



Ozone impacts: A Vegetation Perspective

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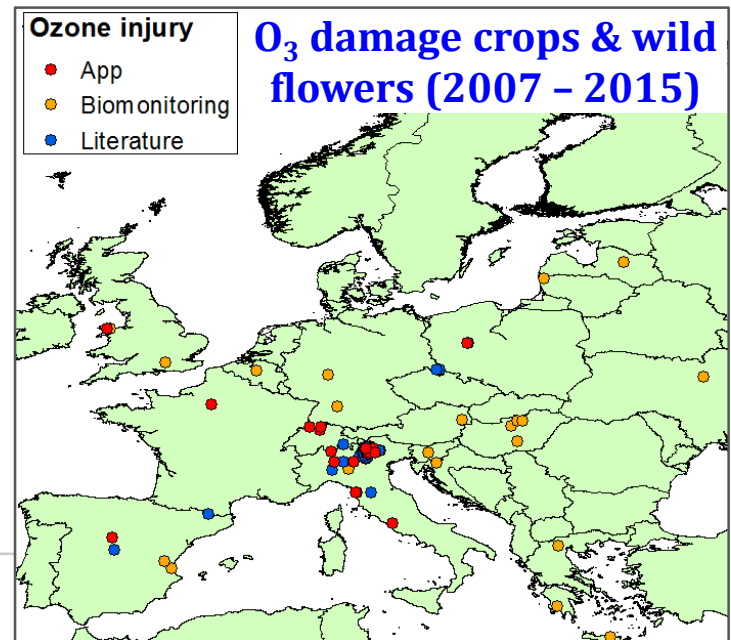
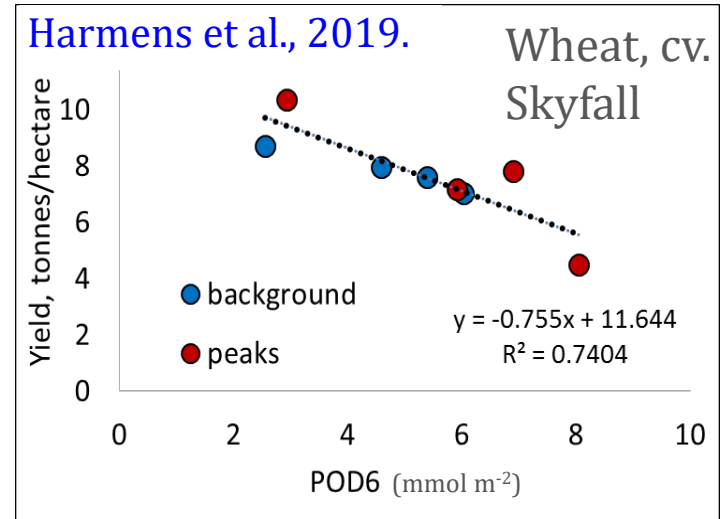
New information

The ozone profile has changed. Reduced 'peak' concentrations, and increased 'background' (for UNECE region).

Baseline/background ozone concentrations contribute to chronic effects including on biomass and yield.

Flux-based risk assessment can take account of the changing ozone profile and modifying effects of climate change. Modifying effects of nitrogen could be included too.

'invisible' impacts on yield biomass and flowering will remain, despite (probably) fewer occurrences of visible leaf injury.



Flux-based critical levels

Currently 21 flux-based critical levels available for use.

Two types of critical levels

POD_ySPEC – species or species-group and region-specific

POD_yIAM – vegetation type, simpler models, for indicative risk and CL exceedance

Take into account reference POD_y (representing pre-industrial ozone burden). Allowing 'realistic' targets.

Species (group)	Effect parameter	Potential effect at CL (% reduction)	Critical level (mmol m ⁻² PLA)	Potential max. rate of reduction (%) per unit POD _v SPEC
Crops (POD₆SPEC)				
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 (POD₁SPEC)				
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 (POD₁SPEC)				
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

Flux-based critical levels: Integrated Assessment Modelling

Crops

- For CL exceedance (amount and area) and maximum potential yield loss calculation

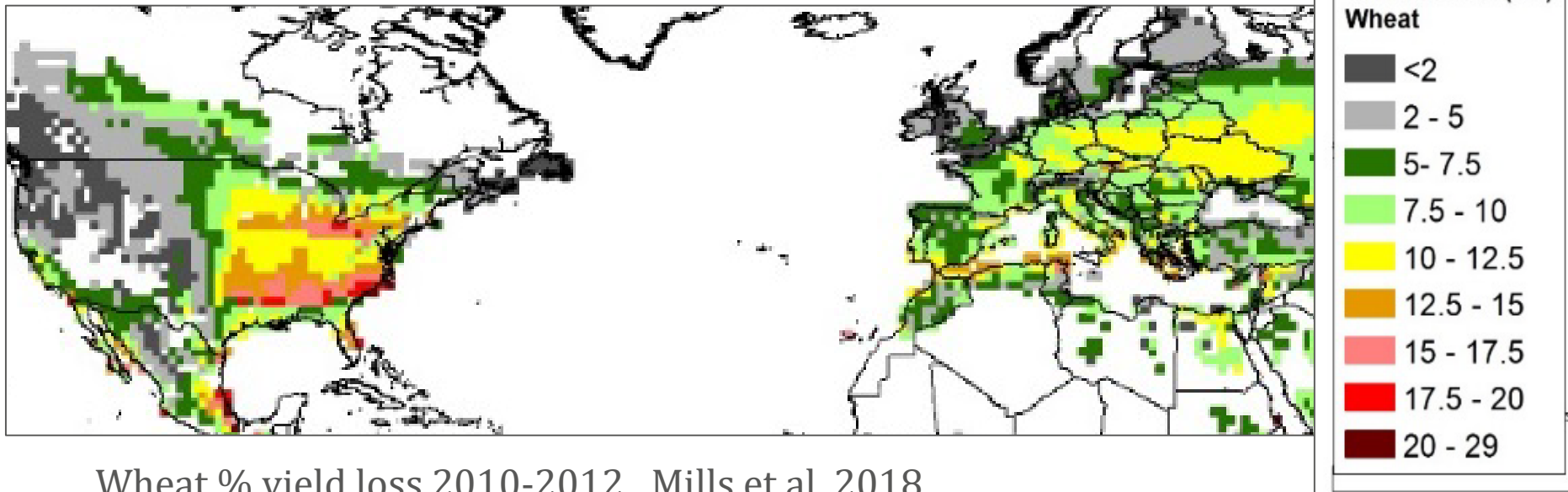
Trees and (semi-)natural vegetation

- Indicative risk, used for **environmental cost** but not economic cost
- Risk of CL exceedance (amount and area)
- Application in a climate change context is not recommended as key factors such as phenology and soil moisture are not considered

Vegetation type (POD _Y IAM)	Effect parameter	Use to assess risk of reduction in	Potential effect at CL (% reduction)	Critical level (mmol m ⁻² PLA)	
Crops (POD ₃ IAM)	Grain yield	Grain yield	5%	7.9	
Forest trees (POD ₁ IAM)	Total biomass	Annual growth of living biomass of trees	4%	5.7	Non-Med.
			4%	13.7	Med.
(Semi-)natural vegetation (POD₁IAM)					
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

Impacts in UNECE region



Wheat % yield loss 2010-2012. Mills et al. 2018

- Quantifiable impacts of ozone.
- Significant effects still occurring (also for other crops and vegetation).
- Good possibilities to reduce impacts.

Questions remaining

Which year(s) should be used (since ozone varies spatially and in magnitude between years)?

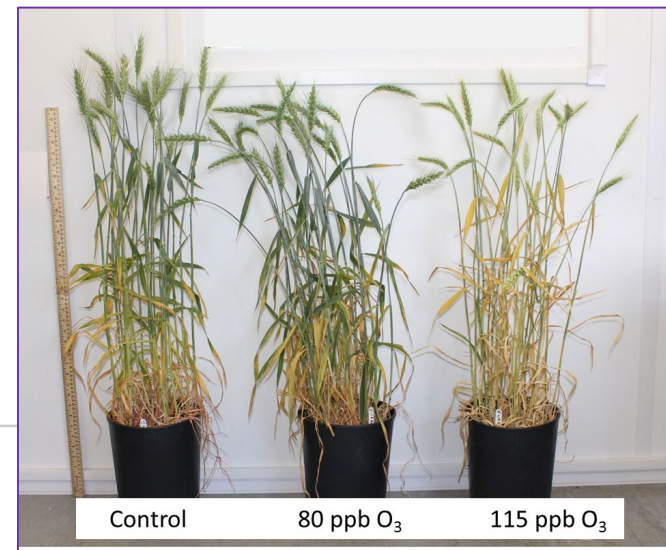
What magnitude of ozone reduction (and impact) could be expected from changes in emissions within the UNECE region alone, compared to (feasible) global emissions reductions?

What magnitude of ozone reductions could be achieved from addressing other priority pollutants (e.g. methane) (inside and outside UNECE region)?

How can maps be used for evidence, or do we need country (or similar)-summed impacts?

How can we verify model predictions of impacts?

Interactions with other stresses and climate change?



Considerations/recommendations

Crop and ecosystem impacts should be considered in addition to health metrics – the impacts are in different places.

Crop and ecosystem impacts are linear (rather than a threshold), therefore, 'low' pollution can still contribute to impacts.

Ozone fluxes should be used, and these also allow climate effects to be included.

When crops and ecosystems have less damage from ozone, other benefits can occur e.g. increased nitrogen use efficiency.