MARINE ENVIRONMENT PROTECTION COMMITTEE
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PREVENTION OF AIR POLLUTION FROM SHIPS

New Inventory of short-lived climate forcing aerosols from international shipping activity in the Arctic

Submitted by Friends of the Earth International (FOEI)

SUMMARY

Executive summary:	This document describes a new high-resolution inventory of black carbon, organic carbon and sulphur oxide emissions from international shipping activity in the Arctic (north of 60 degrees North latitude) for the years 2004, 2020 and 2030
Strategic direction:	7.3
High-level action:	7.3.1
Planned output:	7.3.1.1
Action to be taken:	Paragraph 21
Related documents:	MEPC 59/4/47, MEPC 59/INF.10 and MEPC 59/INF.15

Introduction

1 This document describes a recent report and analysis of inventories of emissions of black carbon, organic carbon and sulphur dioxide emissions from international shipping activity in the Arctic (north of 60 degrees North latitude) for the years 2004, 2020, and 2030. The report was commissioned by the International Council on Clean Transportation (ICCT) and summarizes recent research completed in the autumn of 2009 by James J. Corbett and James J. Winebrake.[1]

[1] Contributors to the work included: *Arctic Shipping Emissions Future Scenarios Through 2030, produced by Energy and Environmental Research Associates (EERA), 2009. Future ship route activity derived from GIS shapefile data taken from the* Arctic Marine Shipping Assessment 2009 Report, *edited by B. Ellis and L. Brigham and published by the Arctic Council, Tromsø, Norway. Diversion scenarios developed with collaboration from Daniel Lack, NOAA. Partial funding for this effort provided by the International Council on Clean Transportation (ICCT), Clean Air Task Force, ClimateWorks Foundation, NOAA's Climate Program, and others. Acknowledgement is made to Jordan Silberman, who worked as an EERA associated providing GIS processing.*

2 This inventory provides the most accurate inventory to date of key short-lived pollutants from international shipping activity in the Arctic region proper, which for the purpose of this analysis means ocean areas north of 60 degrees North latitude. Of course, much greater amounts of these pollutants are emitted south of this area, and it should be noted that preliminary modelling has found that a substantial portion of shipping emissions north of 40 degrees North latitude are transported to the Arctic.

3 The purpose of this inventory was to provide a more accurate picture of present black carbon (BC), organic carbon (OC) and sulphur oxide (SO_x) emissions from shipping, and based on current projections of future melting of Arctic land and sea ice and the resulting potential for the future growth of shipping in ice-free Arctic waters, to estimate how those emissions might grow over the next several decades. Such a picture is important due to the impact of such emissions on the climate of both the Arctic and the rest of the planet. In this regard, FOEI note in particular that:

.1 average temperatures in the Arctic have increased at twice the global rate in the past 100 years;

.2 black carbon likely contributes a substantial share of Arctic warming given its strong direct and feedback effects on ice and snow. Shindell *et al.*, 2009 estimate that black carbon may be responsible for between 22% and 61% of Arctic warming;

.3 summer sea ice extent has decreased by 40 per cent since measurements first taken in 1979, and in 2007 this dropped to its lowest level, which coincided with the first complete opening of the Northwest passage; and

.4 as the international fleet of ships utilizes new Arctic routes, the quantity of black carbon emitted in the Arctic and deposited on ice and snow will likely increase.

Inventory Methodology

4 Seasonal inventories representing winter, spring, summer, and autumn were developed for each of the target years 2004, 2020, and 2030.

5 Emission inventories were also developed for four potential diversion routes available mid-July through mid-November in the Arctic. One per cent of global ship traffic was assumed to divert through these routes in 2020. Two per cent was assumed to divert in 2030.

6 All inventories used vessel routes north of 60 degrees North latitude that were identified for each season from empirical data reported by Arctic Council Member States for the year 2004.

7 Assumptions from the *Arctic Marine Shipping Assessment 2009* (AMSA)[2] of vessel characteristics were applied to all ships except for general cargo ships, which were assumed to be smaller vessels with less installed power based on empirical data.

8 Emissions were calculated for each vessel trip for which data were available using the activity-based approach defined in AMSA.

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2 Arctic Council, Protection of the Arctic Marine Environment Working Group (2009), available on the internet at: http://web.arcticportal.org/uploads/L9/LP/L9LPqHzJZ88Zp4EOdasTcA/AMSA_Scenarios_NEW.pdf.

9 Emission estimates for 2020 and 2030 were developed using the Corbett, *et al.* scenario model applied in the Second IMO GHG Study 2009.[3] Separate inventories were developed for a business-as-usual and a high-growth scenario, and all assume the same vessel mix seen in the Arctic in 2004.

10 Ships evaluated in this inventory include containerships, general cargo ships, bulk carriers, passenger vessels, tankers, government vessels, tug and barge vessels, and offshore service vessels.

11 Future emission factors for black carbon were assumed to remain equal to current emission factors in the absence of new regulatory mandates, while sulphur dioxide and organic carbon emissions were assumed to fall in equal proportion and in accordance with the new sulphur limitations in the revised MARPOL Annex VI.

12 One maximum feasible reduction (MFR) scenario was developed that assumes a fleet-wide reduction of 70 per cent of black carbon emissions.

Results

13 The following table summarizes the total estimated and annual emissions of black carbon, organic carbon, and sulphur dioxide in 2004.

Table 1 – 2004 Seasonal Emissions of Short-Lived Aerosols from Marine Arctic Shipping

Season	BC (t/yr)	OC (t/yr)	SO_2 (t/yr)
Autumn	230	703	35500
Winter	179	546	27600
Spring	195	596	30100
Summer	278	850	42900
Annual	**882**	**2695**	**136100**

14 The following table summarizes emissions by vessel category for each pollutant in 2004.

Table 2 – 2004 Emissions of short-lived aerosols from marine Arctic shipping, by vessel category

Vessel Type	BC (kg/yr)	OC (kg/yr)	SO_2 (kg/yr)
Containership	259,596	793,492	40,051,896
General Cargo Ship	218,840	668,916	33,763,877
Bulk Ships	132,973	406,450	20,515,760
Passenger Vessels	123,610	377,831	19,071,195
Tanker	98,270	300,375	15,161,595
Government Vessels	41,460	126,728	6,396,643
Tug and Barge	3,886	11,878	599,552
Offshore Service Vessel	1,184	3,618	182,621
Total	**879,817**	**2,689,288**	**135,743,140**

[3] MEPC 59/INF.10.

15 The following table summarizes estimates of in-Arctic black carbon emissions for future years under high growth assumptions and assuming diversion through newly available Arctic routes.

Table 3 – Estimated in-Arctic black carbon emissions from marine shipping and share of global marine black carbon inventory, 2004 - 2050

		2004	2020	2030	2050
High-growth scenario					
	Marine BC in-Arctic Total (Gg/yr)	0.880	2.364	4.563	15.947
	Share of global marine BC	0.6%	0.9%	1.2%	2.2%
Maximum Feasible Reduction (70%)					
	Marine BC in-Arctic Total (Gg/yr)	0.880	0.709	1.369	4.784
	Share of global marine BC	0.6%	0.3%	0.4%	0.7%

Conclusions

16 The summer season represented approximately 32 per cent of annual emissions in 2004. Autumn and spring were the second and third most active seasons representing 26 and 22 per cent of the annual total, respectively. Winter was the least active season and represented 20 per cent of the annual total.

17 In 2004 containerships were the largest contributors to black carbon emissions from shipping activity in the Arctic. General cargo ships, bulk carriers, passenger vessels, tankers and containerships together accounted for 95 per cent of black carbon emissions from shipping in the Arctic that year.

18 Under a high-growth scenario including diversion of shipping activity through new Arctic routes, emissions from shipping activity in the Arctic in 2050 would approach levels more than 18 times what they were in 2004. In contrast, a maximum feasible reduction scenario would limit this growth in 2050 to no more than five times their 2004 levels.

19 Marine shipping activity in the Arctic accounted for 0.6 per cent of the global inventory of maritime black carbon emissions in 2004. In the absence of control mechanisms, this share may grow to 2.2 per cent by 2050. In the presence of the most stringent technologically feasible controls, this growth may be limited to no more than 0.7 per cent of the inventory.

20 This new inventory data has been provided to several expert climate modelling groups, that will perform additional analysis this year of radiative forcing and temperature impacts of these emissions in the Arctic.

Action requested of the Committee

21 The Committee is invited to consider the information contained in this document and to take action as appropriate, and more specifically to consider this new inventory of present and future in-Arctic shipping activity in its deliberations on the impact of shipping emissions on climate, human health and the environment.

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