Addressing GHG emissions from international maritime transport

ICAO/IMO Side Event UNFCCC COP 20

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Marine Environment Division, 1st December 2014

IMO INTERNATIONAL MARITIME ORGANIZATION

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International Maritime Organization

- The IMO Convention adopted in 1948 and IMO first met in 1959
- A specialized agency of the UN
- 170 Member States
- Role is to develop and maintain a comprehensive regulatory framework for shipping
- Safety, environment, legal, technical co-operation, security

Safe, secure and efficient shipping on clean oceans

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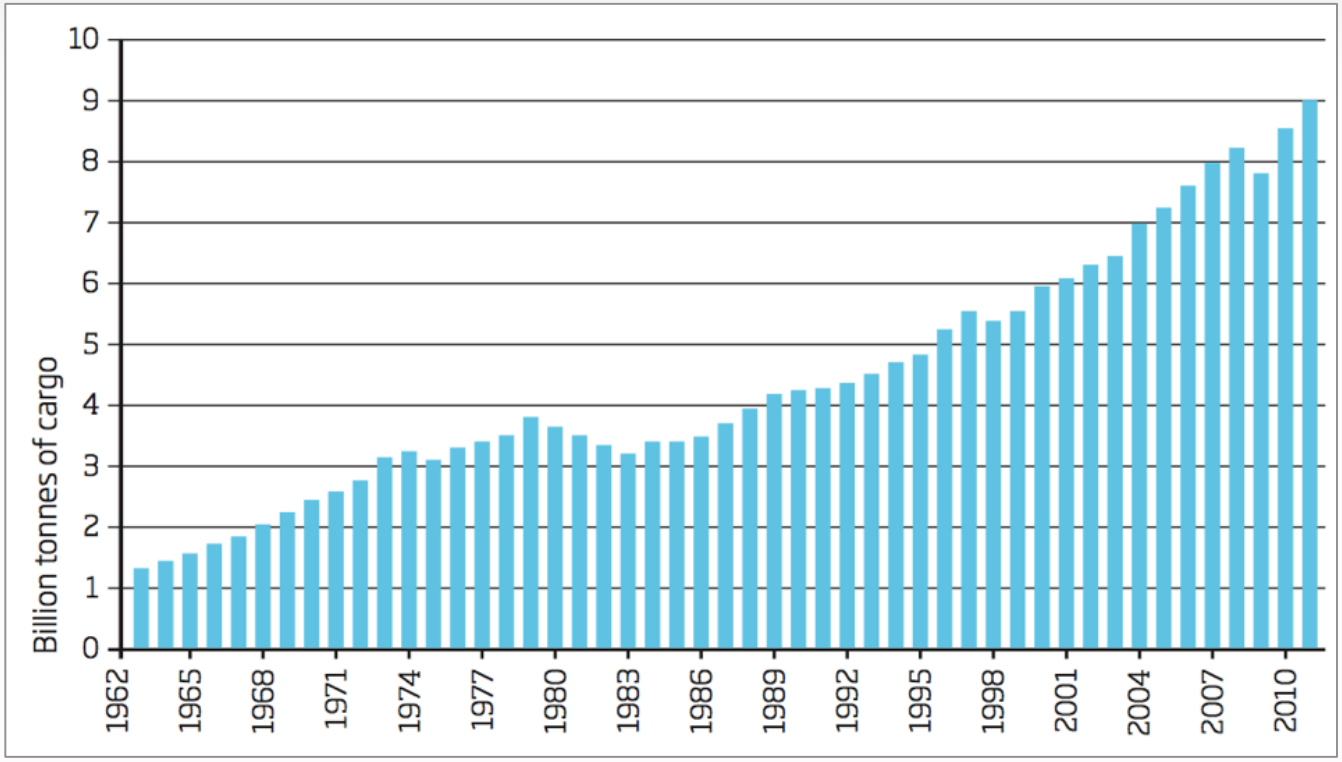
Key factors for shipping activity

Key factors for international maritime transport emissions:

1. World economy / trade volumes
2. Economics of shipbuilding / ship operation
3. Changes to trades / types of vessels needed
4. Cost of fuel / energy efficiency
5. Charter rates
6. Regulatory drivers e.g. emission limits
7. Scrutiny by stakeholders e.g., carbon footprint

Trade is growing

- Food, energy, raw materials and finished products
- Around 90 % of global trade by volume



World merchandise trade volumes expanded by 2.2% in 2013 to 9.6 billion tonnes (UNCTAD, 2014)

Source: Royal Academy of Engineering, Future Ship powering options, Exploring alternative methods of ship propulsion, July 2013

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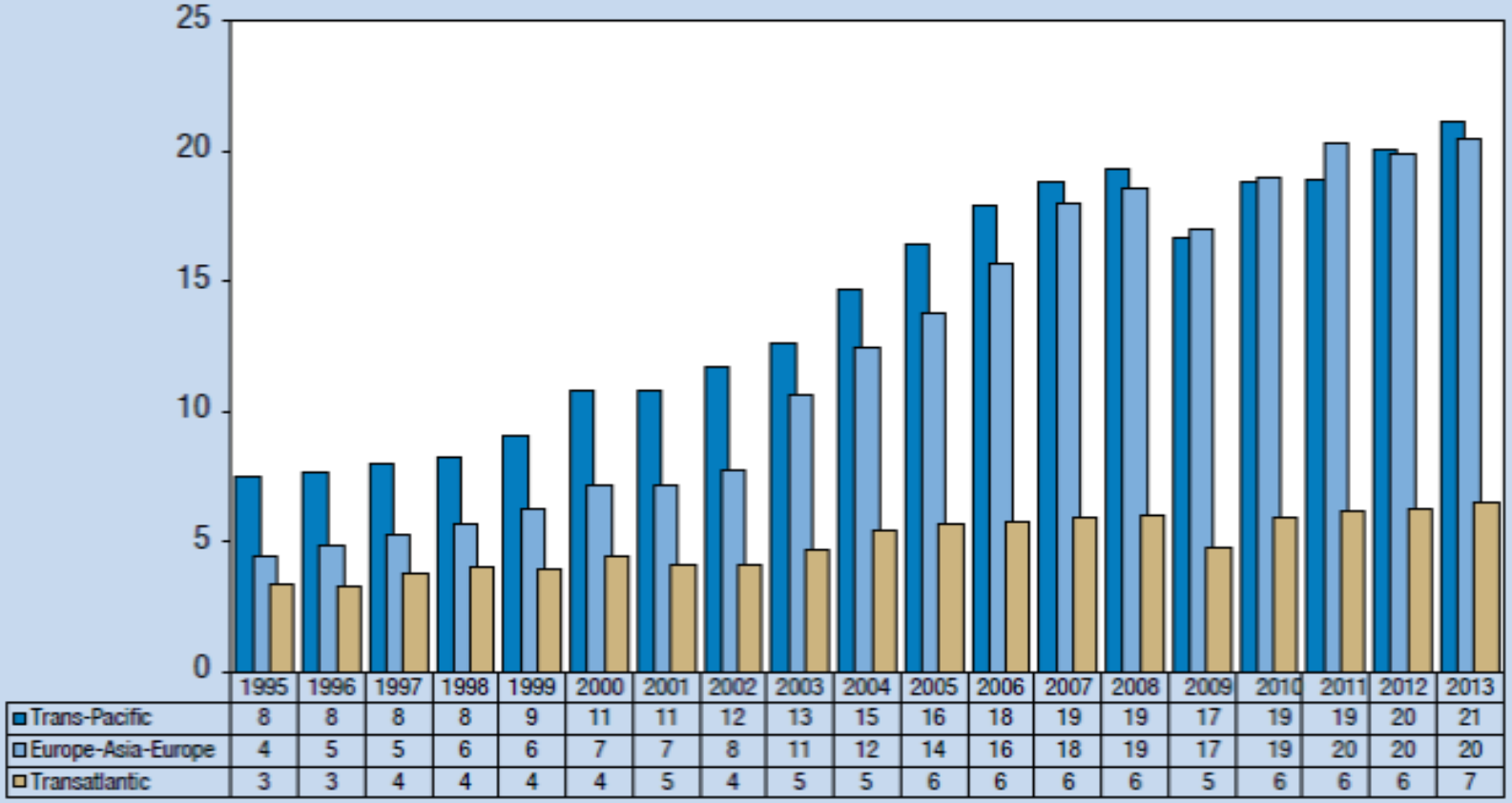
Growth in major trade routes

Figure 1.5 (c). Estimated containerized cargo flows on major East–West container trade routes, 1995–2013 (Millions of TEUs)



	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Trans-Pacific	8	8	8	8	9	11	11	12	13	15	16	18	19	19	17	19	19	20	21
Europe-Asia-Europe	4	5	5	6	6	7	7	8	11	12	14	16	18	19	17	19	20	20	20
Transatlantic	3	3	4	4	4	4	5	4	5	5	6	6	6	6	5	6	6	6	7

Source: UNCTAD Review of Maritime Transport 2014

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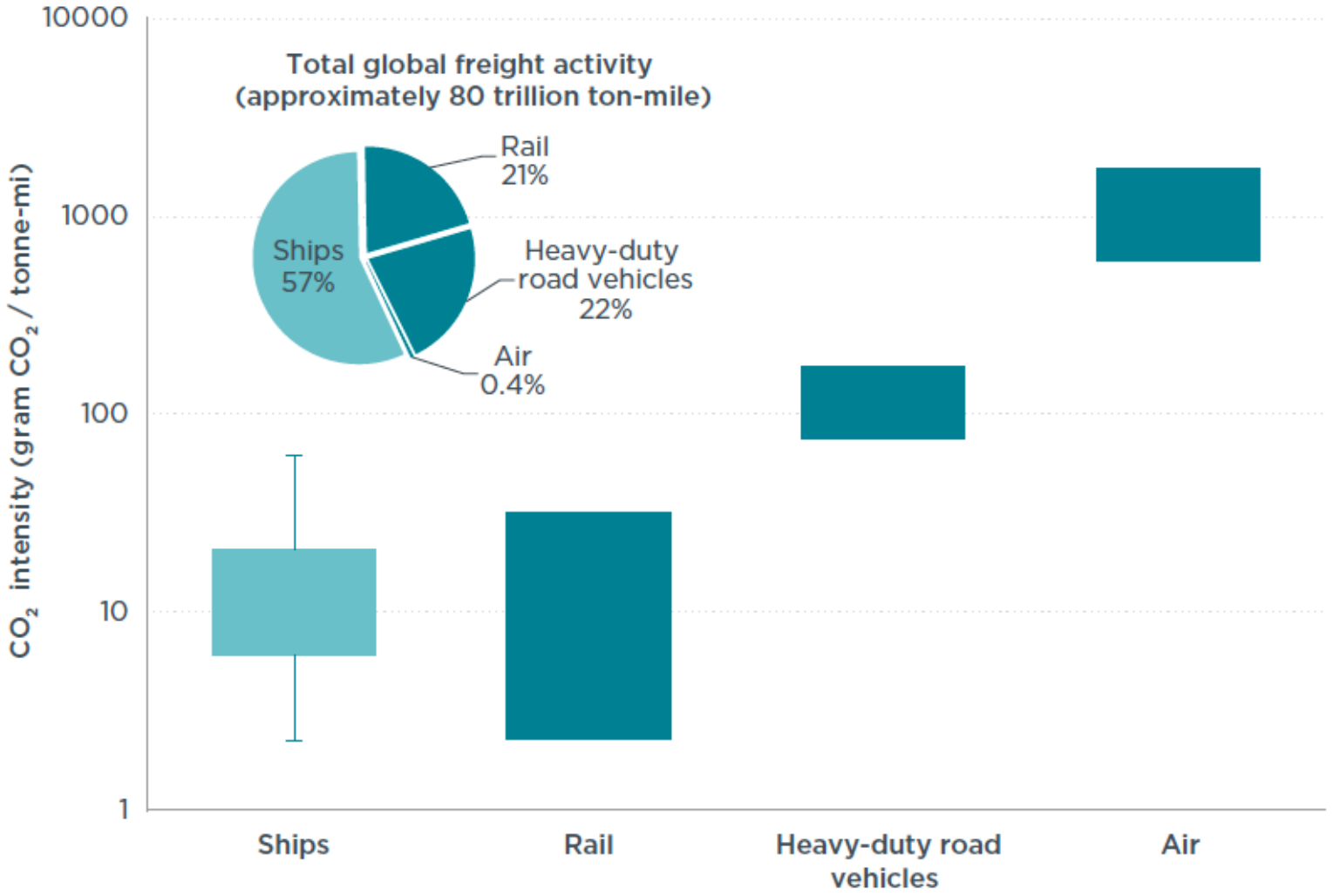
Energy efficiency of shipping



Source: International Council on Clean Transportation (ICCT), Long-term potential for increased shipping efficiency through the adoption of industry-leading practices, Wang & Lutsey, 2013

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IMO work to address GHG emissions from international shipping

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IMO Resolution A.963(23)

- **IMO Policies and Practices Related to the Reduction of Greenhouse Gas Emissions from Ships, adopted by Assembly 23 in December 2003**
- **IMOs work to address GHG emissions has investigated three distinct routes:**

Technical

Mainly applicable to new ships - EEDI

Operational

Applicable to all ships in operation – SEEMP (EEOI – voluntary)

Market-based Measures (MBM)

carbon price, incentive, may generate funds

- consideration suspended at MEPC 65 (May 2013)

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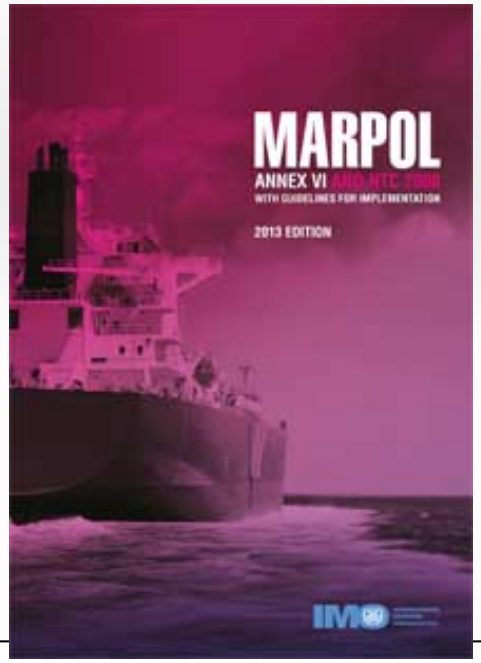
Regulations on energy efficiency for ships



- New chapter 4 added to MARPOL Annex VI (regulations 19 to 23)
- Entered into force on 1 January 2013
- First ever global and legally binding CO_2 reduction regime for an international industry sector or transport mode
- Apply to internationally trading ships of ≥ 400 GT

RESOLUTION MEPC.203(62)

Adopted on 15 July 2011

AMENDMENTS TO THE ANNEX OF THE PROTOCOL OF 1997 TO AMEND THE INTERNATIONAL CONVENTION FOR THE PREVENTION OF POLLUTION FROM SHIPS, 1973, AS MODIFIED BY THE PROTOCOL OF 1978 RELATING THERETO

(Inclusion of regulations on energy efficiency for ships in MARPOL Annex VI)

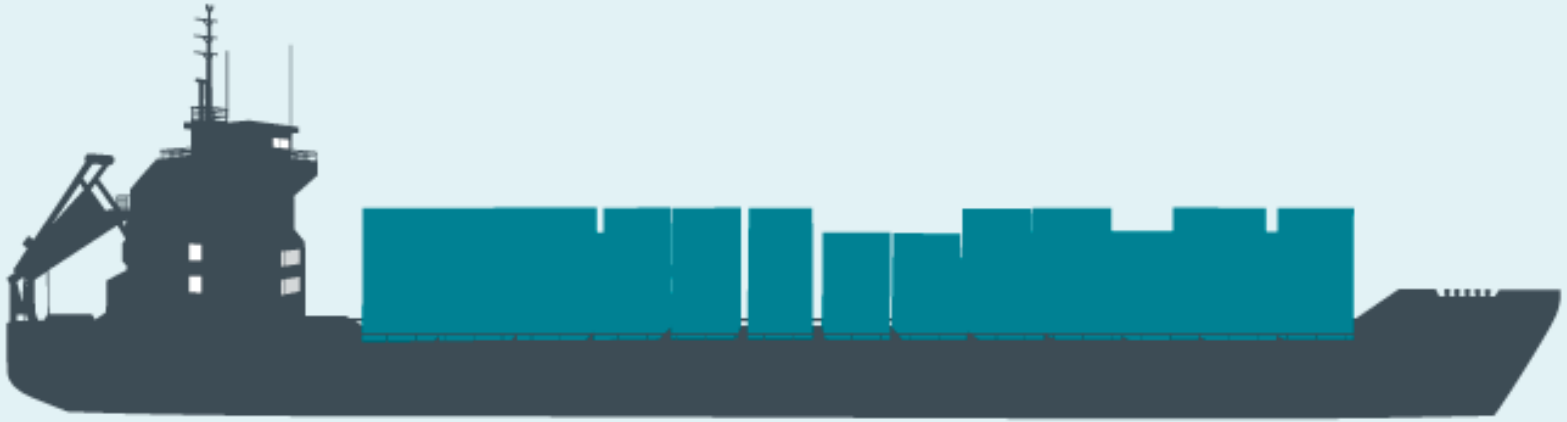
THE MARINE ENVIRONMENT PROTECTION COMMITTEE

Potential energy efficiency improvements

Operational
Weather routing **1-4%**
Autopilot upgrade **1-3%**
Speed reduction **10-30%**

Auxiliary power
Efficient pumps, fans **0-1%**
High efficiency lighting **0-1%**
Solar panel **0-3%**

Aerodynamics
Air lubrication **5-15%**
Wind engine **3-12%**
Kite **2-10%**



Thrust efficiency
Propeller polishing **3-8%**
Propeller upgrade **1-3%**
Prop/rudder retrofit **2-6%**

Engine efficiency
Waste heat recovery **6-8%**
Engine controls **0-1%**
Engine common rail **0-1%**
Engine speed de-rating **10-30%**

Hydrodynamics
Hull cleaning **1-10%**
Hull coating **1-5%**
Water flow optimization **1-4%**

Source: ICCT, 2013

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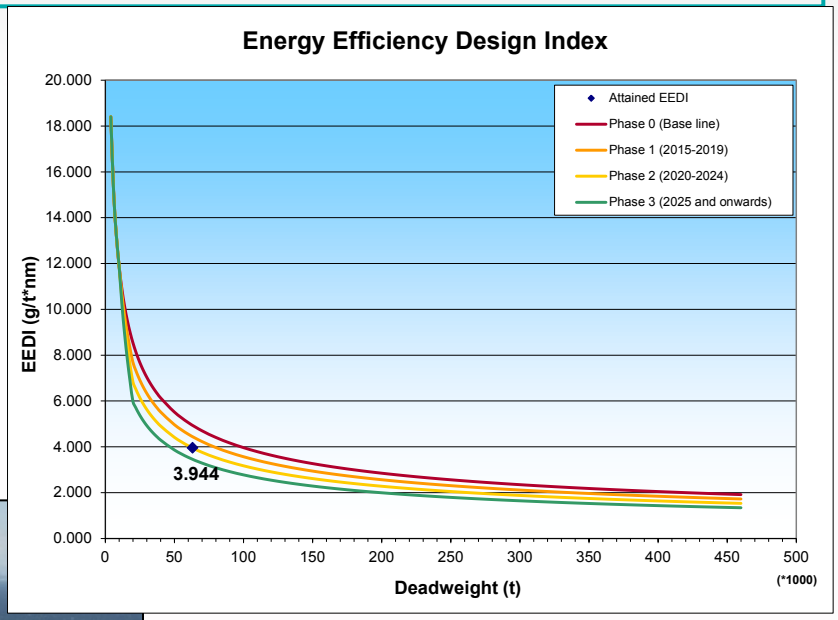
Energy Efficiency Design Index

$$EEDI = \frac{\text{Impact to environment}}{\text{Benefit to society}} = \frac{\text{Power} \times \text{fuel consumption} \times CO_2 \text{ emission factor}}{\text{Capacity} \times \text{ship speed}}$$

(transportation work)

- **The EEDI is likely to promote innovation at the design stage of ships for a reduction of their energy consumption at full load**
- **The EEDI is applicable to ship types responsible for 85% of CO_2 emissions from international shipping**



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EEDI – applicable ship types

Attained EEDI: For ships over 400 GT:

- **Bulk carrier**
- **Gas carrier**
- **Tanker**
- **Container ship**
- **General cargo ship**
- **Refrigerated cargo carrier**
- **Combination carrier**
- **Passenger ships**
- **Ro-ro cargo ship (vehicle carrier)**
- **Ro-ro cargo ship**
- **Ro-ro passenger ship**
- **LNG Carrier***
- **Cruise passenger ship having non-conventional propulsion***

Required EEDI: For ships above a given size (regulation 21, Table 1):

- **Bulk carrier**
- **Gas carrier**
- **Tanker**
- **Container ship**
- **General cargo ship**
- **Refrigerated cargo carrier**
- **Combination carrier**
- **Ro-ro cargo ship (vehicle carrier)***
- **Ro-ro cargo ship***
- **Ro-ro passenger ship***
- **LNG carrier***
- **Cruise passenger ship having non-conventional propulsion***

***MEPC 66 (April 2014) adopted amendments to MARPOL Annex VI to add these ship types to regulation 20 and 21 respectively. These amendments are expected to enter into force on 1 September 2015**

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Ship Energy Efficiency Management Plan

SEEMP – operational management tool to include:

- **All ships 400 gross tonnage and above**
- **Improved voyage planning** (Weather routeing/Just in time arrival at port)
- **Speed and power optimization**
- **Optimized ship handling** (ballast/trim/use of rudder and autopilot)
- **Improved fleet management**
- **Improved cargo handling**
- **Energy management**
- **Monitoring tools**
  - **EEOI (MEPC.1/Circ.684)**

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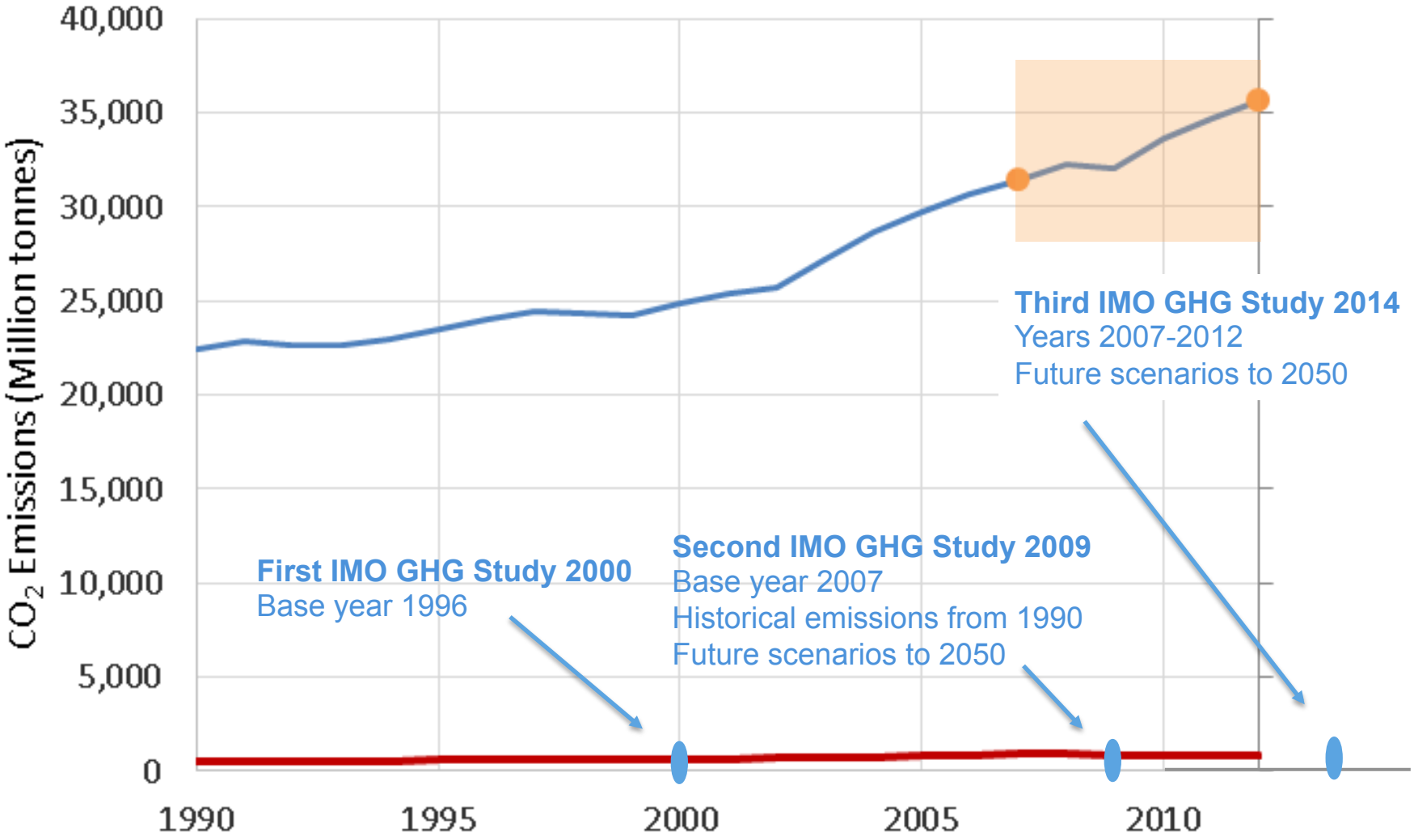
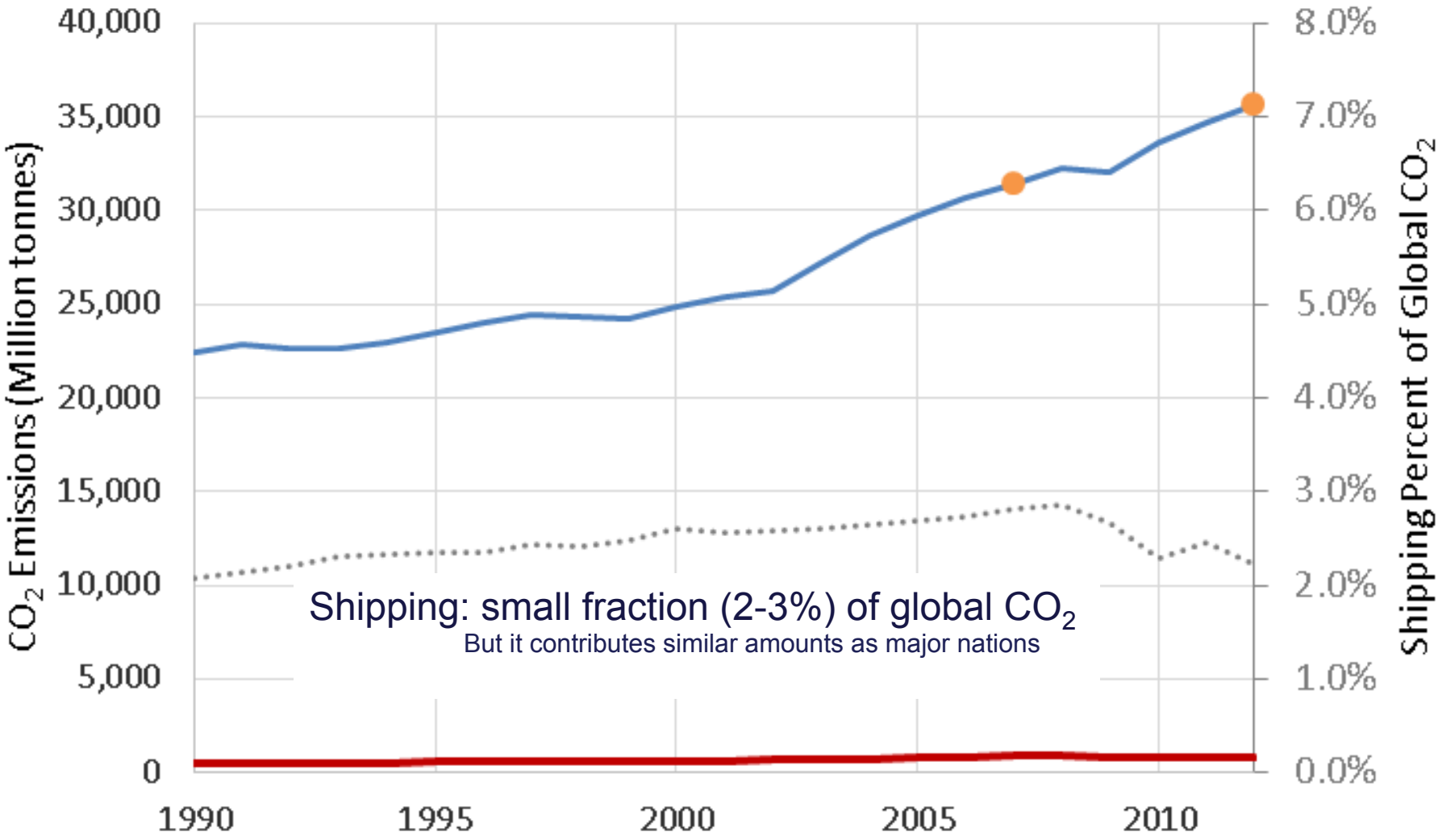
Brief history of IMO GHG studies



Global CO_2 IPCC

Shipping CO_2 IMO

Global CO_2 and economy trends



Global CO_2 IPCC **Shipping CO_2 IMO**

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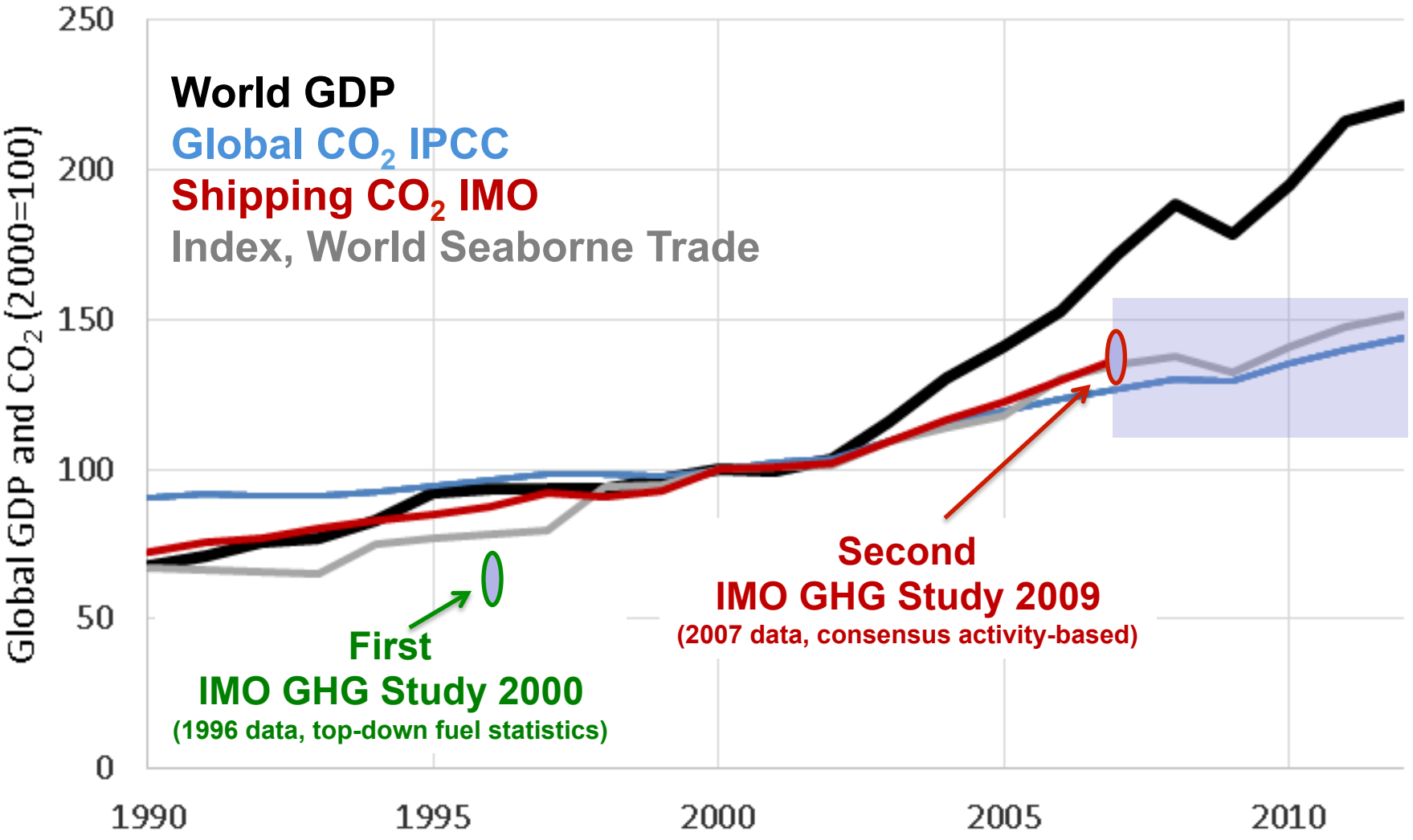
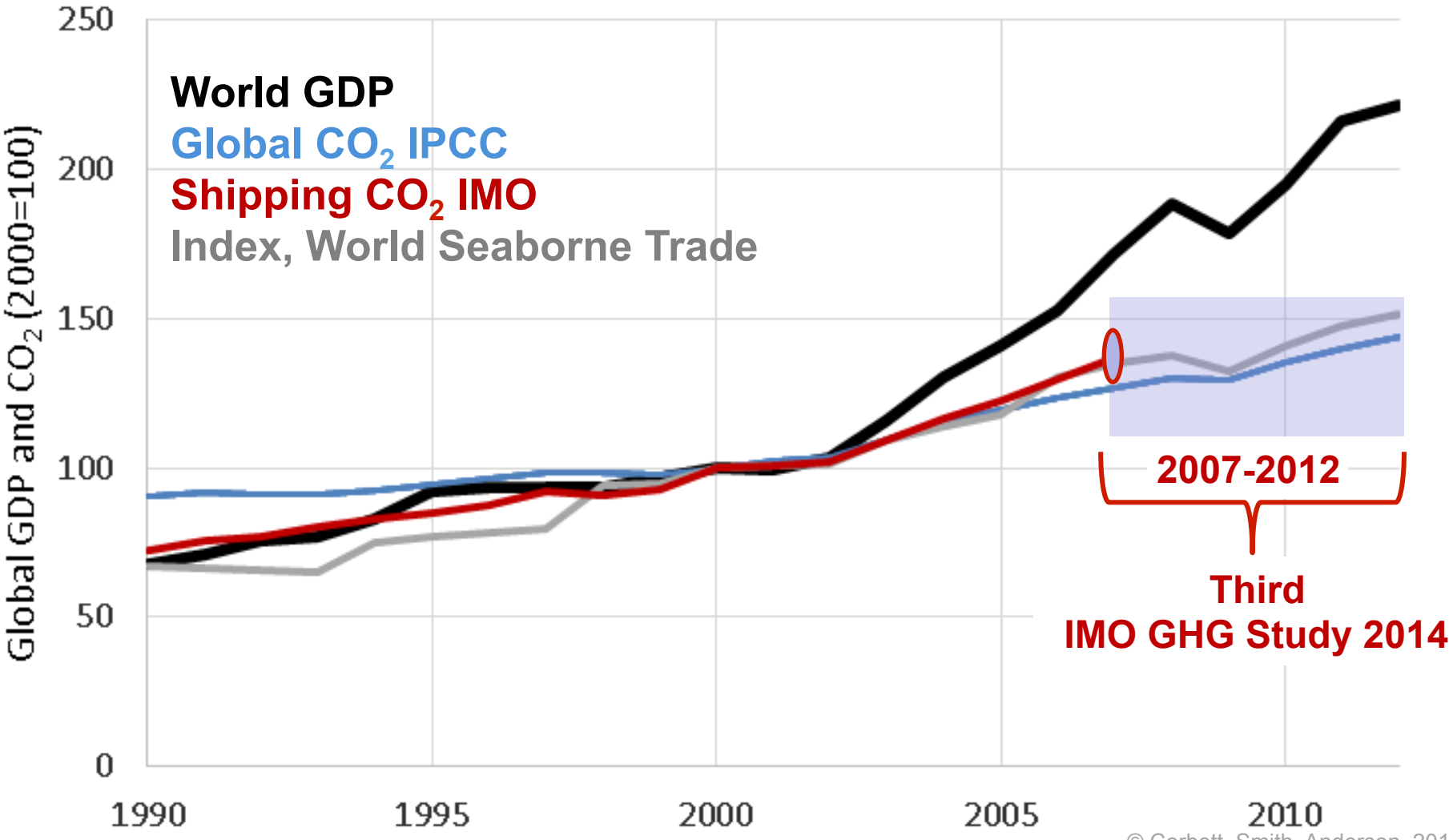
Global CO_2 and economy trends - indexed



GDP data, World Bank, http://data.worldbank.org/indicator/NY.GDP.MKTP.CD, accessed October 2014.
Global CO_2 estimates, Table 6.1 of WG AR5 2013 report, http://www.climatechange2013.org/images/report/
Shipping CO_2 estimates spanning 1990-2012, IMO GHG Studies 2000, 2009, 2014.
World Seaborne Trade, Review of Maritime Transport, UNCTAD, 2013.

Global CO_2 and economy trends – indexed



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Third IMO GHG Study 2014

OPRF Ocean Policy Research Foundation

UCL ENERGY INSTITUTE

STARCREST CONSULTING GROUP, LLC
ENVIRONMENTAL MANAGEMENT
AIR QUALITY • CLIMATE • SUSTAINABILITY

ENERGY & ENVIRONMENTAL RESEARCH ASSOCIATES

ILMATIETEEN LAITOS
METEOROLOGISKA INSTITUTET
FINNISH METEOROLOGICAL INSTITUTE

τScientific

思匯 CIVIC EXCHANGE

CE Delft

exactEarth

EVI Sustainable Solutions for the Environment

KYSTVERKET

IHS Fairplay

Marine Traffic

StarBulk

V.Ships

GEARBULK

ALMI TANKERS S.A.
Committed to operational integrity

KYLA SHIPPING

IMAREM

GASLOG

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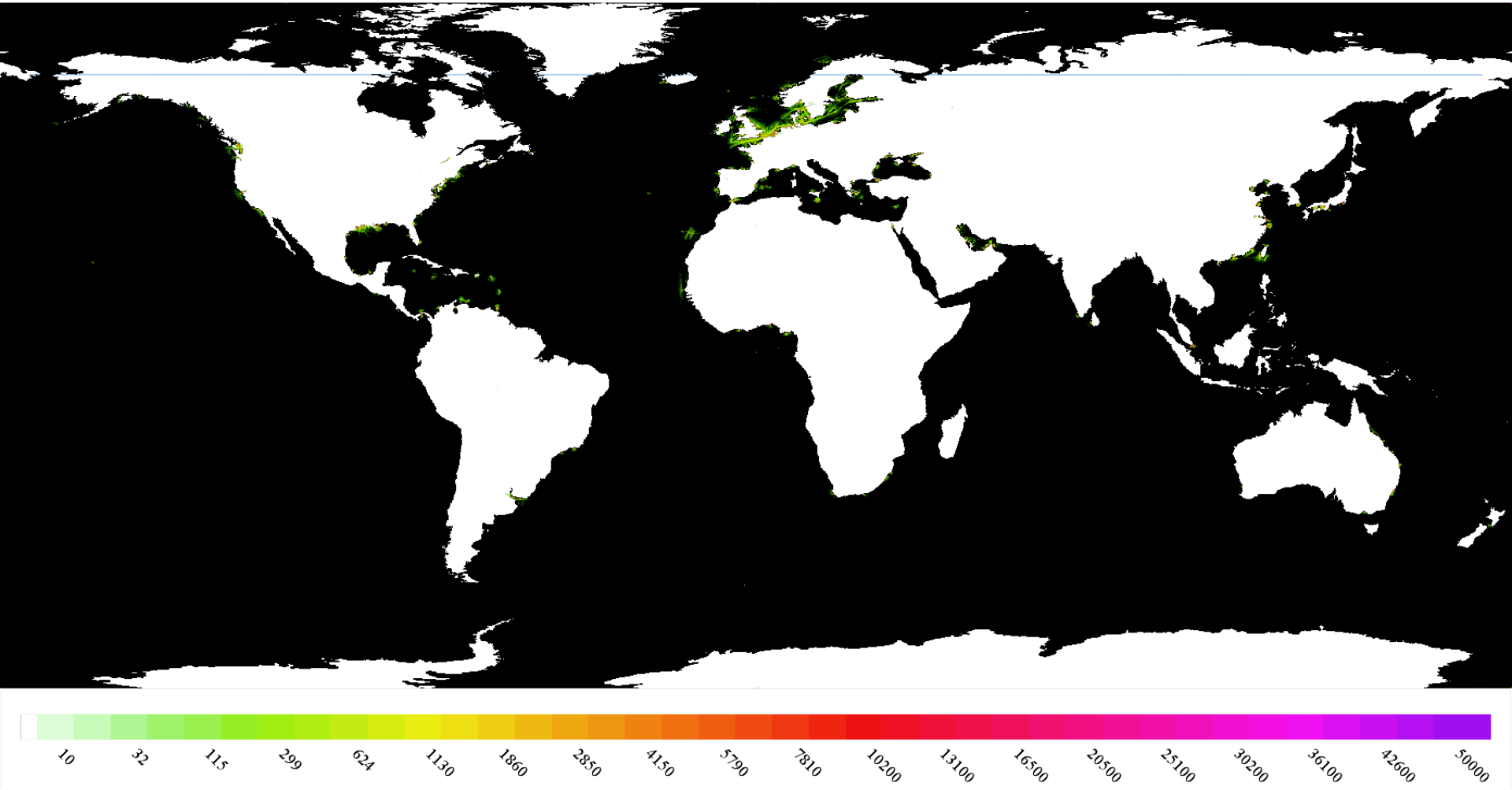
Methodology

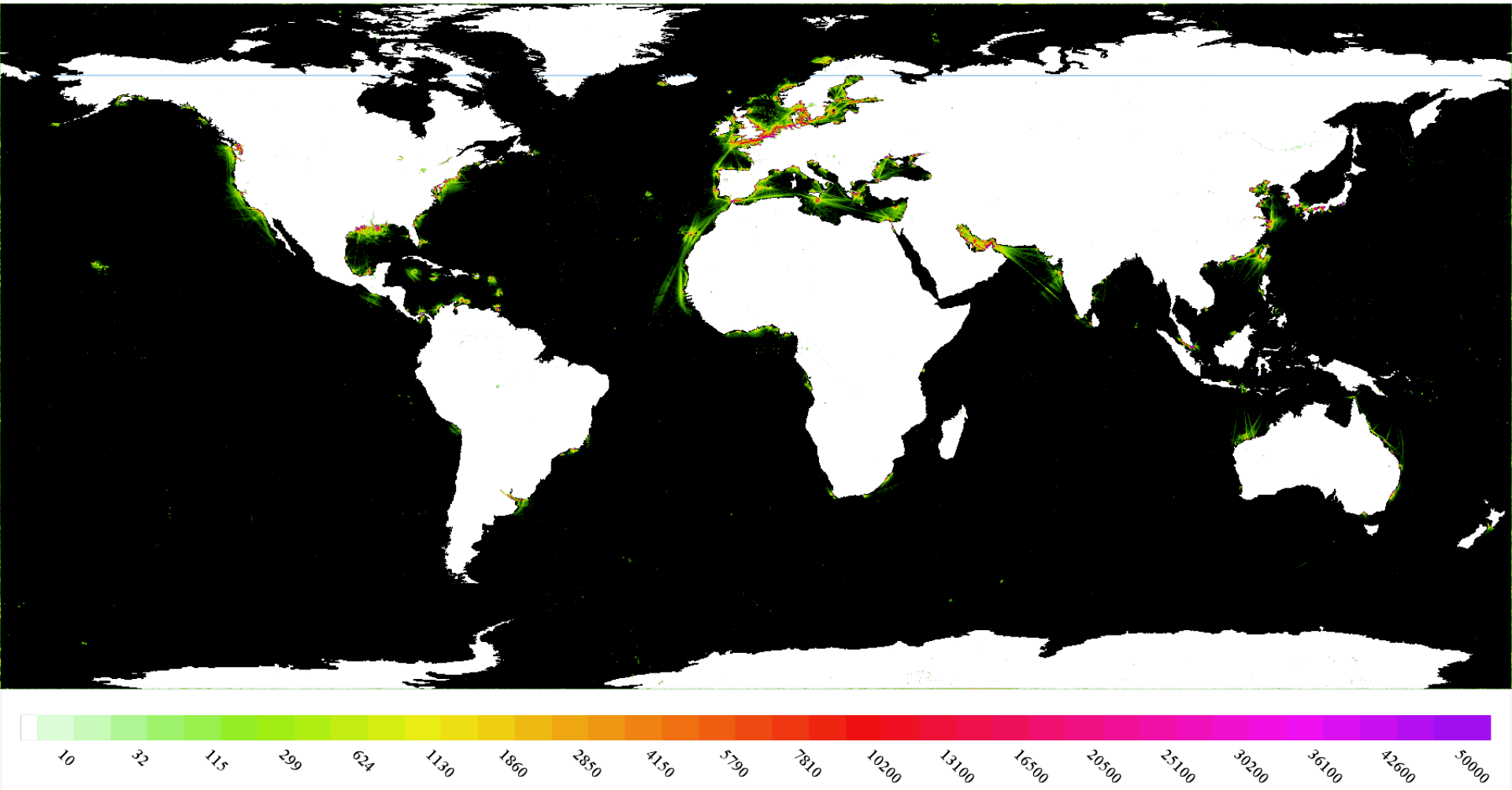
- Calculations of activity, fuel consumption (per engine) and emissions (per GHG and pollutant substances) for each in-service ship during each hour of each of the years 2007-2012
- Aggregation to find totals of each fleet
- Aggregation to find total shipping (international, domestic, and fishing) and international shipping only

Advantages:

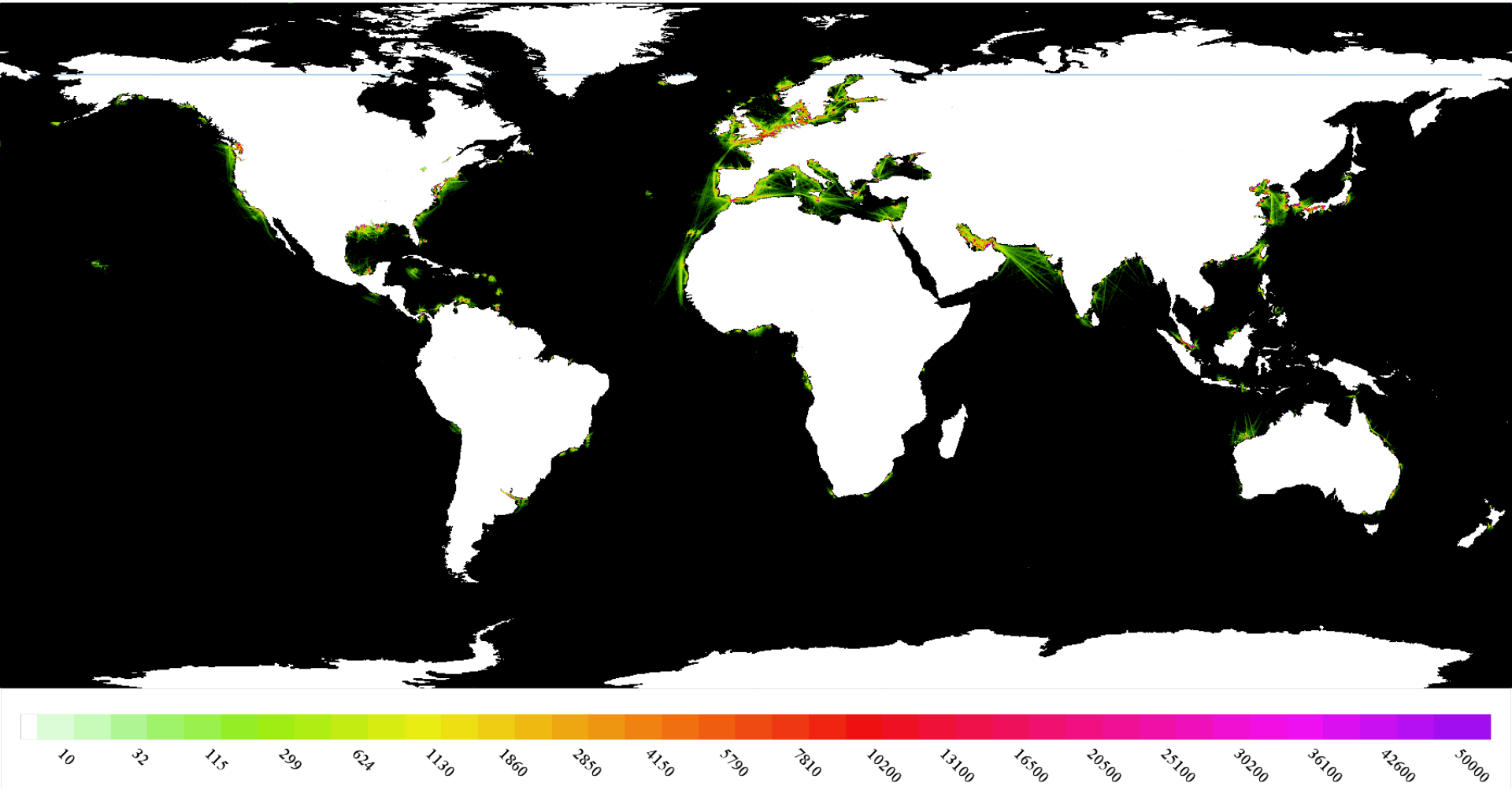
- Approach removes any uncertainty attributable to use of average values
- Substantial improvement in resolution of shipping activity, energy demand and emissions data



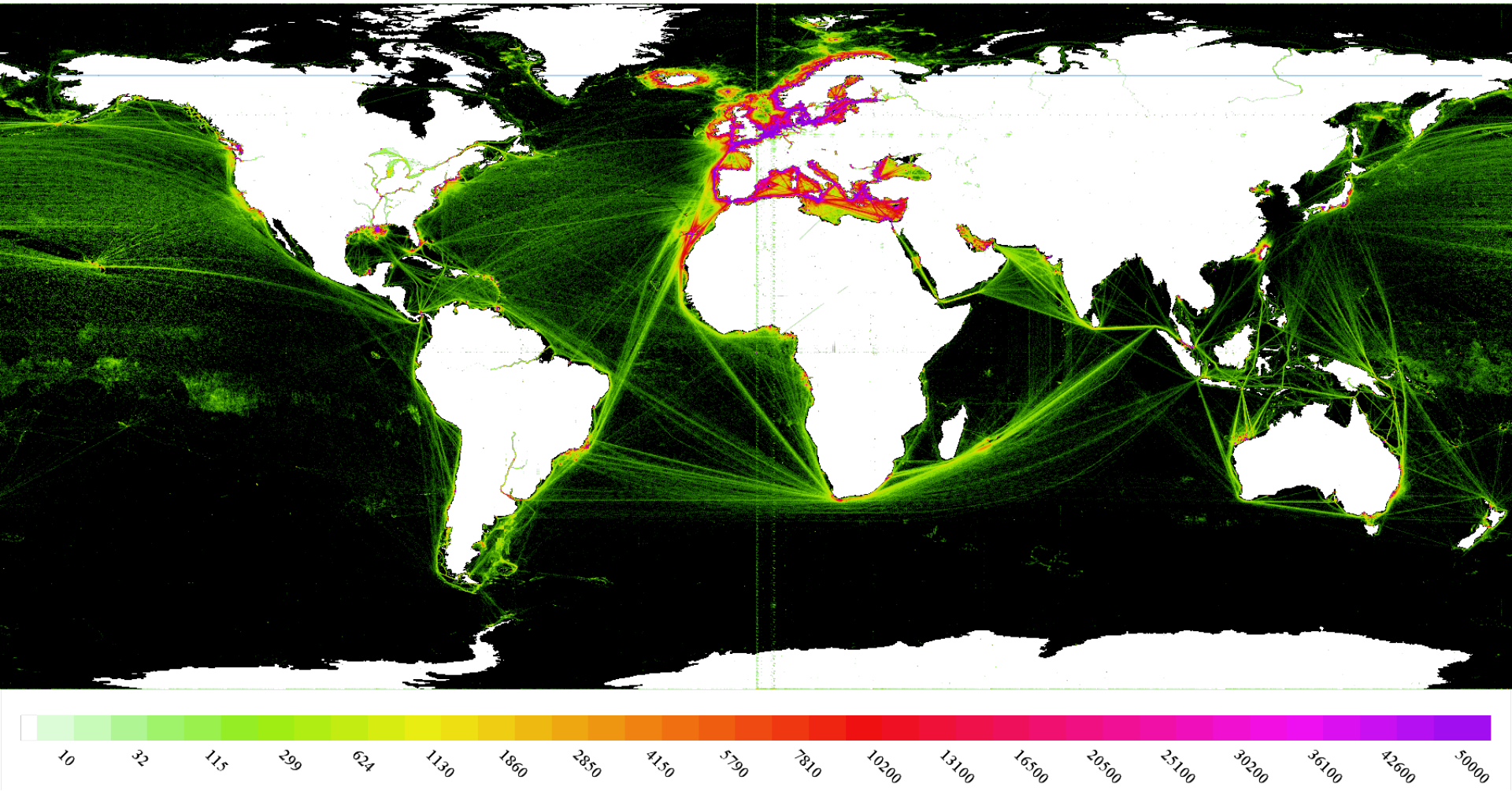
2007



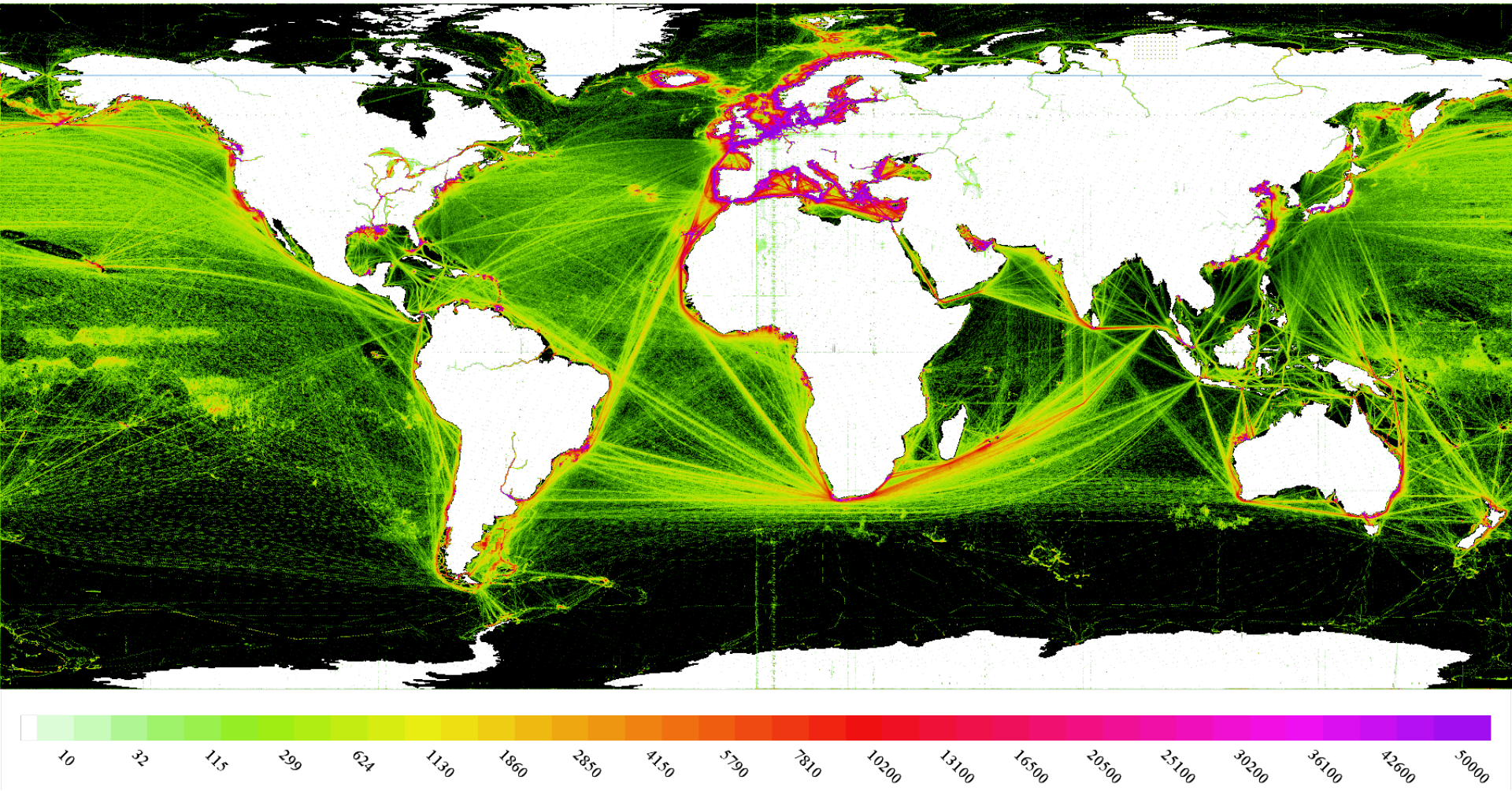
2008



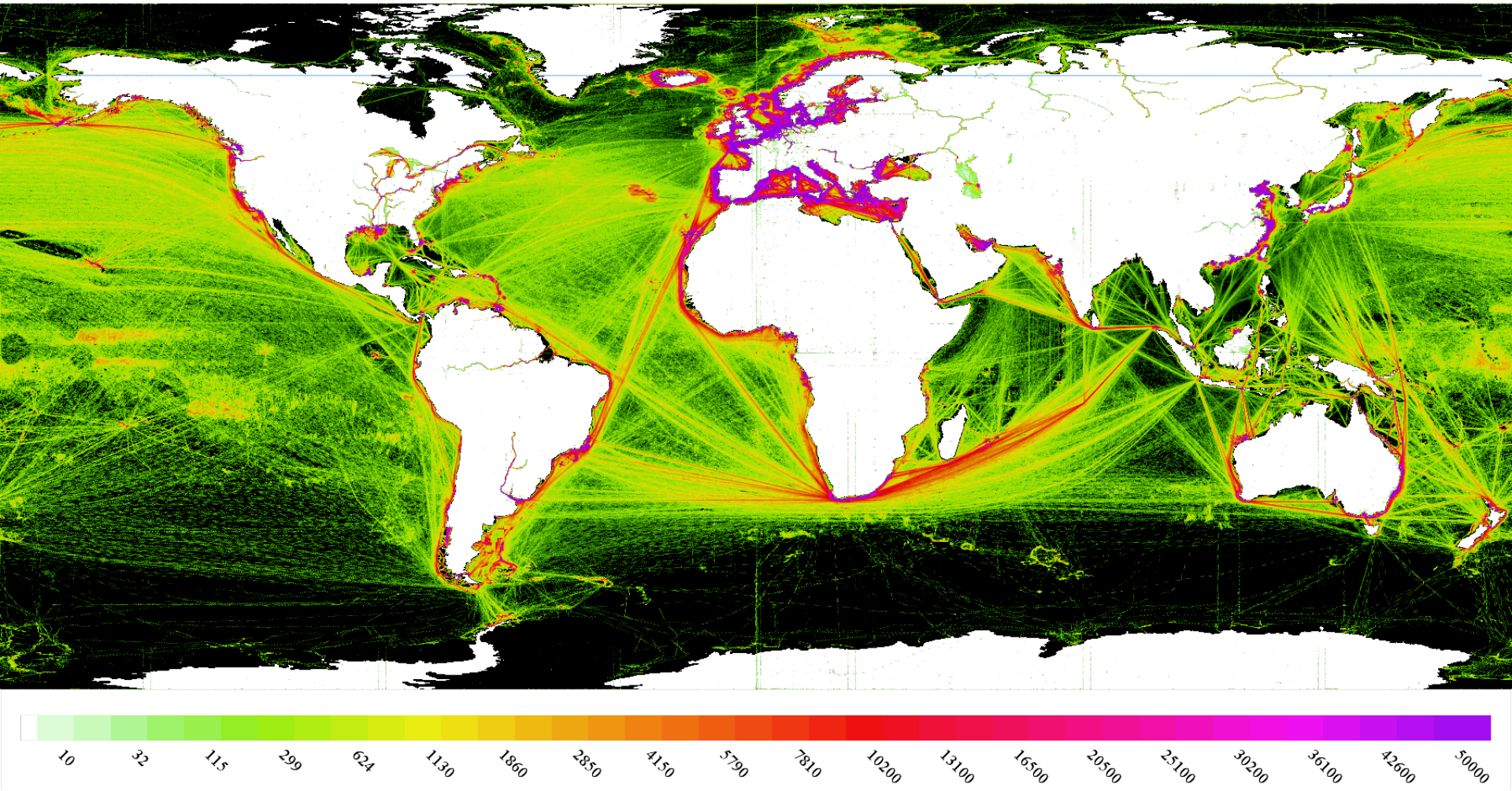
2009



2010

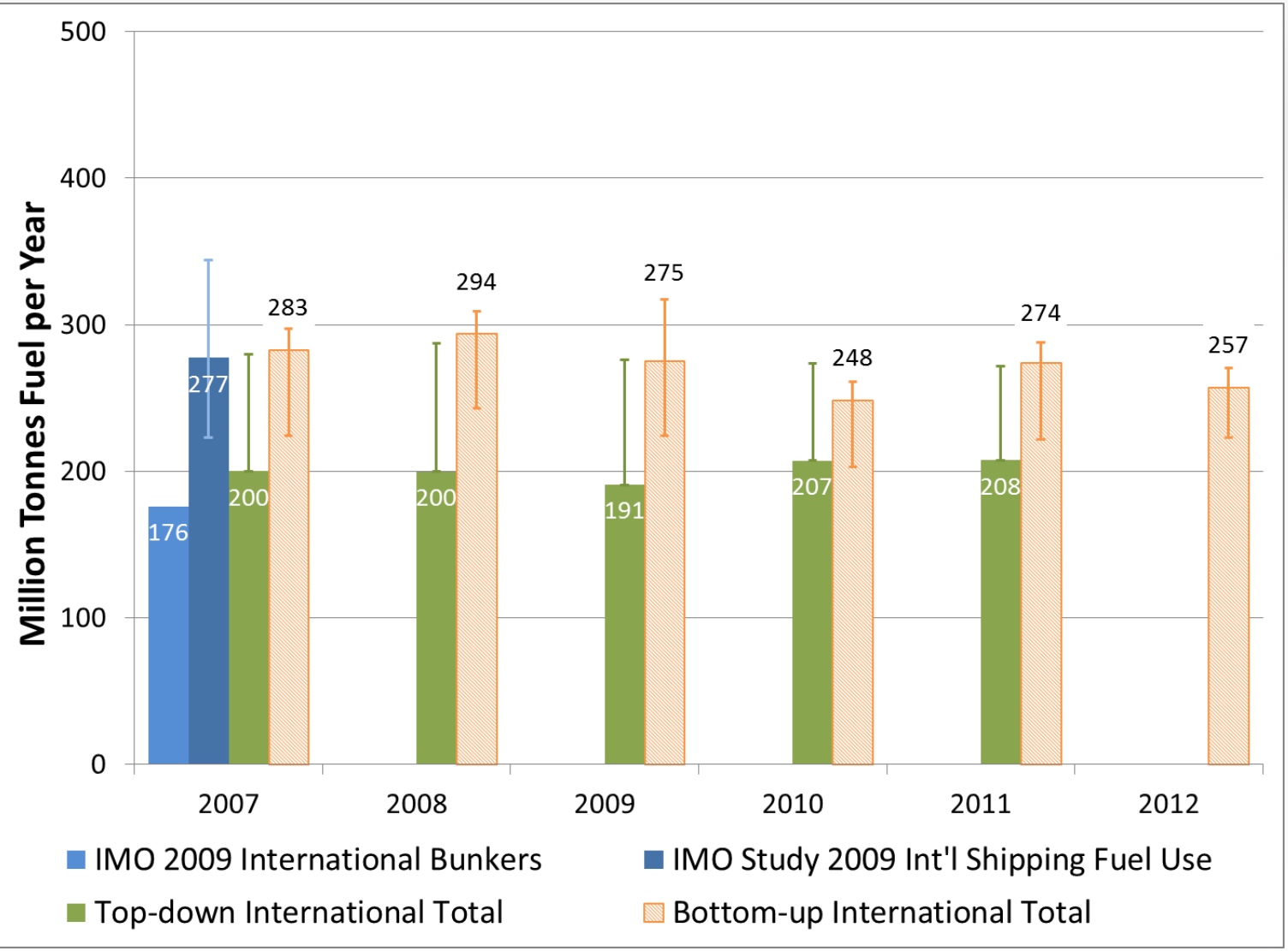


2011



2012

Top-down (TD) and bottom-up (BU) results
IMO GHG Study 2009 and 2014, international shipping



- Year 2007 best-estimates for both IMO Study 2009 and 2014 are in close agreement
- Greater differences between BU/TD than between studies

CO_2 emissions estimate 2007-2012

- Consensus CO_2 emissions estimate (tonnes) and shipping as a % share of global CO_2 emissions

Year	Global CO_2[1]	IMO GHG Study 2014 CO_2 Total shipping	Percent of global	International shipping	Percent of global
2007	31,409	1,100	3.5%	885	2.8%
2008	32,204	1,135	3.5%	921	2.9%
2009	32,047	978	3.1%	855	2.7%
2010	33,612	915	2.7%	771	2.3%
2011	34,723	1,022	2.9%	850	2.4%
2012	35,640	949	2.7%	796	2.2%
Average	**33,273**	**1,016**	**3.1%**	**846**	**2.6%**

- From 2007 to 2012 study estimates a reduction in CO_2 emissions from international shipping in both absolute terms and as a percentage of global CO_2 emissions

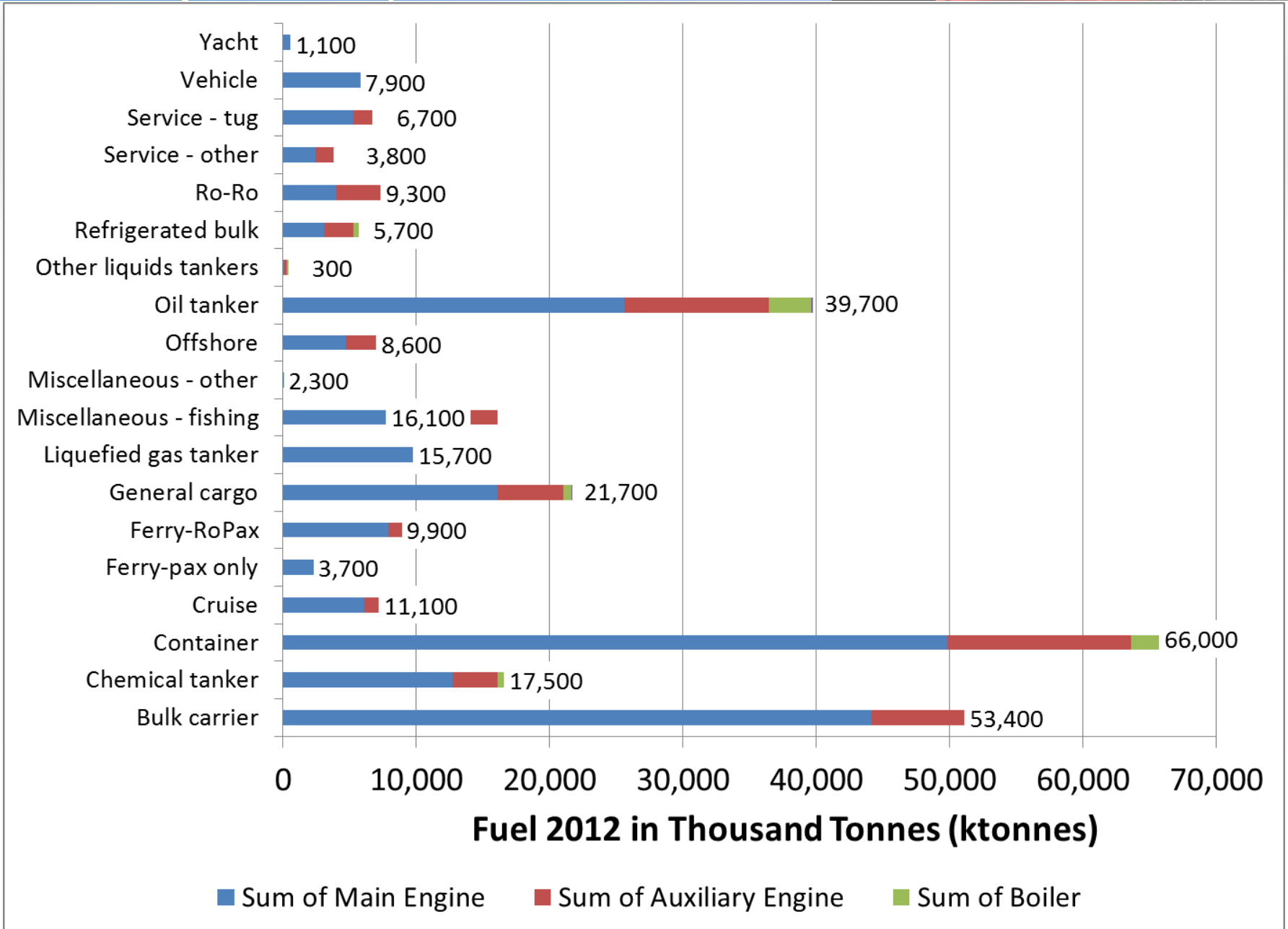
Time series of shipping's CO_2e emissions 2007-2012

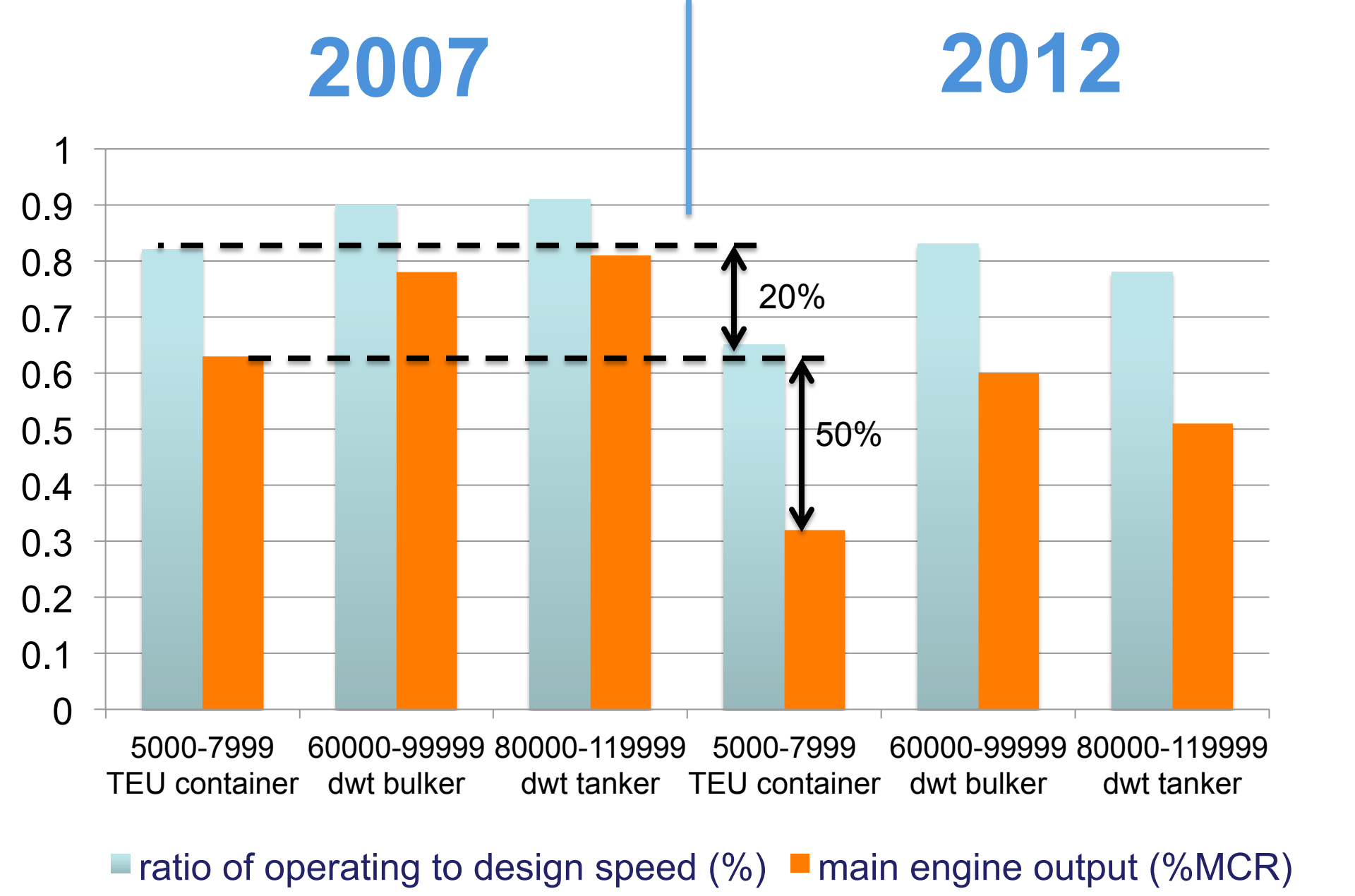
- Consensus CO_2e emissions estimate (tonnes) and shipping as a % share of global CO_2e emissions

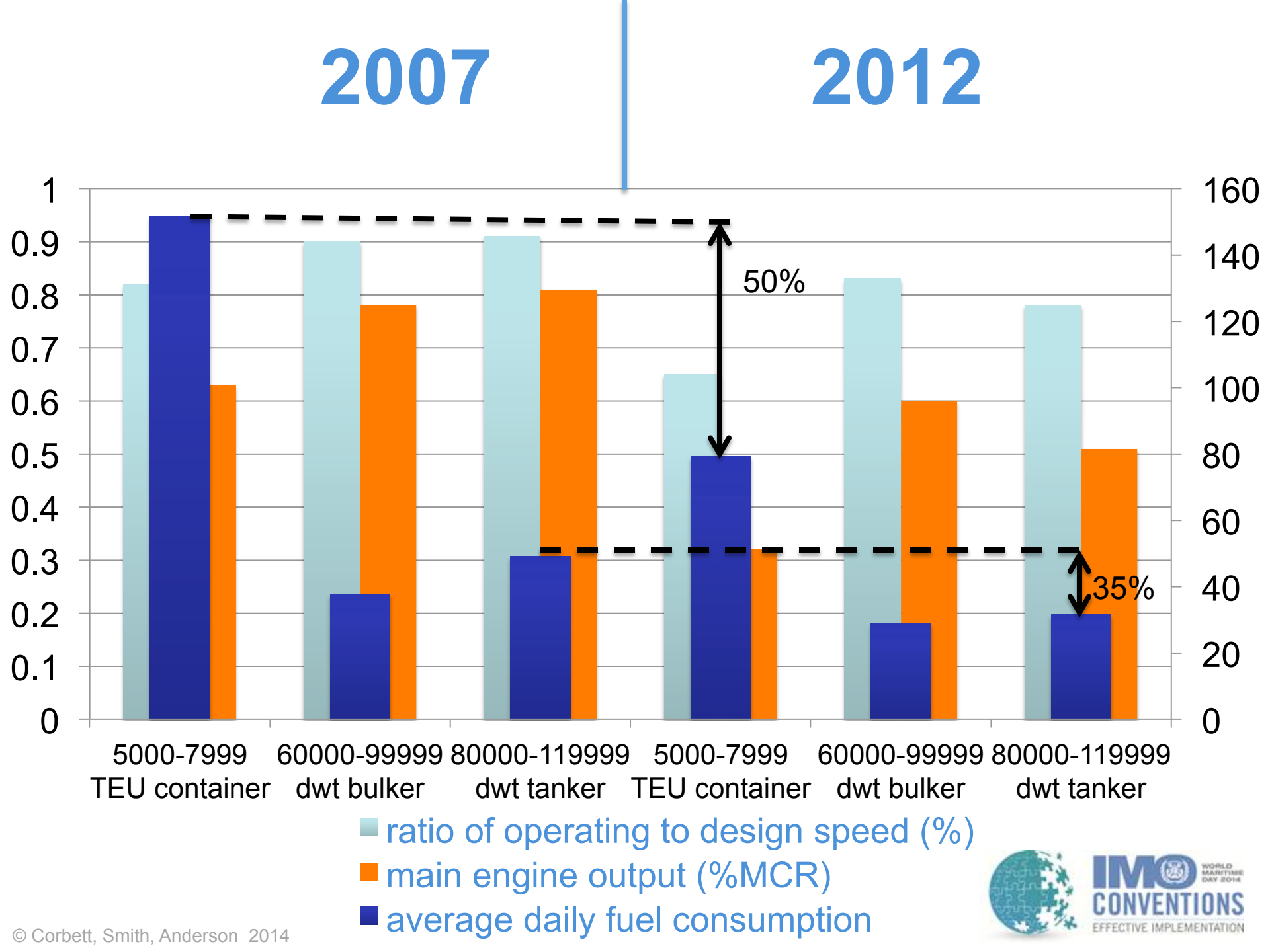
Year	Global CO_2e[2]	IMO GHG Study 2014 CO_2e			
		Total shipping	Percent of global	International shipping	Percent of global
2007	34,881	1,121	3.2%	903	2.6%
2008	35,677	1,157	3.2%	940	2.6%
2009	35,519	998	2.8%	873	2.5%
2010	37,085	935	2.5%	790	2.1%
2011	38,196	1,045	2.7%	871	2.3%
2012	39,113	972	2.5%	816	2.1%
Average	**36,745**	**1,038**	**2.8%**	**866**	**2.4%**

- From 2007 to 2012 study estimates a reduction in equivalent CO_2 emissions from international shipping in both absolute terms and as a percentage of global equivalent CO_2 emissions

Fuel consumption 2012 by ship type (bottom-up method)





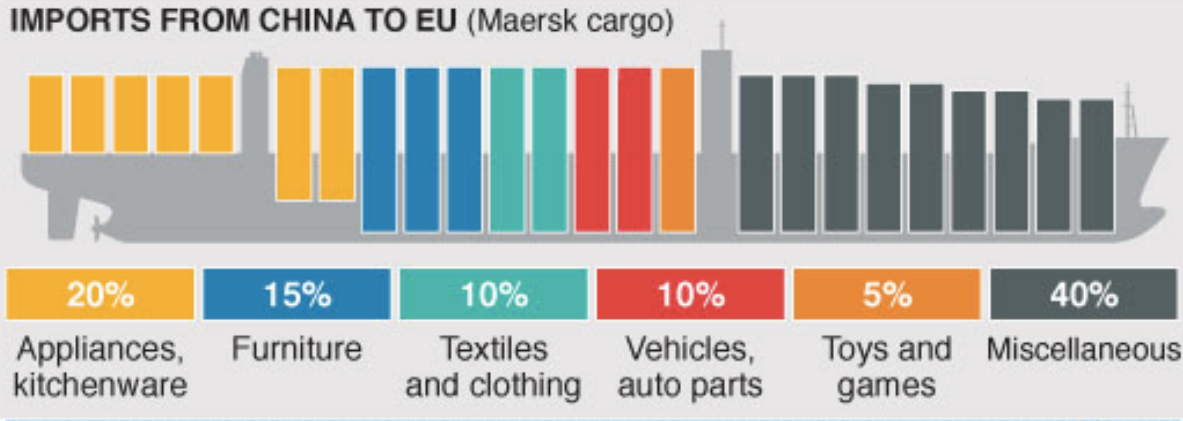


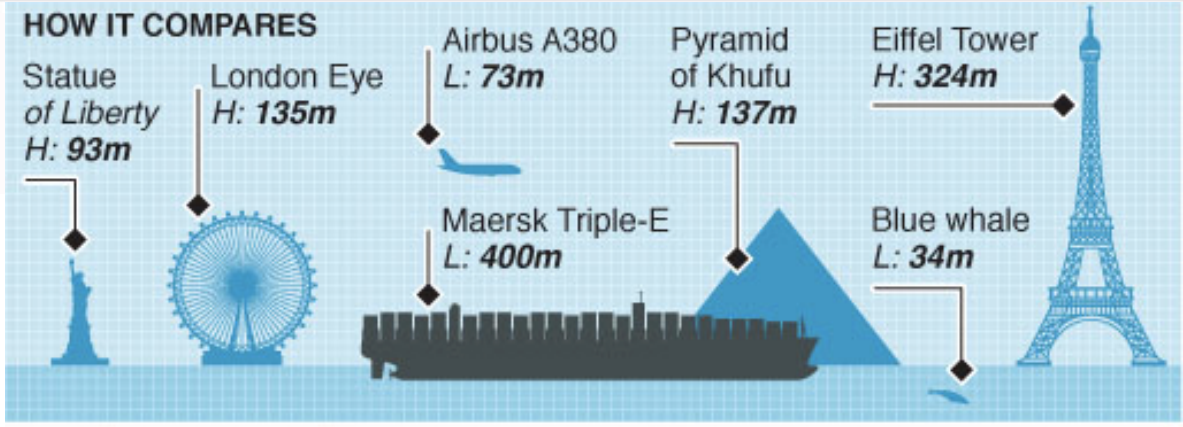
Scenarios for projections (2012 – 2050)

- 2nd IMO GHG Study 2009 projected rapid emissions increase, but since publication:
  - new set of long-term socio-economic scenarios has been developed by IPCC
  - larger & more efficient container ships have entered market
  - new emission projection methods have been developed:
    - based on transport work activity, rather than tonnes of cargo
    - taking into account non-linear relations between activity drivers (e.g. GDP) and activity (i.e., transport work)
- 3rd Third IMO Study 2014 has developed new projections

Energy efficiency of a ship

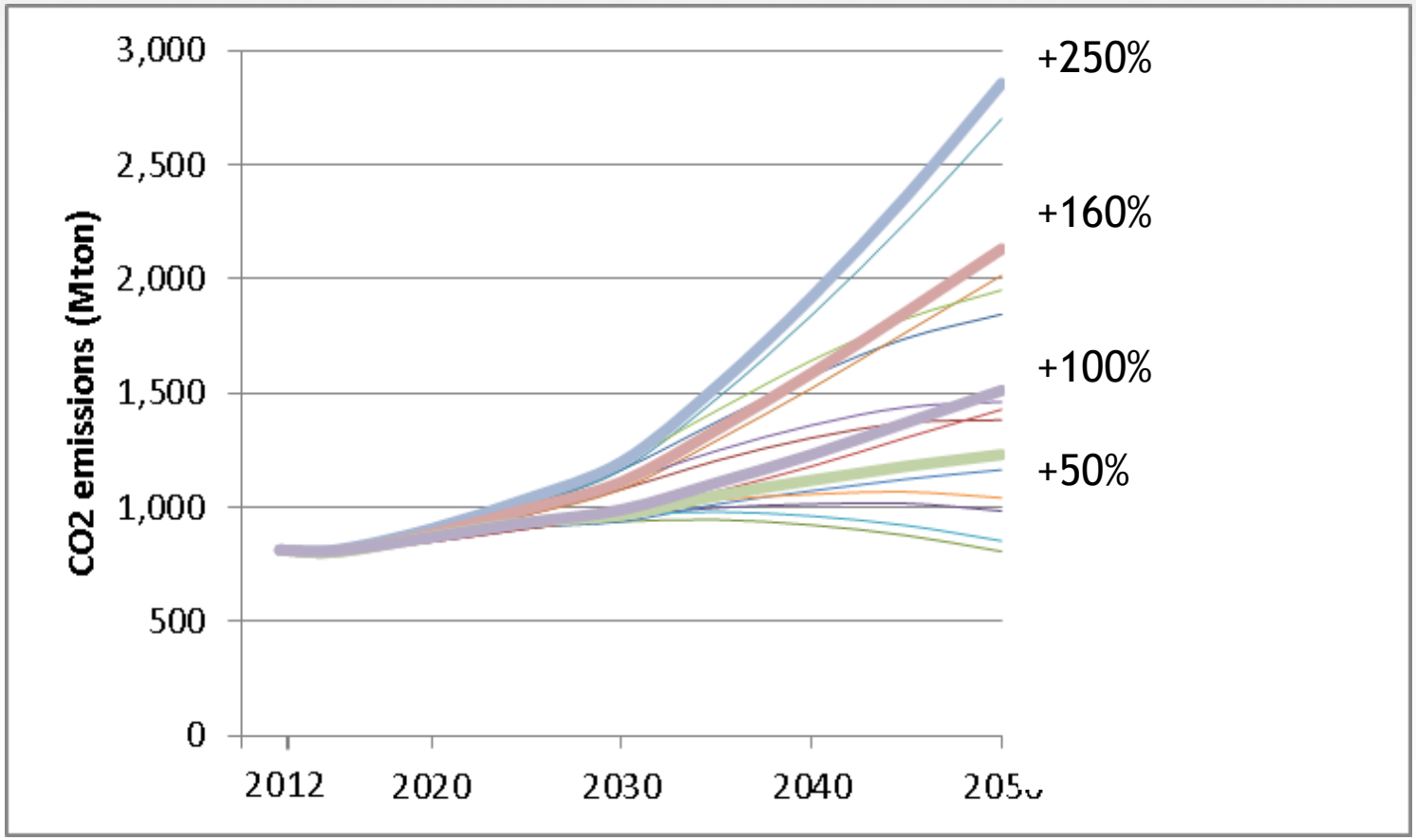
The Triple-E ship is able to move one tonne of cargo 184 kilometres using one kilowatt-hour of energy, for the same amount of energy, a Boeing 747 can transport a tonne of cargo 0.5 kilometres





CO_2 emissions projections

- **Shipping CO_2 emissions are projected to increase by 50% to 250% in the period to 2050, despite fleet average efficiency improvements of about 40%**



Future scenarios (2012 – 2050)

- Maritime CO_2 emissions are projected to increase significantly in the coming decades
- Depending on future economic and energy developments, BAU scenarios project increase by 50% to 250% in the period to 2050
- Further action on efficiency and emissions can mitigate emissions growth, although all scenarios but one project emissions in 2050 to be higher than 2012
- Demand for transport of unitized cargoes projected to increase most rapidly in all scenarios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