Atmospheric Emissions from Ships:
Air Quality and Climate Change Impacts and Mitigation Options

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ICCT Background

The goal of the International Council on Clean Transportation (ICCT) is to dramatically reduce conventional pollutant and greenhouse gas emissions from personal, public and goods transportation in order to improve air quality and human health, and mitigate climate change.

The Council is made up of leading regulators and experts from around the word that participate as individuals based on their experience with air quality and transportation issues.

The ICCT promotes best practices and comprehensive solutions to improve vehicle emissions and efficiency, increase fuel quality and sustainability of alternative fuels, reduce pollution from the in-use fleet, and curtail emissions from international goods movement.

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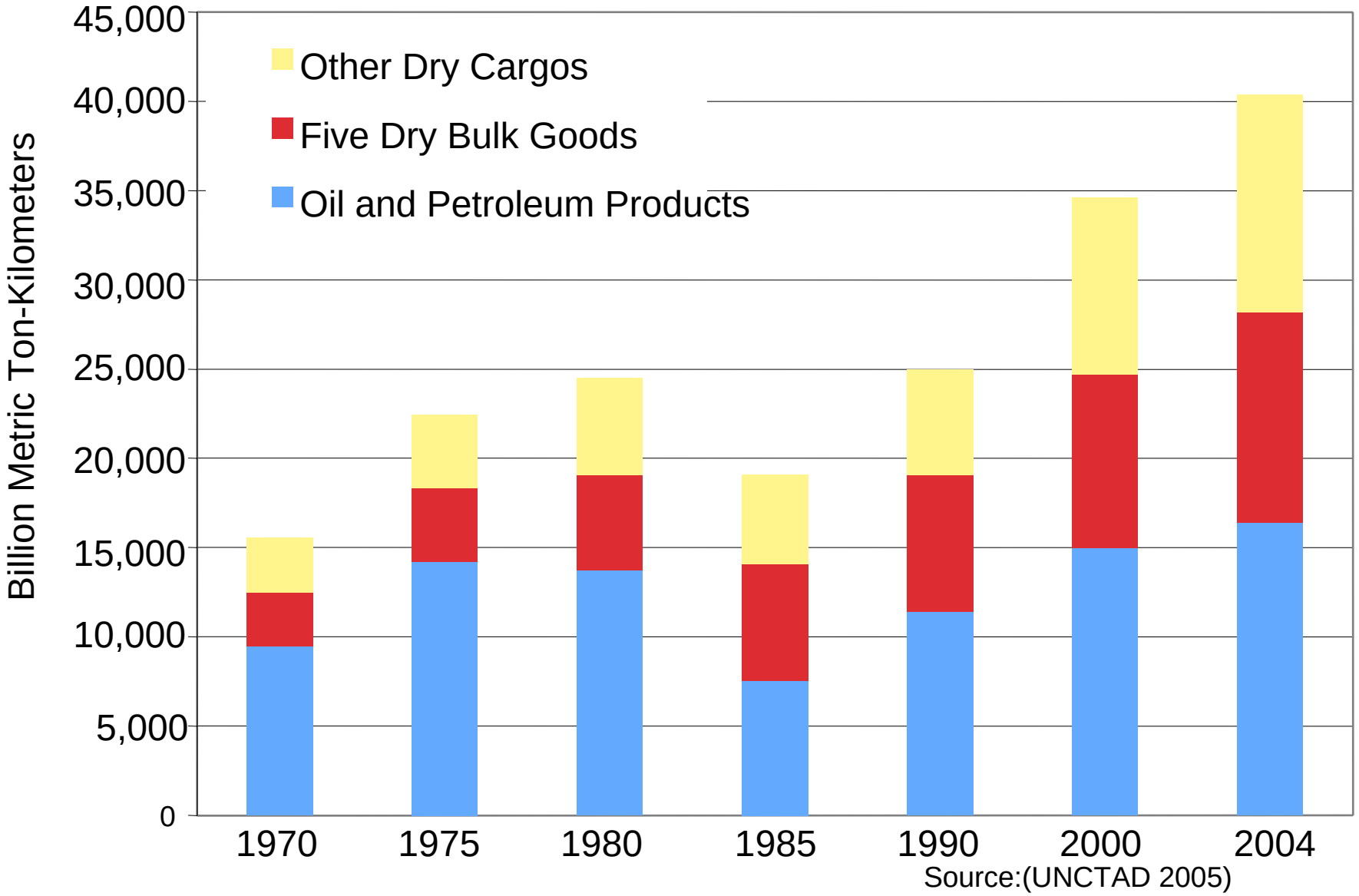
THE INTERNATIONAL COUNCIL ON CLEAN TRANSPORTATION

ICCT Participants

THE INTERNATIONAL COUNCIL ON CLEAN TRANSPORTATION

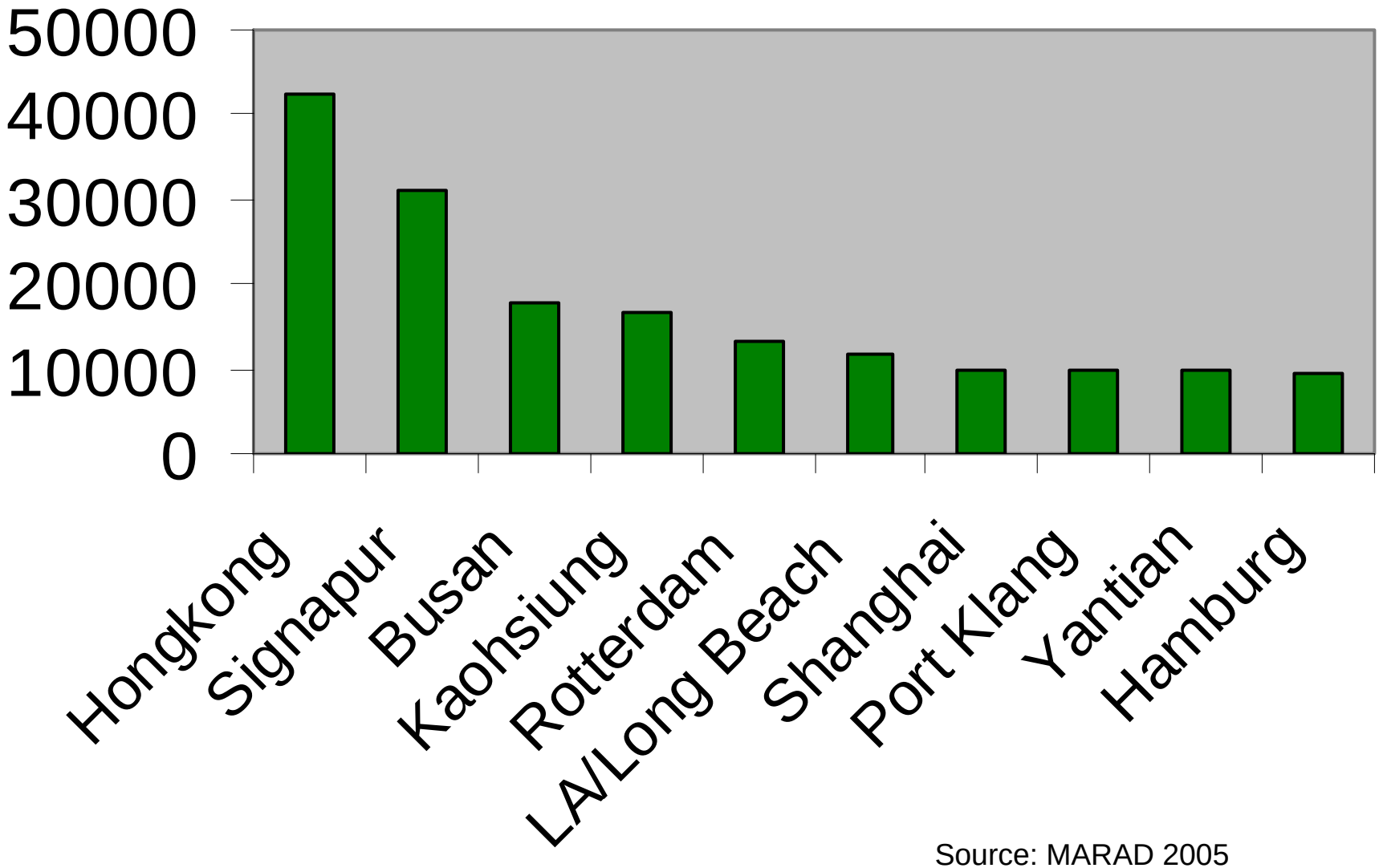
World Seaborne Freight

in Metric Ton-Kilometers by Type of Freight



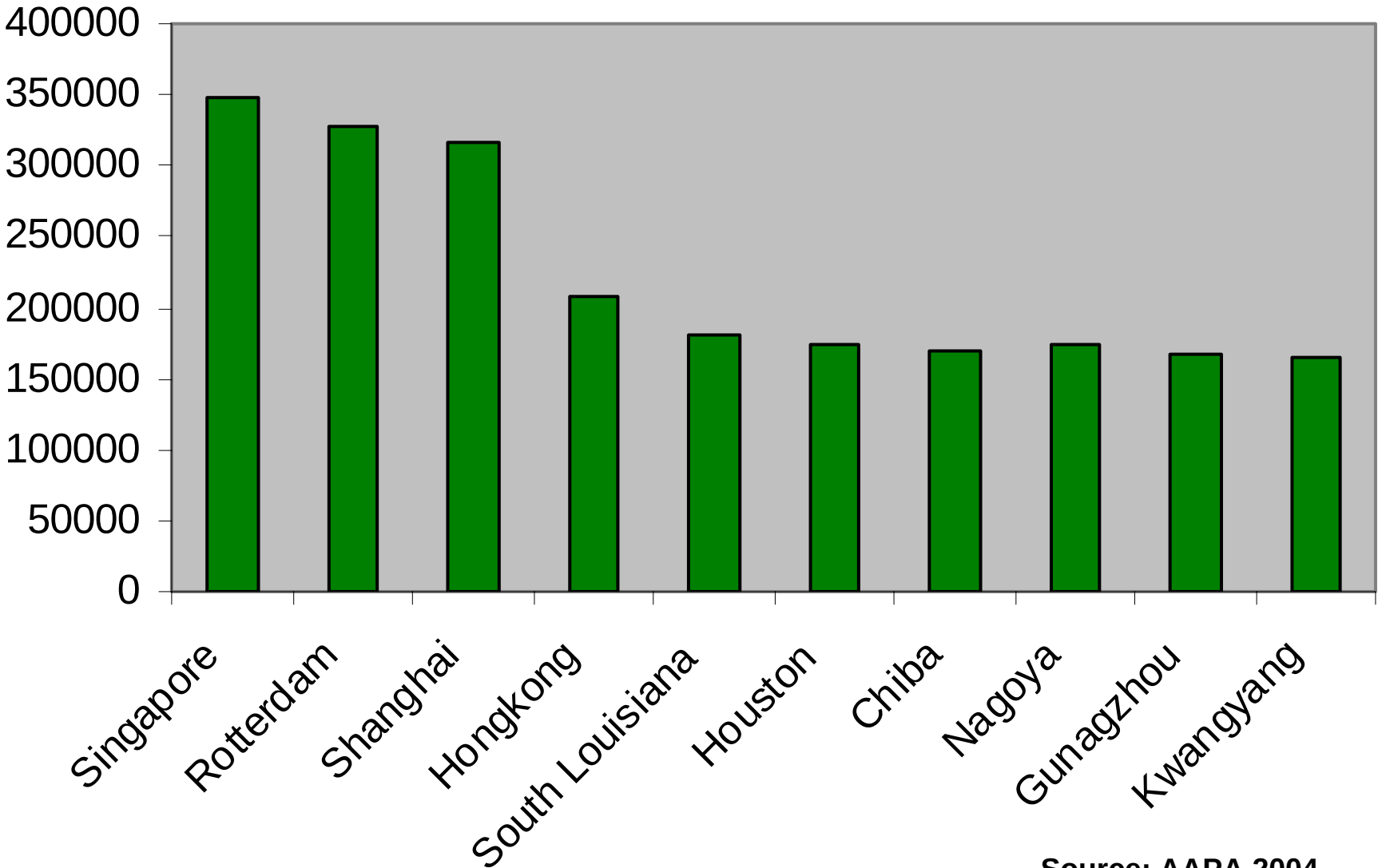
Source:(UNCTAD 2005)

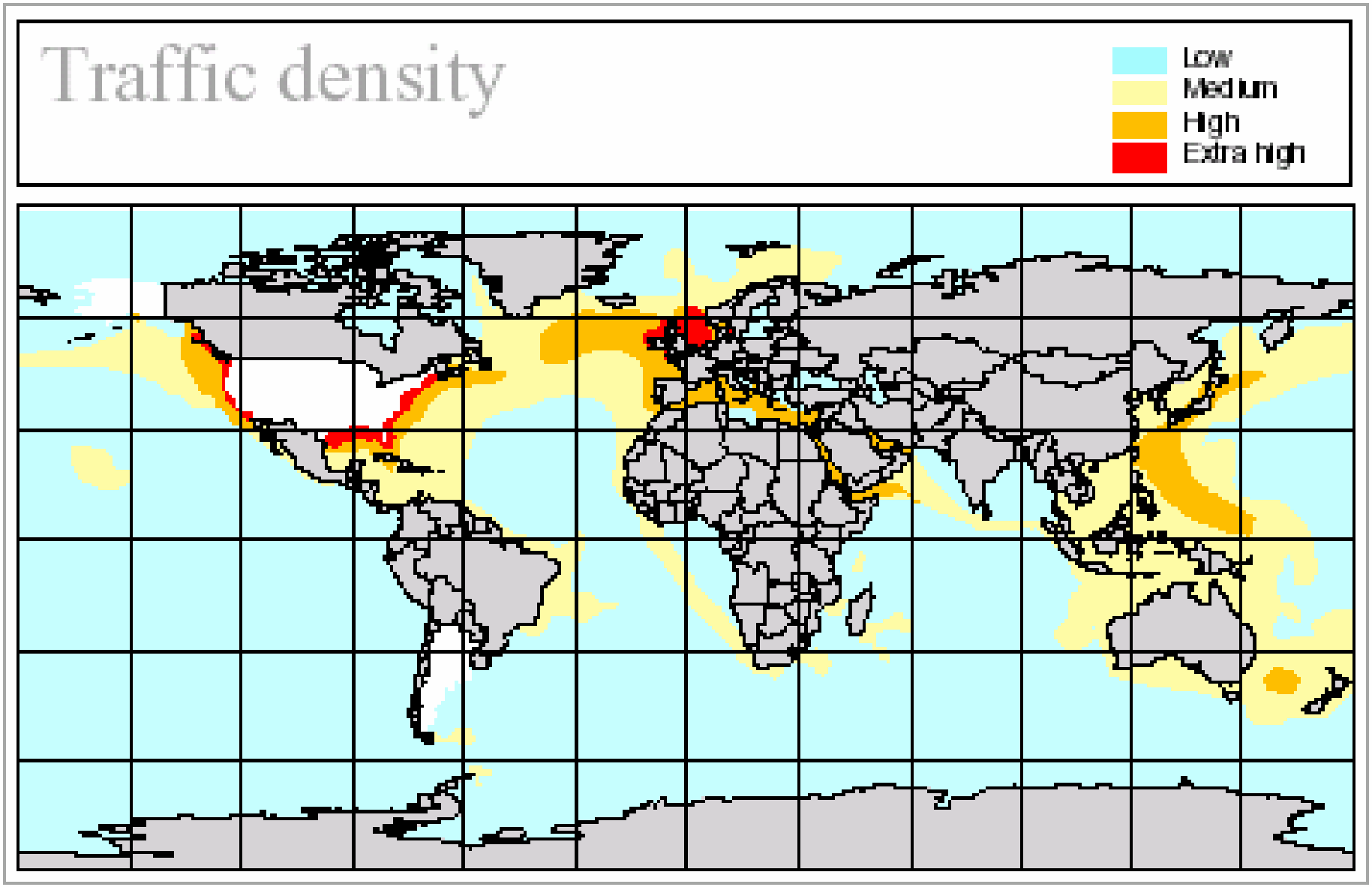
Top Ten Ports by Container Volume in 2004



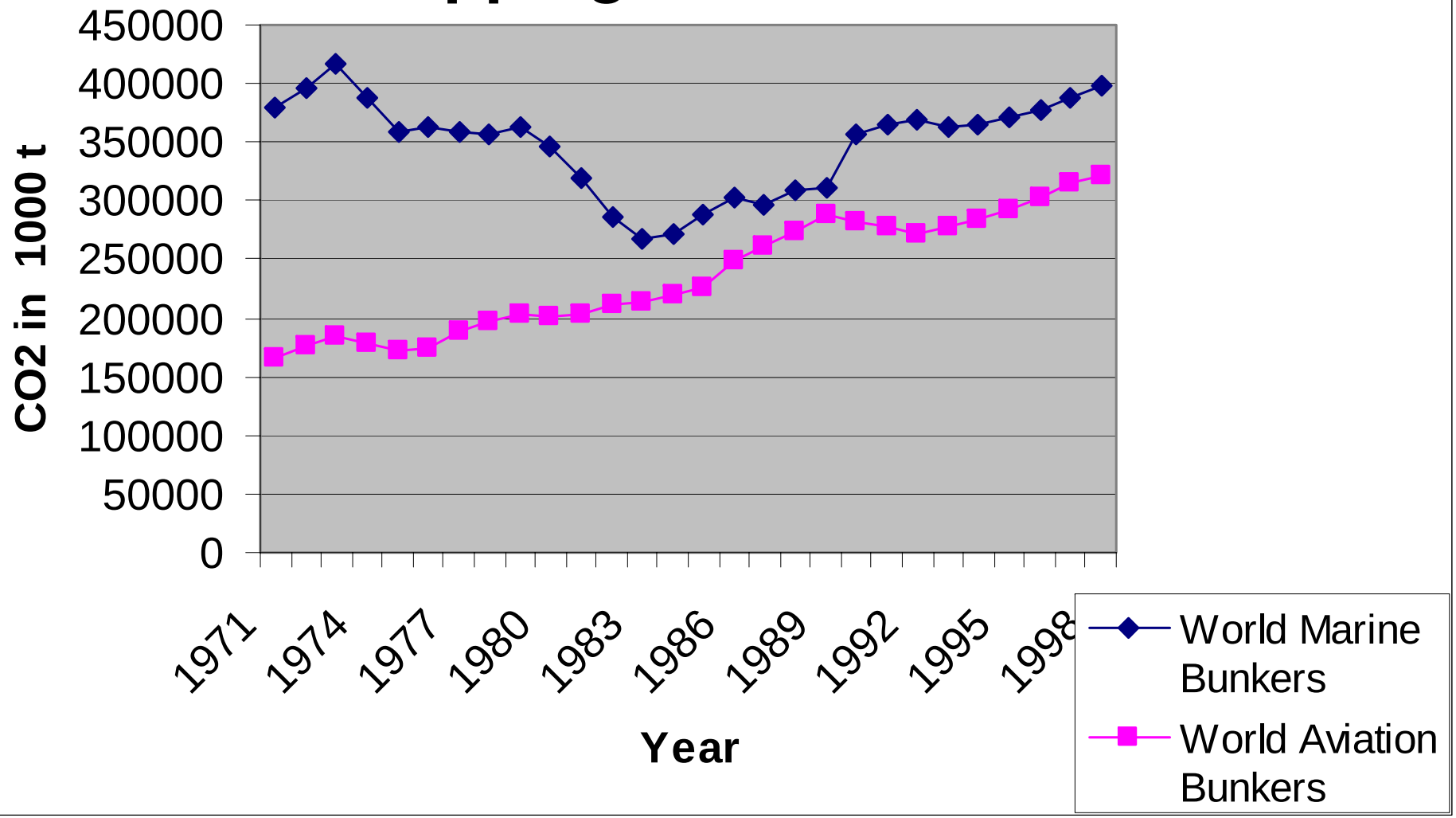
Source: MARAD 2005

Top Ten Ports by Cargo Volume in 2003

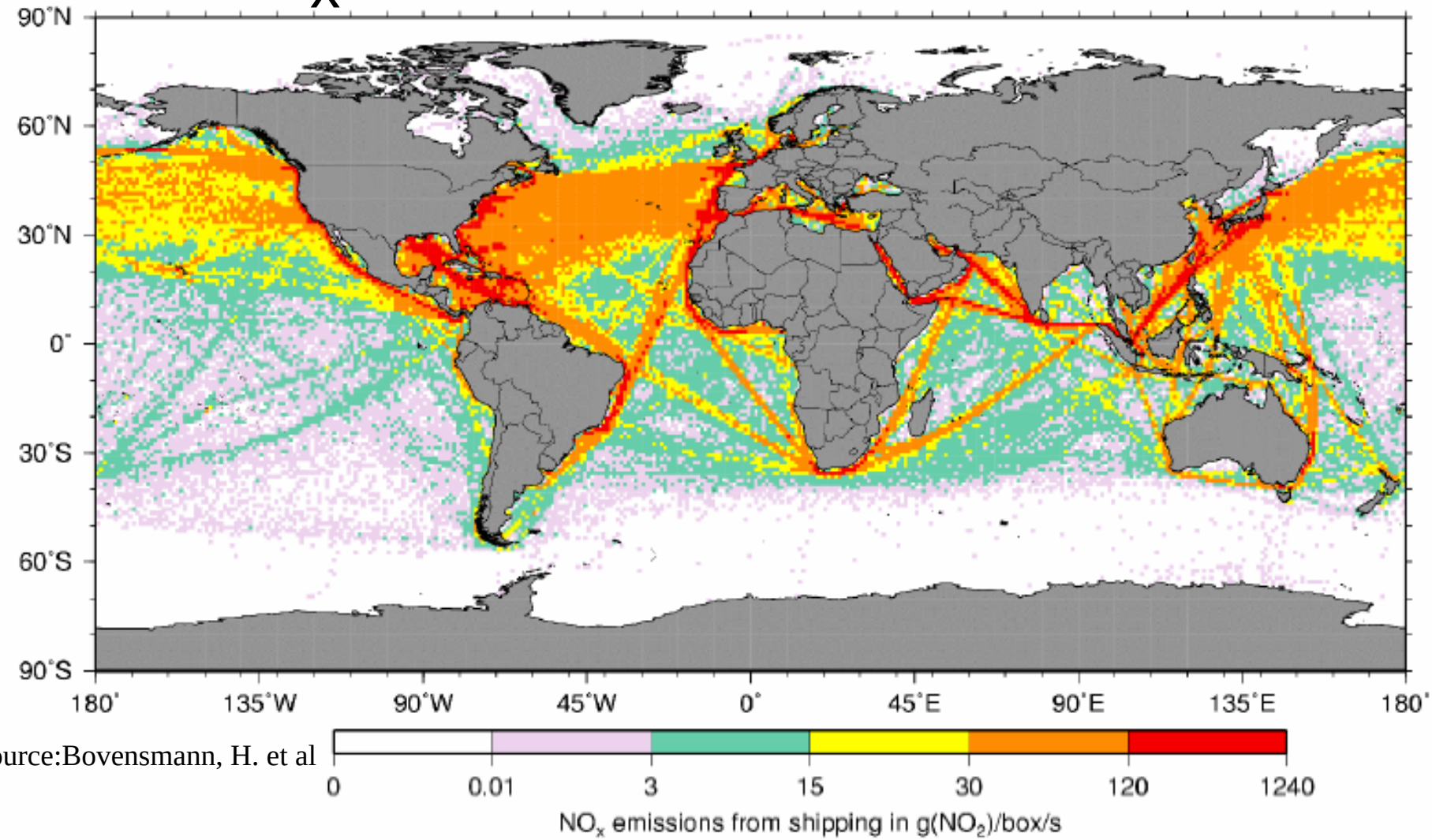



Traffic density
Low
Medium
High
Extra high

CO2- Emission of the Maritime Shipping and Aviation



NO_x Emissions from Ships



Source:Bovensmann, H. et al

About 30% of World total NOx emissions are from marine ships

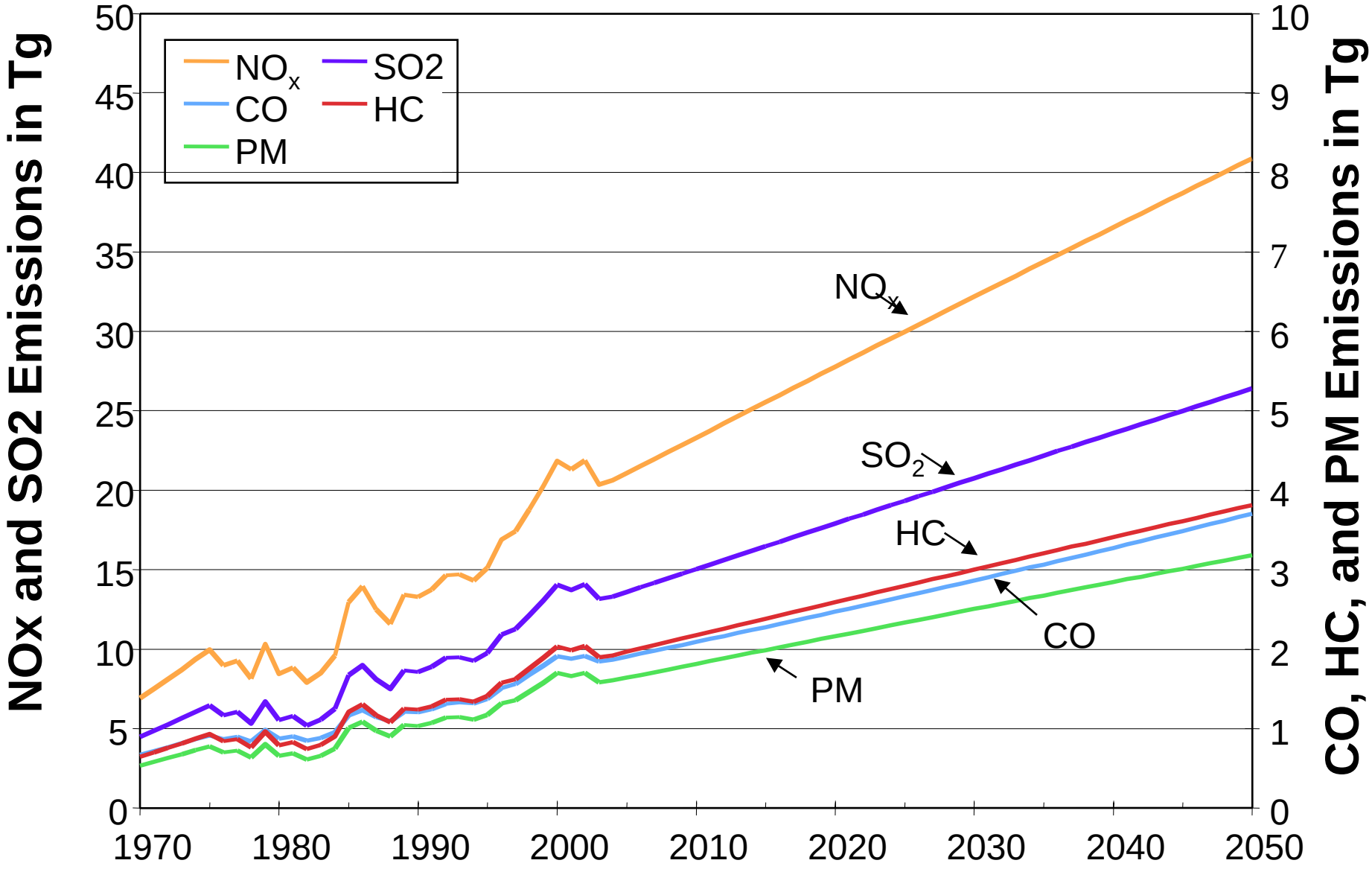
It was estimated that ships contribute with about **29 up to 31 %** to worldwide NO_x-emissions.

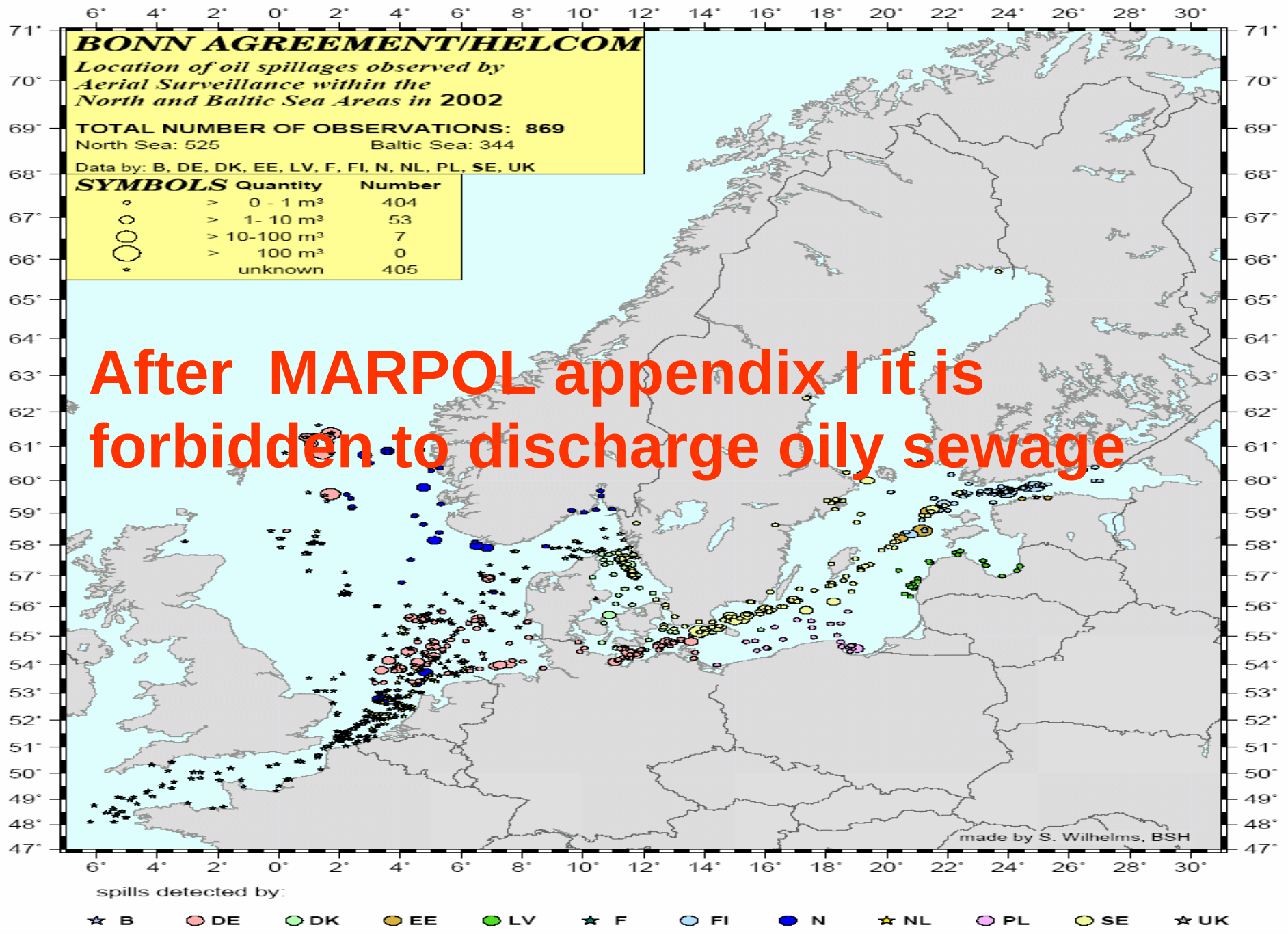
About **9 %** of all sulphur emissions from energy products are due to shipping

Source:Corbett and Koehler, Eyring et al.

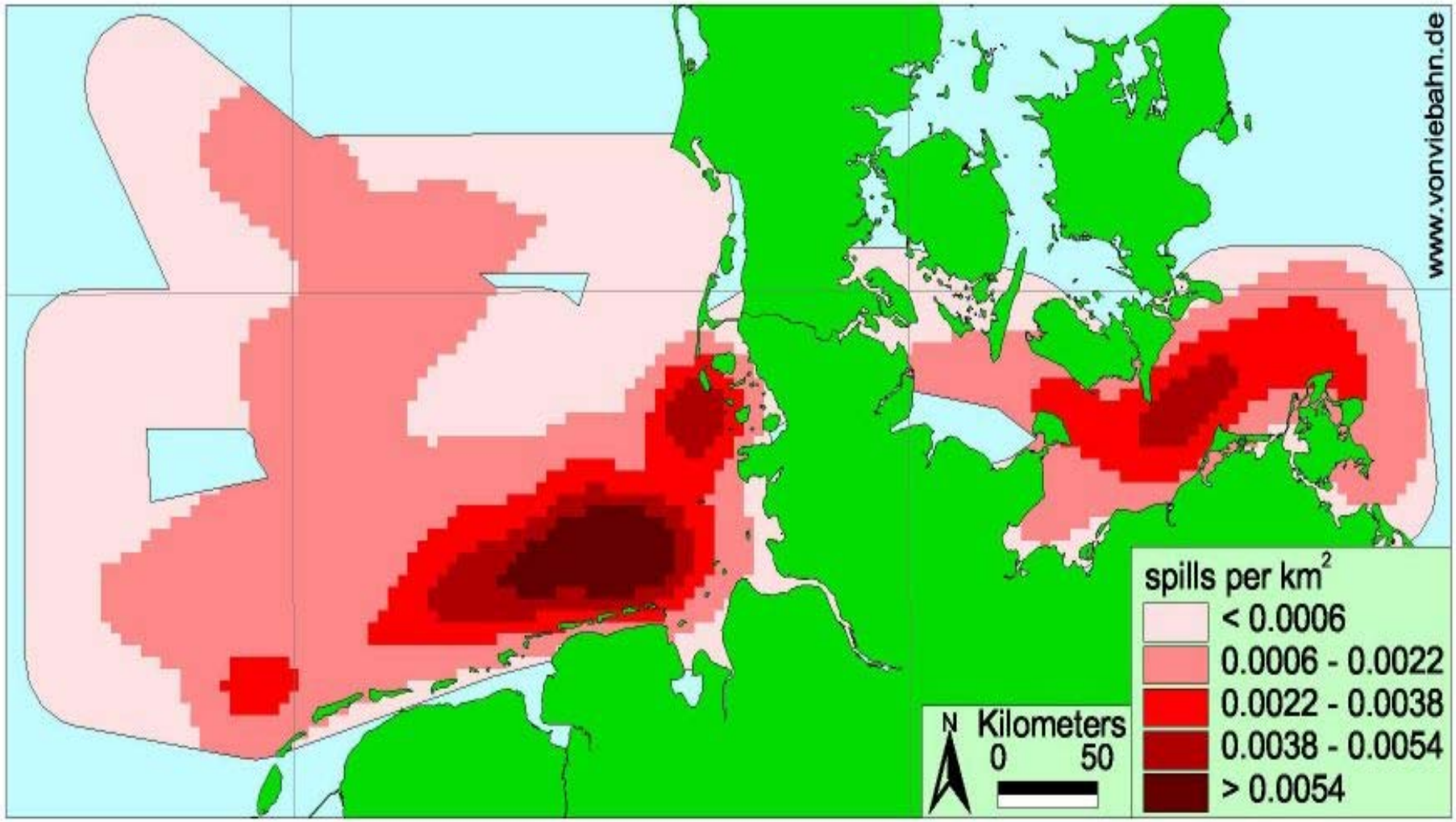
About 70 % of the ship emissions occur within 400 km of land

Global Marine NO_x SO_2, CO, HC, and PM Emissions from 1970 to 2050

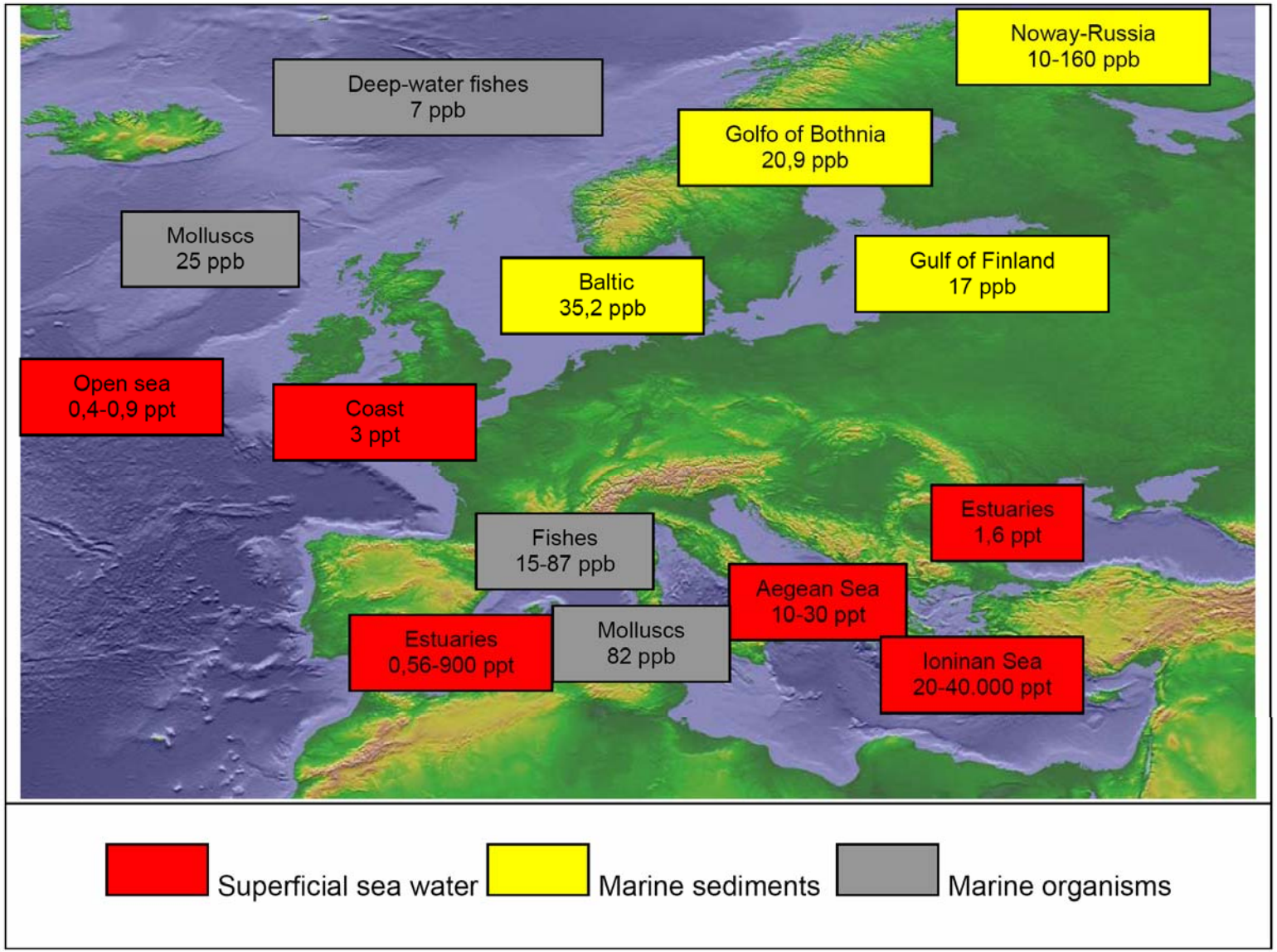



BONN AGREEMENT/HELCOM
Location of oil spillages observed by
Aerial Surveillance within the
North and Baltic Sea Areas in 2002
TOTAL NUMBER OF OBSERVATIONS: 869
North Sea: 525
Baltic Sea: 344
Data by: B, DE, DK, EE, LV, F, FI, N, NL, PL, SE, UK
SYMBOLS Quantity Number
> 0 - 1 m³ 404
> 1- 10 m³ 53
> 10-100 m³ 7
> 100 m³ 0
unknown 405
After MARPOL appendix I it is forbidden to discharge oily sewage
made by S. Wilhelms, BSH
spills detected by:
B DE DK EE LV F FI N NL PL SE UK

Oil Spill


www.vonviebahn.de
spills per km²
< 0.0006
0.0006 - 0.0022
0.0022 - 0.0038
0.0038 - 0.0054
> 0.0054
N
Kilometers
0
50

PAH Levels in Marine Ecosystems



Source: OCEANA THE EU FLEET AND CHRONIC HYDROCARBON CONTAMINATION OF THE OCEANS

Illegal Hydrocarbon Waste Dumping to the Sea

In the case of the North Sea alone, the volume of illegal hydrocarbon dumping estimated at between 15,000 and 60,000 tonnes per year, added to which are another 10-20,000 tonnes of authorised dumping. In the Mediterranean, it has been estimated at more than 400,000 tonnes and in the Baltic, if we assume
that close to 10% comes from this source, we would be looking at another 1,750-5,000 tonnes a year.

Source: OCEANA THE EU FLEET AND CHRONIC HYDROCARBON CONTAMINATIOI
OF THE OCEANS

The fuel is one of the most significant aspects of environmental impact defined in Wallenius Wilhelmsen's extensive environmental programme. As a part of that programme the Wallenius Lines owned PCTC (Pure Car and Truck Carrier) TURANDOT has been running on Marine Diesel Oil, MDO, from January 1998 until December 2001. The bunker specification was DMB quality but with a Sulphur content of less than 1%. By this the SO2 emissions were reduced by 75% compared to the sister vessel TITUS operating on HFO 380 cSt. This is in line with the company's long term target to reduce SO2 emissions by operating on fuel containing less than 1.5% S by the end of 2003. **Fuel consumption was reduced by at least 5% thanks to the higher heat value and less heating of fuel tanks**.

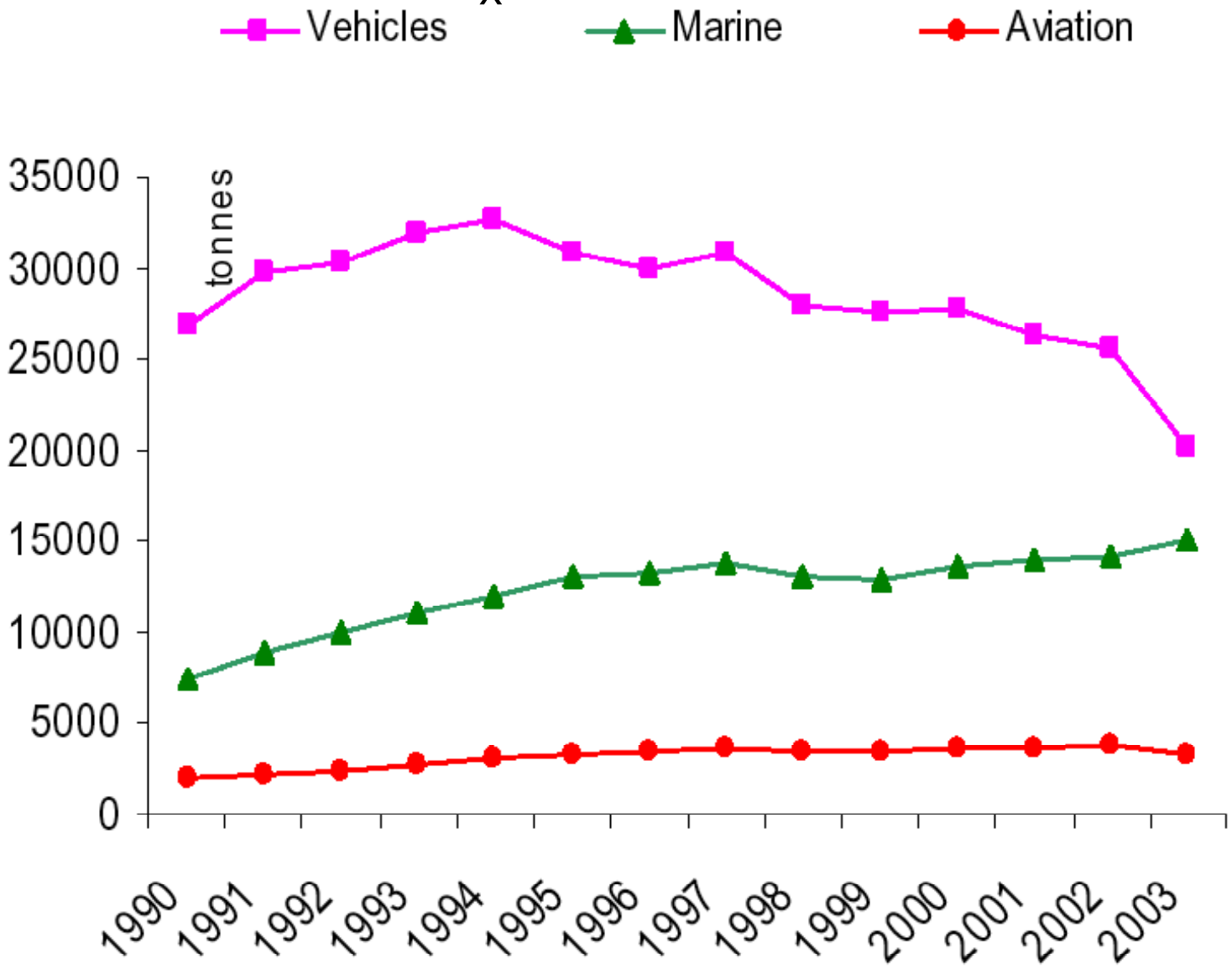
Findings from the work onboard indicate that savings from fully utilized MDO operation corresponds to an price difference of about **20 USD/mt** compared to ordinary 380cST HFO. The most important savings are from crew reduction, fairway fees and cylinder oil consumption. Due to regulations regarding safety crew, the crew reduction is not utilized on TURANDOT. The savings in work could also be used to reduce the cost of external services, e.g. onboard trucks, hydraulics and electric motors

Maritime Shipping Fuel:

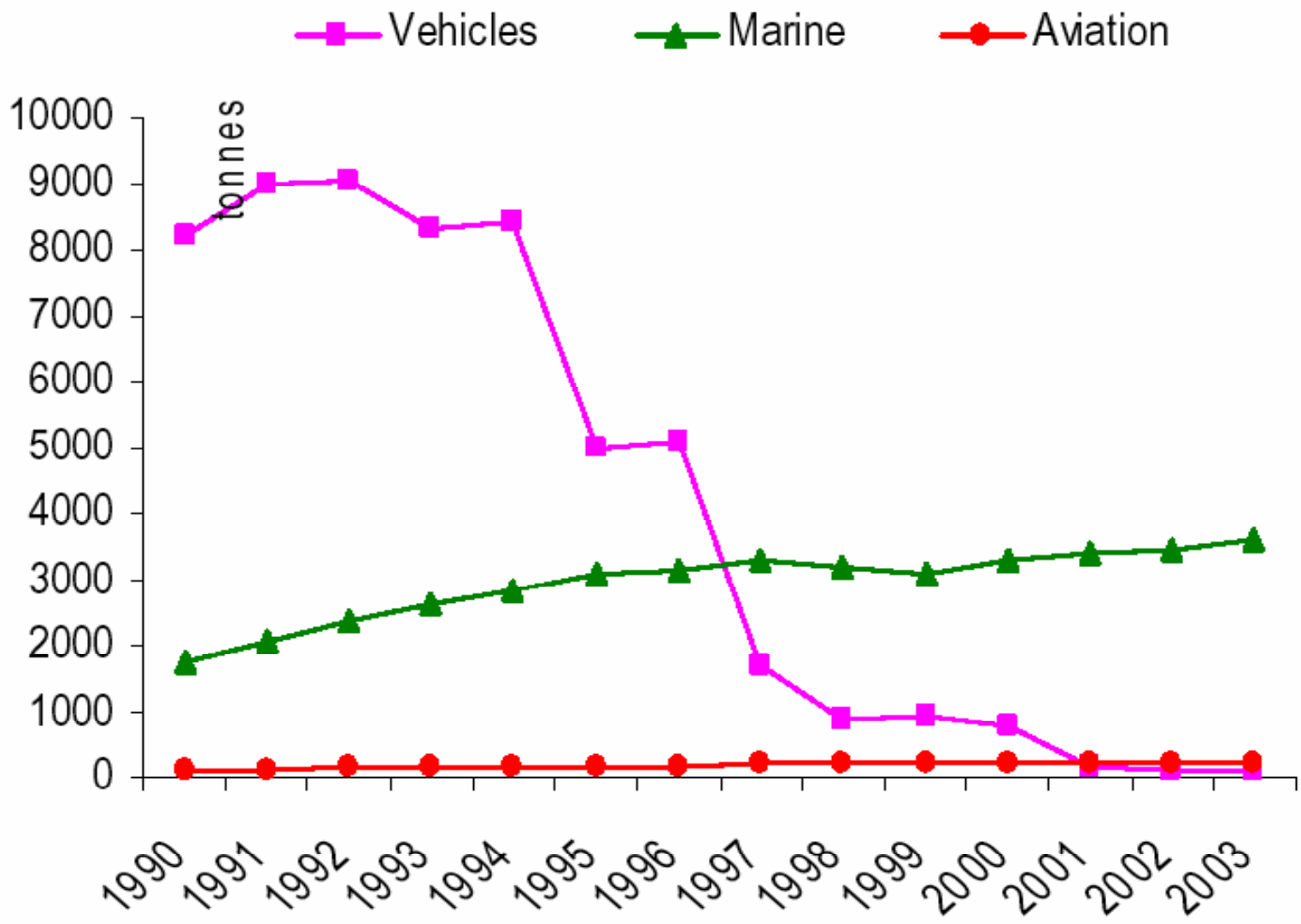
Waste incineration at Sea

Hong Kong Mobile Source Emissions Inventory

NO_x Emissions

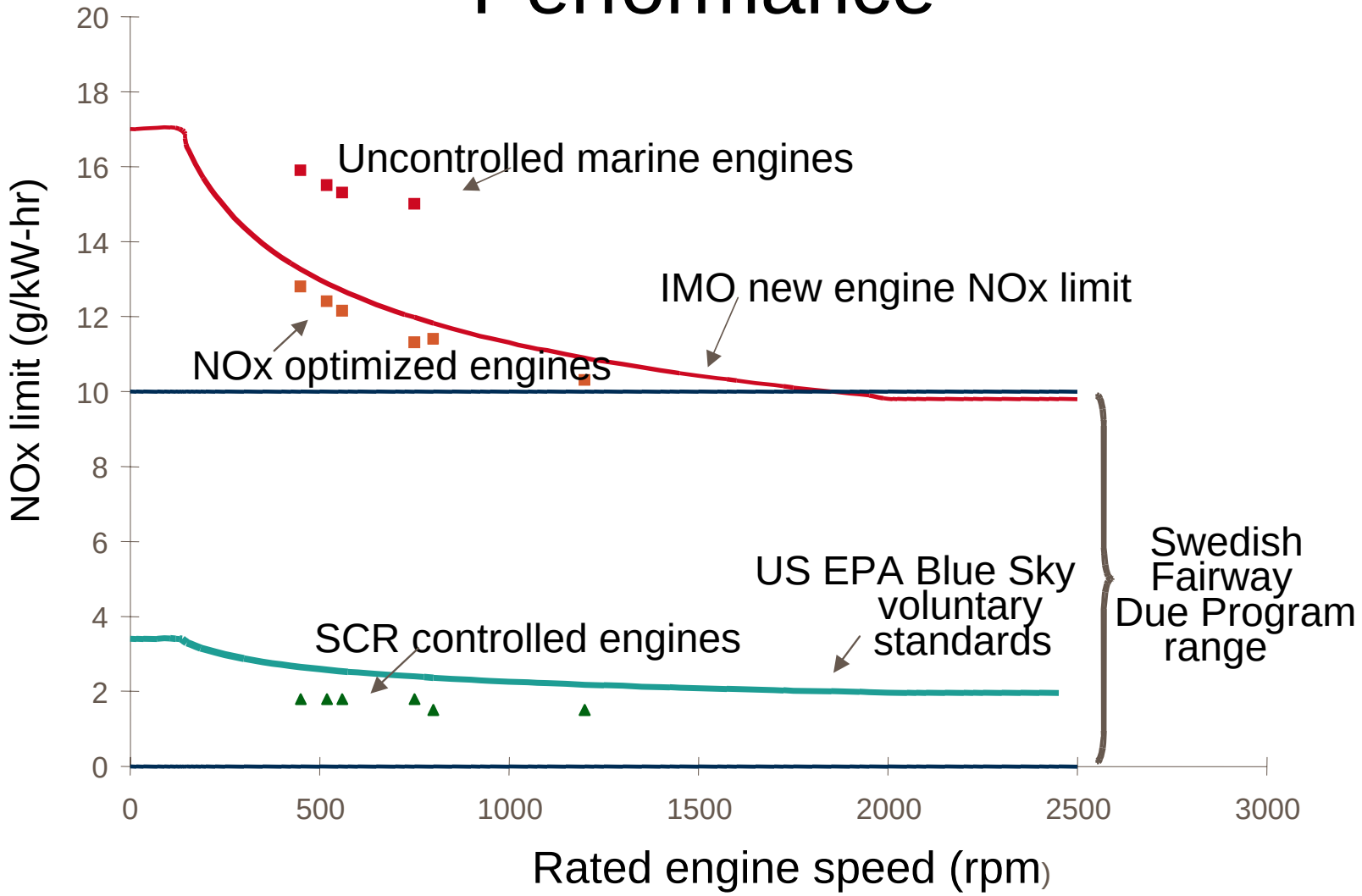


Hong Kong Mobile Source Emissions Inventory SO_2 Emissions



Source: Hong Kong Environmental Protection Department

Marine Emission Standards and Engine Performance



Eyring et al. 2005, SMA 2005

Technologies to Reduce NOx Emissions

Technology	NOx Reduction	Engine Application	Technology Status
Engine Modification	20%-30%	2 and 4 stroke	Standard in new engines
Selective Catalytic Reduction	85%-95%	4 stroke and some 2 stroke	Commercially available
Fuel Water Emulsion	0%-30%	2 and 4 stroke	Demonstration/custom order
Direct Water Injection	50%	4 stroke	Commercially available
Humid Air Motor	70%	4 stroke	Limited demonstration
Combustion Air Saturation System	30%-50%	4 stroke	Research and development
Exhaust Gas Recirculation	35%	4 stroke	Research and development

Technologies to Reduce SO_x Emissions

Technology	SOx Reduction	Engine Application	Technology Status
1.5% Sulfur Fuel Oil	44%	2 and 4 stroke	Commercially available
0.5% Sulfur Fuel Oil	81%	2 and 4 stroke	Commercially available
Sea Water Scrubber	75%	2 and 4 stroke	Demonstration/custom order 1)

ICCT forthcoming

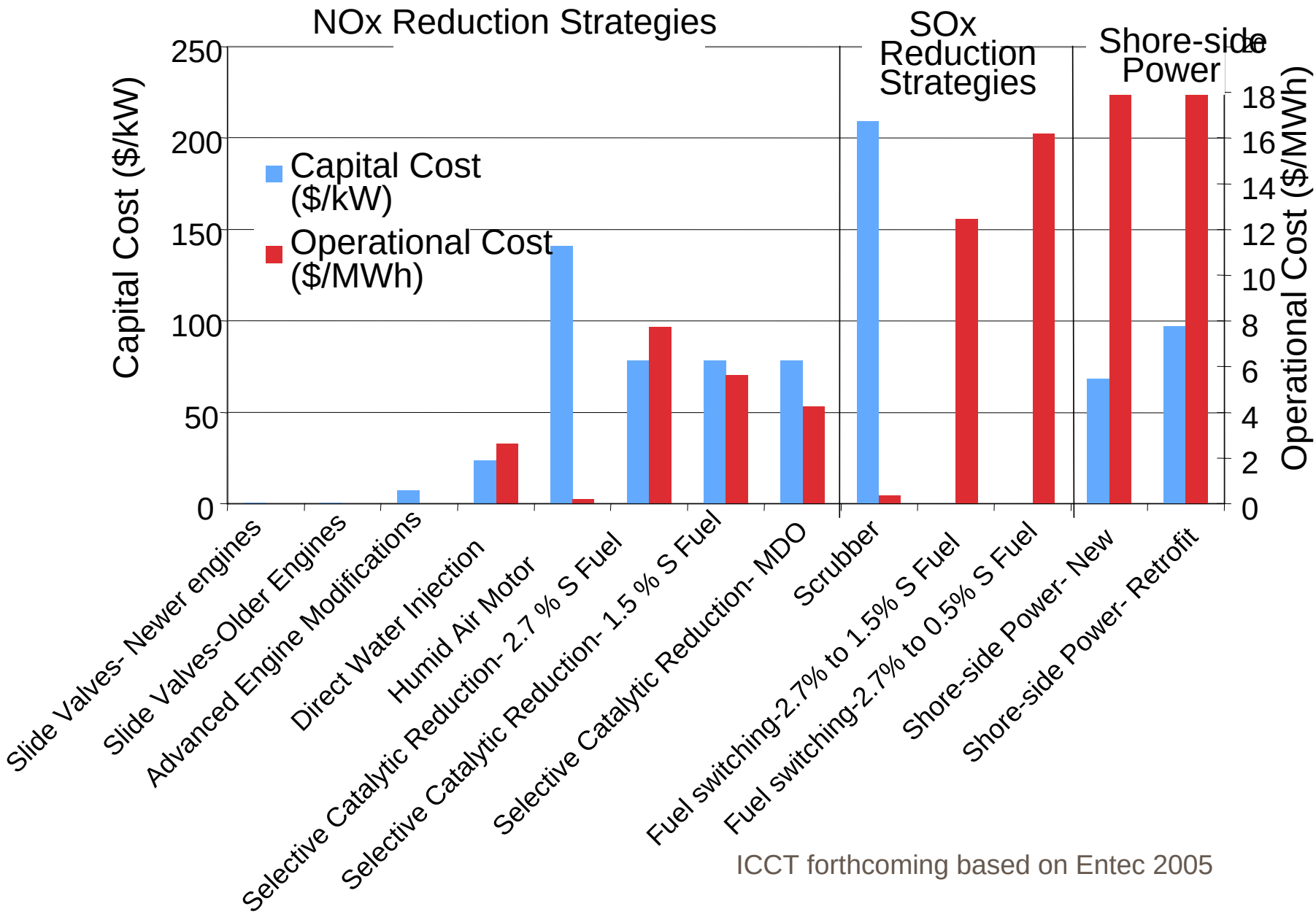
1) Sea Water Scrubbers are not acceptable due to the discharge to sea (high PAH and heavy metal content)

Technologies to Reduce Hotelling Emission

Technology	Emission Reduction	Engine Application	Technology Status
0.5% Sulfur Marine Diesel Oil	SOx: 80% PM: 75%	2 and 4 stroke	Commercially available
0.1% Sulfur Marine Diesel Oil	SOx:>90% PM :>80%	2 and 4 stroke	Commercially available
Marine Gas Oil	SOx:>90% PM :>80%	2 and 4 stroke	Commercially available
Shore-side power	NOx, SOx, PM: >90%	2 and 4 stroke	Commercially available
Shore-side emission treatment	NOx, SOx, PM: >90%	2 and 4 stroke	Pilot demonstration

ICCT forthcoming

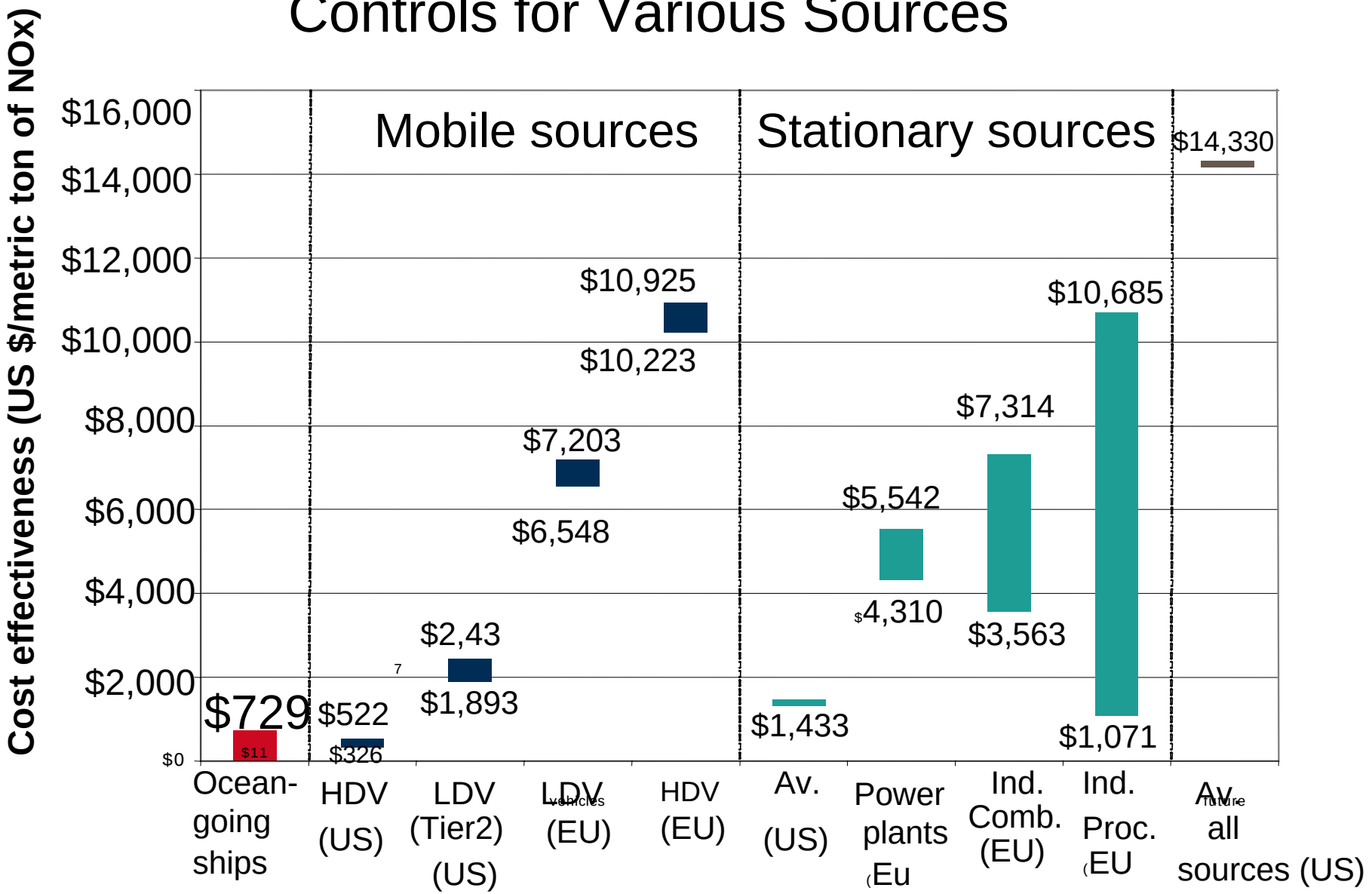
Incremental Capital and Operating Costs



ICCT forthcoming based on Entec 2005

Cost Effectiveness Comparison of NOx

Controls for Various Sources



ICCT forthcoming based on Entec 2005 and US EPA 1999, 2000, 2005

ICCT Recommendations on Fuels

Short term:

- Lower allowed fuel sulfur level in Sulfur Emission Control Areas (SECAs) from 1.5% to 0.5%.
- Expand SECA program to high ship ship-traffic areas in Pacific Rim and North Atlantic.

Medium term: Require 0.5% sulfur fuel

Long term: Harmonization with with sulfur requirement for on-road diesel fuels (500 ppm to 10-15 ppm over time)

ICCT Recommendations on New Engines

Short term:

- NOx: 40% percent below current IMO standards (2000 level).
- PM: 20% below uncontrolled

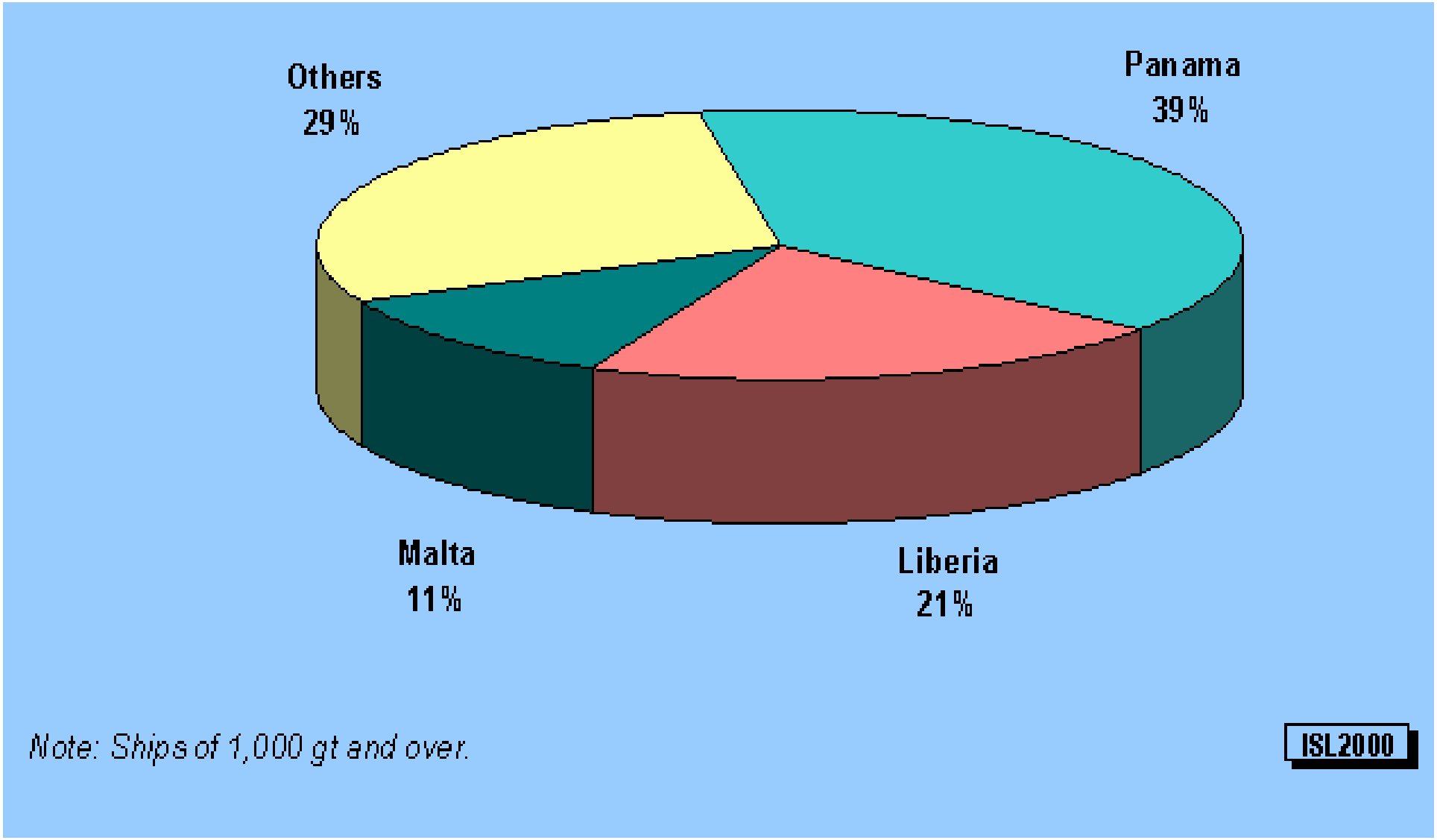
Medium term:

- NOx: 95% percent reduction below current IMO standards (2000 level)
- PM: 95% reduction below uncontrolled

Fuel	Fuel consumption		Cost diff
	in German water		Mill $
MDO	166	23%	
HFO	554	77%	28
Sum	720	100%	
	in EU 15 water		
MDO	8.300	24%	
HFO	27.000	76%	1.350
Sum	35.300	100%	
	world wide		
MDO	40.000	26%	
HFO	111.000	74%	5.550
Sum	151.000	100%	

MARPOL- Agreement

Article 15 *(1)*; *this agreement comes into force twelve months after the day, when at least 15 states have ratified the agreement and cover* ***at least more than fifty per cent of the total tonnage of the merchant fleet of the world****.*



62% of the world naval fleet are not registered in the mother countries of the ship owners.

To wait for IMO means to hope for 20 years with unknown results

Fuel Preparation onboard

The bunker oils are so inferior that they must be processed onboard of the sea ships by separators. With the processing as a function of the kind and quality of the fuel disposal oil mud are produced:

1.5 - 3% of the fuel consumption with HFO (heavy fuel oil):

0.5% of the fuel consumption with MDO (marine diesel oil):

0% of the fuel consumption with MGO (marine gas oil):

The heavy oils are so viscous liquid that they are pumping-capable only in the heated state.

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