Methods to analyze interactions between emissions of air pollutants in Europe

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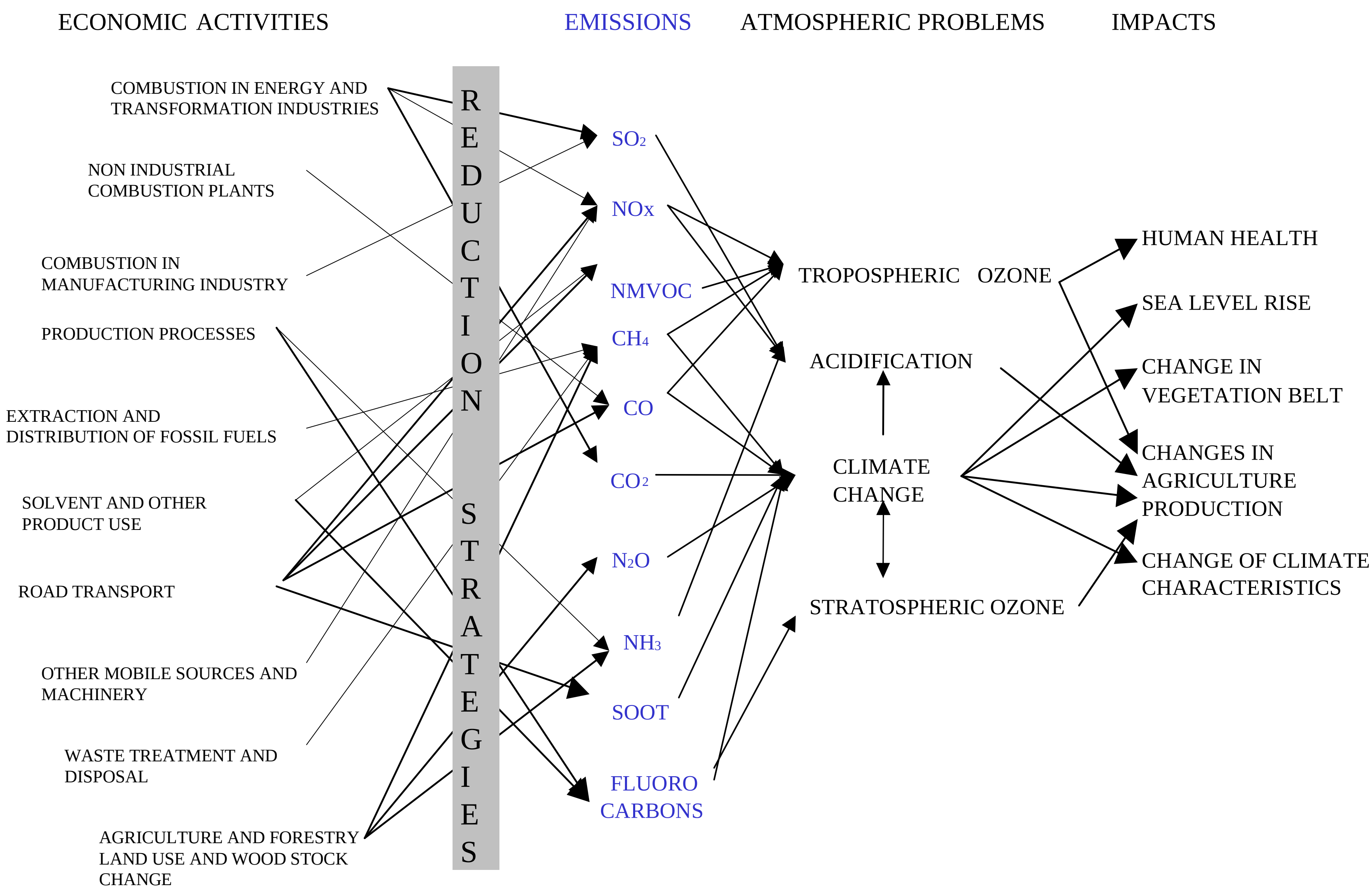
Overview of the presentation

- Introduction
- Purpose of the study
- Comparison of emissions inventory databases
- Comparison of model databases
- Conclusions and Recommendations

Background

- Global warming, acidification, eutrophication, enhanced levels of tropospheric ozone and stratospheric ozone depletion are interrelated problems
- However, these problems are usually studied in isolation
- Emission inventories are usually limited to only one of the problems and ignore interactions
- First step towards an integrated analysis: analyze interactions affecting emissions

Interactions between environmental problems



Purpose of the study

To analyze some basic characteristics and requirements of emission inventories for Europe to be used in integrated assessments that analyze future global warming, acidification, eutrophication and ozone related problems simultaneously

1 Interactions between emissions and underlying processes
2 Existing emissions inventories: comparison of characteristics
3 Comparison of reduction strategies in model databases
4 Basic requirements of emission inventories for integrated analyses in Europe

Four types of interactions between air pollutants

- Human activities giving a rise to emissions of more then one gas

  e.g. energy use is a source of CO_2, NO_x, SO_2, N_2O

- Biogenic and biogeochemical processes underlying emissions of more than one gas

  e.g. denitrification is a source of NO_x and N_2O

- Reduction strategies affecting more then one pollutants

  e.g. switch from coal to natural gas reduces SO_2 and lowering NO_x

- Effects of changes in the environment on emissions

  e.g. global warming increases microbiological production of N_2O

Comparison of emission inventories

- Emission inventories databases
  - EDGAR: Emission Database for Global Atmospheric Research
  - CORINAIR:CO-oRdination d'INformation Environmentale
  - EMEP: Monitoring and Evaluation of the Long Range Transmission of Air Pollutants in Europe
  - IPCC: National Communication Database for GHGs
  - PER: Pollutant Emission Register for the Netherlands
- Model databases
  - IMAGE:Integrated Model to Assess the Greenhouse Effect
  - RAINS:Regional Air pollution INformation System for Europe
  - LOTOS: LOng Term Ozone Simulation model for Europe

Characteristics of emission inventories for Europe

Number of pollutants included range from 1 (METDAT) to ~170 (PER)

Source categories of emissions included range from 20 (LOTOS) to 375 (CORINAIR)

Spatial system boundaries are Europe (EMEP) or world (IMAGE2.0)

Spatial aggregation level is country based (CORINAIR) or gridded (LOTOS)

Temporal system boundaries range from 1 year (LOTOS) to 1890-1995 (EDGAR)

Temporal aggregation level range from annual totals (RAINS) to diurnal profiles (LOTOS)

Uncertainty assessment limited

Methods of emission estimation: mostly emission factor approach

Reduction options for energy sector in models

	Supply Side Options			*Demand Side Options*
	End of pipe technologies	Fuel switch	Energy efficiency improvement	
IMAGE 2.0	SO_2, CO_2, CH_4, N_2O, HFCs, PFCs, SF_6,CO, NMVOC	SO_2, CO_2, CH_4, N_2O, HFCs, PFCs, SF_6, CO, NMVOC	CH_4, CO_2	CH_4, CO_2
RAINS EUROPE 7.2	SO_2, NO_x, NH_3, VOC	-	-	-
RAINS-ASIA	SO_2	SO_2	-	-
LOTOS	-	-	-	-
MERGE	-	CO_2, CH_4, N_2O	CO_2, CH_4, N_2O	CO_2, CH_4, N_2O
MARKAL MATTER	CO_2, CH_4, N_2O	-	CO_2, CH_4, N_2O	CO_2, CH_4, N_2O

Requirements for emission inventories in integrated analyses for Europe

	For Economic Analysts	*For Atmospheric Scientists*	*For Policy Analysts*
Components	Every	Every	Every
Emission sources included	Economic sectors	Point and area sources	Economic sectors/ per fuel type
Spatial system boundaries	Europe	Europe	Europe
Spatial aggregation level	National	Fine grid	Regional
Temporal system boundaries	Historical and future	Historical	Long term historical and future
Temporal aggregation level	Annual	Hourly	Annual
Uncertainties	Medium importance	High importance	Low importance
Reduction strategies	Detailed	Not needed	Detailed

Ideal emission inventory meets all these needs

How far away are the current models?

Characteristics	IMAGE	RAINS	LOTOS	IDEAL
Components	+/-	+/-	+/-	All
Emission sources included	+	+	-	Detailed
Spatial system boundaries	+	+	+	Europe
Spatial aggregation level	-	-	+	Fine grid
Temporal system boundaries	+	+	-	Long term
Temporal aggregation level	-	-	+	Hourly
Uncertainties	-	+/-	-	High
Reduction strategies	+	+	-	Detailed

Conclusions (1)

1 Interactions

- Four types of interactions between air pollution problem exist that affect emissions

2 Emission databases

- Emission database differ considerably with respect to gases included, spatial and temporal characteristics and number of sources included
- Poor uncertainty assessment
- Most emissions are based on simple emission factor approaches

3 Reduction strategies in models

- Models usually do not include both demand and supply side options for a wide range of gases
- Most models do not include interactions between pollutants

Conclusions (2)

4 Requirements for emission data for integrated analyses could be based on the data needs of economic, atmospheric and policy-oriented models

- Atmospheric models: need high resolution temporal and spatial data
- Economic models: need detailed specifications of source categories
- Policy oriented models: need long time datasets and reduction strategies

A consistent dataset meeting all these needs for all compounds may not be easy to achieve

Recommendations

- Linking of existing emission inventories
- Make inventories more flexible
- Soft linking of existing models for the purpose of scenario analyses
- Linking of models for optimization analysis
- Develop a modeling framework for an integrated analysis of different air pollution problems accounting for all interactions between pollutants