EMEP Centres Joint Report for HELCOM
EMEP/MSC-W TECHNICAL REPORT 3/2008

Atmospheric Supply of Nitrogen, Lead, Cadmium, Mercury and Dioxines/Furanes to the Baltic Sea in 2006

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OSLO
October 2008

ISSN 0332-9879

Summary

The results presented in this EMEP Centres Joint Report for HELCOM are based on the modelling and monitoring data presented to the 33th Session of the Steering Body of EMEP in Geneva in September 2008. It includes measurements, as well as emissions and depositions calculated by the EMEP models of nitrogen compounds, heavy metals and PCDD/F for the year 2006.

The measured monthly and annual 2006 concentrations in air and precipitation for nitrogen species, heavy metals, as well as air concentrations for lindane are presented in the report. Both for nitrogen and heavy metals a significant south-east gradient can be noticed in the measured concentrations in 2006. The temporal patterns of monthly Cd and Pb concentrations show a strong winter maximum and temporal pattern of Hg monthly concentrations weaker winter maximum. During winter the atmospheric residence time is longer due to reduced vertical mixing.

Annual emissions from the HELCOM Contractig Parties in 2006 are shown below for all pollutants considered in the report. The annual nitrogen oxides emission from the international ship traffic on the Baltic Sea in 2006 is 346.7 kt NO_2).

Country	POLLUTANT					
	NO_2 kt N	NH_3 kt N	Cd tonnes	Pb tonnes	Hg tonnes	PCDD/F g TEQ
Denmark	56,4	73,7	0.7	6	1.3	25
Estonia	9,3	7,7	0.5	34	0.5	3
Finland	58,7	30,3	1.3	25	1.0	14
Germany	424,4	511,3	2.7	108	2.8	85
Latvia	13,3	12,0	0.6	18	0.0	14
Lithuania	18,7	28,8	0.4	6	0.4	11
Poland	270,8	236,1	42.2	524	21.3	449
Russia	1019,6	495,8	59.4	355	14.0	778
Sweden	53,1	42,8	0.5	14	0.6	37
HELCOM	**1924,2**	**1438,2**	**108**	**1089**	**42**	**1416**

Annual depositions of all considered pollutants in 2006 are shown in the Table below for 6 sub-basins of the Baltic Sea and for the entire Baltic Sea.

Basin	POLLUTANT					
	Ox-N kt N	Red-N kt N	Cd tonnes	Pb tonnes	Hg tonnes	PCDD/F g TEQ
GUB	16,6	10,4	1.0	33	0.68	9
BAP	7,2	4,4	4.4	137	1.80	23
GUF	5,5	3,8	0.5	16	0.23	5
GUR	61,0	50,1	0.4	13	0.16	3
BES	8,8	14,2	0.5	17	0.24	6
KAT	8,1	9,5	0.4	18	0.25	4
BAS	**107,1**	**92,4**	**7.1**	**234**	**3.4**	**50**

Oxidised nitrogen depositions in 2006 were slightly higher than in 2005 in all sub-basins and in the entire Baltic Sea Basin. Contrary, reduced nitrogen depositions in 2006 wre slightly lower or remained on the same level as in 2005. Levels of lead and cadmium deposition to the entire Baltic Sea slightly decreased in 2006 comparing to 2005 by 4% and 2%, respectively. At the same time mercury deposition to the entire Baltic Sea for 2006 were almost 13% higher than for 2005. In case of PCDD/Fs there is a decrease of net deposition from 2005 to 2006 by 11%.

Preface

The Co-operative Program for Monitoring and Evaluation of the Long-Range Transmission of Air Pollutants in Europe (EMEP) and the Baltic Marine Environment Protection Commission (HELCOM) are both conducting work on air monitoring, modelling and compilation of emission inventories. In 1995, HELCOM decided to rationalize its current programs by avoiding duplication of efforts with specialised international organizations. At the request of HELCOM, the steering Body of EMEP at its nineteenth session agreed to assume the management of atmospheric monitoring data, the preparation of air emission inventories and the modelling of air pollution in the Baltic region.

Following the coordination meeting held in Potsdam in Germany and the Pollution Load Input meeting held in Klajpeda-Joudkrante in Lithuania, both 1996, it was agreed that EMEP Centres should be responsible for regular evaluation of the state of the atmosphere in the Baltic Sea region and should produce an annual joint summary report which includes updated emissions of selected air pollution, modelled deposition fields, allocation budgets and measurement data.

This report was prepared for the HELCOM, based on model estimates and monitoring results presented to the thirtieth session of the Steering Body of EMEP. Following decision of the HELCOM /MONAS-10 Meeting, it presents the results for the year 2006.

Acknowledgements

The authors are indebted to the scientific teams at MSC-E, MSC-W and CCC for providing the results included in this.

We are most grateful to Marina Varygina, Ilia Ilyin and Victor Shatalov from MSC-E, and to Per Helmer Skaali from MSC-W for their help in preparation of this report.

Contents

1. Introduction

The first EMEP Centres Joint Report for HELCOM was delivered in 1997 (Tarrason *et al*. 1997) and was followed by eight annual reports (Bartnicki *et al*. 1998, 2000, 2001, 2002, 2003, 2004, 2005, 2006, 2007). The present EMEP Centres Joint Report for HELCOM is focused on the year 2006. It is based on the modelling and monitoring data presented to the 32th Session of the Steering Body of EMEP in Geneva in September 2008.

Following decisions of the 9th HELCOM MONAS Meeting held in Silkeborg in 2006, the main deliverables expected from the EMEP Centres are the Indicator Fact Sheets for nitrogen, heavy metals and PCDD/Fs. These Indicator Fact Sheets include time series of emissions and depositions of selected pollutants, and are presented in Appendices C – H. In this report we present additional important information about emissions, depositions and source allocation budgets for nitrogen, heavy metals and PCDD/Fs in the year 2006.

The EMEP Unified Eulerian model system has been used for all nitrogen computations presented here. The model has been documented in detail in EMEP Status Report 1/2003 Part I (Simpson *et al.* 2003) and in EMEP Status Report 1/2004 (Tarrasón *et al*., 2004). In EMEP Status Report 1/2003 Part II (Fagerli *et al.* 2003) we presented an extensive evaluation of the acidifying and eutrophying components for the years 1980, 1985, 1990 and 1995 to 2000. In EMEP Status Report 1/2003 Part III (Fagerli *et al.* 2003), a comparison of observations and modelled results for 2001 was conducted, and in EMEP Status Report 1/2004 (Fagerli, 2004) we presented results for 2002 with an updated EMEP Unified model, version 2.0. This version differed slightly from the 2003 version, as described in EMEP Status Report 1/2004 (Fagerli, 2004), however the main conclusions on the model performance was the same. In 2005, we presented results for the year 2003 in EMEP Status Report 1/2005 (Fagerli, 2005) and last year we presented results for 2004 in EMEP Status Report 1/2006 (Fagerli *et al.* 2006). It has been shown that the EMEP model performance is rather homogeneous over the years (Fagerli *et al.* 2003), but depend on geographical coverage and quality of the measurement data. The EMEP model has also been validated for nitrogen compounds in Simpson *et al.*, 2006, and for dry and wet deposition of sulphur, and wet depositions for nitrogen in Simpson *et al*., 2006b with measurements outside the EMEP network. Since last year, no changes with significant effects on the results for acidifying and eutrophying compounds have been introduced in the model. Moreover, the comparison between model results and observations for 2005 give similar correlation coefficients and bias as the comparisons performed for earlier years. The previous evaluations of the model are thus still valid.

Atmospheric input and source allocation budgets of heavy metals (cadmium, lead, and mercury) to the Baltic Sea were computed using the latest version of MSCE-HM model. MSCE-HM is the regional-scale model operating within the EMEP region. This is a three-dimensional Eulerian model which includes processes of emission, advection, turbulent diffusion, chemical transformations of mercury, wet and dry depositions, and inflow of pollutant into the model domain. Horizontal grid of the model is defined using stereographic projection with spatial resolution 50 km at 60º latitude. The description of EMEP horizontal grid system can be found in the internet (http://www.emep.int/grid/index.html). Vertical structure of the model consists of 15 non-uniform layers defined in the terrain-following σ-coordinates and covers almost the whole troposphere. Detailed description of the model can be found in EMEP reports (Travnikov and Ilyin, 2005) and in the Internet on EMEP web page http://www.emep.int under the link to information on Heavy Metals.

Evaluation of PCDD/F atmospheric input to the Baltic Sea was carried out using the latest version of MSCE-POP model. MSCE-POP model is a three-dimensional Eulerian multimedia POP transport model operating within the geographical scope of EMEP region with spatial resolution 50 km at 60º latitude. Vertical structure of MSCE-POP is defined similar to MSCE-HM model. MSCE-POP considers the following compartments: air, soil, sea, vegetation and forest litter fall. The model includes the following basic processes: emission, advective transport, turbulent diffusion, dry and wet deposition, gas/particle partitioning, degradation, and gaseous exchange between the atmosphere and the underlying surface (soil, seawater, vegetation). Detailed description of MSCE-POP model is given in EMEP report (Gusev *et al.*, 2005) and in the Internet on EMEP web page http://www.emep.int under the link to information on Persistent Organic Pollutants.

The formulation of MSCE-HM and MSCE-POP models and their performance were thoroughly evaluated within the framework of activity of EMEP/TFMM on the EMEP Models Review (ECE/EB.AIR/GE.1/2006/4). One of the main conclusions of the TFMM Workshop held in Moscow in 2005 was that MSCE-HM and MSCE-POP models represent the state of the science and fit for the purpose of evaluating the contribution of long-range transport to the environmental impacts caused by HMs and POPs.

As decided by HELCOM all depositions, as well as, source allocation budgets have been calculated for the six sub-basins and catchments of the Baltic Sea. Names and acronyms of these regions, often used in the report are given below:

1. Gulf of Bothnia (GUB)
2. Gulf of Finland (GUF)
3. Gulf of Riga (GUR)
4. Baltic Proper (BAP)
5. Belt Sea (BES)
6. The Kattegat (KAT)

Depositions and source allocation budgets have been also calculated for the entire basin and the entire catchment of the Baltic Sea. According to HELCOM requirements, the present annual joint report includes mainly figures and tables describing emissions, depositions and source allocation budgets for nitrogen, heavy metals and PCDD/Fs.

2. Observed Concentrations of Nitrogen, Cadmium, Lead, Mercury and Lindane at HELCOM Stations in 2006

2.1 HELCOM measurement stations

Nine countries have submitted data from all together twenty HELCOM stations for 2006 (Table 2.1. and Fig. 2.1).

Table 2.1. Available measurements of nitrogen, lead, cadmium, mercury and lindane from HELCOM stations for 2006.

Sites			In precipitation						In air						
region	Site	Name	NO3	NH4	Cd	Pb	Hg	γHCH	NO2	sNO3	sNH4	Cd	Pb	Hg	γHCH
BAP	DE0009R	Zingst	■	■	■	■	■	■	■	■	■	■	■	■	
BAP	DK0020R	Pedersker	■	■	■	■									
BAP	EE0011R	Vilsandi	■	■		■			■						
BAP	FI0009R	Utö	■	■					■	■	■				
BAP	LT0015R	Preila	■	■	■	■			■	■	■	■	■		
BAP	LV0010R	Rucava	■	■	■	■			■	■	■	■	■		
BAP	PL0004R	Leba	■	■	■	■			■	■	■				
BAP	SE0012R	Aspvreten						■							
BAP	SE0051R	Arup			■	■									
BES	DK0005R	Keldsnor	■	■					■	■	■		■		
BES	SE0011R	Vavihill	■	■					■	■	■				
KAT	DK0003R	Tange								■	■		■		
KAT	DK0008R	Anholt	■	■	■	■			■	■	■		■		
KAT	SE0014R	Råö	■	■			■	■	■	■	■	■	■	■	■
KAT	SE0097R	Gårdsjön			■	■									
GUF	EE0009R	Lahemaa	■	■	■				■						
GUF	FI0017R	Virolahti II	■	■	■	■			■	■	■				
GUF	RU0016R	Shepeljovo	■	■											
GUB	FI0004R	Ähtari	■	■											
GUB	SE0005R	Hailuoto II	■	■					■	■	■				
GUB	SE0053R	Bredkälen	■	■											
GUB	FI0053R	Rickleå			■	■									
GUR	LV0016R	Zoseni	■	■	■	■			■	■	■	■	■		

The stations are distributed in the six sub-basins (Fig. 2.1) as following: One in the Gulf of Riga (GUR),four in the Gulf of Bothnia (GUB) and in Kattegat (KAT), three in the Belt Sea (BES) and in the Gulf of Finland (GUF), and nine in the Baltic proper (BAP). There is one station from: Germany, Lithuania, Poland and Russia, two stations from Latvia and Estonia, four stations from Denmark and Finland, and six stations from Sweden. No stations have delivered data for all the components in air and precipitation. In this section we provide a broad view of the patterns and levels evident in monitoring data from 2006. Where possible regional average values are provided for the principal regions within the Baltic Sea. For actual monthly values on a component-by-component basis, the reader is referred to Appendix A. A description of sampling and analytical methods is given in Appendix B.

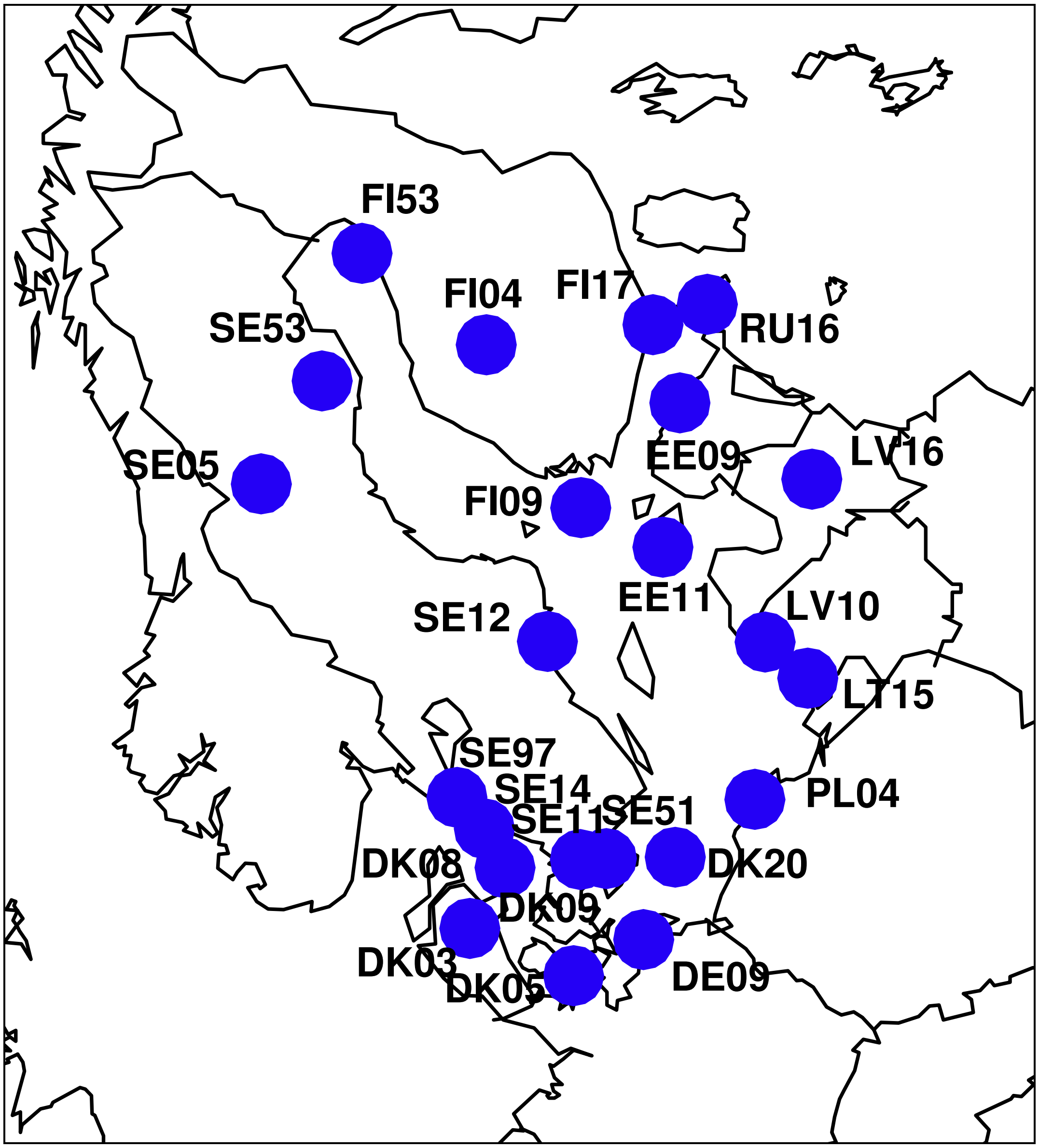


Figure 2.1. Geographical locations of the HELCOM stations with available measurements for the year 2006.

2.2 Nitrogen concentrations in air

Altogether 15 stations have delivered data for one or more nitrogen species in air: 13 for respectively total reduced nitrogen (NH_3+NH_4^+), or total nitrate (HNO_3+NO_3^-), and 14 for nitrogen dioxide (NO_2). Stations from all the six sub-basins have delivered data of nitrogen concentration in air. Annual averages of the different nitrogen species are presented in Figure 2.2. Average air concentrations are arithmetic averages of the reported values. The lowest concentrations for all the three nitrogen species were reported at the northernmost Swedish site (SE05) in 2006: The concentrations were 0.23, 0.08, 0.14 µg N/m^3 for respectively NH_3+NH_4^+, HNO_3+NO_3^- and NO_2 at this site. Highest concentrations of nitrogen in aerosols were found at the German site DE09, more than 2 µgN/m^3 of sum ammonium, and 1 µgN/m^3 for sum nitrate. The Estonian sites show highest level of NO_2 with more than 3 µgN/m^3

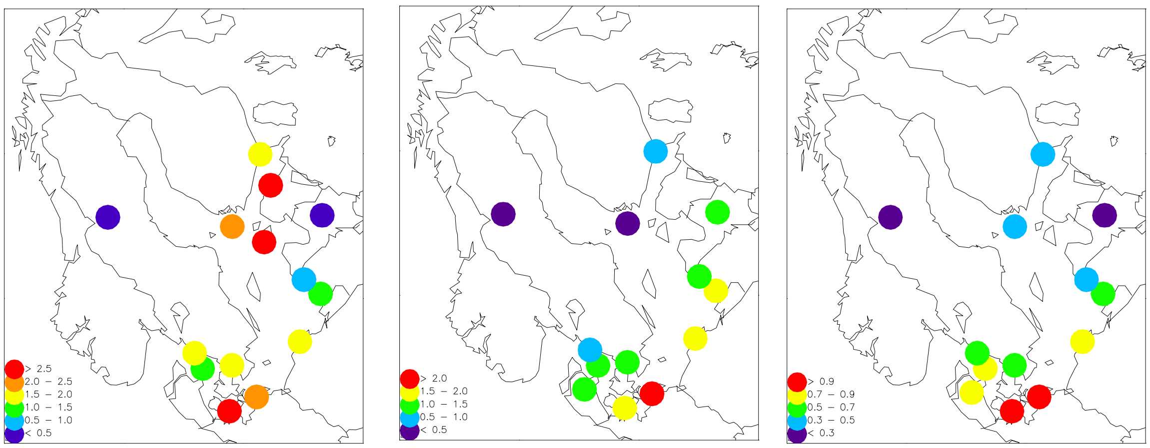


Figure 2.2. Concentrations of left: NO_2 in air, middle: total reduced nitrogen (NH_3+NH_4^+), and right: total nitrate (HNO_3+NO_3^-) in 2005 Unit: µg N/m^3.

. There is a tendency of decreasing concentrations from south to north. A similar south north gradient can also be noticed in Figure 2.3-2.5 displaying the station averages of NH_3+NH_4^+, HNO_3+NO_3^- and NO_2 observations across six sub-basins

Observations of the total reduced nitrogen (NH_3+NH_4^+), show a seasonal pattern similar for most the sub-basins with highest concentrations during April, and a peak is also common in august. Agricultural activities (natural fertilizer) are the main source for NH_3+NH_4^+. During the summer half year, NH_3 is normally emitted from the ground due to higher temperatures.

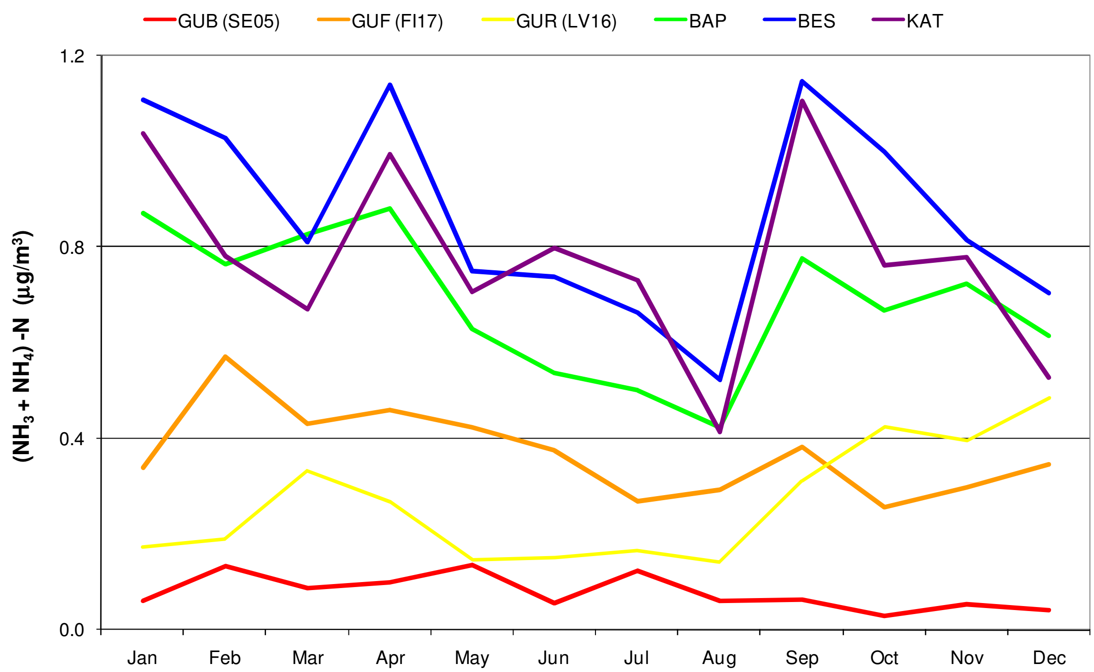


Figure 2.3. Monthly total reduced nitrogen (NH_3+NH_4) concentrations in the air in 2006

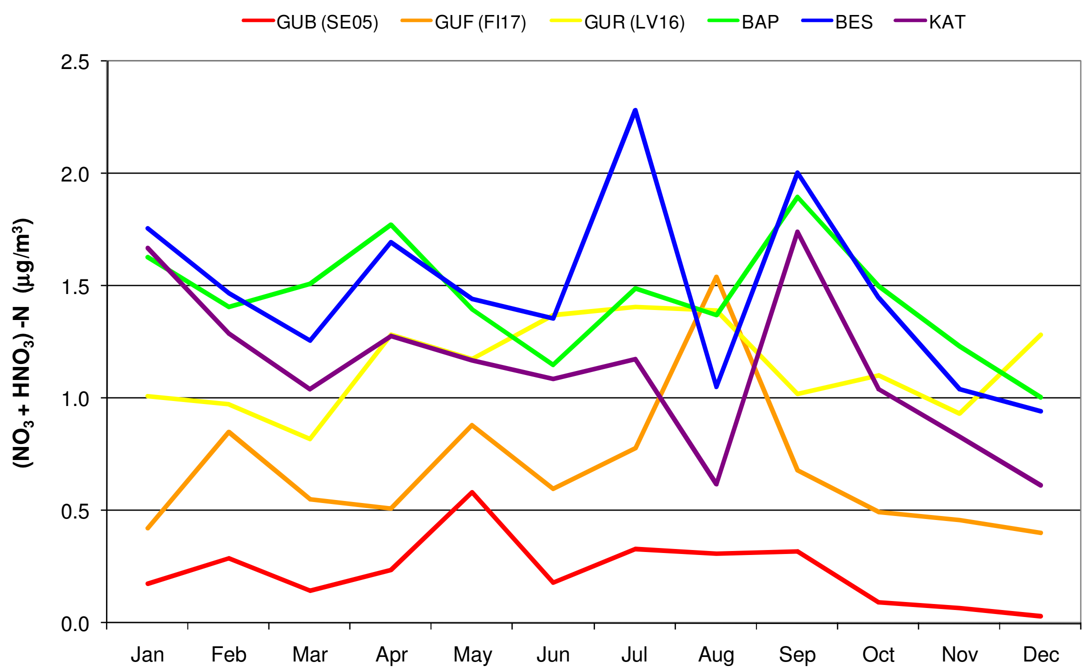


Figure 2.4. Monthly total oxidized nitrate (HNO_3+NO_3^-) concentrations in the air in 2006

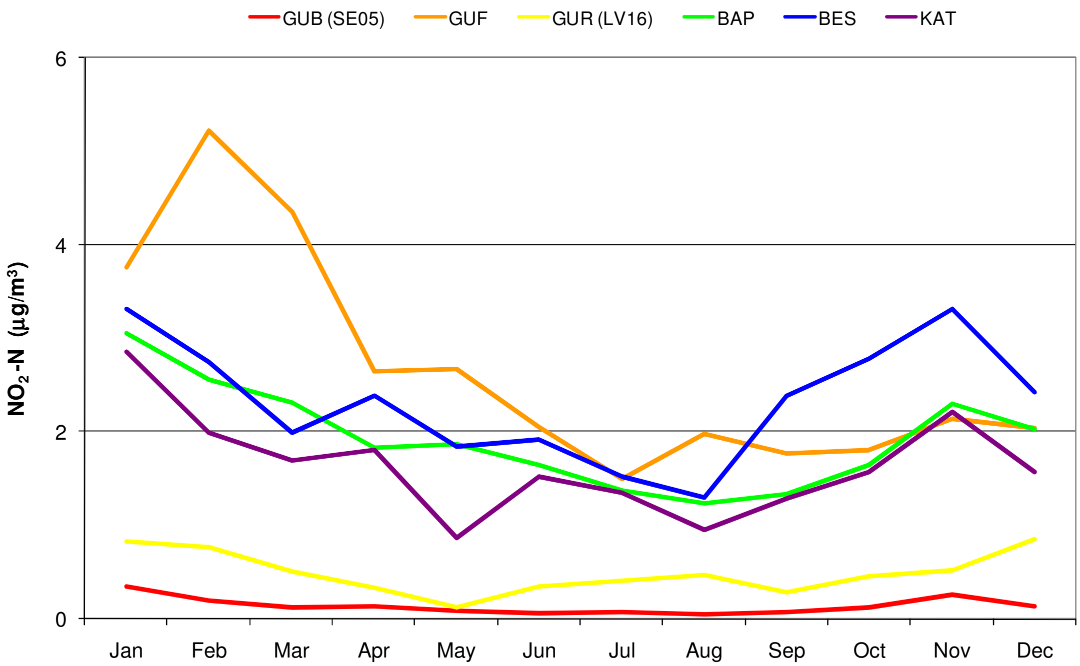


Figure 2.5. Monthly NO_2 concentrations in the air in 2006

Total nitrate (HNO_3+NO_3^-) concentration doesn't show any clear seasonal pattern, there are elevated levels for some months varying between the regions. NO_2 is reacting photochemically and the reaction product is total nitrate. This reaction is mostly dominating during spring and summer. However, total nitrate is dominated by particulate nitrate in the cold season, which has a higher residence time in the atmosphere than nitric acid. In the summer, more of total nitrate consists of nitric acid, which is dry deposited very fast. The overall effect is a less pronounced seasonal pattern. Concentrations of NO_2 show not unexpected temporal patterns with a winter maxima/summer minima. During winter the atmospheric residence time is longer due to high emissions, low photochemically activity and reduced vertical mixing.

2.3 Nitrogen in precipitation

Altogether 18 stations have delivered data for ammonium and nitrate in precipitation. Stations from all the six sub-basins have delivered data for ammonium and nitrate in precipitation. Annual averages of the two nitrogen species are presented in Figure 2.6.

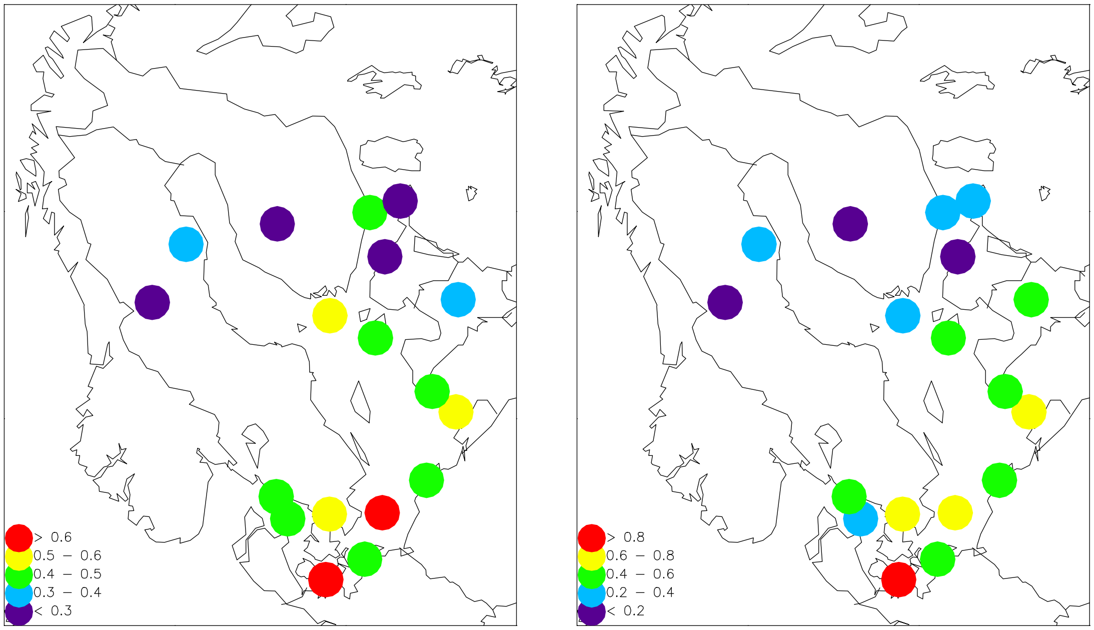


Figure 2.6. Concentrations of left: nitrate (NO_3^-)), and right: ammonium (NH_4^+ in precipitation in 2006. Units: mg N/l.

The yearly mean concentrations in precipitation have been calculated from daily, weekly or monthly reported values as precipitation-weighted averages. A south-north gradient similar to air can also be seen for nitrogen in precipitation with higher concentrations in the south. But also a west-east gradient is seen. The concentration differences for ammonium are much higher than for nitrate, because stations can be affected by local agricultural activities. Lowest concentrations for both for ammonium and nitrate were seen at SE05, annual concentration of 0.11 and 0.13 mg N/L respectively. The highest concentrations were found at the DK05, 0.95 mg N/l and 0.65 mg N/l for ammonium and nitrate respectively. Figure 2.7 displays the station average deposition of oxidized and reduced nitrogen across the regions given.

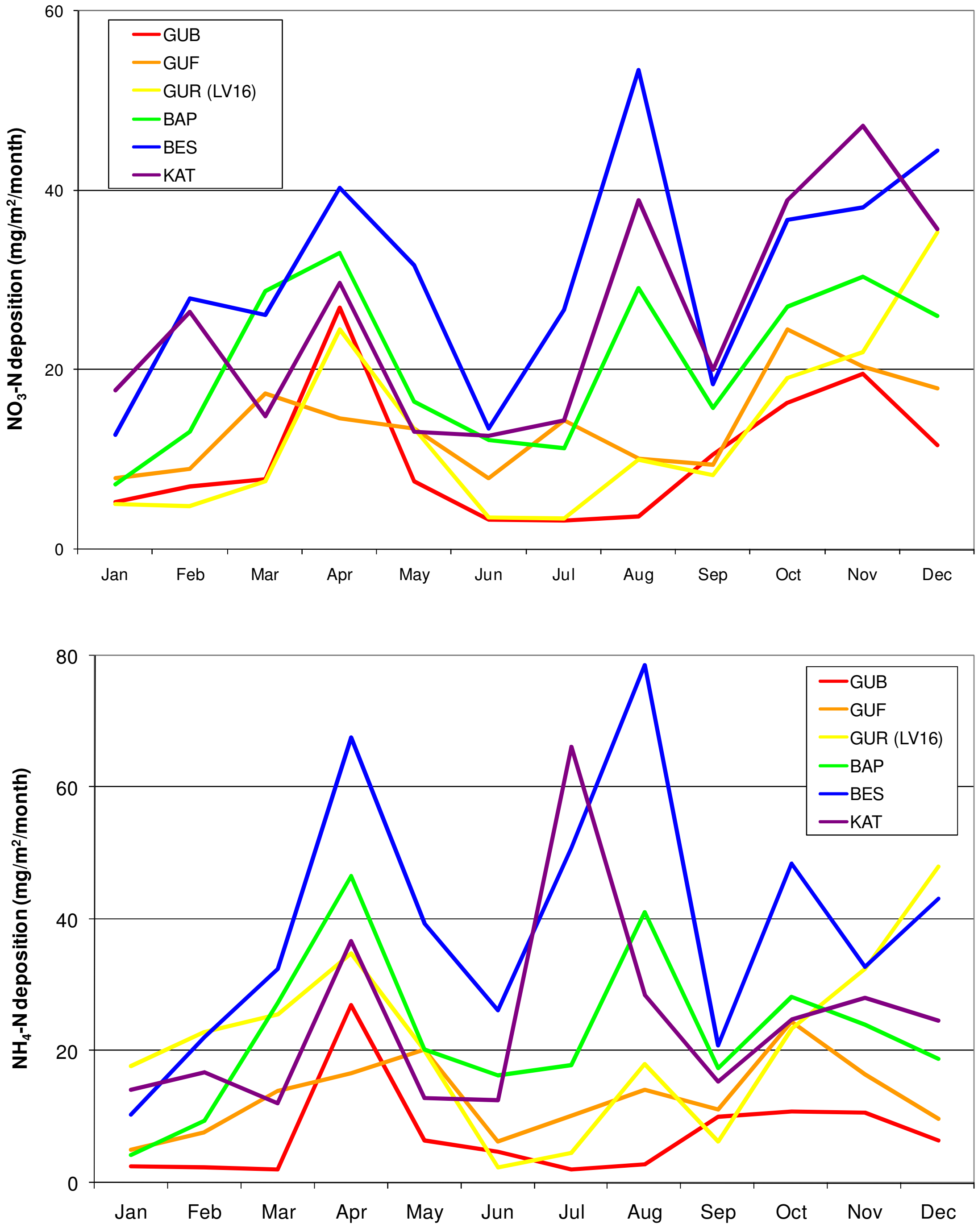


Figure 2.7. Monthly nitrogen depositions in 2006 averaged for the sub-basins. Top: nitrate (NO_3^-), and bottom: reduced nitrogen (NH_4^+).

It is to be observed that seasonal patterns are not as strong as for airborne components. This is due to the presence of the precipitation effect. Airborne nitrogen species will be washed out at precipitation events during transport. The spatial pattern persists, however, with clearly decreasing depositions with progression northwards. For example, the northern regions typically receive half the deposition of reduced nitrogen supplied to southern areas.

2.4 Heavy metals in the air

Altogether eight stations have delivered heavy metal data in air whereof five measuring cadmium, eight with lead and only two (SE12 and DE09) have delivered data for Hg in air. Annual averages of Cd and Pb are presented in Figure 2.8. Average air concentrations are arithmetic averages of the reported values. The lowest concentrations for Cd in aerosols were reported at SE14, 0.15 ng/m^3. The lowest concentration (3.1 ng/m^3) for Pb in aerosols was reported at LV16. The highest concentrations were found at LV10 for cadmium (0.22 ng/m^3) and LT15 (6.9 ng/m^3) for lead

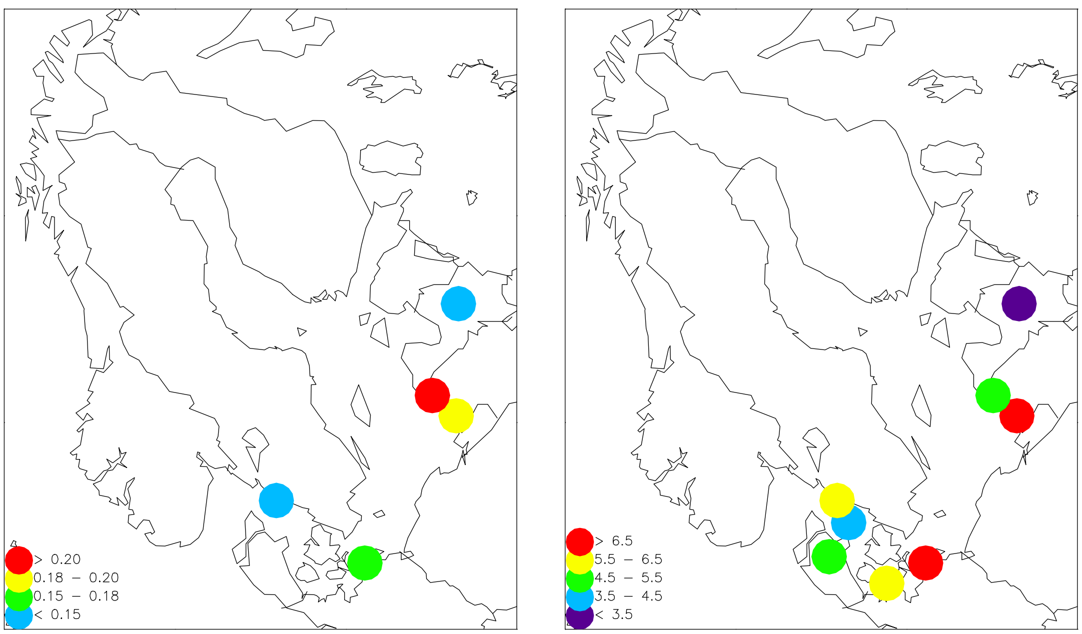


Figure 2.8. Concentrations of left: lead (Pb) and right: cadmium (Cd) in aerosol in air in 2006. Units: ng/m^3.

There are insufficient stations to reasonably represent regional patterns, hence the station data itself is presented here for some of the sites (Fig. 2.9).

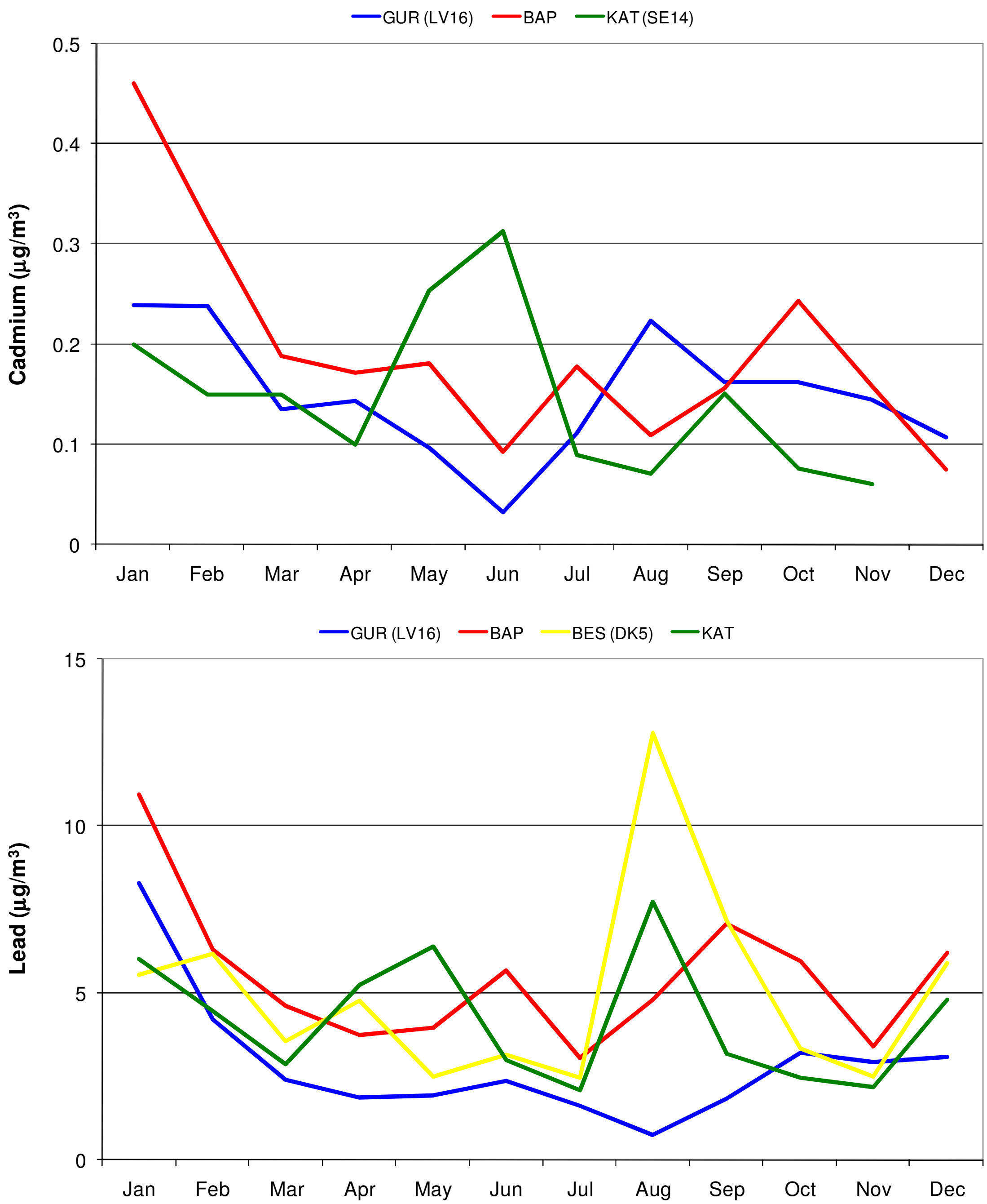


Figure 2.9. Monthly concentrations in air in 2006 averaged for the sub-basins: Top: cadmium, bottom: lead

From this, it is to be observed that the temporal patterns for Cd and Pb show a winter maximum. In addition there is elevated level of Pb at several sites in august. During winter the atmospheric residence time is longer due to reduced vertical mixing. Hg concentrations at the two sites are similar and show a weak winter maxima for the two stations, Figure 2.10

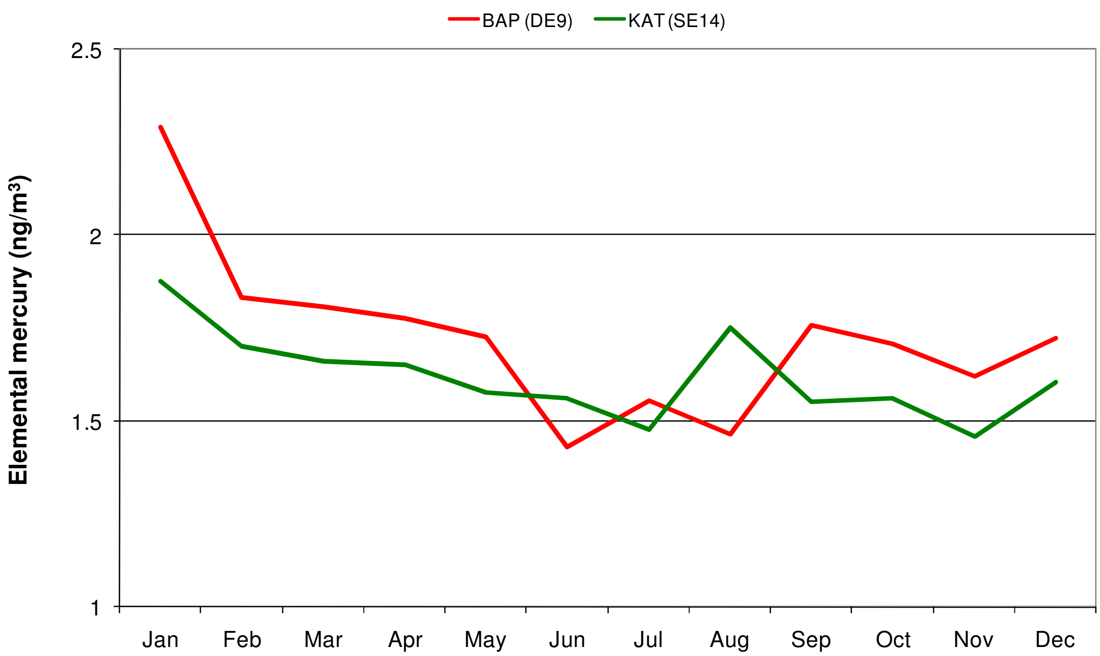


Figure 2.10. Monthly concentrations of Hg in air in 2006 averaged for the sub-basins:

2.5 Heavy metals in precipitation

In all twelve stations have delivered data for Cd and Pb in precipitation, and two have delivered data for Hg in precipitation. Stations from five of the six sub-basins have delivered data for Cd and Pb. Annual averages of Cd and Pb are presented in Figure 2.11. The yearly mean concentrations in precipitation have been calculated from daily, weekly or monthly reported values as precipitation-weighted averages. The lowest concentration for Cd in precipitation was reported at the the sites SE97 and FI53 with about 0.03 µg/l. The lowest concentrations for Pb with 0.55 were observed at EE11. The highest concentration of Pb was measured at LT15 (4.1 µg/l) while at PL04 for Cd (0.10 µg/l.)

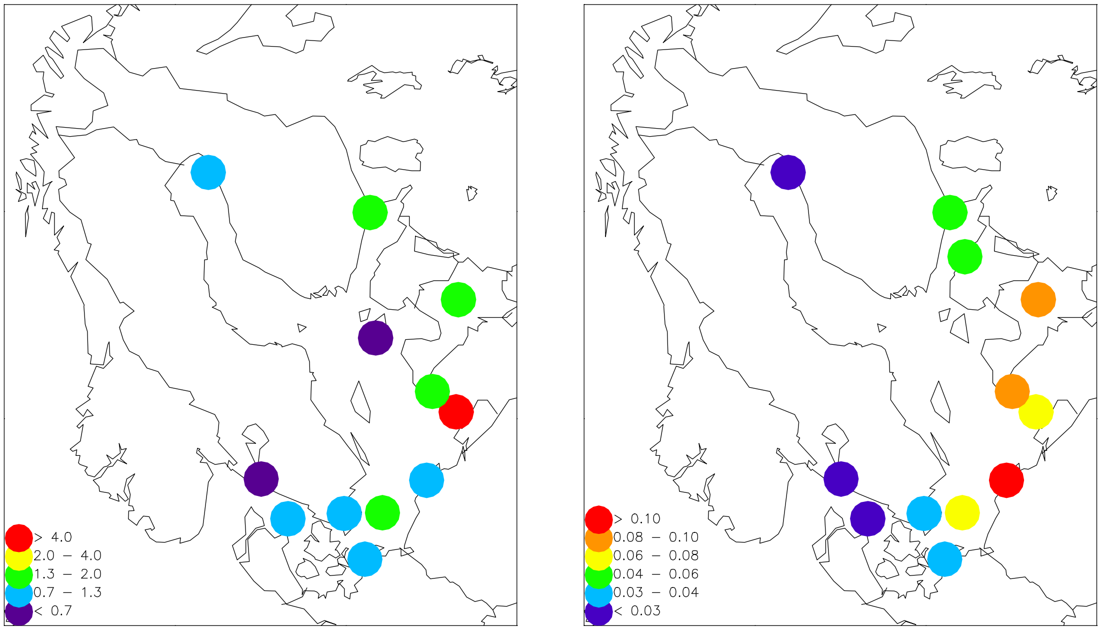


Figure 2.11. Concentrations of left: lead (Pb), right: cadmium (Cd) in precipitation. in precipitation in 2006. Units: µg/l.

2.6. Lindane (γ-HCH)

Only Sweden delivered data for γ-HCH in air, while Germany in addition delivered data for γ-HCH in precipitation. Fig. 2.12 displays monthly averages of γ-HCH in air at SE14.

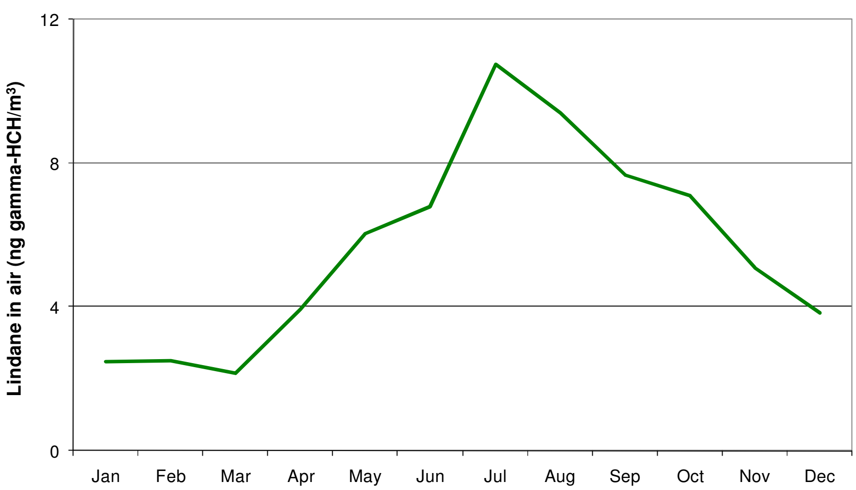


Figure 2.11 Monthly concentrations of γ-HCH in air at SE14 in 2006

From this, it is to be observed that the temporal patterns for γ-HCH shows a summer maximum. In western countries the use of lindane (containing >95% γ-HCH) in agricultural application is still allowed, explaining the summer maximum. The deposition data are not shown, because of where different sampling methods make the this difficult to compare. The data are found in appendix A.

2.7. Laboratory intercomparisons

The HELCOM laboratories have participated in different laboratory and field intercomparisons in 2006 which have been presented in EMEP's QA/QC report (EMEP/CCC 3/2008). The laboratory uncertainty is one source to the total uncertainty and the performance of the different labs are testes in the annual EMEP laboratory intercomparison. The results from the intercomparison on main components in air and precipitation (Table 2.2) representative for the 2006 data showed that the laboratories generally have a good quality.

	Precip		Air		
Lab	NH4	NO3	HNO3	NH3	NO2
DE	1.5	1.4			
DK	0.5	1.6	1.9	2.8	0.7
EE	1.0	1.6	3.8	2.1	0.5
FI	0.9	1.5	3.8	2.2	
LT	3.5	3.3	3.8	8.4	1.8
LV	1.2	1.4	1.9	5.1	0.9
PL	3.9	1.1	1.9		1.4
RU	16.2	5.7	5.7		55.2
SE	0.7	1.3	3.8	1.0	0.9

between 10 and 25 % RSD

> 25% RSD

Table 2.2. Relativ standard deviation (RSD) in nitrogen species in the EMEP's 25th laboratory intercomparison for precipitation and air.

Results from the EMEP laboratory intercomparison of heavy metals in 2006 is shown in table 2.3, and it is quite good quality for Pb, and somewhat higher uncertainty for the cadmium measurements.

	Cd		Pb	
	low	high	low	high
DK	146	11	15	21
FI	13	12	9	11
DE	2	2	3	6
PL	0	0	9	3
LT	23	5	19	4
LV	15	1	4	6
EE	<DL	12	21	3

between 10 and 25% RSD

Between 25 and 50% RSD

> 50% RSD

Table 2.3. Average per cent error (absolute) in low and high concentration samples, results from the heavy metal laboratory intercomparison in EMEP, 2006.

3. Atmospheric Supply of Nitrogen to the Baltic Sea in 2006

Nitrogen emission data, as well as the model results presented here have been approved by the 32nd Session of the Steering Body of EMEP in Geneva in September 2008. The EMEP Unified Eulerian model system has been used for all nitrogen computations presented in this Chapter. Annual deposition of total nitrogen to the Baltic Sea basin in 2006 was 196 ktonnes approximately 6% less than in 2005. Deposition of oxidized nitrogen accounted for 54% of total nitrogen deposition in 2006.

3.1 Nitrogen emissions

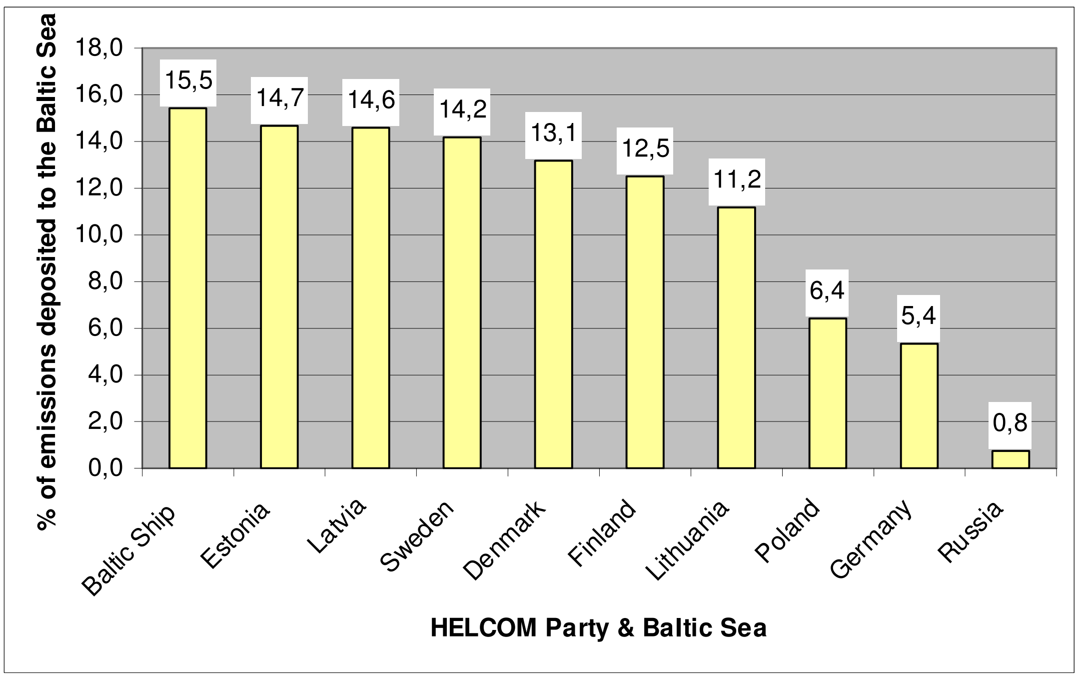


Figure 3.1. Percent of annual emissions of total (oxidized + reduced) nitrogen from the HELCOM Parties and international ship traffic emissions on the Baltic Sea (Baltic Ship) deposited to the Baltic Sea basin in 2006.

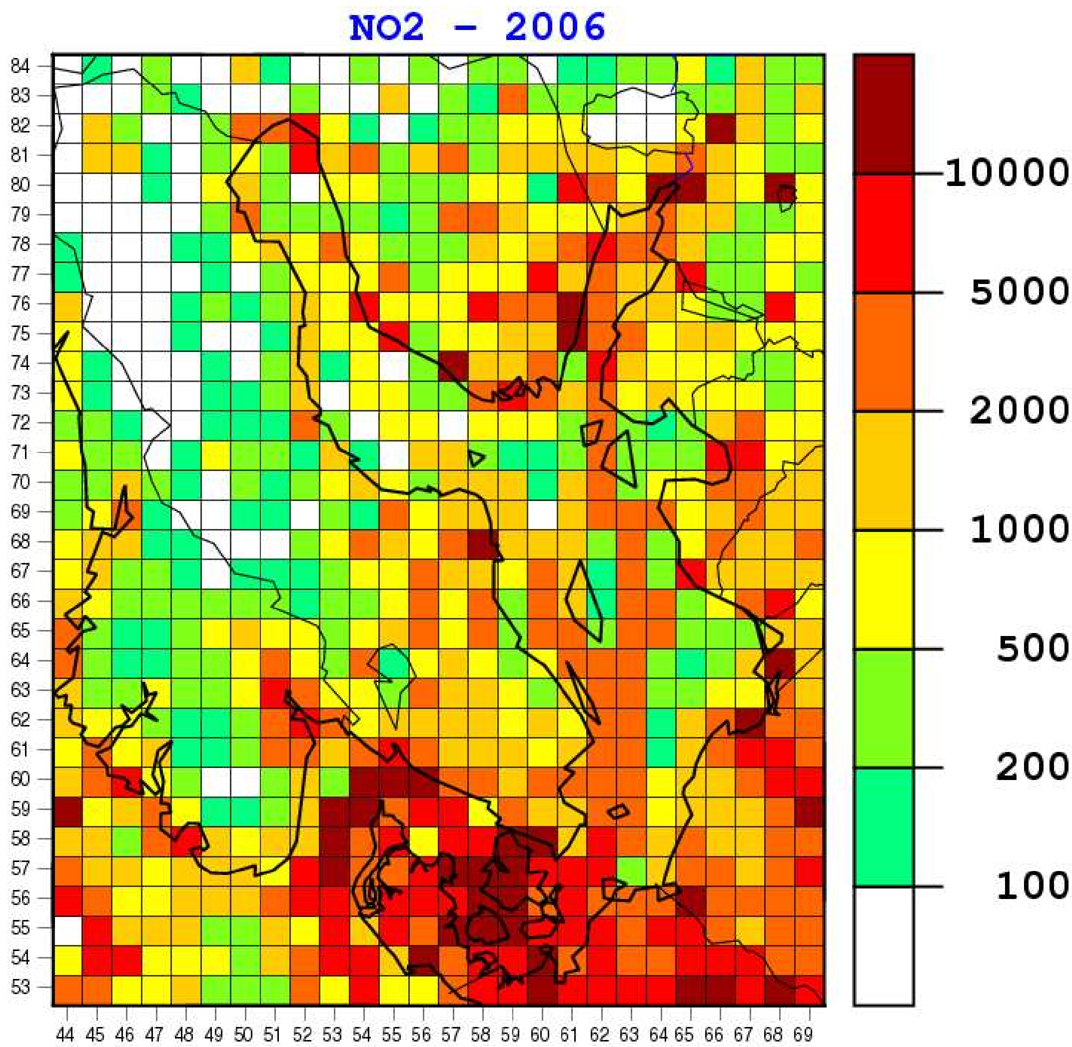


Figure 3.2. Map of annual emission of oxidized nitrogen (including emissions from the ship traffic) in the Baltic Sea region in 2006. Units: Mg (tones) of NO_2 per year and per 50×50 km grid cell.

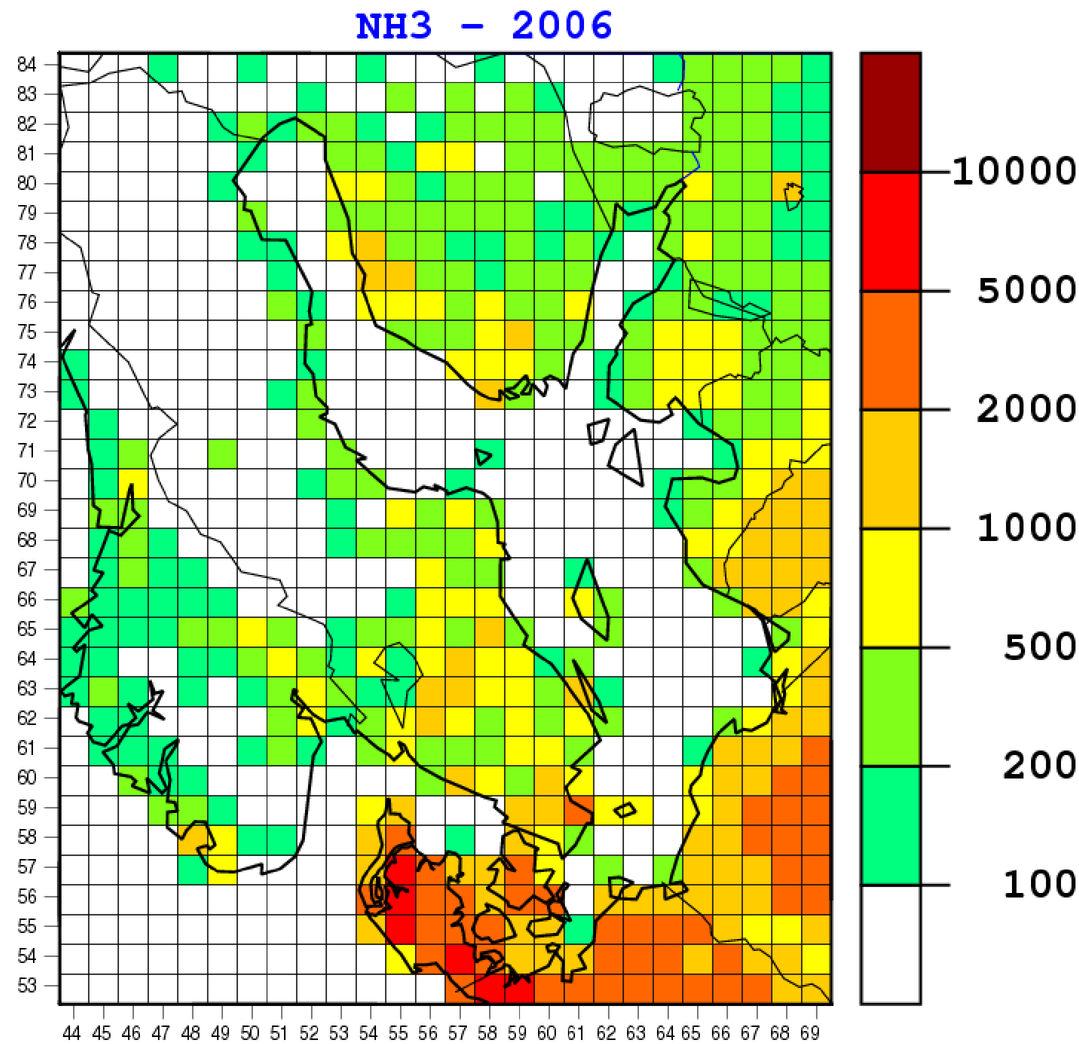


Figure 3.3. Map of annual emission of ammonia in the Baltic Sea region in 2006. Units: Mg of NH_3 per year and per 50×50 km grid cell.

Table 3.1. The list of 11 SNAP emissions sectors as specified in the EMEP-CORINAIR Emission Inventory Guidebook.

Sector 1	Combustion in energy and transformation industry
Sector 2	Non-industrial combustion plants
Sector 3	Combustion in manufacturing industry
Sector 4	Production processes
Sector 5	Extraction and distribution of fossil fuels and geothermal energy
Sector 6	Solvent and other product use
Sector 7	Road transport
Sector 8	Other mobile sources and machinery (including ship traffic)
Sector 9	Waste treatment and disposal
Sector 10	Agriculture
Sector 11	Other sources and sinks

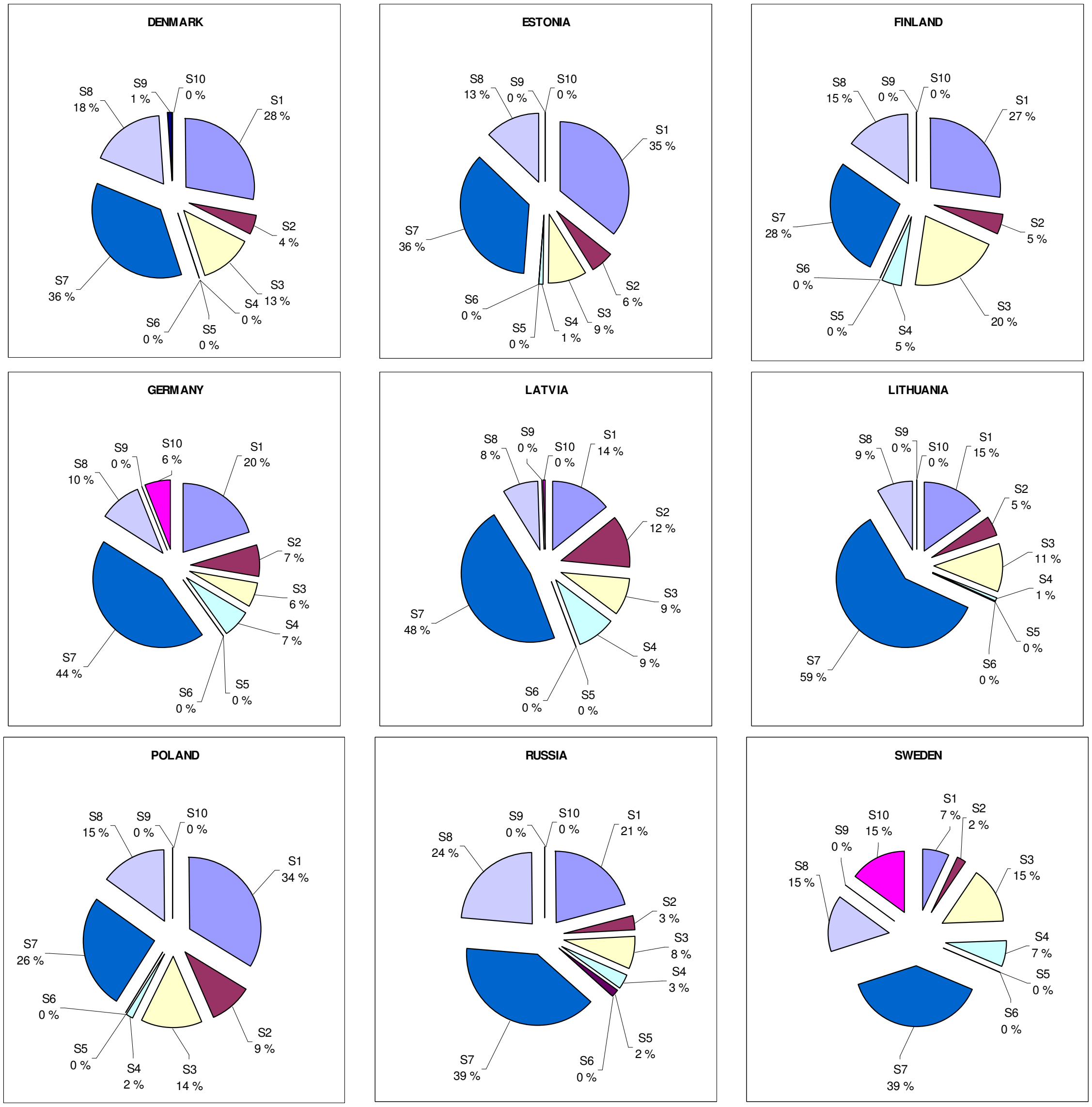


Figure 3.4. Annual 2006 nitrogen oxides emissions from the HELCOM Parties split into the SNAP sectors.

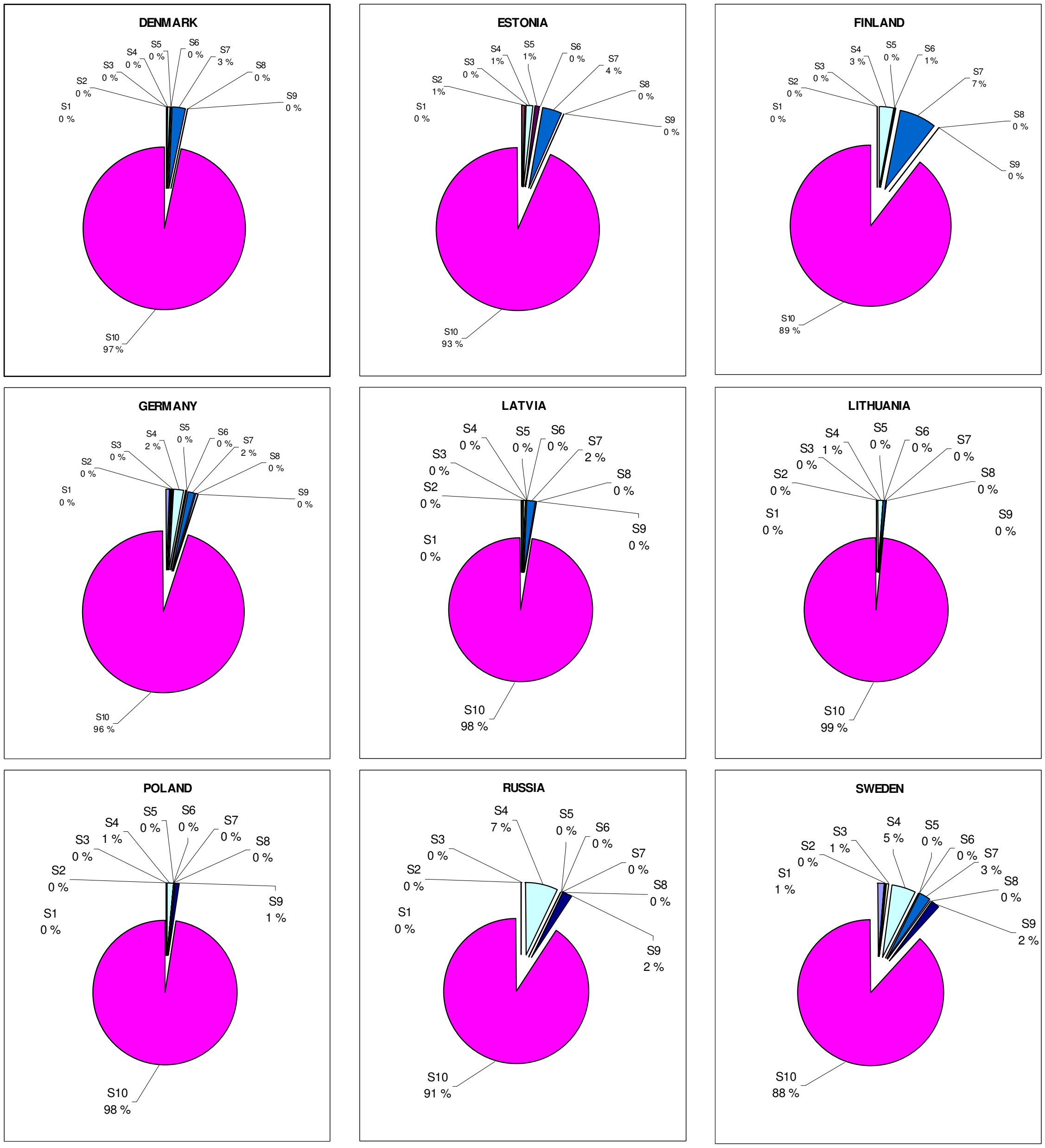


Figure 3.5. Annual 2004 ammonia emissions from the HELCOM Parties split into the SNAP sectors.

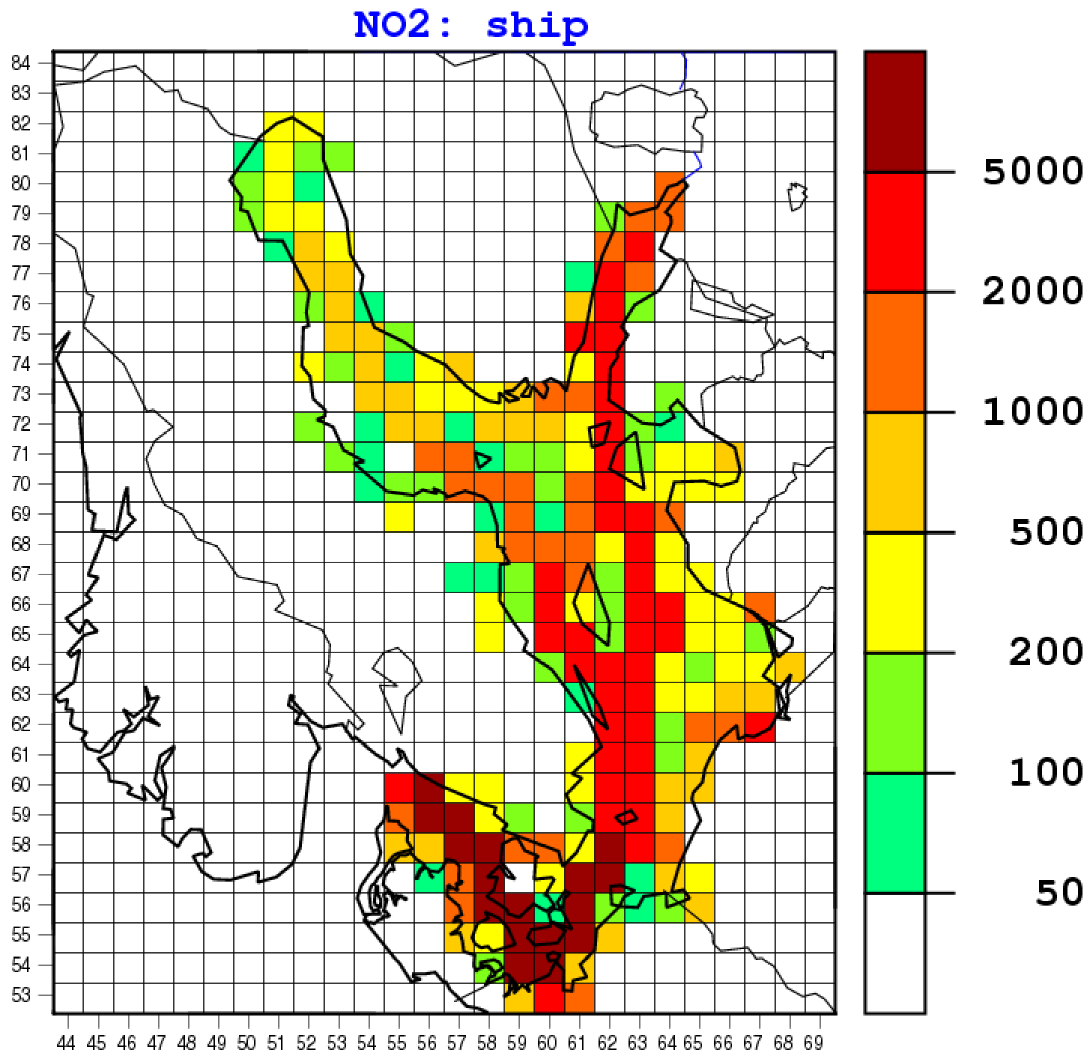


Figure 3.6 Map of annual emissions of nitrogen oxides from the international ship traffic on the Baltic Sea in 2006 used in the EMEP model calculations. Units: Mg of NO_2 per year and per 50×50 km grid cell. There are large uncertainties in the estimate for ship traffic emissions. The international ship emissions and their spatial distribution have been updated based on new emission estimates derived by ENTEC for the year 2000. Ship emissions for 2006, were deduced by applying an increase factor of 2.5 % per year on cargo vessel traffic and 3.9 % per year on passenger vessel traffic. The factors are the same as used by ENTEC (UK – Environmental and Engineering Consultancy) for predicting emissions of nitrogen in 2010 based on the emission estimates for 2000.

3.2 Annual deposition of nitrogen

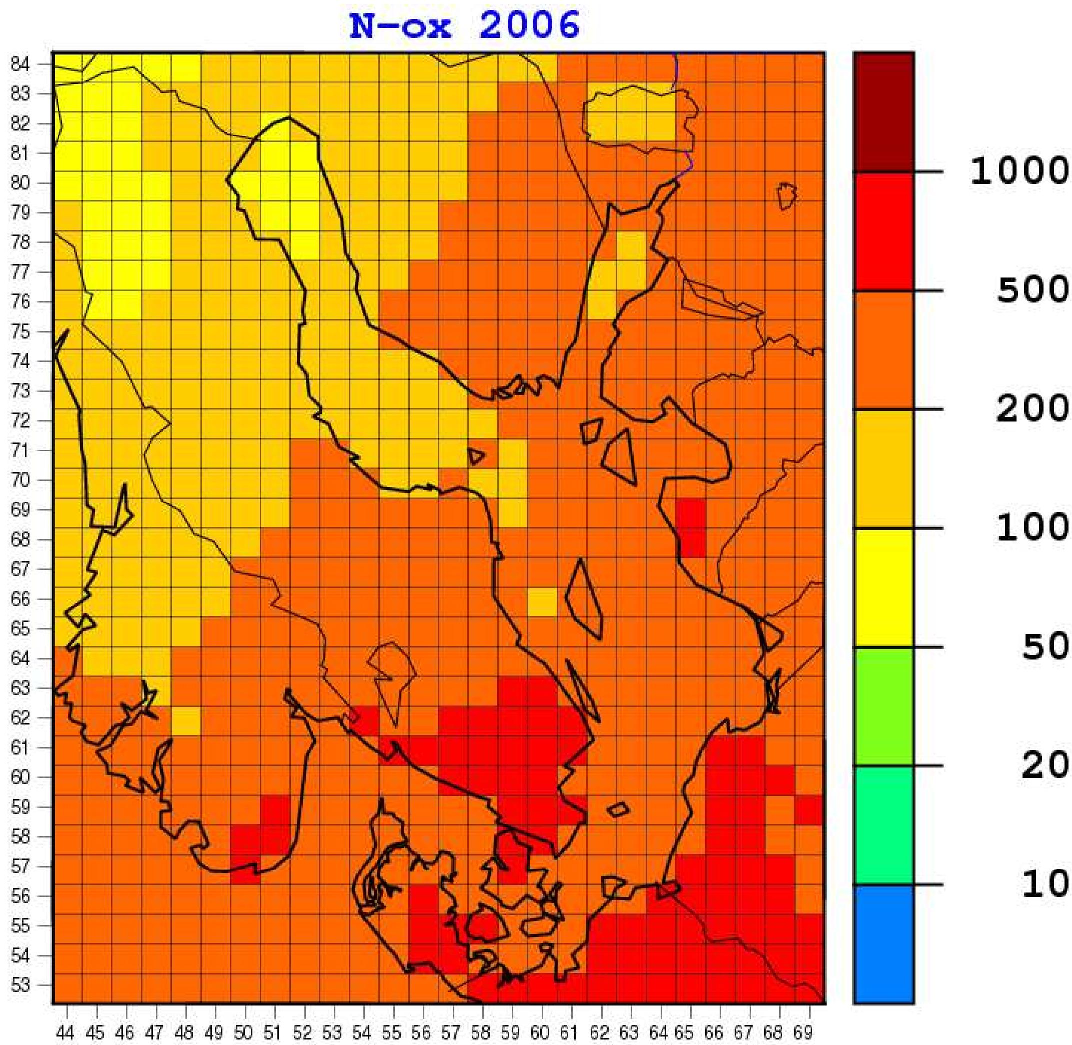


Figure 3.7. Map of annual deposition flux of oxidized nitrogen (dry + wet) in 2006. Units: mg N m^{-2} yr^{-1}.

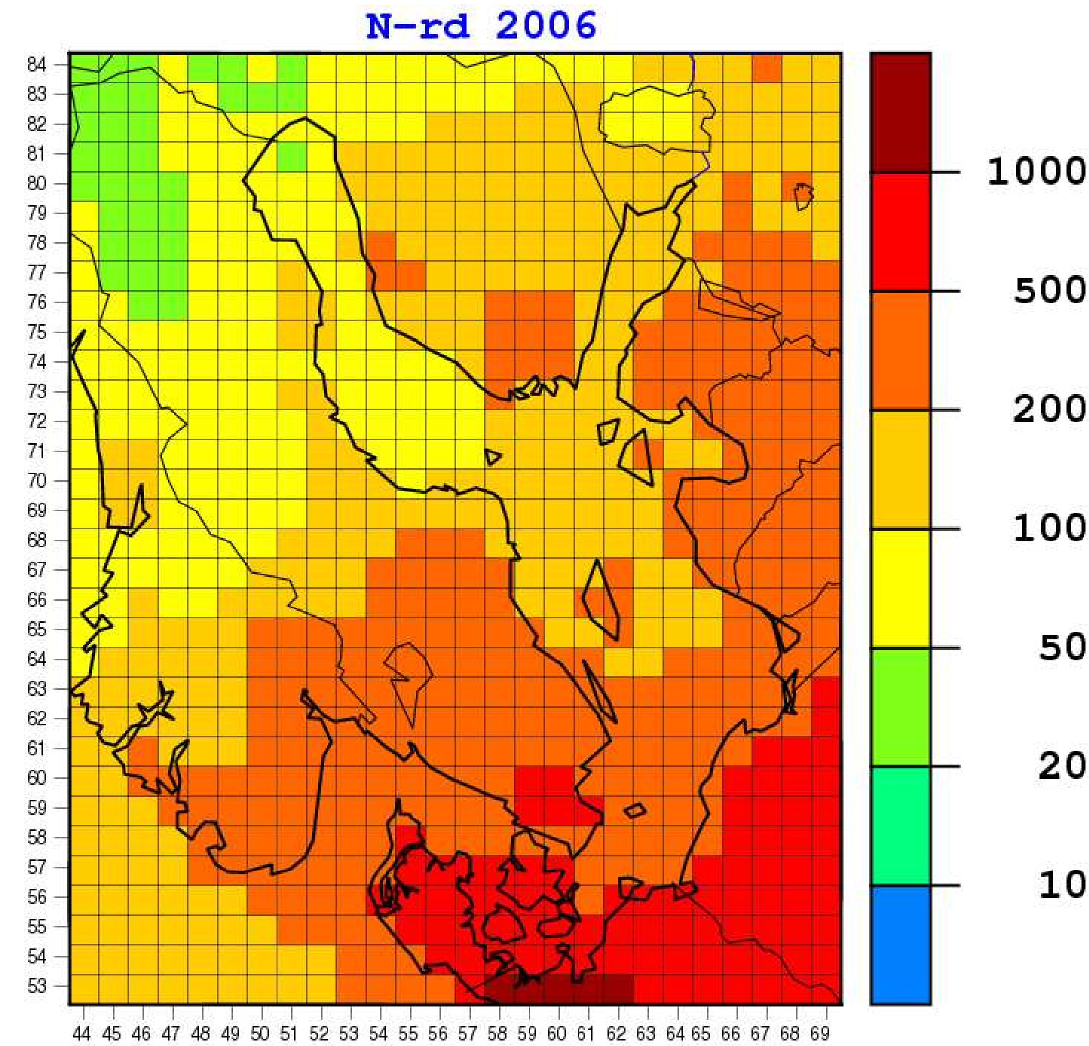


Figure 3.8. Map of annual deposition flux of reduced nitrogen (dry + wet) in 2006. Units: mg N m^{-2} yr^{-1}.

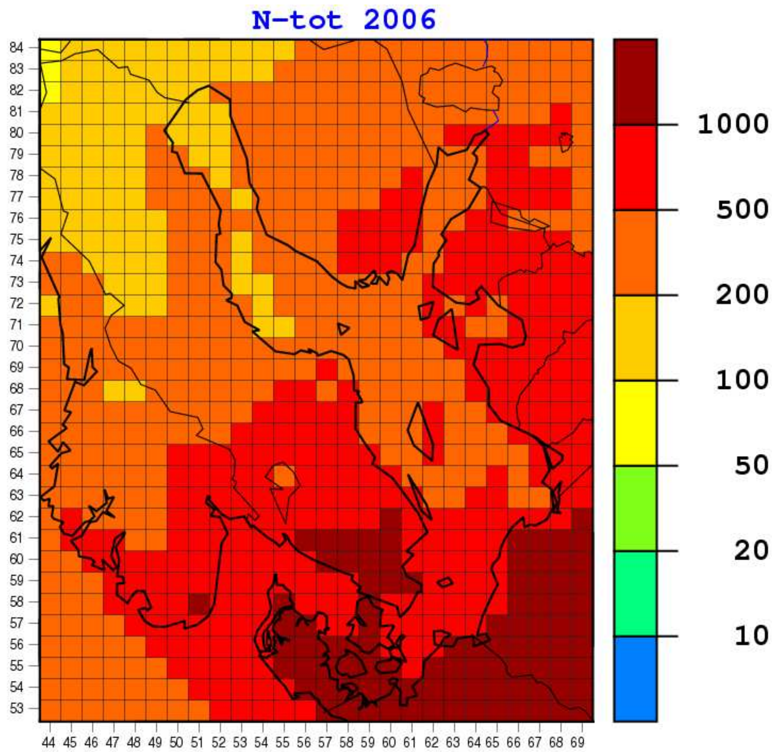


Figure 3.9. Map of annual deposition flux of total (oxidized + reduced) nitrogen in 2006. Units: mg N m^{-2} yr^{-1}.

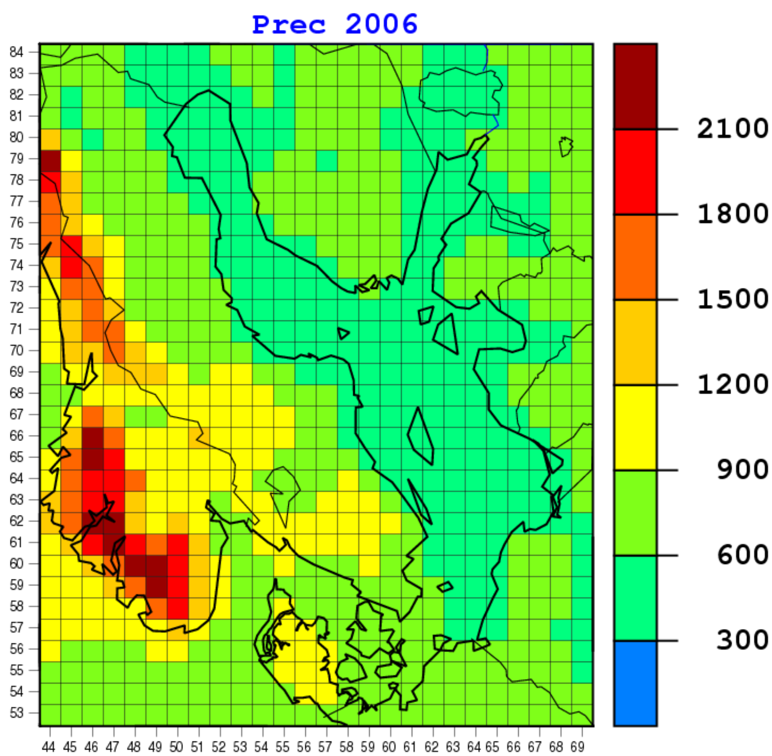


Figure 3.10. Map of annual precipitation in 2006. Units: mm yr^{-1}.

3.3 Monthly depositions of nitrogen

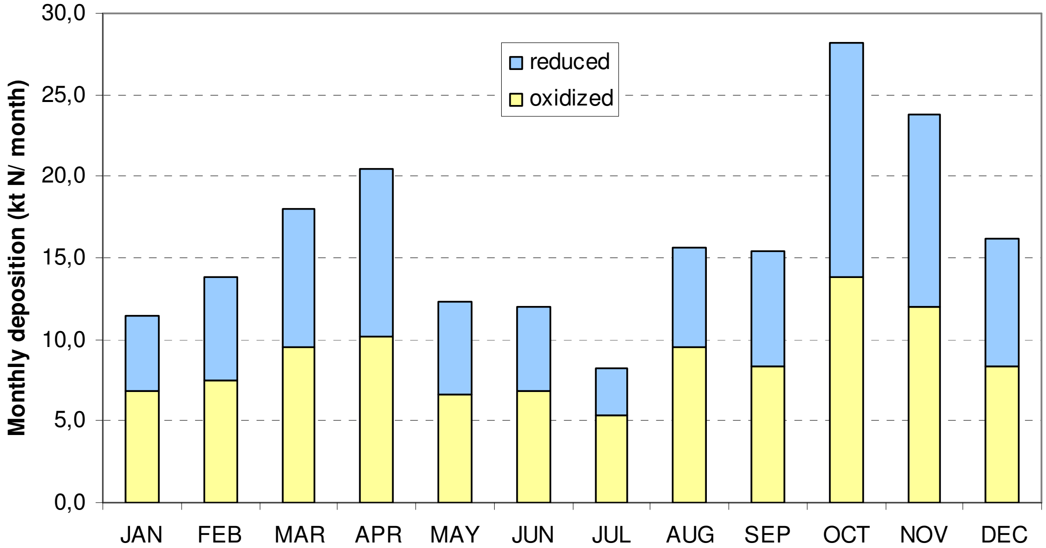


Figure 3.11. Monthly depositions of oxidized, reduced and total (oxidized +reduced) nitrogen to the entire Baltic Sea basin in 2006. Units: ktonnes N month^{-1}.

Table 3.2. Values of monthly depositions of oxidized, reduced and total (oxidized +reduced) nitrogen to the entire Baltic Sea basin in 2006. Units: ktonnes N month^{-1}.

Month	Oxidized	Reduced	Total
January	6,8	4,6	11,4
February	7,5	6,4	13,8
March	9,6	8,5	18,1
April	10,2	10,3	20,5
May	6,7	5,7	12,4
June	6,8	5,1	12,0
July	5,4	2,9	8,3
August	9,5	6,2	15,7
September	8,4	7,0	15,4
October	13,8	14,4	28,2
November	12,0	11,8	23,8
December	8,4	7,8	16,1

3.4 Source allocation of nitrogen deposition

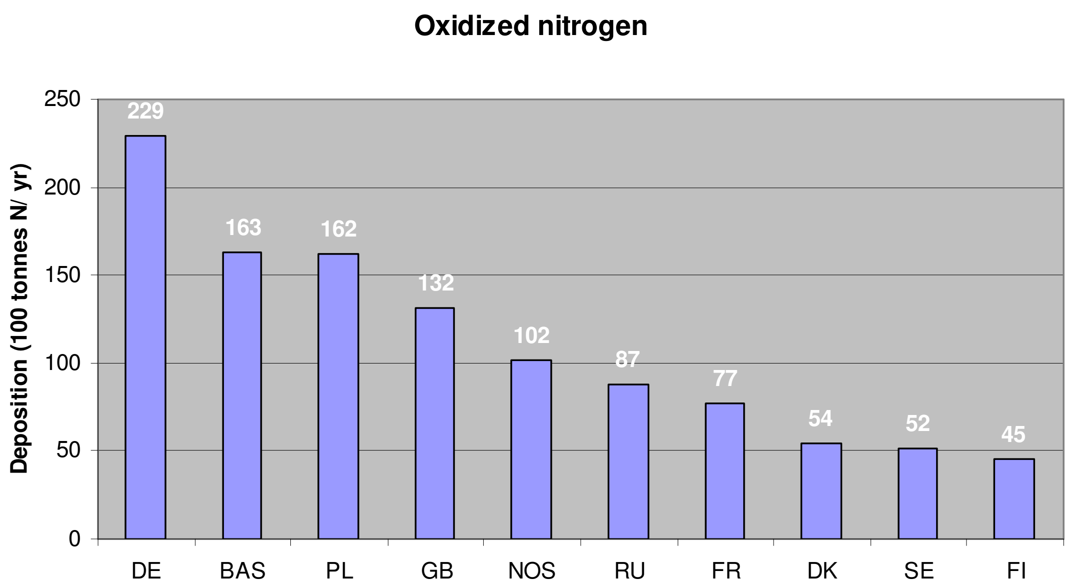


Figure 3.12. Top ten countries with highest contributions of nitrogen emissions to annual deposition of oxidized nitrogen into the Baltic Sea basin in the year 2006. Units: 100 tonnes N year^{-1}. BAS and NOS denote ship emissions form the Baltic Sea and from the North Sea, respectively.

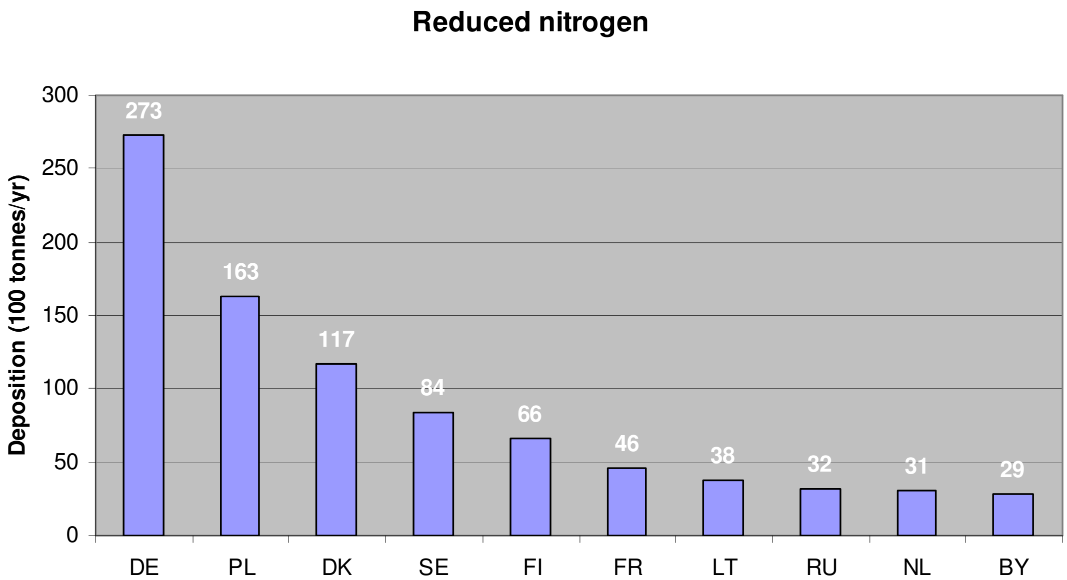


Figure 3.13. Top ten countries with highest contributions of nitrogen emissions to annual deposition of reduced nitrogen into the Baltic Sea basin in the year 2006. Units: 100 tonnes N year^{-1}. BAS and NOS denote ship emissions form the Baltic Sea and from the North Sea, respectively.

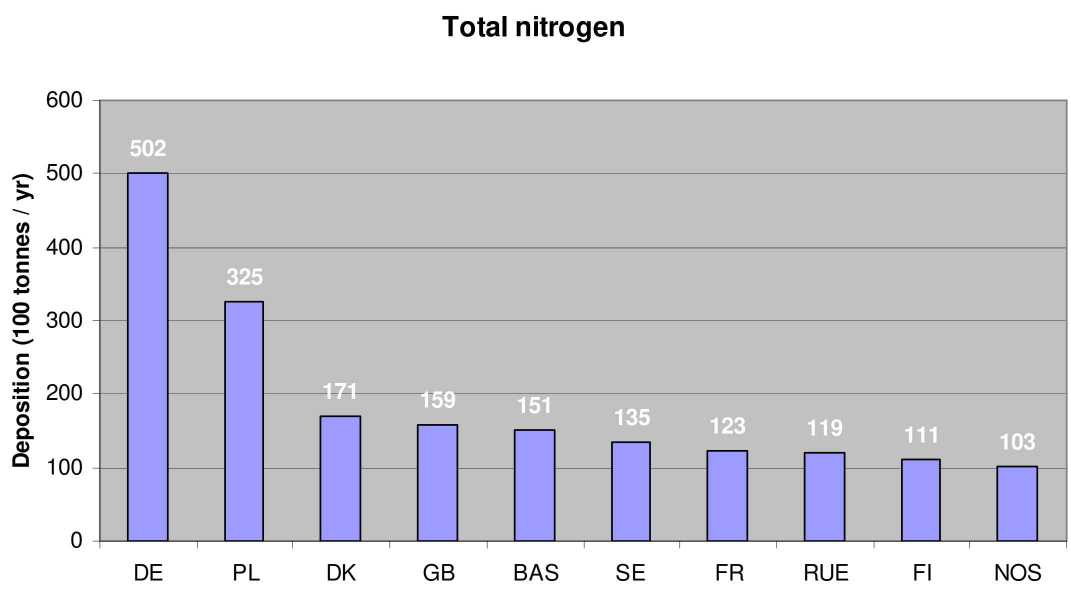


Figure 3.14. Top ten countries with highest contributions of nitrogen emissions to annual deposition of total (oxidized + reduced) nitrogen into the Baltic Sea basin in the year 2006. Units: 100 tonnes N year^{-1}. BAS and NOS denote ship emissions form the Baltic Sea and from the North Sea, respectively.

4. Atmospheric Supply of Lead to the Baltic Sea in 2006

In this chapter the results of model evaluation of lead atmospheric input to the Baltic Sea and its sub-basins for 2006 is presented. Modelling of lead atmospheric transport and depositions was carried out using MSC-E Eulerian Heavy Metal transport model MSCE-HM (*Travnikov and Ilyin*, 2005). Latest available official information on lead emission from HELCOM countries and other European countries for 2006 was used in computations. Based on these data levels of annual and monthly lead depositions to the Baltic Sea region have been obtained and contributions of HELCOM countries emission sources to the depositions over the Baltic Sea are estimated. Model results were compared with observed levels of lead concentrations in air and precipitation measured at monitoring sites around the Baltic Sea in 2006.

4.1 Lead emissions

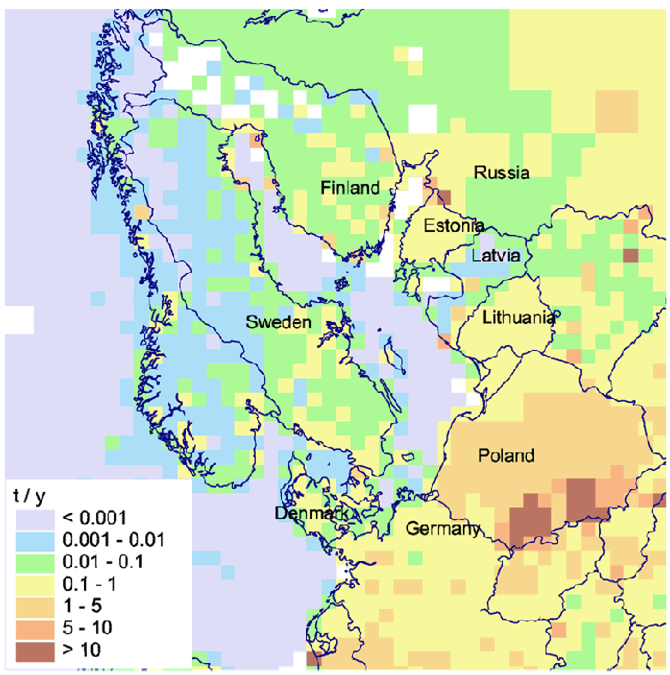


Figure 4.1. Annual total anthropogenic emissions of lead in the Baltic Sea region for 2006, t/y.

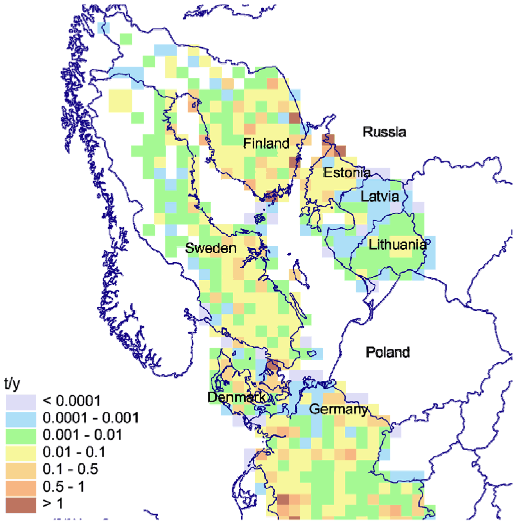


Figure 4.2. Annual lead emission from Combustion in Power Plants and Industry sector for 2006, t/y.

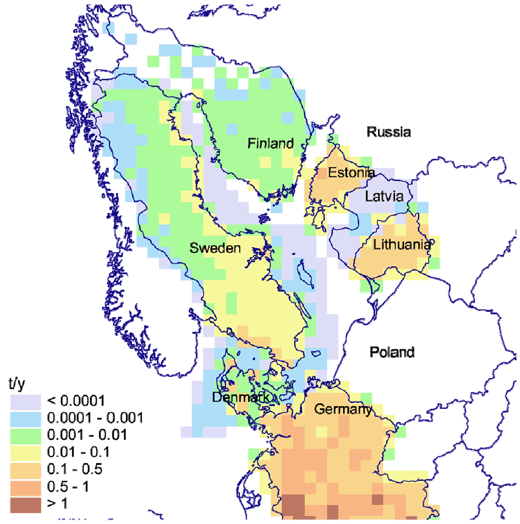


Figure 4.3. Annual lead emission from Transport sector for 2006, t/y.

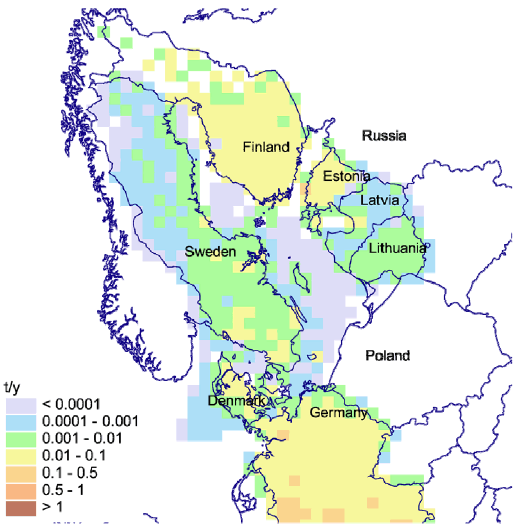


Figure 4.4. Annual lead emission from Commercial, Residential and Other Stationary Combustion sector for 2006, t/y.

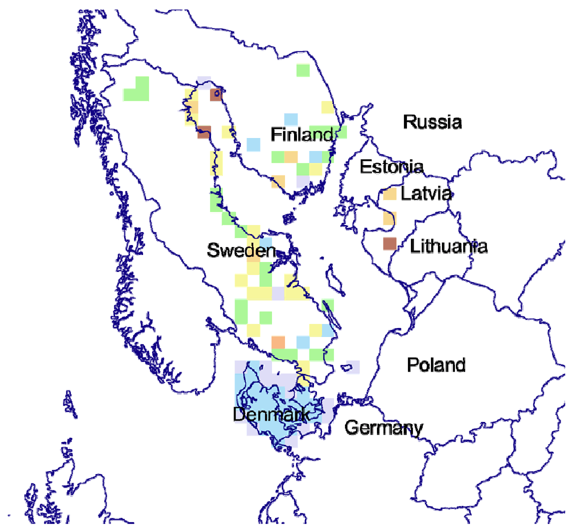


Figure 4.5. Annual lead emission from Industrial processes sector for 2006, t/y.

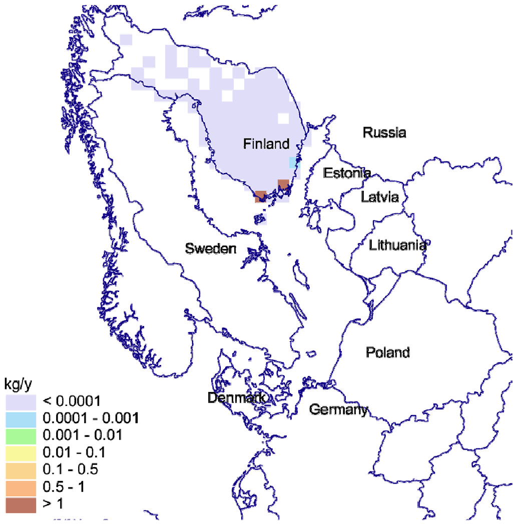


Figure 4.6. Annual lead emission from Solvent and Other Product Use sector in Finland for 2006, kg/y.

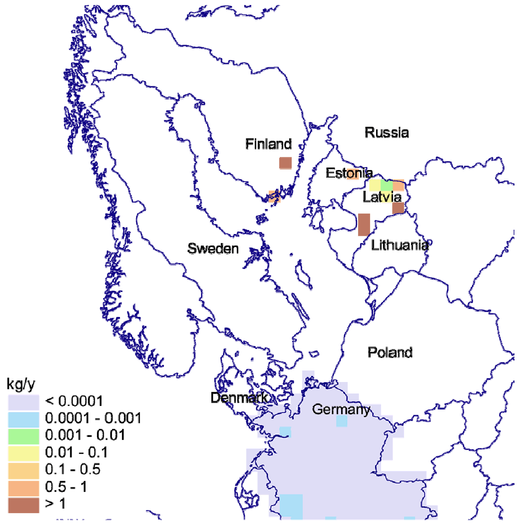


Figure 4.7. Annual lead emission from Waste sector for 2006, kg/y.

Table 4.1. Annual total lead anthropogenic emissions of HELCOM countries from different sectors for 2006, in tonnes per year

NFR emission sector	Sector name	Denmark	Estonia	Finland	Germany	Latvia	Lithuania	Poland	Russia	Sweden
1	Combustion in Power Plants and Industry	4.4	29.0	16.1	13.2	0.058	0.7	267.3	355.0	4.3
2a	Transport above 1000m	0	NA	0.1	NE	NA	NA	NA	NA	NE
2b	Transport below 1000m	1.4	4.0	0.4	83.2	0.002	5.2	17.8		4.4
3	Commercial, Residential and Other Stationary Combustion	0.4	0.8	2.6	9.6	0.057	0.1	147.6		0.7
4	Fugitive Emissions From Fuels		NA	0.02				2.1		NA
5	Industrial Processes	0.1	0	5.4	1.6	17.3		88.0		4.5
6	Solvent and Other Product Use	NA	NA	0.01				NA		
7	Agriculture							NA		
8	Waste		0.2	0.004	6.24E-06	0.037		1.4		
9	Other									
Total		**6.2**	**34.0**	**24.7**	**107.7**	**17.5**	**6.0**	**524.2**	**355.0**	**14.0**

NA – not available
NE – not estimated

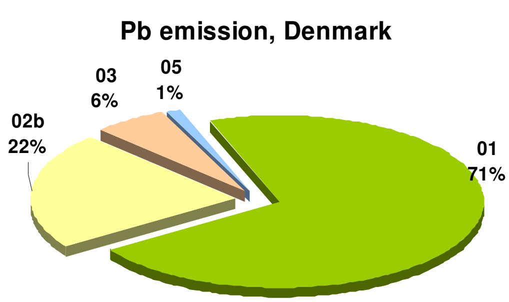


Figure 4.8. Percentage of annual total lead emission from different sectors in Denmark for 2006.

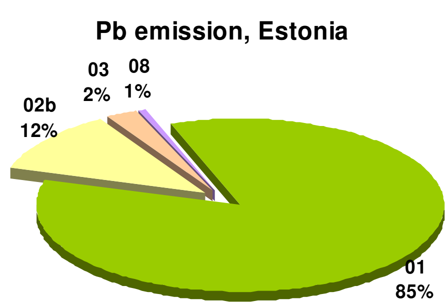


Figure 4.9. Percentage of annual total lead emission from different sectors in Estonia for 2006.

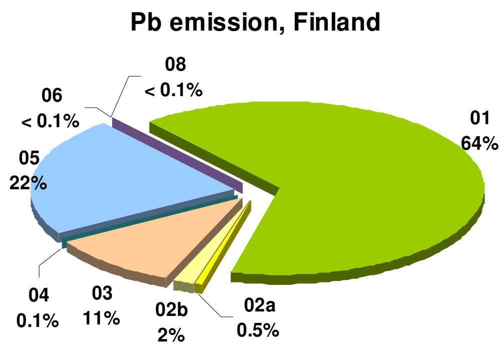


Figure 4.10. Percentage of annual total lead emission from different sectors in Finland for 2006.

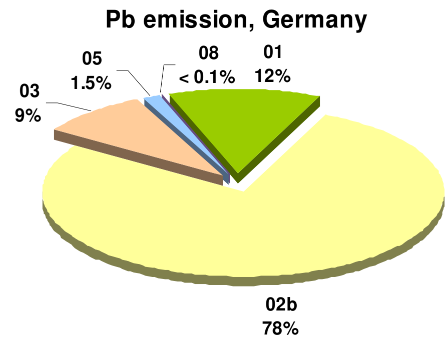


Figure 4.11. Percentage of annual total lead emission from different sectors in Germany for 2006.

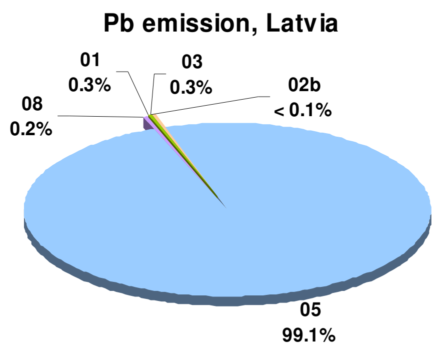


Figure 4.12. Percentage of annual total lead emission from different sectors in Latvia for 2006.

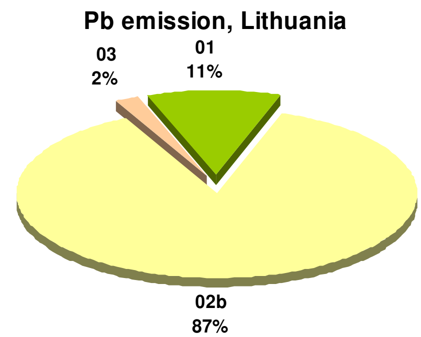


Figure 4.13. Percentage of annual total lead emission from different sectors in Lithuania for 2006.

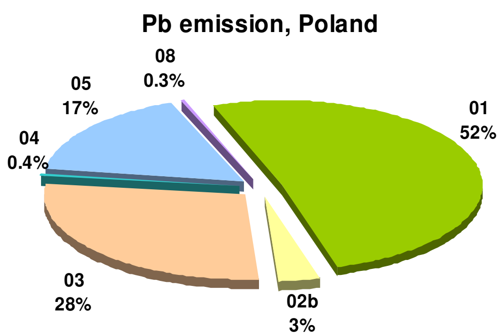


Figure 4.14. Percentage of annual total lead emission from different sectors in Poland for 2006.

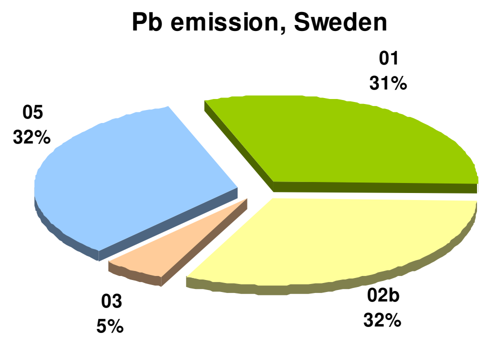


Figure 4.15. Percentage of annual total lead emission from different sectors in Sweden for 2006.

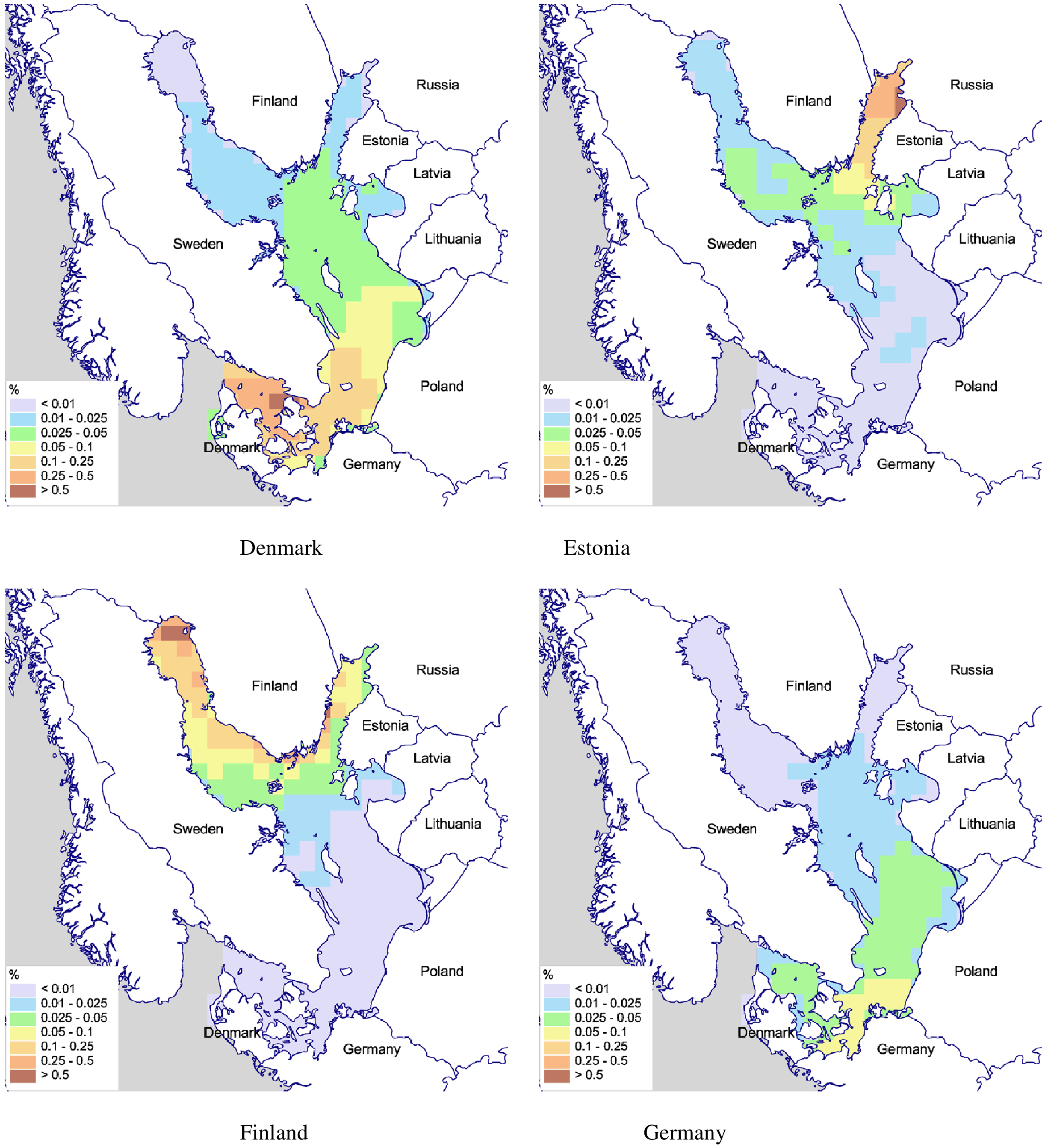
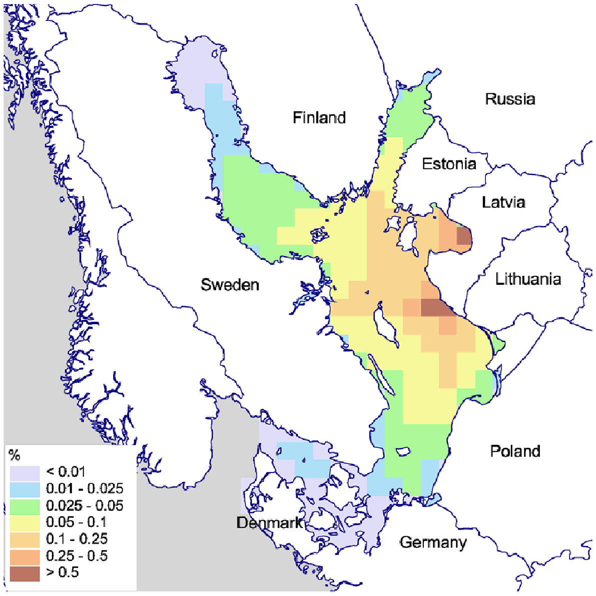
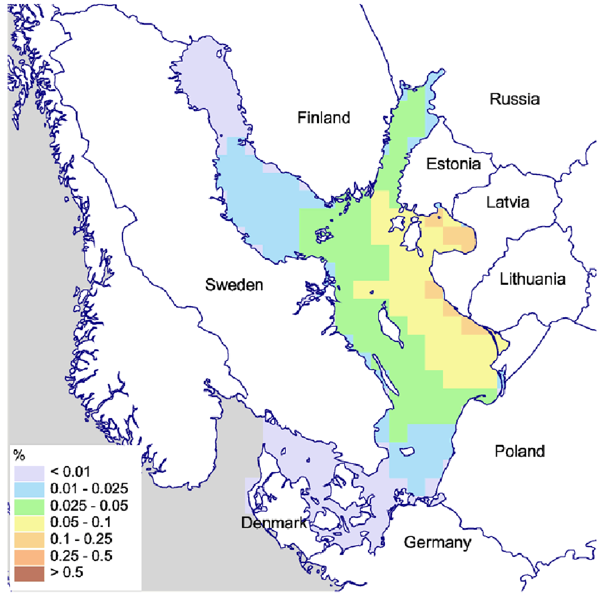


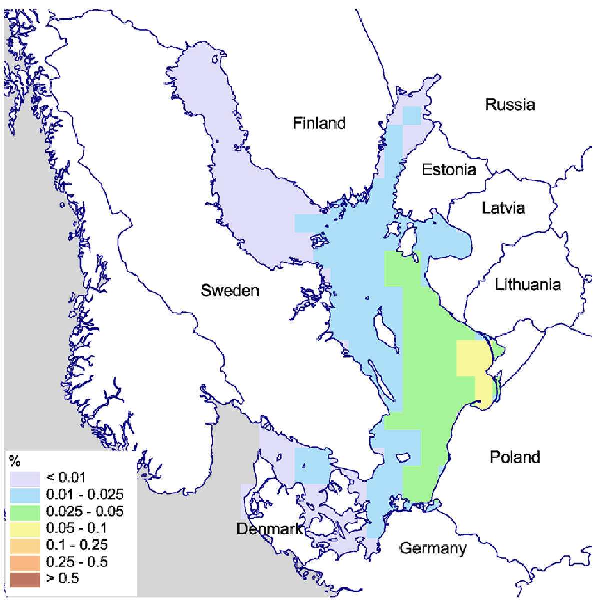
Figure 4.16. Maps with the fractions (in %) of annual total anthropogenic lead emissions from HELCOM Parties deposited into the Baltic Sea in 2006 (percent per deposition over the 50x50 km grid cell).



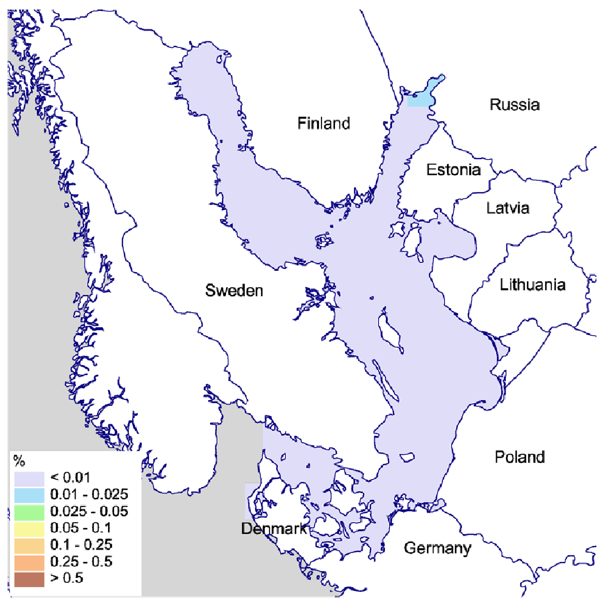
Latvia



Lithuania

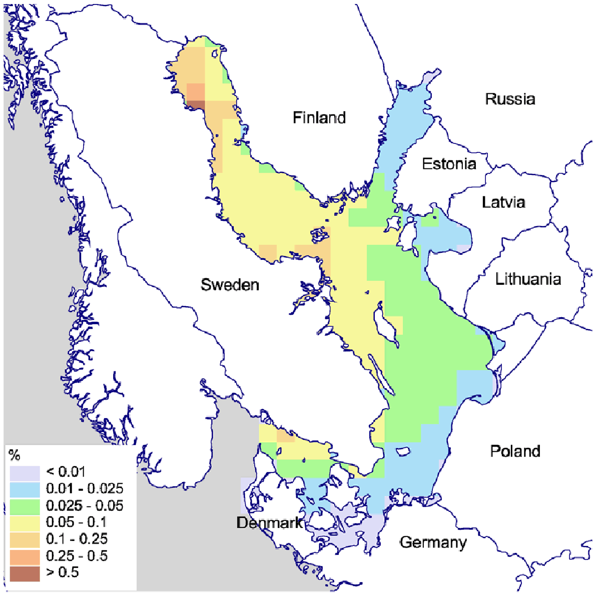


Poland



Russia

Figure 4.16. **(cont.)** Maps with the fractions (in %) of annual total anthropogenic lead emissions from HELCOM Parties deposited into the Baltic Sea in 2006 (percent per deposition over the 50x50 km grid cell).



Sweden

Figure 4.16. **(cont.)** Maps with the fractions (in %) of annual total anthropogenic lead emissions from HELCOM Parties deposited into the Baltic Sea in 2006 (percent per deposition over the 50x50 km grid cell).

Table 4.2. Annual total anthropogenic emissions of lead of HELCOM countries and other EMEP countries in period 1990-2006, tonnes (Expert estimates of emissions are shaded)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Denmark	120	97	88	47	12	12	10	7.7	7.0	7.1	6.8	6.1	5.3	5.0	5.3	5.7	6.2
Estonia	201	185	121	101	124	84	65	52	46	44	37	34	34	39	38	37	34
Finland	327	248	174	99	58	56	35	18	21	15	36	38	40	34	28	24	25
Germany	1801	1055	761	606	405	331	222	95	94	95	102	105	106	105	106	107	108
Latvia	21	17	9.8	7.6	9.6	8.1	9.9	12	13	12	12	12	12	13	13	14	18
Lithuania	47	49	32	28	33	30	18	20	22	19	16	15	15	15	5.2	5.7	6.0
Poland	1372	1336	986	997	966	937	960	896	736	745	647	610	588	596	600	536	524
Russia	3591	3553	3095	3276	2643	2426	2304	2247	2262	2339	2352	2235	2118	2207	330	355	355
Sweden	361	317	296	144	51	37	33	33	32	29	26	23	20	19	18	15	14
HELCOM	**7840**	**6856**	**5563**	**5304**	**4301**	**3920**	**3656**	**3380**	**3233**	**3306**	**3235**	**3079**	**2939**	**3034**	**1143**	**1099**	**1089**
Albania	33	34	35	36	37	38	39	40	41	42	43	39	35	32	28	24	20
Armenia	11	0.820	0.610	0.790	0.340	0.334	0.009	0.009	0.010	0.005	0.005	0.503	1.0	2.5	2.6	2.7	2.7
Austria	207	172	120	86	60	16	15	14	13	12	12	12	12	13	13	14	14
Azerbaijan	12	12	12	12	12	12	12	12	12	12	12	13	13	13	13	14	14
Belarus	794	519	450	377	348	147	46	42	41	38	46	41	44	43	45	50	57
Belgium	442	418	397	320	259	247	251	267	189	155	118	102	72	68	81	77	76
Bosnia and Herzegovina	97	97	97	97	97	97	97	97	97	97	97	91	85	79	72	66	60
Bulgaria	436	408	381	353	325	297	279	231	251	224	213	177	105	148	143	115	124
Croatia	466	426	385	345	304	264	268	190	183	178	147	107	60	23	16	12	9.1
Cyprus	31	31	33	33	33	33	33	32	30	29	27	26	24	23	9.8	3.8	4.0
Czech Republic	269	240	247	232	202	180	165	180	169	157	108	47	47	39	37	47	43
France	4272	2866	2084	1830	1627	1450	1280	1132	1013	778	252	214	208	156	142	138	128
Georgia	6.9	6.9	6.9	6.9	6.9	6.9	6.9	6.9	6.9	6.9	6.9	7.0	7.2	7.3	7.5	7.6	7.8
Greece	505	499	493	488	482	476	470	470	470	470	470	470	470	470	470	470	470
Hungary	663	488	208	187	155	130	100	90	82	39	42	51	34	34	34	38	37
Iceland	6.4	5.8	5.1	4.5	3.9	3.3	2.7	2.1	1.4	0.816	0.197	0.197	0.197	0.197	0.197	0.197	0.197
Ireland	127	114	120	103	91	79	65	68	45	41	30	18	17	16	16	17	16
Italy	4378	3318	2440	2240	2049	1928	1804	1610	1449	1263	935	702	237	242	256	266	274
Kazakhstan	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18
Luxembourg	77	71	65	59	53	30	26	18	6.8	2.3	1.8	2.0	1.9	1.9	1.9	1.9	1.9
Malta	0.695	0.695	0.695	0.695	0.695	0.695	0.695	0.695	0.695	0.695	0.695	0.769	0.756	0.816	0.790	0.816	0.826
Monaco	3.9	4.0	4.1	3.7	2.1	0.780	0.673	0.564	0.486	0.427	0.059	0.063	0.056	0.046	0.041	0.041	0.030
Netherlands	338	294	250	225	191	162	111	63	52	44	37	41	45	41	43	39	39
Norway	187	144	129	89	25	23	12	11	11	10	9.0	8.2	9.3	9.0	10	7.6	7.6
Portugal	593	611	656	636	608	586	569	544	531	358	165	185	184	187	188	177	177
Republic of Moldova	249	220	103	71	23	34	28	22	7.9	11	2.8	3.4	3.3	11	2.3	5.1	5.0
Romania	585	573	561	550	538	526	514	502	491	420	402	476	398	319	241	162	118
Serbia and Montenegro	597	567	538	508	478	448	419	389	359	329	300	275	250	225	200	176	151
Slovakia	150	149	148	116	84	71	73	73	70	58	67	68	69	64	70	71	73
Slovenia	329	292	289	307	307	197	81	69	54	47	44	27	18	19	17	17	18
Spain	2681	1809	1220	1115	1104	932	902	839	779	709	589	389	268	265	261	267	270
Switzerland	429	387	342	288	254	192	163	144	124	59	36	33	29	26	25	24	24
The FYR of Macedonia	210	198	185	173	161	148	136	124	112	99	87	83	79	74	70	66	62
Turkey	765	765	765	765	765	765	765	765	765	765	765	717	669	620	572	524	476
Ukraine	3878	3586	3293	3001	2709	2417	2124	1832	1540	1248	955	663	145	123	195	304	297
United Kingdom	2913	2657	2435	2160	1859	1549	1316	1153	849	493	163	155	142	129	134	117	106
EMEP	**34603**	**28859**	**24080**	**22141**	**19576**	**17426**	**15851**	**14429**	**13097**	**11522**	**9438**	**8337**	**6737**	**6576**	**4579**	**4438**	**4290**

Expert estimates:

§ *Denier van der Gon, H.A.C., M. van het Bolscher A.J.H. Visschedijk P.Y.J. Zandveld [2006]*

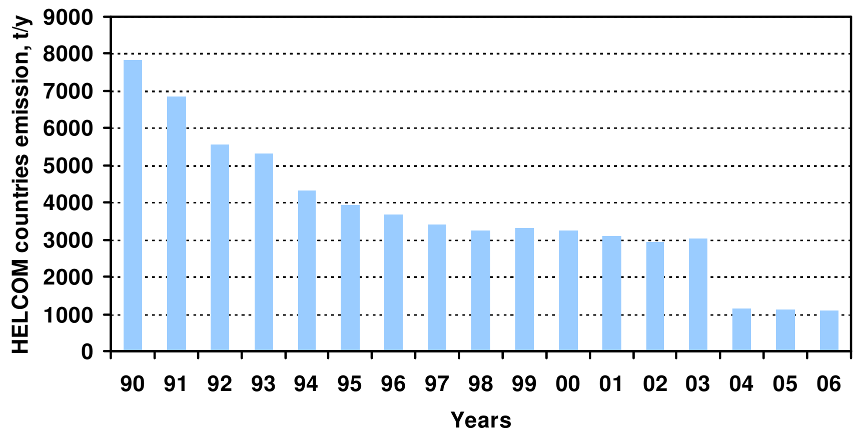


Figure 4.17. Time-series of total annual lead emissions of HELCOM countries in 1990-2006, tonnes/y.

4.2 Annual total depositions of lead

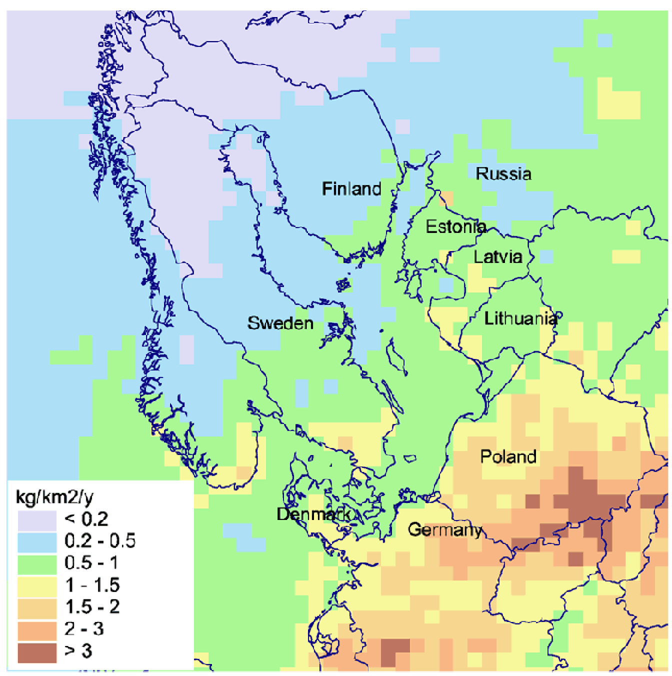


Figure 4.18. Annual total deposition fluxes of lead over the Baltic Sea region for 2006, kg/km^2/year.

4.3 Monthly total depositions of lead

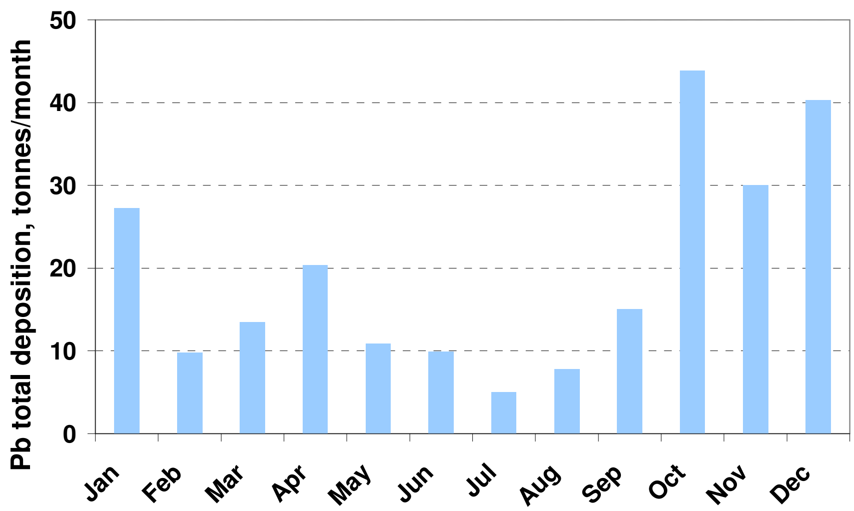


Figure 4.19. Monthly total depositions of lead to the Baltic Sea for 2006, tonnes/month.

Table 4.3. Monthly total depositions of lead to the Baltic Sea for 2006, tonnes/month.

Month	Deposition
Jan	27
Feb	10
Mar	13
Apr	20
May	11
Jun	10
Jul	5
Aug	8
Sep	15
Oct	44
Nov	30
Dec	40

4.4 Source allocation of lead deposition

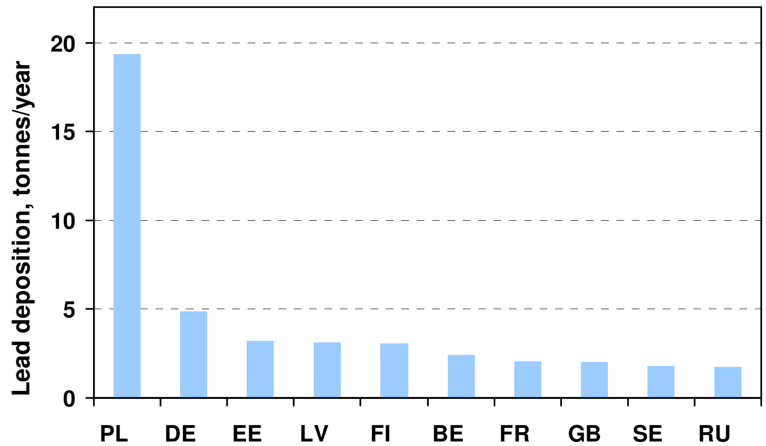


Figure 4.20. Top ten countries with the highest contribution to annual total deposition of lead into the Baltic Sea for 2006, tonnes/year.

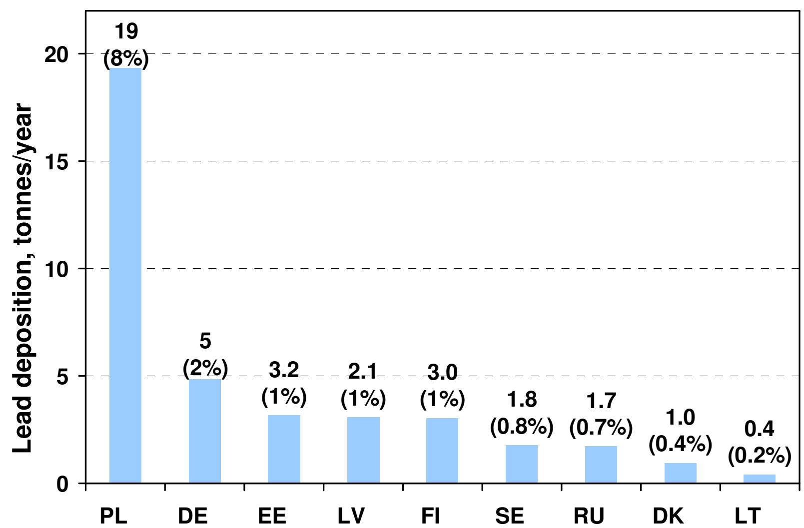


Figure 4.21. Sorted contributions (in %) of HELCOM countries to total depositions to the Baltic Sea for 2006. HELCOM countries emissions of lead contributed about 16% to the total annual lead depositions over the Baltic Sea in 2006. Contribution of other EMEP countries accounted for 7%. Significant contribution was made by other emission sources, in particular, remote emissions sources, natural emissions and re-emission of lead (76%).

Table 4.4. Two most significant contributors to the annual total depositions of lead to the six Baltic Sea sub-basins for 2006.

Sub-basin	Country	%	Country	%	*, %
GUB	Finland	7	Poland	6	73
GUF	Estonia	13	Poland	6	67
GUR	Poland	9	Latvia	4	75
BAP	Poland	10	Germany	2	76
BES	Germany	4	Poland	3	82
KAT	Poland	3	Germany	2	83
BAS	Poland	8	Germany	2	76

* - contribution of re-emission, natural and remote sources.

4.5 Comparison of model results with measurements

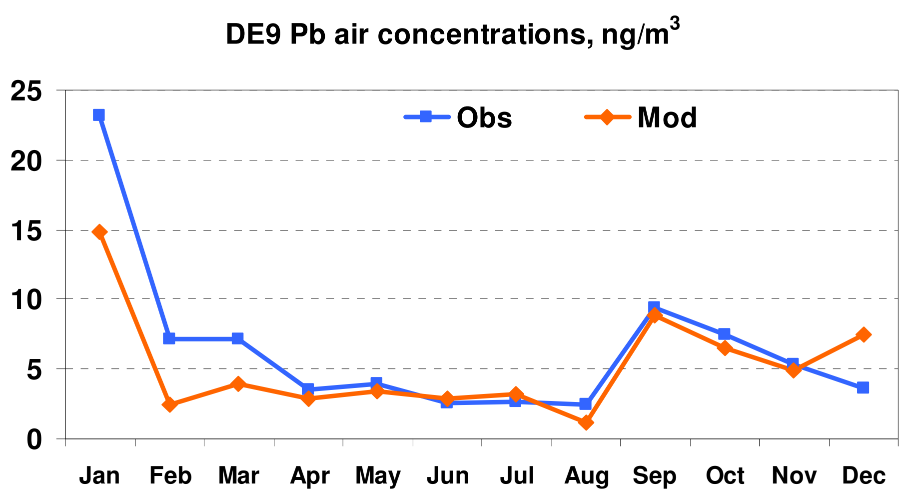


Figure 4.22. Comparison of calculated mean monthly lead concentrations in air for 2006 with measurements of the station Zingst (DE9). Units: ng / m^3.

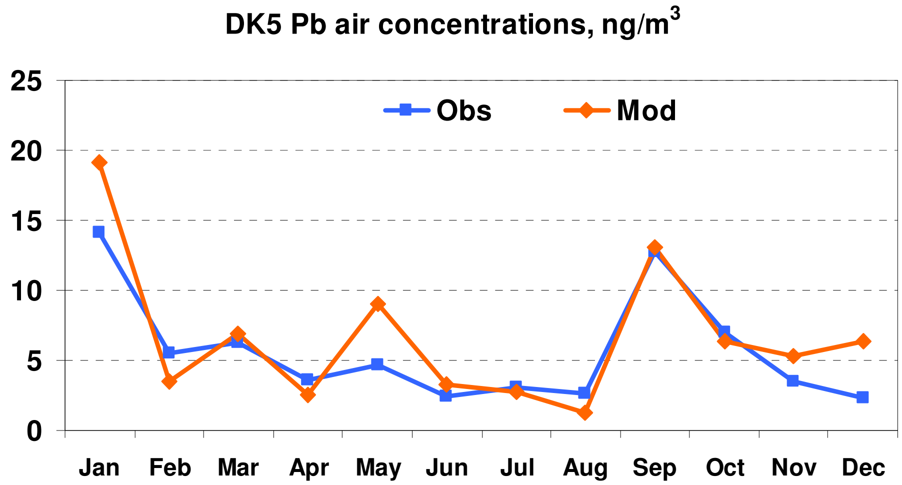


Figure 4.23. Comparison of calculated mean monthly lead concentrations in air for 2006 with measurements of the station Keldsnor (DK5). Units: ng / m^3.

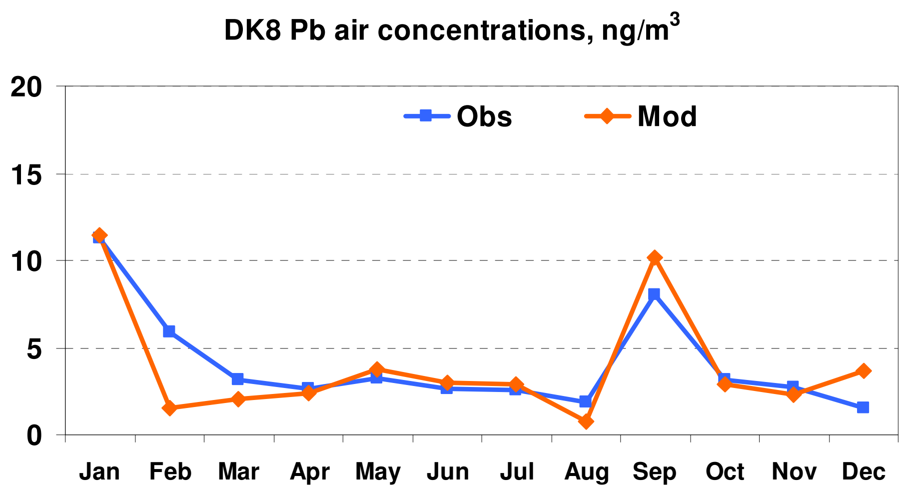


Figure 4.24. Comparison of calculated mean monthly lead concentrations in air for 2006 with measurements of the station Anholt (DK8). Units: ng / m^3.

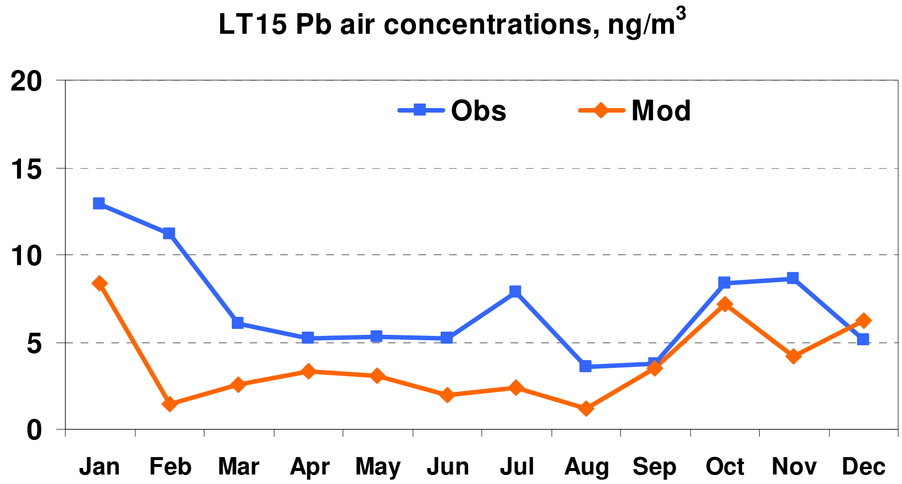


Figure 4.25. Comparison of calculated mean monthly lead concentrations in air for 2006 with measurements of the station Preila (LT15). Units: ng / m^3.

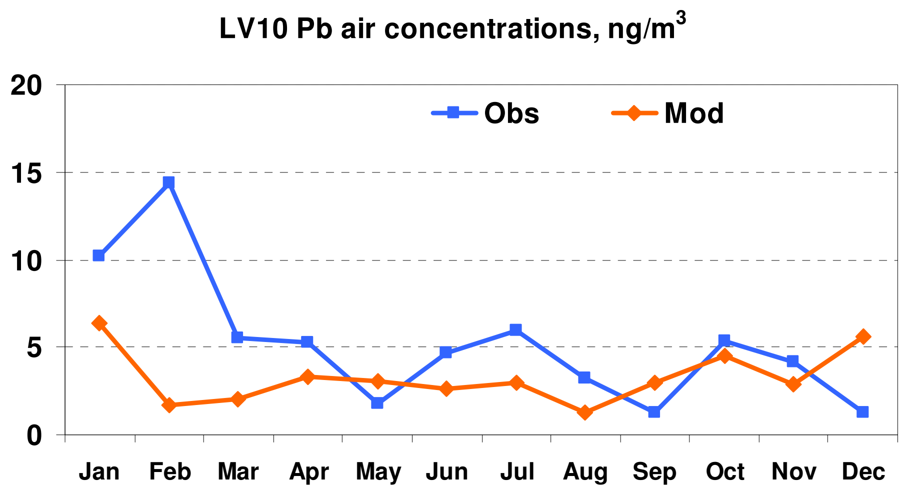


Figure 4.26. Comparison of calculated mean monthly lead concentrations in air for 2006 with measurements of the station Rucava (LV10). Units: ng / m^3.

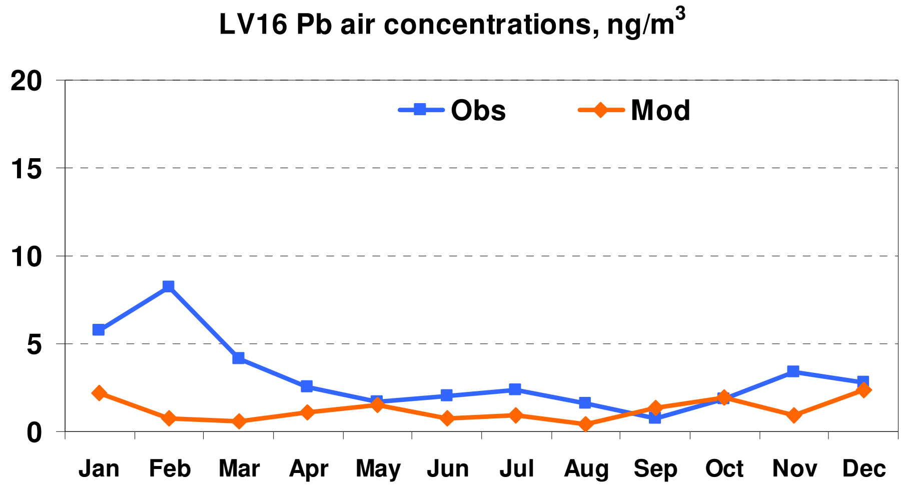


Figure 4.27. Comparison of calculated mean monthly lead concentrations in air for 2006 with measurements of the station Zoseni (LV16). Units: ng / m^3.

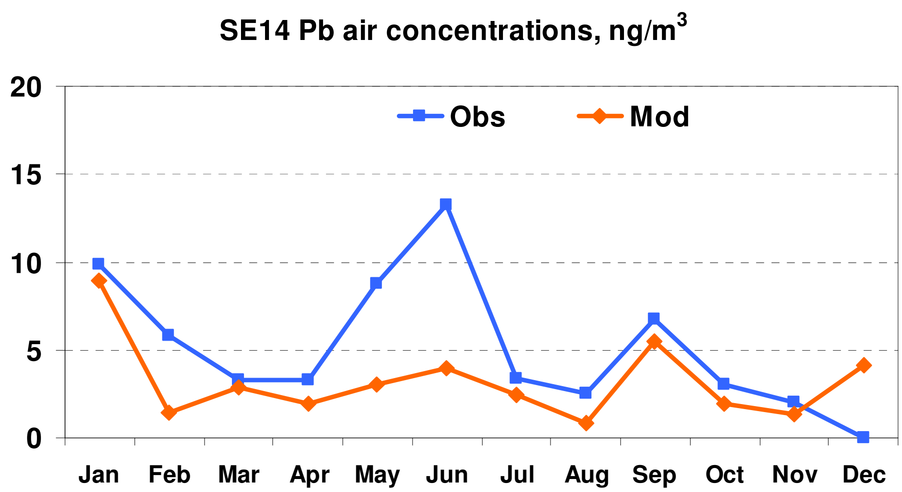


Figure 4.28. Comparison of calculated mean monthly lead concentrations in air for 2006 with measurements of the station Räo (SE14). Units: ng / m^3.

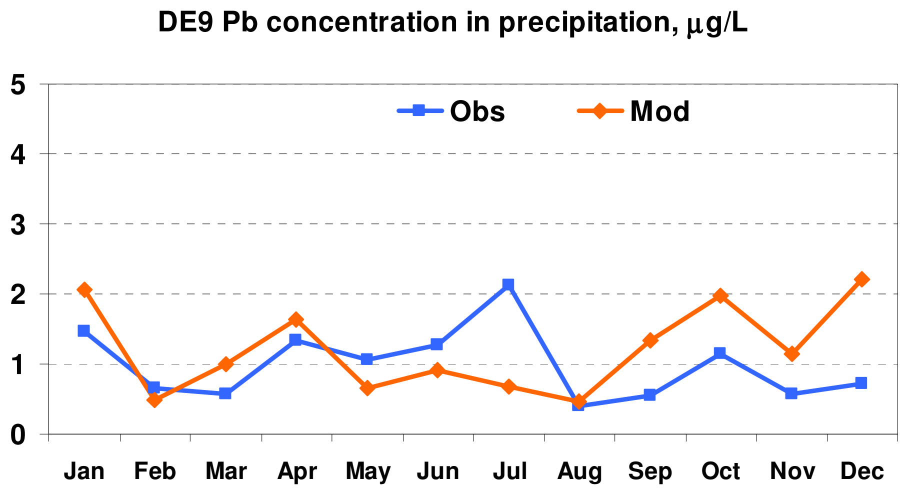


Figure 4.29. Comparison of calculated mean monthly lead concentrations in precipitation for 2006 with measurements of the station Zingst (DE09). Units: µg / L.

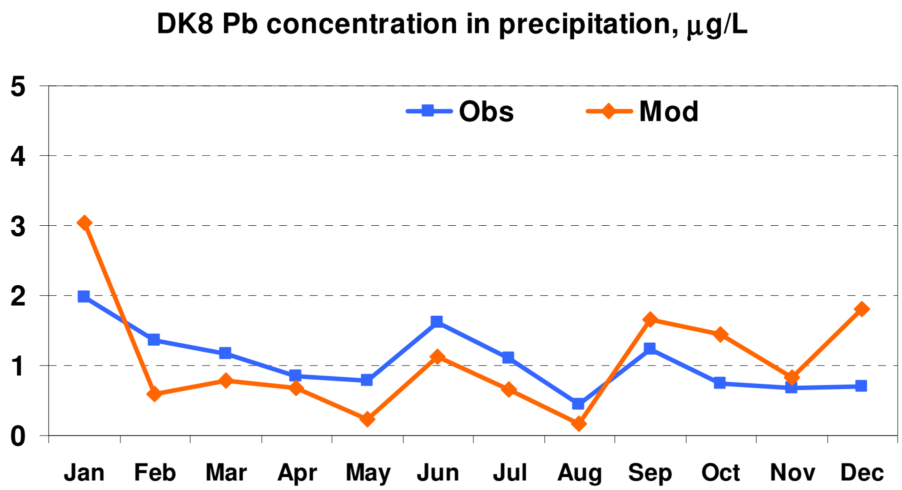


Figure 4.30. Comparison of calculated mean monthly lead concentrations in precipitation for 2006 with measurements of the station Anholt (DK08). Units: µg / L.

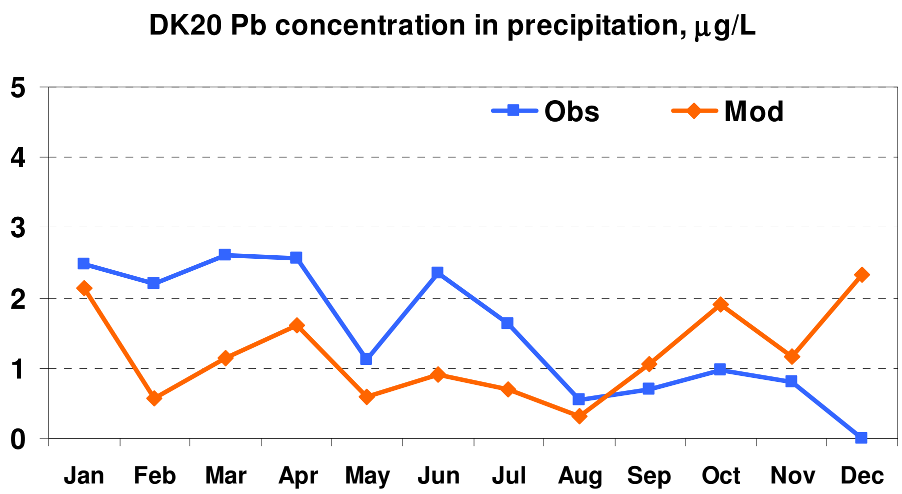


Figure 4.31. Comparison of calculated mean monthly lead concentrations in precipitation for 2006 with measurements of the station Pedersker (DK20). Units: µg / L.

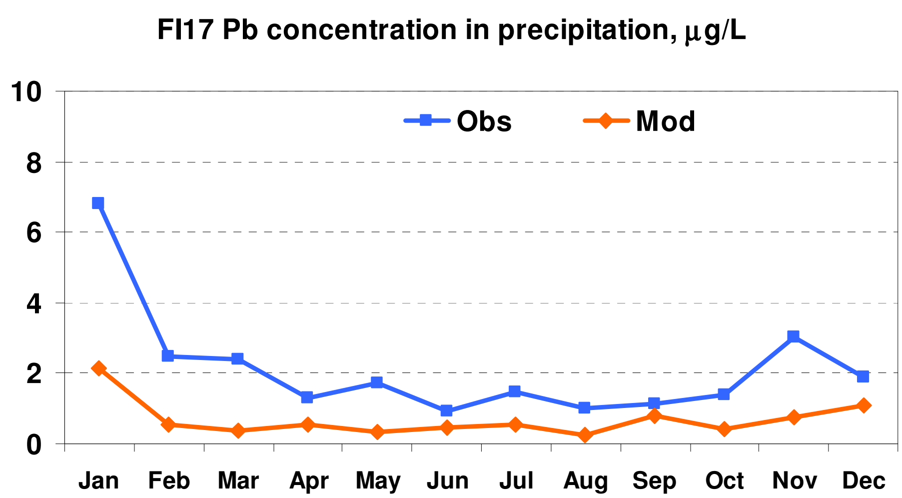


Figure 4.32. Comparison of calculated mean monthly lead concentrations in precipitation for 2006 with measurements of the station Virolahty II (FI17). Units: µg / L.

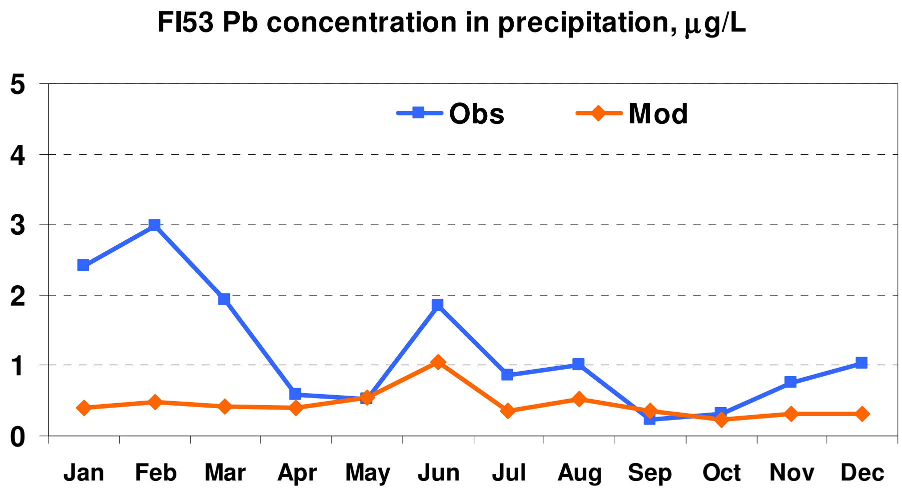


Figure 4.33. Comparison of calculated mean monthly lead concentrations in precipitation for 2006 with measurements of the station Hailuoto (FI53). Units: µg / L.

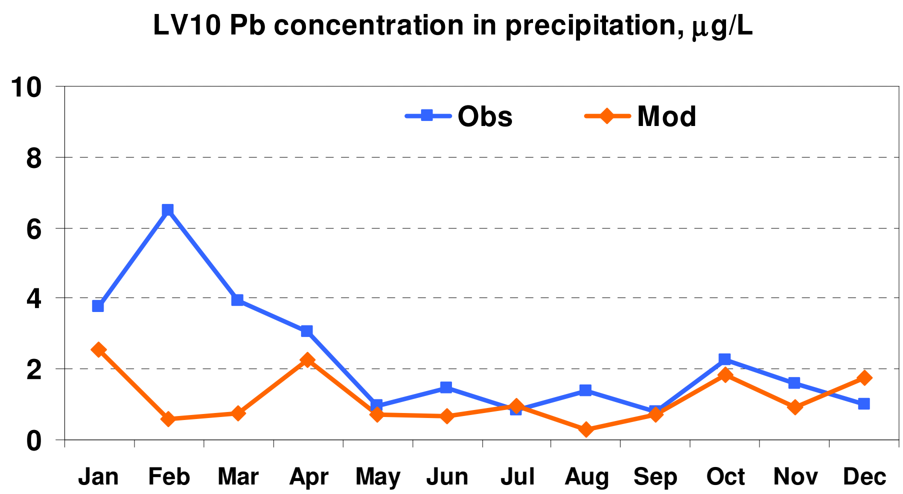


Figure 4.34. Comparison of calculated mean monthly lead concentrations in precipitation for 2006 with measurements of the station Rucava (LV10). Units: µg / L.

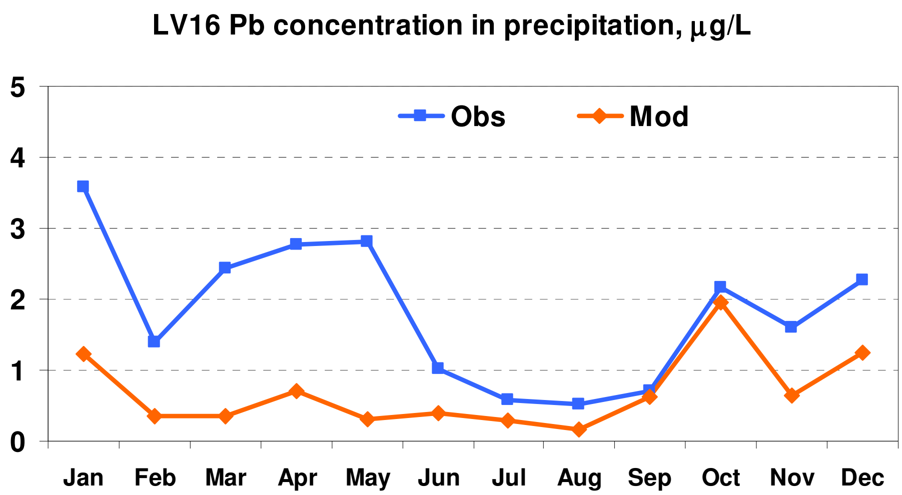


Figure 4.35. Comparison of calculated mean monthly lead concentrations in precipitation for 2006 with measurements of the station Zoseni (LV16). Units: µg / L.

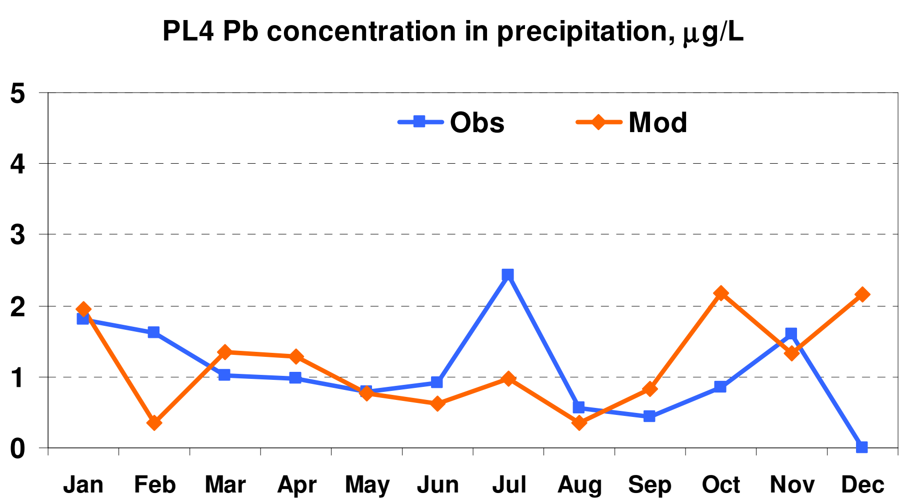


Figure 4.36. Comparison of calculated mean monthly lead concentrations in precipitation for 2006 with measurements of the station Leba (PL04). Units: µg / L.

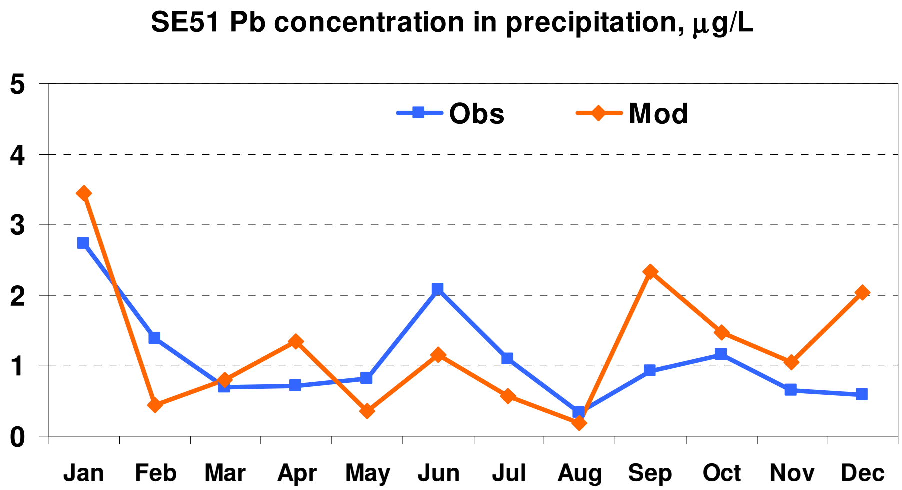


Figure 4.37. Comparison of calculated mean monthly lead concentrations in precipitation with measured at station Arup (SE51). Units: µg / L.

It can be seen that in general, computed concentrations of lead in air and in precipitation obtained for the selected monitoring sites around the Baltic Sea reasonably agree with the measured concentrations. Some deviations between simulated and observed monthly mean concentrations of lead can be connected with the uncertainties in seasonal variation of lead emission used in modeling, differences between measured precipitation amount and the one used in the model, and difficulties in measurements of heavy metals.

5. Atmospheric Supply of Cadmium to the Baltic Sea in 2006

In this chapter the results of model evaluation of cadmium atmospheric input to the Baltic Sea and its sub-basins for 2006 is presented. Modelling of cadmium atmospheric transport and depositions was carried out using MSC-E Eulerian Heavy Metal transport model MSCE-HM (*Travnikov and Ilyin*, 2005). Latest available official information on cadmium emission from HELCOM countries and other European countries was used in computations. Based on these data levels of annual and monthly cadmium depositions to the Baltic Sea region have been obtained and contributions of HELCOM countries emission sources to the depositions over the Baltic Sea are estimated. Model results were compared with observed levels of cadmium concentrations in air and precipitation measured at monitoring sites around the Baltic Sea in 2006.

5.1 Cadmium emissions

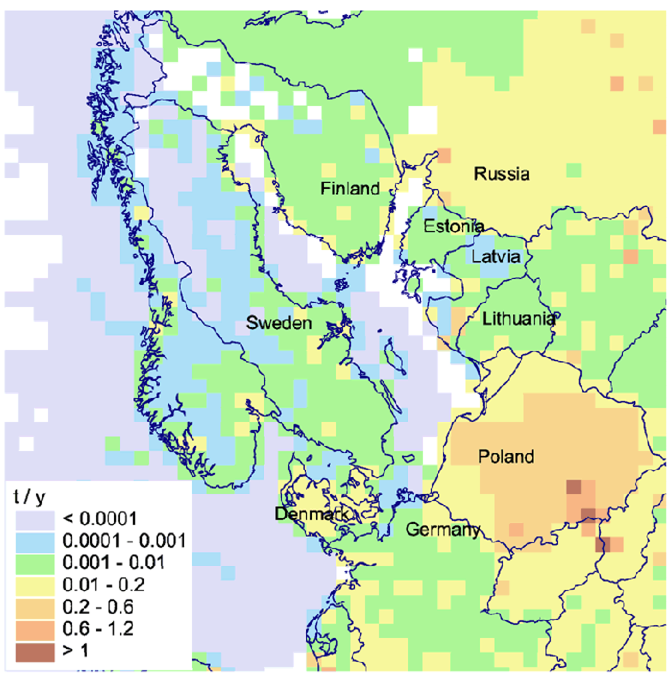


Figure 5.1. Annual total anthropogenic emissions of cadmium in the Baltic Sea region for 2006, t/y.

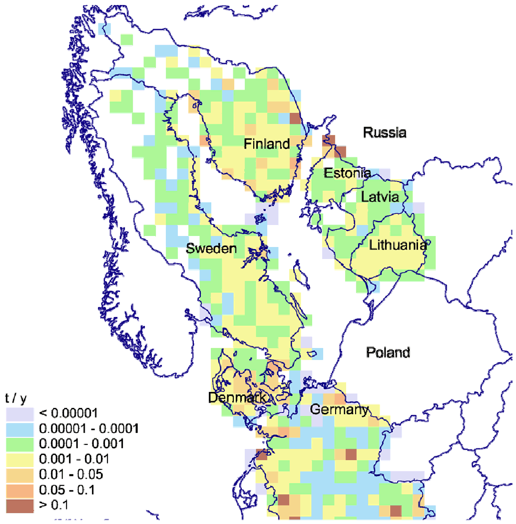


Figure 5.2. Annual cadmium emission from Combustion in Power Plants and Industry sector for 2006, t/y.

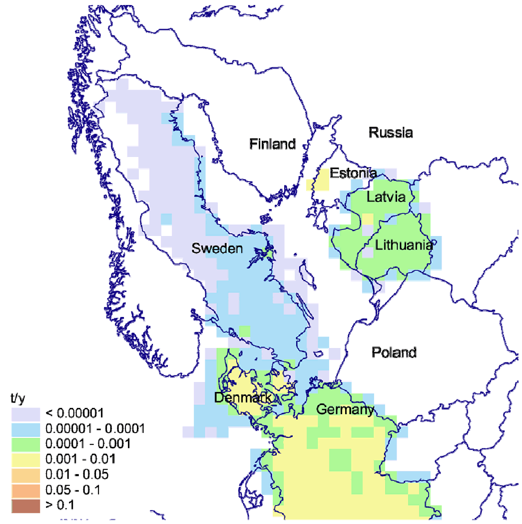


Figure 5.3. Annual cadmium emission from Transport sources below 1000 m sector for 2006, t/y.

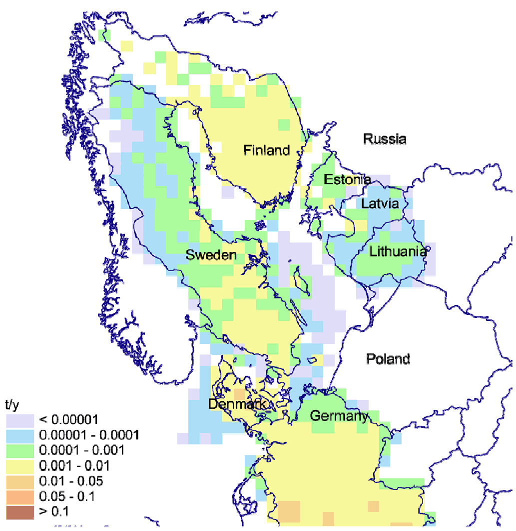


Figure 5.4. Annual cadmium emission from Commercial, Residential and Other Stationary Combustion sector for 2006, t/y.

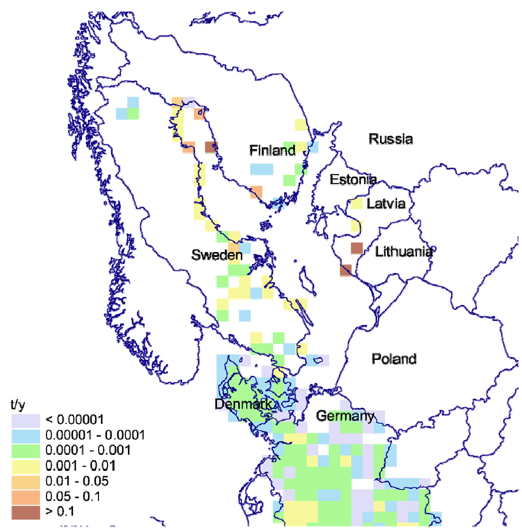


Figure 5.5. Annual cadmium emission from Industrial Processes sector for 2006, t/y.

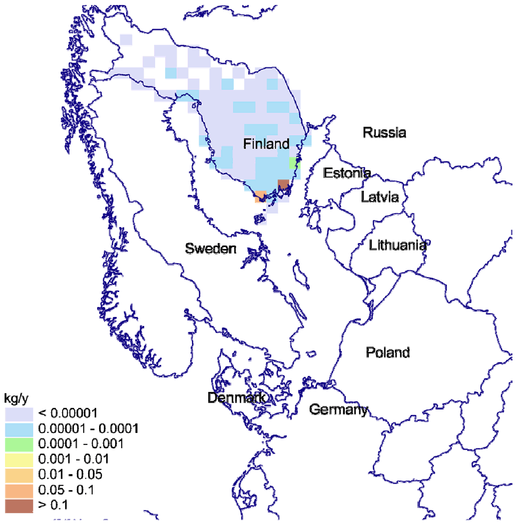


Figure 5.6. Annual cadmium emission from Solvent and Other Product Use sector for 2006, kg/y.

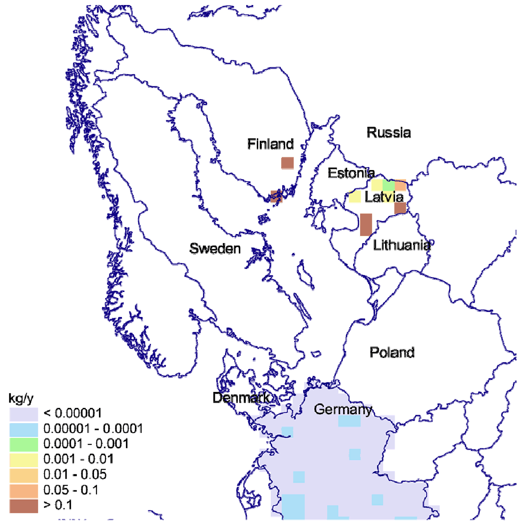


Figure 5.7. Annual cadmium emission from Waste sector for 2006, kg/y.

Table 5.1. Annual total anthropogenic emissions of cadmium of HELCOM countries from different sectors for 2006, in tonnes per year

NFR emission sector	Sector name	Denmark	Estonia	Finland	Germany	Latvia	Lithuania	Poland	Russia	Sweden
1	Combustion in Power Plants and Industry	0.43	0.52	0.75	1.62	0.03	0.35	12.16	59.40	0.23
2a	Transport above 1000m	0.0003	NA	NA	NE	NA	NA	NA	NA	NE
2b	Transport below 1000m	0.04	0.01	4.9E-07	0.30	0.01	0.01	0.41		0.004
3	Commercial, Residential and Other Stationary Combustion	0.24	0.02	0.25	0.65	0.01	0.003	26.91		0.13
4	Fugitive Emissions From Fuels		NA	NA				0.48		NA
5	Industrial Processes	0.005	0	0.29	0.08	0.55		2.11		0.16
6	Solvent and Other Product Use	NA	NA	0.0004				NA		
7	Agriculture							NA		
8	Waste		0	0.001	1.0E-06	0.003		0.12		
9	Other									
Total		**0.71**	**0.55**	**1.29**	**2.66**	**0.59**	**0.37**	**42.18**	**59.40**	**0.53**

NA – not available
NE – not estimated

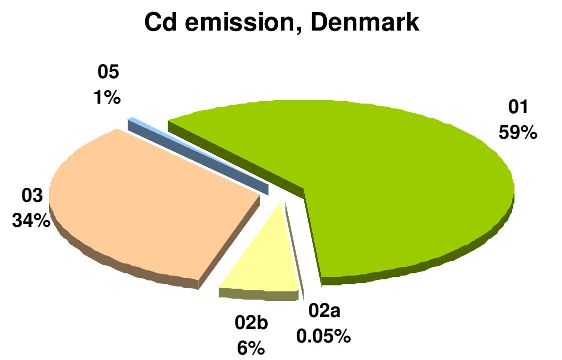


Figure 5.8. Percentage of annual total cadmium emission from different sectors in Denmark for 2006.

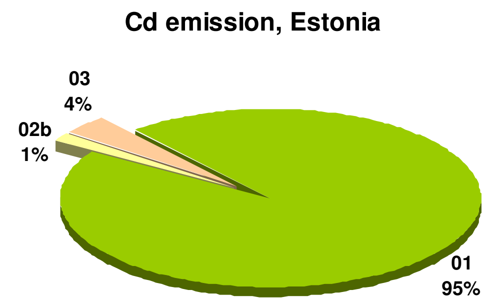


Figure 5.9. Percentage of annual total cadmium emission from different sectors in Estonia for 2006.

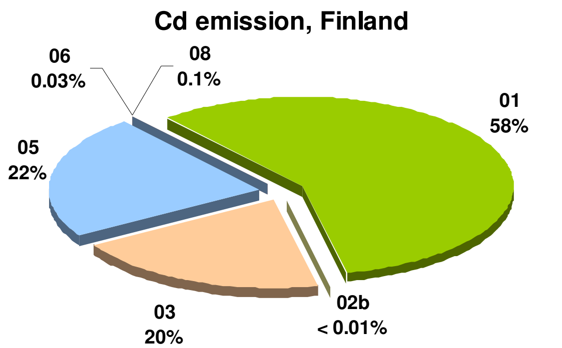


Figure 5.10. Percentage of annual total cadmium emission from different sectors in Finland for 2006.

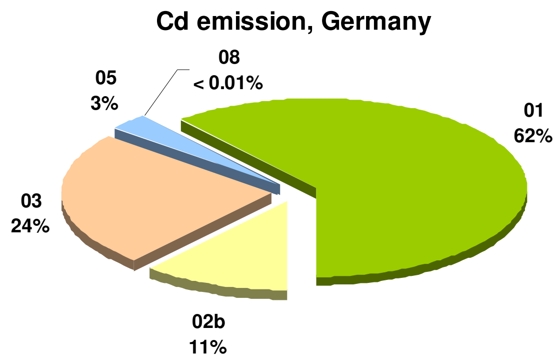


Figure 5.11. Percentage of annual total cadmium emission from different sectors in Germany for 2006.

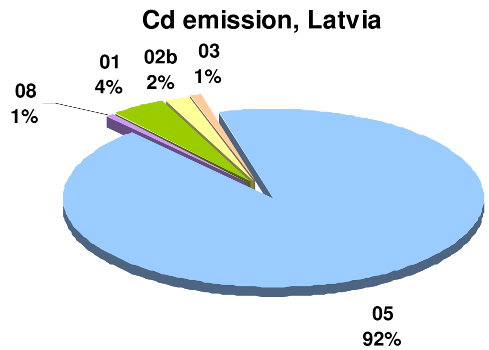


Figure 5.12. Percentage of annual total cadmium emission from different sectors in Latvia for 2006.

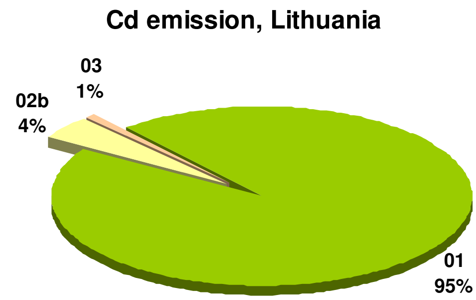


Figure 5.13. Percentage of annual total cadmium emission from different sectors in Lithuania for 2006.

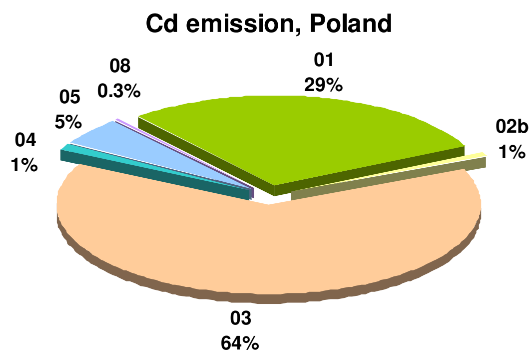


Figure 5.14. Percentage of annual total cadmium emission from different sectors in Poland for 2006.

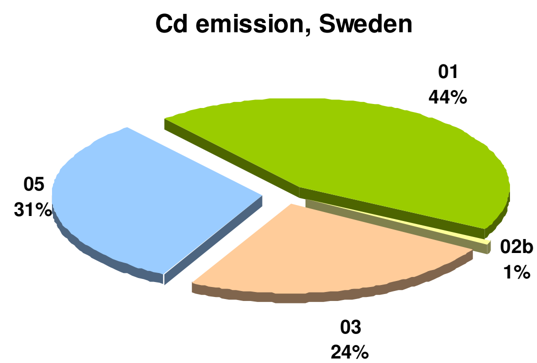
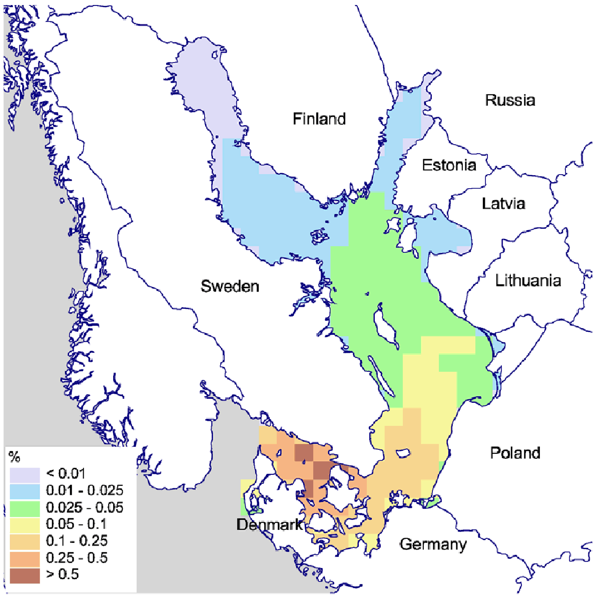
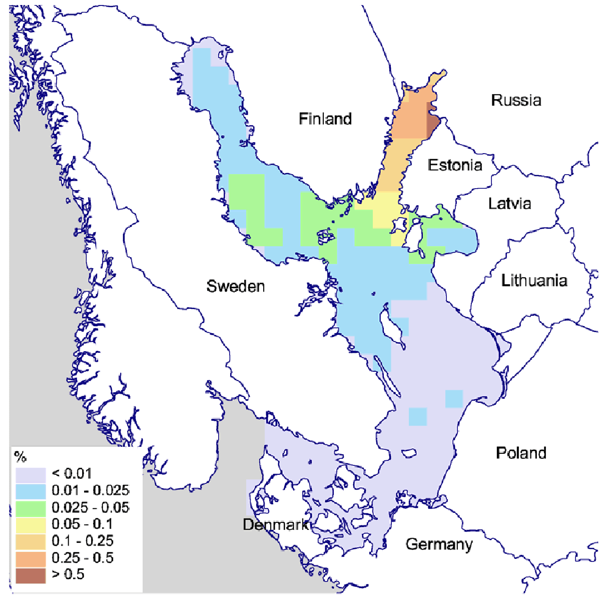


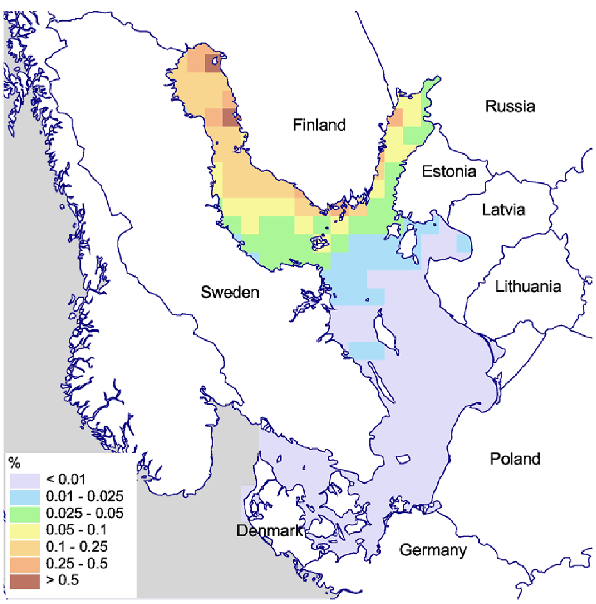
Figure 5.15. Percentage of annual total cadmium emission from different sectors in Sweden for 2006.



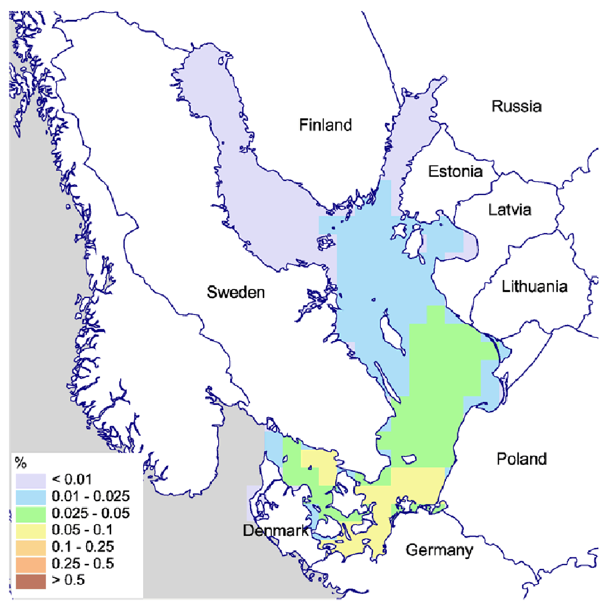
Denmark



Estonia

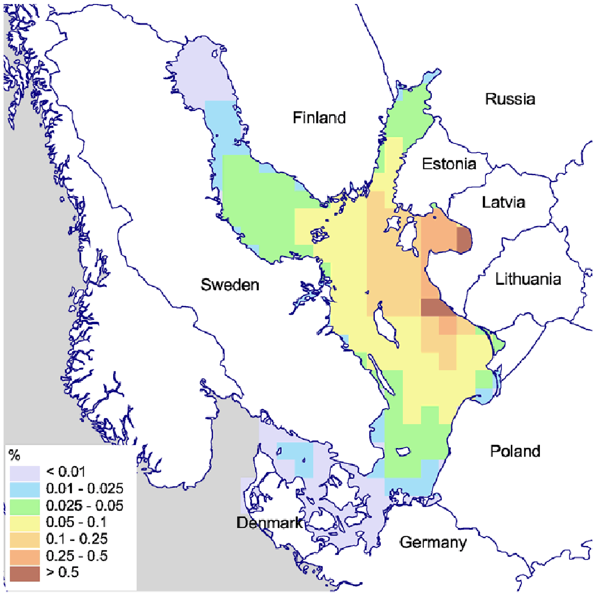


Finland

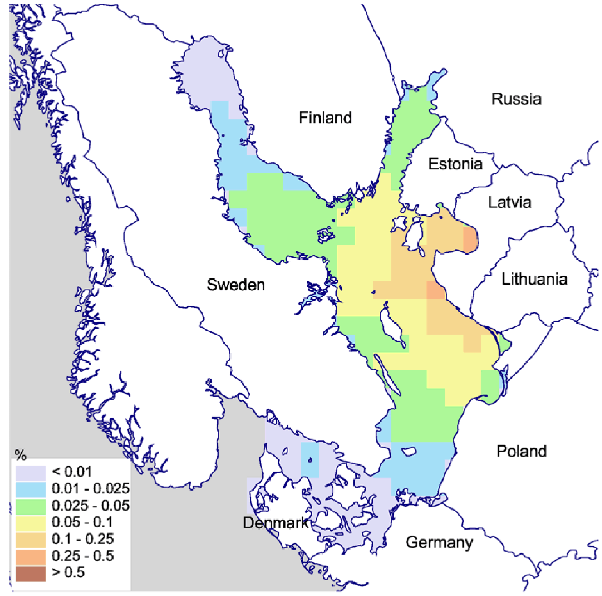


Germany

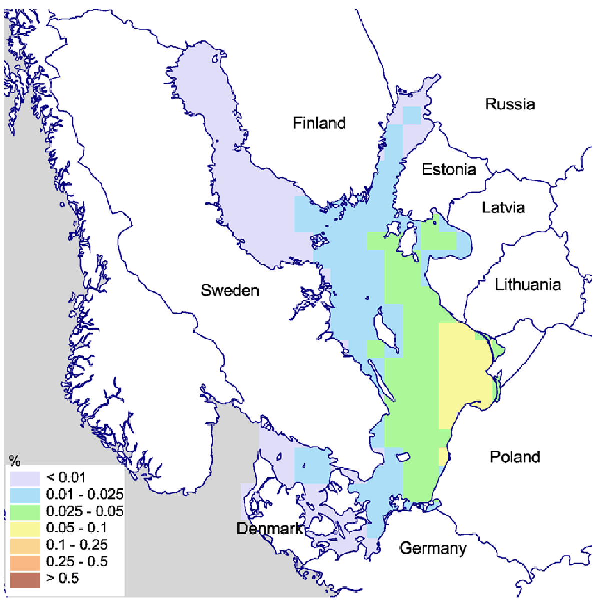
Figure 5.16. Maps with the fractions (in %) of annual total anthropogenic cadmium emissions from HELCOM Parties deposited into the Baltic Sea in 2006 (percent per deposition over the 50x50 km grid cell).



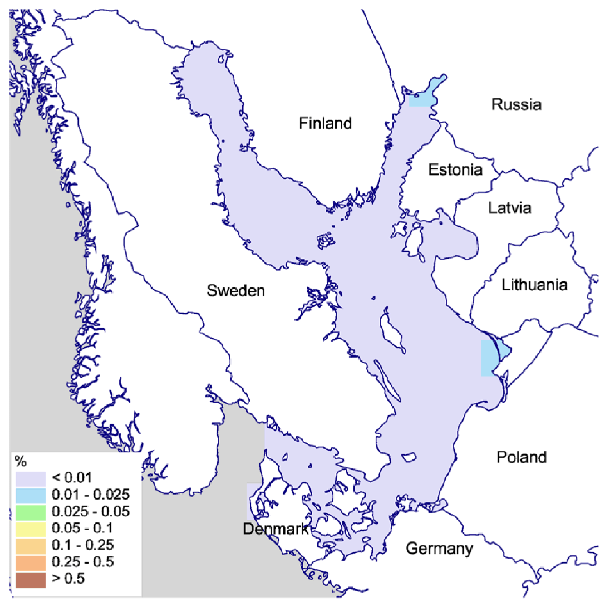
Latvia



Lithuania

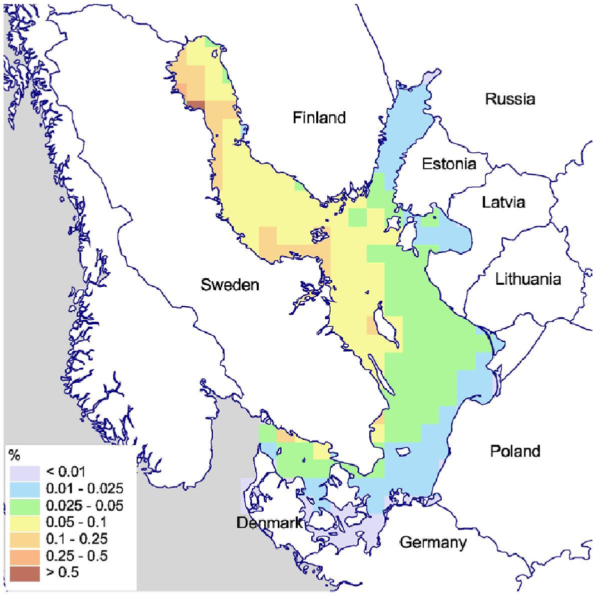


Poland



Russia

Figure 5.16. **(cont.)** Maps with the fractions (in %) of annual total anthropogenic cadmium emissions from HELCOM Parties deposited into the Baltic Sea in 2006 (percent per deposition over the 50x50 km grid cell).



Sweden

Figure 5.16. **(cont.)** Maps with the fractions (in %) of annual total anthropogenic cadmium emissions from HELCOM Parties deposited into the Baltic Sea in 2006 (percent per deposition over the 50x50 km grid cell).

Table 5.2. Annual total anthropogenic emissions of cadmium of HELCOM countries and other EMEP countries in period 1990-2006, tonnes (Expert estimates of emissions are shaded).

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Denmark	1.1	1.2	1.2	1.1	1.0	0.831	0.811	0.734	0.721	0.704	0.625	0.676	0.640	0.623	0.625	0.651	0.711
Estonia	4.4	4.2	3.0	2.2	2.9	2.0	1.0	1.1	1.0	0.945	0.605	0.560	0.560	0.620	0.586	0.576	0.548
Finland	6.3	3.5	3.0	2.8	2.2	1.6	1.5	0.860	1.3	0.562	1.3	1.6	1.3	1.2	1.5	1.3	1.3
Germany	12	8.0	5.1	3.6	2.5	2.3	2.2	2.4	2.2	2.7	2.4	2.5	2.7	2.7	2.7	2.7	2.7
Latvia	1.5	1.3	0.895	0.758	0.957	0.743	0.921	0.775	0.827	0.724	0.516	0.471	0.463	0.475	0.457	0.499	0.594
Lithuania	3.8	2.8	2.5	2.3	2.1	2.1	2.2	2.2	2.6	2.0	1.4	1.2	1.0	0.916	0.524	0.371	0.367
Poland	92	85	84	92	86	83	91	86	55	62	50	53	49	48	46	46	42
Russia	79	68	69	59	57	57	51	50.4	49.0	50.9	51	51	52	57	55	59	59
Sweden	2.3	1.7	1.4	1.1	0.753	0.730	0.699	0.694	0.613	0.528	0.511	0.592	0.517	0.501	0.516	0.514	0.527
HELCOM	**202**	**176**	**170**	**165**	**155**	**150**	**152**	**145**	**114**	**121**	**108**	**111**	**107**	**113**	**108**	**112**	**108**
Albania	0.647	0.602	0.557	0.513	0.468	0.423	0.378	0.333	0.289	0.244	0.199	0.199	0.198	0.198	0.198	0.197	0.197
Armenia	0.129	0.129	0.129	0.129	0.129	0.129	0.129	0.129	0.129	0.129	0.129	0.132	0.135	0.137	0.140	0.143	0.146
Austria	1.6	1.5	1.2	1.2	1.1	0.974	0.995	0.971	0.900	0.975	0.946	0.979	0.998	1.0	1.0	1.1	1.1
Azerbaijan	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.4	2.4	2.5	2.5	2.6
Belarus	2.1	2.2	2.0	1.7	1.3	1.1	1.2	1.3	1.5	1.4	1.4	1.8	1.9	1.8	1.8	2.1	2.5
Belgium	7.4	7.3	7.9	6.7	5.3	5.5	4.6	4.8	3.3	2.9	2.5	2.4	2.1	1.7	2.3	1.7	1.7
Bosnia and Herzegovina	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.6	1.6	1.6	1.6
Bulgaria	28	25	22	19	16	13	14	14	15	14	11	10	12	15	15	12	12
Croatia	1.6	1.5	1.3	1.2	1.1	0.950	1.0	1.0	1.1	1.1	1.0	0.874	0.929	0.948	0.877	0.826	0.838
Cyprus	0.550	0.570	0.650	0.700	0.740	0.670	0.720	0.750	0.820	0.870	0.920	0.900	1.0	0.890	1.1	1.1	1.2
Czech Republic	4.3	3.9	3.6	3.5	3.5	3.6	2.9	3.0	2.7	2.7	2.9	2.6	2.7	2.2	2.4	3.1	3.2
France	20	20	19	18	18	17	17	16	15	14	14	13	12	9.1	6.7	6.6	4.6
Georgia	0.210	0.210	0.210	0.210	0.210	0.210	0.210	0.210	0.210	0.210	0.210	0.215	0.221	0.226	0.232	0.237	0.243
Greece	4.5	4.2	4.0	3.7	3.5	3.2	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Hungary	5.5	4.7	4.0	4.1	4.1	3.8	3.4	3.3	3.1	3.0	3.0	3.0	2.8	2.9	2.7	1.5	1.7
Iceland	0.166	0.158	0.149	0.141	0.132	0.124	0.115	0.107	0.098	0.090	0.081	0.082	0.082	0.082	0.083	0.083	0.083
Ireland	0.828	0.831	0.858	0.847	0.923	0.914	0.897	0.929	0.970	0.963	0.962	0.800	0.626	0.547	0.580	0.582	0.500
Italy	10	11	10	9.7	9.4	9.4	9.1	8.9	8.6	8.5	8.8	8.7	7.0	7.3	7.9	8.2	8.4
Kazakhstan	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1
Luxembourg	0.600	0.575	0.550	0.525	0.500	0.400	0.400	0.300	0.200	0.054	0.051	0.054	0.047	0.047	0.047	0.047	0.047
Malta	0.480	0.480	0.480	0.480	0.480	0.480	0.480	0.480	0.480	0.480	0.480	0.536	0.526	0.573	0.573	0.593	0.601
Monaco	0.056	0.058	0.063	0.069	0.006	0.006	0.007	0.008	0.007	0.007	0.008	0.008	0.007	0.006	0.005	0.005	0.004
Netherlands	2.1	2.4	2.1	1.7	1.4	1.1	1.1	1.2	1.2	1.1	1.0	1.6	2.2	2.4	1.8	1.7	1.7
Norway	1.1	1.0	1.0	1.1	1.2	0.985	1.1	1.0	1.1	1.0	0.690	0.685	0.682	0.660	0.602	0.542	0.542
Portugal	5.3	5.8	5.9	5.2	5.5	5.6	4.8	5.3	6.0	6.0	5.4	5.3	6.1	5.3	5.3	5.9	5.4
Republic of Moldova	2.4	3.5	1.7	1.4	0.819	0.594	0.659	0.364	0.328	0.148	0.173	0.114	0.226	0.122	0.114	0.145	0.158
Romania	22	20	19	18	17	15	14	13	12	12	8.7	7.4	8.1	8.7	9.4	10	6.5
Serbia and Montenegro	8.3	8.3	8.4	8.4	8.4	8.5	8.5	8.5	8.6	8.6	8.7	8.6	8.6	8.6	8.6	8.5	8.5
Slovakia	9.4	10	11	8.7	6.6	10	9.0	10	7.8	6.6	7.2	7.2	5.4	5.8	3.6	6.1	6.0
Slovenia	1.3	1.0	1.1	1.1	1.1	1.1	1.0	1.0	1.0	1.0	1.0	1.1	1.1	1.1	1.2	1.2	1.2
Spain	24	23	22	20	21	21	19	19	19	19	18	18	19	17	17	17	16
Switzerland	3.7	3.5	3.3	3.0	2.8	2.5	2.4	2.2	2.2	1.7	1.6	1.5	1.3	1.1	1.1	1.1	1.1
The FYR of Macedonia	9.1	9.2	9.3	9.3	9.4	9.4	9.5	9.6	9.6	9.7	9.8	9.8	9.7	9.7	9.7	9.7	9.7
Turkey	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17
Ukraine	54	50	46	42	38	34	30	26	22	18	14	10	2.0	28	3.1	6.8	5
United Kingdom	24	24	24	15	14	12	10	9.2	6.8	6.4	6.2	4.9	4.7	3.4	3.6	3.7	4.0
EMEP	**482**	**447**	**427**	**396**	**373**	**358**	**348**	**335**	**292**	**290**	**266**	**261**	**249**	**277**	**244**	**252**	**241**

Expert estimates:

§ *Denier van der Gon, H.A.C., M. van het Bolscher A.J.H. Visschedijk P.Y.J. Zandveld [2006]*

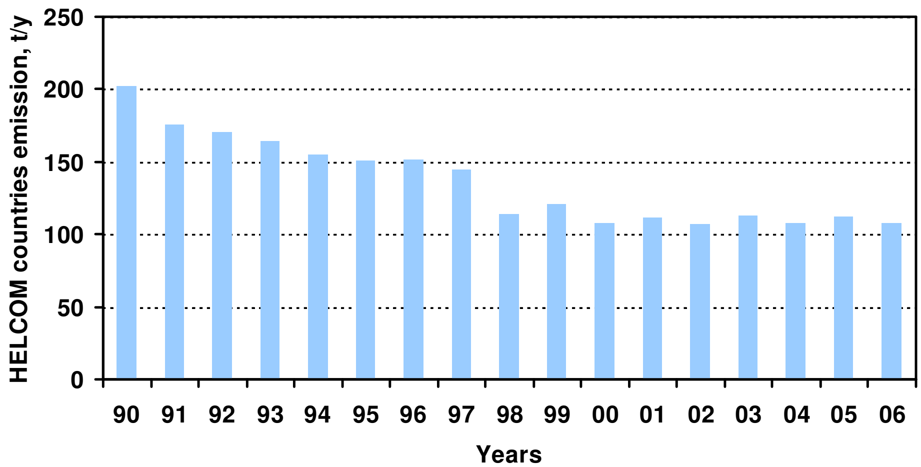


Figure 5.17. Time-series of annual cadmium emissions of HELCOM countries in 1990-2006, tonnes/y.

5.2 Annual total deposition of cadmium

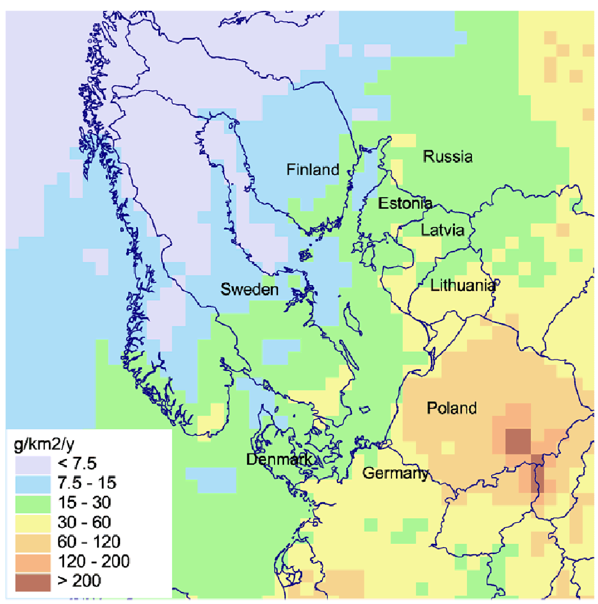


Figure 5.18. Annual total deposition fluxes of cadmium over the Baltic Sea region for 2006, g/km^2/year.

5.3 Monthly total depositions of cadmium

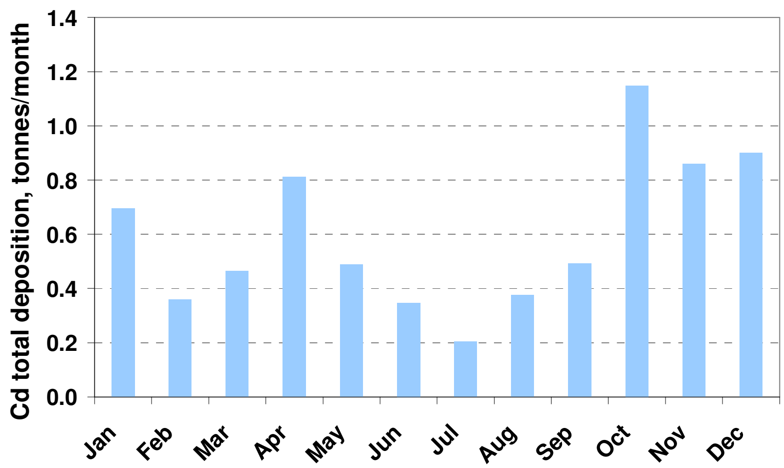


Figure 5.19. Monthly total depositions of cadmium to the Baltic Sea for 2006, tonnes/month.

Table 5.2. Monthly total depositions of cadmium to the Baltic Sea for 2006, tonnes/month.

Month	**Cd**
Jan	0.70
Feb	0.36
Mar	0.46
Apr	0.81
May	0.49
Jun	0.35
Jul	0.21
Aug	0.38
Sep	0.49
Oct	1.15
Nov	0.86
Dec	0.90

5.4 Source allocation of cadmium deposition

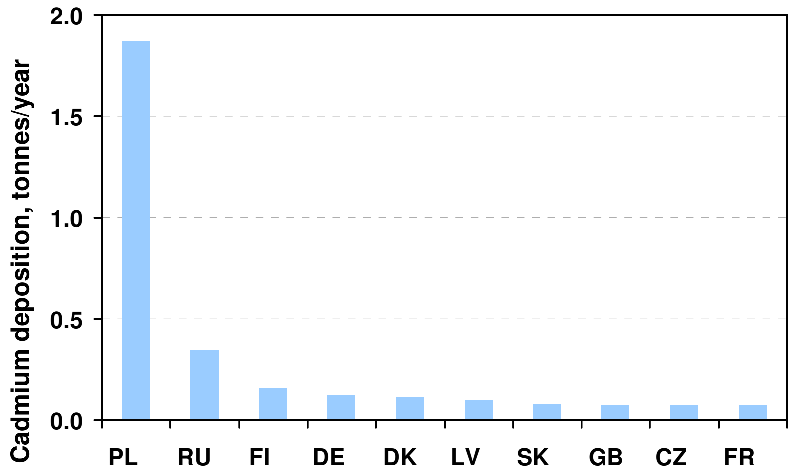


Figure 5.20. Top ten countries with the highest contribution to annual total deposition of cadmium over the Baltic Sea for 2006, tonnes/year.

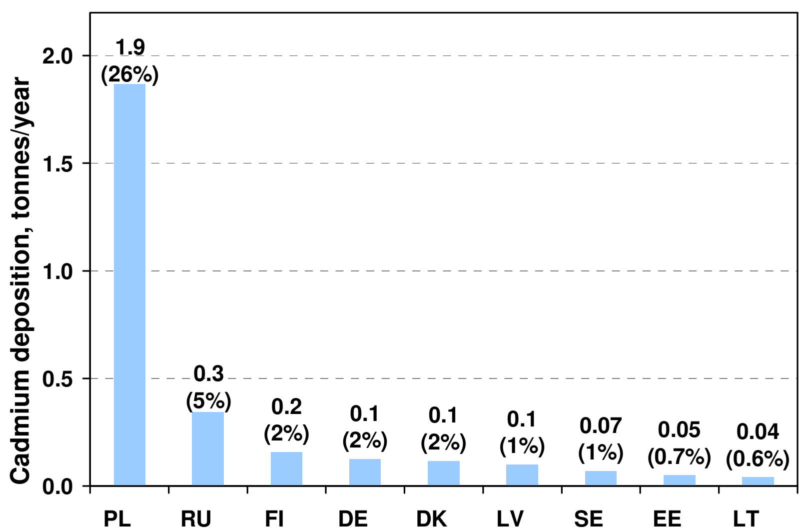


Figure 5.21. Sorted contributions (in %) of HELCOM countries to total depositions over the Baltic Sea for 2006. HELCOM countries emissions of cadmium contributed about 40% to the total annual cadmium depositions over the Baltic Sea in 2006. Contribution of other EMEP countries accounted for 10%. Significant contribution was made by other emission sources, in particular, remote emissions sources, natural emissions and re-emission of cadmium (50%).

Table 5.3. Two most significant contributors to the annual total depositions of cadmium to the six Baltic Sea sub-basins for 2006.

Sub-basin	Country	%	Country	%	*, %
GUB	Poland	17	Finland	13	48
GUF	Poland	17	Russia	16	44
GUR	Poland	27	Latvia	6	48
BAP	Poland	32	Russia	4	48
BES	Poland	11	Denmark	6	66
KAT	Poland	9	Denmark	8	65
BAS	Poland	26	Russia	5	50

* - contribution of re-emission, natural and remote sources.

5.5 Comparison of model results with measurements

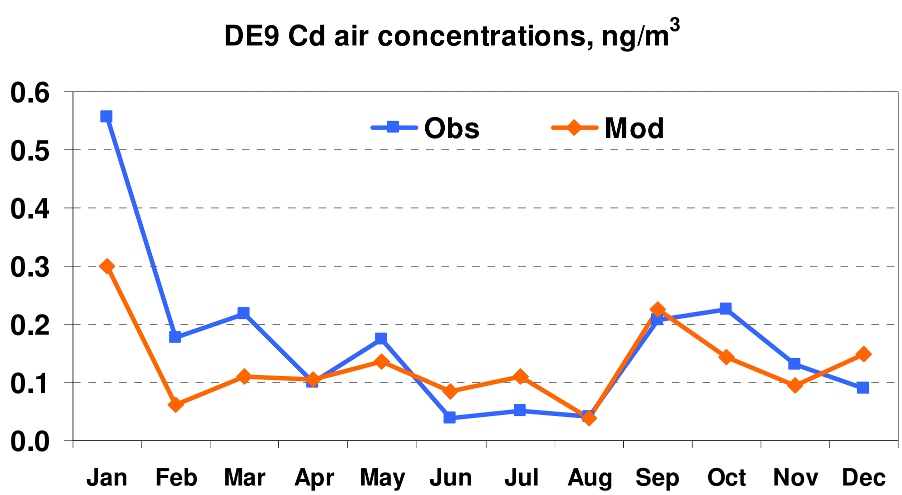


Figure 5.22. Comparison of calculated mean monthly cadmium concentrations in air for 2006 with measurements of the station Zingst (DE9). Units: ng / m^3.

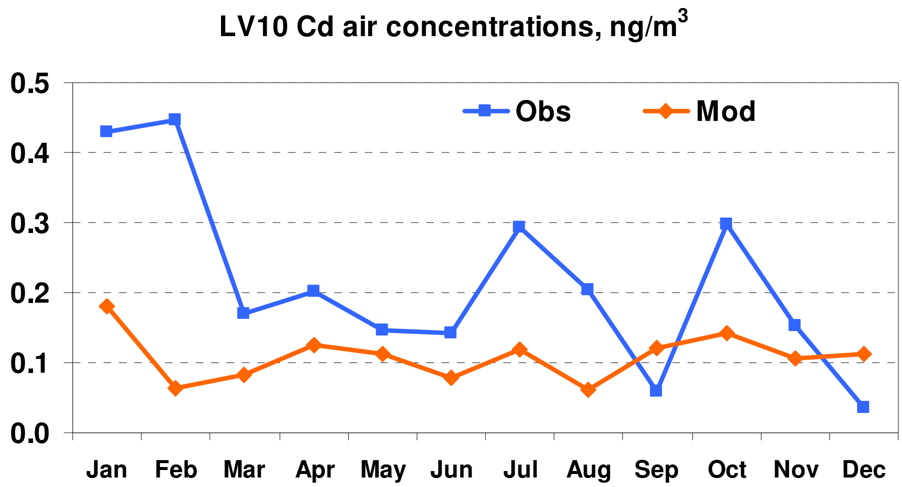


Figure 5.23. Comparison of calculated mean monthly cadmium concentrations in air for 2006 with measurements of the station Rucava (LV10). Units: ng / m^3.

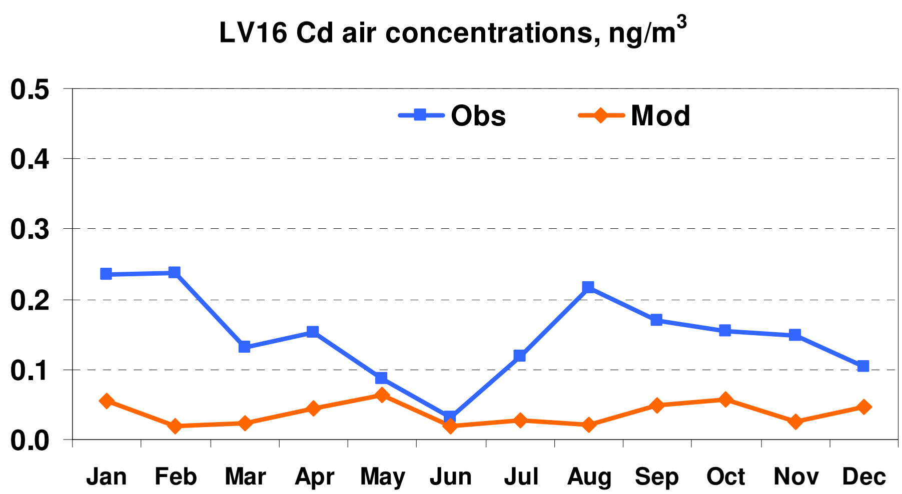


Figure 5.24. Comparison of calculated mean monthly cadmium concentrations in air for 2006 with measurements of the station Zoseni (LV16). Units: ng / m^3.

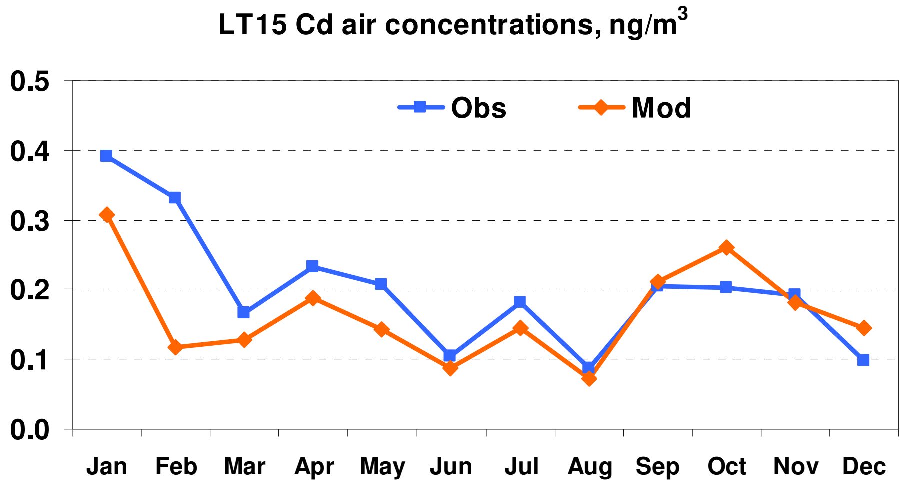


Figure 5.25. Comparison of calculated mean monthly cadmium concentrations in air for 2006 with measurements of the station Preila (LT15). Units: ng / m^3.

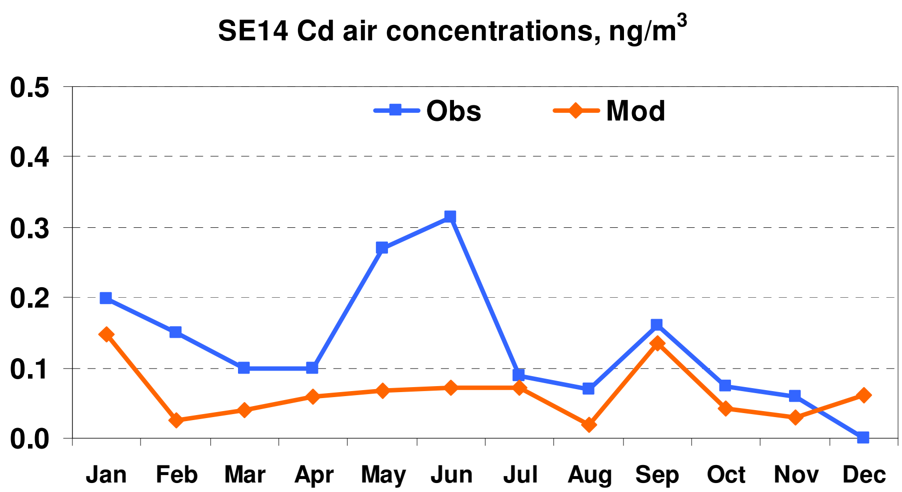


Figure 5.26. Comparison of calculated mean monthly cadmium concentrations in air for 2006 with measurements of the station Räö (SE14). Units: ng / m^3.

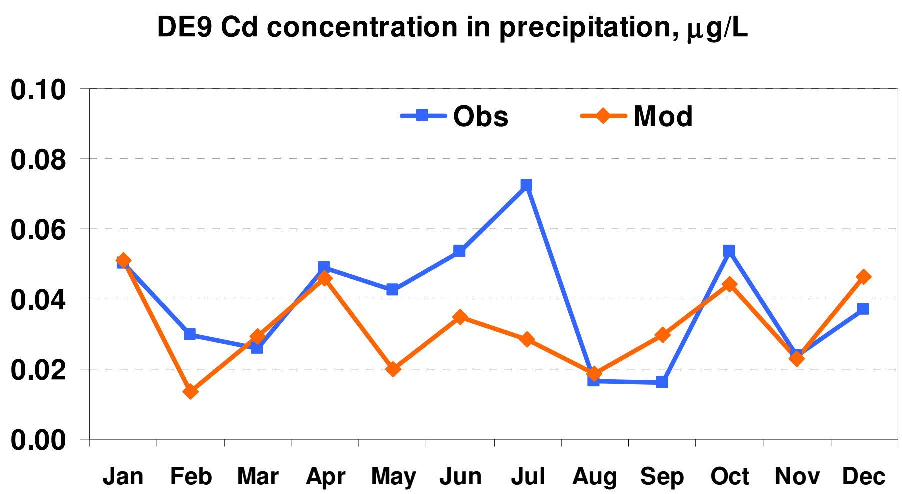


Figure 5.27. Comparison of calculated mean monthly cadmium concentrations in precipitation for 2006 with measurements of the station Zingst (DE09). Units: µg / L.

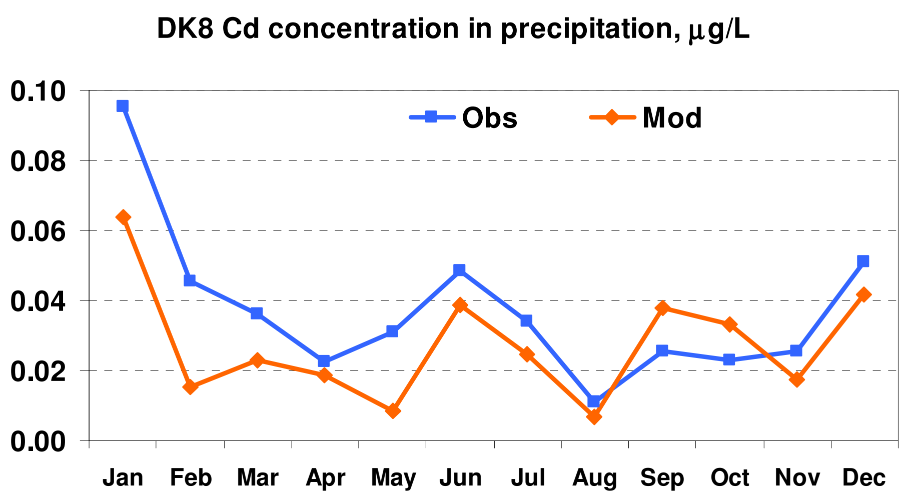


Figure 5.28. Comparison of calculated mean monthly cadmium concentrations in precipitation for 2006 with measurements of the station Anholt (DK8). Units: µg / L.

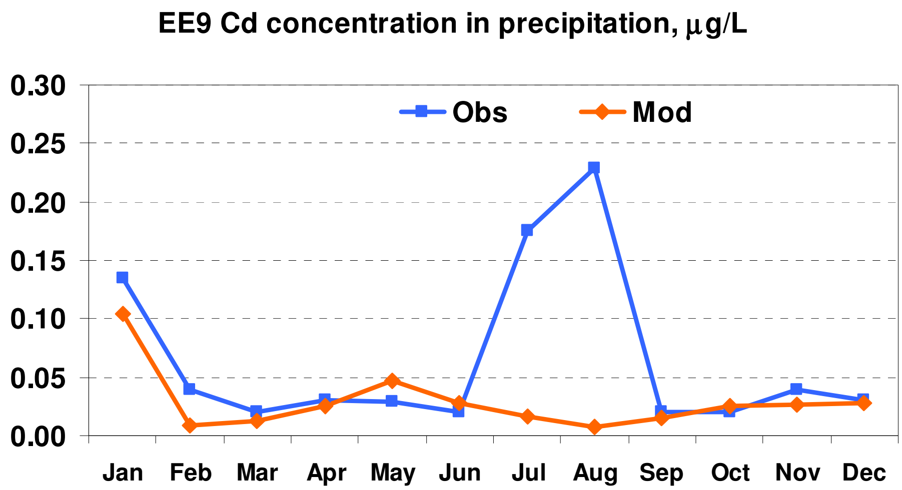


Figure 5.29. Comparison of calculated mean monthly cadmium concentrations in precipitation for 2006 with measurements of the station Lahemaa (EE9). Units: µg / L.

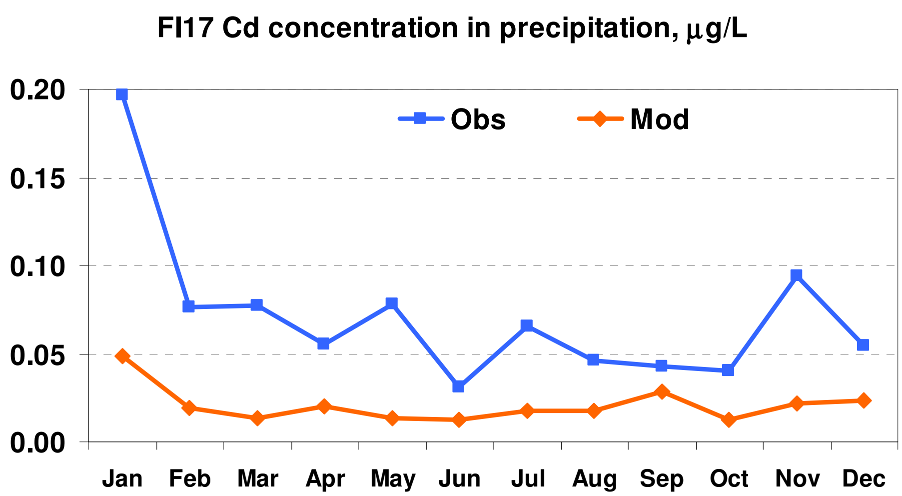


Figure 5.30. Comparison of calculated mean monthly cadmium concentrations in precipitation for 2006 with measurements of the station Virolahty II (FI17). Units: µg / L.

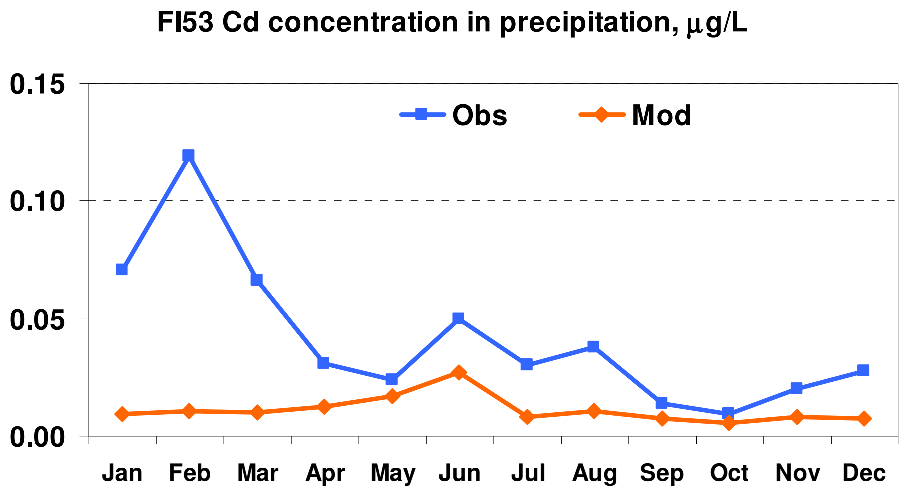


Figure 5.31. Comparison of calculated mean monthly cadmium concentrations in precipitation 2006 with measurements of the station Hailuoto (FI53). Units: µg / L.

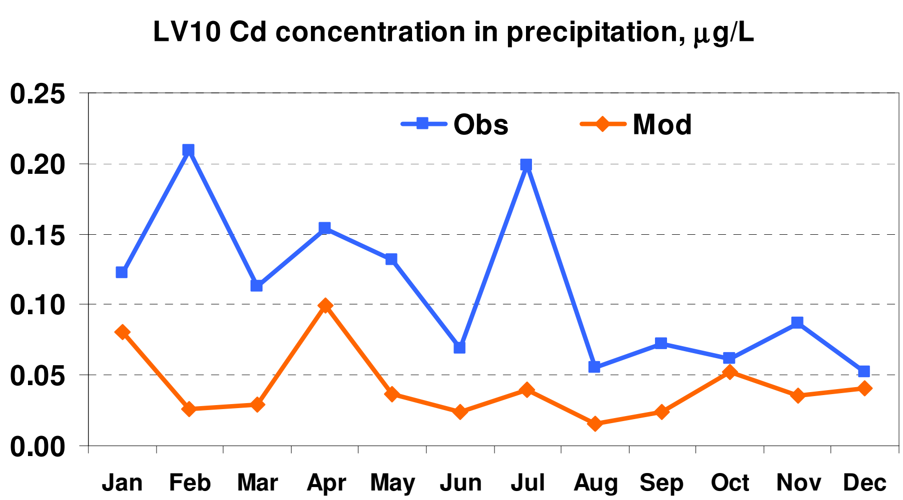


Figure 5.32. Comparison of calculated mean monthly cadmium concentrations in precipitation for 2006 with measurements of the station Rucava (LV10). Units: µg / L.

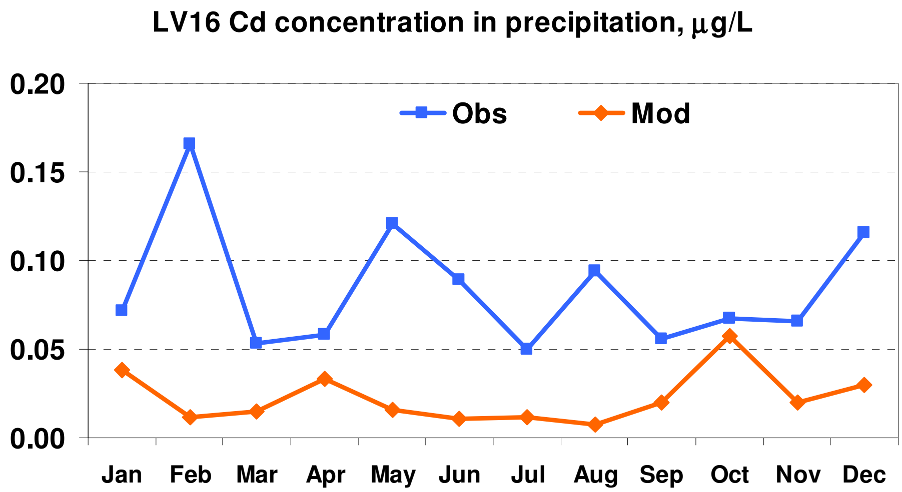


Figure 5.33. Comparison of calculated mean monthly cadmium concentrations in precipitation for 2006 with measurements of the station Zoseni (LV16). Units: µg / L.

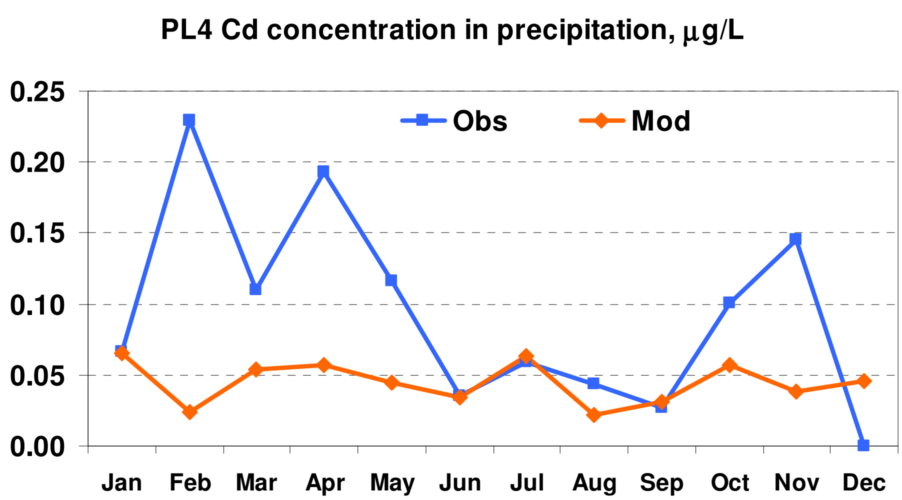


Figure 5.34. Comparison of calculated mean monthly cadmium concentrations in precipitation for 2006 with measurements of the station Leba (PL4). Units: µg / L.

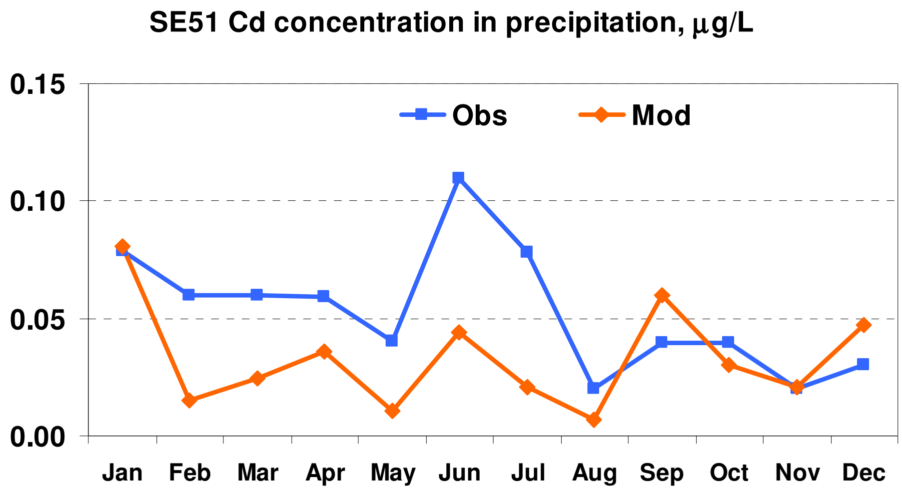


Figure 5.35. Comparison of calculated mean monthly cadmium concentrations in precipitation for 2006 with measurements of the station Arup (SE51). Units: µg / L.

In general, reasonable level of agreement between the computed concentrations of cadmium in air and in precipitation is obtained for the selected monitoring sites around the Baltic Sea. Comparing to lead more significant deviations between simulated and observed monthly mean concentrations of cadmium can be mentioned. The reason of deviations is connected with the uncertainties in seasonal variation of cadmium emission, differences between measured precipitation amount and the one used in the model, and difficulties in measurements of heavy metals.

6. Atmospheric Supply of Mercury to the Baltic Sea in 2006

In this chapter the results of model evaluation of mercury atmospheric input to the Baltic Sea and its sub-basins for 2006 is presented. Modelling of mercury atmospheric transport and depositions was carried out using MSC-E Eulerian Heavy Metal transport model MSCE-HM (*Travnikov and Ilyin*, 2005). Latest available official information on mercury emission from HELCOM countries and other European countries was used in computations. Based on these data levels of annual and monthly mercury depositions to the Baltic Sea region have been obtained and contributions of HELCOM countries emission sources to the depositions over the Baltic Sea are estimated. Model results were compared with observed levels of mercury concentrations in air and precipitation measured at monitoring sites around the Baltic Sea in 2006.

6.1 Mercury emissions

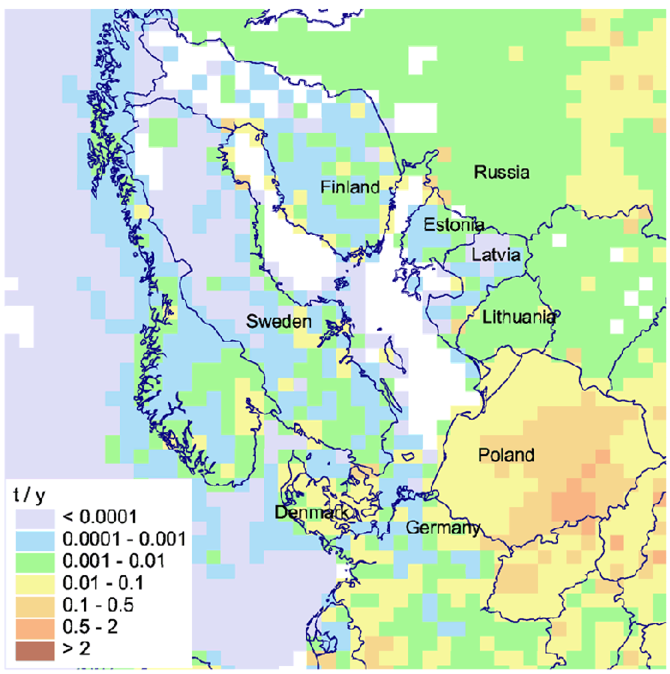


Figure 6.1. Annual total anthropogenic emissions of mercury in the Baltic Sea region for 2006, t/y.

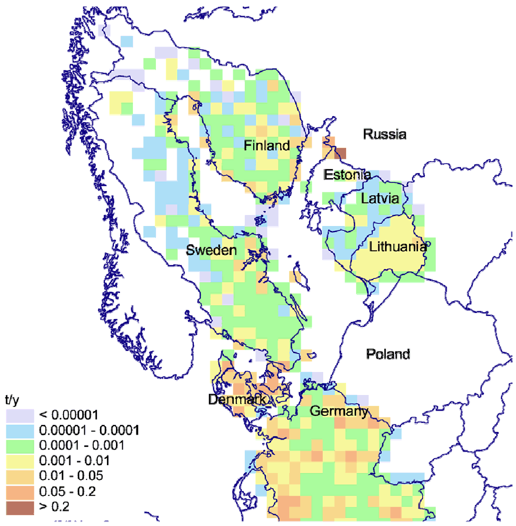


Figure 6.2. Annual mercury emission from Combustion in Power Plants and Industry sector for 2006, t/y.

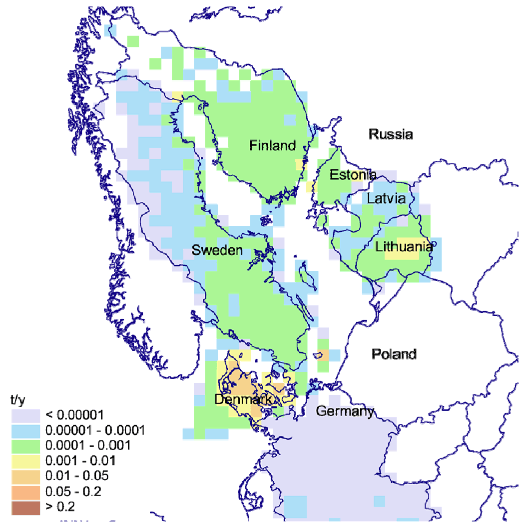


Figure 6.3. Annual mercury emission from Commercial, Residential and Other Stationary Combustion sector for 2006, t/y.

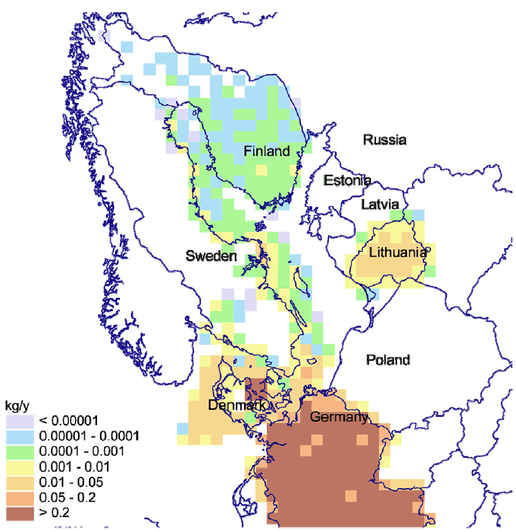


Figure 6.4. Annual mercury emission from Transport sources below 1000 m sector for 2006, kg/y.

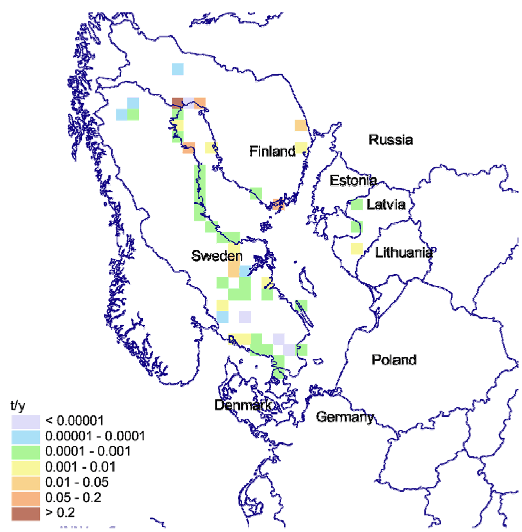


Figure 6.5. Annual mercury emission from Industrial Processes sector for 2006, t/y.

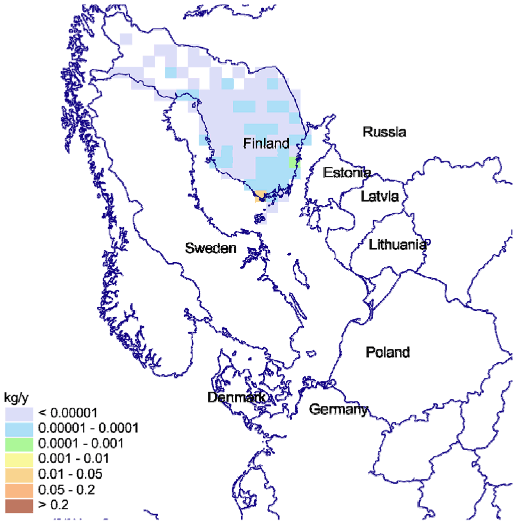


Figure 6.6. Annual mercury emission of Finland from Solvent and Other Product Use sector for 2006, kg/y.

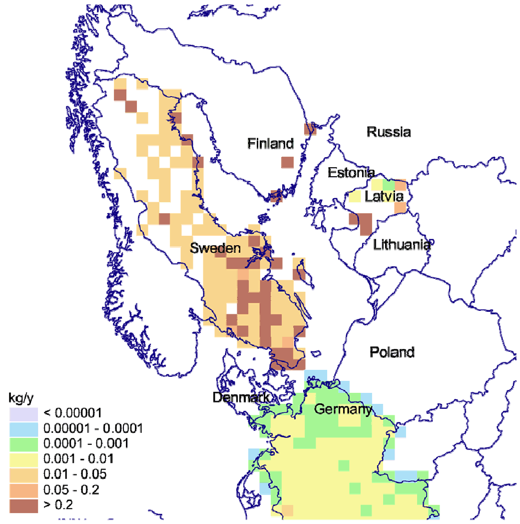


Figure 6.7. Annual mercury emission from Waste sector for 2006, kg/y.

Table 6.1. Annual total mercury anthropogenic emissions of HELCOM countries from different sectors for 2006, in tonnes per year

NFR emission sector	Sector name	Denmark	Estonia	Finland	Germany	Latvia	Lithuania	Poland	Russia	Sweden
1	Combustion in Power Plants and Industry	0.94	0.5	0.42	2.68	0.01	0.39	18.26	14	0.27
2a	Transport above 1000m	0	NA	NA	NE	NA	NA	NA	NA	NE
2b	Transport below 1000m	0.005	0	2.0E-05	0.11	NA	0.0004	0		0.0002
3	Commercial, Residential and Other Stationary Combustion	0.33	0.02	0.03	0.001	0.004	0.02	1.44		0.02
4	Fugitive Emissions From Fuels		NA	NA				0.29		0.004
5	Industrial Processes	0	0	0.52	0.001	0.007		1.15		0.17
6	Solvent and Other Product Use	NA	NA	1.2E-05				NA		
7	Agriculture							NA		
8	Waste		0	0.006	0.0003	0.003		0.12		0.12
9	Other									
Total		**1.28**	**0.52**	**0.98**	**2.79**	**0.03**	**0.42**	**21.26**	**14**	**0.59**

NA – not available
NE – not estimated

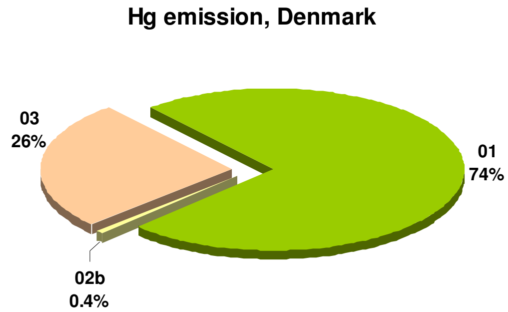


Figure 6.8. Percentage of annual total mercury emission from different sectors in Denmark for 2006

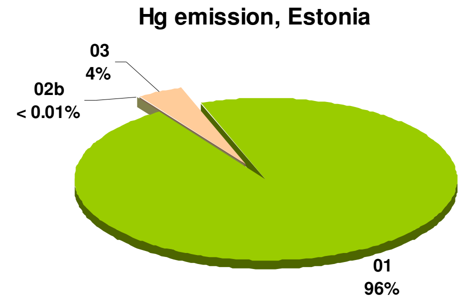


Figure 6.9. Percentage of annual total mercury emission from different sectors in Estonia for 2006

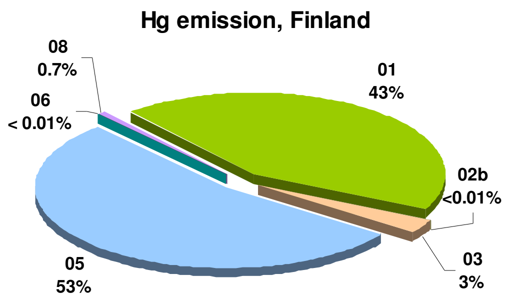


Figure 6.10. Percentage of annual total mercury emission from different sectors in Finland for 2006

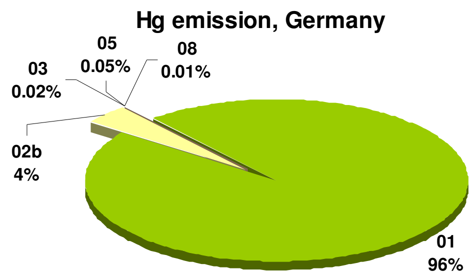


Figure 6.11. Percentage of annual total mercury emission from different sectors in Germany for 2006

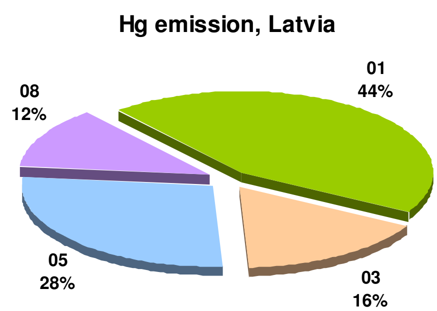


Figure 6.12. Percentage of annual total mercury emission from different sectors in Latvia for 2006

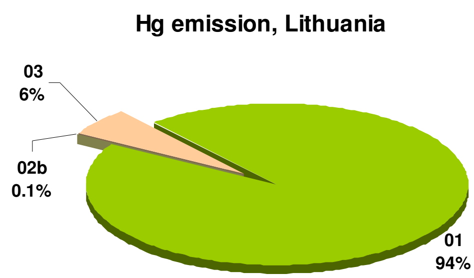


Figure 6.13. Percentage of annual total mercury emission from different sectors in Lithuania for 2006

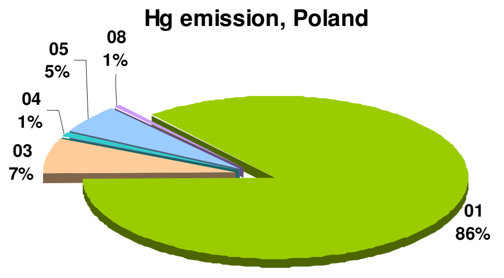


Figure 6.14. Percentage of annual total mercury emission from different sectors in Poland for 2006

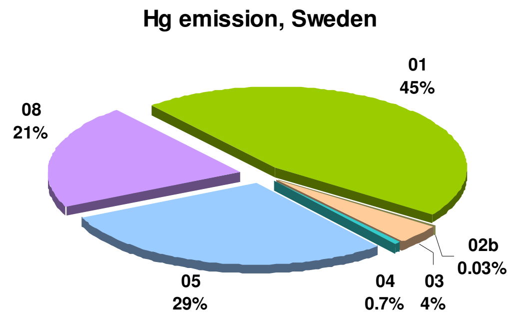


Figure 6.15. Percentage of annual total mercury emission from different sectors in Sweden for 2006

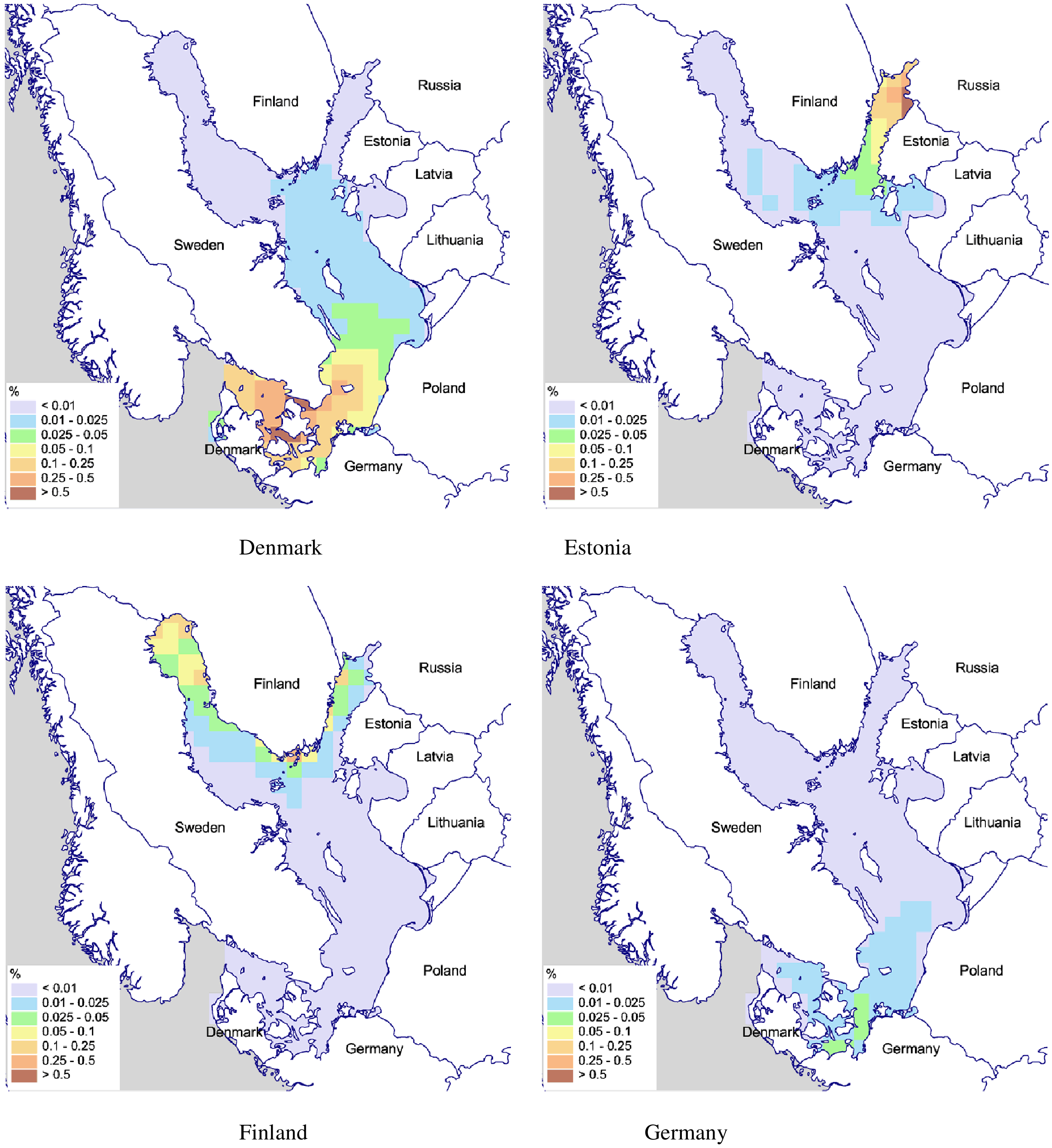
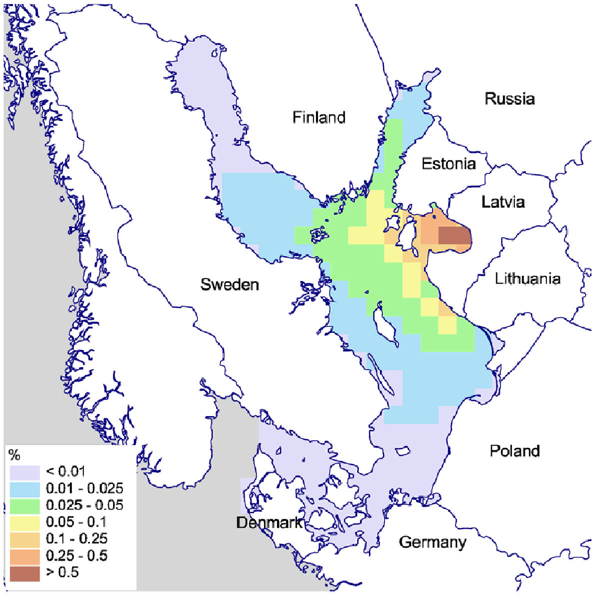
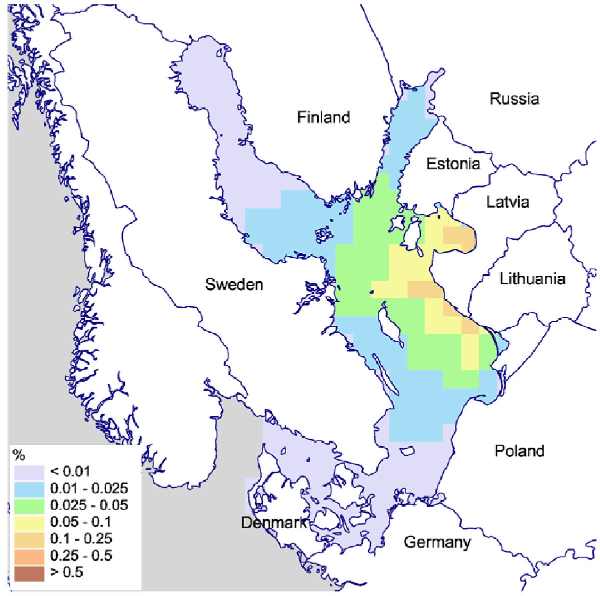


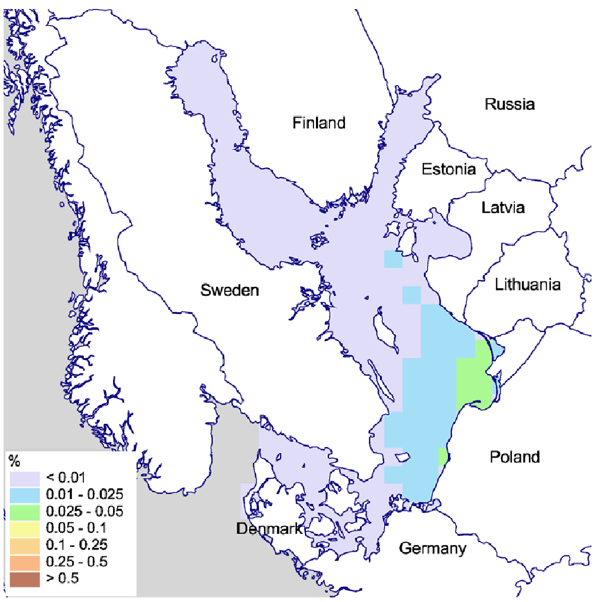
Figure 6.16. Maps with the fractions (in %) of annual total anthropogenic mercury emissions from HELCOM Parties deposited into the Baltic Sea in 2006 (percent per deposition over the 50x50 km grid cell).



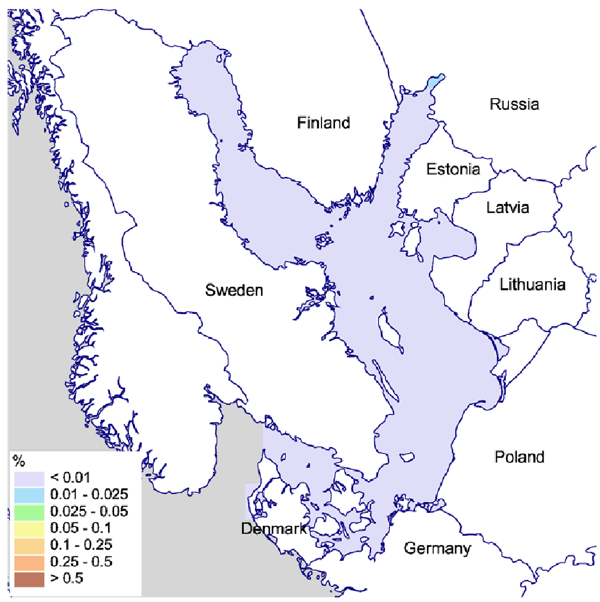
Latvia



Lithuania

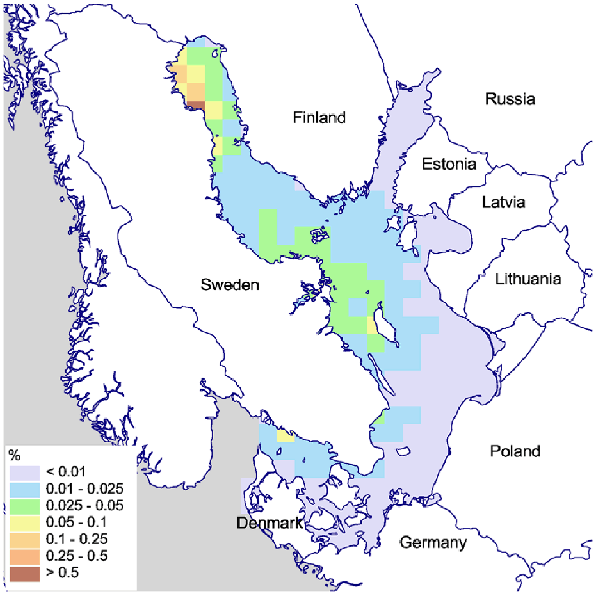


Poland



Russia

Figure 6.16. (cont.) Maps with the fractions (in %) of annual total anthropogenic mercury emissions from HELCOM Parties deposited into the Baltic Sea in 2006 (percent per deposition over the 50x50 km grid cell).



Sweden

Figure 6.16. (cont.) Maps with the fractions (in %) of annual total anthropogenic mercury emissions from HELCOM Parties deposited into the Baltic Sea in 2006 (percent per deposition over the 50x50 km grid cell).

Table 6.2. Annual total anthropogenic emissions of mercury of HELCOM countries and other EMEP countries in period 1990-2006, tonnes (Expert estimates of emissions are shaded).

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Denmark	3.2	3.5	3.3	3.3	2.4	2.4	2.5	2.0	1.9	2.0	1.2	1.3	1.2	1.3	1.1	1.4	1.3
Estonia	1.1	1.0	0.830	0.640	0.640	0.600	0.610	0.590	0.530	0.510	0.550	0.490	0.500	0.580	0.540	0.520	0.520
Finland	1.1	0.865	0.738	0.609	0.656	0.713	0.764	0.570	0.548	1.1	0.574	0.731	0.659	0.778	0.744	0.851	0.981
Germany	19	13	8.4	5.3	2.8	2.4	2.5	2.5	2.6	2.4	2.7	2.7	2.8	2.9	2.8	2.7	2.8
Latvia	0.310	0.241	0.209	0.200	0.229	0.171	0.202	0.150	0.141	0.120	0.063	0.049	0.040	0.032	0.028	0.027	0.026
Lithuania	0.018	0.016	0.011	0.014	0.013	0.153	0.159	0.232	0.245	0.253	0.252	0.516	0.314	0.352	0.417	0.413	0.418
Poland	33	33	32	33	32	32	34	33	30	27	26	23	20	20	20	20	21
Russia	16	13	11	12	10	10	10	9.6	9.4	9.9	10	10	10	11	12	14	14
Sweden	1.6	1.3	1.3	1.1	1.2	1.1	1.1	1.0	0.949	0.934	0.777	0.660	0.679	0.761	0.786	0.730	0.595
HELCOM	**76**	**66**	**58**	**56**	**51**	**50**	**52**	**50**	**46**	**44**	**42**	**40**	**36**	**38**	**38**	**41**	**42**
Albania	0.511	0.480	0.449	0.419	0.388	0.357	0.326	0.296	0.265	0.234	0.203	0.202	0.202	0.201	0.200	0.199	0.199
Armenia	0.164	0.164	0.164	0.164	0.164	0.164	0.164	0.164	0.164	0.164	0.164	0.167	0.170	0.174	0.177	0.180	0.184
Austria	2.1	2.0	1.6	1.4	1.2	1.2	1.2	1.1	0.948	0.936	0.895	0.954	0.935	0.976	0.943	0.996	1.0
Azerbaijan	0.984	0.984	0.984	0.984	0.984	0.984	0.984	0.984	0.984	0.984	0.984	1.0	1.0	1.0	1.1	1.1	1.1
Belarus	1.1	1.1	0.879	0.721	0.602	0.511	0.297	0.310	0.392	0.380	0.358	0.522	0.565	0.603	0.632	0.649	0.716
Belgium	6.6	5.7	5.8	3.9	4.2	3.6	3.7	3.7	3.0	3.1	2.5	2.1	3.1	2.8	2.9	1.8	1.8
Bosnia and Herzegovina	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	1.9	1.9	1.9	1.9
Bulgaria	13	12	11	9.4	8.1	6.9	4.7	4.3	4.7	4.1	4.2	4.0	3.9	5.0	4.7	3.4	3.7
Croatia	1.2	0.977	0.805	0.632	0.460	0.287	0.297	0.318	0.320	0.307	0.410	0.405	0.449	0.563	0.710	0.693	0.587
Cyprus	0.660	0.680	0.770	0.830	0.880	0.800	0.850	0.890	0.950	1.0	1.1	1.0	1.2	1.1	1.2	1.3	1.3
Czech Republic	7.5	7.4	7.3	7.5	7.2	7.4	5.9	5.5	5.2	3.7	3.8	3.3	2.8	1.8	2.1	3.8	3.8
France	27	28	26	24	23	22	21	16	16	14	13	11	11	8.8	8.6	9.1	7.9
Georgia	0.253	0.253	0.253	0.253	0.253	0.253	0.253	0.253	0.253	0.253	0.253	0.258	0.264	0.269	0.274	0.279	0.284
Greece	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13
Hungary	6.3	5.8	5.0	5.0	4.7	4.9	4.7	4.5	4.3	4.3	4.4	4.4	4.0	4.0	3.8	4.1	3.2
Iceland	0.048	0.054	0.060	0.066	0.072	0.078	0.084	0.091	0.097	0.103	0.109	0.108	0.108	0.108	0.108	0.107	0.107
Ireland	1.0	1.1	0.994	0.992	0.943	0.937	0.858	0.725	0.619	0.491	0.415	0.438	0.422	0.407	0.410	0.424	0.374
Italy	12	11	11	10	10	11	10	10	10	9	10	10	10	10	10	10	11
Kazakhstan	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5
Luxembourg	0.300	0.275	0.250	0.225	0.200	0.100	0.100	0.100	0.100	0.286	0.275	0.293	0.288	0.288	0.288	0.288	0.288
Malta	0.489	0.489	0.489	0.489	0.489	0.489	0.489	0.489	0.489	0.489	0.489	0.546	0.535	0.582	0.582	0.602	0.610
Monaco	0.108	0.110	0.121	0.132	0.069	0.069	0.073	0.083	0.078	0.079	0.081	0.086	0.077	0.064	0.057	0.057	0.041
Netherlands	3.5	3.9	3.3	2.6	2.0	1.2	1.0	0.705	0.633	0.549	0.875	0.742	0.715	0.663	1.0	0.813	0.814
Norway	1.5	1.4	1.2	0.928	1.0	0.877	0.905	0.905	0.868	0.910	0.756	0.704	0.667	0.678	0.707	0.690	0.690
Portugal	3.8	3.9	4.3	3.9	3.7	4.0	3.6	3.9	4.1	4.1	3.7	3.5	3.8	3.1	3.0	3.2	2.9
Republic of Moldova	3.4	3.8	3.3	1.8	1.3	0.894	0.954	0.571	0.406	0.180	0.259	0.226	0.392	0.340	0.323	0.244	0.217
Romania	7.5	7.5	7.4	7.4	7.3	7.3	7.2	7.2	7.2	6.3	6.7	7.3	8.3	9.4	10	11	8.3
Serbia and Montenegro	3.9	4.0	4.2	4.3	4.5	4.7	4.8	5.0	5.2	5.3	5.5	5.5	5.5	5.4	5.4	5.4	5.4
Slovakia	12	9.3	6.2	5.0	3.9	3.9	3.4	3.7	4.1	3.7	4.3	3.8	3.6	2.9	3.2	2.9	3.4
Slovenia	0.770	0.610	0.600	0.540	0.600	0.650	0.570	0.610	0.620	0.590	0.610	0.650	0.640	0.630	0.650	0.640	0.683
Spain	13	14	15	13	13	13	12	9.9	10	11	11	11	12	10	10	10	9.1
Switzerland	6.6	6.1	5.8	5.4	4.9	4.1	3.8	3.5	3.3	2.4	2.1	1.8	1.4	1.1	1.1	1.1	1.1
The FYR of Macedonia	1.5	1.5	1.6	1.6	1.6	1.7	1.7	1.7	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8
Turkey	18	18	18	18	18	18	18	18	18	18	18	19	19	19	20	20	21
Ukraine	36	35	34	33	32	31	30	29	28	27	26	25	5.9	30	6.6	6.0	16
United Kingdom	38	38	36	23	21	20	15	12	11	8.2	8.2	7.9	6.9	7.5	6.5	7.2	7.5
EMEP	**328**	**313**	**294**	**264**	**251**	**244**	**231**	**218**	**210**	**199**	**196**	**190**	**167**	**190**	**168**	**172**	**179**

Expert estimates: Denier van der Gon, H.A.C., M. van het Bolscher A.J.H. Visschedijk P.Y.J. Zandveld [2006]

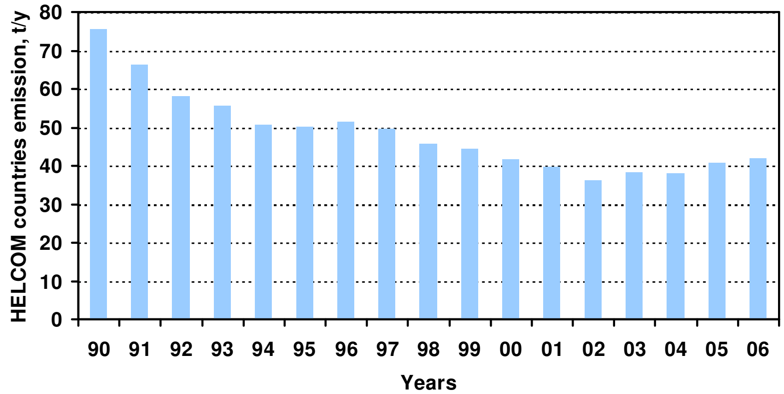


Figure 6.17. Time-series of total annual mercury emissions of HELCOM countries in 1990-2006, tonnes/y.

5.2 Annual total depositions of mercury

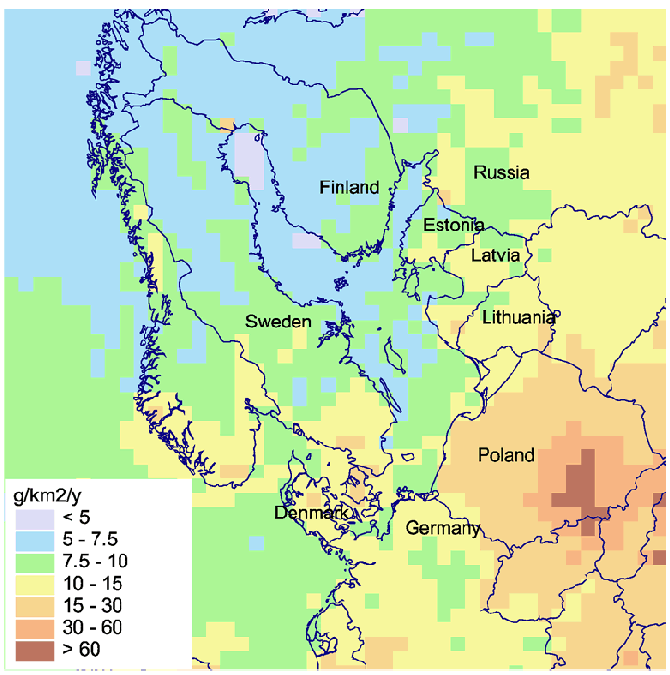


Figure 6.18. Annual total deposition fluxes of mercury over the Baltic Sea region for 2006, g/km^2/y.

5.3 Monthly total depositions of mercury

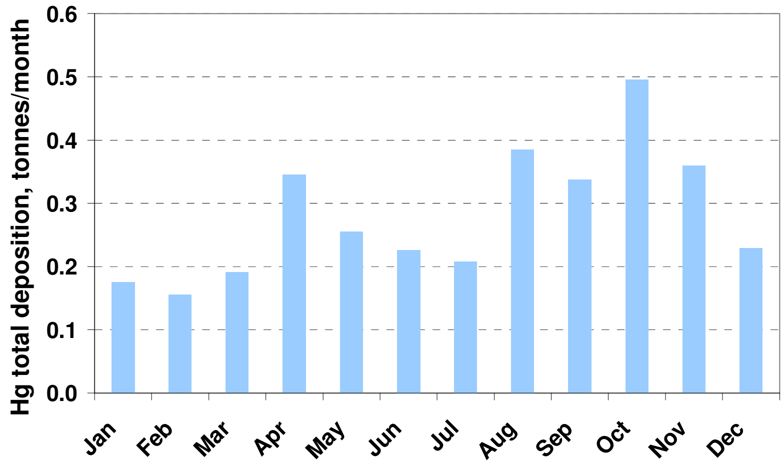


Figure 6.19. Monthly total depositions of mercury to the Baltic Sea for 2006, tonnes/month.

Table 6.2. Monthly total depositions of mercury to the Baltic Sea for 2006, tonnes/month.

Month	Hg
Jan	0.18
Feb	0.16
Mar	0.19
Apr	0.35
May	0.25
Jun	0.23
Jul	0.21
Aug	0.38
Sep	0.34
Oct	0.50
Nov	0.36
Dec	0.23

5.4 Source allocation of mercury deposition

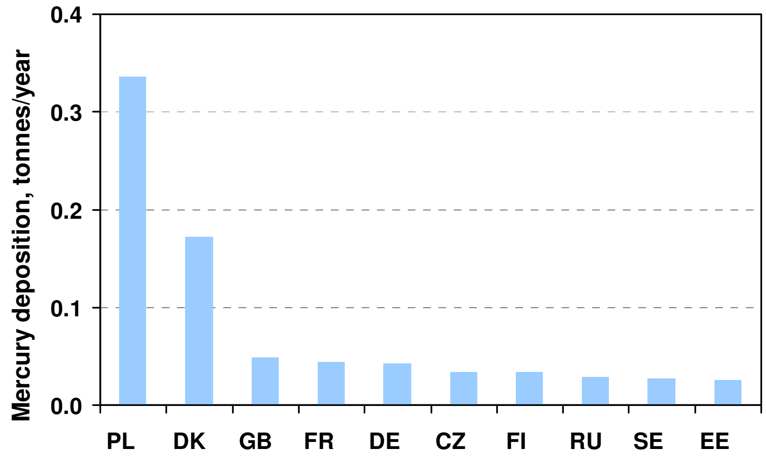


Figure 6.20. Top ten countries with the highest contribution to annual deposition of mercury over the Baltic Sea for 2006, tonnes/year.

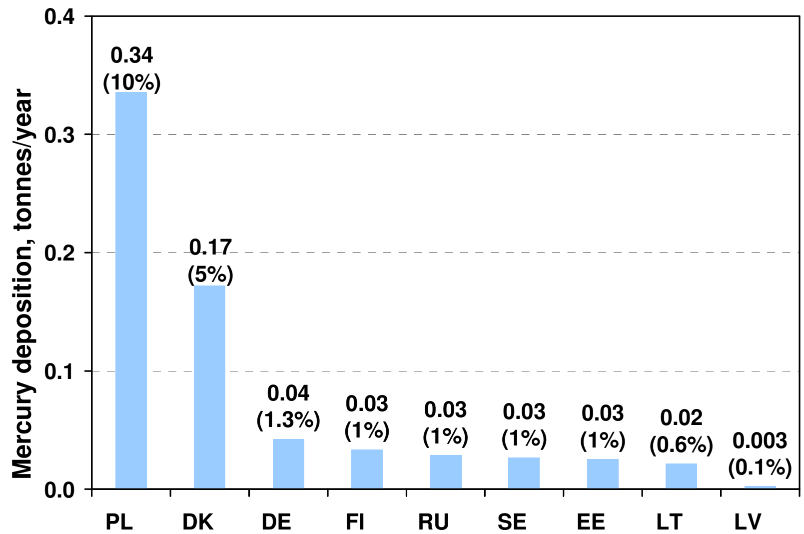


Figure 6.21. Sorted contributions (in %) of HELCOM countries to total depositions over the Baltic Sea for 2006. HELCOM countries emissions of mercury contributed 21% to the total annual mercury depositions over the Baltic Sea in 2006. Contribution of other EMEP countries accounted for 8%. Significant contribution was made by other emission sources, in particular, remote emissions sources, natural emissions and re-emission of mercury (71%).

Table 6.3. Two most significant contributors to the annual total depositions of mercury to the six Baltic Sea sub-basins for 2006.

Sub-basin	Country	%	Country	%	*, %
GUB	Finland	4	Poland	4	83
GUF	Estonia	9	Poland	6	72
GUR	Poland	11	Lithuania	3	74
BAP	Poland	14	Denmark	3	69
BES	Denmark	25	Poland	4	58
KAT	Denmark	18	Poland	4	66
BAS	Poland	10	Denmark	5	71

* - contribution of re-emission, natural and remote sources.

5.5 Comparison of model results with measurements

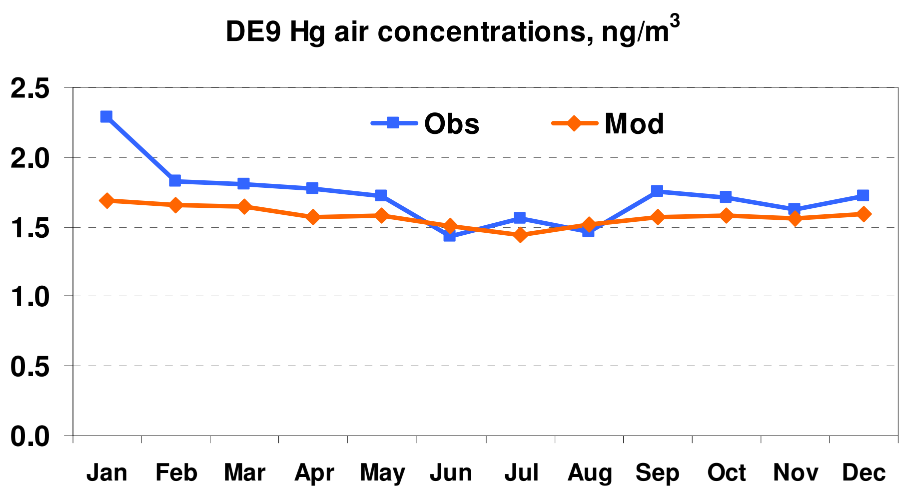


Figure 6.22. Comparison of calculated monthly mean Hg concentrations in air for 2006 with measurements of the station Zingst (DE9). Units: ng / m^3.

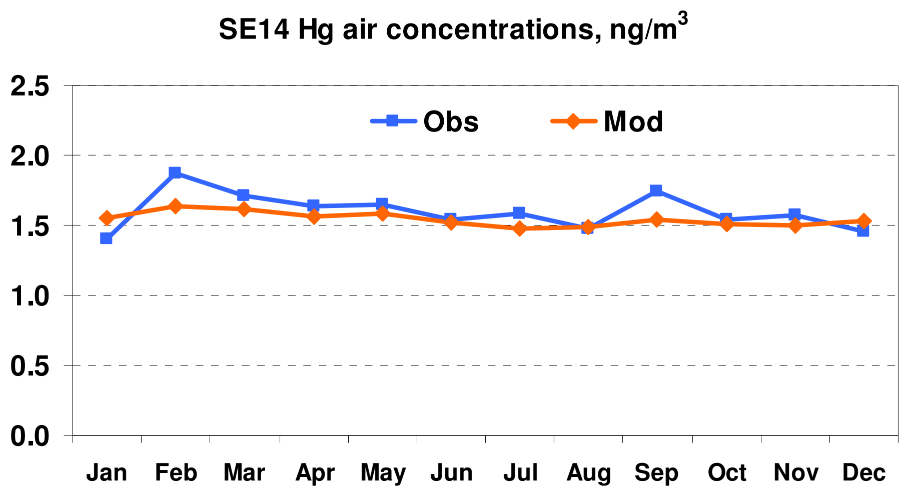


Figure 6.23. Comparison of calculated monthly mean Hg concentrations in air for 2006 with measurements of the station Råö (SE14). Units: ng / m^3.

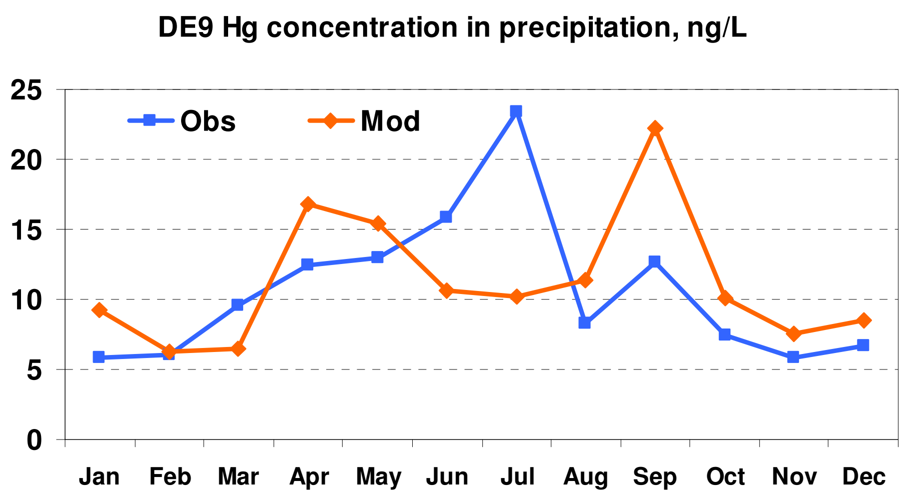


Figure 6.24. Comparison of calculated monthly mean Hg concentrations in precipitation for 2006 with measurements of the station Zingst (DE9). Units: ng/L.

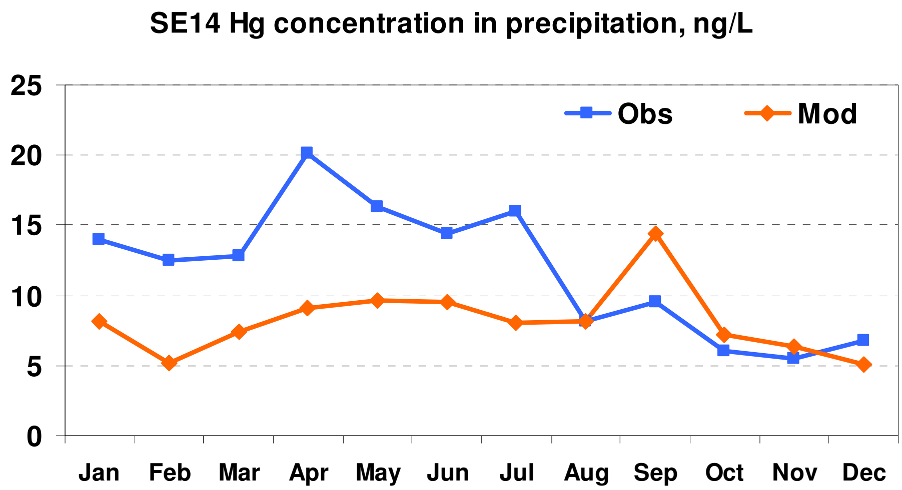


Figure 6.25. Comparison of calculated monthly mean Hg concentrations in precipitation for 2006 with measurements of the station Råö (SE14). Units: ng/L.

Computed concentrations of mercury in air and in precipitation were compared with the measurement data of four monitoring sites around the Baltic Sea. It can be seen that that the model values reasonably agree with the measured concentrations. Some deviations between simulated and observed monthly mean concentrations of mercury can be connected with the uncertainties in seasonal variation of mercury emission used in modeling, differences between measured precipitation amount and the one used in the model, and difficulties in measurements of mercury.

7. Atmospheric Supply of PCDD/Fs to the Baltic Sea in 2006

In this chapter the results of model evaluation of dioxins and furans (PCDD/Fs) atmospheric input to the Baltic Sea and its sub-basins for 2006 is presented. Modelling of PCDD/F atmospheric transport and depositions was carried out using MSC-E Eulerian Persistent Organic Pollutant transport model MSCE-POP (*Gusev et al.*, 2005). Latest available official information on PCDD/F emission from HELCOM countries and other European countries was used in computations. Based on these data levels of annual and monthly PCDD/F depositions to the Baltic Sea region have been obtained and contributions of HELCOM countries emission sources to the depositions over the Baltic Sea are estimated.

7.1 PCDD/Fs emissions

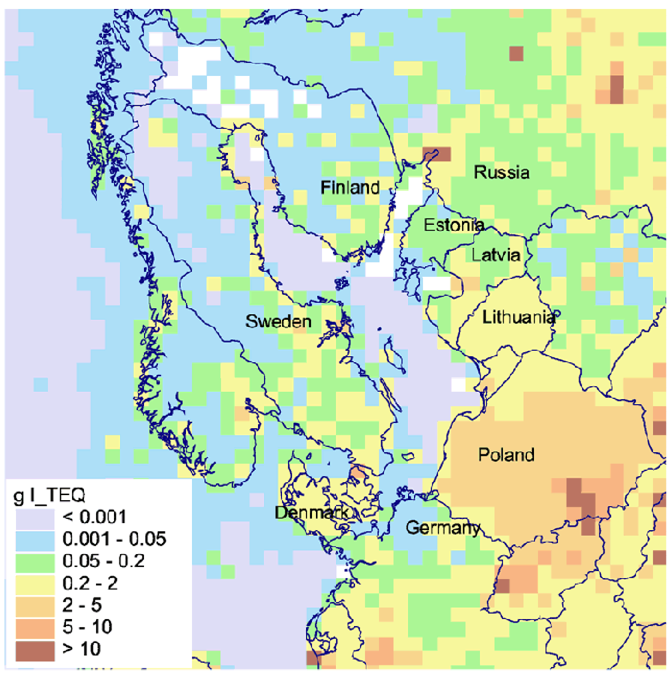


Figure 7.1. Annual total anthropogenic emissions of PCDD/F in the Baltic Sea region for 2006, g TEQ/year.

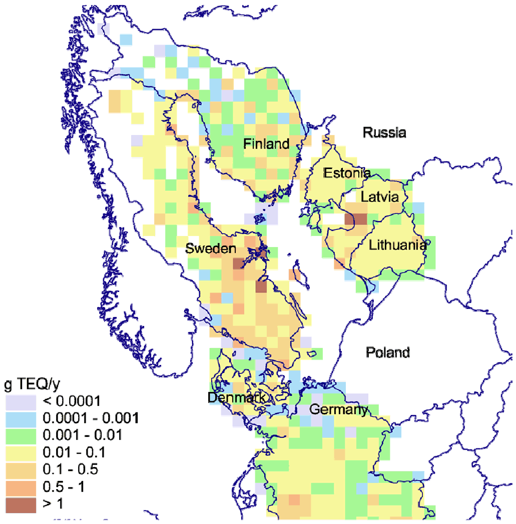


Figure 7.2. Annual PCDD/F emission of HELCOM countries from Combustion in Power Plants and Industry sector for 2006, g TEQ/y.

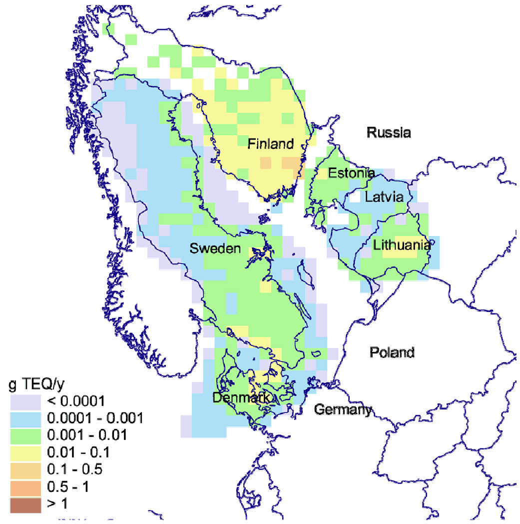


Figure 7.3. Annual PCDD/F emission of HELCOM countries from Transport sources below 1000 m sector for 2006, g TEQ/y.

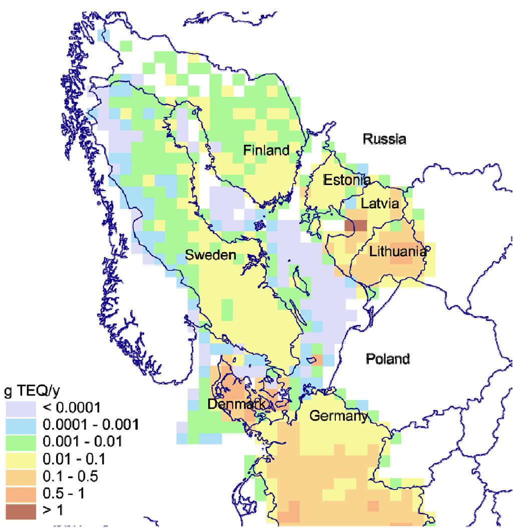


Figure 7.4. Annual PCDD/F emission of HELCOM countries from Commercial, Residential and Other Stationary Combustion sector for 2006, g TEQ/y.

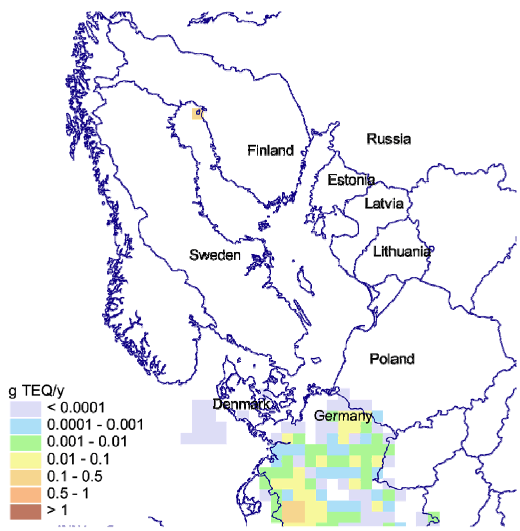


Figure 7.5. Annual PCDD/F emission of HELCOM countries from Fugitive Emissions From Fuels sector for 2006, g TEQ/y.

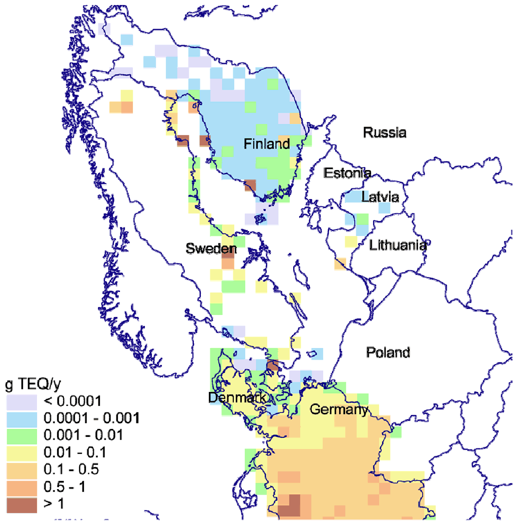


Figure 7.6. Annual PCDD/F emission of HELCOM countries from Industrial Processes sector for 2006, g TEQ/y.

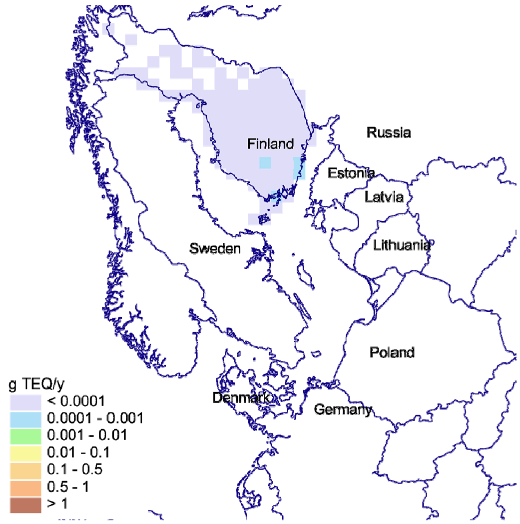


Figure 7.7. Annual PCDD/F emission of HELCOM countries from Solvent and Other Product Use sector for 2006, g TEQ/y.

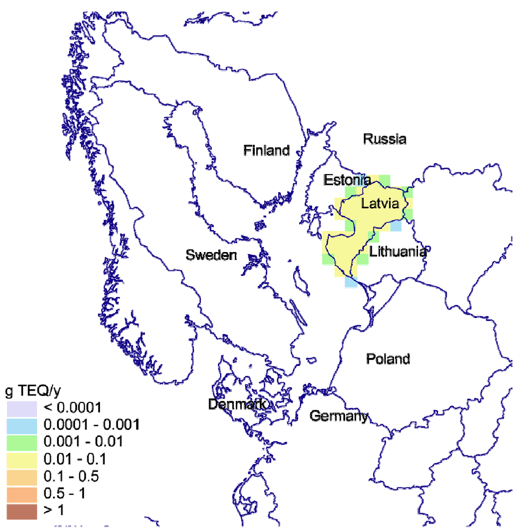


Figure 7.8. Annual PCDD/F emission of HELCOM countries from Agriculture sector for 2006, g TEQ/y.

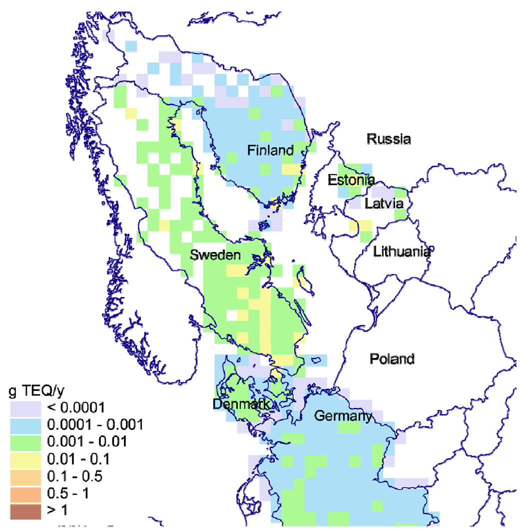


Figure 7.9. Annual PCDD/F emission of HELCOM countries from Waste sector for 2006, g TEQ/y.

Table 7.1. Annual total PCDD/F anthropogenic emissions of HELCOM countries from different sectors for 2006, in g TEQ/year

NFR emission sector	Sector name	DK	EE	FI	DE	LV	LT	PL	RU	SE
1	Combustion in Power Plants and Industry	1.9	1.2	5.1	6.9	5.8	1.4	46.7	777.5	27.0
2	Transport	0.3	0.05	2.7	3.6	0.02	0.2	0.7		0.6
3	Commercial, Residential and Other Stationary Combustion	16.5	1.3	1.1	23.8	6.4	9.5	201.4		2.9
4	Fugitive Emissions From Fuels	1.8E-04	NA	0.2	1.7	NO		2.9		
5	Industrial Processes	6.1		5.0	48.4	0.3		14.8		5.9
6	Solvent and Other Product Use	NA	NA	0.002	NA			NA		NA
7	Agriculture				NA	1.2		0.5		
8	Waste	0.04	0.05	0.2	0.1	0.1		182.2		1.1
9	Other				NA					
Total		**24.8**	**2.7**	**14.2**	**84.6**	**13.8**	**11.2**	**449.3**	**777.5**	**37.5**

NA – not available
NO – not observed

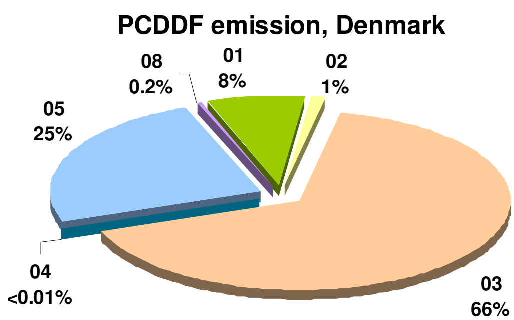


Figure 7.10. Percentage of annual total PCDD/F emission from different sectors in Denmark for 2006

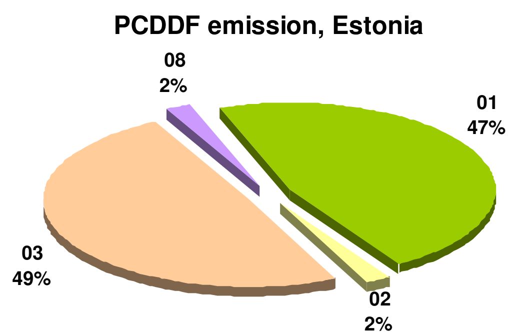


Figure 7.11. Percentage of annual total PCDD/F emission from different sectors in Estonia for 2006

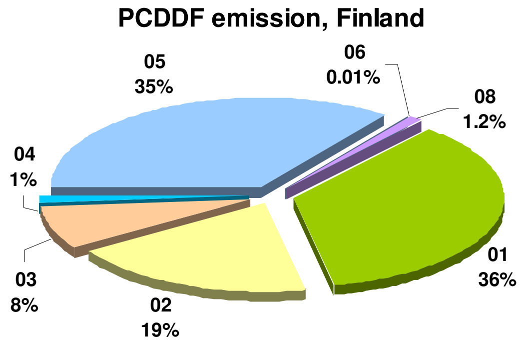


Figure 7.12. Percentage of annual total PCDD/F emission from different sectors in Finland for 2006

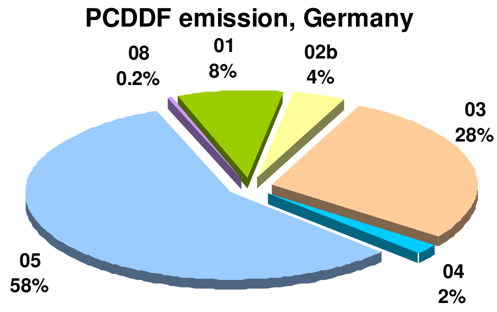


Figure 7.13. Percentage of annual total PCDD/F emission from different sectors in Germany for 2006

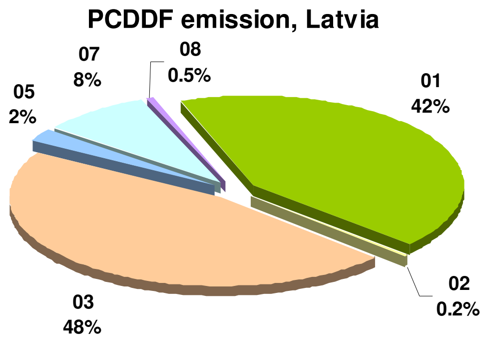


Figure 7.14. Percentage of annual total PCDD/F emission from different sectors in Latvia for 2006

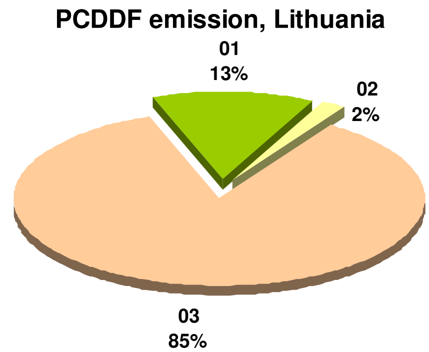


Figure 7.15. Percentage of annual total PCDD/F emission from different sectors in Lithuania for 2006

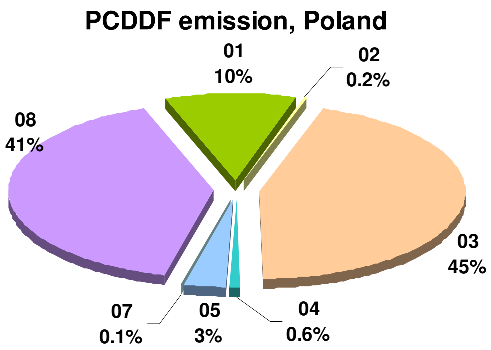


Figure 7.16. Percentage of annual total PCDD/F emission from different sectors in Poland for 2006

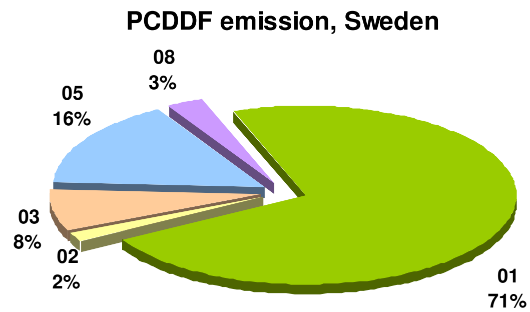
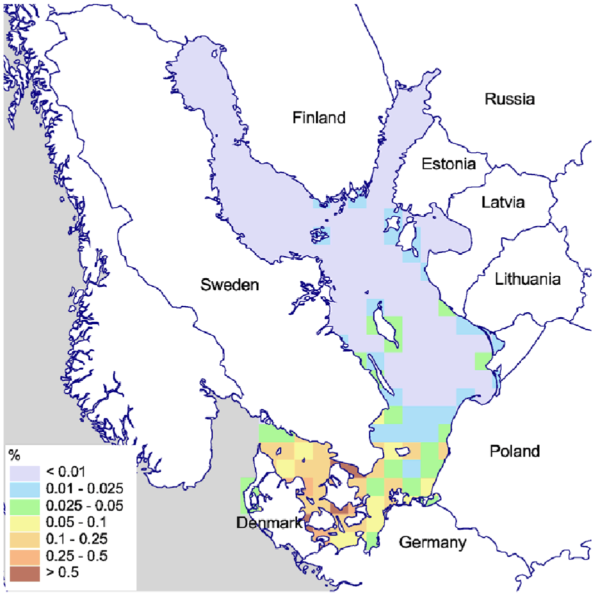
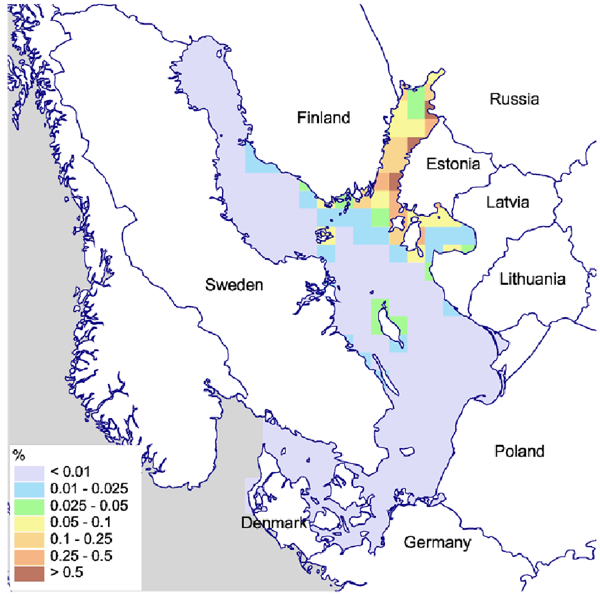


Figure 7.17. Percentage of annual total PCDD/F emission from different sectors in Sweden for 2006



Denmark



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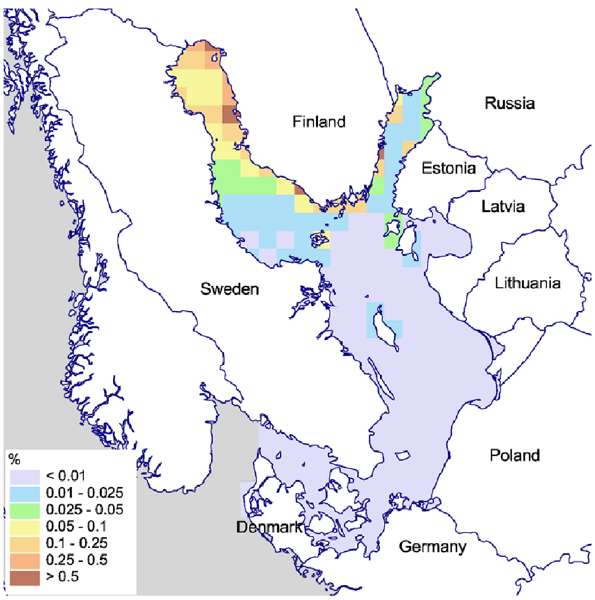
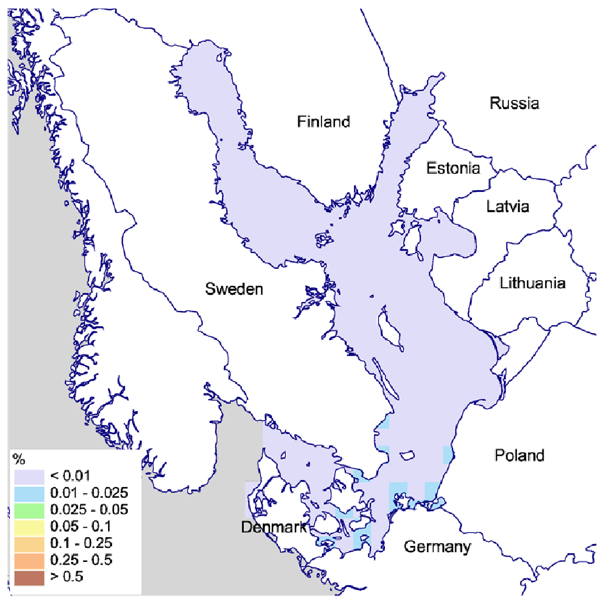
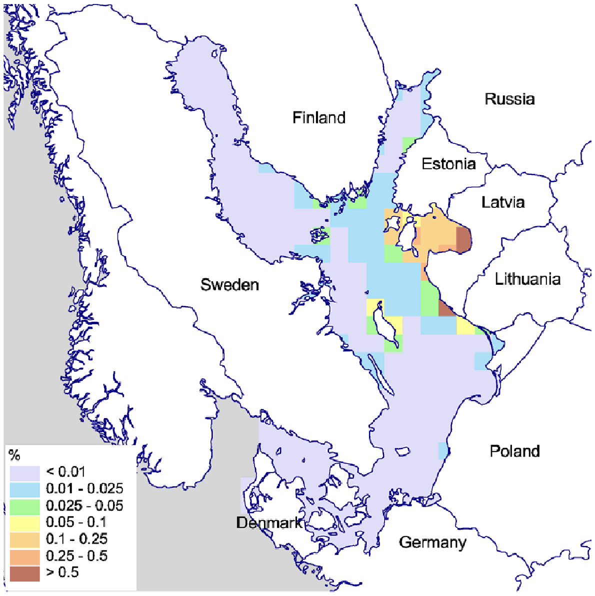


Finland

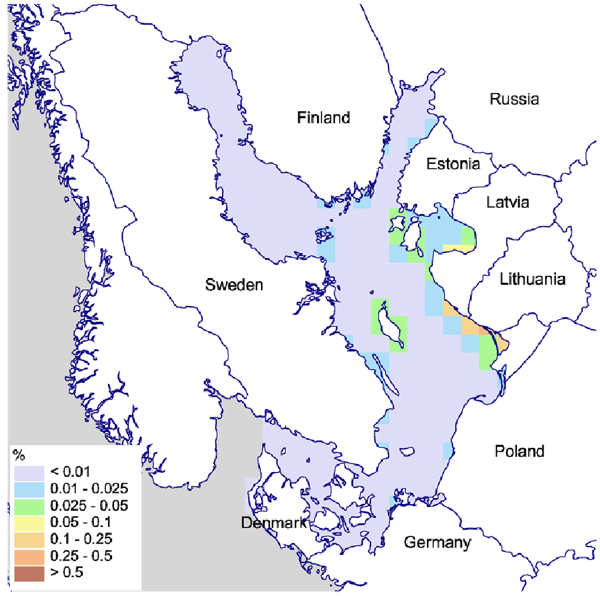


Germany

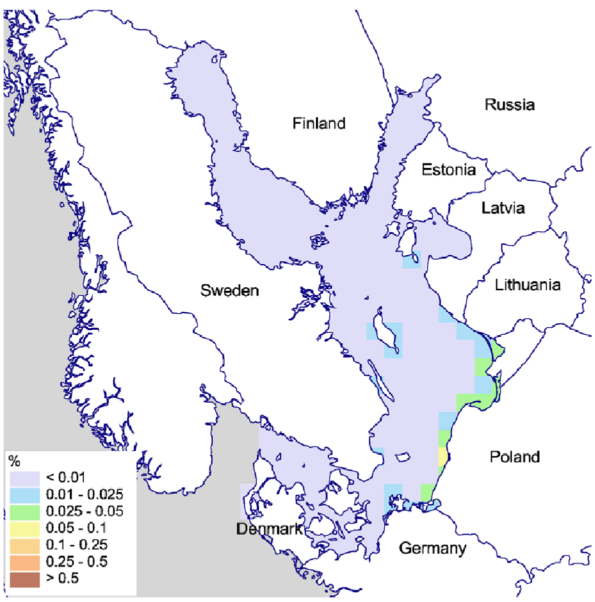
Figure 7.18. Maps with the fractions (in %) of annual total anthropogenic PCDD/F emissions from HELCOM Parties deposited over the Baltic Sea in 2006 (percent per deposition over the 50x50 km grid cell).



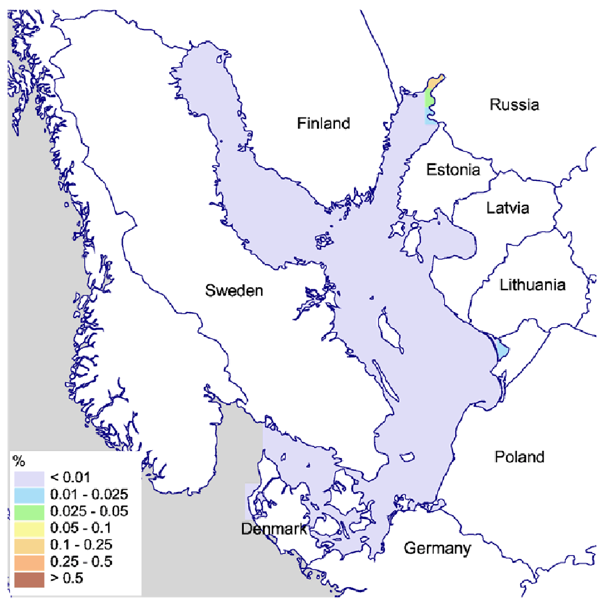
Latvia



Lithuania

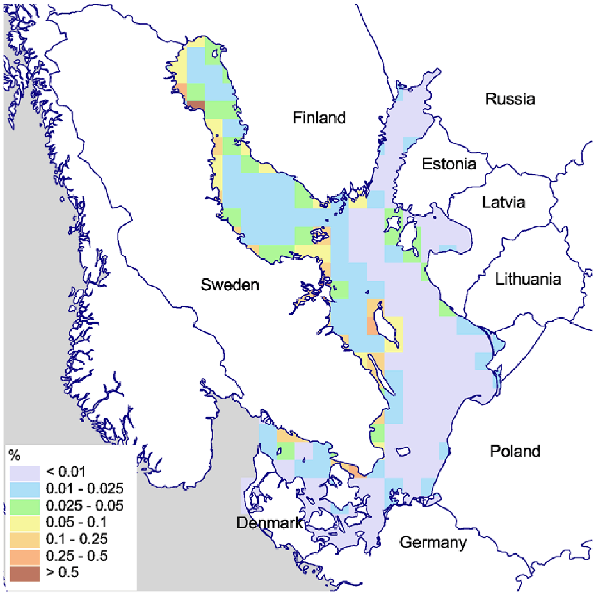


Poland



Russia

Figure 7.18. (cont.) Maps with the fractions (in %) of annual total anthropogenic PCDD/F emissions from HELCOM Parties deposited over the Baltic Sea in 2006 (percent per deposition over the 50x50 km grid cell).



Sweden

Figure 7.18. (cont.) Maps with the fractions (in %) of annual total anthropogenic PCDD/F emissions from HELCOM Parties deposited over the Baltic Sea in 2006 (percent per deposition over the 50x50 km grid cell).

Table 7.2. Annual total anthropogenic emissions of PCDD/Fs of HELCOM countries and other EMEP countries in period 1990-2006, g TEQ/year (Unofficial emissions are shaded).

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Denmark	67	64	59	54	51	49	47	44	37	31	32	30	27	29	24	26	25
Estonia	5.7	5.4	4.3	3.6	3.8	4.5	4.9	4.8	3.8	3.4	3.4	3.5	3.7	4.1	3.7	3.3	2.7
Finland	36	35	33	35	41	41	40	39	40	41	32	31	32	32	32	26	14
Germany	114	105	86	82	80	89	85	90	84	80	83	82	81	81	83	83	85
Latvia	7.1	7.6	7.3	8.4	9.0	10	11	12	11	12	10	11	11	12	13	13	14
Lithuania	5.6	5.6	5.6	5.6	5.6	5.6	5.6	5.6	6.0	5.0	4.3	13	12	12	11	11	11
Poland	529	535	517	592	520	515	484	440	381	381	333	447	433	482	387	416	449
Russia	991	947	901	878	825	769	637	614	606	625	631	643	655	686	716	747	778
Sweden	60	53	50	47	44	40	38	37	35	34	33	34	34	33	36	38	37
HELCOM	**1814**	**1758**	**1663**	**1705**	**1579**	**1523**	**1353**	**1285**	**1204**	**1213**	**1162**	**1294**	**1289**	**1372**	**1306**	**1364**	**1416**
Albania	43	43	43	43	43	43	43	43	43	43	43	43	44	44	44	44	44
Armenia	47	47	47	47	47	47	47	47	47	47	47	47	47	47	47	47	47
Austria	160	135	76	67	56	58	60	59	56	54	52	54	43	43	43	45	44
Azerbaijan	98	98	98	98	98	98	98	98	98	98	98	99	100	101	102	102	103
Belarus	16	16	16	16	16	16	16	16	16	15	18	23	25	26	25	24	27
Belgium	569	563	529	496	489	402	352	378	271	140	124	88	59	62	65	59	55
Bosnia and Herzegovina	67	67	67	67	67	67	67	67	67	67	67	65	63	61	59	57	56
Bulgaria	554	535	515	495	476	456	341	310	288	245	233	201	219	255	239	230	247
Croatia	179	165	152	138	124	111	97	95	111	98	109	76	75	97	93	91	93
Cyprus	7.7	7.4	7.8	7.9	7.8	7.8	7.5	7.3	7.3	7.3	7.1	7.2	7.3	6.1	5.9	5.9	5.9
Czech Republic	1252	1220	1220	1140	1135	1135	922	830	767	643	744	620	177	114	187	179	175
France	1763	1814	1836	1894	1893	1695	1479	1043	939	611	520	385	358	237	299	216	127
Georgia	122	122	122	122	122	122	122	122	122	122	122	122	111	98	85	85	85
Greece	279	279	279	279	279	279	279	279	279	279	279	255	231	207	183	159	135
Hungary	172	148	104	103	100	95	90	84	74	77	74	76	75	74	74	92	92
Iceland	9.2	9.0	8.7	7.7	7.0	6.0	5.3	5.1	4.2	3.4	3.1	2.8	2.5	2.1	1.5	1.5	1.5
Ireland	27	27	27	27	27	27	27	27	27	27	27	27	27	26	27	26	26
Italy	473	495	476	451	441	460	419	426	413	388	369	293	283	282	290	294	302
Kazakhstan	40	40	40	40	40	40	40	40	40	40	40	40	41	41	41	42	42
Luxembourg	45	40	34	29	23	24	16	16	8.0	6.7	5.4	4.1	2.9	1.6	1.6	1.6	1.6
Malta	3.9	3.9	3.9	3.9	3.9	3.9	3.9	3.9	3.9	3.9	3.9	3.9	3.9	3.9	3.9	3.9	3.9
Monaco	2.4	2.4	2.6	2.9	3.1	3.1	3.3	3.8	3.5	3.6	3.7	3.9	3.5	2.9	2.6	2.6	1.9
Netherlands	742	979	752	524	297	66	59	54	43	33	31	30	29	26	28	36	35
Norway	129	97	95	95	93	70	49	40	34	38	34	33	32	29	32	24	24
Portugal	18	18	18	18	18	18	19	21	18	17	15	11	11	11	11	9.2	10
Republic of Moldova	14	11	6.9	5.5	5.1	3.0	3.4	2.9	6.4	2.4	2.4	2.2	2.5	3.9	5.2	5.5	5.5
Romania	113	113	113	113	113	113	113	113	113	87	101	104	152	201	249	297	268
Serbia and Montenegro	172	172	172	172	172	172	172	172	172	172	172	170	169	167	166	164	162
Slovakia	136	132	128	124	120	116	106	96	109	98	90	87	91	70	65	86	67
Slovenia	16	17	15	14	13	12	12	12	11	11	11	10	10	10	9.1	8.6	8.4
Spain	181	187	195	192	186	161	160	133	134	140	147	141	142	147	150	150	155
Switzerland	175	159	149	137	122	105	96	88	81	63	54	42	29	17	16	16	16
The FYR of Macedonia	166	166	166	166	166	166	166	166	166	166	166	166	166	163	163	163	163
Turkey	1012	1012	1012	1012	1012	1012	1012	1012	1012	1012	1012	1018	1024	1029	1035	1041	1047
Ukraine	1022	1022	1022	1022	1022	1022	1022	1022	1022	1022	1022	1024	1026	1027	1029	1030	1032
United Kingdom	1146	1124	1097	889	692	739	476	379	284	258	229	218	201	199	227	199	197
EMEP, kg TEQ/ year	**13**	**13**	**12**	**12**	**11**	**10**	**9.4**	**8.6**	**8.1**	**7.4**	**7.2**	**6.9**	**6.4**	**6.3**	**6.4**	**6.4**	**6.3**

Expert estimates:

§ *Denier van der Gon, H.A.C., M. van het Bolscher A.J.H. Visschedijk P.Y.J. Zandveld [2006]*

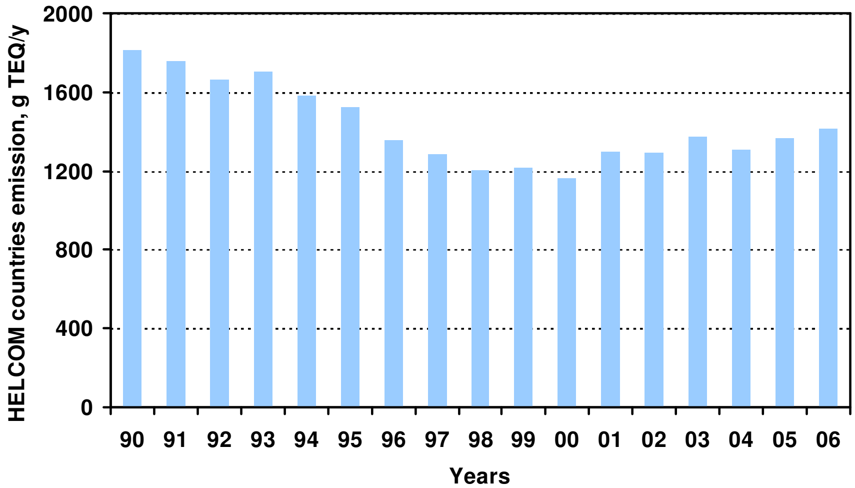


Figure 7.19. Time-series of total annual PCDD/F emissions of HELCOM countries in 1990-2006, g TEQ/year.

7.2 Annual net depositions of PCDD/F

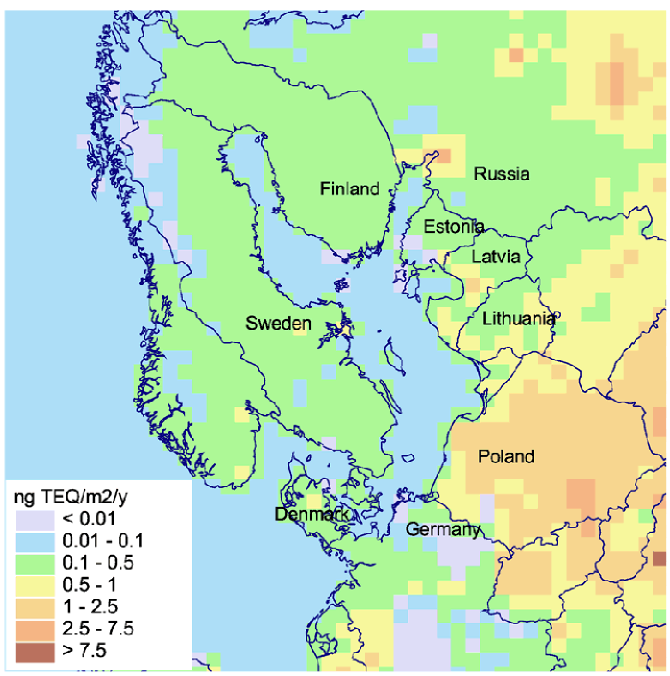


Figure 7.20. Annual net deposition fluxes of PCDD/Fs over the Baltic Sea region for 2006, ng

TEQ/m^2/year.

7.3 Monthly net depositions of PCDD/F

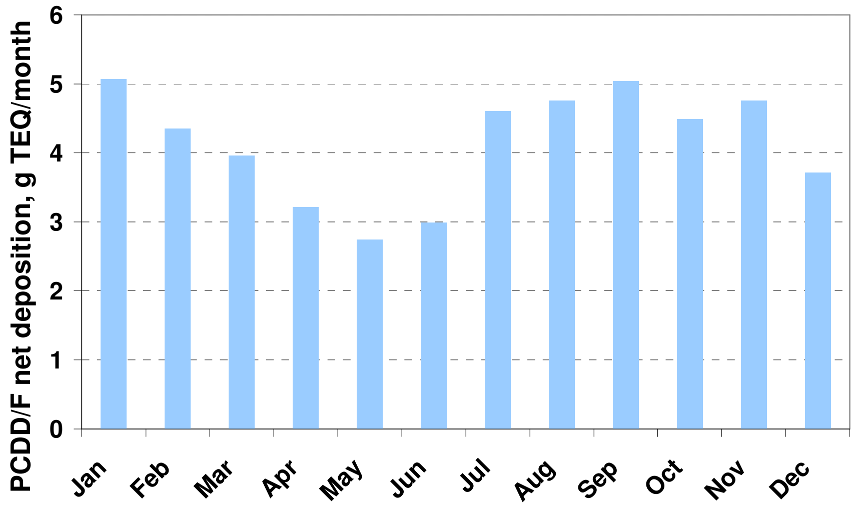


Figure 7.21. Monthly net depositions of PCDD/Fs over the Baltic Sea for 2006, g TEQ/month.

Table 7.3. Monthly net depositions of PCDD/Fs over the Baltic Sea for 2006, g TEQ/month.

Month	PCDD/Fs
Jan	5.1
Feb	4.4
Mar	4.0
Apr	3.2
May	2.7
Jun	3.0
Jul	4.6
Aug	4.8
Sep	5.0
Oct	4.5
Nov	4.7
Dec	3.7

7.4 Source allocation of PCDD/F deposition

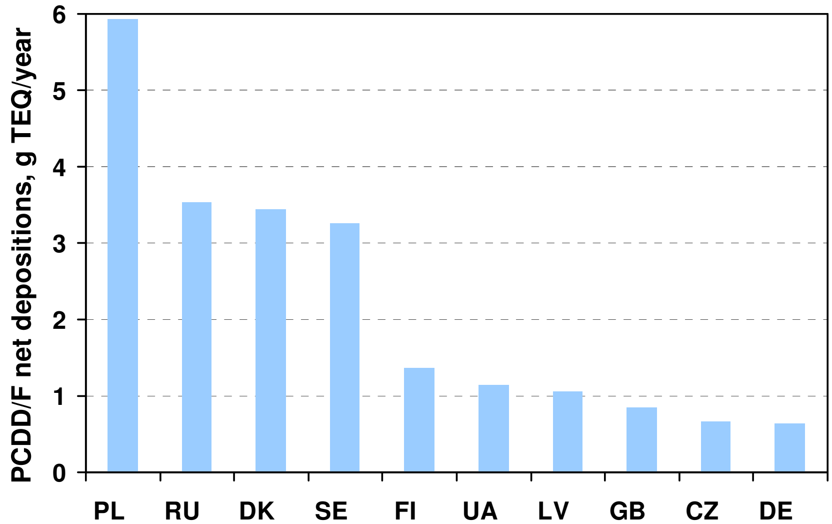


Figure 7.22. Top ten countries with the highest contribution to annual deposition of PCDD/Fs over the Baltic Sea for 2006, g TEQ/y.

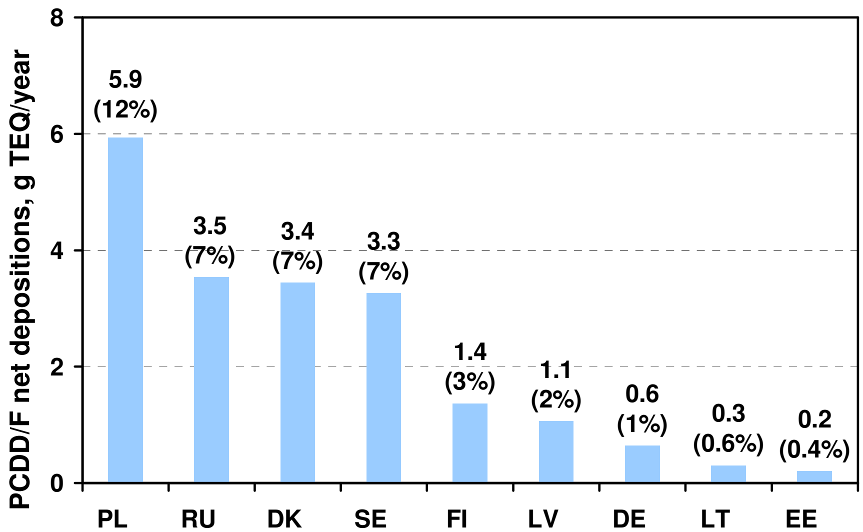


Figure 7.23. Contributions (in %) of HELCOM countries to the net PCDD/F depositions to the Baltic Sea for 2006. HELCOM countries emissions of PCDD/Fs contributed 40% to the net annual PCDD/F depositions over the Baltic Sea in 2006. Contribution of other EMEP countries accounted for 10%. Significant contribution was made by other emission sources, in particular, remote emissions sources and re-emission of PCDD/Fs (50%).

Table 7.4. Two most significant contributors to the annual net depositions of PCDD/Fs to the six Baltic Sea sub-basins for 2006.

Sub-basin	Country (1)	%	Country (2)	%	*, %
GUB	Sweden	16	Finland	12	51
GUF	Russia	46	Finland	4	35
GUR	Latvia	18	Poland	8	54
BAP	Poland	20	Sweden	6	51
BES	Denmark	29	Poland	4	52
KAT	Denmark	26	Sweden	5	51
BAS	Poland	12	Russia	7	50

* - contribution of re-emission and remote sources.

7.5 Comparison of model results with measurements

PCDD/Fs are not currently included into the EMEP measurement programme. For this reason verification of the MSCE-POP model results for PCDD/Fs was based on the comparison with the data of various measurement campaigns. Due to the limited information on measured atmospheric levels of PCDD/Fs and their temporal variations the comparison with the model results for this contaminant is of a preliminary character.

The performance of MSCE-POP model for computation of PCDD/F pollution levels within the European region was evaluated during the model review carried out in the framework of EMEP Task Force on Monitoring and Measurements. In particular, MSCE-POP model results on long-range transport of one of the toxic PCDD/F congeners 2,3,4,7,8-PeCDF for the EMEP region and the period 1990-2003 were compared with measurements of EMEP monitoring network and observations of other studies within the European region (*Shatalov et al.*, 2005). One of the main conclusions of the TFMM Workshop on the Review of the EMEP Models on Heavy Metals and Persistent Organic Pollutants in Moscow in 2006 was that "the MSCE-POP model represents the state-of-the-science and fits to the purpose of evaluating the contributions of long-range transport to the environment impacts caused by POPs". It was recognized that the MSCE-POP model results demonstrated its ability to provide spatially and temporally resolved air concentrations and depositions of POPs across Europe. The model provided reasonable agreement with long-term temporal trends of air pollution at most EMEP monitoring sites.

Additional comparison of PCDD/Fs modelling results obtained for 2004 was carried out with the measurement data of monitoring campaign carried out in Denmark. The results of the comparison are presented in the Joint report of EMEP Centres for HELCOM (*Bartnicki et al.*, 2006).

In this report no results of comparison of modeling results with measurement is presented since there was no available measurements of dioxins and furans within the European region for 2006 were found.

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Appendix A: Tables with measurements available at HELCOM stations for 2006

Deposition of reduced and oxidized nitrogen at HELCOM sites

Site	Comp		jan	febr	mars	apr	may	june	july	aug	sept	oct	nov	dec	year	Total N
DE0009R	ammonium	mg N m/2	8.4	16.1	36.9	44.3	42.5	20.8	46.3	53.7	13.3	9.6	16.2	16.6	324.4	
DE0009R	nitrate	mg N m/2	15.9	19.2	21.5	28.5	32.9	17.3	25.6	62.5	13.1	8.8	19.9	15.7	281.2	605.6
DE0009R	precipitation_amount	mm	24.9	37.7	51.6	30.7	58.4	36.0	21.0	172.5	44.2	28.6	62.2	41.2	609.1	
DK0005R	ammonium	mg N m/2	11.2	17.6	35.1	48.6	27.7	39.6	64.8	94.2	23.4	40.3	17.7	24.5	444.8	
DK0005R	nitrate	mg N m/2	16.2	23.8	23.9	30.5	20.6	18.9	33.8	44.6	21.5	27.0	23.3	21.4	305.5	750.3
DK0005R	precipitation_amount	mm	15.5	29.3	43.6	30.4	41.6	21.3	38.1	107.3	19.9	47.5	45.4	31.4	471.2	
DK0008R	ammonium	mg N m/2	9.9	20.2	18.7	21.4	14.4	10.1	21.5	26.6	4.1	15.3	15.9	12.5	190.5	
DK0008R	nitrate	mg N m/2	16.0	31.9	22.3	18.7	16.6	14.0	21.8	48.2	12.6	31.6	33.9	23.6	291.2	481.7
DK0008R	precipitation_amount	mm	23.4	55.5	39.9	27.2	34.0	34.5	41.6	212.3	20.2	66.4	68.9	63.2	687.0	
DK0020R	ammonium	mg N m/2	8.9	20.9	34.7	48.1	26.6	22.6	16.5	46.1	45.2	46.3	23.4	6.8	346.3	
DK0020R	nitrate	mg N m/2	15.0	29.3	70.8	34.2	18.7	11.2	10.5	47.0	24.8	21.8	30.4	10.1	324.1	670.4
DK0020R	precipitation_amount	mm	18.7	34.6	41.7	25.7	46.6	13.5	12.8	132.0	48.4	59.3	61.8	12.3	508.3	
EE0009R	ammonium	mg N m/2	2.7	1.5	3.6	7.7	16.7	3.0	0.0	7.4	0.2	16.9	7.6	9.9	77.1	
EE0009R	nitrate	mg N m/2	4.2	6.9	11.2	9.8	10.9	5.8	0.0	5.6	0.4	22.4	13.1	21.6	111.7	188.8
EE0009R	precipitation_amount	mm	9.8	24.8	37.9	15.9	33.1	23.6	0.5	65.4	13.5	109.6	48.5	61.8	444.5	
EE0011R	ammonium	mg N m/2	2.2	10.5	54.7	84.6	1.3	0.6	1.9	88.4	4.1	18.7	5.3	18.4	290.8	
EE0011R	nitrate	mg N m/2	2.7	10.7	28.6	56.9	6.2	0.6	3.8	7.2	3.8	21.1	26.8	45.2	213.6	504.4
EE0011R	precipitation_amount	mm	6.9	28.4	34.0	49.9	32.6	32.0	32.7	33.4	27.3	111.8	76.3	67.4	532.5	
FI0004R	ammonium	mg N m/2	4.1	1.6	1.9	12.3	5.7	5.1	1.9	3.7	17.3	9.0	11.3	7.6	81.7	
FI0004R	nitrate	mg N m/2	8.5	7.3	9.0	15.6	10.1	5.0	3.4	5.0	15.4	16.1	20.1	17.4	132.8	214.6
FI0004R	precipitation_amount	mm	20.3	12.5	28.6	44.1	48.8	23.0	21.2	31.4	66.2	99.9	54.6	61.1	511.9	
FI0009R	ammonium	mg N m/2	1.1	0.6	3.3	19.7	5.2	8.7	12.0	6.9	5.6	19.7	19.9	7.6	110.2	
FI0009R	nitrate	mg N m/2	3.1	1.5	8.4	22.4	9.0	10.4	10.2	10.0	10.5	30.0	35.8	15.0	166.2	276.5
FI0009R	precipitation_amount	mm	2.7	2.3	13.2	34.2	22.0	19.9	21.7	26.7	18.1	82.6	59.1	13.2	315.9	

Site	Comp		jan	febr	mars	apr	may	june	july	aug	sept	oct	nov	dec	year	Total N
FI0017R	ammonium	mg N m/2	8.7	4.2	9.6	14.6	12.6	5.4	4.9	5.2	21.6	38.6	27.2	16.8	170.3	
FI0017R	nitrate	mg N m/2	12.2	7.0	16.3	16.9	13.6	7.2	4.5	3.3	20.3	40.2	31.0	25.9	200.2	370.5
FI0017R	precipitation_amount	mm	11.8	10.0	28.9	27.7	24.4	16.4	10.3	23.0	62.4	131.5	87.0	40.7	474.3	
LT0015R	ammonium	mg N m/2	4.9	3.0	14.6	24.6	27.5	17.5	19.5	39.2	19.7	37.1	55.6	23.9	286.8	
LT0015R	nitrate	mg N m/2	5.6	5.8	13.0	19.5	19.1	14.0	10.3	23.9	21.3	29.9	39.7	23.1	224.9	511.6
LT0015R	precipitation_amount	mm	15.4	5.3	10.2	12.3	28.5	18.4	23.4	76.5	34.4	85.6	90.3	48.5	448.8	
LV0010R	ammonium	mg N m/2	1.7	5.4	26.4	31.0	14.1	19.1	11.1	21.1	18.0	51.2	28.6	36.2	260.3	
LV0010R	nitrate	mg N m/2	3.6	10.7	36.9	23.6	10.8	12.5	9.6	18.9	18.8	61.5	32.3	44.5	277.6	538.0
LV0010R	precipitation_amount	mm	9.6	25.0	33.8	21.6	33.8	30.1	10.3	85.7	58.1	141.0	91.0	89.9	629.9	
LV0016R	ammonium	mg N m/2	17.7	23.0	25.5	34.9	20.1	2.4	4.5	18.1	6.3	23.4	32.4	48.0	250.6	
LV0016R	nitrate	mg N m/2	5.1	4.8	7.6	24.5	13.4	3.5	3.4	10.0	8.3	19.1	22.0	35.4	157.6	408.2
LV0016R	precipitation_amount	mm	17.9	12.1	27.9	32.0	46.8	8.6	16.6	61.3	35.5	71.1	49.8	74.1	453.7	
PL0004R	ammonium	mg N m/2	2.0	9.5	20.5	74.4	24.7	25.4	18.0	32.7	15.7	15.3	18.9	22.2	278.0	
PL0004R	nitrate	mg N m/2	5.1	14.8	22.4	46.3	18.9	20.0	9.1	34.7	18.5	16.2	27.5	28.8	259.3	537.3
PL0004R	precipitation_amount	mm	7.0	26.1	21.3	67.0	60.6	38.5	13.8	108.2	50.0	69.6	75.5	41.7	579.3	
RU0016R	ammonium	mg N m/2	3.8	17.7	28.5	27.5	31.5	10.8	25.9	29.5	11.5	17.7	14.6	2.4	221.3	
RU0016R	nitrate	mg N m/2	7.5	13.0	24.6	17.2	16.0	10.8	38.6	21.5	7.7	11.0	17.2	6.5	191.5	412.8
RU0016R	precipitation_amount	mm	24.5	33.8	48.8	33.7	70.8	43.7	111.7	129.5	34.4	51.6	37.2	20.3	640.0	
SE0005R	ammonium	mg N m/2	0.8	0.3	0.4	6.5	8.6	2.3	3.5	1.8	3.2	2.0	1.1	0.3	30.7	
SE0005R	nitrate	mg N m/2	2.0	1.2	3.2	5.6	6.2	2.0	2.9	1.7	3.1	4.9	4.4	0.9	38.1	68.8
SE0005R	precipitation_amount	mm	6.8	6.0	17.2	18.2	44.5	9.4	15.8	14.2	36.6	90.0	18.4	7.7	284.8	
SE0011R	ammonium	mg N m/2	9.4	26.7	29.8	86.8	51.2	12.7	36.8	63.1	18.3	56.8	47.7	61.7	500.5	
SE0011R	nitrate	mg N m/2	9.3	32.0	28.3	50.1	42.8	8.1	19.6	62.2	15.2	46.6	52.9	67.4	434.1	934.6
SE0011R	precipitation_amount	mm	7.2	41.8	38.2	64.8	75.0	15.3	26.8	187.4	22.7	120.6	97.0	117.9	813.6	

Site	Comp		jan	febr	mars	apr	may	june	july	aug	sept	oct	nov	dec	year	Total N
SE0014R	ammonium	mg N m/2	18.2	13.3	5.4	52.1	11.1	15.1	111.0	30.7	26.6	34.2	40.2	37.0	394.9	
SE0014R	nitrate	mg N m/2	19.5	21.0	7.5	40.8	9.8	11.3	6.9	29.6	27.4	46.3	60.6	47.7	328.1	723.0
SE0014R	precipitation_amount	mm	20.2	41.8	20.3	45.4	23.6	28.4	39.2	116.7	46.2	138.5	122.5	108.9	751.7	
SE0053R	ammonium	mg N m/2	-	5.4	3.9	62.0	5.0	6.9	0.9	2.9	9.4	21.6	19.5	11.3	148.7	
SE0053R	nitrate	mg N m/2	-	12.3	11.2	59.7	6.3	2.8	3.2	4.3	13.0	28.0	34.1	16.4	191.1	339.8
SE0053R	precipitation_amount	mm	0.0	23.7	27.2	77.5	28.3	9.4	16.4	32.7	91.6	152.6	97.5	56.6	613.0	

Deposition of heavy metals (Pb, Cd and Hg) and lindane (γ HCH) at HELCOM sites

Site	Comp		jan	febr	mars	apr	may	june	july	aug	sept	oct	nov	dec	year
DE0009R	cadmium	µg Cd /m2	1.2	1.1	1.4	1.3	2.5	1.9	1.7	2.8	0.9	1.4	1.5	1.5	19.0
DK0008R	cadmium	µg Cd /m2	1.8	2.2	1.6	0.8	1.0	1.7	1.8	2.5	0.6	1.6	2.0	3.9	21.7
DK0020R	cadmium	µg Cd /m2	2.0	4.6	5.0	1.6	2.0	2.2	1.8	3.3	5.7	2.8	1.5	-	32.6
EE0009R	cadmium	µg Cd /m2	1.4	1.0	0.4	0.5	1.0	0.2	0.0	15.0	0.1	1.1	1.9	1.9	24.5
FI0017R	cadmium	µg Cd /m2	2.0	0.8	1.9	1.3	1.7	0.7	0.5	1.7	1.1	7.5	5.1	2.8	27.1
FI0053R	cadmium	µg Cd /m2	0.4	0.8	0.3	0.9	1.3	0.1	0.5	0.2	0.5	0.4	1.1	1.4	7.8
LT0015R	cadmium	µg Cd /m2	0.1	1.5	2.7	2.3	8.1	0.5	2.3	1.9	2.8	3.3	4.4	3.2	33.2
LV0010R	cadmium	µg Cd /m2	0.5	5.2	4.1	3.2	4.7	2.0	1.9	5.5	3.9	8.1	8.6	4.3	52.0
LV0016R	cadmium	µg Cd /m2	1.4	4.3	1.6	0.9	5.0	2.1	0.5	10.1	4.4	8.3	4.8	8.9	51.6
PL0004R	cadmium	µg Cd /m2	0.3	6.1	2.2	13.1	7.2	1.3	0.9	4.8	1.2	6.9	10.9	-	54.8
SE0051R	cadmium	µg Cd /m2	1.84	2.7	1.74	3.06	2.72	1.98	1.89	3.4	4.92	5.12	2.76	3.24	35.344
SE0097R	cadmium	µg Cd /m2	5.67	2.4	2.12	8.16	3.68	0.5	2.44	2.58	2.85	3.92	2	2.23	38.532
DE0009R	lead	µg Pb /m2	35.4	23.1	29.5	36.3	61.3	44.7	48.9	69.3	29.2	29.3	35.2	30.0	471.1
DK0008R	lead	µg Pb /m2	37.9	66.6	51.5	29.7	26.4	56.6	58.7	98.2	30.8	52.2	56.7	53.0	618.3
DK0020R	lead	µg Pb /m2	36.3	101.4	124.4	82.8	58.1	29.8	46.0	60.6	39.8	67.3	50.6	-	697.9
EE0011R	lead	µg Pb /m2	-	15.5	10.9	48.6	16.4	16.0	15.1	17.9	13.7	55.9	48.2	23.7	281.4
FI0017R	lead	µg Pb /m2	68.6	26.3	59.8	31.0	37.9	19.7	11.7	36.0	28.8	259.6	164.4	94.8	837.8
FI0053R	lead	µg Pb /m2	13.6	20.0	9.2	16.6	28.9	3.9	13.3	5.8	7.9	14.2	39.8	49.7	222.7
LT0015R	lead	µg Pb /m2	0.8	27.9	27.1	65.3	957.4	108.9	29.8	31.6	85.6	119.7	223.1	71.3	1748.0
LV0010R	lead	µg Pb /m2	16.2	158.4	142.5	65.6	34.2	41.4	7.8	137.0	44.7	297.2	154.5	86.5	1186.7
LV0016R	lead	µg Pb /m2	69.3	36.8	74.8	41.7	115.7	22.9	6.0	51.2	57.0	252.9	123.2	172.9	1064.7
PL0004R	lead	µg Pb /m2	12.8	42.5	21.7	65.7	47.3	34.3	38.5	60.6	21.0	57.1	120.0	-	521.5
SE0051R	lead	µg Pb /m2	64.4	62.55	20.01	36.21	55.08	37.8	26.04	56.1	113.16	151.04	89.7	62.64	774.225
SE0097R	lead	µg Pb /m2	89.91	52	41.87	123.76	48.76	9	59.78	81.27	48.45	123.48	110	102.58	890.033

Site	Comp		jan	febr	mars	apr	may	june	july	aug	sept	oct	nov	dec	year
DE0009R	mercury	ng Hg /m2	137.9	203.5	451.5	294.2	751.7	593.8	541.1	1405.3	657.2	242.0	356.2	272.7	5897.7
SE0014R	mercury	ng Hg /m2	224.0	251.3	290.0	878.7	658.5	411.8	576.0	819.7	384.2	674.7	474.7	385.6	6029.1
DE0009R	gamma_HCH	ng γHCH/m2	28.4	39.3	100.9	48.8	92.0	90.5	52.4	122.7	78.6	43.9	72.1	48.1	817.9
Precip + dry dep:															
SE0012R	gamma_HCH	ng γHCH/m2 (month)	0	0	0	0.19	0.29	2.46	0.14	0.53	0.03	1.15	0	0.06	
SE0014R	gamma_HCH	ng γHCH/m2 (month)	0.026	0.059	0.038	0.165	0.533	0.37	0.523	0.861	0.614	0.95	0.333	0.526	

Air concentrations of reduced and oxidized nitrogen at HELCOM sites

Site	Component	Unit	Jan	Febr	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
DE0009R	nitrogen_dioxide	µg N /m3	4.11	3.04	1.99	2.05	1.94	2.01	1.62	1.38	1.29	2.44	2.86	1.83	2.24
DK0005R	nitrogen_dioxide	µg N /m3	4.18	3.92	2.29	3.48	2.67	2.73	2.14	1.66	3.47	3.64	3.80	2.81	3.07
DK0008R	nitrogen_dioxide	µg N /m3	-	-	-	-	0.57	1.23	1.46	0.99	1.38	1.75	2.12	1.47	1.46
EE0009R	nitrogen_dioxide	µg N /m3	4.97	6.21	5.70	3.60	3.21	2.43	1.89	2.69	2.29	2.50	2.74	2.72	3.40
EE0011R	nitrogen_dioxide	µg N /m3	3.27	3.85	4.22	3.67	3.71	2.48	1.78	1.45	2.23	1.95	3.87	3.93	3.03
FI0009R	nitrogen_dioxide	µg N /m3	3.95	4.54	4.29	1.84	2.61	2.48	1.48	1.22	1.24	1.11	1.54	1.35	2.30
FI0017R	nitrogen_dioxide	µg N /m3	2.55	4.24	3.01	1.69	2.13	1.68	1.09	1.26	1.24	1.11	1.54	1.35	1.89
LT0015R	nitrogen_dioxide	µg N /m3	2.03	1.39	1.09	1.26	1.04	0.99	1.30	1.14	0.90	1.40	1.59	1.50	1.30
LV0010R	nitrogen_dioxide	µg N /m3	1.36	0.82	0.53	0.69	0.59	0.58	0.70	0.61	0.67	1.07	1.48	1.55	0.89
LV0016R	nitrogen_dioxide	µg N /m3	0.84	0.77	0.51	0.34	0.13	0.35	0.42	0.48	0.29	0.47	0.52	0.86	0.49
PL0004R	nitrogen_dioxide	µg N /m3	3.60	1.73	1.73	1.47	1.37	1.33	1.43	1.66	1.74	1.94	2.46	2.04	1.88
SE0005R	nitrogen_dioxide	µg N /m3	0.34	0.20	0.12	0.14	0.09	0.06	0.07	0.05	0.07	0.12	0.26	0.14	0.14
SE0011R	nitrogen_dioxide	µg N /m3	2.44	1.57	1.67	1.30	1.01	1.11	0.90	0.93	1.31	1.91	2.83	2.04	1.59
SE0014R	nitrogen_dioxide	µg N /m3	2.85	1.99	1.69	1.81	1.16	1.80	1.24	0.92	1.20	1.39	2.30	1.68	1.67
DE0009R	sum_ammonia_and_ammonium	µg N /m3	2.65	2.24	2.38	2.97	2.23	1.97	2.22	1.92	3.28	2.04	1.34	1.08	2.14
DK0003R	sum_ammonia_and_ammonium	µg N /m3	2.38	1.61	1.49	1.26	1.26	1.17	1.15	0.63	1.86	1.14	0.93	0.64	1.29
DK0005R	sum_ammonia_and_ammonium	µg N /m3	2.23	1.96	1.54	1.96	1.48	1.38	1.36	1.14	2.12	1.64	1.12	1.11	1.60
DK0008R	sum_ammonia_and_ammonium	µg N /m3	1.55	1.28	0.91	1.51	1.13	1.08	1.12	0.64	1.82	1.13	0.91	0.70	1.14
FI0009R	sum_ammonia_and_ammonium	µg N /m3	0.30	0.45	0.37	0.33	0.37	0.28	0.34	0.56	0.54	0.24	0.31	0.26	0.36
FI0017R	sum_ammonia_and_ammonium	µg N /m3	0.42	0.85	0.55	0.51	0.88	0.60	0.78	1.54	0.68	0.50	0.46	0.40	0.68
LT0015R	sum_ammonia_and_ammonium	µg N /m3	1.74	1.87	1.87	2.34	1.88	0.94	1.48	1.65	1.93	1.77	1.78	1.40	1.72
LV0010R	sum_ammonia_and_ammonium	µg N /m3	1.08	0.95	1.21	1.58	1.15	1.08	1.47	1.38	1.81	1.87	1.48	1.26	1.36
LV0016R	sum_ammonia_and_ammonium	µg N /m3	1.01	0.98	0.82	1.28	1.18	1.37	1.41	1.39	1.02	1.11	0.93	1.29	1.15
PL0004R	sum_ammonia_and_ammonium	µg N /m3	2.38	1.53	1.73	1.67	1.36	1.49	1.95	1.33	1.94	1.59	1.23	1.01	1.60
SE0005R	sum_ammonia_and_ammonium	µg N /m3	0.17	0.29	0.14	0.24	0.58	0.18	0.33	0.31	0.32	0.09	0.07	0.03	0.23
SE0011R	sum_ammonia_and_ammonium	µg N /m3	1.29	0.98	0.98	1.44	1.41	1.34	3.20	0.97	1.89	1.26	0.96	0.78	1.38
SE0014R	sum_ammonia_and_ammonium	µg N /m3	1.08	0.96	0.74	1.07	1.12	1.02	1.27	0.60	1.55	0.87	0.66	0.51	0.95

Site	Component	Unit	Jan	Febr	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
DE0009R	sum_nitric_acid_and_nitrate	µg N /m3	1.49	1.36	1.23	1.33	0.92	0.83	0.77	0.70	1.57	1.17	1.02	1.01	1.09
DK0003R	sum_nitric_acid_and_nitrate	µg N /m3	1.44	0.94	0.88	0.93	0.83	0.80	0.66	0.38	1.18	0.75	0.76	0.46	0.83
DK0005R	sum_nitric_acid_and_nitrate	µg N /m3	1.42	1.44	1.01	1.42	0.99	0.97	0.87	0.74	1.42	1.24	0.95	0.80	1.10
DK0008R	sum_nitric_acid_and_nitrate	µg N /m3	1.00	0.90	0.66	1.17	0.74	0.82	0.80	0.53	1.23	0.88	0.82	0.59	0.84
FI0009R	sum_nitric_acid_and_nitrate	µg N /m3	0.34	0.37	0.50	0.58	0.55	0.46	0.36	0.38	0.48	0.24	0.34	0.28	0.40
FI0017R	sum_nitric_acid_and_nitrate	µg N /m3	0.34	0.57	0.43	0.46	0.42	0.38	0.27	0.29	0.38	0.26	0.30	0.35	0.37
LT0015R	sum_nitric_acid_and_nitrate	µg N /m3	0.88	0.79	0.85	0.94	0.68	0.47	0.40	0.39	0.74	0.70	0.82	0.67	0.69
LV0010R	sum_nitric_acid_and_nitrate	µg N /m3	0.53	0.46	0.48	0.54	0.38	0.31	0.32	0.28	0.48	0.55	0.61	0.50	0.45
LV0016R	sum_nitric_acid_and_nitrate	µg N /m3	0.17	0.19	0.33	0.27	0.15	0.15	0.17	0.14	0.31	0.43	0.40	0.49	0.27
PL0004R	sum_nitric_acid_and_nitrate	µg N /m3	1.12	0.84	1.08	1.02	0.60	0.61	0.65	0.36	0.61	0.68	0.82	0.61	0.75
SE0005R	sum_nitric_acid_and_nitrate	µg N /m3	0.06	0.13	0.09	0.10	0.14	0.06	0.12	0.06	0.06	0.03	0.05	0.04	0.08
SE0011R	sum_nitric_acid_and_nitrate	µg N /m3	0.79	0.62	0.61	0.85	0.51	0.51	0.46	0.31	0.87	0.75	0.69	0.61	0.63
SE0014R	sum_nitric_acid_and_nitrate	µg N /m3	0.69	0.51	0.47	0.89	0.55	0.77	0.72	0.34	0.91	0.66	0.76	0.54	0.65

Air Concentrations of heavy metals (Pb, Cd and Hg) and lindane (γ HCH) at HELCOM sites

Site	Comp		jan	febr	mars	apr	may	june	july	aug	sept	oct	nov	dec	year
DE0009R	cadmium	ng Cd/m3	0.557	0.178	0.218	0.101	0.174	0.037	0.052	0.040	0.208	0.226	0.131	0.089	0.168
LT0015R	cadmium	ng Cd/m3	0.393	0.335	0.169	0.224	0.218	0.100	0.184	0.085	0.207	0.205	0.187	0.101	0.198
LV0010R	cadmium	ng Cd/m3	0.433	0.448	0.178	0.191	0.151	0.141	0.300	0.204	0.054	0.301	0.157	0.036	0.215
LV0016R	cadmium	ng Cd/m3	0.239	0.238	0.135	0.143	0.097	0.032	0.111	0.223	0.162	0.162	0.144	0.107	0.149
SE0014R	cadmium	ng Cd/m3	0.200	0.150	0.150	0.100	0.254	0.313	0.089	0.070	0.151	0.076	0.060	-	0.146
DE0009R	lead	ng Pb/m3	23.21	7.12	7.19	3.53	4.01	2.53	2.64	2.40	9.44	7.45	5.32	3.63	6.57
DK0003R	lead	ng Pb/m3	11.01	6.32	4.36	2.75	4.04	3.38	3.04	1.88	8.81	3.22	2.83	2.72	4.55
DK0005R	lead	ng Pb/m3	14.66	5.55	6.17	3.54	4.76	2.48	3.14	2.46	12.77	7.17	3.35	2.48	5.88
DK0008R	lead	ng Pb/m3	11.37	5.93	3.20	2.53	3.40	2.65	2.53	1.88	8.03	3.23	2.54	1.66	4.07
LT0015R	lead	ng Pb/m3	12.88	11.45	6.14	5.14	5.40	4.99	8.04	3.57	3.75	8.45	8.35	5.33	6.89
LV0010R	lead	ng Pb/m3	10.34	14.31	5.62	5.23	1.84	4.37	6.36	3.22	1.20	5.34	4.25	1.24	5.22
LV0016R	lead	ng Pb/m3	5.81	8.30	4.21	2.40	1.90	1.95	2.40	1.63	0.76	1.85	3.23	2.94	3.08
SE0014R	lead	ng Pb/m3	10.00	5.81	5.81	3.32	8.25	13.12	3.42	2.54	6.37	3.14	2.03	-	5.78
DE0009R	mercury (TGM)	ng Hg/m3	2.29	1.83	1.81	1.78	1.73	1.43	1.56	1.46	1.76	1.71	1.62	1.72	1.72
SE0014R	mercury (TGM)	ng Hg/m3	1.40	1.88	1.70	1.66	1.65	1.58	1.56	1.48	1.75	1.55	1.56	1.46	1.60
SE0014R	mercury (aerosol)	ng Hg/m3	12.94	24.94	14.51	8.82	12.44	8.96	7.38	7.19	7.23	7.63	7.44	5.11	10.43
SE0014R	gamma_HCH	pg γ-HCH/m	2.48	2.50	2.16	3.93	6.03	6.80	10.74	9.39	7.67	7.10	5.10	3.84	5.67

Appendix B: Monitoring methods

The monitoring regime for nitrogen compounds, metals and lindane are summarised in tables B.1 to B.5:

Table B.1. General information about sampling and analysis of nitrogen compounds in precipitation in 2006.

Country		Sampling period	Sampler		Analytical methods
			Wet only	Bulk	
Denmark	Nitrate ammonium	Biweekly	x		IC Spect. (CFA)
Estonia	Nitrate Ammonium	Weekly		X	IC Spect (indophenol)
Finland	Nitrate Ammonium	Weekly		X	IC IC
Germany	Nitrate Ammonium	Weekly	X		IC IC
Latvia	Nitrate Ammonium	Daily	X (LV10)	X (LV16)	IC Spect (indophenol)
Lithuania	Nitrate Ammonium	Daily	X		IC Spect (indophenol)
Poland	Nitrate Ammonium	Daily		x	IC Spect (chloramin T)
Russia	Nitrate Ammonium	Daily		x	IC
Sweden	Nitrate Ammonium	Weekly	X		IC Spect (FIA)

*IC: Ion chromatograpy
**Spect Spectrofotometric detection

Table B.2. General information about sampling and analysis of nitrogen compounds in air in 2006.

Country		Sampl period	Sampler	Analytical methods
Denmark	NO_2	Daily	KI method 0.73m^3/day	Spect
	NO_2 (DK05)	Hourly	Chemiluminisence	
	Sum of nitric acid and nitrate	Daily	Millipore RAWP, 1.2 µm + KOH-impregnated Whatman 41, 58 m^3/day	IC
	Sum of ammonia and ammonium	Daily	Millipore RAWP, 1.2 µm + Oxalic acid impregnated Whatman 41, 58 m^3/day	Spect (CFA)
Estonia	NO_2	Hourly	Chemiluscence	
Finland	NO_2	Hourly	Chemiluscence	
	Sum of nitric acid and nitrate	Daily	Whatman 40 + NaOH impregnated Whatman 40 filter, 24 m^3/day	IC
	Sum of ammonia and ammonium	Daily	Oxalic acid impregnated Whatman 40 filter, 24 m^3/day	IC
Germany	NO_2	Daily	NaI imp. Glass filters, 0.7m^3/day	FIA
	Sum of nitric acid and nitrate	Daily	Aerosol + KOH impr W40 filter, 22 m^3/day	IC
	Sum of ammonia and ammonium		Aerosol + Oxalic acid impr W40 filter	FIA
Latvia	NO_2	Daily	KI method 0.2-0.4 m^3/day	Spect. Griess
	Sum of nitric acid and nitrate	Daily	KOH-impregnated Whatman 41 filter, 14-20 m^3/day	IC
	Sum of ammonia and ammonium	Daily	Oxalic acid impregnated Whatman 41 filter, 14-20 m^3/day	Spect (indophenol)
Lithuania	NO_2,	Daily	KI method 0.4-0.7 m^3/day	Spect. Griess
	Sum of nitric acid and nitrate	Daily	KOH impregnated Whatman 40 filter, 16-17 m^3/day	IC
	Sum of ammonia and ammonium	Daily	Oxalic acid impregnated Whatman 40 filter, 16-17 m^3/day	Spect (indophenol)
Poland	NO_2	Daily	Abs.sol. TGS 0.73^3/day	Spect. Griess
	Sum of nitric acid and nitrate	Daily	NaF impregnated Whatman 40 filter, 3.5-4 m^3/day	Spect. Griess
	Sum of ammonia and ammonium	Daily	Oxalic acid impregnated Whatman 40 filter, 3.5-4 m^3/day	Spect. Chloramin T)
Russia	Ammonium, Nitrate	Daily	Whatman 40 filter, 10-15 m^3/day	IC
Sweden	NO_2	Daily	NaI imp. glass sinters 0.7 m^3/day	Spect
	Sum of nitric acid and nitrate		Aerosol filter as for sulphate + KOH-impregnated Whatman 40 filter, 20 m^3/day	IC
	Sum of ammonia and ammonium		Aerosol filter as for sulphate + Oxalic acid impregnated Whatman 40 filter, 20 m^3/day	FIA

GF-AAS: Graphite furnace atomic absorption spectroscopy
ICP-MS: Inductively coupled plasma - mass spectrometry
CV-AFS: Cold vapour atomic fluorescence spectroscopy

***Table B.3**. General information about sampling and analysis of heavy metals in 2006.*

Country	Precipitation		Air and aerosols		Laboratory method
	Field method	Frequency	Field method	Frequency	
Germany	wet only	Weekly	Low volume sampler	weekly	ICP-MS
Hg	wet only	Weekly	TGM:gold trap	daily	CV-AFS
Denmark	Bulk	Monthly	Filter-3pack	daily at DK3,8,31 weekly at DK11	Precip: GF-AAS Aerosols: PIXE
Hg	Bulk (Hg)	Monthly	Hg-monitor (Tekran)	hourly	
Estonia	Bulk	Monthly	Sampling High Volume Sampler	Weekly	GF-AAS, Zn: F-AAS
Finland	Bulk	Monthly	Teflon, Millipore, Fluoropore, 3 µm, 50 l/min, cut off 15 µm	weekly	ICP-MS
Hg	Bulk (Hg)	Monthly	Hg: gold traps (TGM)	2 X 24 h a week	CV-AFS
			Hg: mini traps (TPM)	weekly	CV-AFS
Lithuania	Bulk	Weekly	Low vol. 0.5-2 m3/h	weekly	GF-AAS
Latvia	Bulk	Weekly	Filter-1pack	Weekly	Cd, Cu, Pb, Ni, As: GF-AAS, Mn, Zn: F-AAS
Poland	Wet-only	Biveekly			GF-AAS (AVS from May); GF-AAS; Zn: F-AAS
Sweden	Bulk	Monthly	Low volume sampler, teflon filter	monthly	ICP-MS
Hg	Bulk (Hg)	Monthly	Hg: gold traps (TGM)	2 X 24 h a week	CV-AFS
			Hg: mini traps (TPM)	2 X 24 h a week	CV-AFS

AAS: Atomic Absorption Spectroscopy
GF-AAS: Graphic Furnace Atomic Absorption Spectroscopy
F-AAS: Furnace Atomic Absorption Spectroscopy
ICP-MS: Inductively Coupled Plasma - Mass Spectrometry
CV-AAS: Cold Vapour Atomic Fluorescence Spectroscopy

***Table B.4**. General information about sampling and analysis of γ-HCH, 2006*

Country	Precipitation		Air and aerosols		Laboratory method
	Sampling method	Frequency	Sampling method	Frequency	
Germany	wet only	Monthly			GC-MS
Sweden	Bulk (precip + dry dep)	monthly	High vol.	SE14 biweekly, SE12: 1 w a month	HPLC, GC-MS

HPLC: High Performance Liquid Chromatography
GC -MS: Gas chromatograph with Mass Spectrometry