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Atmospheric Supply of Nitrogen, Lead, Cadmium, Mercury and Dioxins/Furans to the Baltic Sea in 2013

Jerzy Bartnicki[1], Alexey Gusev[2], Wenche Aas[3], Semeena Valiyaveetil[1], Ágnes Nyíri[1]

[1]Meteorological Synthesizing Centre-West (MSC-W)
[2]Meteorological Synthesizing Centre-East (MSC-E)
[3]Chemical Coordinating Centre (CCC)

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Summary

The results presented in this EMEP Centres Joint Report for HELCOM are based on the modelling and monitoring data presented to the 37th Session of the Steering Body of EMEP in Geneva in September 2013. 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 2011.

Until 2012, the Baltic Sea basin was sub-divided into six sub-basins. In 2013, new nine sub-basins were introduced for the first time. The new sub-basins of the Baltic Sea have been used for computing all atmospheric nitrogen depositions presented in this report. The are listed below in alphabetical order, together with their abbreviations and surface areas.

Sub-basin	Abbreviation	Area in km^2
Archipelago Sea	ARC	13405
Baltic Proper	BAP	209258
Bothnian Bay	BOB	36249
Bothnian Sea	BOS	65397
Gulf of Finland	GUF	29998
Gulf of Riga	GUR	18646
Kattegat	KAT	23659
The Sound	SOU	2328
Western Baltic	WEB	18647
Baltic Sea basin	**BAS**	**417587**

The measured monthly and annual 2011 concentrations in air and precipitation for nitrogen species and heavy metals are presented in the report. For most components a significant south-east gradient can be noticed in the measured concentrations in 2011. Further the concentration levels seem to be higher in southwest than southeast for the nitrogen components, maybe due to influence of the extensive traffic (ship as well as cars) and agricultural activities in this region.

The temporal patterns of monthly Cd and Pb concentrations in air show a winter maximum, similar tendency for elemental Hg. Also nitrogen concentration in air show elevated levels in the spring and generally higher concentrations in winter than summer. These elevated concentrations in winter occur probably due to longer atmospheric residence time and reduced vertical mixing. The seasonal patterns in precipitation are not as strong as for airborne components. This is due to the presence of the precipitation

effect, but there is a maxima of reduced nitrogen wet deposition in summer due to enhanced agricultural activities.

Annual emissions from the HELCOM Contractig Parties in 2011 are shown below for all pollutants considered in the report.

Country/ship	POLLUTANT					
	NO_2 kt N	NH_3 kt N	Cd tonnes	Pb tonnes	Hg tonnes	PCDD/F g TEQ
Denmark	38	61	0.2	10	0.4	24
Estonia	11	9	0.7	38	0.6	5
Finland	47	31	1.3	22	0.7	13
Germany	393	464	5.3	190	10	63
Latvia	10	11	0.2	5	0.1	27
Lithuania	15	24	0.1	3	0.2	14
Poland	259	223	42	559	10	269
Russia	838	1053	23	32	1	900
Sweden	44	43	0.5	11	0.6	39
HELCOM	**1656**	**1917**	**73**	**870**	**23**	**1355**
Ship-Baltic	103					

Annual depositions of all considered pollutants in 2011 are shown in the Table below for the new, nine 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
ARC	3,3	2,0	0.2	5	0.1	8
BOB	66,2	53,3	0.3	7	0.2	15
BOS	5,0	3,5	0.5	15	0.3	19
BAP	11,6	7,0	4.3	112	1.5	101
GUF	8,1	5,1	0.5	12	0.2	33
GUR	5,9	4,0	0.3	9	0.1	24
KAT	10,0	10,4	0.5	18	0.2	16
SOU	1,1	1,1	0.1	2	0.0	7
WEB	7,8	10,8	0.5	14	0.2	29
BAS	**119,0**	**97,2**	**7.1**	**194**	**2.8**	**251**

Compared to 2010, nitrogen oxides emissions in 2011 are lower (2-14%) in all nine HELCOM Contracting Parties, but ship emissions from the Baltic Sea are 1.6% higher.

Annual 2011 ammonia emissions remain on the same level as 2010 ammonia emissions in three out of nine HELCOM countries: Finland, Poland and Sweden. The 2010 emissions are higher than 2009 emissions in three CPs: Estonia (1%), Germany (3%) and Russia (11%). They are lower in Denmark (-1%), Latvia (-34%) and Lithuania (-3%). The reduction of ammonia emission in Latvia is surprisingly large.

Among the HELCOM Contracting Parties, the largest per cent of 2011 nitrogen emissions deposited to the Baltic Sea basin can be noticed for Denmark (15.8%) and the lowest for Russia (0.3%).

Calculated annual deposition of total nitrogen to the Baltic Sea basin in 2011 is 216 kt, approximately 1% lower than in 2010. Deposition of oxidised nitrogen was 4% lower and deposition of reduced nitrogen is 3% higher in 2011 compared to 2010. Deposition of oxidized nitrogen accounts for 55% of total nitrogen deposition in 2011.

Normalised nitrogen depositions to the Baltic Sea have been calculated for the first time in 2013. Normalised depositions of oxidized, reduced and total nitrogen to the Baltic Sea show clear decreasing pattern in the period 1995-2011.

Germany, Poland, ship traffic on the North Sea and on the Baltic Sea are the main emission sources contributing to oxidized nitrogen deposition into the Baltic Sea basin in 2011. The main difference between 2010 and 2011 is higher contribution of ship traffic on the North Sea to oxidized nitrogen deposition in 2011.

As in 2009 and in 2010, Germany, Poland and Denmark are top three sources contributing to reduced nitrogen deposition into the Baltic Sea basin in 2011.

As in previous years, also in 2011 some distant sources like United Kingdom. France and ship traffic on the North Sea contribute significantly to nitrogen deposition into the Baltic Sea basin.

The main sources contributing to total nitrogen deposition to the Baltic Sea basin are: Germany, Poland, Denmark, United Kingdom and Sweden. Compared to 2010, contribution from the United Kingdom is higher and contribution from Russia is lower, in 2011. Contribution of other distant sources like ship traffic on the North Sea, France and the Netherlands is also significant.

The results of the EMEP/MSC-W model are routinely compared with available measurements at EMEP and HELCOM stations. The comparison of calculated versus measured data indicates that the model predicts the observed air concentrations and depositions of nitrogen compounds within the accuracy of approximately 30%.

Annual 2011 emissions of cadmium, lead, mercury, and dioxins and furans have slightly decreased comparing to 2010 (by 7%, 3%, 1.3%, and 1.4%).

Levels of cadmium and mercury deposition to the entire Baltic Sea have declined in 2011 comparing to 2010 by 2% and 4%, respectively. At the same time deposition of lead to the Baltic Sea has increased by 15% from 2010 to 2011. Annual deposition of PCDD/Fs in 2011 has dropped by 27% comparing to 2010.

Anthropogenic emission sources of HELCOM countries contributed to annual deposition over the Baltic Sea in 2011 about 20% for lead and about 14% for mercury, respectively. For cadmium and PCDD/Fs this contribution is accounted for 37% and 34%. Among the HELCOM countries the most significant contribution to deposition of HMs and PCDD/Fs to the Baltic Sea in 2011 was made by Poland and Germany.

Essential amount of these pollutants in total annual deposition (more than 50%) was contributed by other sources, in particular, natural emissions, re-suspension with dust, distant emissions, and re-emission.

Modelling results in comparison with available measurements for 2011 made around the Baltic Sea are within an accuracy of 40% for Pb, 70% for Cd, and 10% for Hg.

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 Klaipeda-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 HELCOM. Based on model estimates and monitoring results presented to the 37th session of the Steering Body of EMEP. Following decision of the HELCOM /MONAS-10 Meeting, it presents the results for the year 2011.

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