



#### **Joint Research Centre (JRC)**



## Analytical Framework to regulate air emissions from maritime transport

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# JRC research projects to define a comprehensive analytical framework for the assessment of policies to abate air emissions from ships:

#### **1. Air pollution**

assessment of external costs of maritime transport in particular in the areas around ports (two evaluation approaches have been tested in the area of the Port of Venice).

#### 2. Climate change

analysis of the available tools to abate CO2 emissions from the maritime sector at a wider scale. A possible instrument which has been taken into consideration has been the introduction of a European Emission Trading scheme applied to the maritime sector.





- Necessity to develop a modeling framework for the evaluation of the emissions due to the maritime sector
- At a first glance not an impossible transportation study
  - Limited extension of the maritime transportation network (in terms of nodes)
  - Origin and destination of the trips are concentred in a discrete number of well controlled points
  - No problems of path choice modeling



• Unfortunately, as will be detailed in the remainder, the situation is not that simple!





- In the last decade several attempts of evaluating emissions from maritime sector have been presented
- Different approaches for different:
  - geographic levels (local vs. global studies)
  - shipping types (international, domestic, etc.)
  - data-sources considered (vessels databases, geographical character., etc.)
- Different approaches for **different results** and however **high degrees of uncertainties**
- A debate on this issue is still open



The Global Impact of Maritime Sector on the Environment is still UNCERTAIN





- Emissions evaluations involves two dimensions:
  - "how much" of them is introduced in the atmosphere
  - "where" they are produced
- Both dimensions may be approached in two different ways:
  - Bottom-up
  - Top-down

#### Quantity of emission produced

- A *bottom-up* approach evaluates the *emissions of each single vessels* and then aggregate to obtain the total amount
- A **top-down** approach evaluates first the **total emissions** (e.g. by means of total fuels sales) and then tries to subdivide among the different ships
- Geographical characterization of emission
  - A bottom-up approach evaluate directly all the emissions where are emitted and then aggregate
  - A top-down approach makes use of spatial proxies to characterize total emissions





		Dimension 2: Emissions geographical characterization	
	Approaches	Bottom-up	Top-down
Dimension 1: Emissions evaluation	Bottom-up	Entec (2005)	
		Wang et al. (2007a, 2007b)	
		Corbett et al. (2009)	Endresen al. (2003,2004 <sup>*</sup> , 2007)
		Jalkanen et al. (2009)	Corbett and Koehler (2003 $^*$ , 2004 $^*$ )
		Olesen et al. (2009)	Eyring et al. (2005)
		Schrooten et al. (2009)	Winther (2008) <sup>*</sup>
		Miola et al. (2009)	Dalsoren et al. (2008)
		Wang et al. (2010)	IMO (2009)
		Paxian et al. (2010)	
		Tzannatos (2010)	
	Top-down	Georgakaki et al. (2005)	
		Wang and Corbett (2005, 2007)	Endresen et al. (2007)
		Wang et al. (2008)	
		Winebrake et al. (2009)	



#### **Results from different studies**



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	Study	Base Year	Global CO <sub>2</sub> emissions from Maritime Transport (Mt)
International Shipping	Endresen et al. (2003)	2001	557
	Corbett and Koelher (2003)	2001	805
	Eyring et al. (2005)	2001	812
	Endresent et al. (2007)	2000	625
	Wang et al. (2008)	2001	650
	Edgar (2009)	2001	440
	IEA	2001	550
	EIA	2001	610
	IMO consensus (2009)	2001	652
	Eyring et al. (2009)	2000	780
	Edgar (2009)	2004	520
	Dalsoren et al. (2008)	2004	654
	IMO consensus (2009)	2004	755
	Eyring et al. (2009)	2005	960
Total Shipping	Corbett and Koelher (2003)	2001	912
	Eyring et al. (2005)	2001	887
	IMO consensus (2009)	2001	784
	Paxian et al. (2010)	2006	695
	IMO consensus (2009)	2006	1008
EU 200 M	Wang et al. (2008)	2001	90
	Edgar (2009)	2001	62
	Entec (2005)	2000	121
EU Tot	Paxian et al. (2010)	2006	310
	Schrooten et al. (2009)	2005	77





- 1. Use of total fuel bunker sales to calibrate fuel consumption and emission models
  - Using these information led to an overall underestimation of global emissions than without using them
  - A possible explanation has been found in the heterogeneous fuel classification made by the different sources used to evaluate the total fuels sales

#### 2. Different sources for ships' activities

- First studies made hypothesis on the average ships' activities (in terms of hours at sea, average engine load, etc.)
- As new information are made available (Automatic Identification System data, port calls data data, aggregated traffic data, etc.) new attempts have been provided to evaluate total emissions





#### **3.** Uncertainties related to the input data considered

- Vessels information:
  - Some incongruence exists between data provided by different sources (Lloyd's Register Fairplay, Lloyd's MIU)
- AIS data:
  - Errors in the communication system
  - Possible weak coverage of the AIS network considered (potential significant improvements connected with the availability of a SATELLITE AIS network)
  - Penetration of AIS among ships (the situation should improve since it is mandatory for all the ships to have the system working on board)
- Movements data (port-to-port calls):
  - Port-to-port calls are registered only for a part of the entire fleet
  - For the same ship it is not granted to have all the calls

A careful and contemporary use of multiple data sources may reduce the global uncertainties



#### **Sources of uncertainties (3)**



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*Effect of the AIS network weak coverage in certain areas on the ships' activities identification* 

## *ICOADS Data for ships' traffic geographic characterization*







- Necessity to include also meteorological information to improve the estimate of ships' movements resistances
  - Data on waves
  - Data on wind

• When a ship slows down it may also mean that its consumption is increasing!!!





Policy measures to abate air emissions from ships are needed. However, to design and to appraise a sectorial environmental strategy future research should cover:

- the lack of data on ships (engine, fuel, movements and traffic data, international bucker fuel, etc..)
- methods to estimate air emissions, to evaluate their impacts and their monetization;
- Necessity to include in the evaluation also data on wind and wave conditions





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### Reports available on the web-site: <u>http://ies.jrc.ec.europa.eu/transport-and-air-quality-unit-2</u>

Miola , A., Ciuffo, B., Marra, M., Giovine, E. (2010) "Analytical framework to regulate air emissions from maritime transport" (EUR24297 – ISBN 978-92-79-15308-2)
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Miola et al. (2008) "Review of the measurement of external costs of transportation in theory and practice" (EUR23714 – ISBN 978-92-79-11279-9)
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