Emissions from the Baltic Sea shipping in 2007

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Key messages

Baltic Sea ship emissions during 2007 have mostly increased when compared to 2006:

- NO_x, 400 kt/year, **increase** from 371 kt (+7.7 %)
- SO_x, 137 kt/year, **decrease** from 147 kt (-6.4 %)
- CO_2 output, fuel consumption and energy content have all increased (+13.3 %) during 2007:
  - CO_2, 19.3 Mt/year, **increase** from 17.0 Mt
  - Fuel consumption, 6205 kt/year, **increase** from 5463 kt
  - Energy consumption, 264 PJ **increase** from 233 PJ
- Number of ships observed during 2007 was 9497 vessels, **increase** from 8510 (+11.6 %)

Results and assessment

Relevance of the indicator for describing the developments

This indicator shows the annual emission levels of NO_x, SO_x and CO_2 arising from ship traffic in the Baltic Sea area in 2007, as well as their change from the previous year.

Policy relevance and policy reference

The Baltic Sea SECA area entered into force during 2006. The year 2007 was the first full calendar year with the SECA in effect, and therefore a benchmark for future SO_x emissions.

HELCOM countries made a joint submission to 57th meeting of the Marine Environment Protection Committee (MEPC) of the International Maritime Organization (IMO) regarding ship emissions.[1] Revised MARPOL Annex VI was outlined and stricter limits for ship emissions were agreed (Table 1).

Table 1. Maximum emission limits agreed by IMO. First column shows the schedule of changes, second column shows emission limits for NO_x in Emission Control Areas, third column shows emission limits for SO_x in SECA areas. The last two columns show planned limits on a global scale.

Time	NOx(ECA)	SOx(SECA)	NOx(global)	SOx(global)
Current	17.7 g/kWh	1.5 mass-% S	-	4.5 mass-% S
01.03.2010		1.0 mass-% S	-	

01.01.2011	14.4 g/kWh		-	
01.01.2012			-	3.5 mass-% S
01.01.2015		0.1 mass-% S	-	
01.01.2016	3.4 g/kWh		14.4 g/kWh	
2018			-	Fuel review
01.01.2020			-	0.5 mass-% S(*)
2025			-	0.5 mass-% S

(*) Subject to feasibility review for production of low-sulphur fuel. If the result is negative, then the time limit will be pushed to year 2025.

Future limitations in Emission Control Areas(ECA)

In the 57th MEPC meeting it was agreed to cut emissions from shipping in several stages in the near future. Future limits are shown in Table 1. It is noteworthy that also old engines, built during 1.1.1990 – 1.1.2000 must conform to current (Tier I) NO_x limit of 17 g/kWh. To decrease sulphur emissions from shipping, MEPC decided to restrict the sulphur content of fuel in Sulphur Emission Control Areas down to 1.0 % (currently 1.5 mass-% of S) starting from 1.3.2010. This limit is tightened further, to 0.1 mass-% of sulphur, from 1.1.2015.

Future global limitations

Global limits for sulphur will be 3.5 % (currently 4.5 %) starting from 1.1.2012. Global sulphur limit of 0.5 % will be enforced in 1.1.2020, subject to a feasibility review of low sulphur fuel availability on 2018. If the review is negative, then the 0.5 % limit will be postponed to 2025. Global NO_x emission limits outside ECA areas will be set to 14.4 g/kWh.

Assessment

Emission inventories for shipping were prepared using the data from HELCOM Automatic Identification System (AIS) database. Based on this data it is possible to pinpoint every ship using an active AIS transmitter, determine its current speed and combine this information with detailed technical knowledge of ships' engines to produce an estimate of emissions and fuel consumption. An analysis for full calendar years 2006 and 2007 was performed and annual emission levels were determined.

In 2007 there were 3700-4500 ships with an active AIS transmitter sailing the Baltic Sea each month and at any given moment there were >2000 vessels. NO_x emission from ships alone reached 400 kilotons during 2007 showing ~30 kt increase from previous year. Fuel consumption was estimated as 6205 kilotons, which corresponds to 264 Petajoules of energy consumed and 19.3 megatons of CO_2 produced by ships. To put these numbers in perspective, combined NO_x emissions of Finland and Sweden was 382 kilotons in 2005.[2] Detailed analysis of ship specific SO_x emissions was performed using the current limit of 1.5 mass-% sulphur content for main engine fuel and 0.5 mass-% for auxiliary engine fuel. Annual release of SO_x during 2007 was estimated as 137 kt. This is roughly the same as the combined SO_2 emissions (133 kt) of Finland, Sweden and Norway in 2005.[2] The amount of SO_x emissions have declined when compared to corresponding estimates for 2006. During 2006 the SO_x release was estimated as 147 kt, taking pre-SECA and post-SECA effects to fuel sulphur content into account. For the period of January-April 2006 it was assumed that the average main engine fuel sulphur content was 2.4 % in the Baltic Sea area.[3] The CO_2 emissions and energy consumption of Baltic Sea shipping are larger than all traffic CO_2 emissions of Finland. Energy consumption in 2006 of all transport modes (air, sea, road, rail) was 227 PJ[4] and CO_2 emissions were estimated as 14.4 Mt.[5]

The geographical distribution of emissions can be seen in Figure 1.

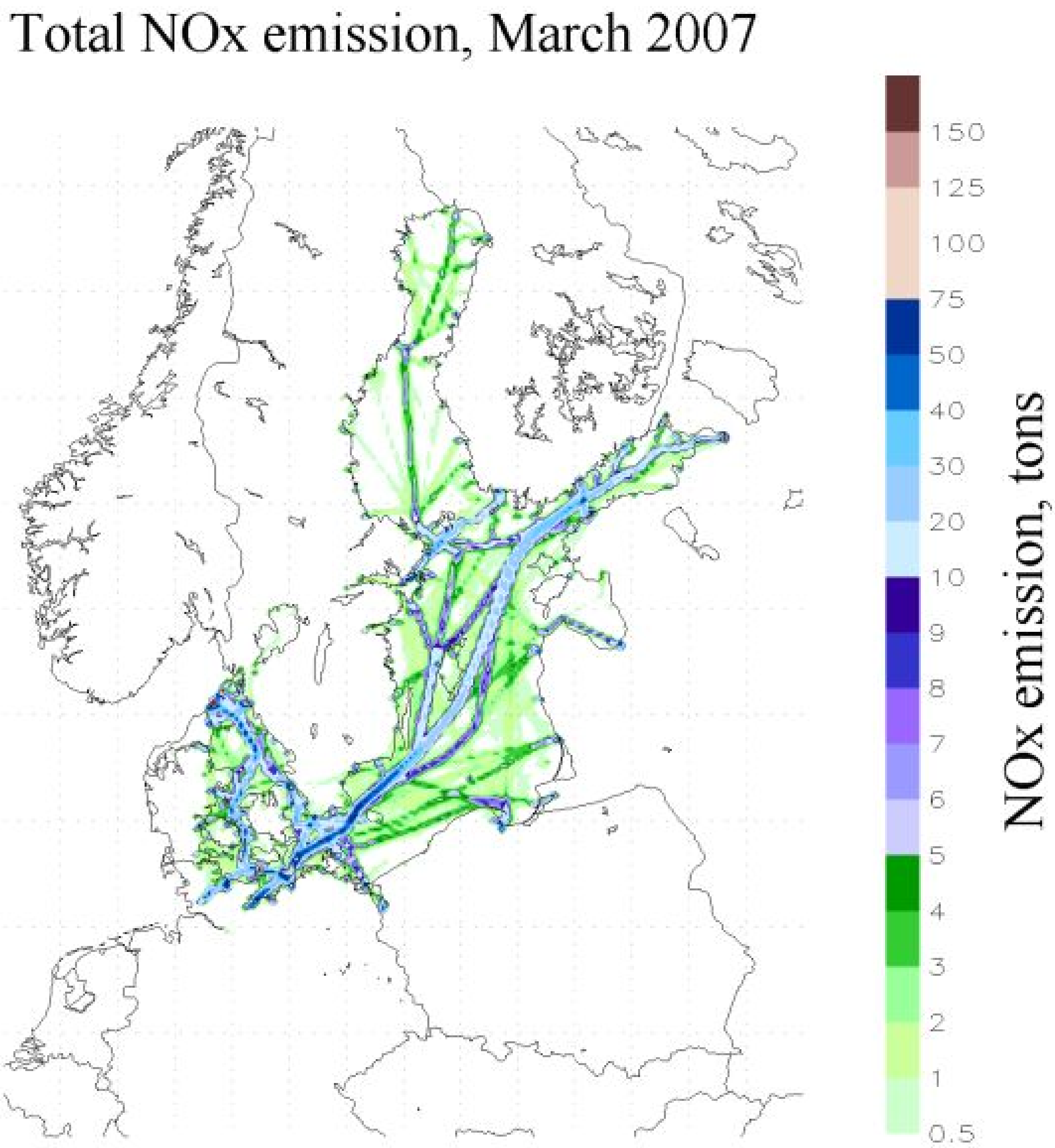

Figure 1. NO_x emission sum, March 2007

The NO_x emission from March 2007 yields 33 kilotons for the HELCOM convention area. On annual level this means that over on average >45 tons of NO_x is released every hour from ships. The monthly variation reveals that the emissions and number of vessels peak at summer months. As can be seen from Figure 1, most of the emissions occur in Southern Baltic Sea.

AIS facilitates the determination of the flag state of the vessel, since the Maritime Mobile Service Identity (MMSI) numbers are assigned by the national authorities and reveal the country where the ship is registered to. Based on this information ship emissions can be classified based on flag state, summary of which is shown in Figure 2.

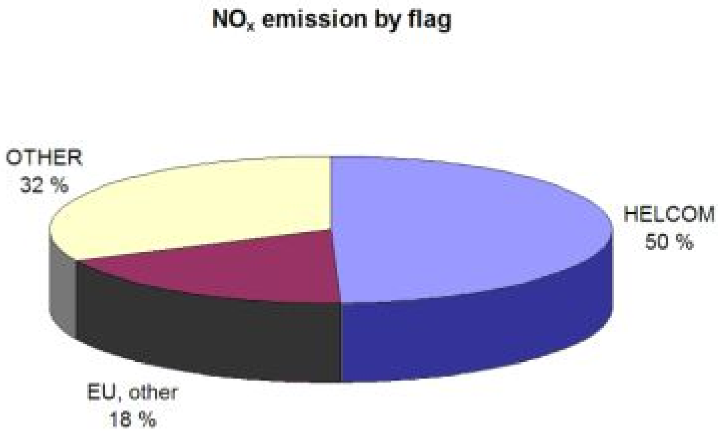

Figure 2. Emission by flag state. Annual NO_x emission is 400 kilotons

Most of the NO_x emissions (~50 %) arising from the Baltic Sea shipping come from ships that are registered to HELCOM member states. Roughly 32 % of NO_x is produced by ships registered outside the EU member states.

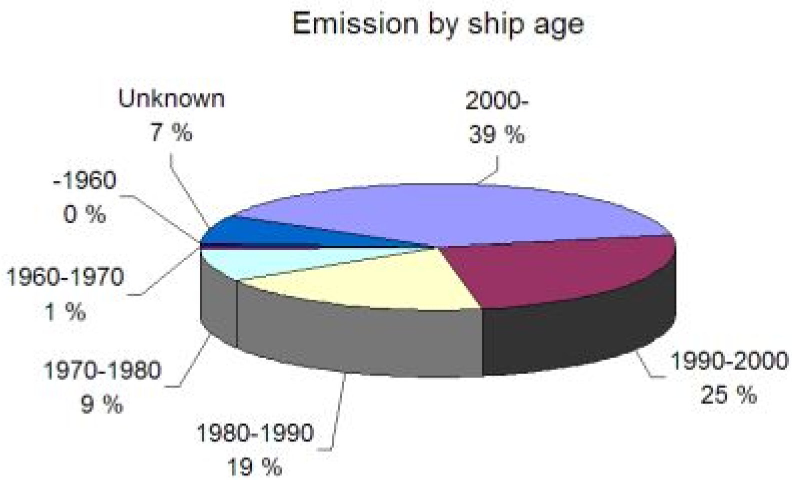

Figure 3. Emission by ship build year. Total NO_x emission is 400 kilotons.

By looking at the NO_x emitted by each age class of ships (Figure 3), it can be concluded that ~39 % comes from new ships, built after 1.1.2000. Ships built in 1990's and 1980's produce ~25 % and ~19 % of the NO_x emissions, respectively.

References

[1] Stipa T., Jalkanen J.-P., Hongisto M., Kalli J., Brink A., "Emissions of NOx from Baltic Sea shipping and first estimates of their effects on air quality and eutrophication of the Baltic Sea", ISBN 978-951-53-3028-4, Helsinki, Finland 2007. Available from http://www.helcom.fi/press_office/news_helcom/en_GB/HELCOM_submission_to_IMO/

[2] Tarrasón L., Fagerli H., Jonson J. E., Simpson D., Benedictow A., Klein H., Vestreng V., Aas W., Hjelbrekke A.-G., "Transboundary acidification, eutrophication and ground level ozone in Europe in 2005", EMEP status report 2007, ISSN 1504-6192, Available from http://www.emep.int/publ/common_publications.html

[3] Endresen Ø, Bakke J, Sørgård E, Berglen TF, Holmvang P, *Atmospheric Environment,* **39** (2005) 3621.

[4] Technical Research Center of Finland, "LIPASTO - CALCULATION SYSTEM FOR TRAFFIC EMISSIONS AND ENERGY CONSUMPTION", http://lipasto.vtt.fi/lipastoe/paast06e.htm

[5] Statistics Finland, Greenhouse gas emissions in 1990, 1995-2006, available from http://www.stat.fi/til/khki/2006/khki_2006_2007-12-12_tie_001_en.html

Metadata

Technical information

Emission estimates for NOx are based on HELCOM AIS-data collected by the member states. It contains detailed information of the position and speed every ship carrying an AIS transmitter required by the IMO. Based on current speed-design speed relation and technical data of ships' engines, an emission estimate can be made based on instantenous power levels of the engines. It is possible to extend emission evaluation to other areas where AIS data is readily available. Thirteen different techniques for emission abatement are included and their impact to emissions are modeled as are ship specific NO_x emission certificates.

Quality information

Reliability of the data

In short: If no AIS data is available, no emissions are calculated either by the program. HELCOM AIS data contains short time periods, up to few days, when no data is available due to technical issues regarding data storage and data transfer between member states and the HELCOM AIS data server (See 17th Helcom AIS EWG meeting document, 2008). The effect of these problems have been decreased by implemeting an interpolation routine that can cope with short data gaps. Future improvements are already planned by HELCOM AIS Expert Working Group to increase the level of availability of the HELCOM AIS data service.

Reliability and the future of emission estimates

The fuel consumption calculations are compared to real-world fuel consumption data from Finnish shipowners. However, a more comprehensive checks are planned to gain better understanding of the development needs of the model. Currently the model produces values that are slightly underestimated and it is likely that in reality the emission levels and fuel consumption are larger than what is described in this document. Uncertainties are downplayed in a way that produce smaller emission estimates in order to get a baseline for NOx emissions. Detailed description of uncertainties and their magnitudes are given in Stipa et al., 2007. Future enhancements include direct measurements of emissions from ships' exhaust pipes and inclusion of other pollutants (e.g. particulate matter) to enhance the accuracy of the emission model.

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