Emissions from Baltic Sea shipping in 2011

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Key Messages

- Particulate Matter (PM) and SOx emissions from Baltic Sea shipping have decreased (PM: - 3 %, SOx: -13 %) from 2010 because of the requirements of SOx Emission Control Area and EU sulphur directive 2005/33/EC. The year 2011 was the first year when both SECA and EU sulphur directive fuel requirements were effective throughout a full calendar year.

- CO2 and NOx emissions as well as the total fuel consumption have increased (NOx: 373 kt, +8 %, CO2: 18.9 Mt, +10 %, fuel consumption: 6220 kt, +10 %), probably because of the recovery of economic activity in the Baltic Sea area. Overall cargo throughput (DWT*km) has increased by +7 %. Especially the containership segment showed a strong increase in cargo throughput (+32.5 %) and NOx emissions (+21 %).

- The number of small vessels without an IMO number has increased strongly, +39 %, during 2011. The overall contribution of small vessels to emissions are NOx: 12 % , SOx: 3 %, CO: 19 %, CO2: 13 %. The popularity of AIS among small craft has probably contributed to this increase the most, not the actual growth of small vessel traffic.

- Number of large vessels have increased by 6 % and cargo throughput (DWT * km) of large vessels by 7 %.

Results and assessment

The sulphur emissions from Baltic Sea shipping have decreased from 2010 because of the SECA and EU sulphur directive requirements, which limit the fuel sulphur to 1.0% during voyages and to 0.1% during harbor stays, respectively. The year 2011 was the first year when both of these requirements were applied throughout the whole calendar year. Emissions from ships in port areas can have a significant impact on air quality close to large human populations. Reduction of sulphur and particulate SO4 removed a large fraction of potentially harmful substances from Baltic Sea shipping.

A significant increase in the number of small vessels (2010: 3953; 2011: 5478, +39%) was observed. However, the contribution of small vessels to SOx and PM are small, 3% and 8 %, but already 19 % of the total CO emitted comes from small boats. The growth of traffic computed from the number of vessels with an IMO number was 6 %. The summary of results is collected to Table 1. It should be noted that during 2011 the total PM has decreased by -3 %, which would have otherwise lead to a PM increase of 10% without the stricter sulphur requirements.

Table 1. Summary of key results from Baltic Sea shipping in 2011

Pollutant	**2011**	**2010**	**Change, %**
NO_x, kt	373	344.5	+8 %

SO_x, kt	78.7	90.2	-13 %	
CO, kt		5	62.9	+14 %
PM*, kt	22.7	23.4	-3 %	
of which				
Elementary Carbon, kt	2.6	2.4	+9 %	
Organic Carbon, kt	6.7	6.1	+10 %	
Ash, kt	1.9	1.7	+9 %	
Hydrated SO_4, kt	11.5	13.2	-13 %	
CO_2, Mt	18.9	17.3	+10 %	
Fuel use, kt	6220	5676	+10 %	
Energy use, petajoules (10^{15} J)	266	242	+10	
%				
Vessels with an IMO number	7527**	7109**	+6 %	
Small vessels, no IMO number	5478‡	3953‡	+39 %	
Cargo throughput (DWT*km), in 10^9 ton km	634‡‡	591‡‡	+7 %	

** Note, that subspecies of PM should not be added together with total PM emissions, but are alternative to each other*

*** Contains only active vessels with an IMO number, which have consumed fuel*

‡ Calculated from the total number of vessels with fuel consumption greater than zero and then by subtracting the vessels with an IMO number.

*‡‡ Cargo throughput of vessels (DWT*km) with an IMO number. Small vessels are not included.*

Strong increase in the containership cargo throughput was observed. In 2011 there were 545 containerships whereas in 2010 only 364. The total traveled containership distance was 10.2 million km in 2011, but only 8.0 million km in 2010, which indicates a growth of over 27% during one year. However, the change in cargo throughput is larger than this, possibly indicating a gradual increase in the containership size.

Table 2. Cargo throughput of different ship types, Baltic Sea 2011. Change of NOx emissions are also given for 2011-2010.

Ship type	**Throughput DWT*km, 2011, in 10^9 ton km**	**Throughput DWT*km, 2010, in 10^9 ton km**	**Throughput Change,%, 2011-2010**	**NOx Emission Change, %, 2011-2010**
Crude oil Tankers	179.1	171.1	+4.7 %	-2.3 %
Chemical Tankers	64.3	64.5	-0.3 %	-1.3 %
Bulk Cargo Ships	131.9	117.2		% %
General Cargo Ships	75.6	74.6	+1.3 %	+3.6 %
Container Cargo Ships	79.9	60.3	+32.5 %	+21.0 %
Oil Product Tankers	42.8	43.3	-1.1 %	-1.2 %
RoRo/Passenger Ships	28.5	29.1	-2.1 %	-0.3 %
RoRo Cargo Ships	17.9	17.5	+2.3 %	-0.2 %
Refrigerated Cargo Ships	5.5	6.5	-15.4 %	-14.8 %
Vehicle Carriers	2.5	2.4	+4.2 %	+8.6 %

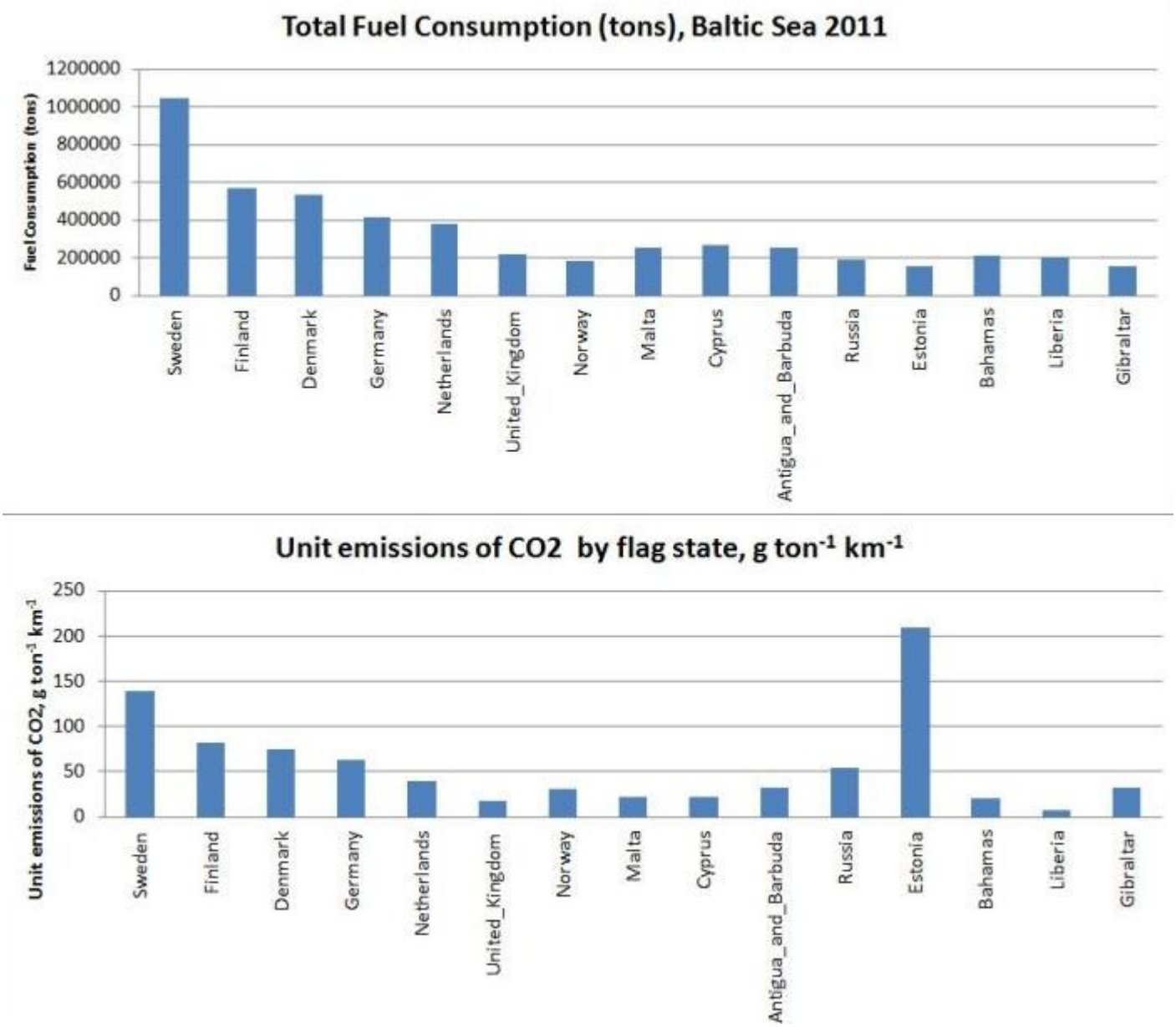

Figure 1. Fuel consumption and unit emissions by flag state, Baltic Sea 2011. Fuel consumption is reported as tons of fuel used. Unit emissions indicate the emissions of CO2 (grams) per transported cargo (ton km).

Cargo tons are calculated as in Lipasto (VTT). Note, that passenger capacity has no impact to these numbers because only DWT of a vessel is considered to have an effect on unit emissions. Unit emissions were calculated for each flag state. Cargo oriented fleets have low unit emissions, contrary to the passenger vessels. It should be noted, that passenger carrying capacity has no effect on the unit emission calculation, because only DWT of vessels is considered. The net weight of the cargo transport onboard was evaluated with a method described by VTT.

References

Jalkanen, J.-P., Brink, A., Kalli, J., Pettersson, H., Kukkonen, J. and Stipa, T., "A modelling system for the exhaust emissions of marine traffic and its application to the Baltic Sea area", *Atmospheric Chemistry and Physics*, **9** (2009) 9209-9223.

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Data

The emission estimates for the year 2011 are based on over 418 million AIS-messages sent by 13005 different ships, of which 7527 had an IMO registry number indicating commercial marine traffic. The AIS position reports were received by terrestrial base stations in the Baltic Sea states and collected to regional HELCOM AIS data server. The HELCOM server contains position updates of every vessel every 5-6 minutes. Emissions are generated using the Ship Traffic Emission Assessment Model (STEAM) of Jalkanen et al. (2009,2012). Temporal coverage of the data was better than in 2010; AIS signals were received 97.9 % of the time, most significant data gaps occurring during May and June 2011. In the cases of missing data, routes of each vessel were interpolated between two known locations.

Metadata

Fuel and vessel operational procedures can have a large impact on exhaust emissions. Emission factors for ships are in accordance with the latest literature and are believed to represent a reasonable estimate of the resulting emissions. Marine currents and sea ice will have a significant impact on emissions, but both of these effects have been neglected. Some uncertainties in predicted emission values arise from the large number of small vessels for which technical details are unavailable.

Definitions of fuel types for different types and ages of engines were updated and some programming bugs were fixed, which will make the comparisons between the results of 2012 Baltic Sea Environment Fact Sheets and those from previous years difficult. Relatively large data gaps in 2010 AIS data (92 % of total number of hours had data) have an impact on the 2010 emissions and affect also 2011-2010 emission changes. Values given in this Baltic Sea Environment Fact Sheet have been scaled to reach 100% temporal coverage.

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