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Atmospheric Supply of Nitrogen, Cadmium, Mercury, Lead, and PCDD/Fs to the Baltic Sea in 2015

Jerzy Bartnicki[1], Alexey Gusev[2], Wenche Aas[3], Michael Gauss[1], Jan Eiof Jonson[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 Third Joint session of the Working Group on Effects and the Steering Body to EMEP which took place 11-15 September 2017 in Geneva. It includes measurements, as well as emissions and depositions calculated by the EMEP models of nitrogen compounds, heavy metals and POPs for the year 2015.

The annual and monthly mean concentrations and deposition for the measured concentrations of nitrogen species and heavy metals (HMs) are presented in the report. Eight countries have submitted data from all together nineteen HELCOM stations for 2015, which is similar to previous years. The spatial coverage of the sites are quite good, with stations distributed in eight of the nine sub-basins defined by HELCOM.

There is a general tendency of decreasing concentrations from south to north for all relevant species, and for many species an east-west gradient. Air concentrations generally peak in winter due to longer atmospheric residence times. For wet depositions, there is no clear seasonal pattern.

Emission data and meteorology are the most important inputs for the EMEP models. For the HELCOM purpose emissions are especially interesting. Annual emissions from the HELCOM Contracting Parties and from the ship traffic on the Baltic Sea in 2015 are shown below for all pollutants considered in the report.

Country/ship	POLLUTANT					
	NO_2 kt N	NH_3 kt N	Cd tonnes	Hg tonnes	Pb tonnes	PCDD/Fs g TEQ
Denmark	35	60	0.66	0.30	12	24
Estonia	9	10	0.75	0.54	28	4
Finland	43	26	0.92	0.64	14	14
Germany	361	625	6.57	9.09	220	62
Latvia	11	15	0.63	0.08	3	16
Lithuania	17	24	0.80	0.69	4.1	24
Poland	217	220	13.5	10.6	508	290
Russia	1045	1070	60.3	16.7	211	1410
Sweden	39	50	0.54	0.41	10	28
HELCOM	**1778**	**2100**	85	39	1011	1872
Ship-Baltic	98					

Compared to 2014, nitrogen oxides emissions in 2015 are lower in two large emitters among HELCOM CPs, in Germany 3% and in Poland 1%. They are also 8% lower in Estonia. Nitrogen oxides emissions in the largest emitter – Russia - are 11% higher in 2015 than in 2014. Russia has not submitted annual emissions for 2015 and they were estimated by the experts and this is the main reason. Increased Russian emissions are also mainly responsible the 5% increase in emissions of nitrogen oxides from all HELCOM CPs together.

For the first time this year, MSC-W has used data for international ship traffic emissions from the Finnish Meteorological Institute (FMI) in the model calculations. Compared to 2014 emissions, nitrogen oxides emissions from the ship traffic in 2015 are 20% higher .

Annual ammonia emissions from all HELCOM countries together are 17% higher in 2015 than in 2014, however this is again mainly due to increase of ammonia emissions from the Russian Federation, as estimated by experts. Ammonia emissions from Russia increased by 39% from 2014 to 2015.

Annual emissions of cadmium, mercury, lead, and PCDD/Fs have declined in the period from 1990 to 2015 by 40%, 46%, 87%, and 31%, respectively. In comparison to levels of emissions in 2014, cadmium, mercury, and PCDD/Fs emissions in 2015 were slightly higher by 1.5%, 4.4%, and 0.6%, whereas emissions of lead were lower by 0.6%.

Annual 2015 depositions of all considered pollutants to individual sub-basins and to the entire Baltic Sea basin are shown in the table below.

Basin	POLLUTANT					
	Ox-N kt N	Red-N kt N	Cd tonnes	Hg tonnes	Pb tonnes	PCDD/Fs g TEQ
ARC	3.1	2.1	0.11	0.09	3.4	5.2
BAP	69.0	63.5	0.16	0.23	4.3	12.2
BOB	4.3	3.3	0.33	0.35	9.3	14.4
BOS	9.4	6.6	2.61	1.53	90.8	68.8
GUF	8.3	5.5	0.40	0.22	10.3	25.1
GUR	5.4	4.4	0.24	0.14	6.8	14.8
KAT	10.4	11.7	0.34	0.22	12.7	10.9
SOU	1.4	1.4	0.04	0.02	1.5	4.7
WEB	10.1	14.4	0.32	0.19	11.5	18.2
BAS	**121.2**	**112.9**	**4.5**	**3.0**	**151**	**174**

The calculated annual deposition of total nitrogen to the Baltic Sea basin in 2015 is 234 kt, i.e. approximately 2% lower than in 2014. Deposition of oxidised nitrogen is 8%

lower and deposition of reduced nitrogen is 4% higher in 2015 compared to 2014. Deposition of oxidised nitrogen accounted for 52% of total nitrogen deposition in 2015.

Compared to 1995 depositions, annual deposition of oxidised nitrogen declined 33% and deposition of total nitrogen declined 18% in 2015. Annual deposition of reduced nitrogen is 5% higher in 2015 than in 1995.

Normalised nitrogen depositions to the Baltic Sea basin have also been calculated for the year 2015. Normalised depositions of oxidised, reduced and total nitrogen to the Baltic Sea show clear decreasing patterns in the period 1995-2015.

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%.

According to model results cadmium, mercury, lead, and PCDD/F depositions to the entire Baltic Sea have decreased from 1990 to 2015 by 63%, 34%, 80%, and 67%, respectively. Levels of depositions in 2015 were lower compared to 2014 by 39% for cadmium, 12% for mercury, 33% for lead, and 22% for PCDD/Fs.

Anthropogenic emission sources of HELCOM countries contributed to annual deposition over the Baltic Sea in 2015 about 36% for cadmium, 14% for mercury, 29% for lead, and 47% for PCDD/Fs. Among the HELCOM countries the most significant contributions to cadmium, mercury, lead, and PCDD/F deposition to the Baltic Sea in 2015 were made by Poland, Russia, and Germany.

Substantial contribution to total annual deposition of cadmium, lead, and mercury (more than 50%) was made by natural emissions, re-suspension with dust, distant emissions, and re-emission.

In comparison with available measurements, made around the Baltic Sea, modelling results for cadmium and lead were within an accuracy of a factor of 2 with regard to observed levels. For mercury model estimates were generally within accuracy of ±10% for concentrations in air and ±50% for concentrations in precipitation in comparison to measurements.

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 rationalise 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 in 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 Third Joint session of the Working Group on Effects and the Steering Body to EMEP which took place 11-15 September 2017 in Geneva. Following decision of the HELCOM /MONAS-10 Meeting, it presents the results for the year 2015.

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