



Pollution sources & identification

Activity 2.5



source: AFP PHOTO/Leon NealLEON NEAL/AFP/Getty Images

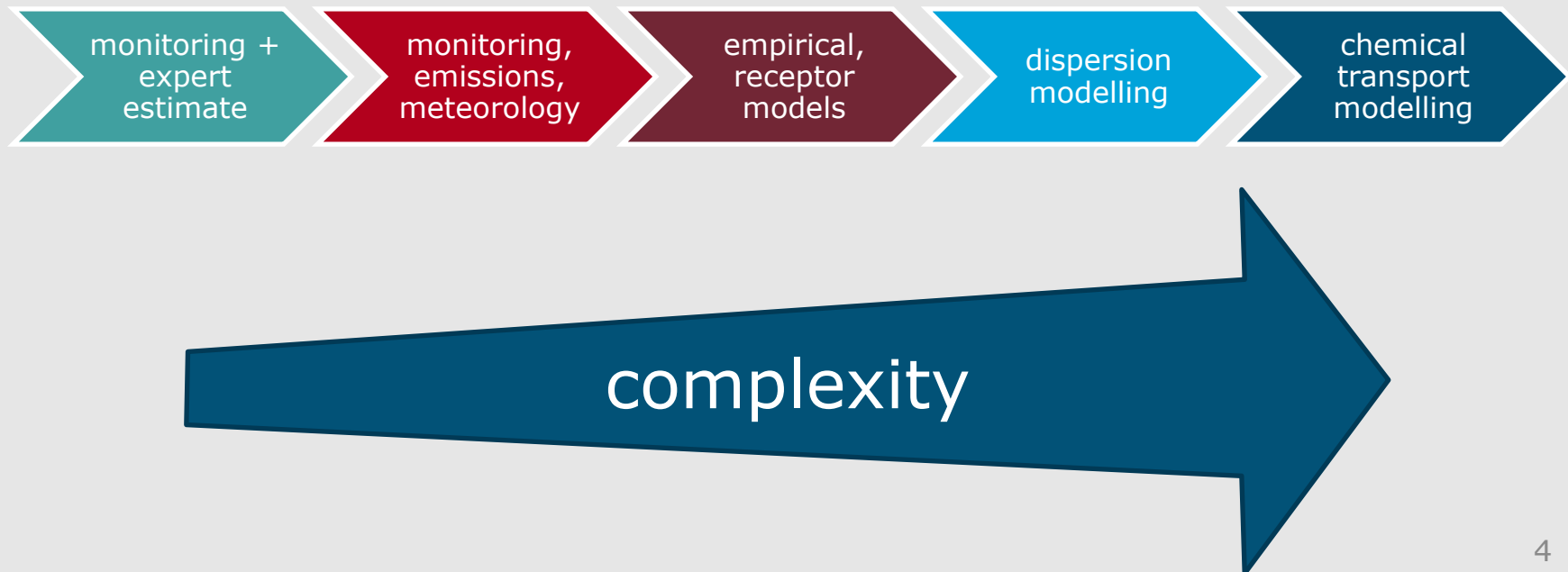
Topics

- General considerations
- Methodologies
- Natural sources

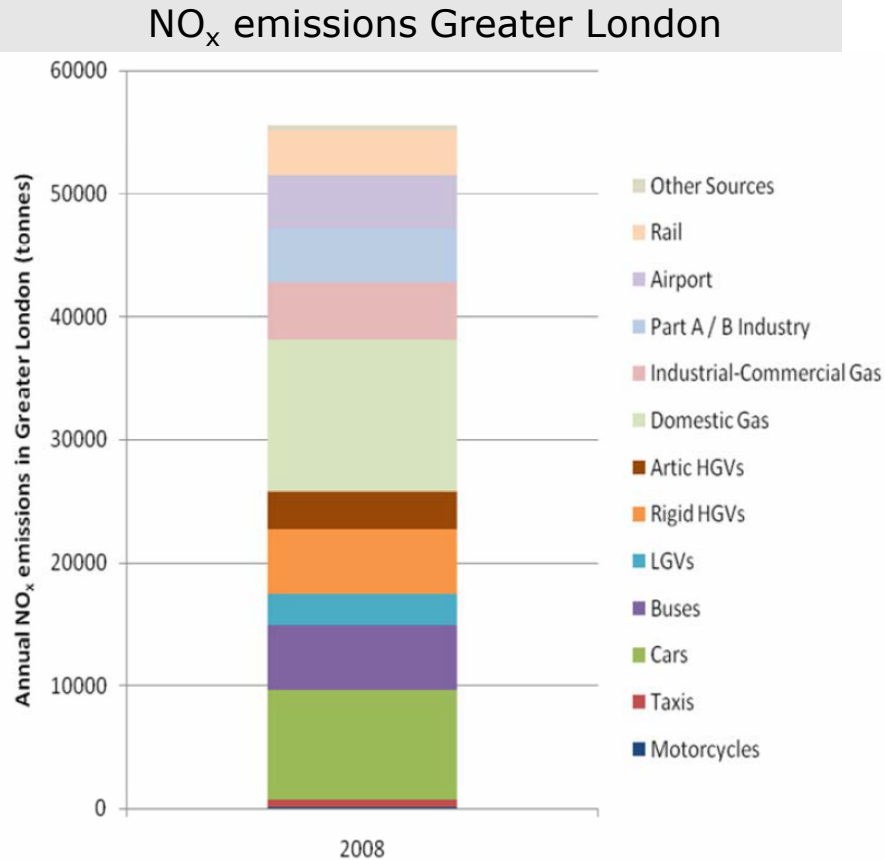
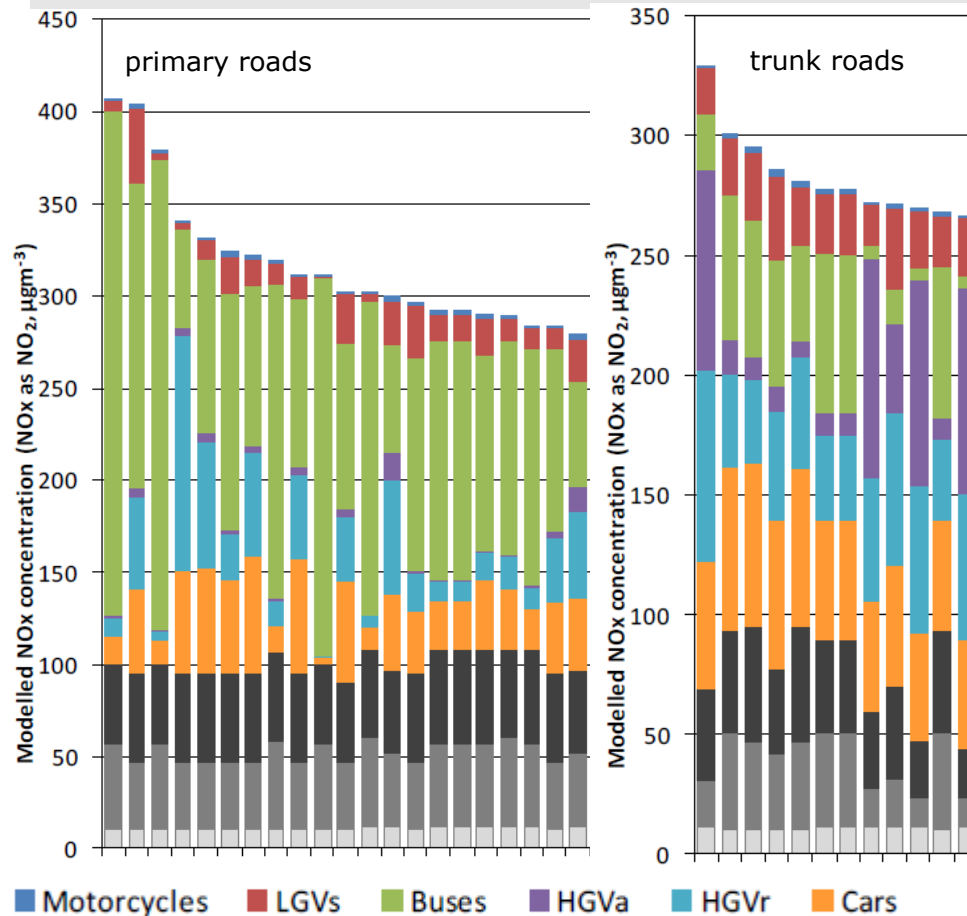
Sources of elevated levels in general

- NO_x : road traffic
- SO_2 : power plants, industry (S-containing fuels)
- HM: non-ferrous metal plants
- PAH: domestic heating, cokeries, aluminium plants
- PM: various primary, secondary, natural sources
- O_3 : various secondary (NO_x , VOC), natural (VOC) sources

Methods to identify sources



Emission \neq sources of pollutants



source: Greater London Authority 2010

UB: Traffic UB: Non traffic Regional Background

source: DEFRA 2011

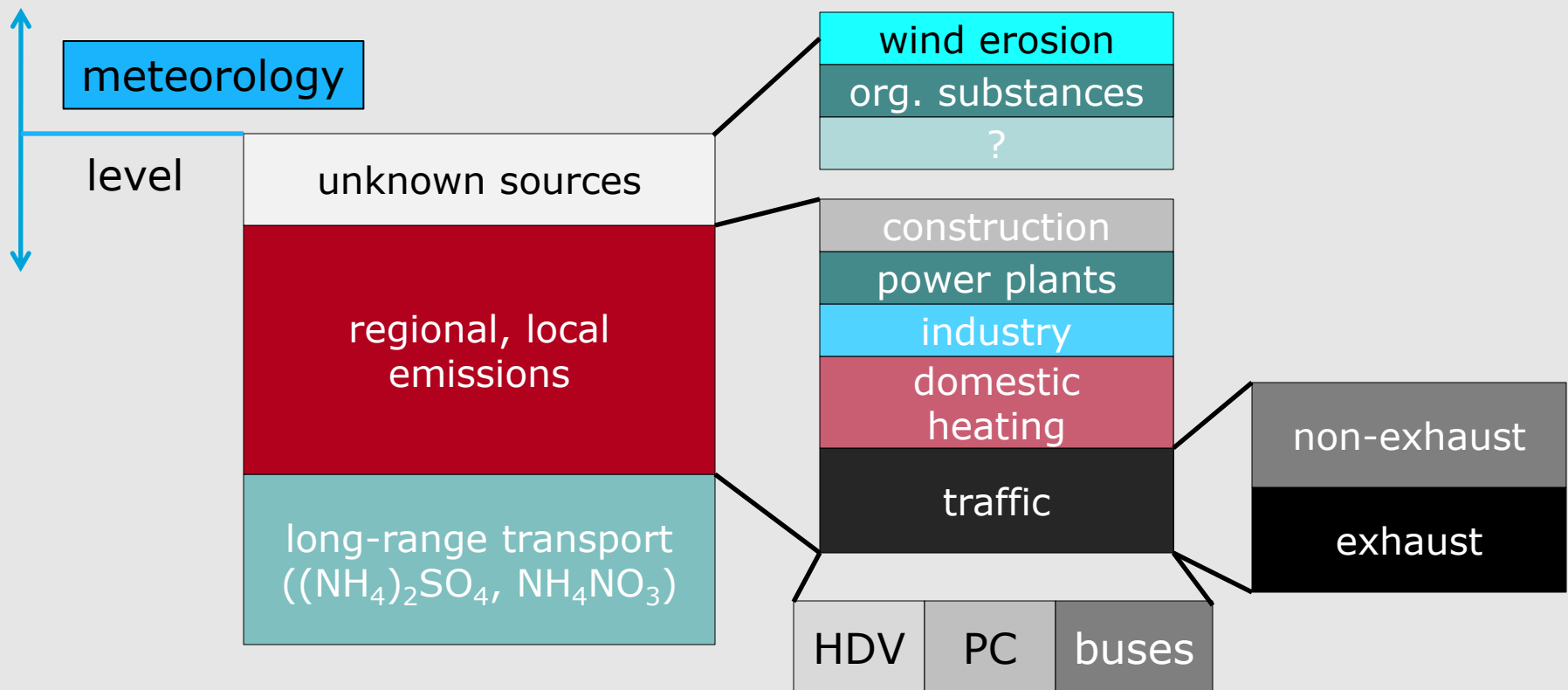
Common source categories

- marine salt
- crustal material
- road dust
- gasoline vehicle exhaust
- diesel vehicle exhaust
- power plants
- industrial emissions
- secondary ammonium sulphate
- secondary ammonium nitrate
- biomass burning / wood burning
- maritime transport
- secondary organic aerosol



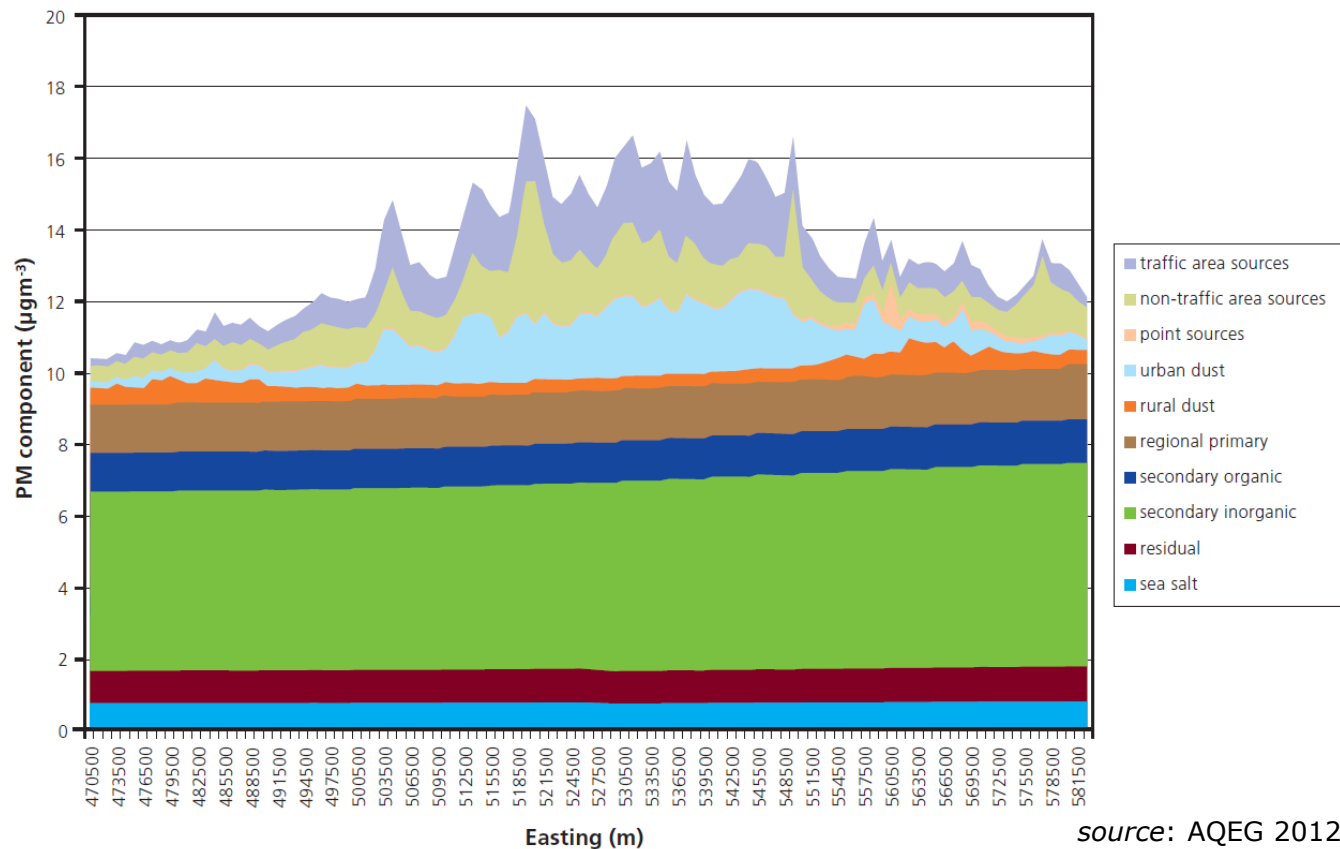
PM sources

PM composition



London: example spatial variability of contributions

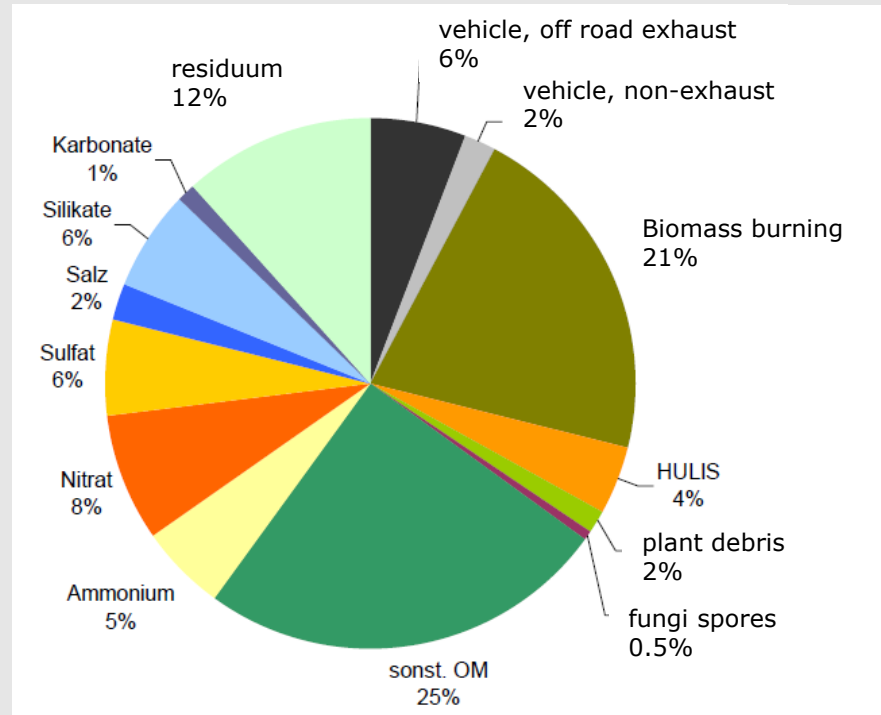
Annual mean PM_{2.5} transect across London for 2009 from PCM model



source: AQEG 2012

Example chemical composition

- Knittelfeld (Styria) PM₁₀ composition, sources at exceedance days



source: Government of Federal Province of Styria 2009

Composition of carbonaceous species

carbonaceous	organic/elemental	primary/secondary	fossil, biomass, burning, biogenic	how is it estimated?
Total carbon (TC)	Elemental carbon (EC)	(only primary)	Fossil fuel (EC_{FF})	by subtracting EC_{BB} from measured EC
			Biomass burning (EC_{BB})	from OC_{BB} and the OC/EC emission ratio for wood burning
	Organic carbon (OC)	Primary organic carbon (POC)	Fossil fuel (OC_{FF})	from EC_{FF} and the OC/EC ratio for fossil-fuel combustion
			Biomass burning (OC_{BB})	from levoglucosan and the OC/levoglucosan ratio for wood burning
			Biogenic (OC_{BIO})	derived from cellulose and the OC/cellulose emission ratio
		Secondary organic carbon (SOC)	Fossil fuel (SOC_{FF})	using the radiocarbon measurement of TC
			Biomass burning (SOC_{BB})	

source: JRC 2014

Fugitive sources

- Most relevant sources:
 - Construction work
 - Unpaved or dirty roads
 - Handling of dusty materials
 - Quarries
 - Saharan dust, wind erosion
- Emissions and contributions difficult to quantify
- Reduction measures available (except for natural sources)



Source: ADQproductions, J.-P. Fortin



source: NOAA George E. Marsh Album

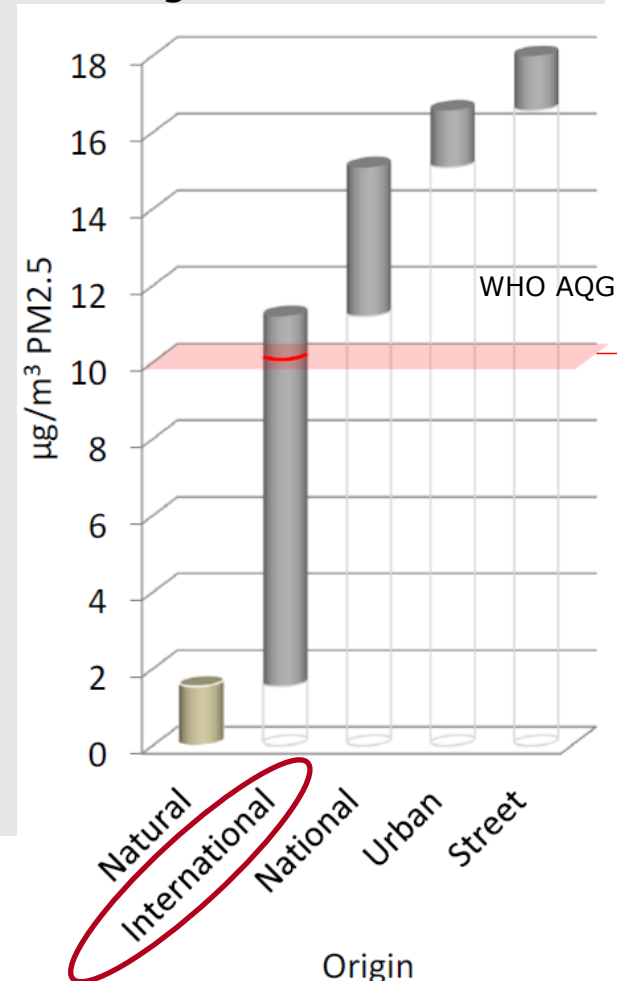


Source: Chris Talbot

Transboundary contributions

- Long atmospheric lifetime of small particles, formation of secondary aerosol
- Relevant especially for small, central European countries
- EMEP source-receptor relationships, backward trajectories, regional models provide information on contributions

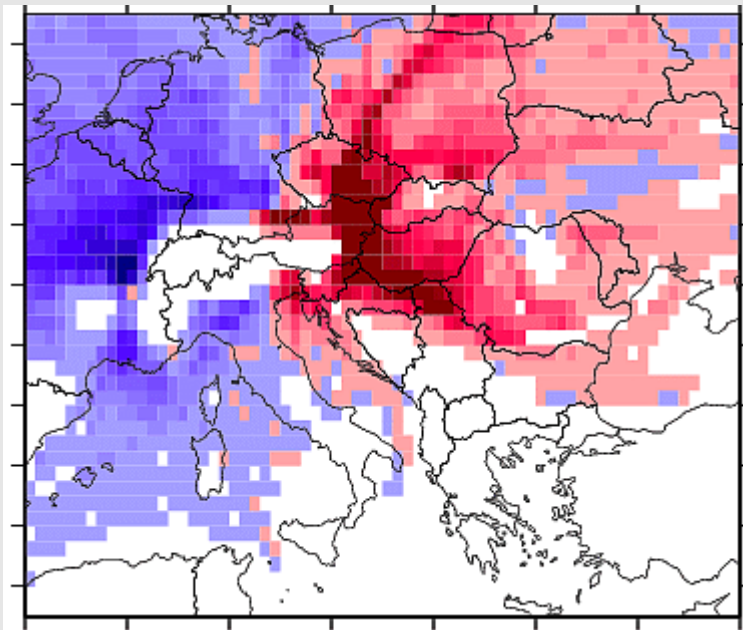
NL average of urban stations



Example of methods

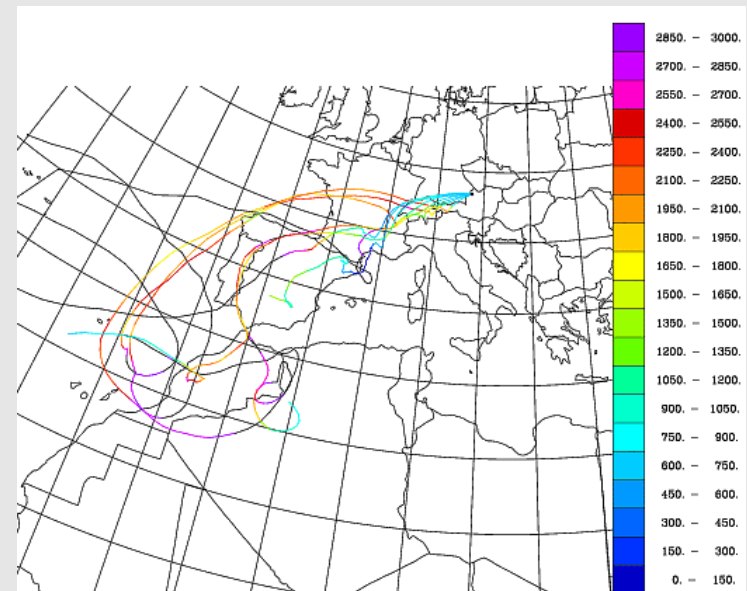
Backward trajectories

statistics of backward trajectories



source: ZAMG; Umweltbundesamt 2008

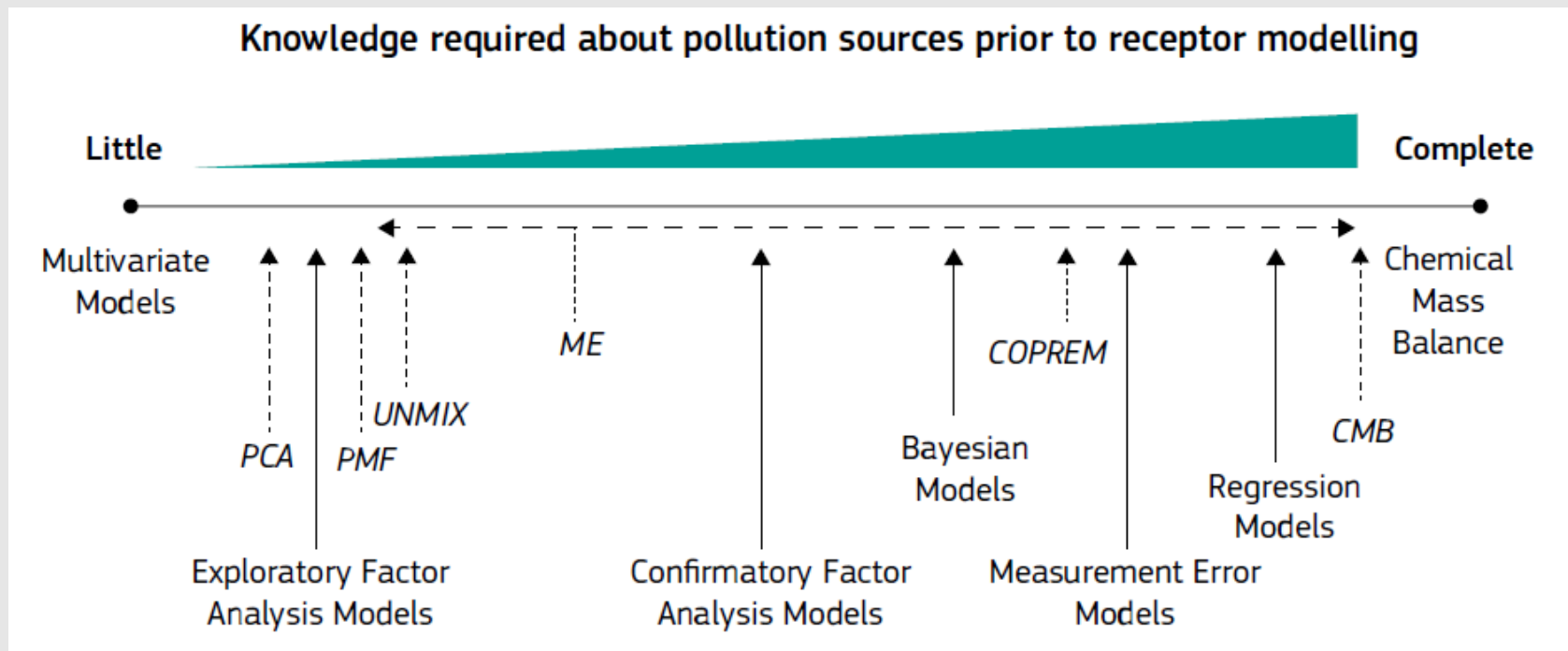
Saharan dust transport to Austria



Receptor models

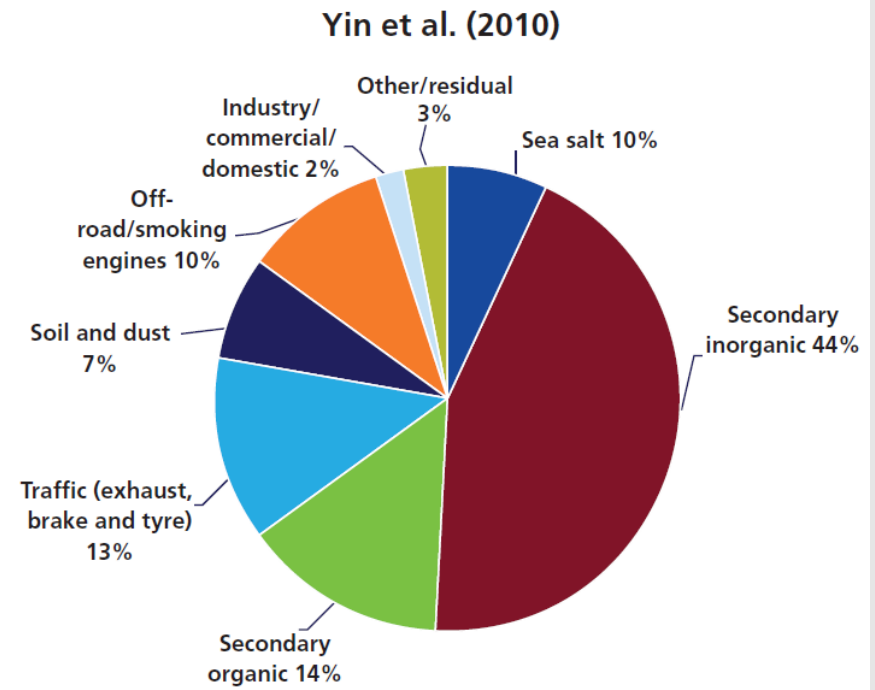
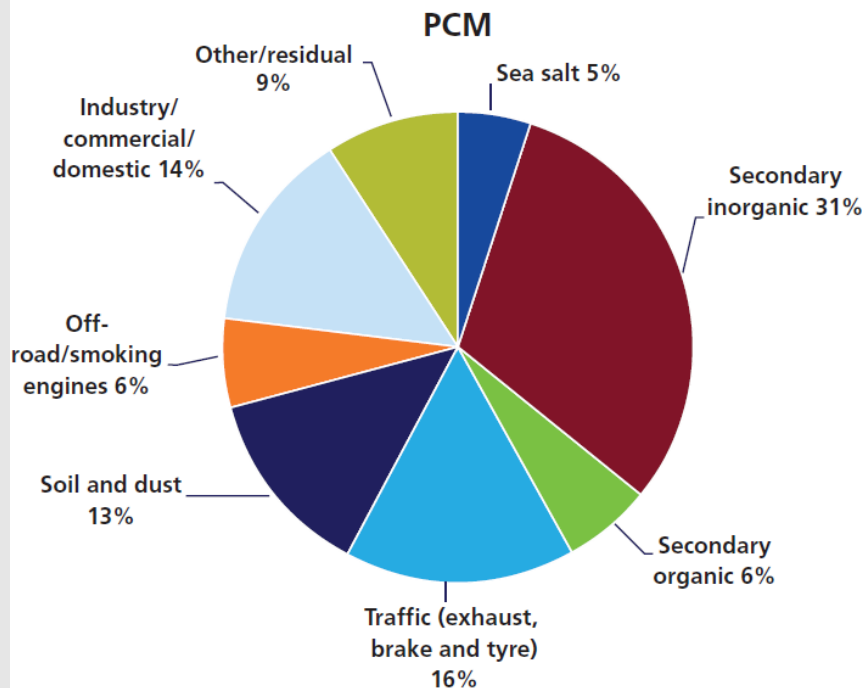
- Measured mass of air pollutant is related to emission sources by solving mass balance equation
- Several methods are available (e.g. PMF, CMB)
- CMB: fingerprint of emission sources is related to concentration of pollutants
- PMF: correlations in chemical analysis data is used to identify common sources ("factors")
- Guidance document from [JRC / FAIRMODE](#)

Receptor models



Variability of results

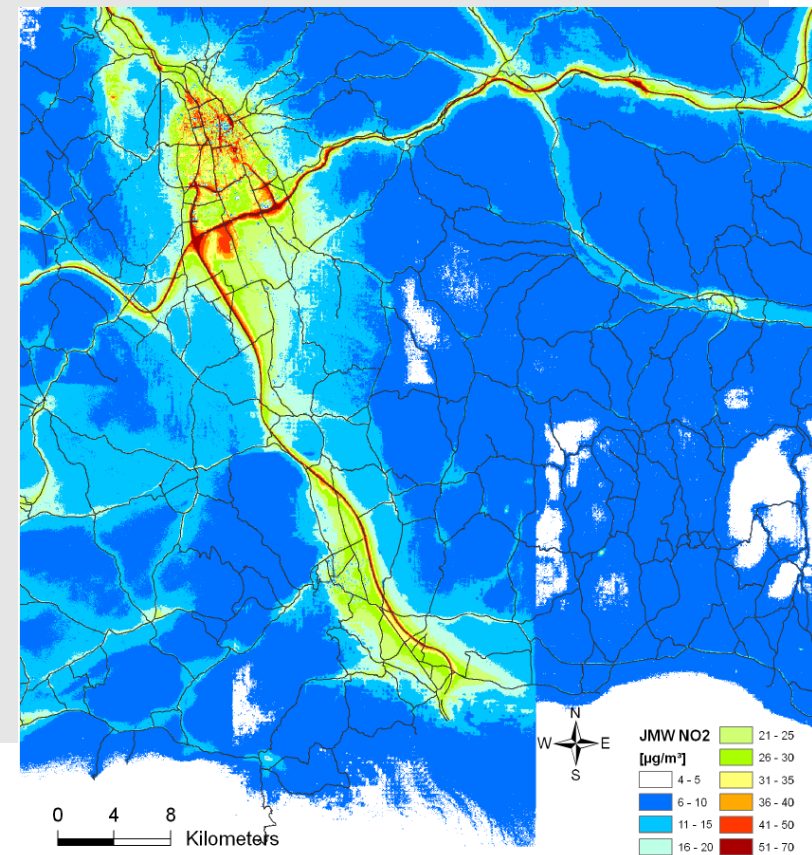
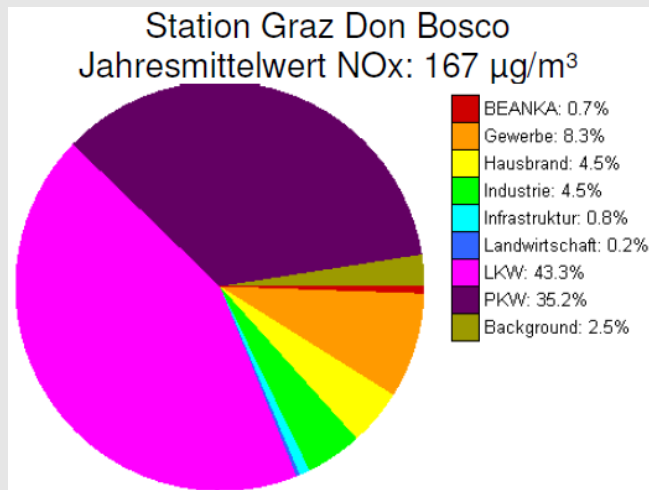
■ PCM model vs. CMB model for PM_{2.5} in Birmingham



source: AQEG 2012

Examples of dispersion modelling results

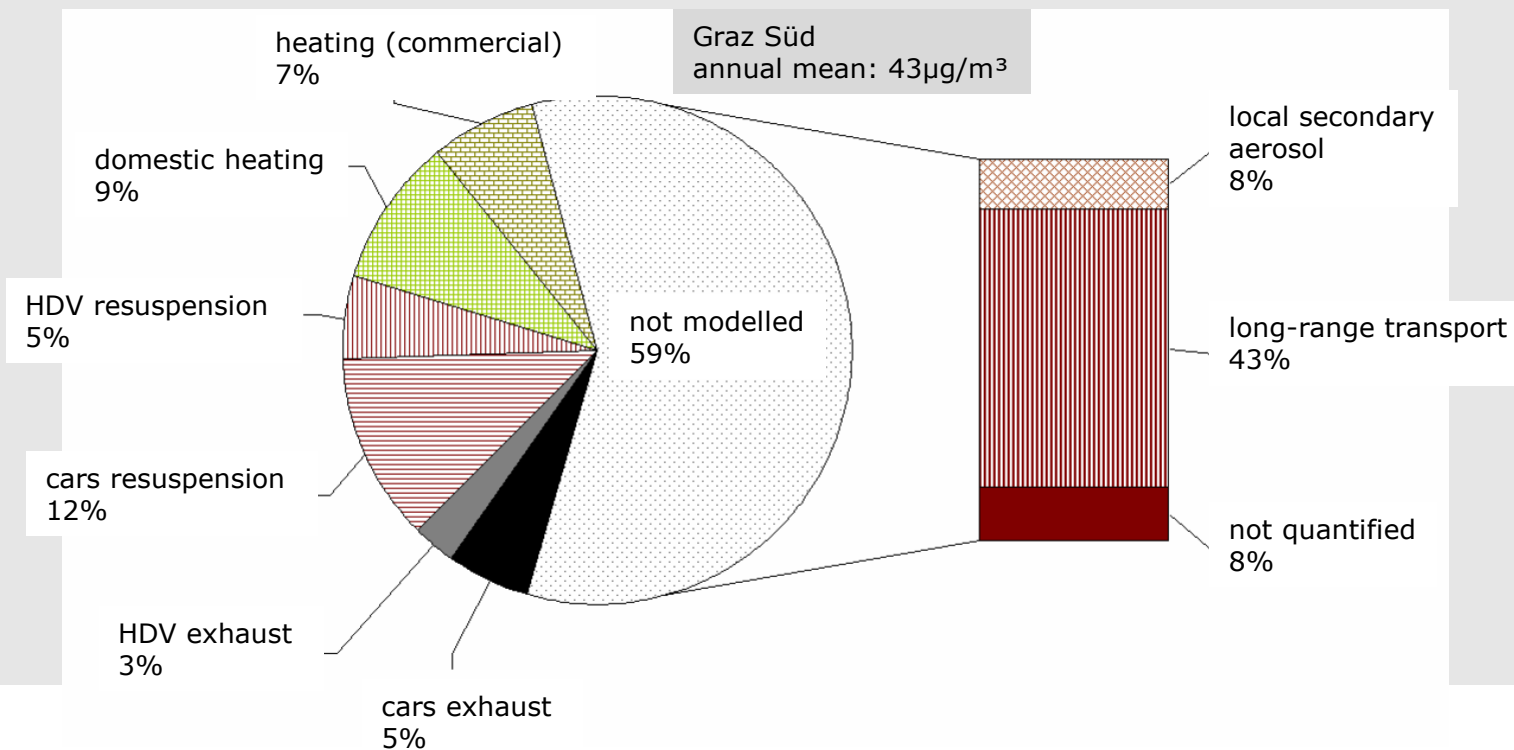
- Require detailed information on emissions, meteorology
- Mainly for primary pollutants
- Identification of main sources



source: Federal Province of Styria 2013

Examples of dispersion modelling results

- PM: large contribution of background, secondary and unknown sources

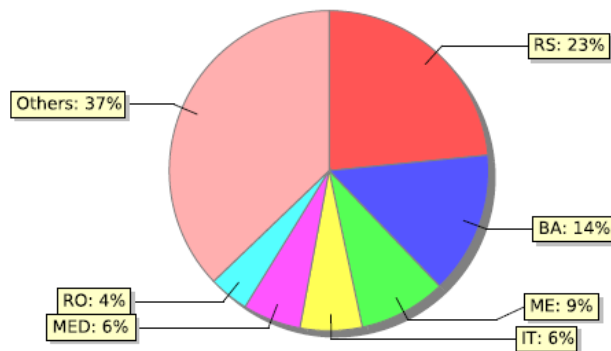
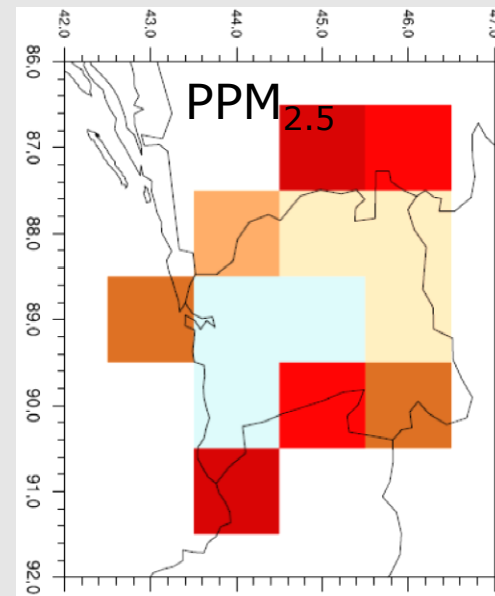
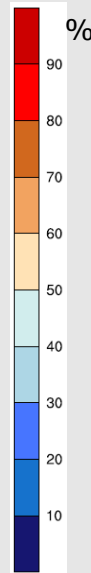
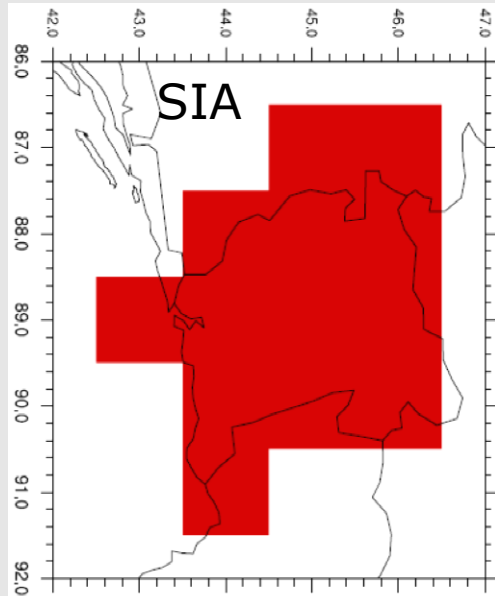


Chemical transport model: source-receptor relationships

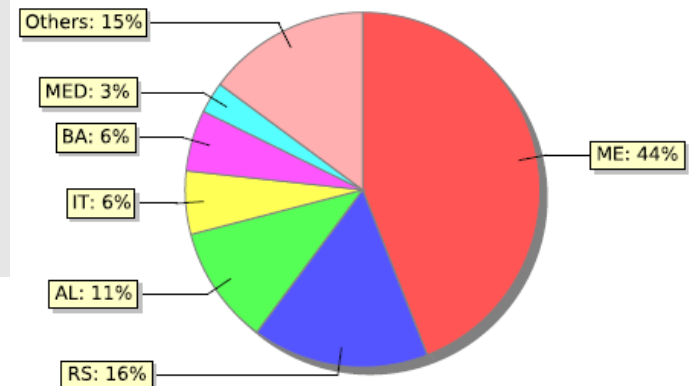
- EMEP calculates the contributions of emissions in a country to concentrations or depositions in another country for regional background ("source-receptor" relationships)
 - Deposition of oxidised sulphur, oxidised and reduced nitrogen
 - Ozone: AOT40, ozone fluxes to deciduous forests, SOMO35 (risk of ozone to human health)
 - PM: PM_{2.5}, PM_{coarse}, SIA, primary PM_{2.5}
- Current grid size: 50×50 km² (in future 0.1°)
- For small, mountainous countries results have to be treated with caution

Source-receptor relationships

Secondary inorganic aerosol and primary PM_{2.5}



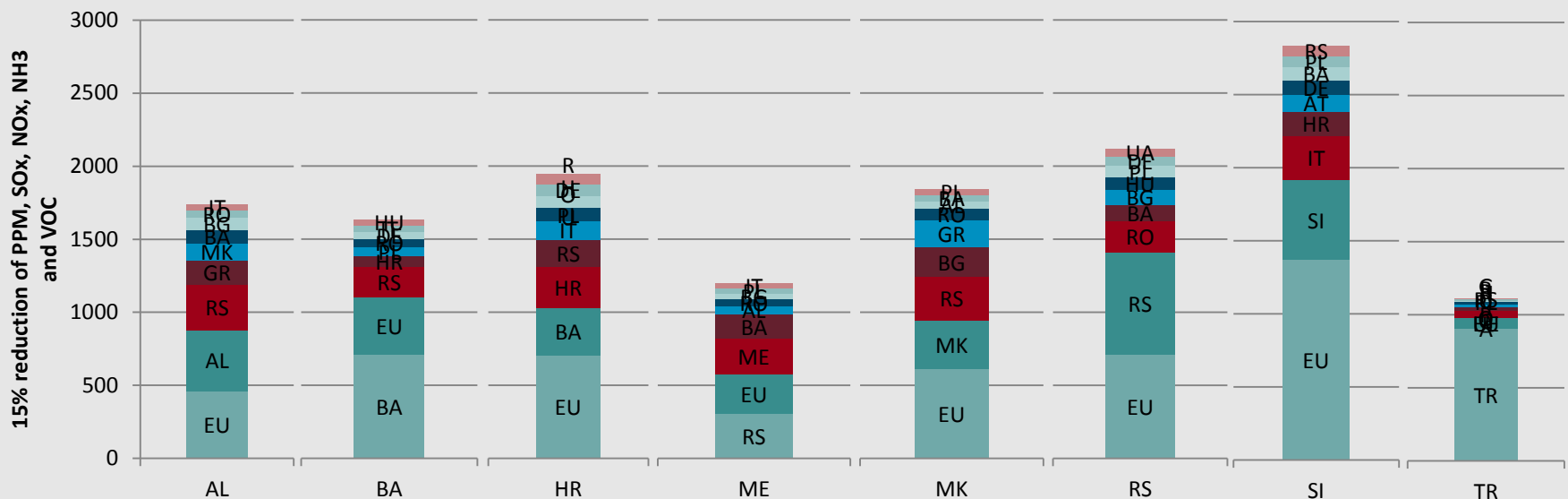
MED: Mediterranean



source: EMEP 2012

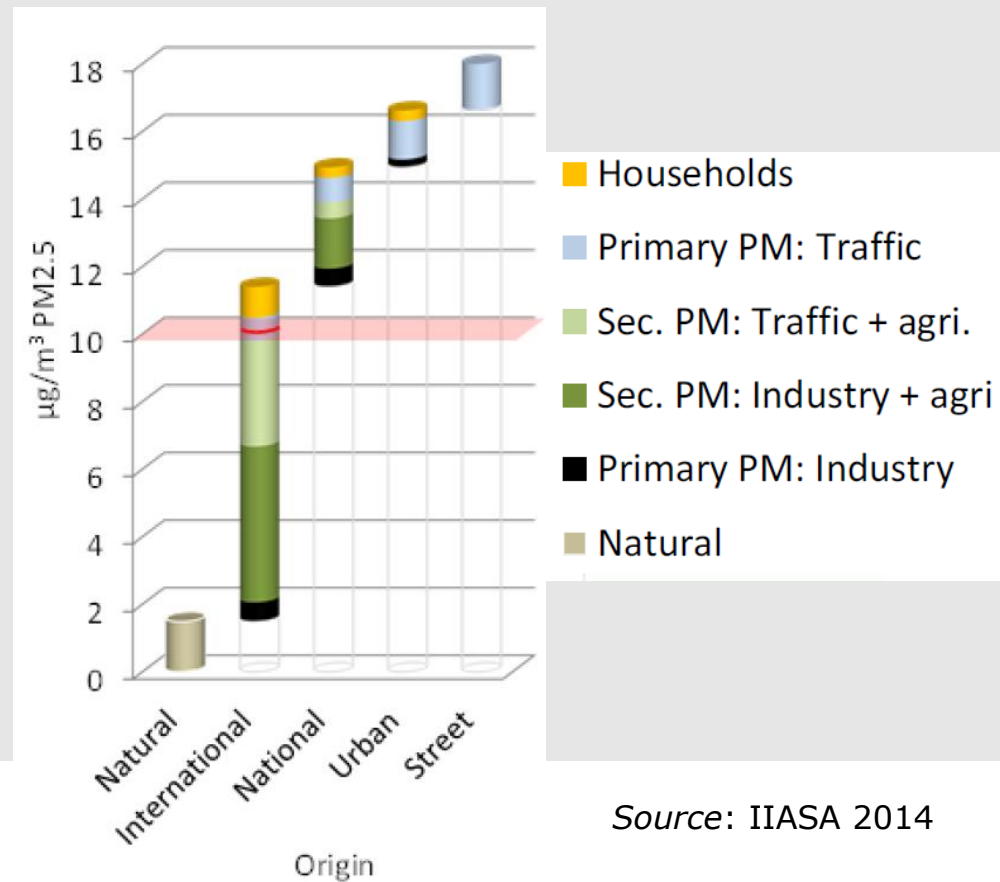
Source-receptor relationships

- Effect of a 15% reduction in all emissions. The contribution from a 15% reduction in PPM, SO_x, NO_x, NH₃ and VOC emissions have been summed up.

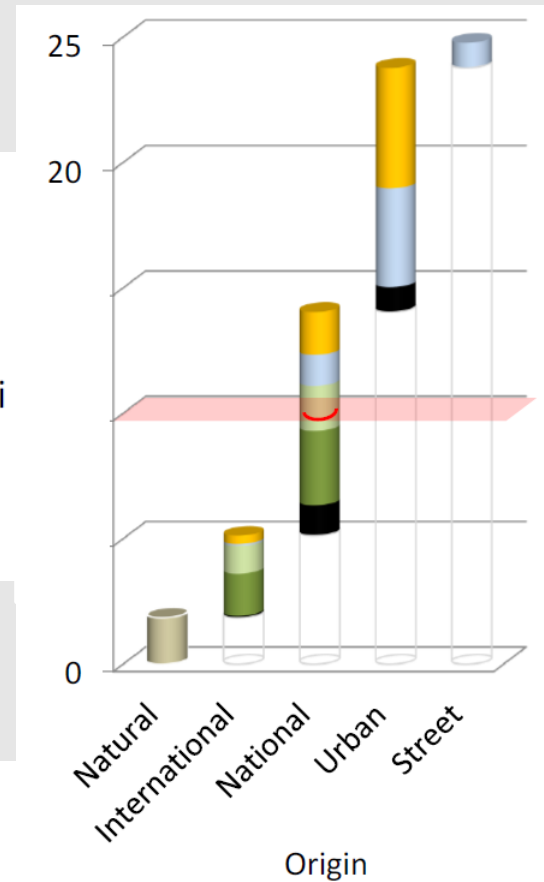


Calculations by IIASA

NL average of urban stations (2009)



Lyon Centre Ville



Natural sources

Identification of natural sources

- Art. 20 of the AAQD allows to consider exceedances due to natural sources not as an exceedance
- [Guidance document](#) specifies definition and methodology
 - Natural source: emissions not caused directly or indirectly by human activities; human action cannot prevent the emissions
 - Saharan dust
 - Wind blown dust from dry regions (needs thorough assessment)
 - Sea spray
 - Volcanoes
 - Wild-land fires (only if transboundary, cooperation needed)



source: wikimedia commons, Árni Friðriksson



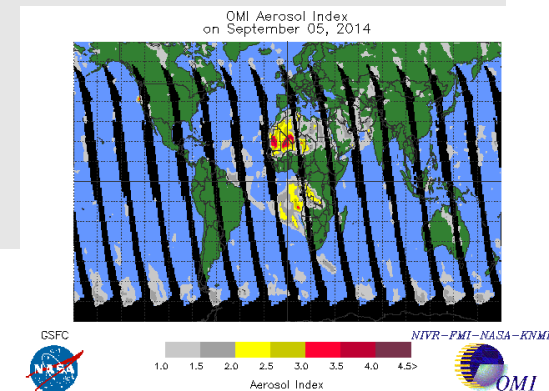
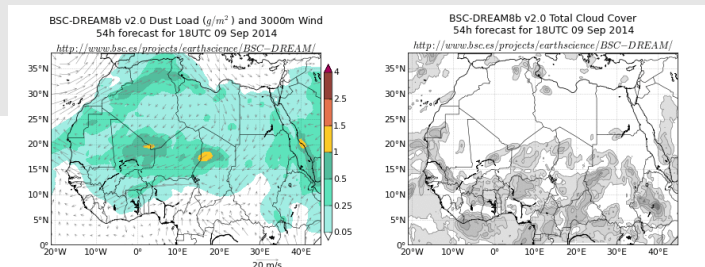
source: NASA, Jeff Schmaltz, MODIS Rapid Response team. Caption by Michon Scott

Non-eligible natural contributions

- Wild-land fires within country (90% originate from human activity)
- Wind erosion from agricultural activity
- Re-suspension
- Primary Biological Aerosol Particles (might be reviewed)
- Secondary Organic Biogenic Aerosols

Saharan dust methodology – identification

- Developed in Spain, Portugal
- Interpretation of the daily meteorological situations with the 5-day back trajectories
- Maps of aerosol index of Ozone Monitoring Instrument ([OMI](#))
- Aerosol models ([SKIRON](#), [BSC-DREAM](#), [NAAP](#))
- (Execution of HIRLAM model from ECMWF)
- [MACC II](#) analysis and forecasts
- PM monitoring at regional background sites



Saharan dust methodology – quantification

- monthly moving percentile 40 for 30 days for representative regional background (excl. Saharan dust days)
- dust load: difference between actual concentration and percentile
- Subtraction of dust load from station in exceedance
- Validation by analysis of mineral composition
- Documentation in annual reports

Contribution from sea salt

- Chemical analysis of PM samples
- Subtraction from PM mass
- Application only to area for which monitoring site is representative
- Possible biases should be considered (coal burning, winter salting)

Further information

- [MDS – Model Documentation System](#)
- [FAIRMODE](#)
 - how to start PM modelling
 - guide on air pollution source apportionment with receptor models
 - NO₂ modelling guide
 - model application under AAQD
- [EMEP](#)
- [MACC II Copernicus](#)
- [European Commission assessment of ambient air quality](#)

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