

SUMMARY

This Technical Note is dedicated to information processing in Meteorological Synthesizing Centre-East (MSC-E). In the first part of the Technical Note database on Heavy Metals (HM) and Persistent Organic Pollutants (POP) is described. The second part contains the description of MSC-E web site and presentation of information on HM and POP modelling on the Internet.

The database is meant for storage of emission data, measurements, geophysical data, physical-chemical properties of pollutants and modelling results. At the present stage the database provides:

- storage of HM and POP data of measurements in different environmental compartments (air, precipitation, soil, sea water, vegetation etc.);
- storage and processing of HM and POP emission data received from different sources (expert estimates and official data);
- search and retrieval of emission data for modelling;
- search and retrieval of measurement data for the comparison and verification of modelling results;
- realization of different levels of access to the database, data protection against unsanctioned access, data archiving.

The main directions of further database development are the following:

- development of a unit for geophysical data (Land Cover, Soils, LAI etc.);
- development of a unit for physical-chemical properties of considered pollutants (HMs and POPs);
- development of a unit for the storage of modelling results.

The database is currently used by specialists of MSC-E and in future it is planned to make it accessible for EMEP countries and interested experts.

The second part of the note describes a general structure of MSC-E web site and gives the list of basic topics presented by the Centre on the Internet. It may be interesting for Parties to the Convention and specialists working in closely related fields. Comparing to its previous version of MSC-E web site is extended by a number of features: search through the documents stored on the site, registration, subscription to news of the site, discussion forum, etc. According to the recommendations of the Steering Body to EMEP information on pollution of European region by HMs and POPs on MSC-E web site is yearly updated (in graphical and digital format).

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PART 1. DESCRIPTION OF MSC-E DATABASE

Introduction

Nowadays within the framework of EMEP there are several databases. Emission data are stored in Meteorological Synthesizing Centre-West (MSC-W). Measurement data processing and storage are a responsibility of Chemical Co-ordinating Centre (CCC). These databases are oriented only to official information. To fulfill tasks connected with the evaluation of long-range transport of HM and POP additional information is required:

1. For analysis of trends in depositions and concentrations, taking into account possible accumulation of pollutants in different environmental compartments, **it is necessary to have emission data for a long period of time** which official data do not cover;
2. For simulation of POP and HM long-range transport **additional geophysical information** is required (data on land cover, leaf area index (LAI) etc.).
3. For the analysis of modelling results of HM and POP **measurements in different media** (air, soil, vegetation, sea water etc.) are needed. Data of EMEP monitoring network include only measurements in air and precipitation.
4. Taking into account global character of HM and POP distribution **there is a need of data on emissions and measurements outside the geographical scope of the EMEP domain.**

For POP model calculations various emission expert estimates and national measurements which significantly exceed the volume of official ones are used. These data alongside official data should be structured and stored. It

is natural that data received by the Centre have different formats making difficulties in their analysis and processing and slowing down the retrieval of required information. It is necessary not only to collect and structure different data but also to be able to store them in a unified format and to provide fast retrieval and processing.

To design a database for supporting HM and POP modelling available databases both within the framework of EMEP (the emission database of MSC-W and measurement database of CCC) and databases of other international programmes and organizations (CORINAIR, UNEP, IIASA etc.) have been studied.

The database general structure responding the tasks of the Centre is given in the section "General structure of MSC-E database". More detailed description of "Emissions" and "Measurements" units with indication of their functional possibilities is presented in sections "Structure of the "Emissions" unit and "Structure of "Measurements" unit respectively. These sections also include a list of data contained in the database. In the section "Examples of database use" alongside examples of emission and measurement data presentation it is shown a possibility to receive integrated information for a given country. The section "Main results and further development" elucidates further development of the database with indication of priorities. The Annex contains the description of table structures and field implication that may be of interest for specialists engaged in similar work and a short description of the user interface (client part).

In future it is planned to provide an access to this database for interested experts.

1. Database Structure

The database was designed to raise the efficiency of HM and POP modelling. In designing the database we took into account the structure of the MSC-W database on emission (The EMEP/MSW Emission database system, 1998) and the CCC database on measurements (Air quality Databases at NILU). At the same time the MSC-E database has some differences of principle:

- the database **stores special data required for modelling and not included in the MSC-W and CCC** databases (data on physical-chemical properties of different pollutants, emission factors, population density, geophysical data etc.).
- the database is meant to store various **expert estimates, data from other programmes and official data**. The MSC-E database stores data received from various sources (national data, literature sources, Internet etc.). Emission data may be presented in different format and with different spatial resolution.
- **the database is at maximum oriented to countries, i.e. it provides integrated information on each country** (emissions, measurements, modelling results etc.).

At present the volume of the database is more than 550 Mb. For example, the table of gridded emission contains more than 700 thous. records. The database is being further extended by including additional procedures and modules.

1.1. Main Units of the Database

Figure 1 demonstrates a general structure of the database. The main units are "Emissions", "Measurements" and "Modelling results", "Geophysical information" and "Physical-chemical properties of different pollutants".

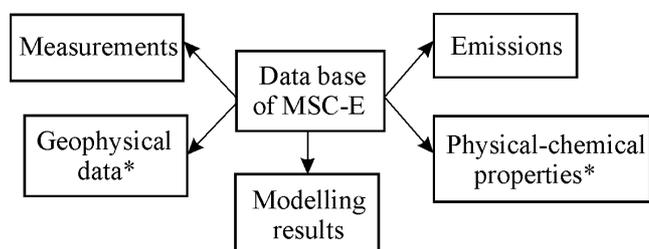


Figure 1. Structure of the MSC-E database
(* indicates units under designing)

At present units "Emissions" and "Measurements" are available, other units are currently under development.

Functional possibilities of the database

- Storage of data on emissions, measurements, modelling results etc. in the unified format;
- Data export/import as ASCII files;
- Archiving of data;
- Data processing (manual and automatic);
- Possibility of data storage with different spatial and temporal scale;
- Data retrieval using complex query;
- Sorting of data using various criteria (by country, pollutant, year etc.);
- Realization of access rights of different levels to data stored in the database;
- Examination of data consistency at different stages of their processing.

1.2. Structure of "Measurements" Unit

The "Measurements" unit is meant for the storage of HM and POP concentrations with

different time scale (annual, monthly, weekly etc.) in various media. To verify MSC-E models, in particular the multi-compartment model of POP long-range transport the pollutants content not only in air and precipitation but their content in other environmental compartments (in soil, vegetation, sea etc.) are required. In this context the following data are considered (Fig.2):

- Concentration in air;
- Concentration in precipitation;
- Concentration in soil;
- Concentration in sea water;
- Concentration in vegetation;
- Deposition fluxes.

The database is oriented to data from different sources of information: primary data from national network stations received on the basis of bilateral co-operation, measurements from international programmes (EMEP, HELCOM, OSPAR, AMAP etc.), from measurement campaigns, databases and publications.

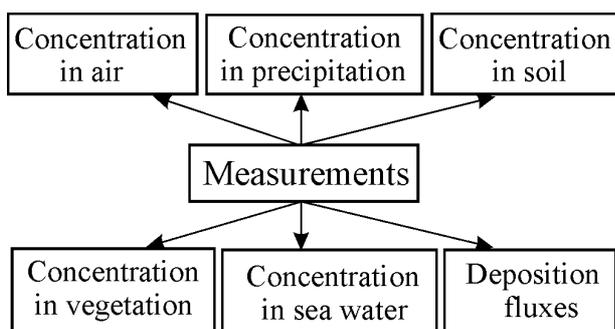


Figure 2. General structure of "Measurements" unit

Functional possibilities

- Storage of measurement data received from different sources;
- Storage of statistically processed and **primary data** (for example data from [Kallweit, 1998, 1999; Holoubek, 2000]);

- Storage of data with different temporal resolution (annual, quarterly, monthly, weekly etc.)
- Search and retrieval of measurement data using complex query (by country, pollutant, monitoring site, time period and by the source of data acquisition);
- Data sorting by different criteria (by country, pollutant, year, monitoring site etc.);
- Data import from ASCII files of prescribed format;
- Data export to ASCII files for further use;
- Viewing the data in graphical form for subsequent data analysis;
- Copying of the selected set.

The database has also dictionaries "Soil types" and "Vegetation types" for storage of measurements for a given soil type or vegetation type.

Allowance is made for the storage of measurements made not only at EMEP stations but at other stations (including mobile platforms what is particularly important for sampling in the marine environment). To input data from the mobile platforms averaged values of geographical latitude and longitude are taken as the sampling point. For measurements from stationary sites longitude and latitude of a station are the geographical co-ordinates for the sampling point.

As reference information which may be useful for analysis of measurement data the dictionary "Measurement methods" was introduced. It contains the information on the media (air, precipitation), pollutant, and sampling method used at a given monitoring station.

Required information on measurements can be retrieved from the database using a

complex query, consisting of the following search conditions:

- name of the data source;
- monitoring station name;
- abbreviated component name (pollutant);
 - time period of measurements;
 - time scale (mean annual, mean monthly values etc.);
- name of the country.

The search is possible by the prescription of one or more conditions and in different regimes (All data, Primary data, and Averaged data). By default, the regime for retrieval of all data sets is used: Data type=All data. To select primary data from database the following regime can be used: Data type=Primary data. Selected data can be exported to ASCII file.

For example, it is necessary to find all mean annual data on Pb air concentrations in 1996 received from CCC. In this case the following search conditions should be used:

- information source = CCC,
- pollutant = Pb,
- category = air concentration,
- time scale = annual data,
- year = 1996.

The results of this query will be presented in the working window.

The different types of data sorting are realized in database (context menu can be activated by a click of the right mouse button over the central part of the window):

- by source,
- by station,
- by component,
- by time scale,
- by total quantity,
- by result quantity.

Measurement data can be imported in different formats. Before import the data are examined for consistency and the results are recorded in the error file.

For user convenience it is possible to view the data in a graphical form (as diagrams) directly in the database without using another application.

At the moment the database contains measurement data on concentrations in air and precipitation of heavy metal (Pb, Ni, Cd, Hg) and POPs received from CCC (for 1987-98), data on POP concentration in soils, sea water, vegetation and deposition fluxes (data sources - national programmes, various reports, articles etc.).

1.3. Structure of "Emissions" Unit

To fulfill the tasks facing the Centre in the field of HM and POP modelling the following structure of the "Emissions" unit was suggested. The main blocks are demonstrated in Figure 3.

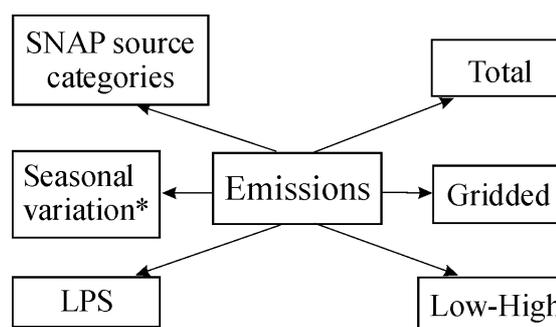


Figure 3. Structure of "Emissions" unit
(*indicates units under designing)

The database stores data on total emissions gridded emissions, low-high total and gridded emissions and emissions from large point sources (LPS emissions). In addition each of the data types can be presented using split by SNAP source categories. In future it is

possible to extend this module and to include seasonal variations of emission.

Note that the "Emissions" unit is also meant for the reception of expert estimates and the official data. The ratio of the volume of expert estimates and official data is as follows:

- for total annual emissions the quantity of data received from official sources to some extent is comparable with the quantity of expert estimates;
- for gridded emissions the official data are practically absent and vice versa there are a number of expert estimates, in particular for POPs (gridded emissions of B[a]P, PCDD/F, HCH).

At present the following emission data are contained in the database (Tables 1 and 2).

Functional possibilities

- Search and retrieval of emission data using complex query (by country, pollutant, time period, data source);
- Data sorting by different criteria (by country, pollutant, year etc.);
- Data import from a file of fixed format (to input official data and expert estimates);
- Data export to ASCII files for further use;
- Linear interpolation of emission data over time (for total and gridded emissions);
- Calculation of total emission with a use of gridded emission;
- Automatic recalculation of gridded emission using the prescribed total value with possible subsequent data replacement;
- Copying of selected data set for further correction.

Table 1. Emission data contained in the database (total emissions)

Pollutant	Years	Reference
PCB	1970, 1975, 1980, 1985, 1990, 1995	<i>J.M.Pacyna et al. [1999]</i>
B[a]P	1970, 1975, 1980, 1985, 1990, 1995	<i>J.M.Pacyna et al. [1999]</i>
γ -HCH	1970 - 1978, 1995	<i>J.M.Pacyna et al. [1999]</i>
Pb, Cd, Hg, As, Cr, Cu, Ni, Zn, Se	1985, 1990 - 1998	Official data
Pb, Cd, Hg, PCB, B[a]P, PCDD/F	1990	<i>J.M. Berdowski et al. [1997]</i>
PCB, HCB, PCDD/F, PAH	1985, 1990 - 1998	Official data
HCH	1990 - 1998	Official data
DDT, Aldrin, Chlordane, Chlordecone, Dieldrin, Endrin, Heptachlor, Hexabromobiphenyl, Mirex, Toxaphene	1990 - 1998	Official data
Paraffins	1990, 1994 - 1998	Official data
Benzo(b)fluoranthene	1994 - 1998	Official data
Benzo[a]pyrene, benzo(k)fluoranthene, indeno(1,2,3-cd)pyrene, benzo(ghi)perylene, fluoranthene	1998	Official data

Table 2. Emission data contained in the database (Gridded emissions)

DESCRIPTION OF MSC-E DATABASE

Pollutant	Years	Reference
Pb, Cd, Hg, PCB, B[a]P, PCDD/F	1990	<i>J.M.Berdowski et al. [1997]</i>
γ -HCH	1970 - 1996	<i>J.M.Pacyna et al. [1999]</i>
HCB, PCDD/F	1970, 1975, 1980, 1985, 1990, 1995	<i>J.M. Pacyna et al [1999]</i>

Below the listed functional possibilities are described in detail. For the search of required information a number of queries are available.

Main queries are:

Total emission - the search is possible by:

- name of a component;
- name of a country;
- source of data acquisition;
- SNAP source category;
- prescribed time period (it is possible to indicate the starting or ending year or both values at the same time in the format "yyyy")

Gridded emission - the search is possible by:

- name of a component;
- grid type (for example, EMEP grid or Latitude/Longitude grid);
- name of a country;
- source of data acquisition;
- SNAP source category;
- prescribed time period (it is possible to indicate the starting or ending year or both values at the same time in the format "yyyy")
- search of a grid cell by prescribed coordinates (X,Y).

Low-High total emission - the search is possible by:

- name of a component;
- name of a country;
- source of data acquisition;
- SNAP source category;
- prescribed time period (it is possible to indicate the starting or ending year or

both values at the same time in the format "yyyy").

Low-High gridded emission - search is possible by:

- name of a component;
- grid type (see above);
- name of a country;
- source of data acquisition;
- SNAP source category;
- prescribed time period (it is possible to indicate the starting or ending year or both values at the same time in the format "yyyy").

Emission of LPS - search is possible by:

- name of a component;
- name of a country;
- source of data acquisition;
- SNAP source category;
- prescribed time period (it is possible to indicate the starting or ending year or both values at the same time in the format "yyyy").

One can make the search by a combination of conditions, i.e. one or several search conditions can be used simultaneously. On the example of Albania we consider possible variants of search and selection of data on cadmium emission.

1. **Query1: Component=Cd** - As a result we retrieve all the data on total Cd emissions from all the countries for all the years received from different sources;
2. **Query2: Component=Cd, Area=Albania** - this query give us all data on total Cd emissions for Albania for all the years received from different sources;

3. **Query3: Component=Cd, Area=Albania, Year from=1980, Year to=1990** - we retrieve total Cd emissions from Albania for 1980-90 received from different sources;
4. **Query4: Component=Cd, Area=Albania, Year from=1980, Year to=1990, Source=Official data** - we retrieve official total Cd emissions from Albania for 1980-90.

The database suggests to use different sorting of information (by year, country, component, grid type) thereby facilitating in many cases the information perception:

- **Order by component** - data will be ordered by the component name;
- **Order by country** - data will be ordered by country name
- **Order by year** - data will be ordered by year;
- **Order by source** - data will be ordered by sources of information;
- **Disorder records** - data will be presented in the order of their location in the database.

It is possible at first to prescribe search conditions and then to make ordering of the selected data over the chosen field. For example, it is necessary to retrieve official data on Cd emissions from Albania and to order them in increasing years. First, we prescribe search conditions (Component=Cd, Area=Albania, Source=Official data) then the selected data are ordered by years (option Order by year).

Selection of data on emission for modelling purposes is automatized. To design various scenarios and data preparation for trend calculations linear interpolation of emission over time and data export in the indicated

format are realized. Qualitative analysis of input information is provided to check data consistency. For instance, checking of a given cell allocation to a selected country or the control of search of duplicated cells with different emission values on the territory of a given country (for one component for one year on the same grid for data from one and the same source) is realized.

To facilitate data input it is possible to import them from the ASCII files realized as dialogue forms allowing:

- to check importing file,
- to form the file of errors,
- to input data on total and gridded emissions in the automatic regime.

1.4. Further Development of the Database

Further development of the database is focused on the units responsible for storage of geophysical data, physical-chemical properties of pollutants, and modelling results.

The unit "Geophysical data" will be used for storage of additional information required for modelling, in particular, data on land cover, vegetation characteristics (LAI, etc.).

The unit "Physical-chemical properties" is meant to store and work with physical-chemical properties of considered HMs and POPs. These data will be used for preparation of model parameterizations.

Modelling results of MSC-E are provided to EMEP countries in annual reports. To systematize this information and to provide the access to computed depositions and concentrations of HMs and POPs additional unit "Modelling results" will be developed. Note, however, that modelling results are available now both for the whole EMEP region and for each EMEP country on MSC-E web

site in graphical and digital form
(www.msceast.org).

2. Examples of the Database Use

In this section we consider examples of use of the database information.

2.1. "Emissions" Unit

The emission data of the database are used for the following purposes:

- 1) preparation of emission files for modelling (emissions can be prepared for all countries and for individual countries (see the section "Structure of the "Emissions" unit);
- 2) analysis of emission temporal variations in different countries (Figs. 4-6);

Figure 4 demonstrates data on B[a]P emissions from Germany [Pacyna *et al.*, 1999]. Analysing the data it is possible to conclude that a general tendency to emission decrease of this pollutant is evident, in particular, during recent years.

Figures 5 and 6 show data on PCB emissions from the United Kingdom ([Pacyna *et al.*, 1999] and official data). For the sake of comparison expert estimates for 1970-95 (26 years) and the official data - for 7 years are presented. To simulate the pollutant accumulation in different environmental compartments the quantity of official data is clearly insufficient. Therefore there is a need of application of expert estimates.

- 3) analysis of spatial distribution of emission on various scales (global, region) (Fig.7).

This case is illustrated by spatial distribution of B[a]P emission in 1990 [Pacyna *et al.*, 1999] with gridsize 50x50 km plotted on the basis of the database information (at first data are exported to the ASCII file then via GIS a map can be constructed).

- 4) linear interpolation necessary for calculations of deposition and concentration

trends under the condition of information availability only for basic years (Fig.5);

- 5) storage and retrieval of emission data on POPs using source categories (Table 3).

- 6) storage and retrieval of data on emission from point sources (Table 4).

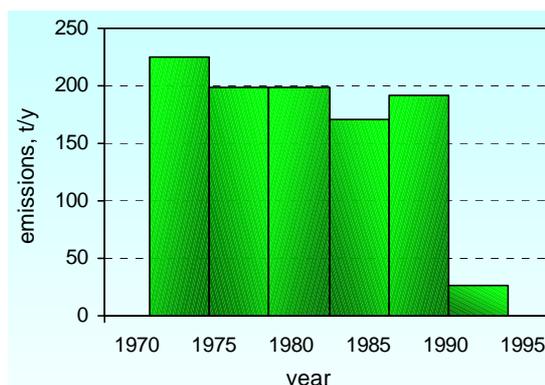


Figure 4. B[a]P emission data for Germany [Pacyna *et al.*, 1999], t/y

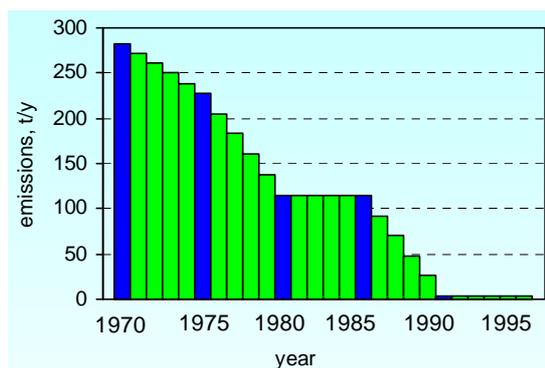


Figure 5. PCB emissions from the United Kingdom (expert estimates [Pacyna *et al.*, 1999] for basic years 1970, 1975, 1980, 1985, 1990, 1995) and linear interpolation, t/y

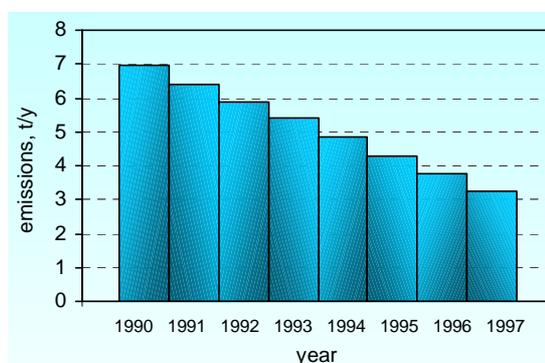


Figure 6. PCBs emission data for United Kingdom (official data), t/y

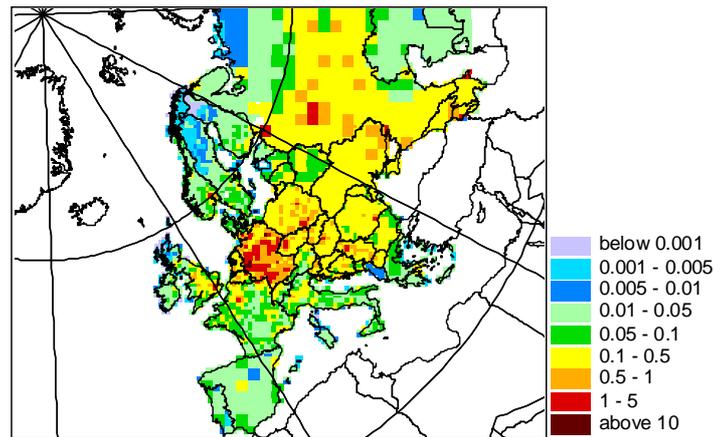


Figure 7. Spatial distribution of B[a]P emissions for 1990 (expert estimates of J.M. Pacyna et al. [1999]), t/y

Table 3. POP emissions split by source categories for Bulgaria, 1995

Source category	HCB, kg	PAH, t	PCDD/F, g I-TEQ	PCB, kg
1. Public power, cogeneration and district heating	-	43.989	141.553	50.803
2. Commercial, institutional and residential combustion plants	-	296.810	201.169	244.200
3. Industrial combustion plants and processes with combustion	-	2.849	17.121	7.553
4. Non-combustion processes	24	30.583	52.336	-
5. Extraction and distribution of fossil fuels	-	-	-	-
6. Solvent use	-	78.000	-	-
7. Road transport	-	56.153	12.723	72.382
8. Other transport	-	3.210	7.104	7.100
9. Waste treatment and disposal	55	9.838	24.031	0.151
10. Agriculture	-	-	-	-
11. Nature	-	-	-	-
TOTAL	79	521.432	456.037	382.189

Table 4. Data on HM emissions from point sources for Bulgaria, 1995

LPS name	X grid	Y grid	Longitude	Latitude	Hg, t/y	Cd, t/y	Pb, t/y	Stack height, m
"Vidahim" Vidin	91	52	26.50	43.55	0.0370	0.0185	0.4319	120
"Svilozha" Svislov	93	55	25.21	43.32	0.0491	0.0268	0.5341	150
PP "Bobovdol"	94	50	23.014	42.16	0.2777	0.0257	0.8471	200
PP "Pernik" Ltd.	94	50	23.03	42.36	0.0807	0.0058	0.0504	120
PP "Sofia-Vrabnitsa" (Liulin)	94	51	23.17	42.42	0.0920	0.0086	0.0111	120
PP "Sofia-Iskar" (Tr. Kostov)	94	51	23.21	42.40	0.0612	0.0593	0.0771	120
PP "Sofia-Serdika"	94	51	23.19	42.43	0.0358	0.0344	0.0447	120
PP "Sofia-Krasna Poliana"	94	51	23.46	42.41	0.0327	0.0320	0.0416	120
PP "Kremikovtsi"	94	51	23.31	42.45	0.0070	0.0064	0.0083	120
"Kremikovtsi" Blast Furnace	94	51	23.31	42.45	0.0321	0.0321	8.0337	48
"Kremikovtsi" Sinter Plant	94	51	23.31	42.45	0.0967	0.3145	23.997	120
PP "Pleven" Ltd.	94	54	24.39	43.20	0.0129	0.0124	0.0161	80
"Plama" PLC Pleven	94	54	24.30	43.20	-	-	-	40
PP "Plama" Pleven	94	54	24.33	43.23	0.0426	0.0423	0.0634	118
PP "Russe East"	94	56	25.56	43.45	0.0694	0.0250	1.0269	120
"MDK" PLC-Pirdop	95	52	24.11	43.41	0.0198	3.9621	19.8105	120

2.2. “Measurements “ Unit

The database information on measurements first of all is meant for the verification of modelling results. Since different selections from the database are envisaged, it becomes possible to compare calculated concentrations

of a pollutant in various compartments (in air, precipitation, sea water etc.). Below it is demonstrated by the comparison of calculated PCB concentrations with observations in different media (Tables 5-8 [*Shatalov et al.*, 2000]).

Table 5. PCB-153 mean annual air concentrations, ng/m³ [*Shatalov et al.*, 2000]

Station	Country	Year	Measurements	Calculation	Meas/Calc.
CZ3	Czech Republic	1997	40.64	9.28	4.4
FI96	Finland	1996	1.52	0.64	2.4
IS91	Island	1995	0.69	0.24	2.9
IS91	Island	1996	1.77	0.30	5.9
IS91	Island	1997	0.27	0.28	1.0
NO42	Norway	1993	0.73	0.19	3.8
NO42	Norway	1994	0.63	0.16	4.0
NO42	Norway	1995	0.32	0.13	2.5
NO42	Norway	1997	0.70	0.12	5.8
SE2	Sweden	1994	5.32	4.08	1.3
SE2	Sweden	1995	4.45	4.17	1.1
SE2	Sweden	1996	2.15	4.32	0.5
SE97	Sweden	1991-1994	2.90	1.16	2.5
DE9	Germany	1995	39.8	5.08	7.8
Augburg	Germany	1992	3.84	20.40	0.2
South United Kingdom	United Kingdom	1990	15	3.48	4.3
Mean			7.55	3.38	2.2

Table 6. PCB-153 mean annual concentrations in precipitation, ng/L [*Shatalov et al.*, 2000]

Station	Country	Year	Measurements	Calculation	Meas/Calc.
IS91	Iceland	1995	0.037	0.003	12.6
IS91	Iceland	1996	0.070	0.004	19.3
IS91	Iceland	1997	0.009	0.003	3.2
DE9	Germany	1996	0.100	0.061	1.6
DE9	Germany	1997	0.428	0.041	10.5
FI96	Finland	1996	1.700	0.230	7.4
CZ3	Czech Republic	1996	0.278	0.030	9.3
Mean			0.37	0.05	7.4

Table 7. PCB-153 concentration in vegetation, ng/g of dry weight [*Shatalov et al.*, 2000]

Station	Country	Year	Measurements	Calculation	Meas/Calc.
SE97	Sweden	1991 - 1994	0.51	1.33	0.38
FIN	Finland	1992	1.52	0.17	9.06
CZ3	Czech Republic	1996	2.76	1.40	1.97
CZ3	Czech Republic	1997	2.85	1.44	1.92
Mean			1.91	1.08	1.77

Table 8. PCB-153 concentration in sea water, ng/L
[Shatalov et al., 2000]

Year	Measurements	Calculation	Meas/Calc.
1989	4.92	10.93	0.45
1991	24.78	6.09	4.07
1992	19.57	5.07	3.86
1993	3.30	4.48	0.74
Mean	13.14	6.64	1.98

2.3. Information per Country

As it was indicated above the MSC-E database is oriented to countries. Therefore it

is possible to provide integrated information on HMs and POPs for each country within EMEP region: modelling results, data on emissions and measurements in different environmental compartments, population density, land cover etc. Partly the information on countries (emissions, measurements and modelling results) since September, 2000 has been presented on the Internet at MSC-E web-site (www.msceast.org). Below on the example of Norway it is demonstrated what information on countries can be retrieved from the database.

NORWAY

a) EMISSIONS OF HEAVY METALS

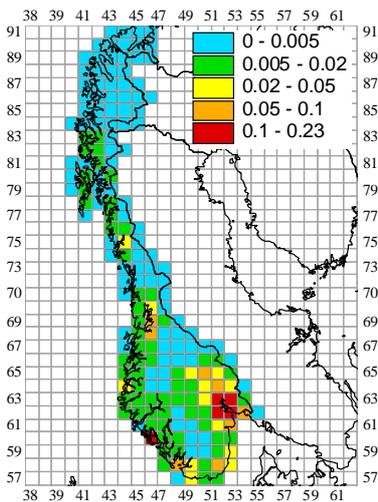


Figure 8. Spatial distribution of Pb emissions in 1998 (50x50 km EMEP grid), t/y

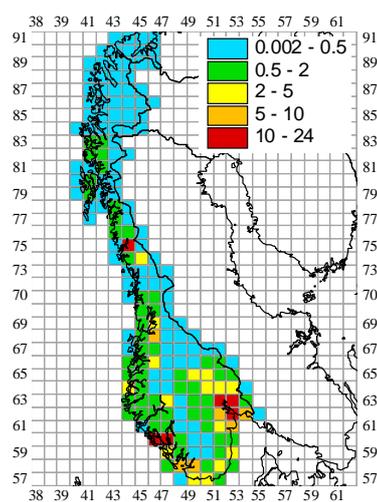


Figure 9. Spatial distribution of Cd emissions in 1998 (50x50 km EMEP grid), t/y

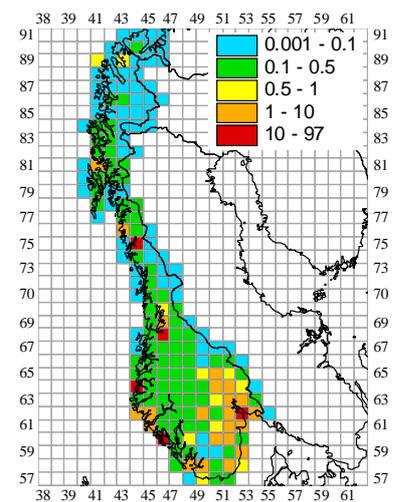


Figure 10. Spatial distribution of Hg emissions in 1998 (50x50 km EMEP grid), t/y

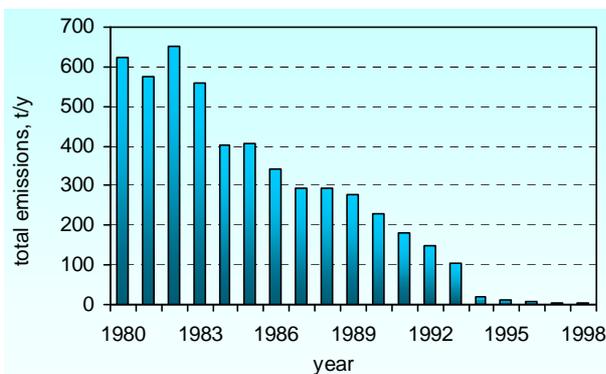


Figure 11. Emission trend of lead - official data for Norway, t/y

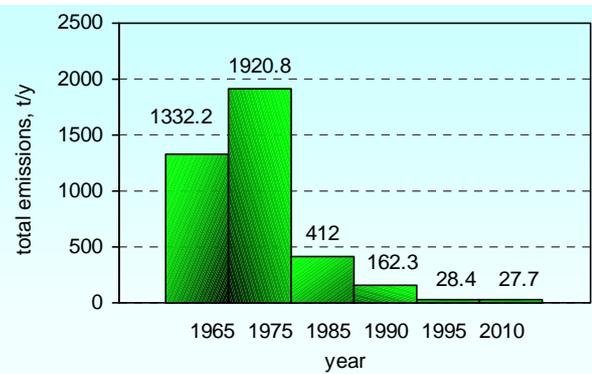


Figure 12. Emission trend of lead - expert estimates for Norway [Pacyna et al., 1999], t/y

b) EMISSIONS OF PERSISTENT ORGANIC POLLUTANTS

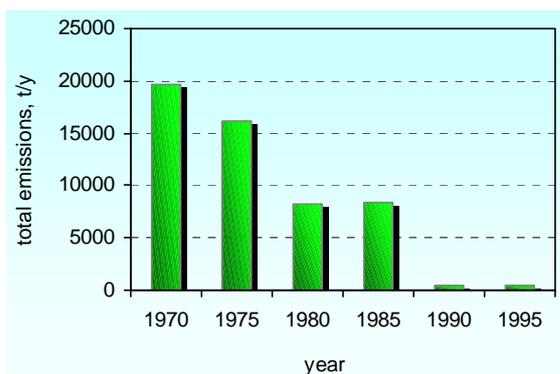


Figure 13. Emission trend of PCB - expert estimates for Norway [Pacyna et al., 1999], kg/y

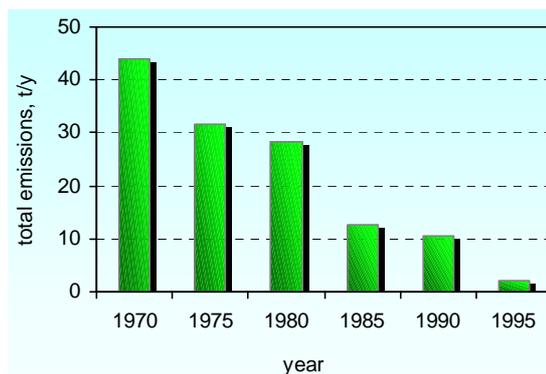


Figure 14. Emission trend of B[a]P - expert estimates for Norway [Pacyna et al., 1999], t/y

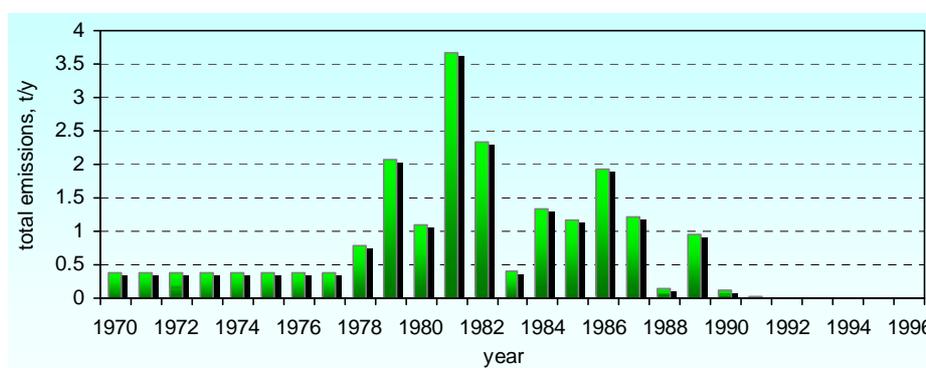


Figure 15. Emission trend of γ -HCH - expert estimates for Norway [Pacyna et al., 1999], kg/y

Modelling results

a) HEAVY METALS

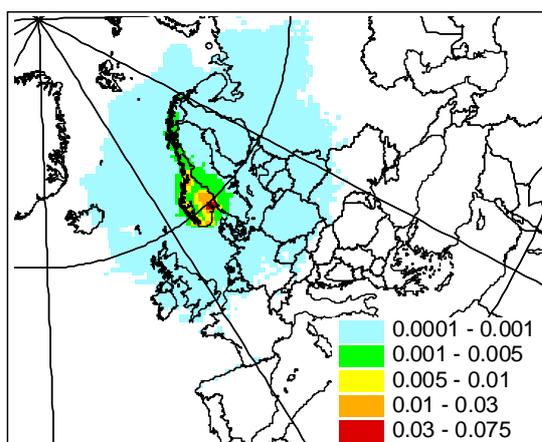


Figure 16. Total deposition of Pb from Norway in the 50 km EMEP grid for 1998, kg/km²/y

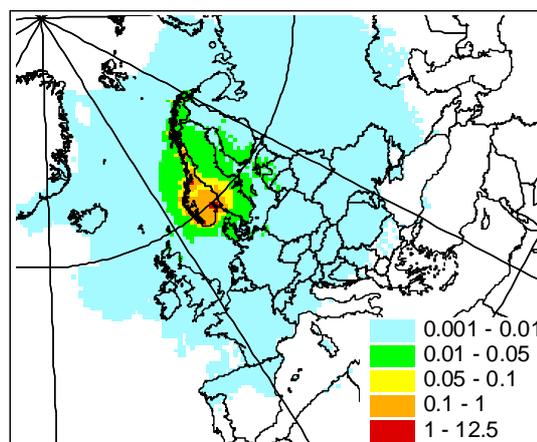


Figure 17. Total deposition of Cd from Norway in the 50 km EMEP grid for 1998, kg/km²/y

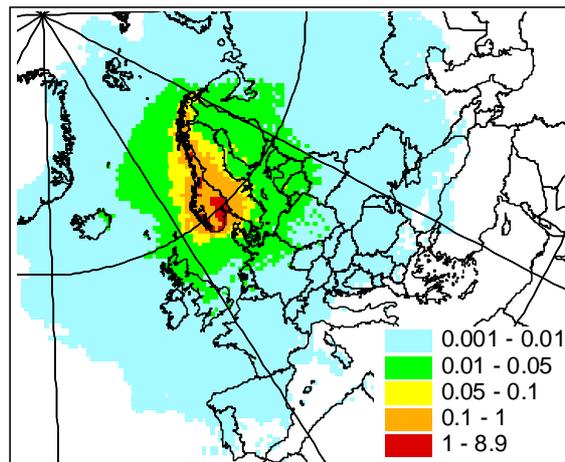


Figure 18. Total deposition of Hg from Norway in the 50 km EMEP grid for 1998, g/km²/y

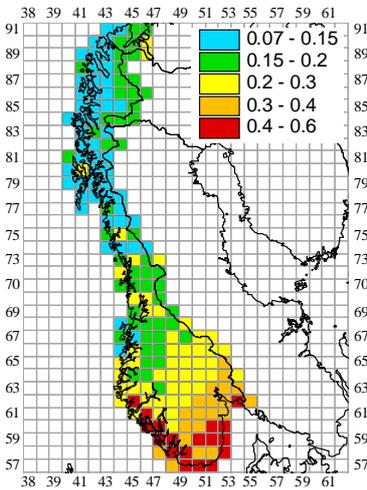


Figure 19. Total deposition of Pb to Norway in the 50 km EMEP grid for 1998, kg/km²/y

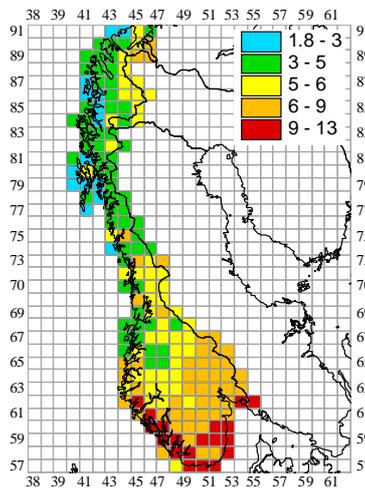


Figure 20. Total deposition of Cd to Norway in the 50 km EMEP grid for 1998, kg/km²/y

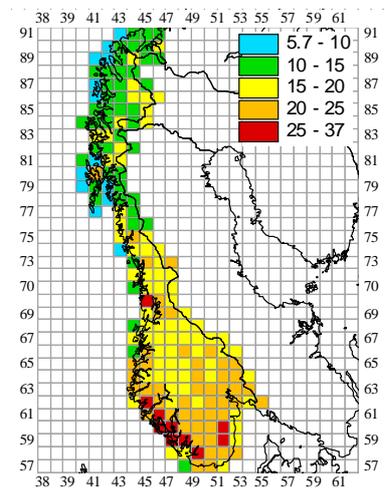


Figure 21. Total deposition of Hg to Norway in the 50 km EMEP grid for 1998, g/km²/y

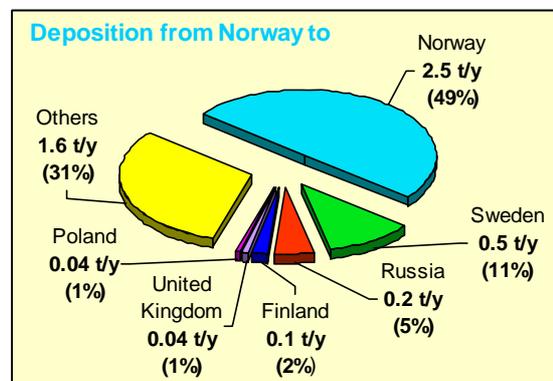
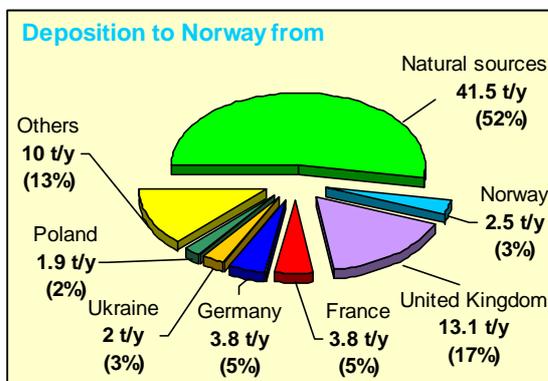


Figure 22. Budget of lead deposition for Norway in 1998

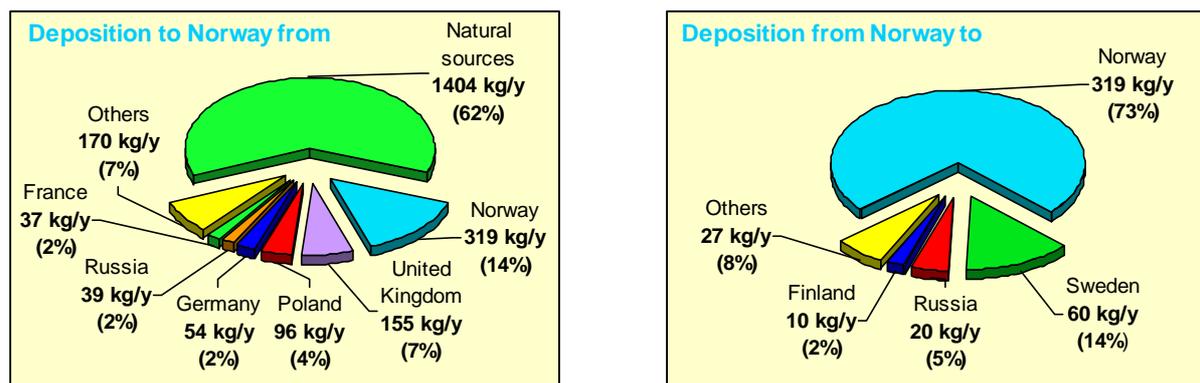


Figure 23. Budget of cadmium deposition for Norway in 1998

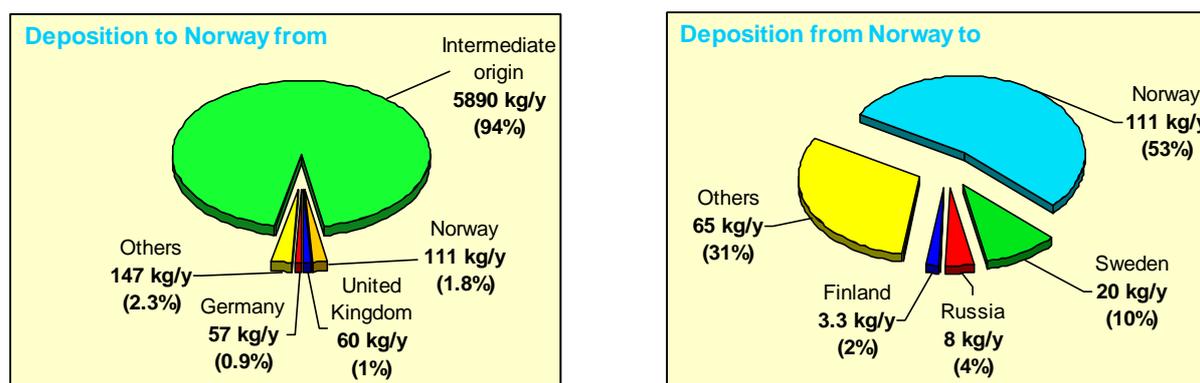


Figure 24. Budget of mercury deposition for Norway in 1998

b) PERSISTENT ORGANIC POLLUTANTS

Table 10. Average POP concentrations and depositions for Norway in 1997

POPs	air ng/m ³	soil ng/g	vegetation ng/g d.w.	sea ng/m ³	deposition density g/km ² /y	total deposition t/y
PCB	0.03	17.90	3.40	36.10	0.6	0.179
B[a]P	0.04	9.70	0.30	147.30	3.9	1.160
γ-HCH	0.04	0.89	1.06	906.27	3.9	1.167

Comparison of modelling results with measurements

a) HEAVY METALS

Table 11. Concentration of heavy metals in air for Norway (1998), ng/m³

Station	Lead		Cadmium		Mercury	
	Observation	Modelling	Observation	Modelling	Observation	Modelling
NO42	0.71	0.33	0.03	0.01	1.55	1.24
NO99	1.84	0.93	0.12	0.01	1.25	1.76

Table 12. Concentration of the heavy metals in precipitation for Norway, 1998

Station	Lead, µg/L		Cadmium, µg/L		Mercury, ng/L	
	Observation	Modelling	Observation	Modelling	Observation	Modelling
NO1	1.59	0.34	0.04	0.01		
NO39	0.19	0.15				
NO93	0.76	0.18				
NO99	2.08	0.37	0.05	0.01		

b) PERSISTENT ORGANIC POLLUTANTS

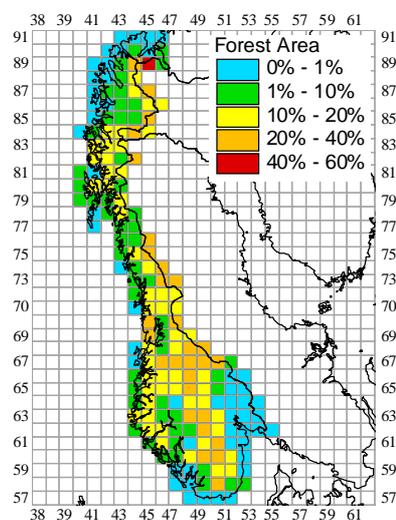
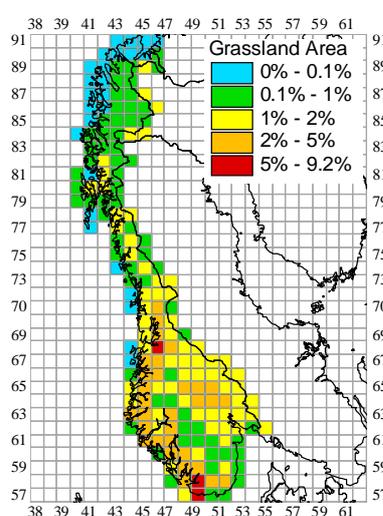
Table 13. Concentration of POPs in air for Norway

POPs	Station	Year	Measurements	Calculation	Meas./Calc.
PCB ₁₃ , pg/m ³	NO42	1993	0.730	0.190	3.80
	NO42	1994	0.630	0.160	4.00
	NO42	1995	0.320	0.130	2.50
	NO42	1997	0.700	0.120	5.80
B[a]P ₁ , ng/m ³	NO42	1994	0.012	0.010	1.20
	NO42	1995	0.012	0.025	0.48
	NO42	1997	0.015	0.010	1.50
γ-HCH, ng/m ³	NO42	1993	0.014	0.001	20.50
	NO42	1994	0.016	0.001	16.30
	NO42	1995	0.013	0.001	20.30
	NO42	1996	0.013	0.002	6.57
	NO42	1997	0.015	0.002	8.75
	NO99	1992	0.086	0.067	1.29
	NO99	1993	0.059	0.101	0.58
	NO99	1994	0.123	0.097	1.27
	NO99	1995	0.065	0.076	0.85
	NO99	1996	0.061	0.093	0.65
	NO99	1997	0.062	0.085	0.73

Table 14. Concentration of POPs in precipitation for Norway, ng/L

POPs	Station	Year	Measurements	Calculation	Meas./Calc.
γ-HCH	NO99	1991	4.05	3.47	1.17
	NO99	1992	5.02	1.59	3.16
	NO99	1993	8.45	3.54	2.38
	NO99	1994	9.98	5.00	2.00
	NO99	1995	5.54	3.81	1.45
	NO99	1996	8.01	7.56	1.06
	NO99	1997	4.89	2.89	1.69

Land Use information was obtained of RIVM

**Figure 25.** Spatial distribution of forests**Figure 26.** Spatial distribution of grassland

(deciduous forests)

PART 2. DESCRIPTION OF MSC-E WEB SITE

Introduction

At present the Internet became easily accessible and convenient means for information exchange and interactive discussion of different issues. In accordance with recommendations of the Steering Body to EMEP, MSC-E and other EMEP Centres put results of their work to the Internet. MSC-E has presented modelling results of long-range transport of Heavy Metals (HM) and Persistent Organic Pollutants (POP) on the Internet. Data on HMs and POPs contain emissions, concentrations and depositions for European region as a whole and for each country of the EMEP domain. In this part of the Technical Note we describe a new version of MSC-E web site, its structure and additional options.

MSC-E presents on web site the following information:

- description of input data used for modelling of HM and POP transboundary transport and depositions;
- estimates of pollution by HMs and POPs both of the whole EMEP area and individual countries;
- information on the development and verification of MSC-E models;
- publications, materials of workshops and conferences on HMs and POPs.

The information presented is meant for the refinement of description of processes occurring with HMs and POPs in different environmental compartments (the atmosphere, soil, sea water, vegetation). The functionality of MSC-E web site is extended with a

possibility of discussion of issues connected with the environmental pollution by HMs and POPs and arrangement of the dissemination of the site news to representatives of countries, interested experts and organizations.

MSC-E Web Site Structure

MSC-E web site consists of a number of sections connected by the navigation system. These sections may be subdivided into three groups:

- *the section for HMs and POPs* contains results of MSC-E activity in this field and the description of models developed in the Centre;
- *information for EMEP countries* - systematized data on emissions, computed depositions and concentrations, measurements for each EMEP country;
- *additional sections* - give information about MSC-E, calendar of events, site news, MSC-E publications and provide a search through the documents on the server, registration and discussion forum.

MSC-E Web Site Home Page

MSC-E web site home page (Fig. 1) is a starting point in navigation through its pages.

This page contains a series of links to the main site sections and links to external sites such as the site of the Convention on Long-Range Transboundary Air Pollution, EMEP web site and the sites of EMEP Centres.

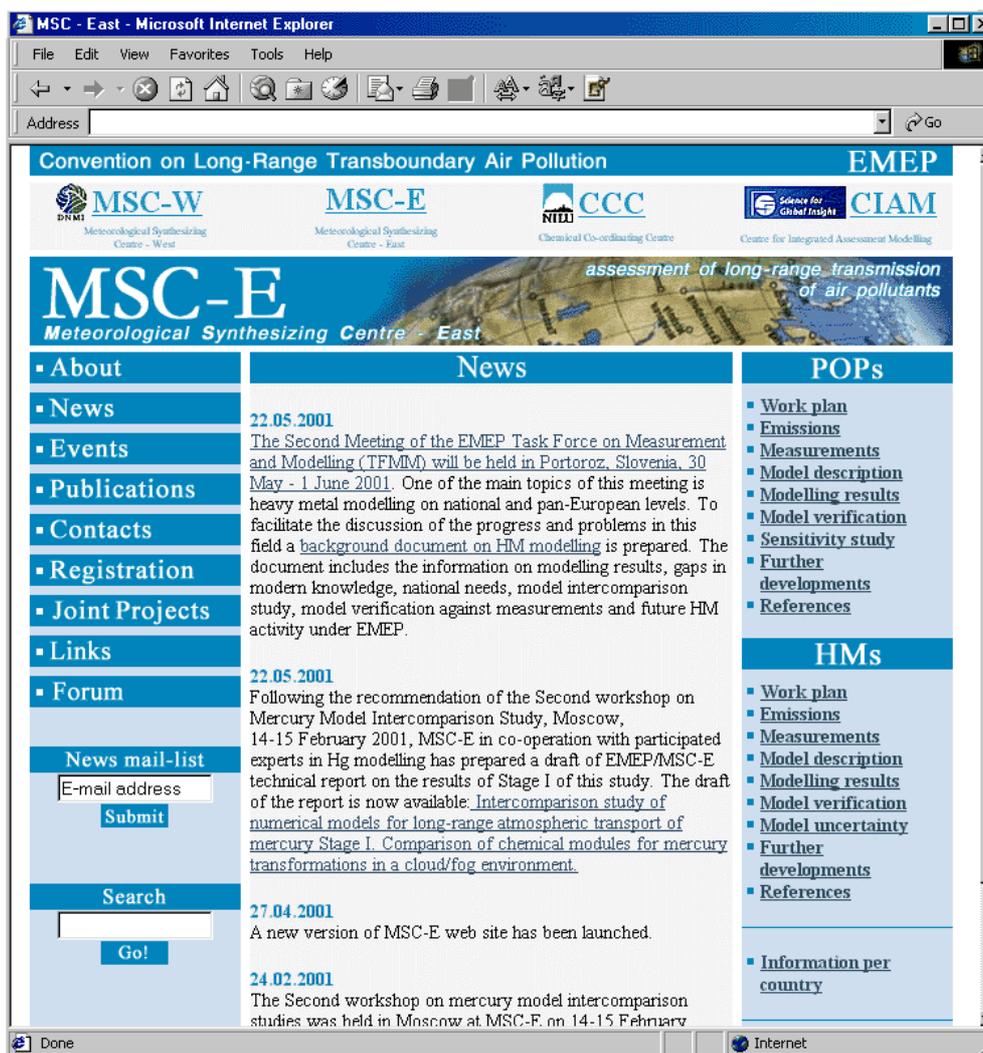


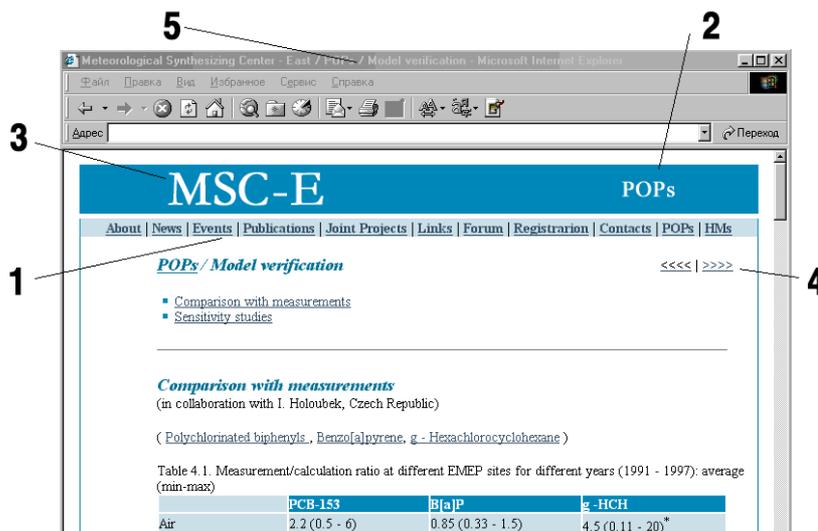
Figure 1. MSC-E web site home page

- The left column provides the links to functional pages: information about MSC-E, news, calendar of events, list of publications, contact information, registration form, information on collaboration with other organizations, links to sites of organizations engaged in the field of HM and POP activity, discussion forum.
- The right column gives links to documents containing: MSC-E work-plans on HMs and POPs, description of models developed in the Centre, input data for modelling, description of MSC-E database, estimates of pollution by HMs and POPs for overall European region and for each EMEP country.
- The central part of the home page contains recent news of MSC-E web site.
- The lower part of the home page provides two short forms: form for searching through the documents on the server and form for subscription to news of the site.

Web Site Navigation System

To ease the browsing through the site each document is supplied by common graphic navigation elements (Fig. 2).

The description of navigation elements in 1. the links to main sections of the site;



accordance with the enumeration in Figure 2 is presented below:

Figure 2. Typical page of MSC-E web site

2. the link to the main document of a given section;
3. the link to MSC-E home page;
4. the links to previous and next pages;
5. the name of a document and its position within the site structure.

MSC-E web site can be found on the Internet at the following address <http://www.msceast.org>. The site is realized using HTML 4.0 and JavaScript 1.4. All server documents can be displayed by all the main programs for viewing HTML documents (Netscape Navigator, MS Internet Explorer, Opera) without loss of information. The program part is realized using PHP and PERL 5. For the operation with data MySQL database is used.

Functional Possibilities

- **ABOUT** - brief information about MSC-E and it's main tasks.
- **NEWS** - MSC-E web site news.

- **EVENTS** - list of conferences and workshops on HMs and POPs and available documents.
- **PUBLICATIONS** - list of the MSC-E reports and publications and a list of references to other publications used in model development and reports.
- **CONTACTS** - MSC-E staff, the list of leading specialists and their contact information.
- **REGISTRATION** - for interaction with representatives and experts of EMEP countries a possibility to register on the server is provided. For this purpose it is suggested to fill out a special form (name, country, organization etc.). The registration is not obligatory.
- **JOINT PROJECTS** - information on MSC-E co-operation with international organizations (HELCOM, AMAP, OSPAR, UNEP, WMO) and with national institutions and experts. This section contains a short

description of joint projects, references to results of the work and publications.

- **LINKS** - references to the Internet pages of other organizations engaged in HM and POP research activity.
- **CONFERENCE** - discussion forum for issues connected with the pollution of environment by HMs and POPs. Representatives of countries, experts and other visitors of the site can ask questions and comment to the previous information.
- **News mail-list** - subscription for the site news. Each visitor may provide his e-mail address and information concerning news of the site will be sent to him.
- **Search** - search through the documents stored on the site by key words.

HM and POP Information

The section of HMs and POPs consists of a set of pages presenting main directions of MSC-E activity, estimates of long-range transport of HMs and POPs, description of the MSC-E models and input data.

- **Work plan** - MSC-E work plan on HMs and POPs approved at the recent session of Steering Body to EMEP.
- **Emissions** - HM and POP emission data used for computations of concentrations and depositions within the EMEP domain. Tables of the HM/Heavy Metals Emission section give data from 1990 to 1998.

The tables demonstrate official data submitted by European countries and expert estimates

(Fig. 3). In addition estimates of lead, cadmium and mercury natural emissions are given as well. There are also data on emission seasonal variations, emission distribution with height and area for 1998 and uncertainties of HM emission estimates. POP official emission data and expert estimates are separated and illustrated in different tables. As expert estimates data of POPCYCLING-Baltic project [Pacyna *et al.*, 1999] for 1970-1995 are presented. They were used for modelling of the transport and depositions of selected POPs (PCBs, B[a]P, lindane). Official emission data can be found on the MSC-W web site (<http://www.emep.int>).

Measurements - the list of EMEP monitoring stations and national network stations. Observation results of these stations were used for the comparison with model calculations and for the analysis of concentration levels of studied pollutants in European regions. Detailed information on measurement data can be found on the web site of Chemical Co-ordinating Centre of EMEP (CCC/EMEP, <http://www.nilu.no/projects/ccc/index.html>)

Model description - description of HM and POP models developed at MSC-E and used for computations of the transport, concentrations and depositions of pollutants considered.

The model description is presented on several pages which contain:

- description of main processes considered in the model;
- description of modelling domain;

<i>HM/ Heavy Metals emission</i>									
<<<< back									
Table 2. Anthropogenic lead emissions to the atmosphere in European countries, t/yr.									
Country	1990	1991	1992	1993	1994	1995	1996	1997	1998
Albania	113	97	81	65	49	33	32	30	29
Armenia ^a	11	1	1	1	0	0	0	0	0
Austria	201					38	38	37	36
Azerbaijan								139	140
Belarus	798					148	46	42	41
Belgium ^b	601	218	230	230	325	336	302	291	210
Bosnia&Herzegovina						39	38	37	35
Bulgaria	436					297	279	231	251
Croatia	466					264	268	190	183
Cyprus	81	63	66	69	68	67	67	72	69
Czech Republic	269	240	247	232	202	180	165	180	169
Denmark	124				46	43	20	9	8
Estonia	172	154	78	69	70	52	43	33	21
Finland	326	247	175	100	60	57	35	19	20
France	4576	3080	2210	1946	1768	1605	1413	1296	1190
Georgia								107	108

- model parameterization for studied pollutants.

Figure 3. Data on lead emissions of EMEP countries for 1990-98, t/y (official data are shaded)

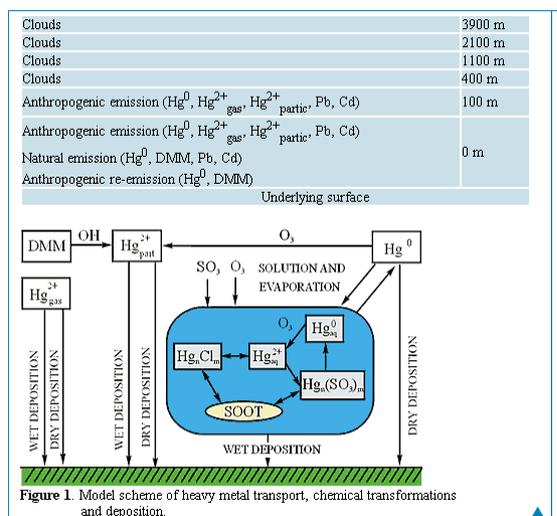


Figure 4. Structure of MSCE-HM model

As an example, Figure 4 shows the structure of MSCE-HM modelling domain and chemical transformation scheme applied.

Modelling results - brief description of modelling results obtained by MSC-E and published in reports [Ilyin *et al.*, 2000; Shatalov *et al.*, 2000]. Results of HM modelling include data on concentrations and deposition of lead, cadmium and mercury in 1997 and 1998. The MSCE-HM model provides “country-to-country” matrices, i.e. it calculates the contributions of national and external emission sources to HM depositions in each country of the EMEP region. In the section **Source-receptor relationships** one can find the results of such computations for lead, cadmium and mercury for 1998 exemplified by several European countries. The detailed information for each EMEP country is put to MSC-E web site in the section **Information per country**. POP modelling results contain data on PCBs, B[a]P and lindane depositions and concentrations in different media for 1998. The analysis of long-term trends of the content of these pollutants in air, soil, vegetation and sea water during 1970-98 is presented.

Model verification - the comparison of calculated HM and POP concentrations in air and precipitation with measurements of EMEP monitoring stations and national stations, in particular those of Germany.

Further development - main directions of further MSC-E activity in the field of HM and POP transport model development for the evaluation of the environment pollution.

Analysis of model uncertainty - analysis of MSCE-HM sensitivity to variations of input parameters and conclusions concerning uncertainties of obtained model results.

Sensitivity study - analysis results of MSCE-POP model sensitivity to a number of processes such as POP transport by sea currents, dry deposition of POP aerosol phase to forests and to a number of other processes.

References - the list of publications used for model development and simulation of HM and POP transport and deposition.

Brief Description of the Database

The page **MSC-E database** briefly describes the structure of MSC-E database on HM and POP. This document provides the information on what kind of data are currently available in the database. Part of these data, in particular emission and measurement data, modelling results, are presented on the site so far. Other data can be received from the database by request.

Information per Country

In this section information about pollution by HMs and POPs for each country - a Party to the Convention - is presented. On relevant pages per each country official data and

expert estimates of emissions as well as calculated depositions and concentrations, their spatial distribution, deposition totals and concentrations in air and precipitation measured at monitoring stations of a given country are presented in comparison with modelling results. The information has the following structure:

Heavy Metals

- HM emission distribution from sources of a given country with spatial resolution 50x50 km (in graphical and digital form);
- HM annual emission totals of a given country for the period 1990-98;
- HM deposition fields for 1998 with spatial resolution 50x50 km (in graphical and digital form) both on the territory of a given country and on territories of other countries from its national sources;

contributions to them of national and of other European countries are demonstrated. HM and POP

- Contribution of European countries to HM depositions on the territory of a given country for 1997 and 1998;
- Contribution of sources of a given country to depositions to other European countries for 1997 and 1998;
- Comparison of model results against measurements for 1997 and 1998.

Persistent Organic Pollutants

- POP emission totals of a given country for the period 1990-98;
- Mean annual concentrations in air, soil, vegetation and computed depositions of selected POPs for 1997;
- Comparison of measurements with POP modelling results.

MAIN RESULTS AND FURTHER DEVELOPMENT

MSC-E Database

The database described in the Technical Note is being developed to provide specialists with required information for HM and POP modelling and at the current stage it allows:

- storage of HM and POP emission data received from different sources (expert estimates and official data);
- storage of HM and POP concentrations measurement data for different environmental compartments (air, precipitation, soil, sea water, vegetation etc.);
- search and retrieval of emission data for their use in modelling;
- search and retrieval of measurement data for the comparison and analysis of modelling results;
- import and export of data;
- realization of different levels of access to the database, data protection against unsanctioned access, data archiving.

Further database development is planned in the following directions:

- developing of a unit for geophysical data storage (Land Cover, Soils, LAI etc.);
- developing of a unit for the storage of physical-chemical properties of considered pollutants (HMs and POPs);
- developing of a unit of the storage of modelling results.

It is also planned to provide an access to information in the database on request of interested experts, countries and organizations (emissions, measurements, modelling results in graphical and digital formats).

MSC-E Web Site

In order to present input data and modelling results to representatives of EMEP countries and a wide range of experts MSC-E web site has been developed. This site contains the following information:

- description of MSC-E HM and POP models;
- description of input data used in calculation of transboundary transport;
- calculated HM and POP concentrations and depositions in European region and individual EMEP countries;
- publications, materials of HM and POP workshops and conferences.
- In future MSC-E is planning:
 - to extend the volume of information on HMs and POPs presented on the web site for EMEP countries;
 - to provide information on the results of the MSC-E collaborative work with other organizations involved in the field of HM and POP investigations.

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ANNEX A

The database was realized on the basis of “client-server” technology. The following program means were used: MS SQL Server 7.0 (server part), Borland Delphi 4.2-5.0 (client part). For database design the ER Win 3.51 was used.

Below the structure of tables in use is briefly described.

A.1 Primary Tables (Dictionaries)

To facilitate the database filling and to accelerate the retrieval the following tables-dictionaries are implemented:

- **Area** - dictionary of countries;
- **CompCategory** - dictionary of component categories;
- **Component** - dictionary of components;
- **Category** - dictionary of categories;
- **TimeScaling** - dictionary of time scale;
- **GridType** - dictionary of grid types;
- **Station** - dictionary of measurement stations;
- **MeasUnit** - dictionary of measurement units;
- **LPS** - dictionary of Large Point Sources;
- **SNAP level** - dictionary of SNAP categories;
- **DataType** - dictionary of data types;
- **GridAllocation** - dictionary of area coverage by the grid;
- **Population** - dictionary of population density;
- **Source** - dictionary of information sources;
- **Method** - measurement method used at a given station for a given pollutant;
- **Soil** - dictionary of soil types;
- **Vegetation** - dictionary of vegetation types;
- **Flux** – dictionary of types of fluxes.

Below we describe the dictionaries with indication of each field meaning.

Area

- this table describes geographical regions. Normally each region is an individual country. Each region can contain one or more sub-regions, by default each region is contained inside itself.

Field	Field description
Area code	Country code (Primary key)
Includeln	Code of region including this country or region (Foreign key)
Full Name	Full name of country
Short_Name	Short name of a country (its ISO code)
Comment	Comments

CompCategory

- this table contains information on component categories (selected HMs and POPs) for which data on emissions, measurements or modelling results are available.

Field	Field description
CompCateg_Code	Component category code (Primary key)
Includeln	Component category code including a given category (FOREIGN KEY)
Description	Full name of the component category
Comment	Comments

Component

- this table contains considered pollutants for which, data on emissions, measurements or modelling results are available.

Field	Field description
Comp_Code	Component code (Primary key)
CompCateg_Code	Component category code (FOREIGN KEY)
Chem_Elem_Code	Short name of a component
Name	Full name of a component
Comment	Comments

Category

- this tables contains data on categories of emission and measurement data. For measurement data it means compartments where measurements were carried out.

Field	Field description
Categ_Code	Category code (Primary key)
Short name	Short name of the category
Description	Full name of the category
TableName	Special field for emission table name
Comment	Comments

TimeScaling

- the table contains data on time scales.

Field	Field description
Scal_code	Code of time scale (Primary key)
Description	Description of the time scale
Comment	Comments

GridType

- the table describes different types of grids. The table stores all characteristics for the selected grid type: number of cells along X and Y directions, gridsize, the North Pole coordinates in a given grid etc.

Field	Field description
Grid_Code	Grid code (primary key)
Descript	Grid description
Xmin	Minimum value along X coordinate
Xmax	Maximum value along X coordinate
Ymin	Minimum value along Y coordinate
Ymax	Maximum value along Y coordinate
Hx	Gridsize along X
Hy	Gridsize along Y
Xpolus	X coordinate of the pole
Y polus	Y coordinate of the pole
MapFactor	Map factor
Projection	Type of projection
Comment	Comments

Station

- the table contains data on stations where the measurements were carried out. Data on stationary and mobile platforms are stored. For stationary stations there is information on its geographical coordinates, country where it is located.

Field	Field description
Stat_Code	Station code (Primary key)
Area_Code	Country code (FOREIGN KEY)
Short_Name	Abbreviated name of the station
Full_name	Full name of the station
DateStart	Date of station establishment
DateEnd	Date of station elimination
Latitude	Geographical latitude of station (for stationary sites only)
Longitude	Geographical longitude of station (for stationary sites only)
Height	Height (m) of station location (for stationary sites only)
Fixed	Flag ("Y"- for stationary stations, "N"- for mobile platforms)
Comment	Comments

MeasUnit

- the table contains units of data stored in database (kg/m³, t/y etc.).

Field	Field description
Unit_Code	Code of measurement units (Primary key)
Descript	Description of measurement units
Coefficient	Rescaling coefficient

SNAPLevel

- this table is an analogue of SNAP classification of emission sources and it contains all categories. Each of them may contain one or more subcategories without limitation of the hierarchy depth. The following meanings of Descript field can serve an example for this table:

- Combustion in energy and transformation industries;
- Non-industrial combustion plants;
- Combustion in manufacturing industries;

- Production process etc.

Field	Field description
Level_code	Level code (Primary key)
Descript	Level description
Includeln	Code of the above level
LevelNumber	Level number in the database
SNAPLevel	SNAP-code

Data Type

- here we store the description of different types of emission (special table). It can be exemplified by the following:

- Total emission;
- Gridded emission;
- Low-High emission;
- Emission of LPS etc.

Field	Field description
DataType_Code	Data type code (Primary key)
Descript	Description of data type
TableName	Table name of data storage
Comment	Comment

LPS

- the table contains data on large point sources (LPS) with their names, geographical coordinates etc.

Field	Field description
LPS_Code	Point source code (Primary key)
Area_Code	Country code (FOREIGN KEY)
Name	Point source name
Latitude	Geographical latitude
Longitude	Geographical longitude
Height	Height of the emission point (m)
ExitSurface	Exit surface of the stack (m ²)
Speed	Speed of the exhaust gases (m/s)
Temperature	Temperature of the exhaust gases (degrees Kelvin)
Comment	Comment

GridAllocation

- the table contains information on the coverage of the selected country by selected grid.

Field	Field description
Alloc_Code	Record code (Primary key)
Area_Code	Country code (FOREIGN KEY)
Grid_Code	Grid code (FOREIGN KEY)
Xgrid	X-coordinate of cell
Ygrid	Y-coordinate of cell
Fraction	Coverage of the country by grid in a given cell

Population

- the table gives data on population density of the selected country in the selected cell. It is planned to use these data for calculations of gridded emission using its total value.

Field	Field description
Pop_Code	Record code (Primary key)
Source_Code	Source code (FOREIGN KEY)
Unit_Code	Unit code (FOREIGN KEY)
Area_Code	Country code (FOREIGN KEY)
Grid_Code	Grid code (FOREIGN KEY)
Xgrid	X- coordinate of cell
Ygrid	Y- coordinate of cell
Density	Population density in the cell

Source

- this table is meant for storage of data on information sources. For example, it may be the MSC-W report on emission data or a file with measurement data from CCC etc. The indication of source type can be found in the Type field (it may be a report, article, file etc.). The source is described in the Description field (the name of a report, article or file).

Field	Field description
Source_Code	Source code (Primary key)
Type	Source type (article, file, report etc.)
Description	Full name of the source
Year	Year of publication (for reports and articles)
Data_Type	Data type (flag) "E"-emission data, "M"-measurements, "P" - density of population etc.
Comment	Comments

Method

- this dictionary has information on sampling methods used at a given monitoring station.

Field	Field description
Method_Code	Method code (Primary key)
Categ_Code	Category key (FOREIGN KEY)
Component	List of pollutant for which this method is used
Description	Full name of the method
Comment	Comments

Soil

- this is a dictionary of soil types. Soil type may be split into subtypes (any level of completeness is possible).

Field	Field description
Soil_Code	Soil type code (Primary key)
Description	Soil type description
Includeln	Soil type code including this type (FOREIGN KEY)
Comment	Comments

Vegetation

- this is a dictionary of vegetation types. Vegetation types may be divided into subtypes (any level of completeness is possible). For example, vegetation type = deciduous forest>subtype = birch-> subtype = Leaves.

Field	Field description
Vegetation_Code	Vegetation type code (Primary key)
Description	Description of vegetation type
Includeln	Code of the vegetation type including a given type (FOREIGN KEY)
Life_Period	Life period
Comment	Comments

Flux

- dictionary of deposition flux types. At present we consider: wet deposition, dry deposition, and bulk deposition.

Field	Field description
Flux_Code	Flux type code (Primary key)
Description	Description of the flux type
Comment	Comments

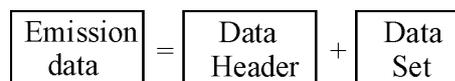
A.2 Structure of the “Emissions” unit tables

At present the database contains the following data on emission:

- Total emission;
- Gridded emission;
- Low-High emission (total);
- Low-High gridded emission;
- LPS emission.

Each set of emission data is split to SNAP source categories.

The storage of emission data has the following structure:



The Data Header (table EmisHeader) contains general information on the source of data acquisition, component, grid, year etc. Data set tables (tables EmisTotal, EmisGrid, LHEmis, LPSEmis) contain emission data. Below the list of tables with the description of each field is given.

Secondary tables

- **EmisHeader** - header (brief description of the emission data set)
- **EmisTotal** - total emission
- **EmisGrid** - gridded emission
- **LHEmis** - Low-High total emission
- **LHGEmis** - Low-High gridded emission
- **LPSEmis** - emission from point sources.

EmisHeader

- this table gives a description of emission data sets.

Field	Field description
EmisH_Code	Data set code (Primary key)
DataType_Code	Data type code (FOREIGN KEY)
Level_Code	Source category code (FOREIGN KEY)
Grid_Code	Grid code (for gridded emission only)
Unit_Code	Code of measurement units (FOREIGN KEY)
Comp_Code	Component code (FOREIGN KEY)
Area_Code	Country code (FOREIGN KEY)
Source_Code	Data source code (FOREIGN KEY)
Year	Year (in format "yyyy")
Comment	Comments

EmisTotal

- the table stores data on total emission for different countries.

Field	Field description
EmisT_Code	Record code (Primary key)
EmisH_Code	Data set code (FOREIGN KEY)
EmisTotal	Emission value

EmisGrid

- the table contains data on gridded emission.

Field	Field description
EmisG_Code	Record code (Primary key)
EmisH_Code	Data set code (FOREIGN KEY)
Xgrid	X - coordinate of the cell
Ygrid	Y - coordinate of the cell
EmisGrid	Emission value in the cell
NewValue	Special field (for emission rescaling over grid)

LHEmis

- the table gives high-low total emission.

Field	Field description
LHEmis_Code	Record code (Primary key)
EmisH_Code	Data set code (FOREIGN KEY)
LowEmis	Emission value at height below 100 m
HighEmis	Emission value above 100m

HGridEmis

- the table stores high-low gridded emission.

Field	Field description
EmisG_Code	Record code (primary key)
EmisH_Code	Data set code (FOREIGN KEY)
Xgrid	X- coordinate of the cell
Ygrid	Y- coordinate of the cell
LowGridEmis	Emission value in the cell below 100 m
HighGridEmis	Emission value in the cell above 100 m

LPSEmis

- emission from point sources.

Field	Field description
LPSEmis_Code	Emission code (Primary key)
EmisH_Code	Data set code (FOREIGN KEY)
LPS_Code	Point source code (FOREIGN KEY)
EmisValue	Emission value

A.3 Structure of "Measurements" unit tables

The database stores measurement data on concentrations in different compartments. The storage of measurement data has the following structure:

$$\boxed{\text{Measurement data}} = \boxed{\text{Data Header}} + \boxed{\text{Data Set}}$$

The data set (MeasHeader table) presents general information on the source of data acquisition, component, grid, year etc. The data set (table MeasInAir, MeasInPrec, MeasInSea, MeasInVeg, MeasFlux) stores measurement data. Below one can find the description of each table.

Secondary tables

- **MeasHeader** - header (brief description of the data set);
- **MeasInVeget** - concentrations in vegetation;
- **MeasInSoil** - concentrations in soil;
- **MeasInAir** - concentrations in air;
- **MeasInPrecip** - concentrations in precipitation;
- **MeasInSea** - concentrations in sea water;
- **MeasFlux** - data on deposition fluxes.

MeasHeader

- header (brief description of the measurement data set).

Field	Field description
MeasH_Code	Measurement data set code (Primary key)
Categ_Code	Category code (FOREIGN KEY)
Comp_Code	Component code(FOREIGN KEY)
Stat_Code	Station code (FOREIGN KEY)
Scal_Code	Time scale code (FOREIGN KEY)
Unit_Code	Code of unit (FOREIGN KEY)
Source_Code	Data source code (FOREIGN KEY)
DateStart	Date of the beginning of measurements in a given data set
DateEnd	Date of finishing measurements in a given data set
QuantTotal	Total number of measurements in a given data set
QuantResult	Number of valid measurements in a given data set (Flag Valid="Y")
Completeness	Data completeness (ratio of measurements performed to potentially possible measurements during the same period)
Detection_Limit	Detection limit of data in a given data set
Precision	Measurement precision in a given data set (deviation value or confidential level)
PrimaryData	Flag ("Y" –primary data, "N" - averaged data)
Comment	Comments

MeasInVeget

- measurements of concentrations in vegetation.

Field	Field description
MeasInVeget_Code	Record code (Primary key)
MeasH_Code	Code of measurement data set (FOREIGN KEY)
Vegetation_Code	Code of vegetation type (FOREIGN KEY)
DateMeas	Measurement date
Veget_Period	Vegetative period
Latitude	Geographical latitude of sampling point
Longitude	Geographical longitude of sampling point
MeasValue	Measured value (concentration in vegetation)
Valid	Flag (whether measured values can be compared with modelling results Y/N)
Comment	Comments

MeasInSoil

- concentration of a pollutant in soil.

Field	Field description
MeasInSoil_Code	Record code (Primary key)
MeasH_Code	Code of measurement data set (FOREIGN KEY)
Soil_Code	Soil type code (FOREIGN KEY)
DateStart	Date of the beginning of sampling
DateEnd	Data of sampling termination
Depth	Sampling depth
Thickness	Layer depth of sampling
Latitude	Geographical latitude of sampling point
Longitude	Geographical longitude of sampling point
MeasValue	Measured value (concentration in soil)
Valid	Flag (whether measured values can be compared with modelling results Y/N)
Comment	Comment

MeasInAir

- measurements of a pollution concentration in air.

Field	Field description
MeasInAir_Code	Record code (Primary key)
MeasH_Code	Code of measurement data set (FOREIGN KEY)
DateStart	Date of the beginning of sampling
HourStart	Time of the beginning of sampling
DateEnd	Date of sampling termination
HourEnd	Time of sampling termination
Latitude	Geographical latitude of sampling point
Longitude	Geographical longitude of sampling point
MeasValue	Measured value (concentration in air)
Valid	Flag (whether measured values can be compared with modelling results Y/N)
Comment	Comments

MeasInPrecip

- measured concentrations in precipitation.

Field	Field description
MeasInPrec_Code	Record code (Primary key)
MeasH_Code	Code of measurement data set (FOREIGN KEY)
DateStart	Date of the beginning of sampling
HourStart	Time of the beginning of sampling
DateEnd	Date of sampling termination
HourEnd	Time of sampling termination
PrecipInCollection	Precipitation amount in sampler
PrecipInDevice	Precipitation amount in measuring device
Latitude	Geographical latitude of sampling point
Longitude	Geographical longitude of sampling point
MeasValue	Measured value (concentration in precipitation)
Valid	Flag (whether measured values can be compared with modelling results Y/N)
Comment	Comments

MeasInSea

- measured concentrations in sea water.

Field	Field description
MeasInSea_Code	Record code (Primary key)
MeasH_Code	Code of measurement data set (FOREIGN KEY)
DateStart	Date of the beginning of sampling
DateEnd	Date of sampling termination
Depth	Sampling depth (m)
Temperature	Mean temperature of sampled water
Latitude	Geographical latitude of sampling point
Longitude	Geographical longitude of sampling point
MeasValue	Measured value (concentration in sea water)
Valid	Flag (whether measured values can be compared with modelling results Y/N)
Comment	Comments

MeasFlux

- measured values of pollutant deposition fluxes.

Field	Field description
MeasFlux_Code	Record code (Primary key)
MeasH_Code	Code of measurement data set (FOREIGN KEY)
Flux_Code	Code of deposition flux type (FOREIGN KEY)
DateStart	Date of sampling beginning
DateEnd	Data of sampling termination
Latitude	Geographic latitude of sampling point
Longitude	Geographical longitude of sampling point
MeasValue	Measured value
Valid	Flag (whether measured values can be compared with modelling results Y/N)
Comment	Comments

A.4. Brief description of the user interface

The purpose of the database designer was to provide users with a convenient interface for operation with data. The main items of menu are duplicated by speed buttons (Fig. A.1).

Main items of the menu:

- **"Measurements"** - operation with measurement data,
- **"Emissions"** - operation with emission data,
- **"Dictionaries"** - operation with dictionaries,
- **"Windows"** - operation with windows (window minimization, ordering, arranging by cascade etc.),
- **"Information"** - information about a program.

As an example figure A.1 demonstrates the window when operations are being made with gridded emissions. In the upper part of the

window search conditions are prescribed alongside a possibility of data sorting (order by component, order by year, order by area, order by grid type, disorder) that facilitates the information perception.

In the right part of the window there are buttons allowing to manipulate with the database. For example:

- **Insert** - insertion of a new record,
- **Edit** - editing the record,
- **Delete** - delete the record,
- **Copy** - record copying,
- **View** - viewing of the selected data set,
- **FromFile** - data import from ASCII file,
- **ToFile** - data export to ASCII file,
- **Synchronize** - synchronization of gridded emissions with total emission values,
- **Interpol** - linear interpolation over time,
- **Model** - preparation of data for modelling etc.

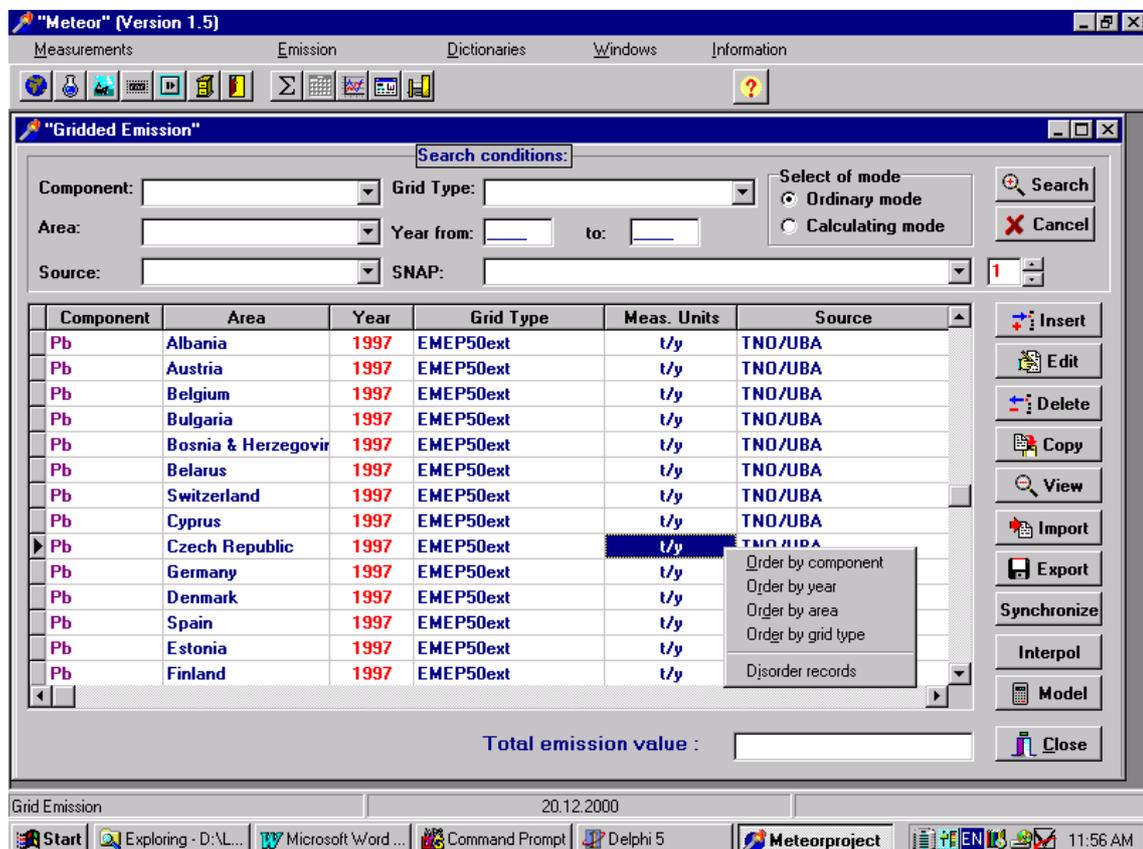


Figure A.1. Operations with gridded emissions (general view of the window)

Using the search conditions, prescribed in the upper part of window, it is possible to select necessary records (Search button). The search is possible in two regimes: Ordinary mode - rapid search without calculation of the sum, Calculating mode - search with calculations of sum (Total emission value).

All operations are as simplified as possible many of them are realized as dialogues. For example, to make linear interpolation over time for all countries it is necessary to fill some fields (Fig.A.2) and to select the regime **All areas**.

Nearly in the same way one can operate with measurement data using menu items (Concentration in air, Concentration in precipitation, Concentration in soil, Concentration in vegetation, Deposition fluxes, see Fig. A.3).

Figure A.3 demonstrates a general view of the window for operations with measurement data on air concentrations. The upper part of the window provides a possibility to prescribe search conditions:

- by data acquisition source;
- by component;
- by the name of monitoring station;
- by time scale;
- by date interval;
- by the name of the country where measurements were made.

It is not obligatory to prescribe all search conditions simultaneously. Prescribing one or several search conditions the search region is narrowed. Selected data can be sorted by different ways (for detailed description see section "Measurements").

Main buttons:

- **Search** - data search by prescribed search conditions;
- **Cancel** - search cancel;
- **View** - viewing of the selected data set;
- **Insert** - addition of a new set of experimental data (header);
- **Edit** - editing of the selected data set (header);
- **Delete** - elimination of the selected data set (header);
- **Copy** - copying of data set header;
- **Import** - data import from ASCII file of prescribed format;
- **From CCC** - data import in the CCC format (CCC);
- **Export** - data export to ASCII file;
- **Chart** - data viewing in graphical form (for data with Valid="Y");
- **Check** - checking the total quantity and the quantity of valid samples in each set;
- **Close** - window closing.

In conclusion it should be mentioned that a detailed description of each module is given in "User's Guide" for a given program complex.

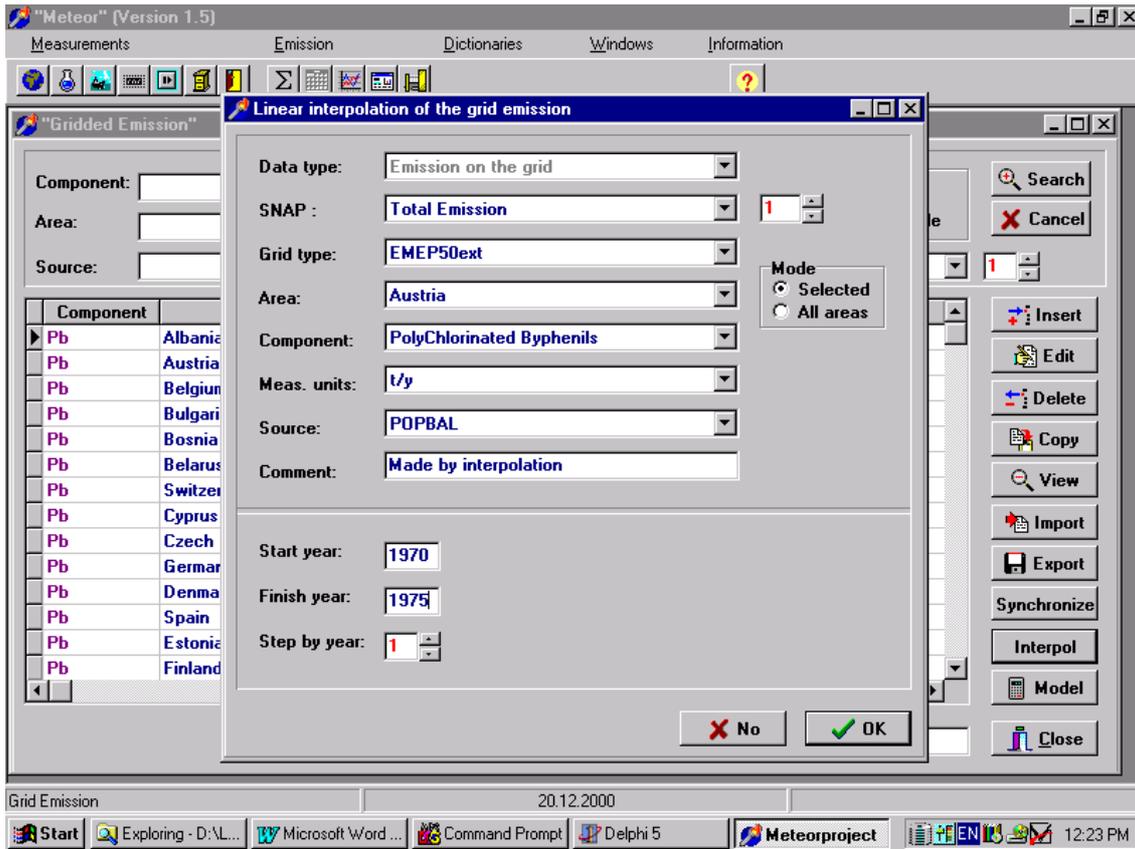


Figure A.2. Gridded emissions (preparation for linear interpolation)

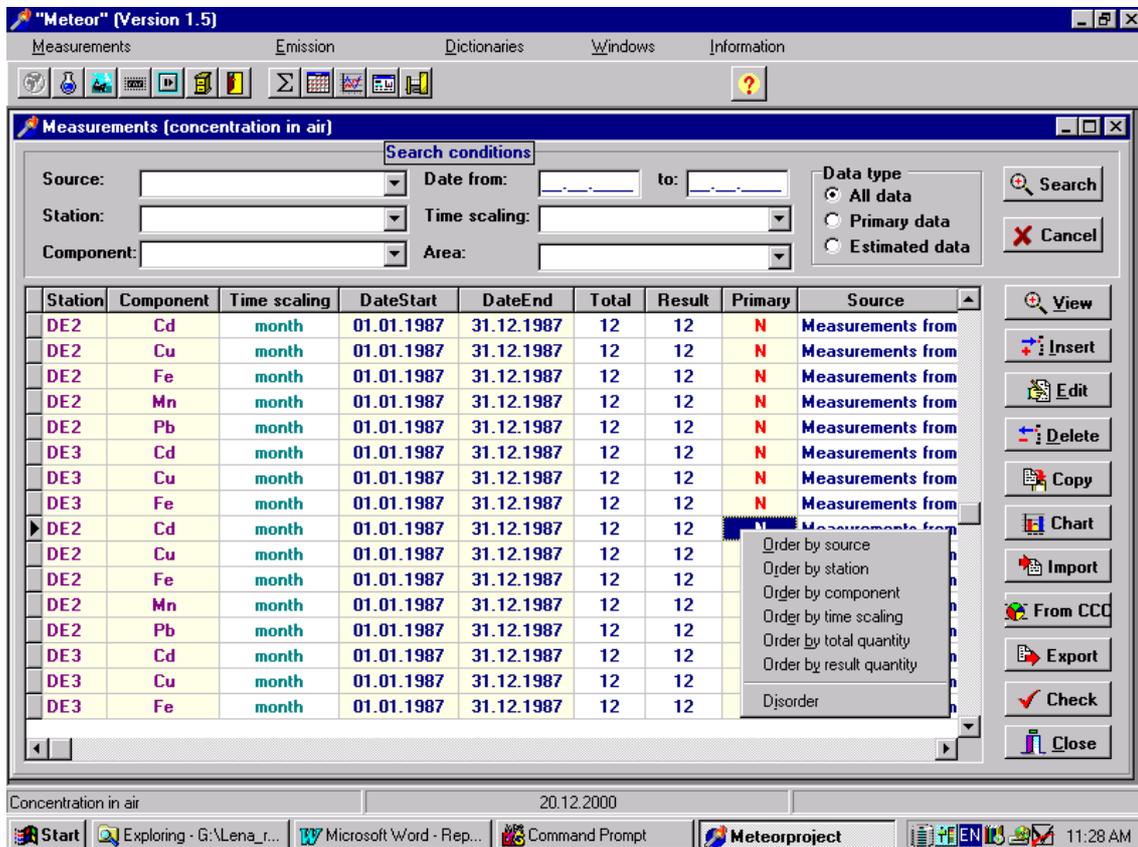


Figure A.3. Measurement data (air concentration). General view of the window.