critical Levels Workshop**, Madrid, **Spain***
  Background document presented with methodology, response functions, proposed critical levels (CLs) and new developments



- 30th ICP Vegetation Task Force meeting, 14-17 February, 2017, Poznan, Poland:
  - Adoption 21 ozone flux-based CLs
  - No changes ozone concentration-based CLs
  - No changes CLs for SO_2, NO_x, NH_3

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* Thank you for contribution in kind!

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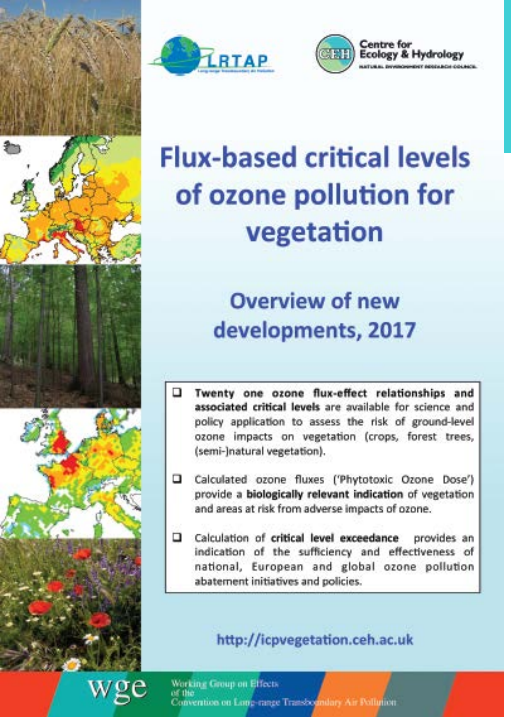


Flux-based ozone CLs

Two types of Phytotoxic Ozone Dose (POD_Y) defined:

- ❑ **POD_YSPEC:** plant species (group)-specific, requires more input data, suitable for detailed risk assessment.
- ❑ **POD_YIAM:** vegetation-type specific, requires less input data, suitable for large-scale modelling, including IAM.

21 flux-based CLs defined

Chapter 3 Modelling and Mapping Manual:

- ❑ Contains main methodology, flux-effect relationships and CLs
- ❑ Revision every 3 – 5 year (depending on new developments)

Two scientific background documents, annual update after Task Force meeting:

A. Supplementary information for Chapter 3

B. Developing areas and new directions of research

Species-specific flux-based CLs ($POD_Y SPEC$)

Species (group)	Effect parameter	Potential effect at CL (% reduction)	Critical level (mmol m^{-2} PLA)	Potential max. rate of reduction (%) per unit $POD_Y SPEC$
Crops ($POD_6 SPEC$)				
Wheat	Grain yield	5%	1.3	3.85
	1000-grain weight	5%	1.5	3.35
	Protein yield	5%	2.0	2.54
Potato	Tuber yield	5%	3.8	1.34
Tomato	Fruit yield	5%	2.0	2.53
	Fruit quality	5%	3.8	1.30
Forest trees ($POD_1 SPEC$)				
Beech and birch	Whole tree biomass	4%	5.2	0.93
Norway spruce	Whole tree biomass	2%	9.2	0.22
Med. deciduous oaks	Whole tree biomass	4%	14.0	0.32
	Root biomass	4%	10.3	0.45
Med. evergreen	Above-ground biomass	4%	47.3	0.09
(Semi-)natural vegetation ($POD_1 SPEC$)				
Temperate perennial grassland	Above- ground biomass	10%	10.2	0.99
	Total biomass	10%	16.2	0.62
	Flower number	10%	6.6	1.54
Med. annual pasture	Above- ground biomass	10%	16.9	0.85
	Flower/ seed biomass	10%	10.8	1.61

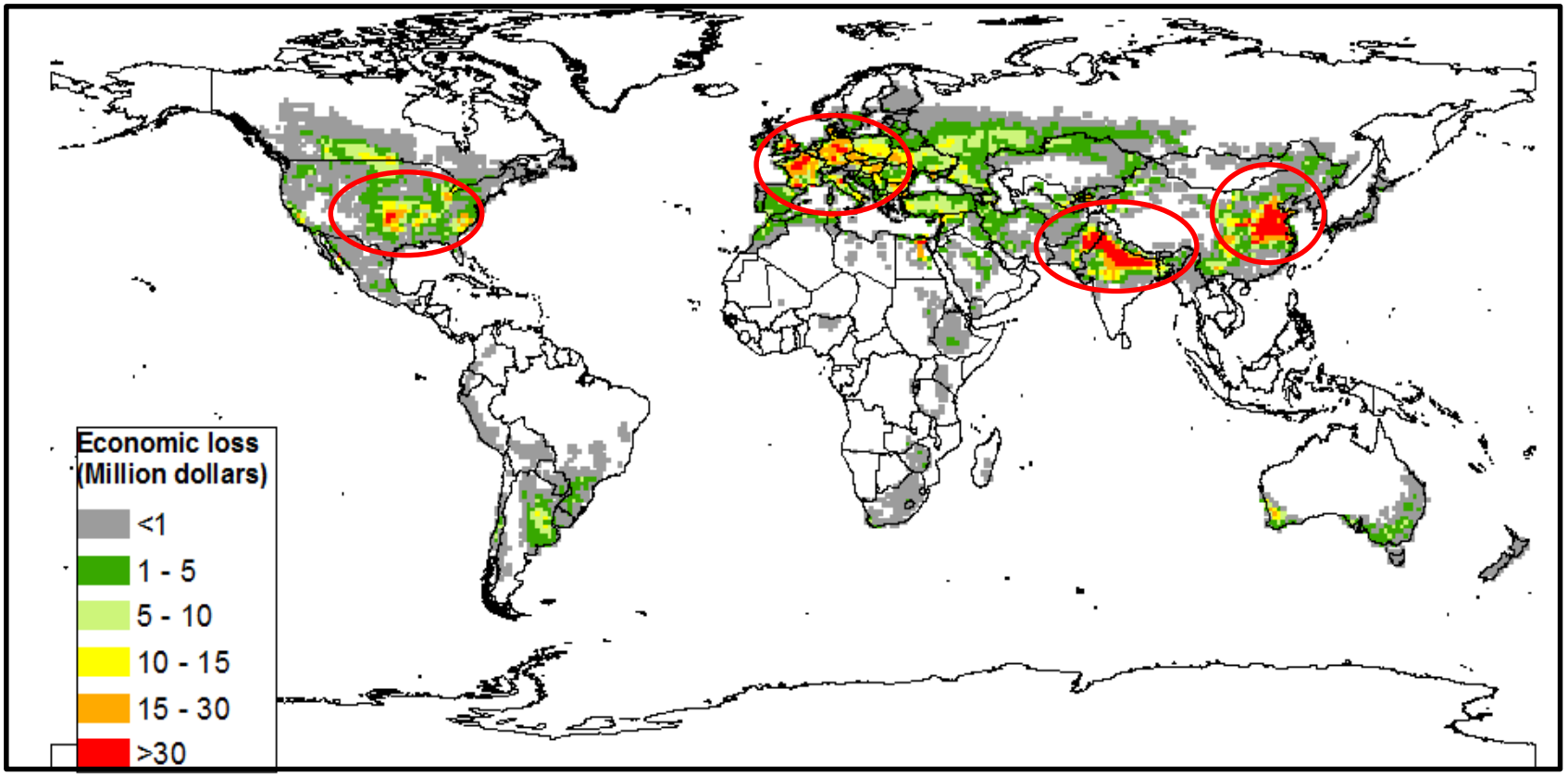
Vegetation type-specific flux-based CLs (POD_YIAM)

Vegetation type (POD_YIAM)	Effect parameter	Use to assess risk of reduction in	Potential effect at CL (% reduction)	Critical level (mmol m^{-2} PLA)	
Crops (POD_3IAM)	Grain yield	Grain yield	5%	7.9	
Forest trees (POD_1IAM)	Total biomass	Annual growth of living biomass of trees	4%	5.7	Non-Med.
			4%	13.7	Med.
(Semi-)natural vegetation (POD_1IAM)					
Temperate perennial grasslands	Flower number	Vitality of species-rich grasslands	10%	6.6	Non-Med.
Med. annual pastures	Flower/ seed biomass		10%	10.8	Med.

- ❑ Indicative risk assessment of impacts on the most ozone-sensitive vegetation
- ❑ Indicative economic assessment for crops, not for trees or (semi-)natural vegetation

Ozone flux-based global assessment

Mills et al. Submitted to PNAS (Proceedings of the National Academy of Sciences)

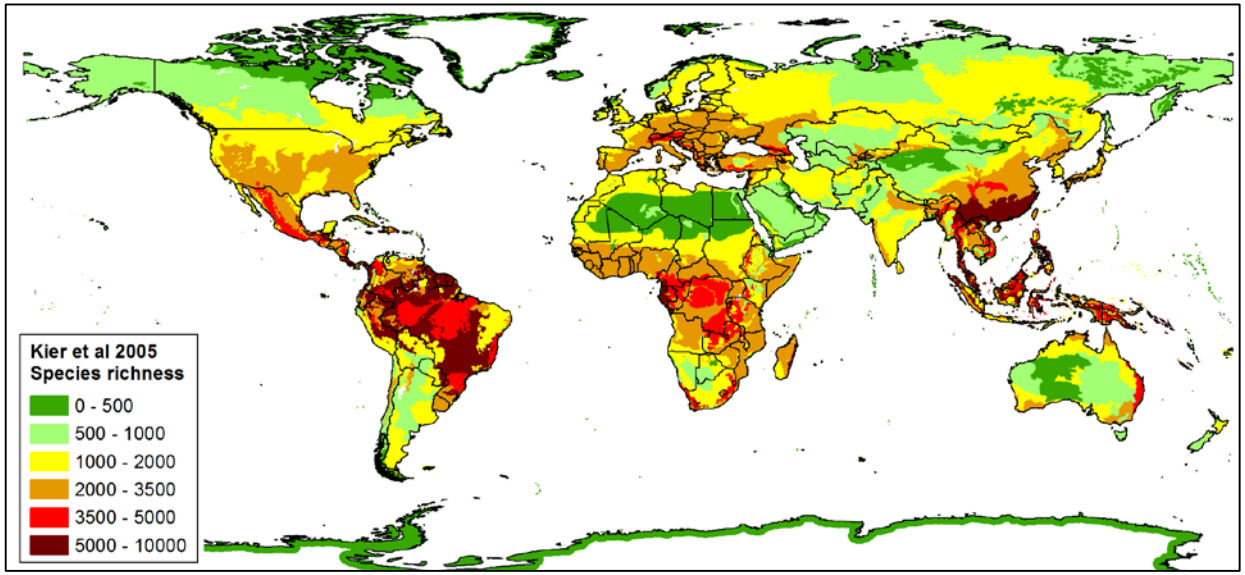


- **Global economic losses due to ozone effects on wheat yield (9.4% loss) are estimated at $24.3 billion**

Data averaged for 2010, 2011, 2012, weighted per grid square by proportion irrigated (based on production) .

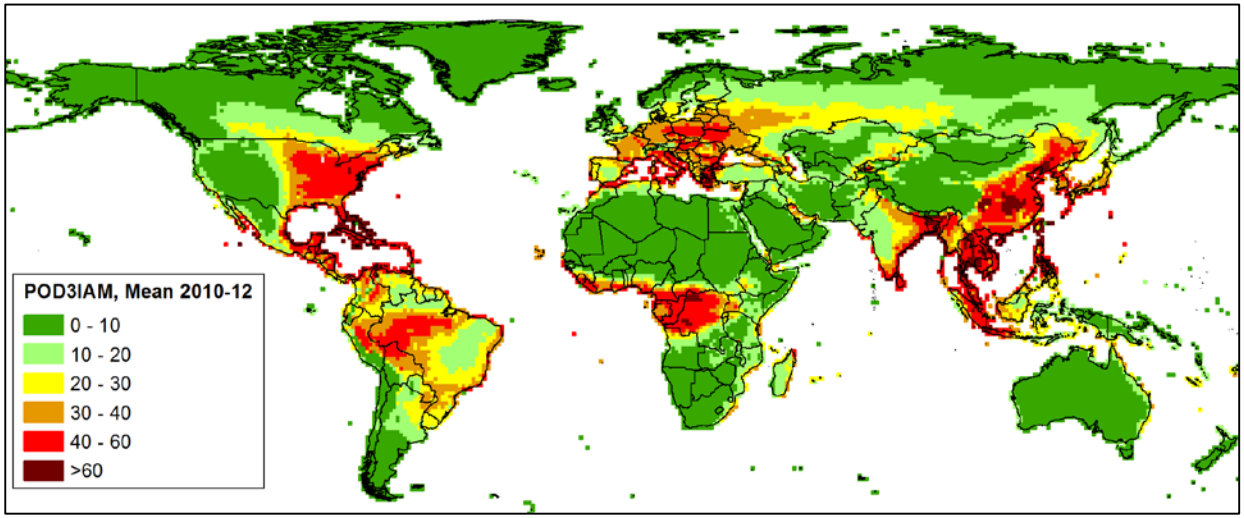
Potential global risk ozone on biodiversity (1)

Fuhrer et al. (2016). Current and future ozone risks to global terrestrial biodiversity and ecosystem processes. Ecology and Evolution 6: 8785-8799 (concentration-based)



***Provisional results**

Plant species richness (Kier et al., 2005. J. Biogeogr. 32: 1107-1116)



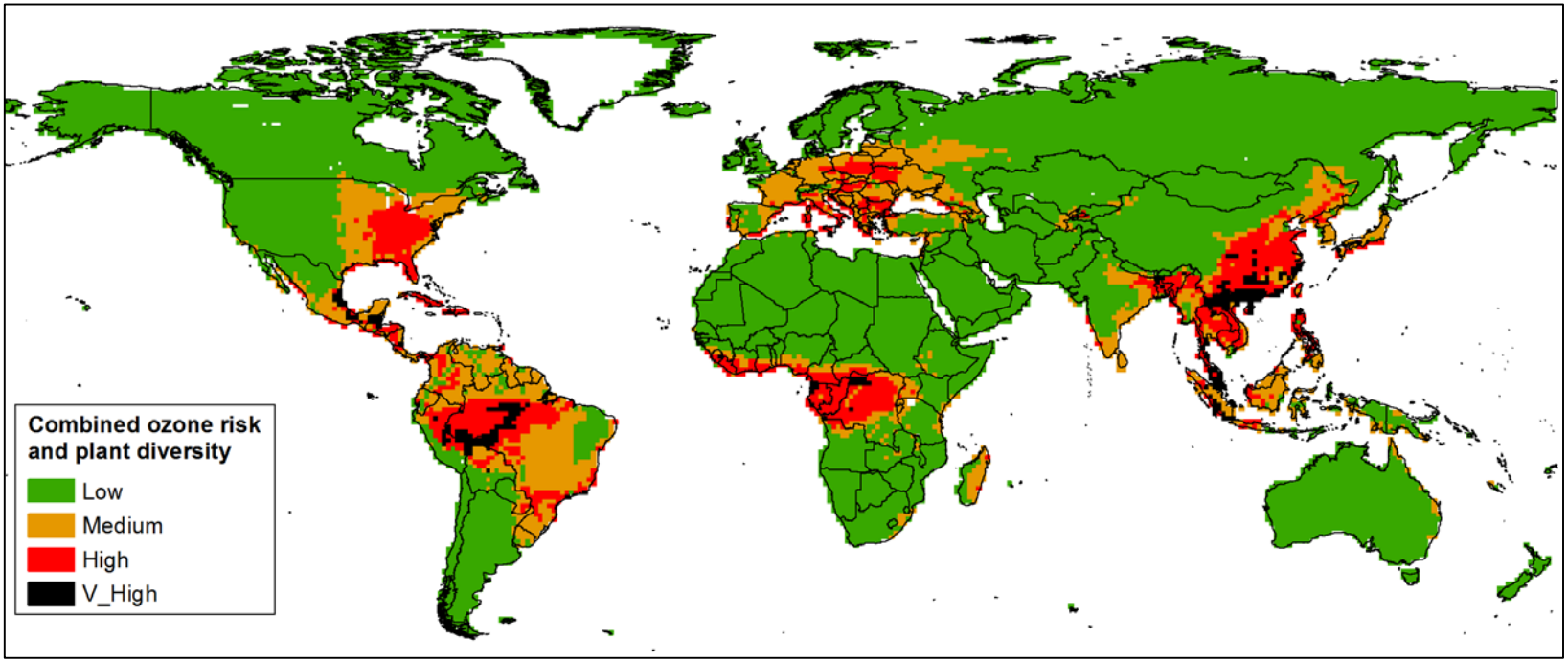
Ozone stomatal flux (POD_3IAM for crops, mean 2010-2012)

Potential global risk ozone on biodiversity (2)

		POD_3IAM (Mean 2010-2012)					
Species richness		0 to 10	11 to 20	21 to 30	31 to 40	41 to 60	>60
	Score	1	2	3	4	5	6
<=500	1	1	2	3	4	5	6
501-1000	2	2	4	6	8	10	12
1001-2000	3	3	6	9	12	15	18
2001-3000	4	4	8	12	16	20	24
3001-5000	5	5	10	15	20	25	30
5001-10000	6	6	12	18	24	30	36

***Provisional results**

		Combined
Green	Low	1 to 9
Orange	Medium	10 to 18
Red	High	19 to 27
Black	Very high	28 to 36

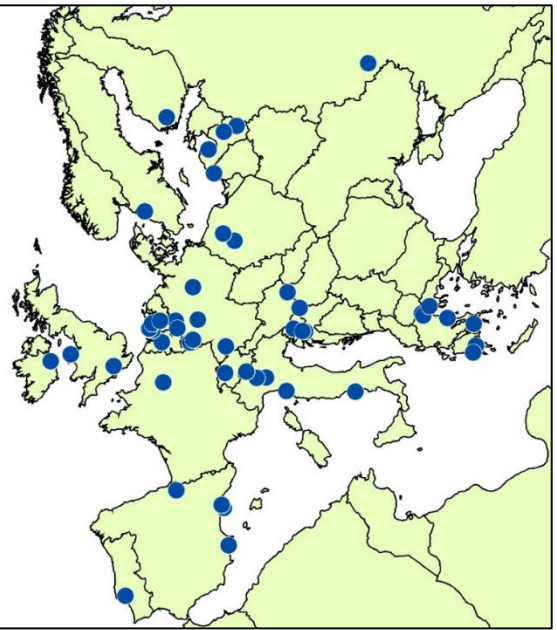


Note: Ozone-sensitivity tested of less than 1% of plant species

Revised NECD (Directive (EU) 2016/2284)

http://ec.europa.eu/environment/air/pollutants/ceilings.htm

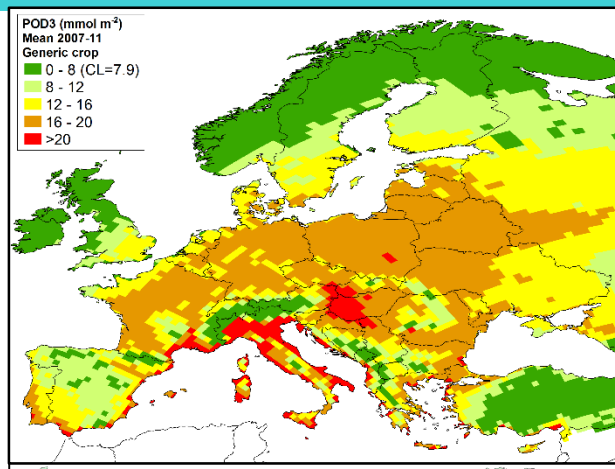
- **Article 9 – Monitoring air pollution impacts:** monitoring negative impacts on ecosystems based on representative network of sites, taking a cost-effective and risk-based approach (if appropriate, collaborate with ICPs of CLRTAP)
- **Annex V – Optional indictors,** including:
  - O_3: Vegetation growth and foliar damage
    Exceedance flux-based critical levels

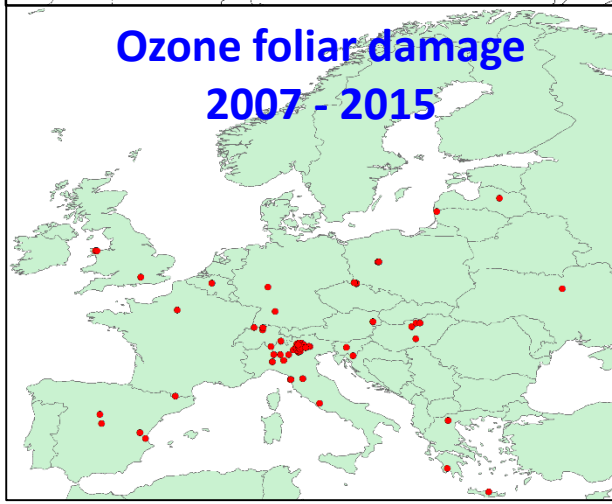


Monitoring 1996-2006:
Foliar injury and growth white clover up to 12 Member States.

Evidence for flux-based critical level approach.

2016: Only UK and Poland





Monitoring, smart-phone App & literature data

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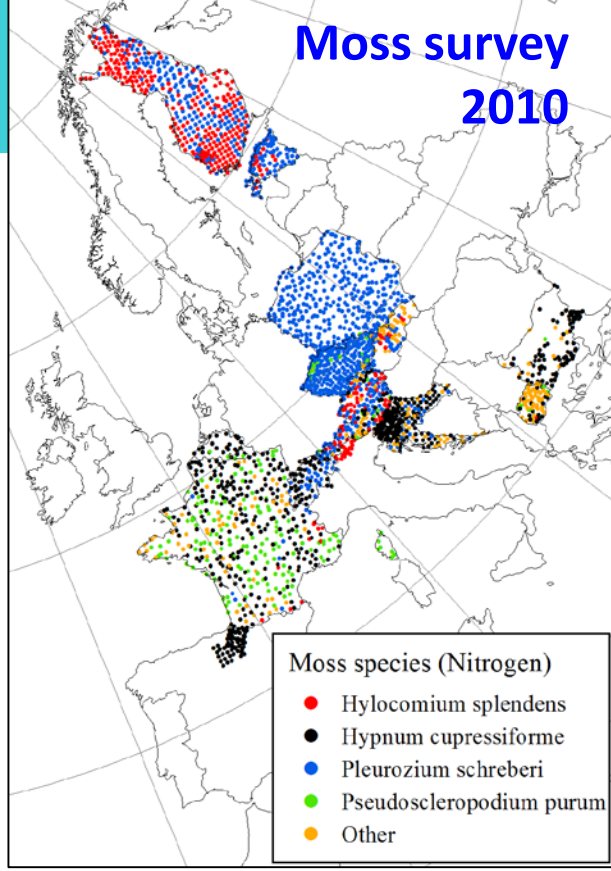
Revised NECD (Directive (EU) 2016/2284) (cont.)

- **Annex V – Optional indictors,** including:
  - N: Nutrient balance in foliage

15 Member States in 2005,
13 in 2010, 11 in 2015



3 – 4 April: meeting in Brussels – How can European Commission help Member States with implementation of NECD? (input provided by monitoring ICPs)

- **European Commission priorities for reinforcement:**
  - Increase participation in/cooperation with relevant networks (e.g. ICPs)
  - Reinforce density of monitoring networks – ecosystem representativity
  - Reinforce integration of monitoring networks (e.g. ICP IM)
  - Maintain the funding of the ICPs and the CCE

Outreach – TOAR and CCAC

Tropospheric Ozone Assessment Report (TOAR)

Deliverables:

1) First TOAR based on the peer-reviewed literature and new analyses

2) Database containing O_3 exposure and dose metrics at thousands of measurement sites around world, freely accessible for research on global-scale impact of O_3 on climate, human health and crop/ecosystem productivity
(Gina Mills lead on ozone metrics for vegetation impacts)

April-June 2017: Submit assessment papers to *Elementa (online journal)*

mid- to late 2017: Publication of the papers and release of the data the

WMO GAW World Health Organization NOAA LRTAP Task Force on Hemispheric Transport of Air Pollution

- **Climate and Clean Air Coalition (CCAC):** ICP Vegetation participated in expert workshop on 'Metrics for evaluating and reporting on methane and BC interventions', 16-17 March, Ottawa, Canada

TOAR members

220+ scientists from 36 nations, representing research on all 7 continents

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Participation moss survey 2015/16

HM: 36-38 (25); N: 13 (15); POPs: 8 (6) - In brackets: 2010/11 survey

Rest of Europe (16)	Rest Europe	SEE Europe (8)	EECCA (9)	Others (3-5)
Austria^{N,POPs}	Italy-Bolzano^{N}	Albania	Armenia	Canada^{N,POPs}
Czech Rep.^{N}	Latvia^{N,POPs}	Bulgaria	Azerbaijan	India (?)
Denmark-Faroer Isl.	Norway^{POPs}	Greece	Belarus	Mongolia
Estonia^{N}	Poland^{N}	Macedonia	Georgia	South Korea (?)
France^{N}	Slovakia	Romania	Kazakhstan	Vietnam
Germany^{N,POPs}	Spain	Serbia	Moldova	
Iceland	Sweden^{N,POPs}	Slovenia^{N}	Russian Fed.	
Ireland^{N,POPs}	Switzerland^{N,POPs}	Turkey	Tajikistan	
			Ukraine	

Blue: data submitted; ^{N} = also nitrogen data; ^{POPs} = also POPs data; Black: data expected

- Launch final report at 8th BioMAP^{1} workshop in Dubna, July 2018

[1] Biomonitoring of Air Pollutants, with emphasis on trace elements

Medium-term workplan

2017:

- Workshop on ozone risk assessment methodology for developing countries (autumn)
- Update App to record ozone-induced visible leaf injury (with latest technology)

2018:

- Establish networks of participants in developing regions
- Collaboration with EMEP on improving and validating soil moisture index in model
- Report on current available evidence of ozone impacts on crops in developing regions
- Report on outcome of moss survey 2015/16

2019:

- **Ozone risk maps for HTAP regions and scenarios**
- Flux maps adapted for soil moisture limited areas (collaboration with EMEP/MSC-West)
- Report on networking activities, including first season field evidence ozone impacts
- Revised moss monitoring manual 2020

2020:

- Report on ozone impacts in developing regions (risk assessment, evidence, policy)

Annual updates: SBDs Mapping Manual, ozone risk maps for LRTAP Convention, preparations 2020 moss survey, report on new scientific developments, contribution to common workplan items WGE/EMEP

http://icpvegetation.ceh.ac.uk

30th ICP Vegetation Task Force meeting, 14 – 17 February 2017, Poznan, Poland

- 88 participants from 24 countries (including Armenia, Belarus, Georgia, Russian Federation)

31st ICP Vegetation Task Force meeting, 5 – 8 March 2018, Dessau-Roßlau, Germany

Thank you!