MAJOR AIR POLLUTANT SOURCES IN EUROPE AND SOURCE IDENTIFICATION

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Outline of the presentation

• Why is important to identify pollution sources?
• How can we identify and quantify the contribution of sources to atmospheric pollution?
• What are the most common sources and how much they contribute to atmospheric pollution in Europe?
ANTHROPOGENIC

AGRICULTURE

SEA SALT

BIOMASS BURNING AND DOMESTIC HEATING

INDUSTRY AND POWER GENERATION

VEHICLES

BIOGENIC EMISSIONS

NATURAL

ATMOSPHERIC CHEMISTRY

DUST RESUSPENSION
Emissions of atmospheric pollutants

- Sources
- Meteorology
- Physical and chemical processes
- Concentrations at the receptor
- To the atmosphere

C. Belis 04/06/2013 Session 1.4
Source estimation methods

1. EMISSION INVENTORIES

2. CHEMICAL TRANSPORT MODELS
   DISPERSION MODELS

3. RECEPTOR MODELS
   INVERSE MODELS

METEOROLOGY

PHYSICAL AND CHEMICAL PROCESSES

TO THE ATMOSPHERE

CONCENTRATIONS AT THE RECEPTOR

SOURCES
1. EMISSION INVENTORIES

- Required for reporting obligations
- Do not consider atmospheric processes
- Official data could be sketchy/inconsistent

2. CHEMICAL TRANSPORT MODELS
   DISPERSION MODELS

- Consider atmospheric processes
- Provide high resolution spatial and temporal estimations
- Intensive computing resources and good parametrization needed
- Simulation for short time windows
- Output depends on input data quality

3. RECEPTOR MODELS
   INVERSE MODELS

- Derive directly from data collected at the point of interest
- Have good uncertainty estimation
- Require field work and chemical analyses
- Not applicable to all pollutants

Source estimation methods
What do AQ Directives say about pollution sources?

Reduction of emissions at source (Preamble point 16)

Local, regional and national air quality plans (Annex XV A item 5)

Background measurements (Annex IV A)

Ozone precursors (Annex X A)

Natural sources, road salting and sanding (Articles 20 and 21)

Public information (Annex XVI item 4)

One of the overarching principles of the Thematic Strategy on Air Pollution.

Emitted quantities and transboundary sources responsible for pollution are to be listed when drafting air quality plans.

To judge the enhanced levels in more polluted areas, assess long-range transport, support source apportionment analysis and understanding of specific pollutants.

Measurements to monitor the efficiency of emission reduction strategies, to check the consistency of emission inventories and to help attribute emission sources.

To provide evidence of exceedances attributable to natural sources or winter sanding or salting of roads.

Information about exceedances of alert thresholds including indication of main source sectors or categories and recommendations for action to reduce emissions.
Sources of sulphur oxides and ammonia in Europe

- **Sulphur oxides (4,574 Gg in 2010)**
  - Energy production and distribution: 57.4%
  - Energy use in industry: 21.3%
  - Commercial, institutional and households: 14.3%
  - Industrial processes: 3.8%
  - Non-road transport: 2.9%
  - Road transport: 2.1%
  - Waste: 2.1%
  - Agriculture: 93.7%

- **Ammonia (3,591 Gg in 2010)**
  - Agriculture: 93.7%
  - Industrial processes: 1.2%
  - Waste: 2.1%

Data source: EEA aggregated and gap-filled air emission dataset, based on 2012 officially reported national total and sectoral emissions to UNECE LRTAP Convention, the EU NEC Directive and EU-MM/UNFCCC.
Sources of nitrogen oxides in Europe

Emissions in 2010: 9,162 Gg

Data source: EEA aggregated and gap-filled air emission dataset, based on 2012 officially reported national total and sectoral emissions to UNECE LRTAP Convention, the EU NEC Directive and EU-MM/UNFCCC.
Sources of non methane volatile organic compounds (NM-VOC) in Europe

- Energy production and distribution: 9.5%
- Energy use in industry: 2.2%
- Industrial processes: 6.6%
- Energy use in industry: 2.2%
- Non-road transport: 2.0%
- Non-road transport: 2.0%
- Road transport: 15.6%
- Solvent and product use: 42.1%
- Commercial, institutional and households: 18.5%
- Agriculture: 2.0%
- Waste: 1.5%

Emissions 2010: 7,412 Gg

Data source: EEA aggregated and gap-filled air emission dataset, based on 2012 officially reported national total and sectoral emissions to UNECE LRTAP Convention, the EU NEC Directive and EU-MM/UNFCCC.
Sources of Particulate Matter in Urban Areas in Europe

- Sea/road salt; 5%
- Secondary inorganic, 33%
- Crustal, 17%
- Traffic, 19%
- Point sources, 15%
- Biomass - wood burning, 14%

272 records, meta-analysis of studies carried out between 1998 and 2012. Source: Belis et al., 2013 Atmospheric Environment 59
Sources of Elemental Carbon (Black Carbon) in PM

Apportionment of the elemental carbon fraction in the PM to the three main primary source categories in selected sites using receptor models

Stationary emissions are the main EC source in the sites from North America.

Mobile sources are the main responsible for EC in many European urban areas.

In South-East Asia and Australia, an equilibrium between mobile and stationary fossil fuelled sources in some urban areas, while mobile sources dominate in others.

Belis et al., 2013 (in preparation)
Conclusions

• Identification of pollution sources is the basis for understanding atmospheric pollution and developing reduction plans.

• There are different methodologies to study sources each of which has strengths and limitations.
  - Emission Inventories
  - CTM and Dispersion models
  - Receptor models / Inverse models
  Combination of techniques provide more robust results.

• The relevance of sources changes among pollutants. The key categories are: energy production (SOx, NOx), transport (NOx, PM), agriculture (NH3), use of solvents (VOC), and secondary (PM, O3) for the most critical pollutants.
Thank you for your attention!

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http://source-apportionment.jrc.ec.europa.eu
Receptor Models studies 1998-2012
Belis et al., 2013

PMCAMX (one month) winter 2009
Megaritis et al., 2013
Sector contributions of emissions of primary particulate matter and secondary precursors (EEA member countries)

- **PM2.5**: 2.5%
  - Sea salt: 52.1%
  - Sulphates: 5.9%
  - Nitrates: 7.4%
  - SIA: 10.4%
  - Mineral dust: 2.9%
  - Traffic: 15.8%
  - Point sources: 1.6%
  - Biomass burning: 1.1%

- **PM10**: 10.3%
  - Sea salt: 41.9%
  - Sulphates: 7.3%
  - Nitrates: 6.4%
  - SIA: 15.1%
  - Mineral dust: 10.8%
  - Traffic: 14.4%
  - Point sources: 1.8%
  - Biomass burning: 1.6%

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Emission Inventory 32 EEA countries
National Emissions 2010 CLRTAP
EEA, 2012

Receptor Models
studies 1998-2012
Belis et al., 2013