WGE trend report:
Trends in ecosystem and health responses to long-range transported atmospheric pollutants

Contributions from

ICP Forests, ICP Integrated Monitoring, ICP Materials, ICP Modelling and Mapping, ICP Vegetation, ICP Waters, JEG DM, TF Health, EMEP, AMAP

Heleen de Wit 1st joint session
EMEP-WGE sept 2015

Timeline

- Discussed and decided on WGE meeting in September 2014
- Draft inputs by December 2014
- Draft presented on WGE-EB meeting March 2015
  - Confirmed contribution from EMEP
- 'Final' contributions delivered between March and June 2015
  - AMAP contribution also included
- Reviews of Chapters in June-July 2015
- Full review in September 2015
- Presentation at joint EMEP-WGE meeting
- Final report in electronic form in October/November 2015

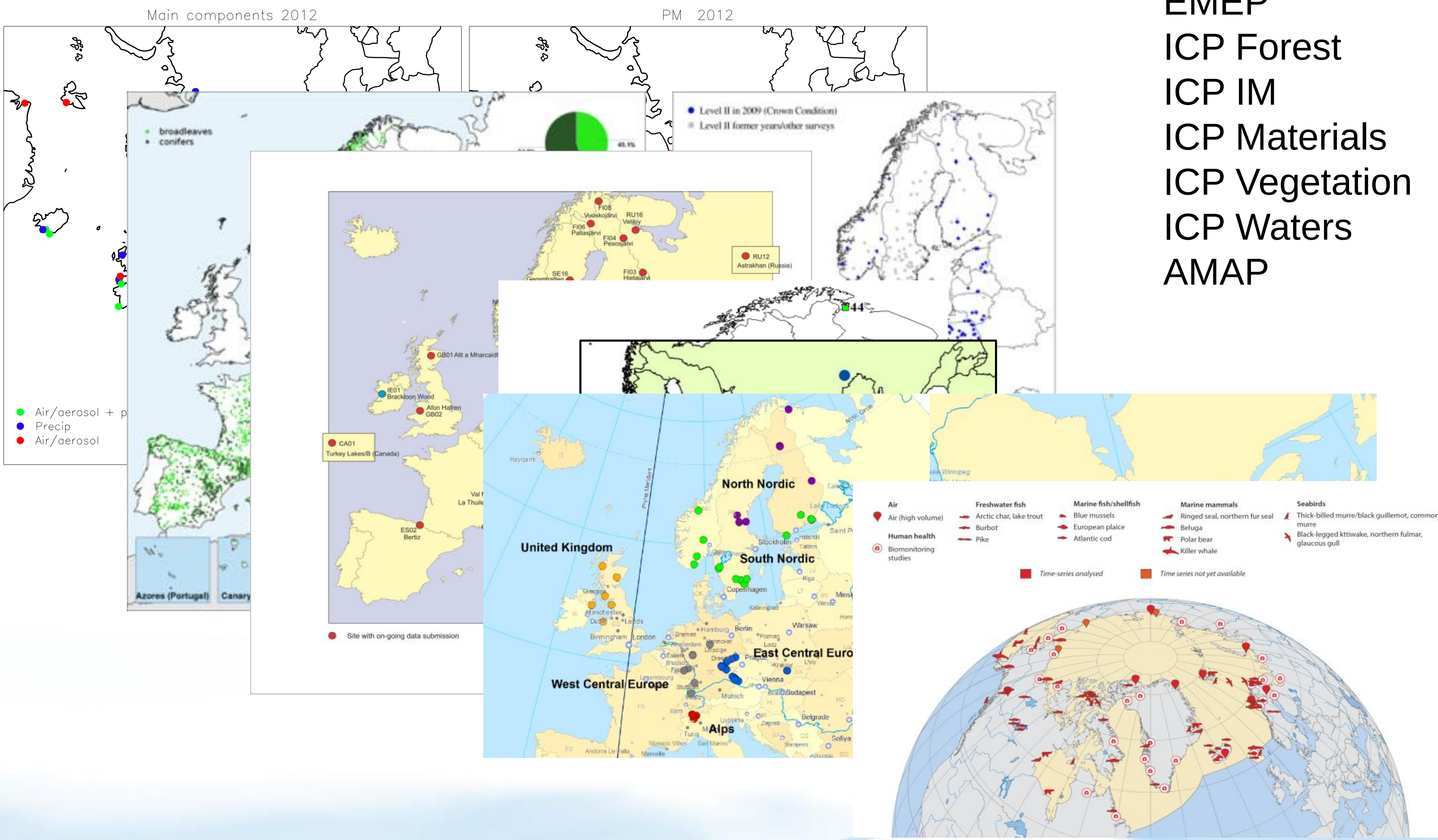
Aims

- To assess the effectiveness of air pollution policies by focusing on effects on environment and health
  - Progress and lack of progress, gaps in the data, gaps in scientific understanding
- To document trends in environmental and health responses to long-range transported air pollution
  - focusing on 1990 to 2012
  - Note! Primarily based on existing work
- To provide support for Assessment Report

Content

- Acidification
  - 1985 Helsinki Protocol, 1994 Oslo Protocol, 1988 Sofia Protocol
- Nitrogen as a nutrient
- Ozone
  - 1991 Geneva Protocol
- Heavy Metals
  - 1998 Aarhus Protocol
- POPs
  - 1998 Aarhus Protocol
- PMs
  - Multipollutant 1999 Gothenburg Protocol (revised in 2012)

Monitoring networks



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ICP IM
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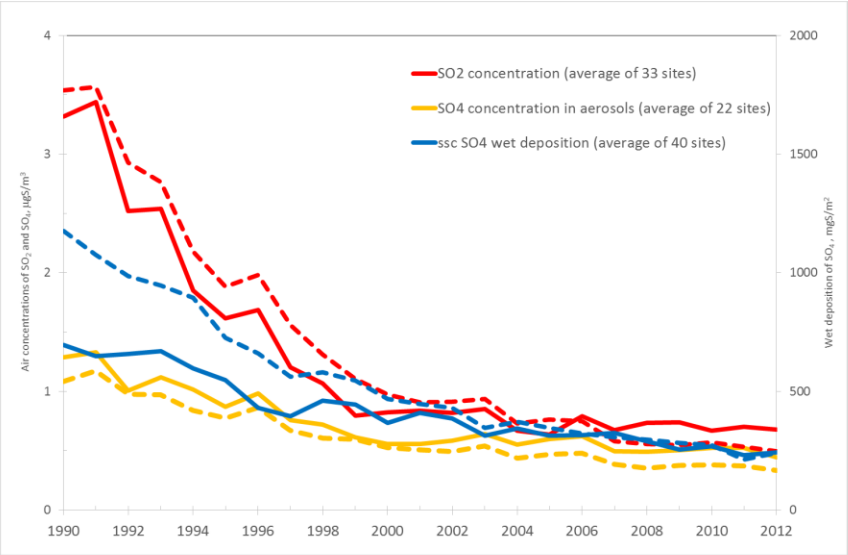
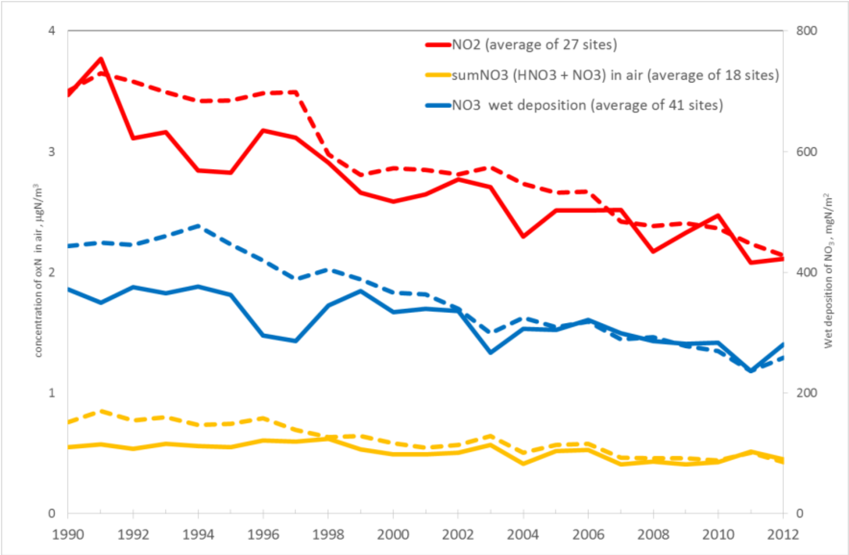
ICP Waters
AMAP

Acidification - atmosphere

Sulfur in air and precipitation



Nitrogen in air and precipitation



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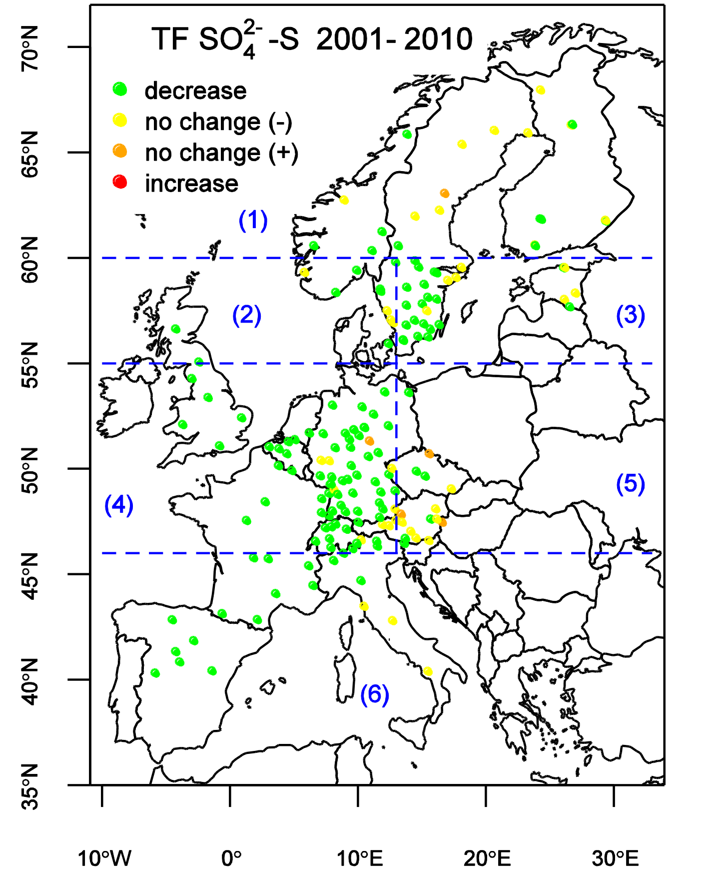
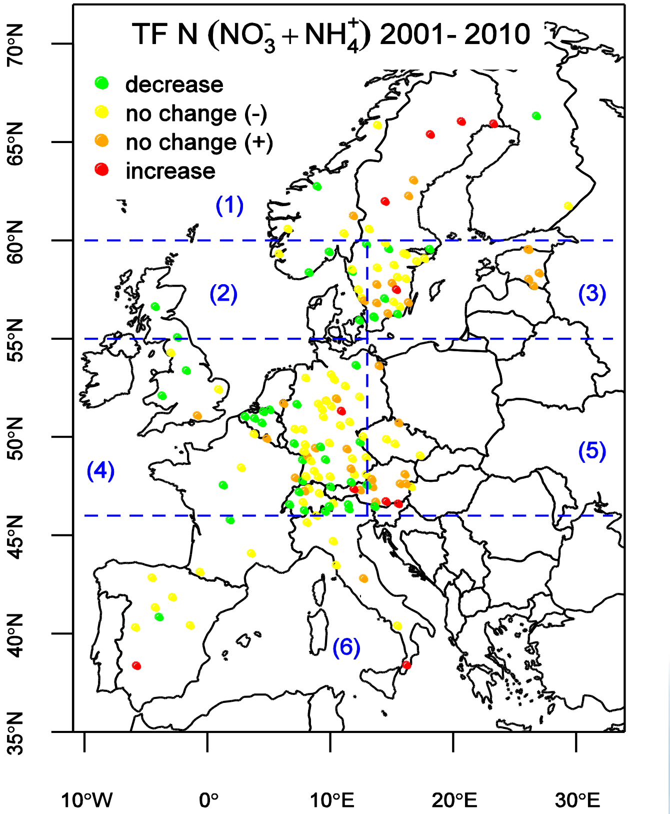
Acidification - throughfall

Sulfur



Nitrogen



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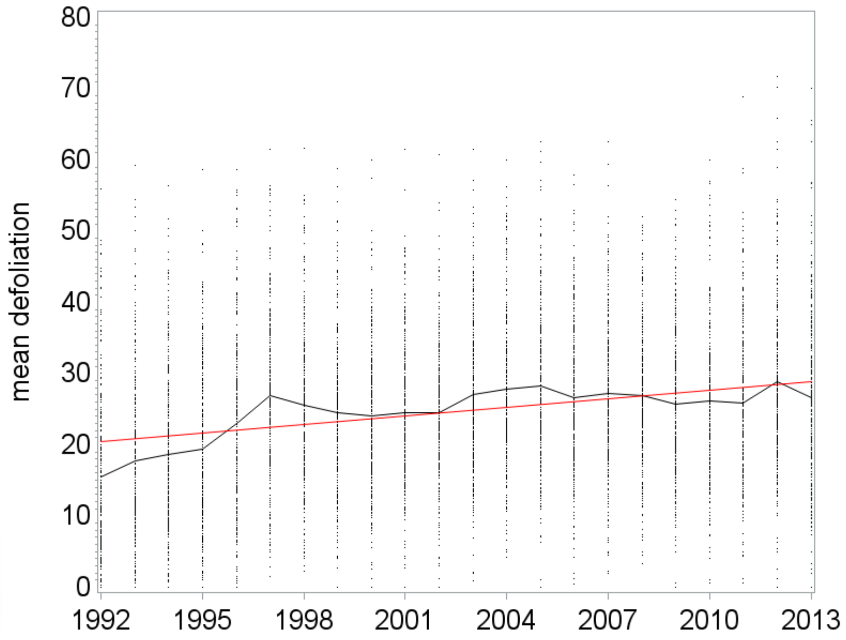
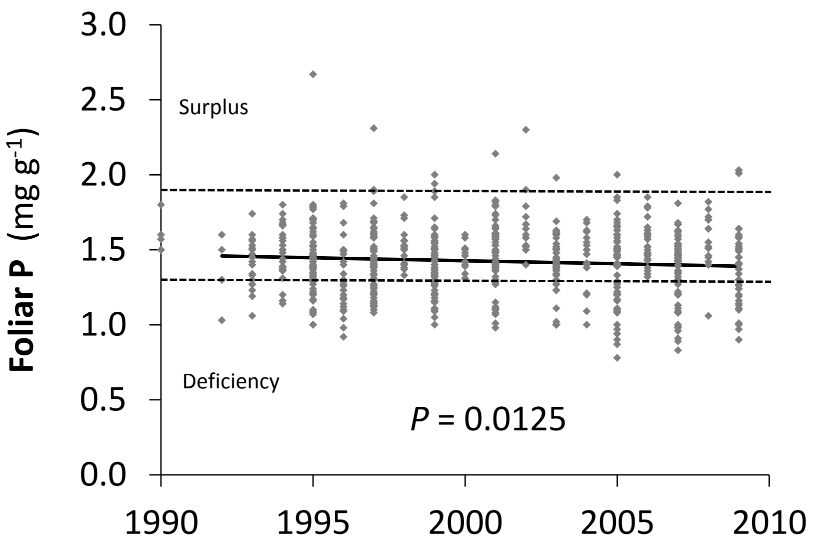
Acidification – crown condition

Increase in defoliation



Reduction in foliar P



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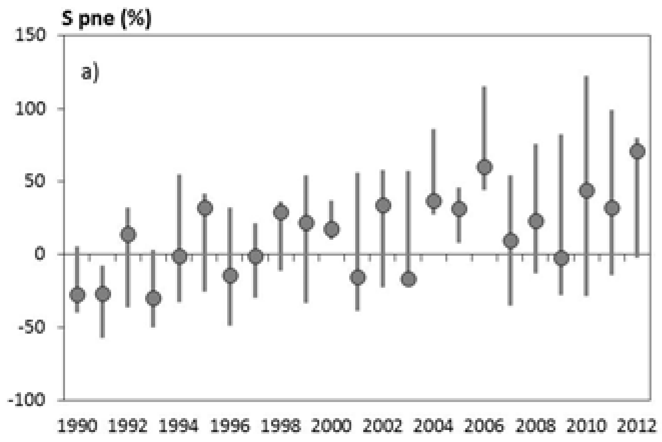
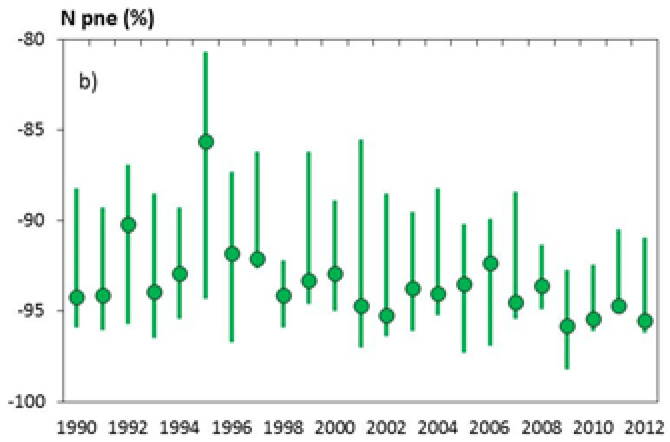
Acidification – input-output budgets

Sulfur



Release of sulfur

Nitrogen

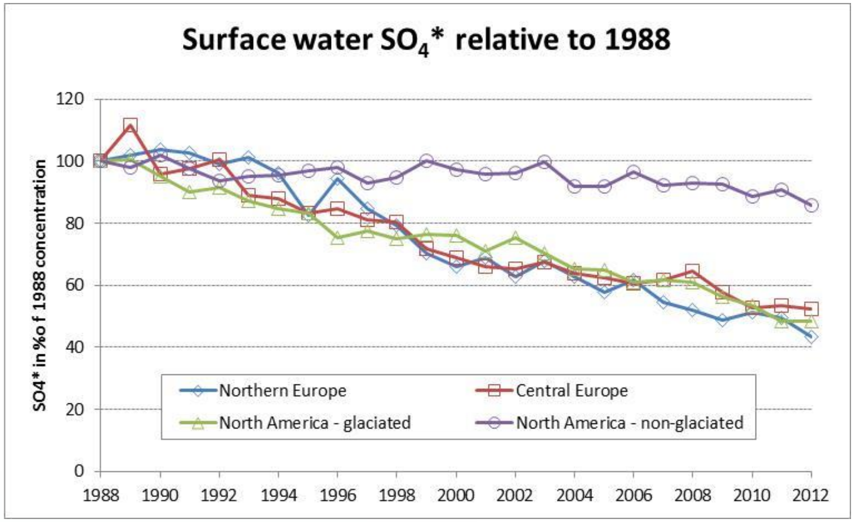


Retention of nitrogen

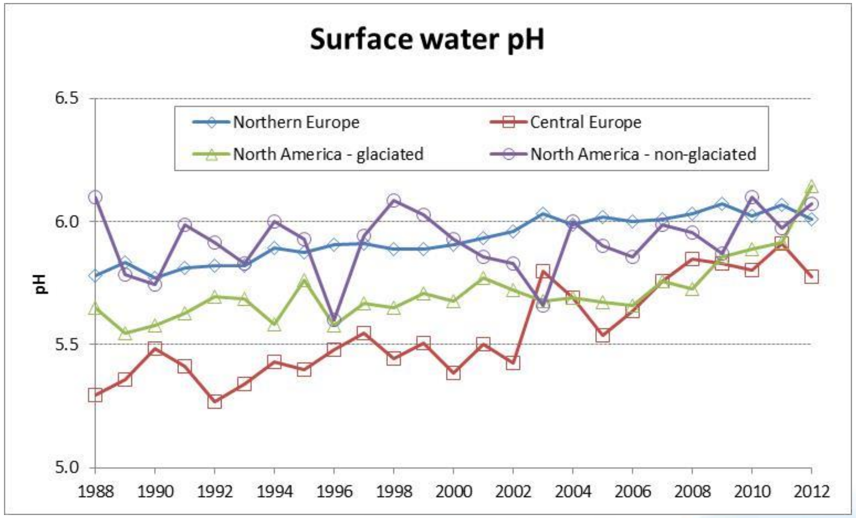
ICP Integrated Monitoring

Acidification – water chemistry

Sulfur



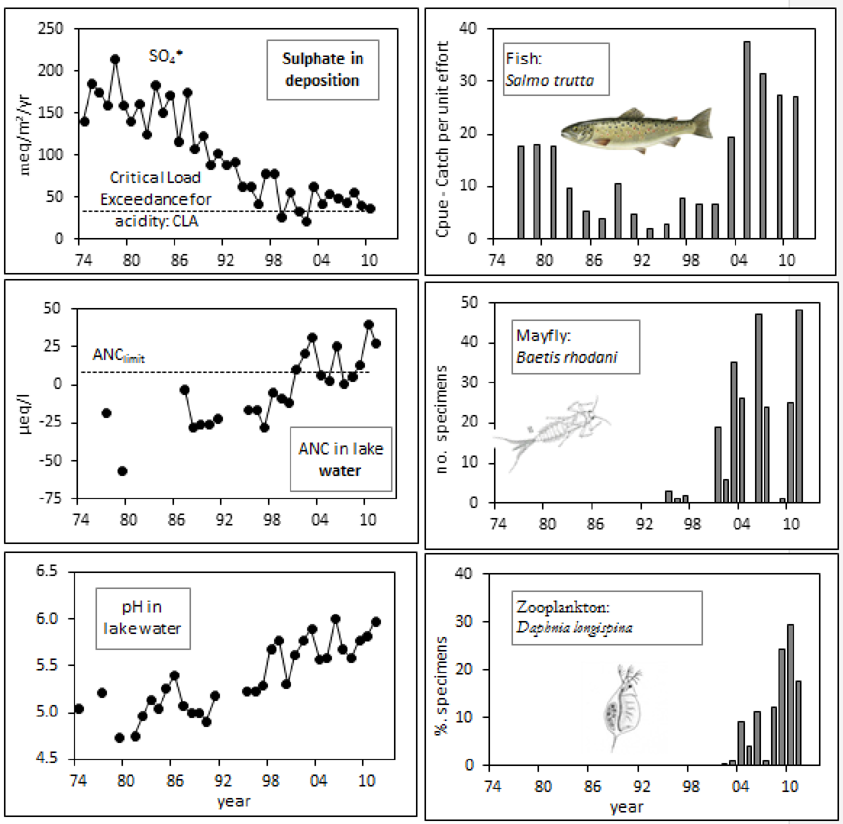
pH



ICP Waters

Acidification – biological recovery of surface waters

Case study

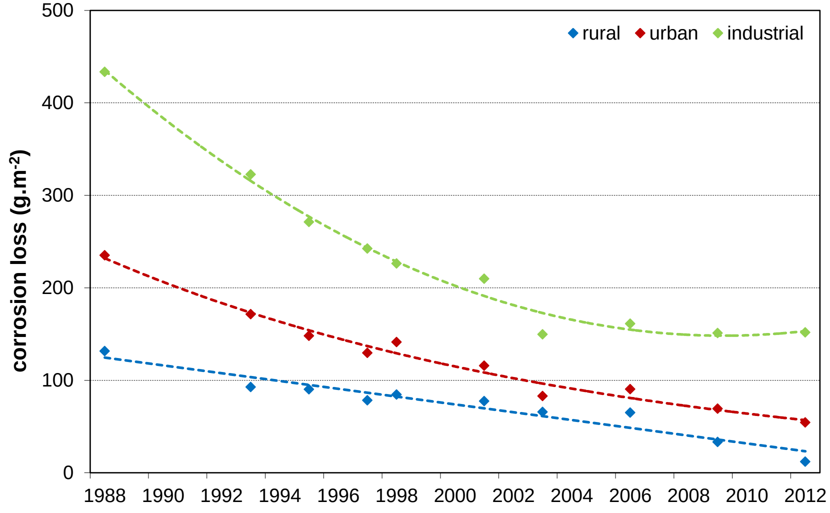


Regional trends

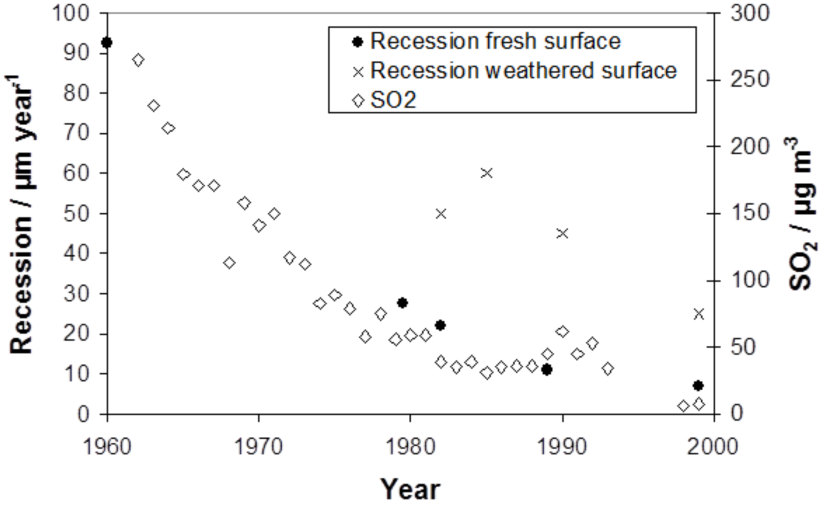
Region	Country	Water body	Biota	Biological parameter	Period	Trends
Nordic	Norway	5 rivers	Zoobenthos	Acidification index, Biodiversity, Acid-sensitive organisms	1982-2013	
	Sweden	8 lakes	Phytoplankton	Species number, abundance, richness	1988-2008	
			Zoobenthos	Species number, abundance	1988-2008	
	Finland	21-30 lakes	Fish	Abundance, Population structure	1985-2012	
		29 lakes	Zoobenthos	Communities	1985-2001	
		30 lakes	Periphyton, phytoplankton	Communities	1985-2001	
Central Europe	Czech Republic	8 lakes	Phytoplankton	Species number, abundancel	1999-2011	
			Zooplankton	Species number, abundance	1999-2011	
			Zoobenthos, Nepomorpha	Species number, abundance	1999-2011	
			Macrophytes	Abundance	2004-2010	
	Germany	lakes, streams	Zoobenthos	Species number, abundance acidification index	1982-2010	
	Switzerland	4 lakes	Zoobenthos	Species number, abundance	2000-2011	
	(Alps)	3 rivers	Zoobenthos	Species number, abundance	2000-2011	

Acidification - materials

Corrosion



Surface weathering –
St Paul Cathedral



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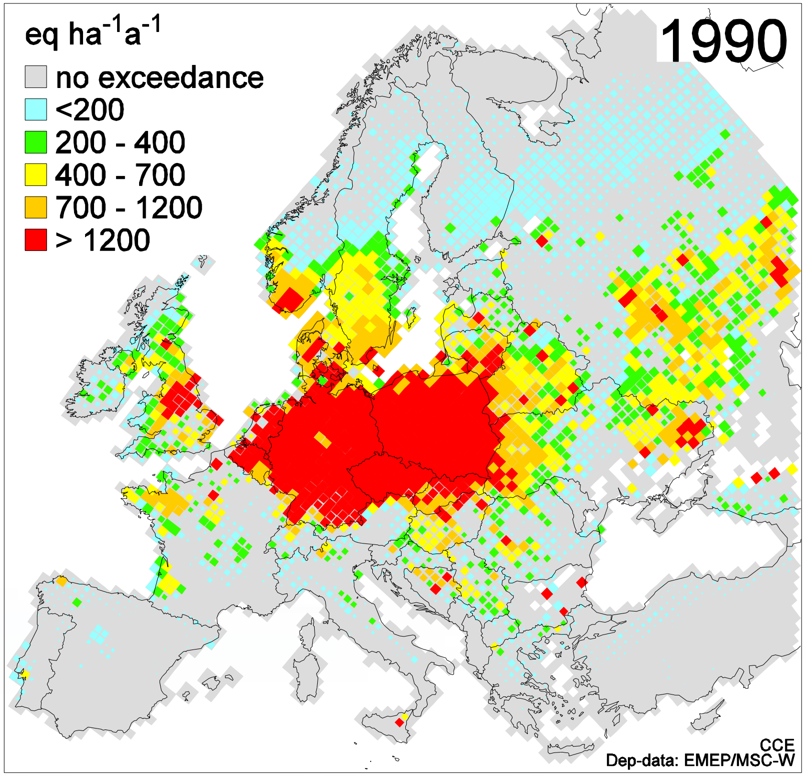
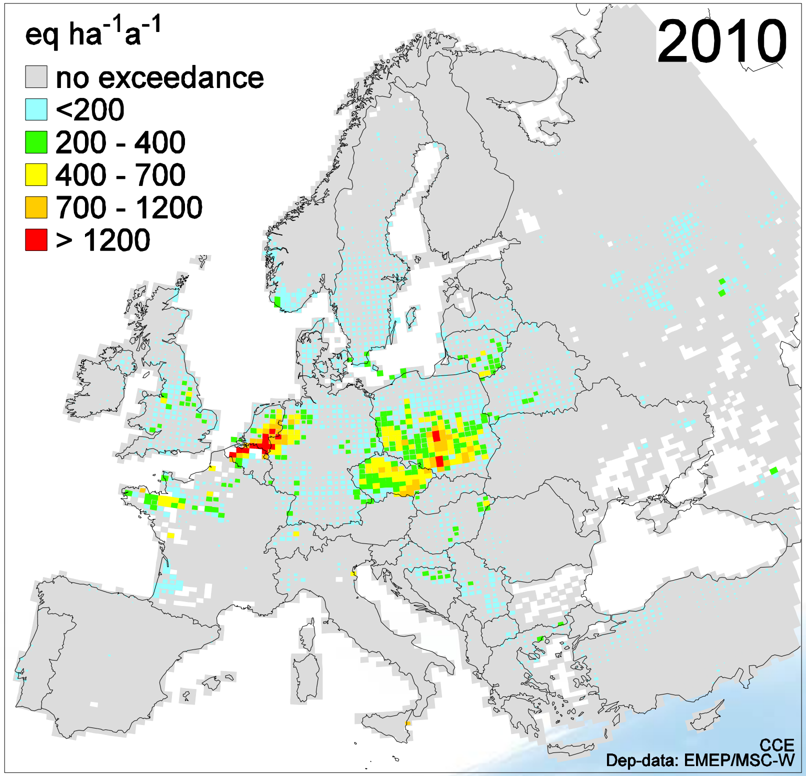
Acidification – exceedance of critical loads





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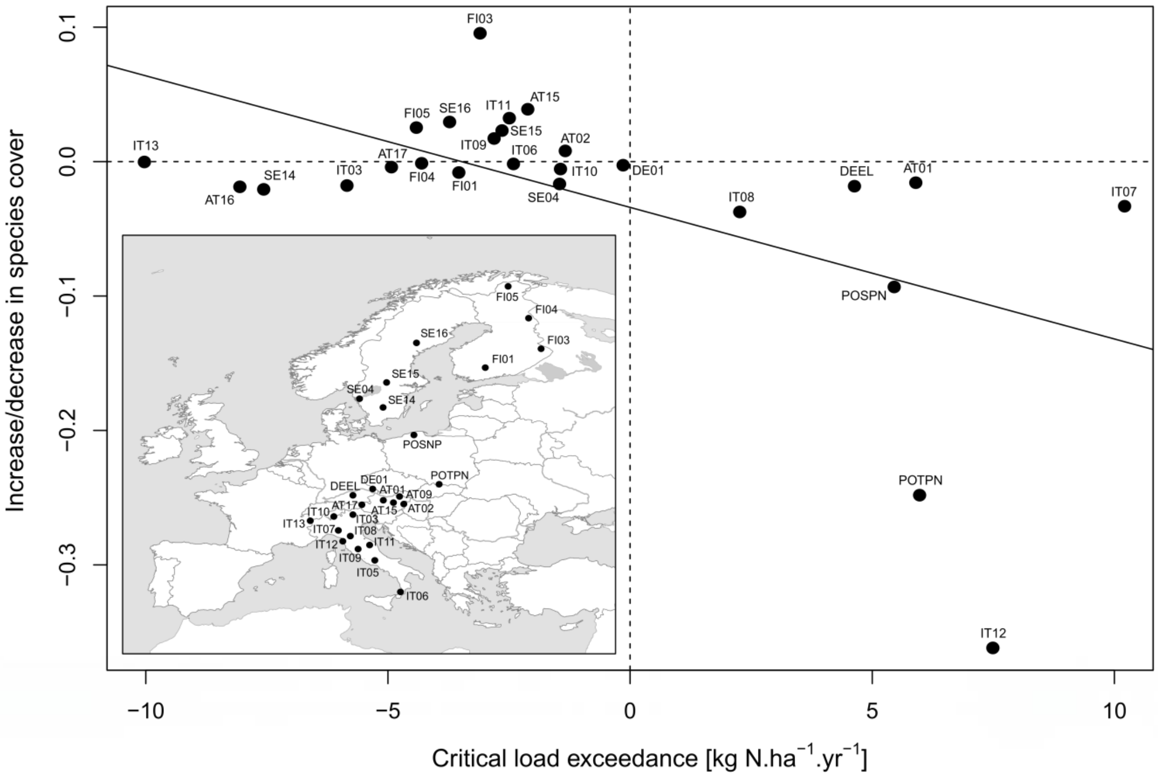
Acidification conclusions

- Documentation of improved environment as a result of reduced sulfur deposition
  - No full recovery
  - Delay factors
  - Still exceedance of critical loads
- While not much additional reduction in sulfur deposition may be expected, damage related to acidification remains an issue for surface waters, materials and buildings.
- Effects of climate change may set back effects of reduced sulfur deposition within the next decades.

Nutrient nitrogen

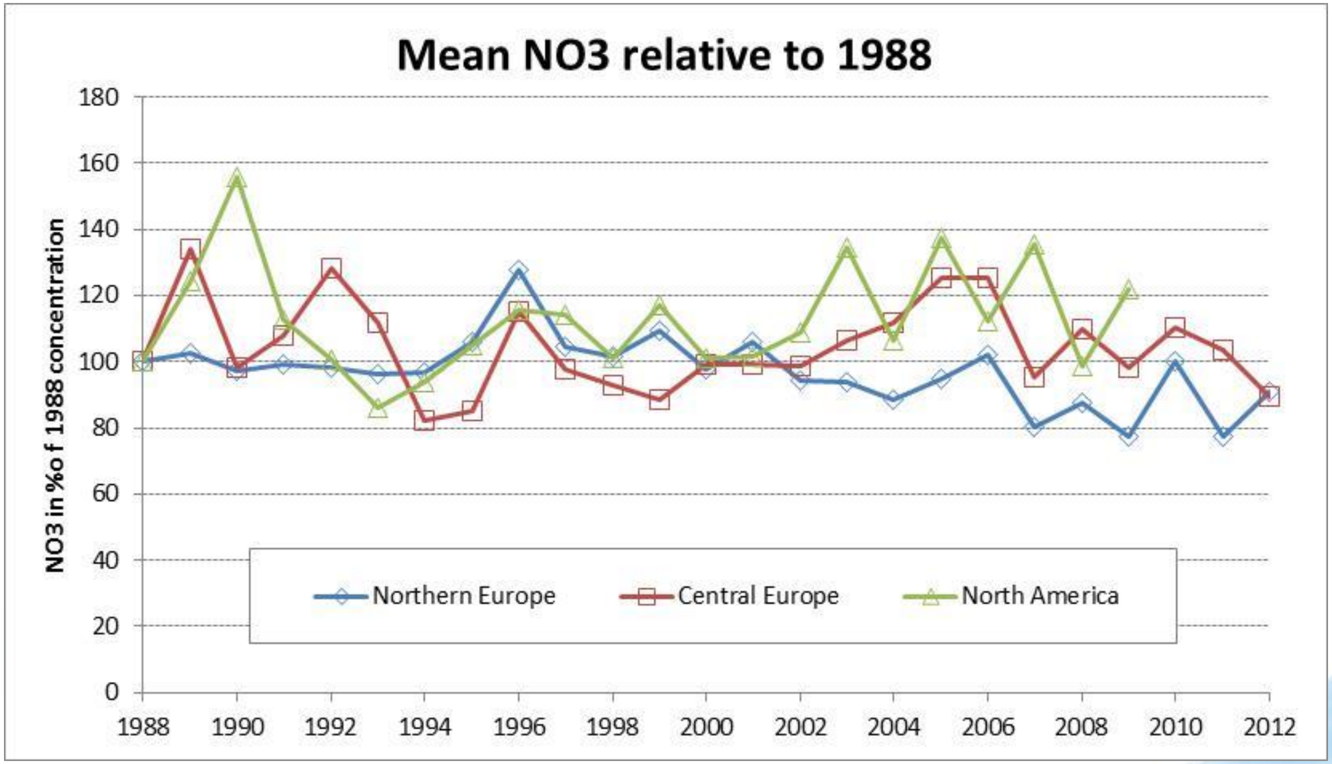
Biodiversity of forest plant species



Cover of oligotrophic plant species (plants that like low nutrients) decreased where CL was exceeded most

Nutrient nitrogen

Nitrate concentrations in surface waters



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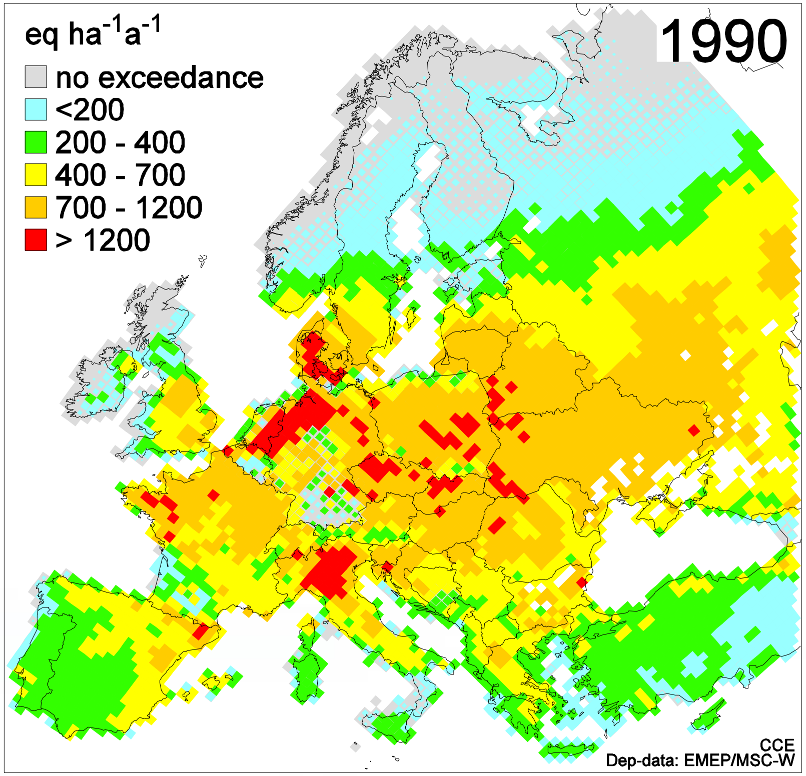
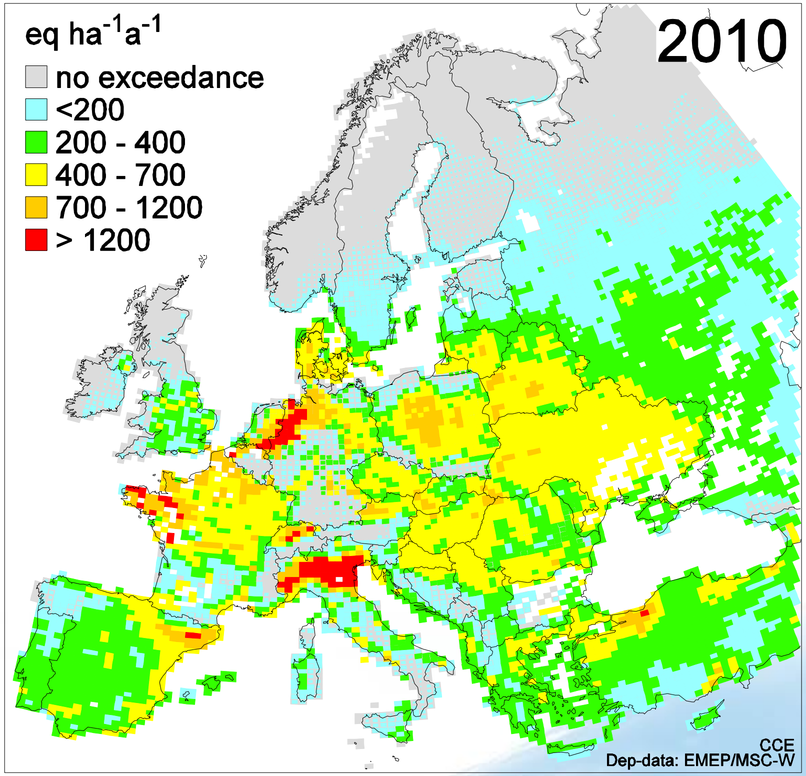
Nutrient nitrogen

Exceedance of critical loads





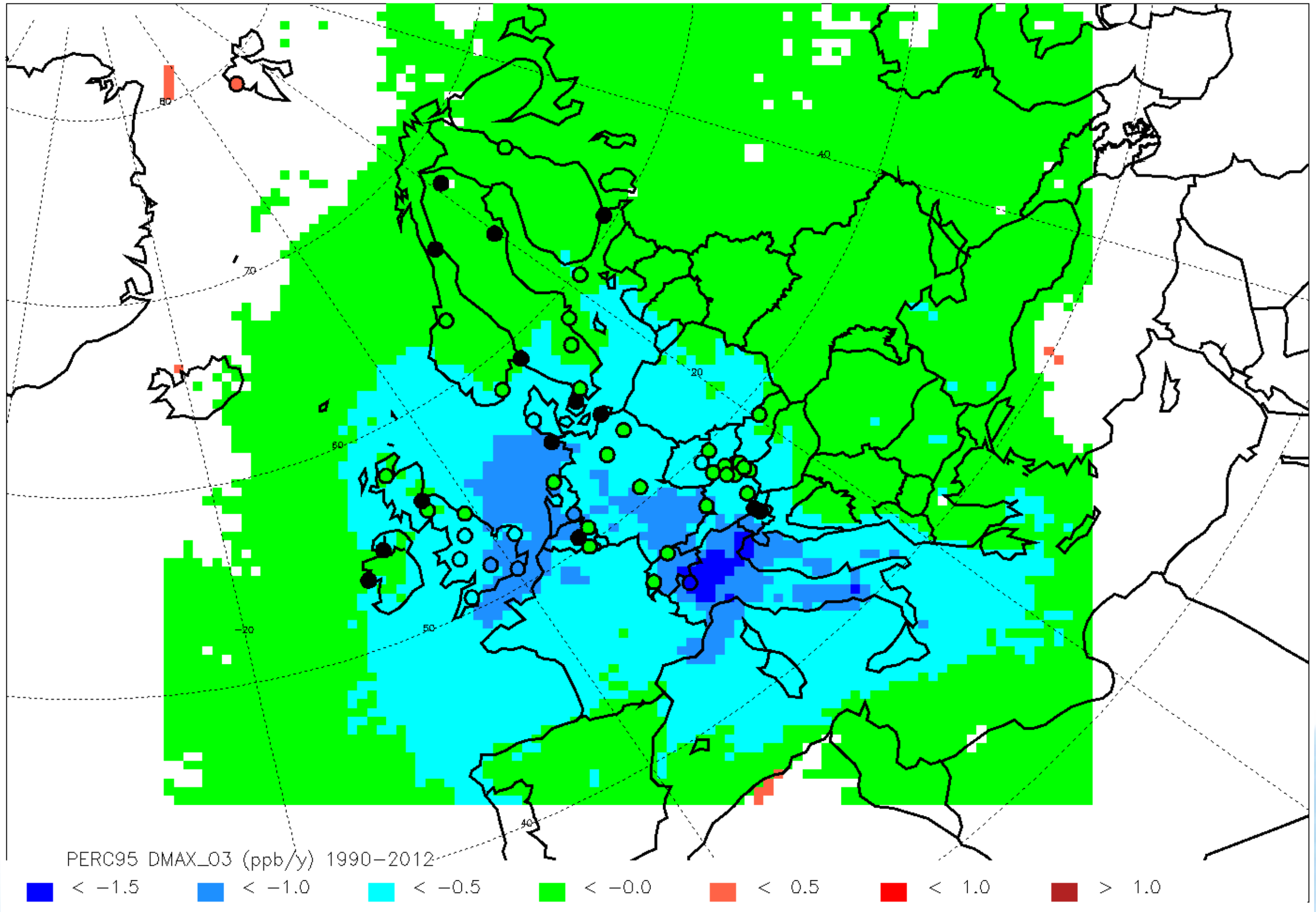
ICP Modeling and Mapping

Nutrient nitrogen - conclusions

- Nitrogen deposition remains high and leads to enrichment of soils
- Species cover of forest plant species is negatively affected
- Area with exceedances of critical loads has declined from 72 to 60% between 1990 and 2010.
- About 55% of the European terrestrial ecosystem area will not be protected from eutrophication in 2020
- Nitrogen remains a problem

Ozone - atmosphere

Trends in daily maximum ozone concentrations 1990-2012



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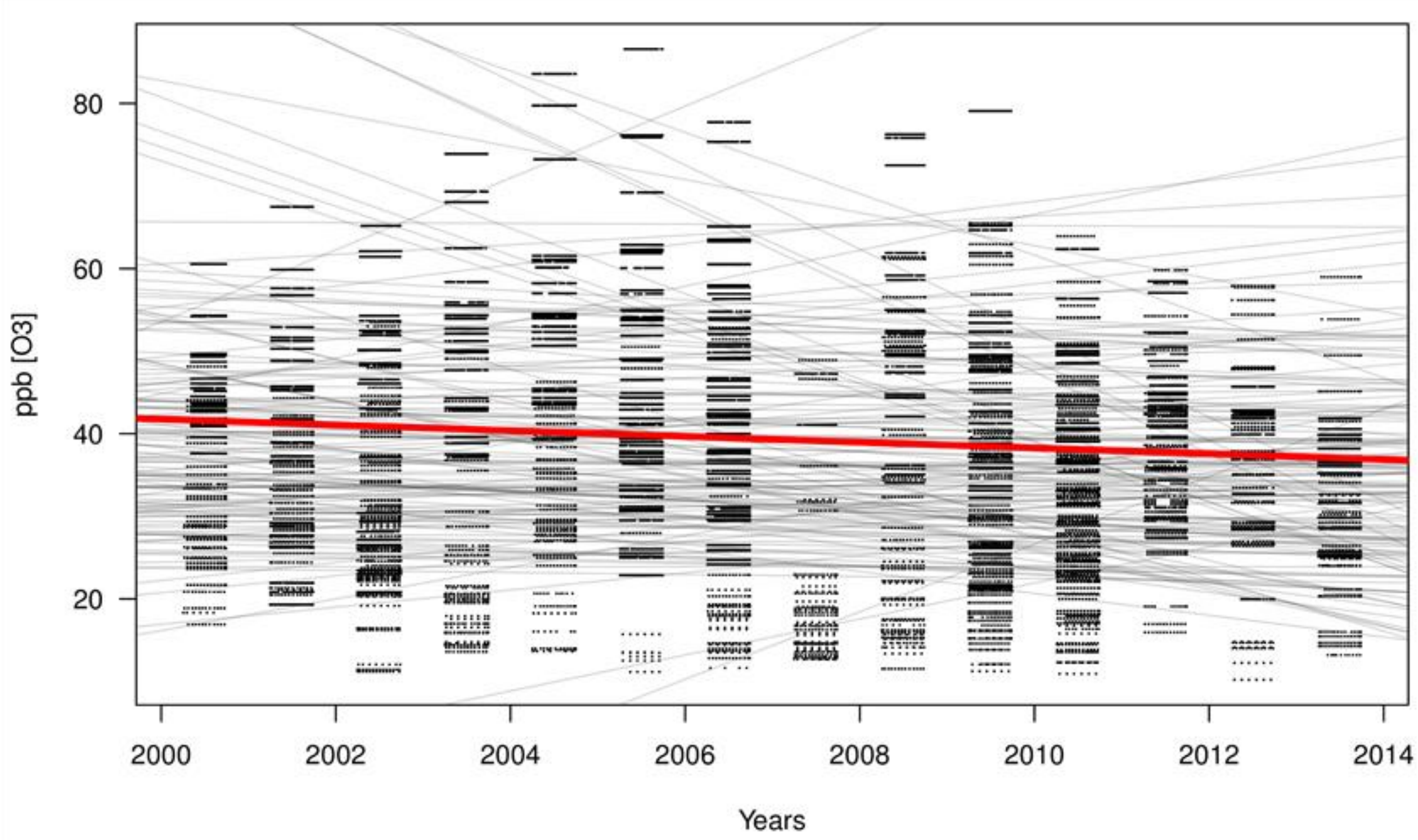
Ozone – forest plots

Ozone in forests



ICP Forests

Ozone – concentrations and fluxes

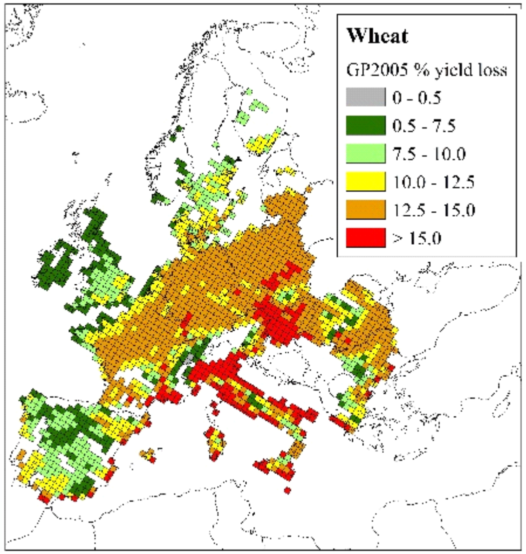
- No reduction in risk of ozone damage (trends 1999-2010)

Country	Site	24 hr mean	Daylight mean	Night mean	Daily max	Daily min	AOT40[a]	POD_3 IAM[b]
Belgium	Tervuren	None	None	Increase	None	Increase	None	None
Slovenia	Ljubljana	None	None	None	Decline	None	Decline	None
European mean		**None**	**None**	**Increase**	**None**	**Increase**	**None**	**None**

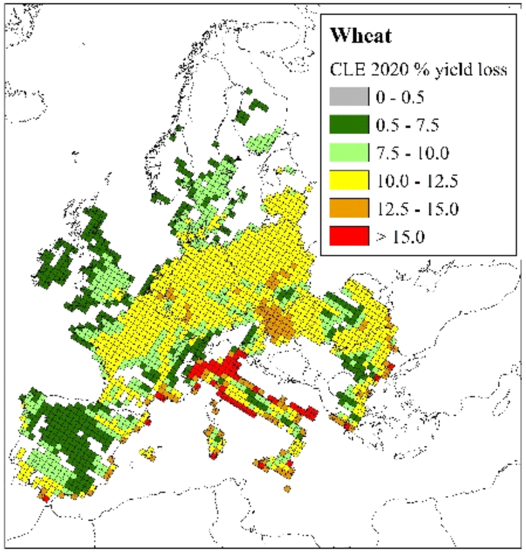
Ozone – crop yield

Calculated percentage yield losses due to ozone effects on wheat

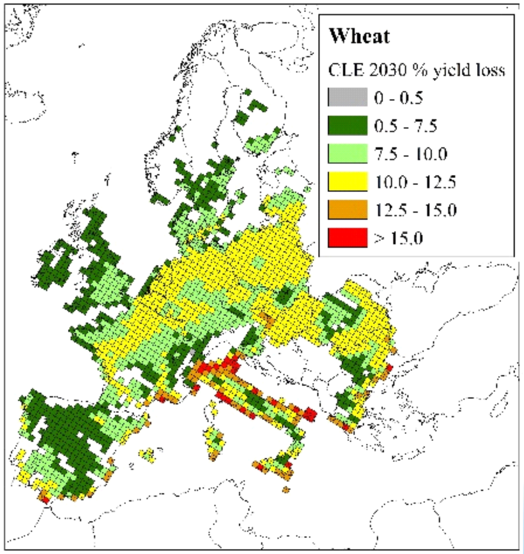
GP2005
10.7% yield loss



GP CLE2020
8.8% yield loss



GP CLE2030
8.2% yield loss



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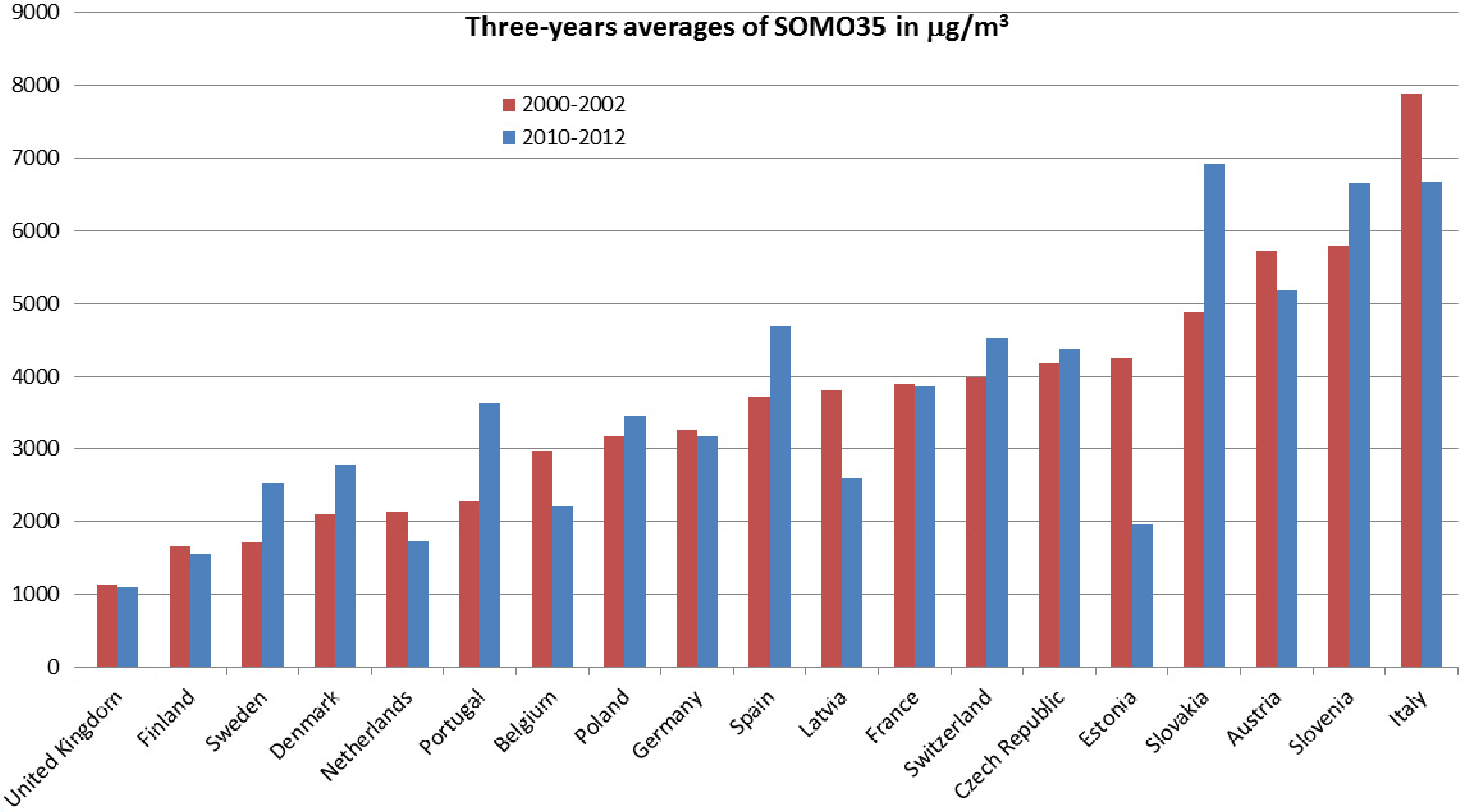
Ozone – population exposure



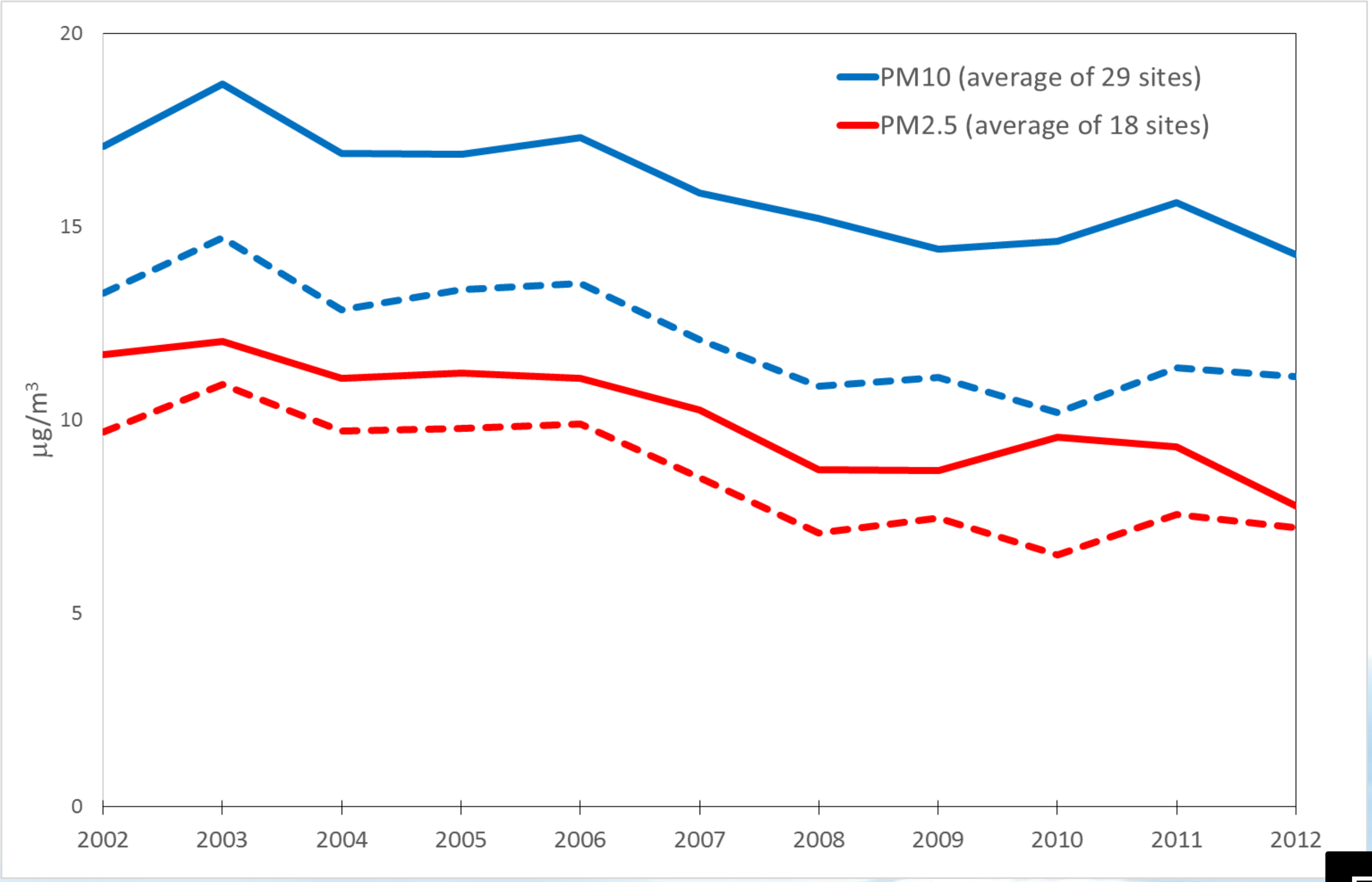
TF Health

Ozone – conclusions

- Peak concentrations of ozone have declined, while background concentrations have increased
  - No change in mean ozone concentrations, despite 30%-reduction in ozone-precursor emissions
  - Interactions with NO2 and methane might be responsible
- No change in population exposure to ozone
- Human health and vegetation (including crops) remains at risk for ozone damage
- Ozone pollution in the future depends on changes in *regional* emissions and *global* transport of ozone precursors

Particulate matter (PMs)

Atmospheric concentrations of PM10 and PM2.5 2002-2012



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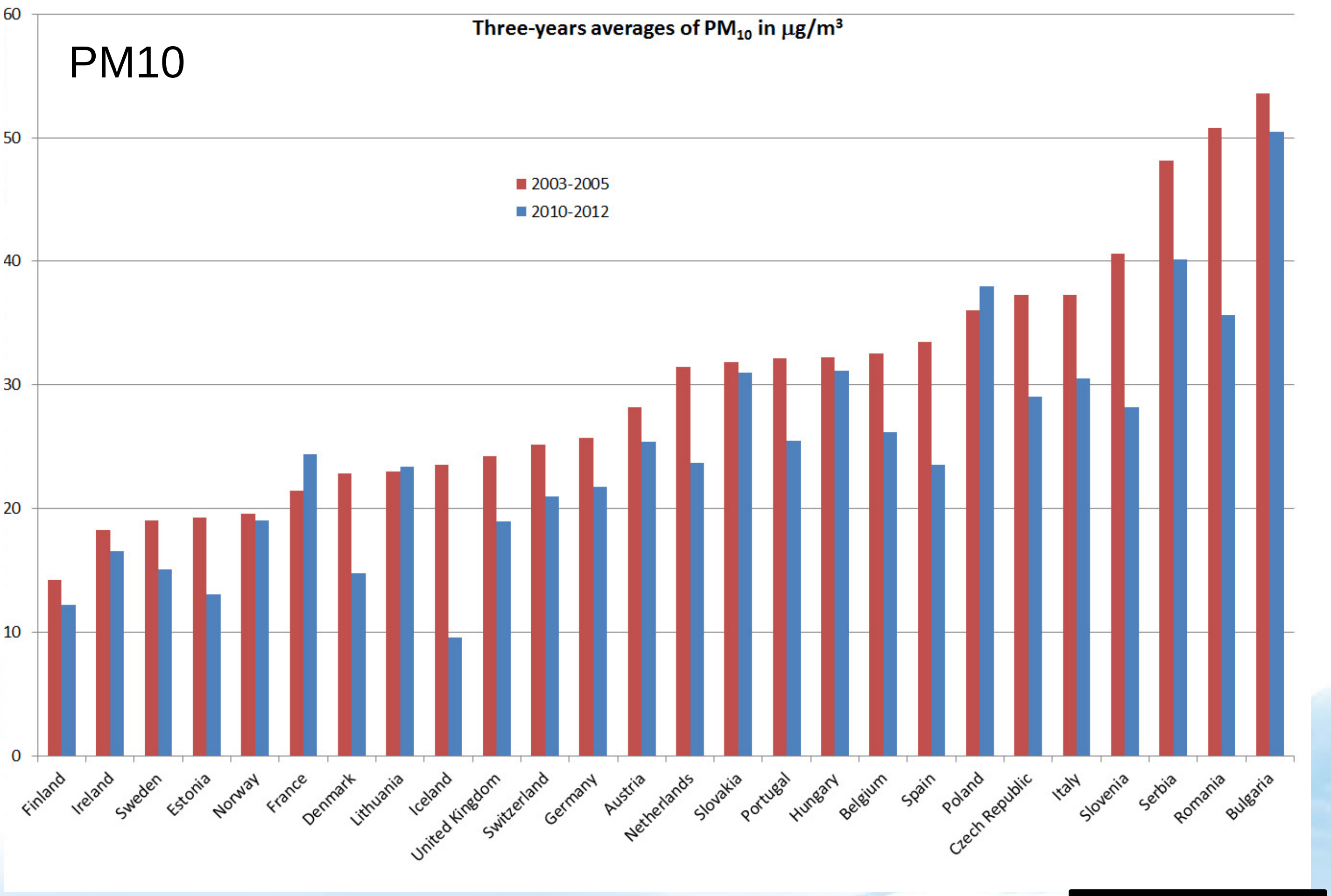
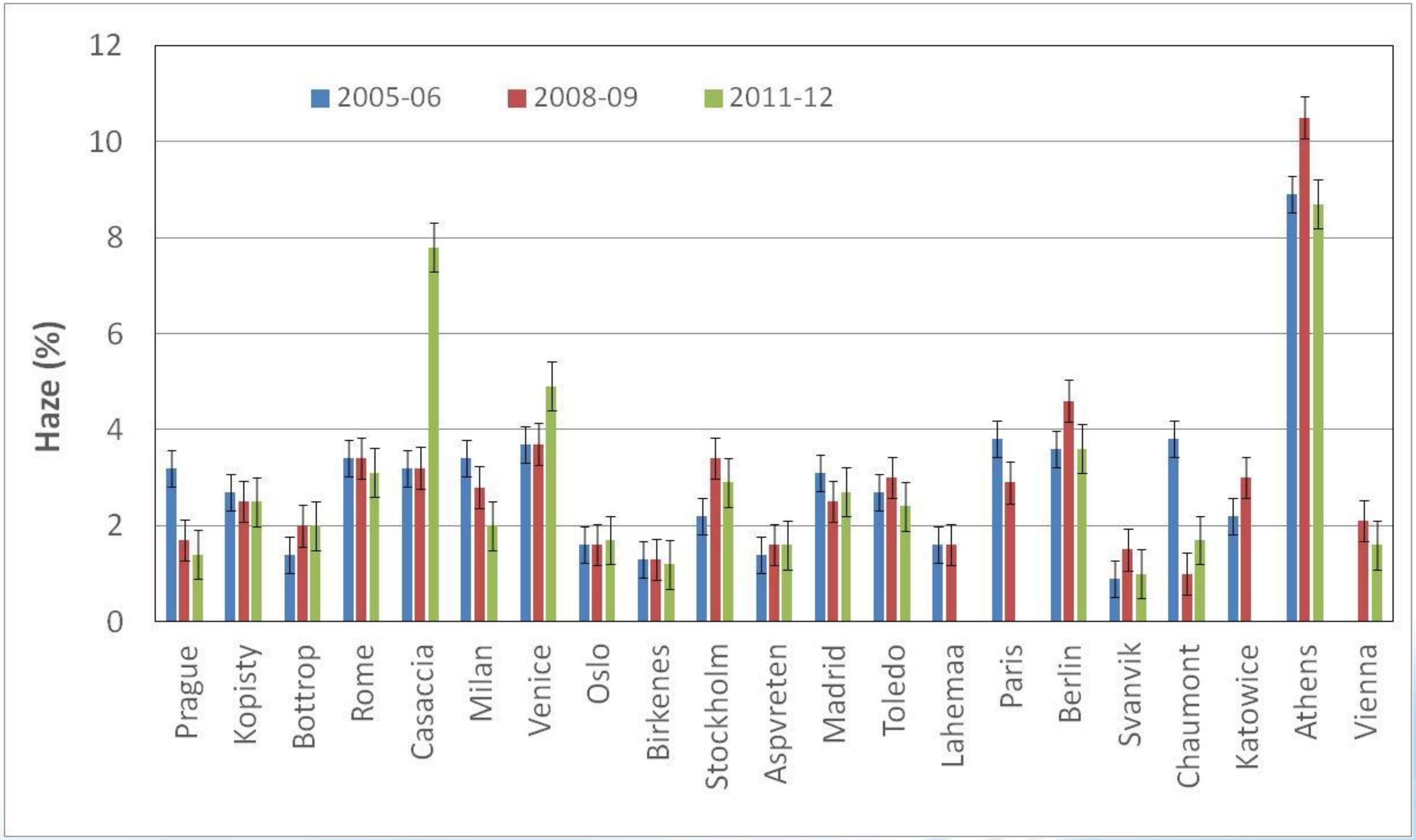
PMs – population exposure



TF Health

PMs – soiling of glass

Haze – visual nuisance on glass (>1%,



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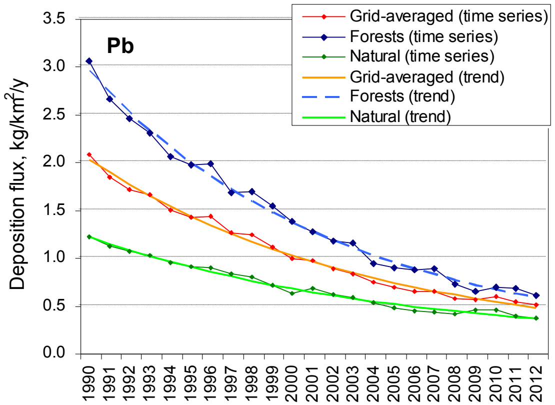
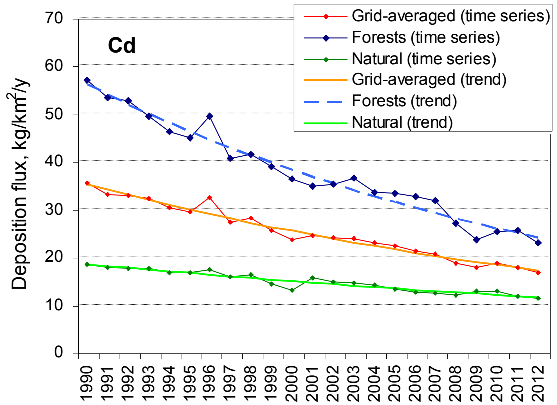
PMs, conclusions

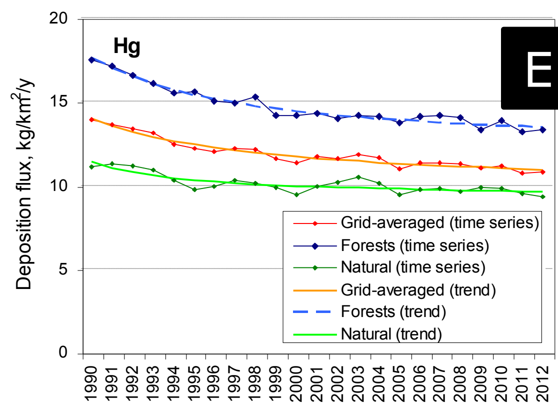
- Monitoring started mostly after 2000
  - Many (urban) areas with insufficient monitoring
- Indications of declines in PMs in background areas, but not in populated areas, since 2000
- No improvements in haze, i.e. visual nuisance related to soiling of glass
- Assessment of change in PMs based on other chemicals indicate large decrease in PMs since the 1980s
- Significant burden of disease from air pollution related to PMs

Heavy metals

Deposition lead (left), cadmium (middle) and mercury (right) for 1990-2012







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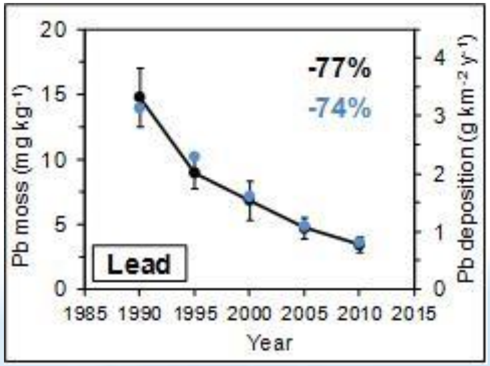
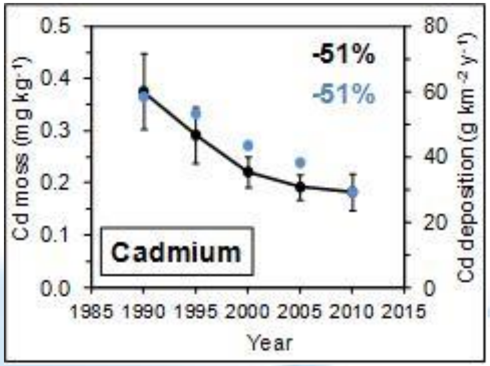
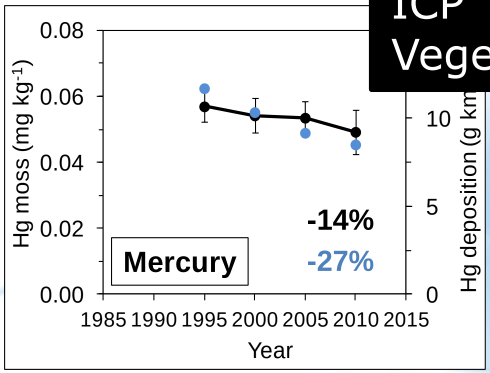
Concentrations in mosses of lead, cadmium and mercury for 1985-2010







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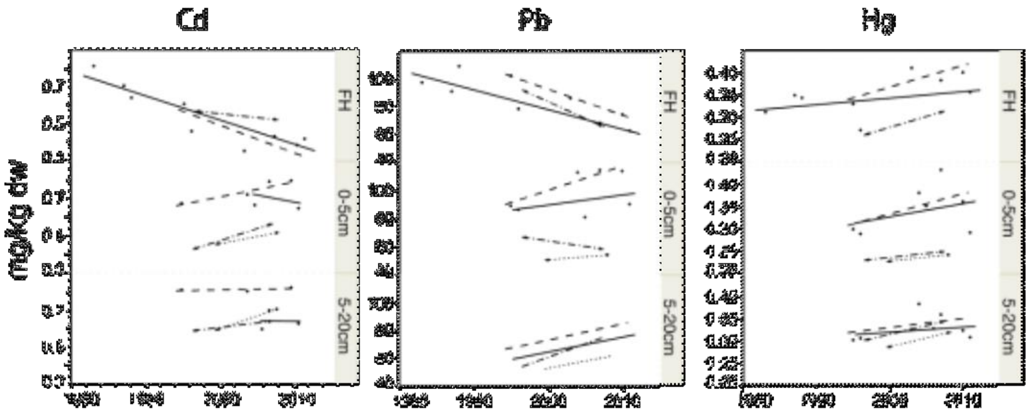
Heavy metals

Cd, Pb, Hg in soils at various depth (1980-2010)



Top soil

Subsoil

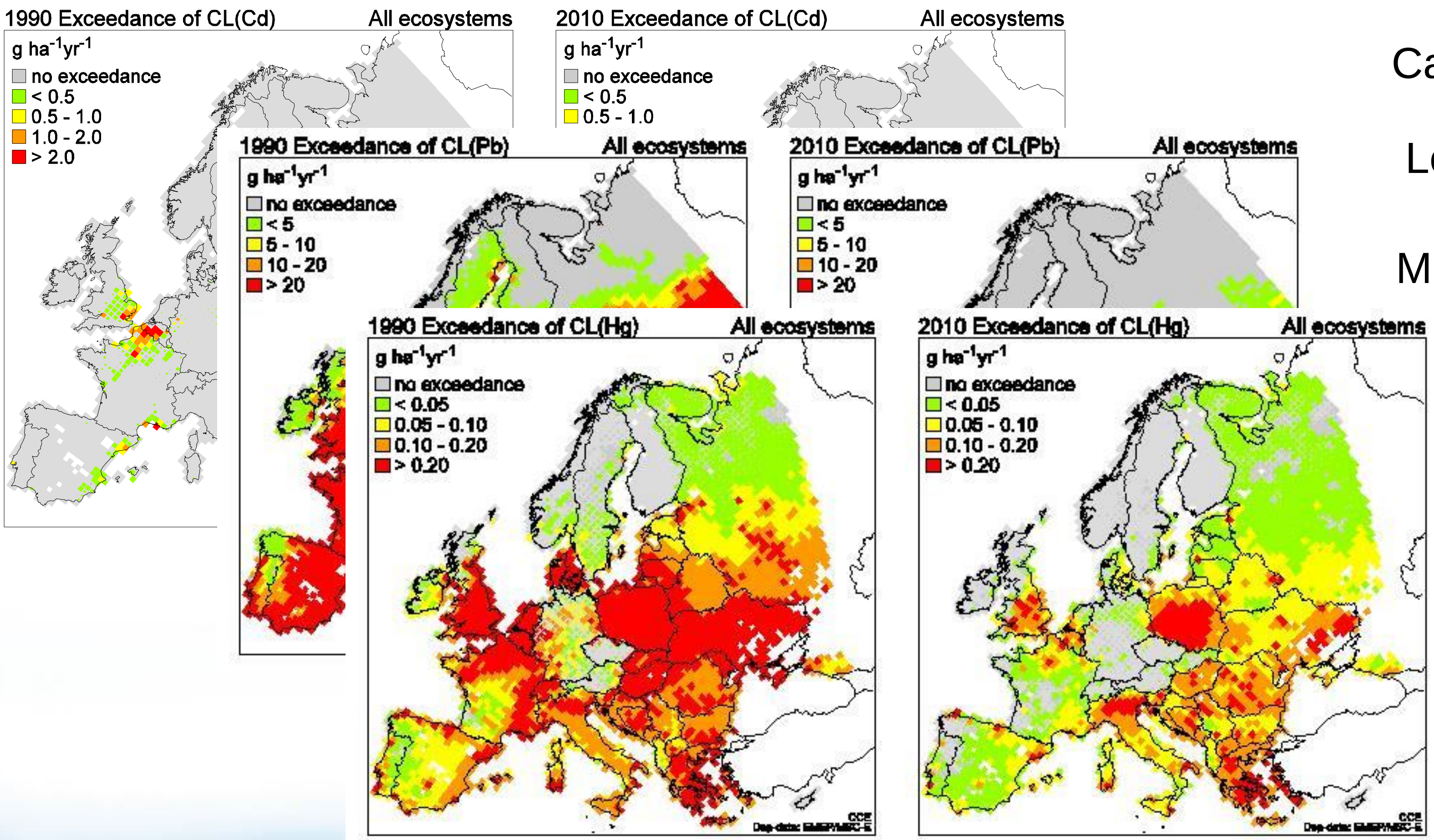
ICP Integrated Monitoring

Heavy metals

- Mercury in fish exceeds in many regions limits for human consumption
- Despite the decline in emissions of Hg, there is no clear indication of a decline of Hg in fish

Heavy metals

Exceedance of CLs – 1990 and 2010



Cadmium

Lead

Mercury

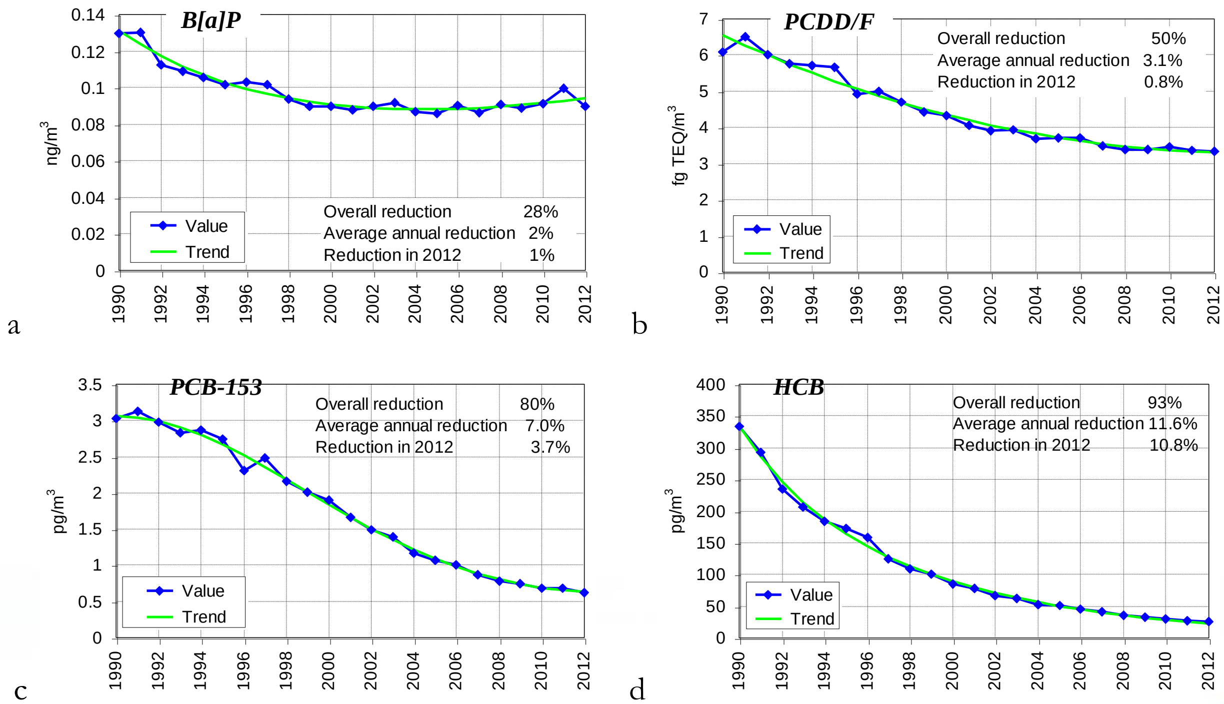
ICP Modeling and Mapping

Heavy metals - conclusions

- 78%, 53% and 23% reduction in total deposition of Pb, Cd and Hg (1990 and 2012) in Europe
- Transfer of heavy metals to deeper soil layers, probably leading to continued leaching to surface waters
- Decline in deposition of Hg is not reflected in Hg in fish
- Continued risk of HMs to human health and ecosystems

Persistant organic pollutants (POPs)

Atmospheric trends 1990 - 2012



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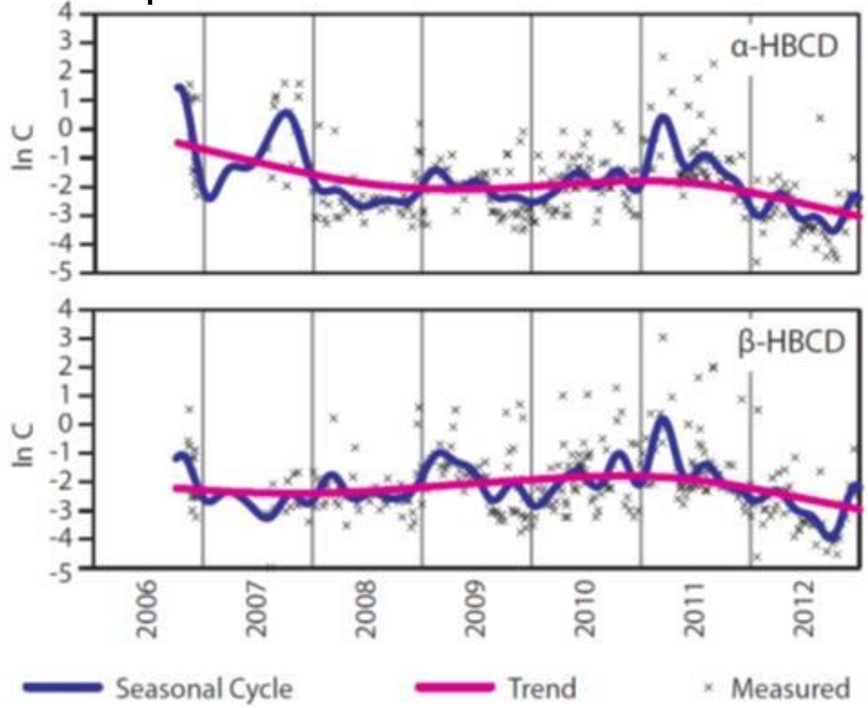
POPs – arctic air

Atmospheric trends - arctic air – 2006-2012



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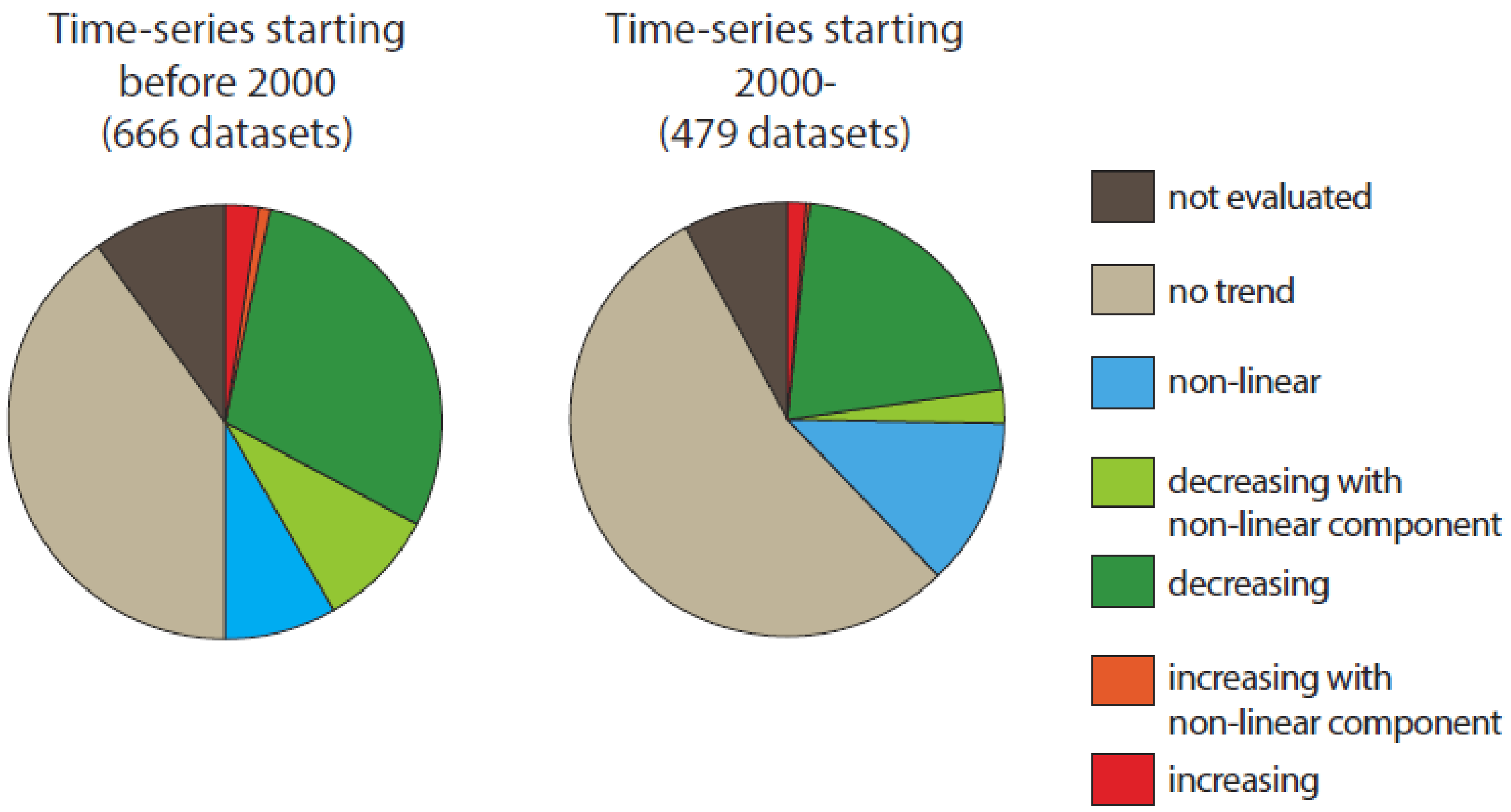
POPs – arctic biota



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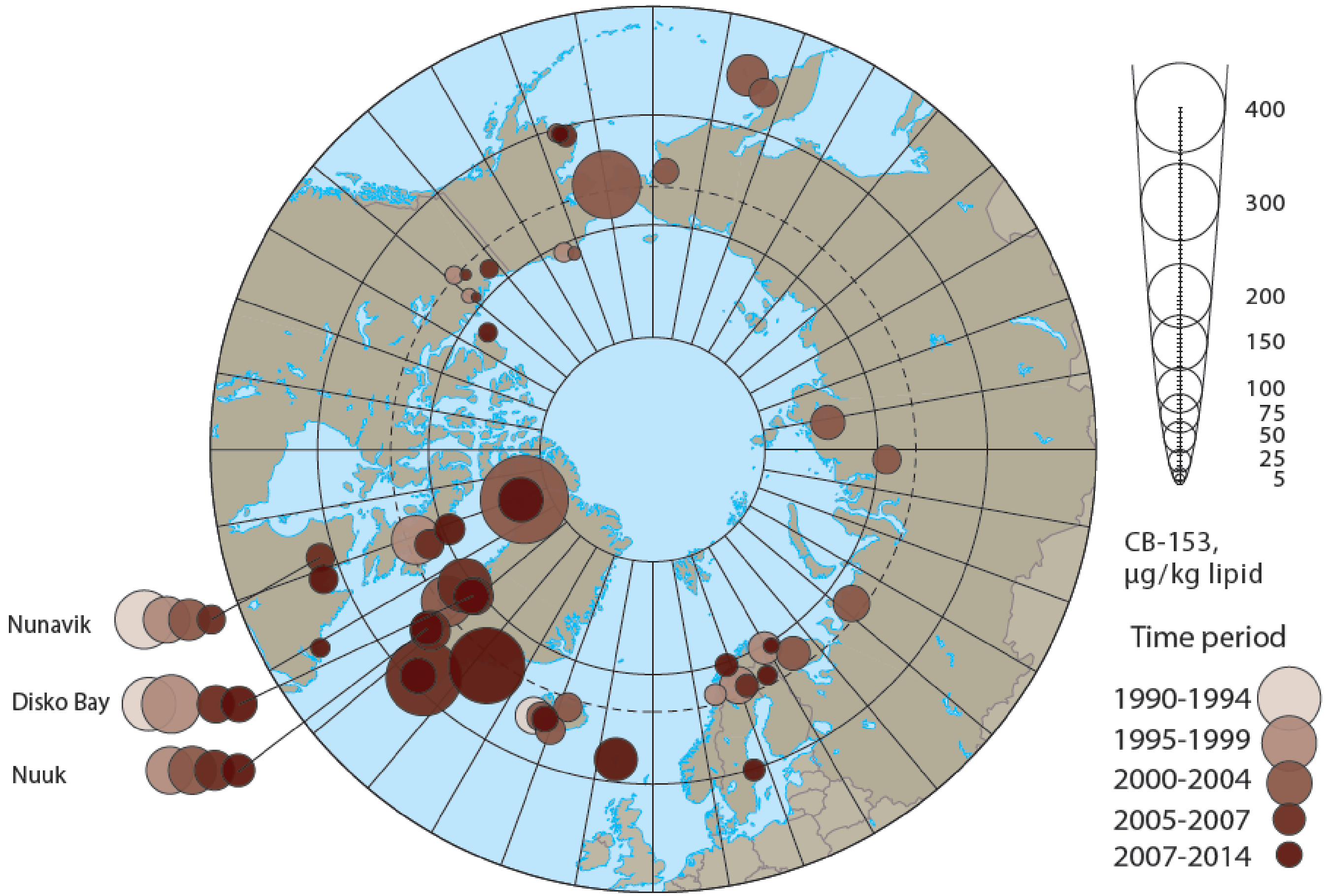
POPs – human blood



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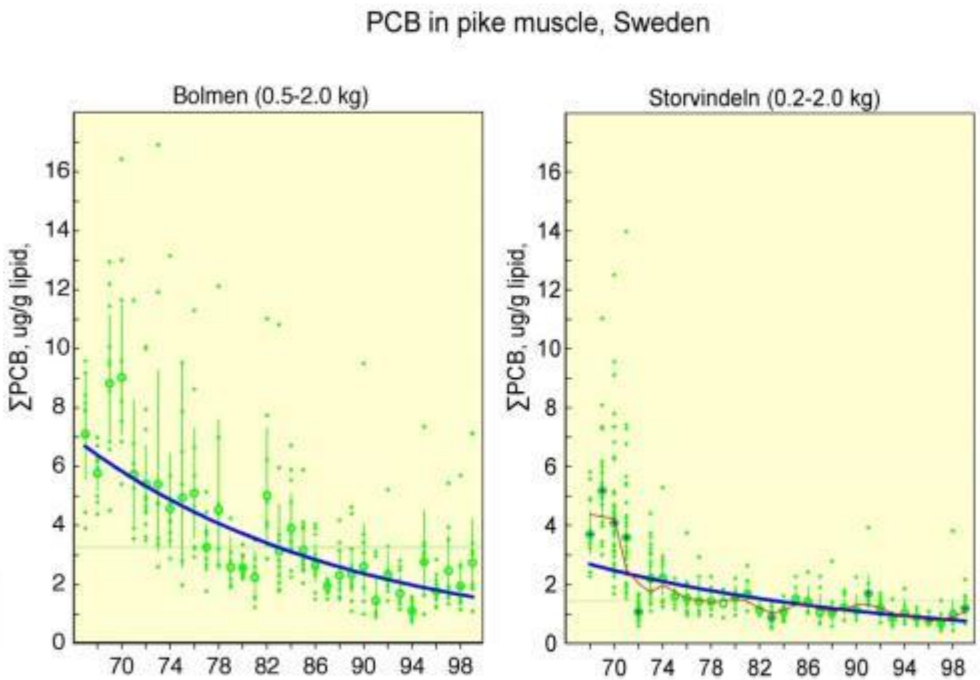
POPs - fish

PCBs in pike muscle, Sweden



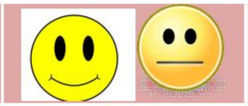
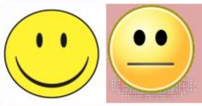
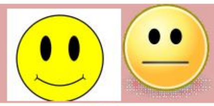
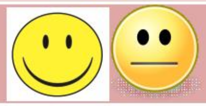
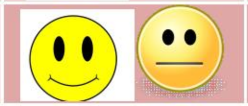
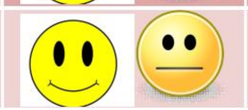
POPs - conclusions

- Decline in atmospheric concentrations 1990-2005, after that increasing tendencies
  - Target values remain exceeded in some areas
- POPs levels in air, biota and humans in the Arctic are generally decreasing
- Conspicuous lack of information on levels and trends of POPs, *originating from atmospheric transport*, in the environment

Overall conclusions

- To assess the effectiveness of air pollution policies by focusing on effects on environment and health
  - Progress and lack of progress, gaps in the data, gaps in scientific understanding
- To document trends in environmental and health responses to long-range transported air pollution
  - focusing on 1990 to 2012
- To provide support for Assessment Report

Overall conclusions

	Acidification	Nutrient - N	Ozone	PMs	Heavy metals	POPs
Trends						
Gaps in knowledge						
Gaps in data						
Environmental status						

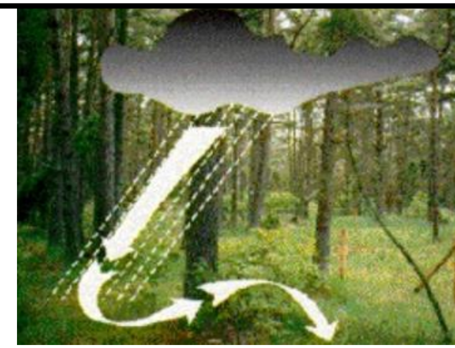
Acknowledgements

All networks: bodies under WGE, EMEP, AMAP, Task Forces, (inter)national monitoring
Individuals who contributed text, ideas, opinions, reviewers

ICP Forests

Task Force on Health

ICP Integrated Monitoring



ICP Materials

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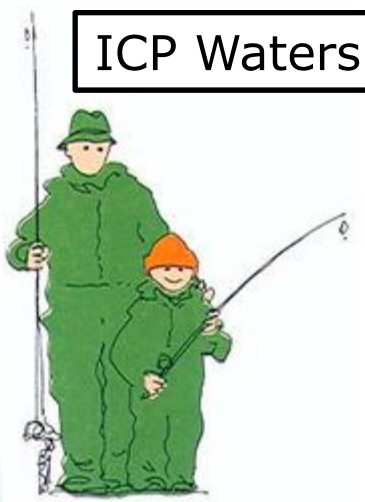
ICP Waters



ICP Modelling & Mapping

ICP Vegetation

AMAP

JEG Dynamic Modelling

wge Working Group on Effects of the Convention on Long-range Transboundary Air Pollution

NIVA

LRTAP Long-range Transboundary Air Pollution