SHEBA

Sustainable Shipping and Environment of the Baltic Sea region

BONUS Research Project

Call2014-41

Deliverable 2.1, type DB

Shipping emissions for the Baltic Sea and selected harbor areas

Due date of deliverable:	project month 15
Actual submission date:	project month 18

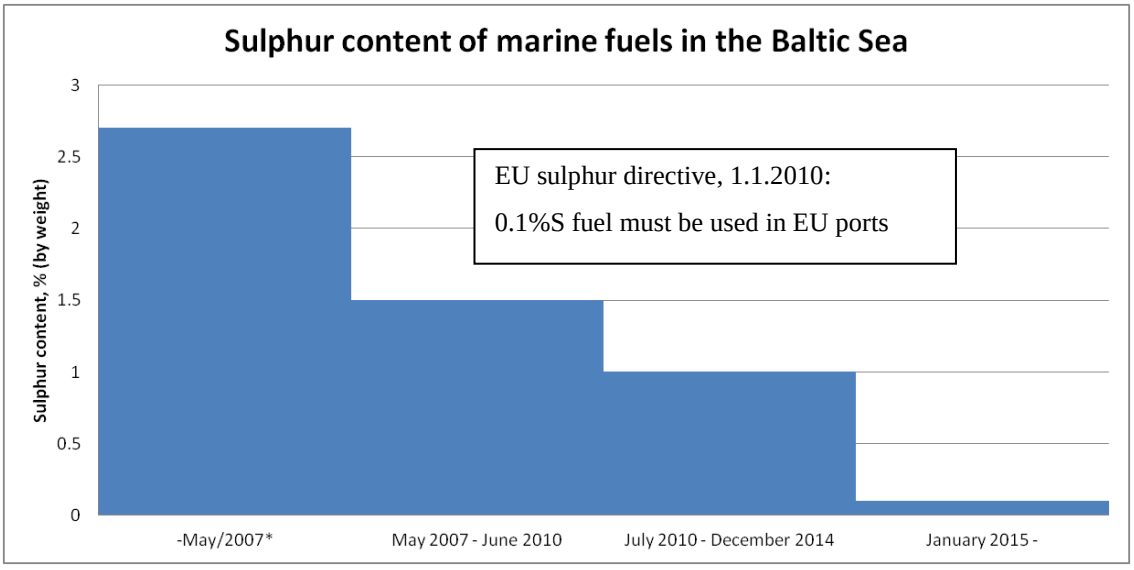
Start date of project: 1 April 2015	Duration:36 months
Organisation name of lead contractor for this deliverable:	FMI
Scientist responsible for this deliverable:	Jukka-Pekka Jalkanen, Lasse Johansson
Organisation name/names responsible for revision:	FMI
Scientist(s) responsible for the review:	Volker Mattias/HZG
	Revision: [1]

Shipping emissions for the Baltic Sea and selected harbor areas

Introduction

This Deliverable builds on the SHEBA D1.2 report, which describes vessel activity data sets for the purpose of generating the emission inventory for Baltic Sea shipping. The ship position reports from the Automatic Identification System (AIS) of the Helcom member states were used in combination with technical descriptions of the vessels. This was done using the Ship Traffic Emission Assessment Model (STEAM; Jalkanen et al, 2009; 2012, Johansson et al, 2013), which models fuel consumption and emissions as a function of vessel activity.

The sulphur content of marine fuels in the Baltic Sea area is regulated both by the International Maritime Organization in the MARPOL convention (IMO, 1998) and the sulphur directive of the European Union (EU, 2012). As a result of these requirements, the sulphur content of marine fuels has been gradually decreasing starting from May 2007 in the Baltic Sea (Figure 1).



*** Global average of sulphur content of marine fuels was 2.7%, but the maximum allowed was 4.5% (by weight).**

Figure 1 Sulphur content of marine fuels in the Baltic Sea

As of January 1st 2015, the sulphur content in marine fuels has been reduced to 0.1%, which is still considerably higher than the sulphur content of fuels used in land transport (0.001%). The emission inventories generated in SHEBA reflect these requirements and assume 100% compliance. Emissions of sulphur oxides (SOx) and Particulate Matter (PM) are directly affected by the changes of sulphur in fuels and the emission factors needed for emission calculations have been adjusted accordingly.

Description of datasets

The regional emission inventories for the whole Baltic Sea area were generated to facilitate further work with atmospheric transport modelling and impact assessments. The ship emission datasets describe the geographical and temporal distribution of emissions during calendar years of 2011, 2012 and 2014.

Description of regional ship emission data

The emissions from Baltic Sea shipping have been produced for years 2011, 2012 and 2014. These data were generated by FMI's STEAM model and they are based on the Automatic Identification System (AIS) position reports from ships. These inventories consist of hourly updated 2 x 2 km gridded binary (netcdf) files for NO_x, SO_x, CO, CO_2 and Particulate Matter (PM), which is further divided into EC (Elementary Carbon), OC (Organic Carbon), SO_4 and ash. The methodology and emission factors used are described in Jalkanen et al (2012) and Johansson et al (2013).

The data can be accessed in the SHEBA Data portal: http://sheba.hzg.de/thredds/catalog/restrictedAccess/bigdata/FMI-STEAM/catalog.html

Ship emission data is provided in compressed zip files in netcdf format, which consists of monthly files for each of the pollutants. These files contain monthly emissions of NO_x, SO_x, CO, CO_2 and PM (EC, OC, Ash, SO4).

In addition to gridded binary data usable in atmospheric models, summary reports of anonymized vessel specific emissions and fuel consumption were produced (Table 1).

Table 1 Summary of Baltic Sea ship emissions, fuel consumption, vessel numbers and transport work during year 2014.

Baltic 2014	MAIN Fuel	AE Fuel	NOx	SOx	PM2.5	CO	CO2	OC	EC	Ash	SO4	Travel	Payload	Ships
	[10^3 ton]	[10^3 ton]	[10^3 ton]	[10^3 ton]	[10^3 ton]	[10^3 ton]	[10^3 ton]	[10^3 ton]	[10^3 ton]	[10^3 ton]	[10^3 ton]	[10^3 km]	[10^6 ton km]	
All	3 690	1 060	320	81	16	34	14 982	5	2	1 569	7	140 163	944 764	21 283
IMO	3 633	854	307	79	15	32	14 143	5	2	1 496	7	118 205	944 764	8 510
Baltic Sea	2 196	491	183	48	9	19	8 469	3	1	891	4	80 500	558 161	0
Kattegat	618	233	60	14	3	6	2 686	1	0.4	280	1	26 780	187 199	0
Gulf of Finland	500	193	47	11	2	5	2 190	0.8	0.3	230	0.9	15 309	134 051	0
Gulf of Bothnia	312	87	23	7	1	3	1 258	0.5	0.2	129	0.6	12 789	47 953	0
Gulf of Riga	42	26	5	1.0	0.2	0.5	217	0.08	0.03	22	0.08	2 656	12 357	0
Other	22	29	3	1.1	0.2	0.4	161	0.06	0.02	16	0.09	2 130	5 044	0
RoPaX_ships	1 194	162	82	25	5	7	4 270	2	0.6	450	2	17 399	33 442	240
Passenger_Cruisers	126	32	9	2.9	0.6	0.9	497	0.2	0.07	52	0.2	1 423	0	102
Passengers_Ferries	13	6	1	0.3	0.06	0.2	60	0.02	0.008	6	0.02	2 284	0	143
Service_ships	6	11	1	0.2	0.04	0.1	52	0.02	0.007	5	0.01	427	0	105
Cargo_ships	625	130	53	13	3	7	2 379	0.8	0.3	248	1	43 356	297 531	3 759
Container_ships	513	170	52	12	2	6	2 154	0.8	0.3	233	1	13 663	157 247	863
Tankers	682	227	71	15	3	7	2 868	1	0.4	310	1	20 458	395 888	1 725
Other_ships	72	55	7	1.5	0.4	1	402	0.2	0.05	39	0.1	6 937	0	904
Fishing_ships	15	19	2	0.4	0.09	0.3	107	0.04	0.01	10	0.03	3 955	0	385
Vehicle_Carriers	387	42	28	8	2	3	1 353	0.5	0.2	144	0.7	8 303	60 656	284
Unknown_ships	57	206	14	2	0.7	2	839	0.4	0.1	74	0.2	21 957	0	12 773

The current dataset establishes a ship emission baseline and allows the generation of future emission scenarios, which will consist of changes relative to the baseline.

Description of port emission data

Emissions from ships in port areas of Gdansk, Gothenburg, Rostock and Riga can be accessed here: http://sheba.hzg.de/thredds/catalog/restrictedAccess/bigdata/FMI-STEAM/2012/PORT_STUDIES/catalog.html

The port emission dataset consists of hourly updated emissions from ships in each port during year 2014 in 250 by 250 m grid with hourly updates. It should be noted that the dataset only contains emissions from ships and does not include other emission sources, like energy production, land based traffic etc., but include combustion emissions from all engines of ships (boilers, auxiliary and main engines). Emission data is presented in gridded binary form (netcdf), which facilitates consecutive atmospheric modelling and impact analysis. Emissions for NO_x, SO_x, CO, CO_2 and PM are divided to two layers; above and below 36 meters in order to differentiate to emissions from big ships with high stacks and those from lower emission heights. The stack release height will have a large impact on the area impacted and the dispersion of pollutants.

References

European Union, Directive 2012/33/EU of the European Parliament and of the Council of 21 November 2012 amending Council Directive 1999/32/EC as regards the sulphur content of marine fuels

International Maritime Organization (IMO): Regulations for the prevention of air pollution from ships and NOx technical code, Annex VI of the MARPOL convention 73/78, London, 1998.

J.-P. Jalkanen, L. Johansson, A. Brink, J. Kalli, J. Kukkonen and T. Stipa, "Extension of an assessment model of ship traffic exhaust emissions for particulate matter and carbon monoxide", Atmos. Chem. Phys., 12 (2012) 2641-2659.

L. Johansson, J.-P. Jalkanen, J. Kalli and J. Kukkonen, “The evolution of shipping emissions and the costs of recent and forthcoming emission regulations in the northern European emission control area”, Atmos. Chem. Phys.,13 (2013) 11375-11389.

Review Report