CRITICAL ANALYSIS OF SHIPPING ENVIRONMENTAL LEGISLATION

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“Any intelligent fool can make things bigger, more complex and more violent. It takes a touch of genius - and a lot of courage – to move in the opposite direction.”

Albert Einstein

Legislation is getting more complicated and ineffective. This must change.

“The art of economics consists in looking not merely at the immediate but at the longer effects of any act or policy, it consists in tracing the consequences of that policy not merely for one group but for all groups.” (*)

This holds true for all legislation.

(*) Henry Stuart Hazlitt (November 28, 1894 – July 9, 1993) American journalist who wrote about business and economics for such publications as *The Wall Street Journal*, *The Nation*, *The American Mercury*, *Newsweek*, and *The New York Times*. He has written 25 books on economics.

A simple idea underpins science: "Trust, but verify"

(The Economist Oct 19-25, 2013)

This presentation is mostly about verification of the effectiveness of regulatory proposals

Some don't stand up to scrutiny

Should regulations be based on:

facts or “*fiat*”?

π = 3.14159265379…

but:

- **The Bible** indicates that π **= 3** (1 Kings 7:23-26). **Also accepted by the Spanish Inquisition (1478-1834)! (*fiat* followed by blinkers despite scientific proof)**
- **Archimedes** (~250 BC) proved that **223/71 <π 22/7** (3.1408 < π 3.1429) **(first scientific approximation)**
- **Ptolemy** (~150 AD) gave a value for π of **3.1416 (better science)**
- **Zu Chongzhi,** (~480 AD), calculated that π **~ 355/113 (a fraction that goes by the name Milü in Chinese)** with a correct value for its seven first decimal digits, this value of π **= 3.141592920... (even better science)**
- **The Indiana House of Representatives** unanimously voted in **1897** that π **= 3.2**!!! **It passed the first Senate hearing. On the second hearing it was postponed indefinitely!.... by the Indiana Senate** (thanks to Prof. C.A. Waldo of Purdue University who was visiting Indianapolis) **(attempted *fiat*)**

Nature's laws are always better thought out than man's.

“Laws are like sausages, it is better not to see them being made”

Otto von Bismarck

“In many ways this quotation is offensive to sausage makers, their process is better controlled and more predictable”

New York Time, December 4th, 2010

Really, what proportion of IMO or other shipping regulators have any seagoing experience or have been involved in commercial shipping, the industry they want to regulate?

You cannot legislate shipping with people “sailing desks”.

Chronology of basic environmental legislation

(A bureaucrat's paradise)

1992 Rio De Janeiro, Framework of UNFCCC
1995 Berlin, 1st Conference of UNFCCC
1997 Kyoto, Kyoto Protocol Concluded
2007 Kyoto Protocol enters into force (13 years later!)

Since 1992 the weather has greatly deteriorated.

22 years have been spent with no visible positive result.

We don’t seem to have got it right.

Example 1:

European Development of Short Sea Shipping

Transport is about time and cost

Transport by ship is slower but environmentally friendlier. Transport by road is faster.
Delays represent a cost element to the receiver.

Goal: **To move cargo to ships to reduce emissions**
Results:

Year	Road	Rail	Sea	Inland w/w	Pipe	Air (*)
1995	42.1%	12.6%	37.5%	4.0%	3.8%	0.1%
2010	45.3%	11.0%	36.8%	3.7%	3.1%	0.1%

The **increase in total emissions** between **1995** and **2010** represents **36.468** mtons of additional CO_2 when estimated for **2010 emission figures**. This represents about **1.270** Panamax bulk carriers trading worldwide for a whole year (total Panamax BC fleet 1.975 ships)!! **This despite: Marco Polo, Motorways of the Seas, TEN-T and other European projects costing a lot of tax payer Euros.**

- **If overall economic implications of regulations are not taken into account they will fail.**
- **The new SOx regulation will further increase road transport hence emissions.**

(*) Data from E.U. Statistical Pocket Book 2013

Example 2:
Legislating on flawed shipping assumptions

Second IMO GHG Study 2009, paragraph 5.25, page 47 says:

"…and it is particularly important that they do not have incentives to contribute to inefficient behavior. As an example of the latter, ship upgrades and major maintenance activities depend on the high-level strategies of the operating companies. In cases where ships are operated by a different company than the commercial operator, **the technical operator may tend to minimize time in dry dock (to minimize off-hire cost) and other maintenance costs (e.g., painting costs) while at the same time handing the fuel bill to the commercial operator**."

This statement in the Study is incorrect and misleading.

Each ship is evaluated by the time charterer based on the speed and consumption warranties given by the shipowner and is **offered a daily rate for a specific trip or period on this basis.**

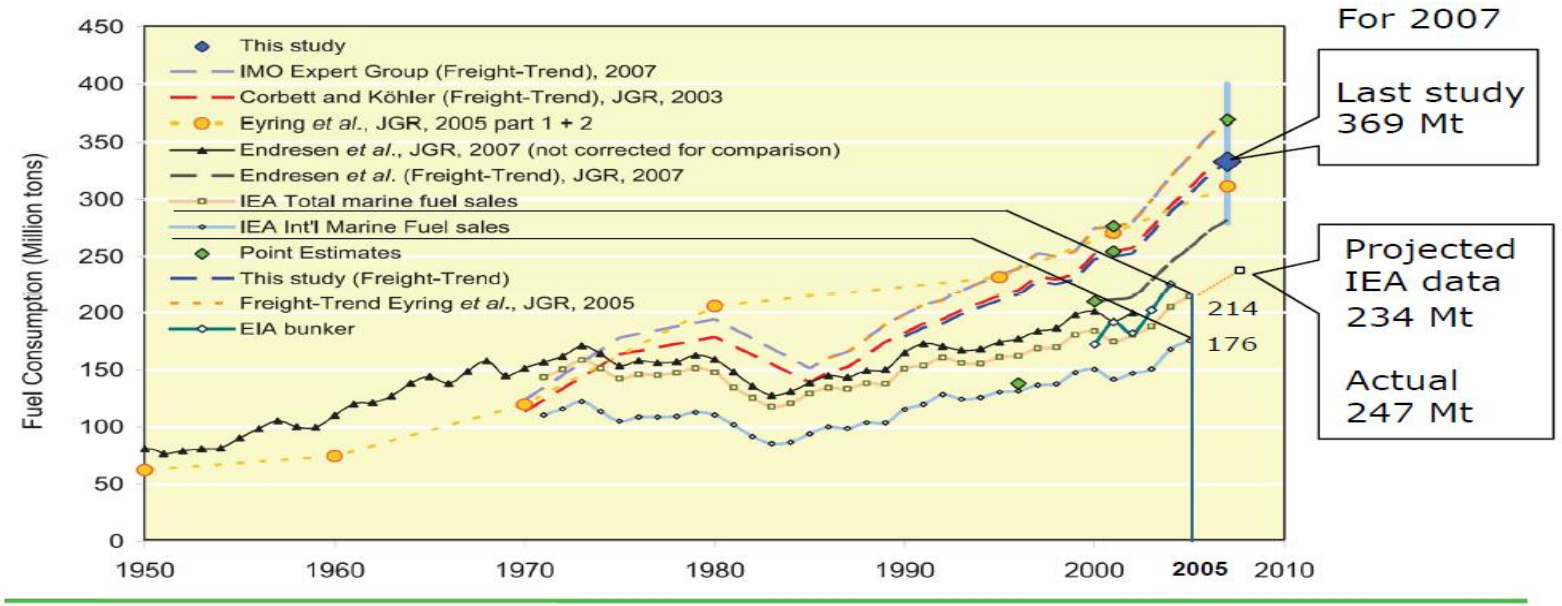
The higher the consumption the lower the T/C rate *ceteris paribus.*

No commercial operator will accept practices leading to inflated fuel bills above the ship's speed/consumption warranties.

Charterers will successfully recoup ship overconsumption or under performance through legal means.

Example 3:
Bunkers consumed

IEA statistics show much lower consumption than estimates based on activity based, bottom up approach. Where did the additional bunkers of activity based estimates come from?



Source: IMO, Second IMO GHG study, 2009, p.175.

International Energy Agency

Therefore shipping emitted 1.8% of world emissions, not 2.7%

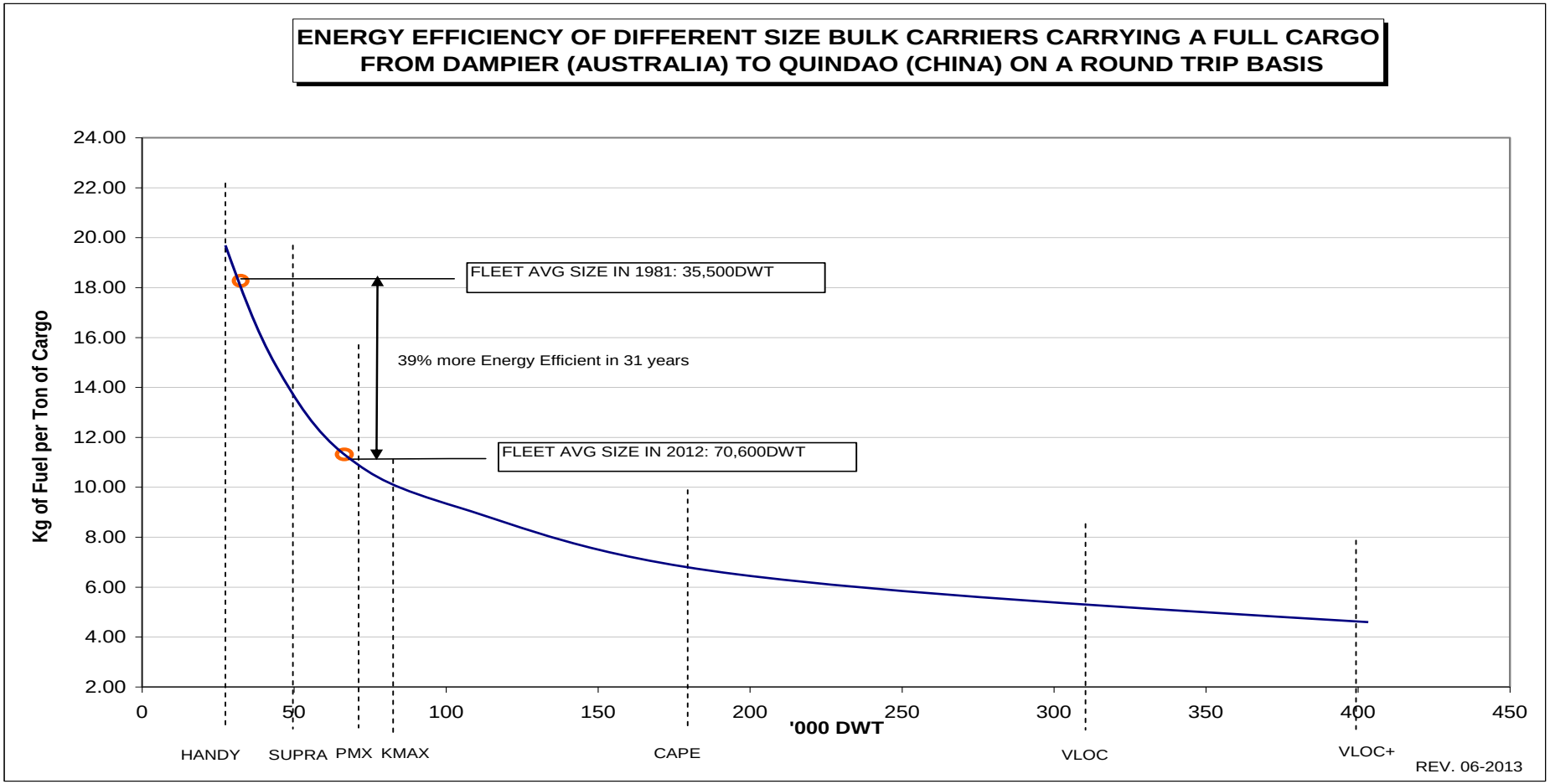
Pertinent question for the discrepancy:

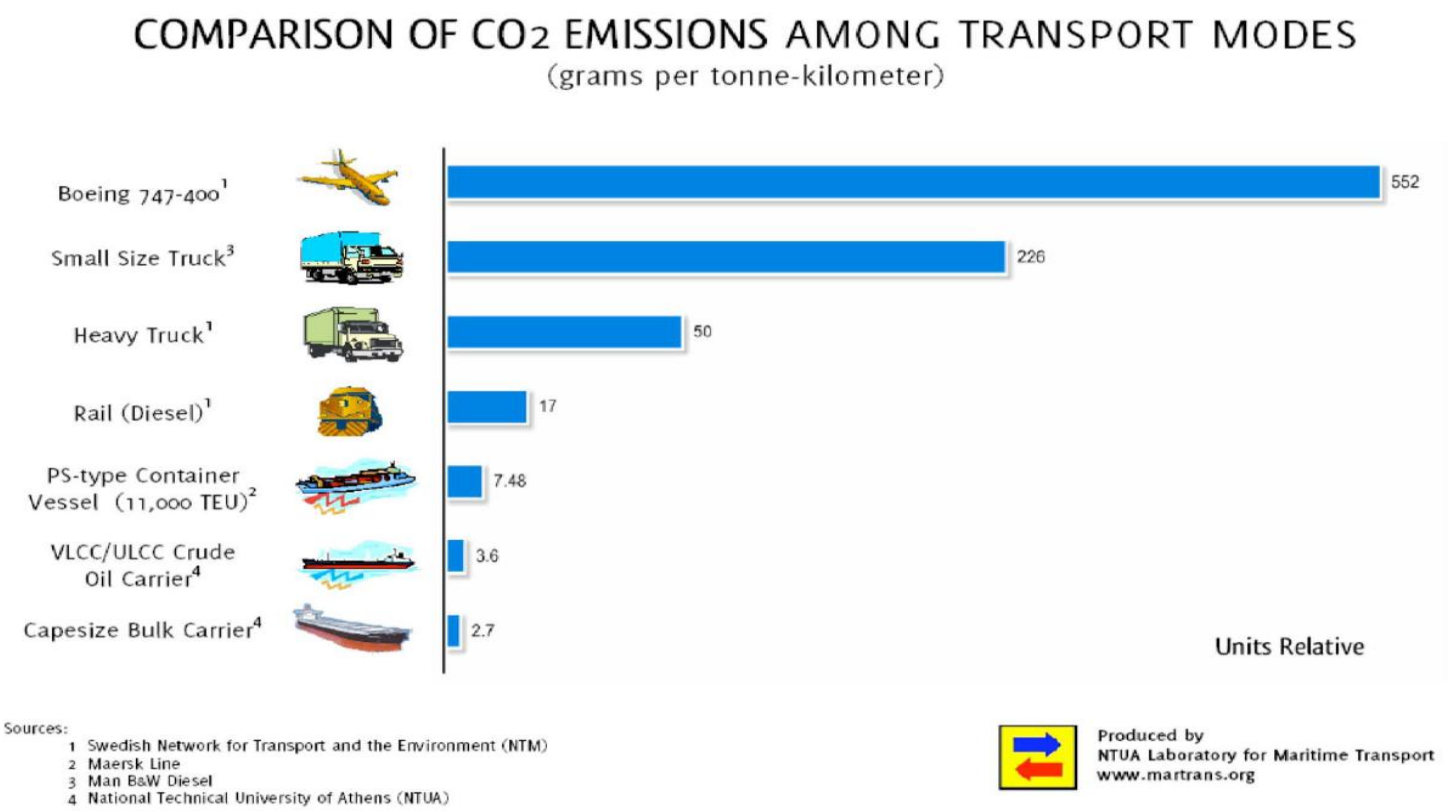
Question: Where does the 50% more fuel above the IEA estimates made by expert "studies" come from? To be credible, studies based on simulations and assumptions must identify rogue oil wells and refineries to explain their discrepancy. "Leakage" from more expensive (taxed) products sold ashore subsequently to be on sold to tax free shipping make no financial sense.

If anything, "leakage" from bunkers allocated to be sold to shipping but eventually on-sold to on land consumers is not only probable but well documented. Therefore even the IEA estimates, as well as bunker receipts, very probably OVERSTATE ship consumption .

Larger ships are more energy efficient. Over the last 31 years energy efficiency of the average ship in the dry bulk fleet improved 39% from the increase in ship size alone or 1.26% PA.

Technological improvements increase efficiency further.





A Boeing 747-400 burns 204 times more fuel per tonne-km than a Cape size bulk carrier

Example 4:

Regulation 14-Annex VI MARPOL increases global warming, violent weather patterns and accidents

SOx Aerosols create clouds, last only few days and cool the atmosphere (*)

NOx Destroys methane lifetime. Methane is a GHG 23 times more potent than CO_2 (*)
Reducing engine's NOx will increase CO_2 emissions

Low sulfur fuel production emits 15% more CO_2 (IPIECA)
Cat fines increase accidents (DNVPS)

With this regulation shipping emissions' cooling effect has been reduced from ~350 years to about ~70 years.

SOx should be regulated only in ECAs – Not globally

(*)Sources:
Environmental Science and Technology-Viewpoint, The Economist, UK MET office, National Science Journal, Cambridge and Erasmus Universities (FT July 25th, 2013)

How emissions affect the climate

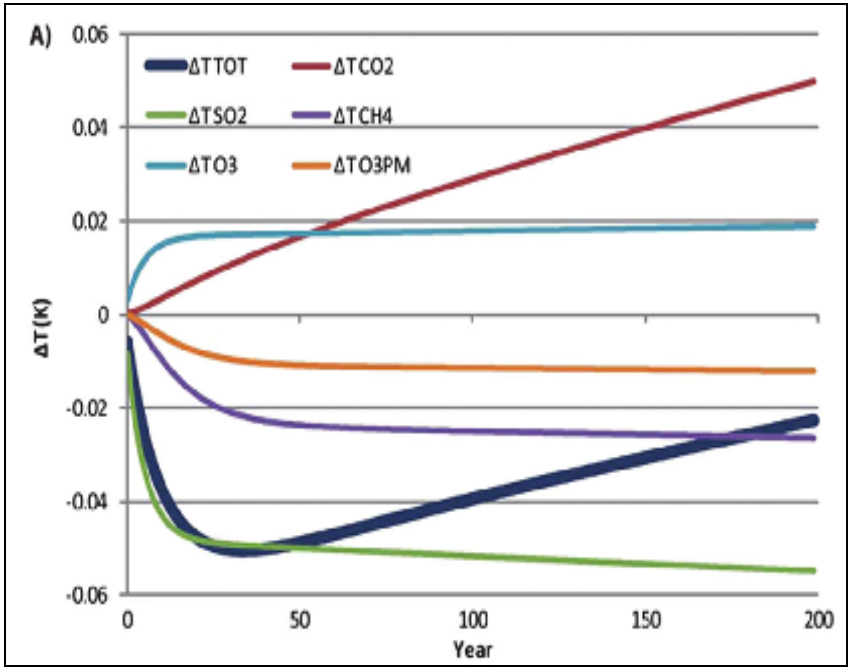
Aerosols such as sulfates and soot are man made and **last only a few days. Clouds grow on aerosols. Rain comes from low flying clouds** which also **reflect sunlight** but **let heat through.** This cools the atmosphere (The Economist October 5-11, 2013).

ENVIRONMENTAL Science & Technology-Viewpoint article titled "Shipping Emissions: From Cooling to Warming of Climate and Reducing Impacts on Health by: Jan Fuglestvedt, Terje Berntsen, Veronika Eyring, Ivar Isaksen, David S.Lee, Robert Sausen, which states:

"…ship emissions of sulfur dioxide (SO_2) cause cooling through effects on atmospheric particles and clouds, while nitrogen oxides (NOx) increase the levels of the greenhouse gas (GHG) ozone (O_3) and reduce the GHG methane (CH_4) causing warming and cooling, respectively." (Methane is a GHG 23 times more potent than CO_2)

According to the authors: **"The long term warming due to CO_2 will lead to a switch from net cooling to net warming after ~ 350 y. With the reduced SO_2 emissions the net temperature effect switches to warming much earlier after ~ 70 y."**

A



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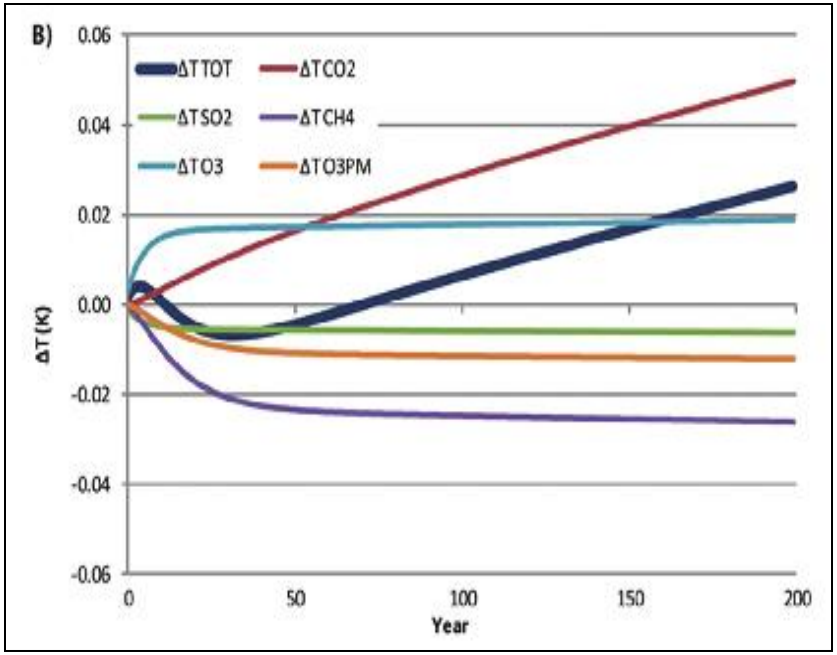


Global mean temperature changes due to emissions of CO2 and SO2 and NO*x*-induced changes in O3, CH4, and O3PM (the latter being the primary mode ozone controlled by CH4), and the total temperature change (Δ*T* TOT). Plotted are (A) the response to a scenario with all emissions kept constant at year 2000 levels and (B) the responses to a scenario with SO2 emissions reduced by 90% with all other emissions at year 2000 levels.

Now shipping will soon tend to <u>increase</u> global warming!

Arctic melt is "economic time bomb"

Costs to world estimated at $60 trillion (FT July 25th, 2013)

The Arctic has been melting twice as fast as the rest of the world. This will "…hasten thawing of permafrost beneath the East Siberian Sea off northern Russia **believed to contain vast deposits of methane…a greenhouse gas some 20 times more potent than carbon dioxide**…". (Research is published in The Nature Science Journal).

Arctic ice regulates "…ocean currents and the climate. As it melts it is likely to cause changes that will damage crops, flood properties and wreck infrastructure around the world, according to research by academics at the UK's University of Cambridge and Erasmus University Rotterdam in the Netherlands."

NOx reduces methane life time. Methane is a GHG 23 times more potent than CO_2. Reducing engine Nox also increases CO_2 production by about 5% or more. Is it wise to reduce it? NO

Extreme weather patterns over the past few years prove it.

Reduction of SOx increases severe hurricane activity

The **U.K. Met Office** paper "Aerosols implicated as a prime driver of twenthieth-century North Atlantic climate variability", September 2011, **clearly indicates that the reduction in sulfur aerosols over the Atlantic Ocean has increased water temperature, increasing the severity of hurricane activity, Sahel and Amazon droughts and have variously influenced the whole planet**.

Reducing the sulfur content of bunker fuels outside SECAs will exacerbate the problem.

From the above, it could be said that presently enacted regulations represent inadvertent geo-engineering increasing violent weather patterns.

To create low sulfur fuel you emit more CO_2

IPIECA submission to IMO (BLG 11/5/14, 9th February 2007) which states:

"Recent studies suggest a net increase in CO_2 emissions (for the production of low sulfur distillates) equivalent to about **15%** of current refinery emissions." **Thus increasing global warming**.

Low sulfur fuel is also more expensive, promoting modal shift to more polluting forms of transport.

Is low sulfur fuel safe? NO

Demand for more low-sulfur fuel for use in Emissions Control Areas (ECAs) will add to bunker quality risks, according to Gunnar Kjeldsen head of DNV Petroleum Services (DNVPS) in Fujairah. (Source: Seatrade Global and Lloyd's List Sept 23, 2013)

Engine damages exceeding $1 m have been recorded from **excessive engine wear caused by "cat" fines (Catalytic fines) in fuel oil.** "Cat" fines are used to convert large hydrocarbon molecules into lots of smaller molecules in order to create fuels like diesel from crude oil through catalytic cracking. Production in the refineries may lead to "cat" fines concentrations in the fuels. This creates **disparity between the quality of the fuel recommended by engine manufacturers, therefore required for ship engines, and that provided by refineries**. **This is dangerous for safe navigation. Refineries remain reluctant to absorb the costs involved in supplying safe fuel at the recommended low sulfur level.**

Legislators would not let such problems occur to aviation fuel. If they want ships to burn low sulfur fuel, **they should insist that refineries produce fuel that is up to the specifications of the engine makers so that it is safe for use.**

Example 5:
Ballast water treatment

Ocean currents move a million times more water all over the world than tankers and bulk carriers.

By now nearly all species have been transported all over the world, have created colonies and multiply.

They are all by now indigenous nearly everywhere.

Ballast water exchanges in deep waters have proved effective and are adequate.

Ballast water treatment

(It is being legislated in order to stop the proliferation of Non Indigenous Species)

Ocean currents move thousands of trillions of tons of sea water yearly. There are also local currents. Even the Bosporus has currents. These currents transport living species worldwide which stay and multiply where conditions are favorable.

It is estimated that the Gulf Stream gradually increases from 30 Sv* in the Florida current to a maximum of 150 Sv* South of Newfoundland. The Antarctic Circumpolar is about 125 Sv*.

These currents transport between **9.4×10^{14} to 4.7×10^{15} cubic meters** of water per year,

Bulk carriers and tankers transport only about **4×10^{9} (4 billion) cubic meters of water** per year. **Nearly a million times less than sea currents.**

(*) 1 Sv (Sverdrup)=1 million cubic meters/second

Ocean currents transport sea life
(NOAA)*

"Currents are important in marine ecosystems because they redistribute water, heat, nutrients, and oxygen about the ocean. **At the same time, currents inevitably sweep over and carry off living organisms.**"

"Although many sea creatures are powerful, efficient swimmers, **many others are ungainly or even immobile**. **For these animals, currents could offer a free ride**. **Corals and sponges**, for instance, are attached to the bottom as adults, but when they reproduce, **they release volumes of planktonic larvae into the water column. These tiny creatures are free to "go with the flow" and could be carried long distances**. This could allow individuals to escape overpopulated areas with too much competition for resources, and allow the species **to spread into and colonize new habitat."**

"Once the juveniles settle down, currents will continue to bring other plankton and organic debris their way, providing a steady supply of food."

(*) National Oceanic & Atmospheric Administration (U.S. Dept. of Commerce)

An ineffective and costly regulation

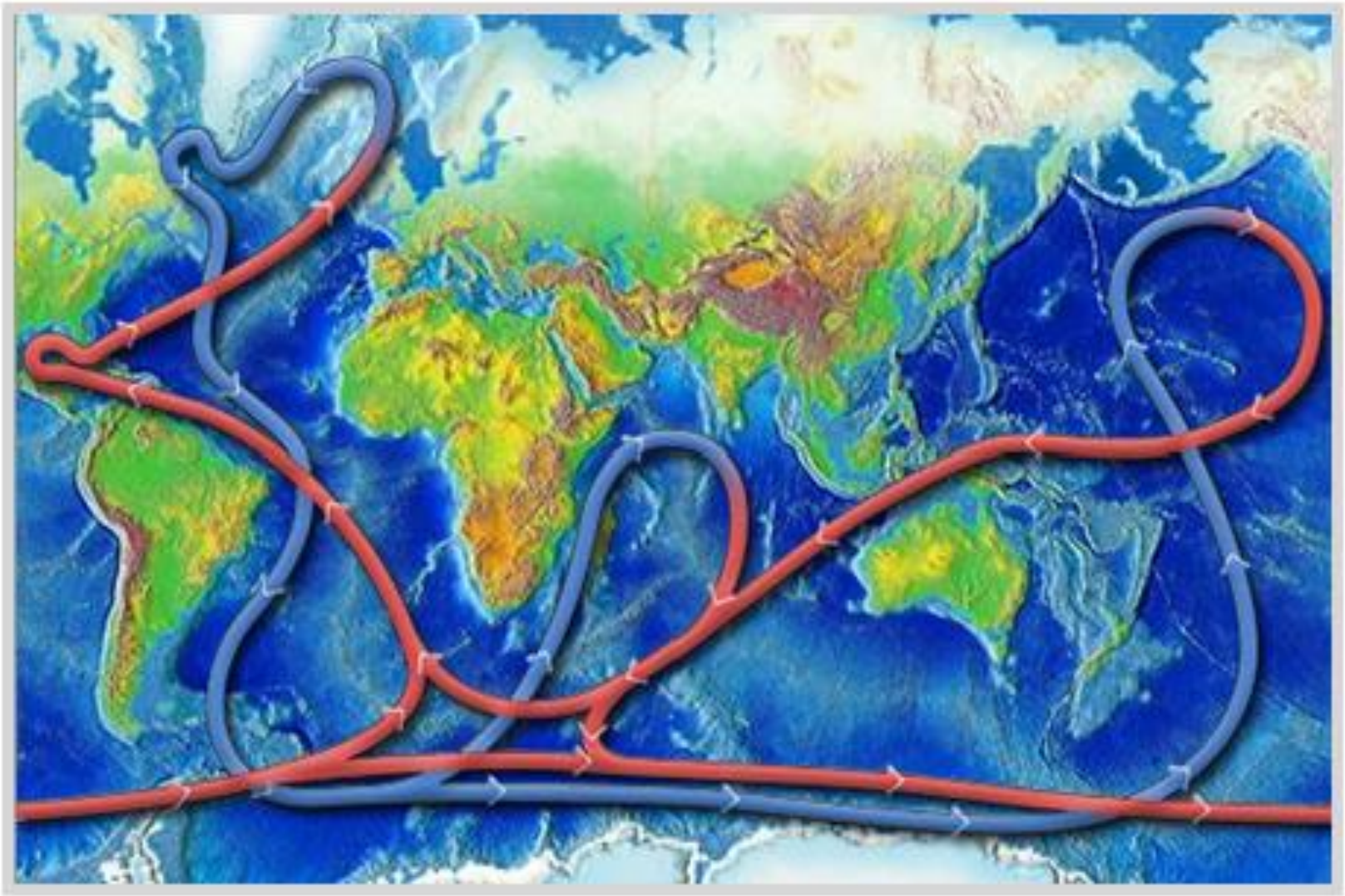
Water ballast carried and deposited worldwide by bulk carriers and tankers is additional to the very much larger volumes transported by sea currents. These transport methods have already created large colonies of **"Non Aboriginal Species"** worldwide. Much like Dutch-Americans, German-Americans, Greek-Americans, European-Americans and others, sea life has migrated over the years in sea currents and ships' ballast water and is already established where it ended up and has been multiplying for "generations". **Therefore these species have already become "naturalized" to those environments and by now have become "Indigenous".**

It is already well known that in the last decades the **Mediterranea**n already has fish and other sea life that was unknown before. By **2000** more than **300** new fish species entered the **Mediterranean**. It is now estimated that a new species is found every **10 days!**

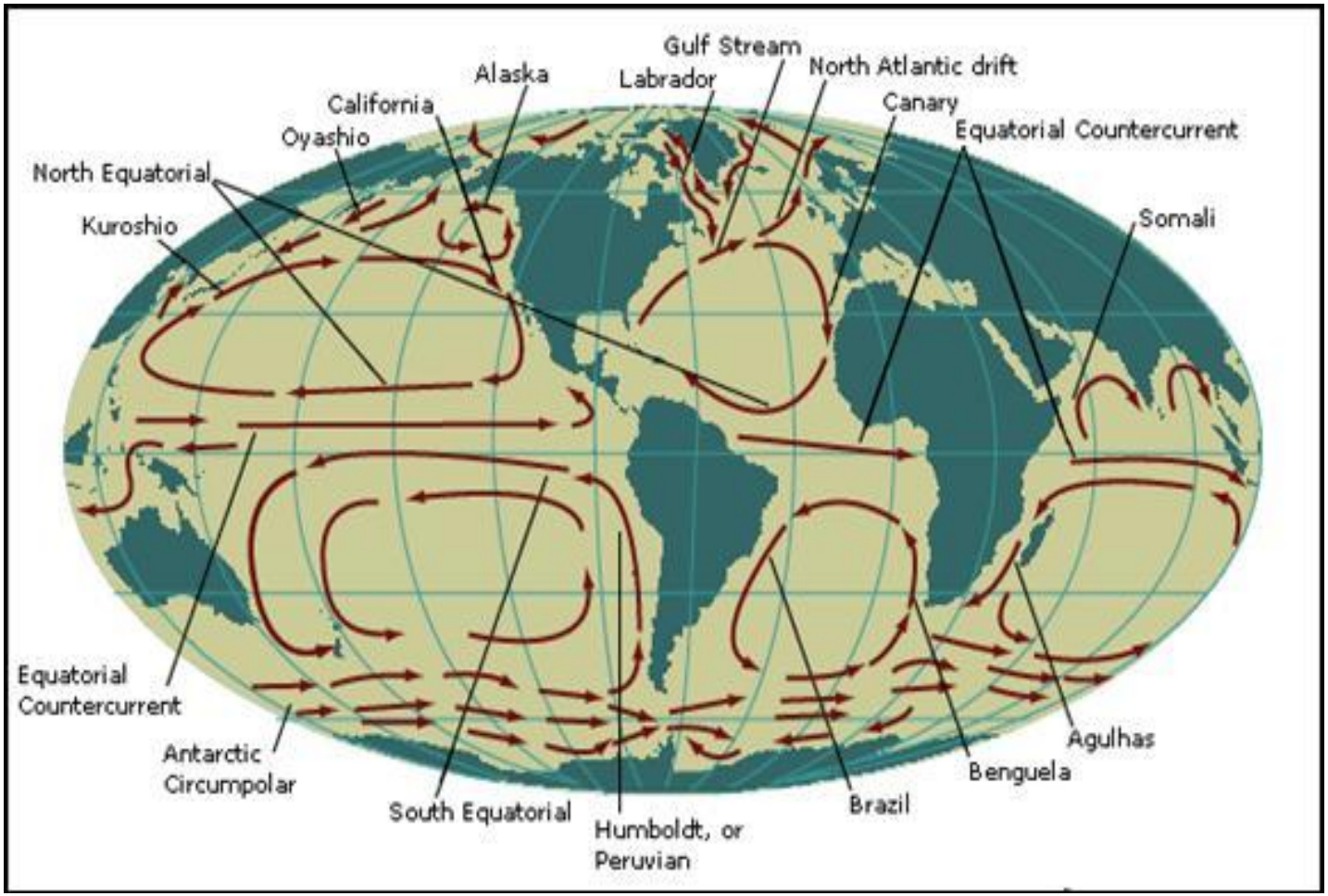
The costs of fitting ballast water management systems are exorbitant . The end result will be minimal. The cost effectiveness of the measure is very small and will produce no perceptible result.

Ballast water exchanges in deep water have proved effective and are adequate.

The Global Conveyor Belt



More localized currents



Even the Bosporus has currents

Example 6:

All similar legislation targets consumption at a certain speed or driving cycle

IMO decided instead to do it targeting power through EEDI.

Result: Underpowered ships
Longer sailing routes and times
Greater emissions

Greece in MEPC 65/5/6 proposed that EEDI be estimated at a specific speed.

The MEPC 64 criteria of 15.7 m/sec and 19 m/sec are clearly insufficient. The IMO Stability Code Severe Wind criterion requires testing in winds of 26 m/sec plus gusts (10+B and 8 m waves)! Recent observed wind speeds reached 31 m/sec, 44 m/sec and 52.8 m/sec !! "*Fiat*"?

Ships, not being able to maneuver in a storm, will ground upright.

Greece, concerned with these developments made a minimum powering study, MSC 93/2/5 and MSC/inf.13, presented and discussed in MSC 93 (May 2014). Ships need ~20% more power. Greece's views were supported, among others, by the Royal Institution of Naval Architects (RINA) and the International Federation of Shipmasters' Associations (IFSMA), two organizations that only care about ship safety.

The matter will be discussed again in MEPC 67 (Oct. 2014), in an effort to avoid setting a reasonable minimum powering requirement. In the meantime more underpowered ships are being built.

Energy efficiency

"BACK TO THE FUTURE?"

The **EEDI** is the Energy Efficiency Design Index. Its purpose is to promote the **design** of energy efficient ships. **That means improved Hulls (the platform) and of course Machinery and Propellers.** The simplified formula is as follows:

The formula → $$\frac{P \cdot SFC \cdot C_f}{dw \cdot v} = EEDI \leq a \cdot dw^{-c}$$ ← the reference line

As formulated (at a V equivalent to P at 75% MCR) it has a bias to reduce power rather than improve the design.

Underpowered ships will have to travel greater distances in order to avoid weather. They will also burn more because they will operate their engines at a higher SFOC.

In MEPC 62/5/6 Greece proposed that the EEDI should instead of be linked to a specific speed for different types of vessels. This would directly link engine power to ship hull design and safe navigation.

The databases that produced the regressions which formulate the reference line are plagued with inconsistencies:

Table from IMO MEPC 62/5/6 of May 5, 2011 submitted by Greece

MO/YEAR	YARD	DWT (Ton)	Engine (HP)	Speed (kn)	EST EEDI
Feb-95	YARD 1	68519	9799	15.00	3.388 (3.730)
Jun-94	YARD 1	68621	9800	13.90	3.652 (4.019)
Jul-81	YARD 2	65337	15200	15.50	5.334 (5.871)
Jul-81	YARD 2	65020	15202	16.80	4.946 (5.444)
Aug-99	YARD 3	73725	10261	14.00	3.533 (3.889)
Sep-99	YARD 3	73659	10261	15.50	3.194 (3.516)

The above 3 pairs of 2 sister ships built by the same yard within a few months of each other have 8%-10% differences in EEDI.

Survivability and maneuvering requirements

With the EEDI as formulated, minimum powering requirements should be established for each ship.

Criteria:
The IMO minimum speed requirement for maneuvering in heavy weather, works out from about 7 kn for Handysize ships to about 10 knots for Capesize ships. **From studies carried out at NTUA for 5 ships, present powering is marginal particularly so for the smaller ships. Any reduction will create underpowered ships which will need to follow longer, fair weather routes thus causing more emissions.**

The IMO Stability Code Severe Wind criterion requires testing in winds of 26m/sec plus gusts (10+B and 8 m waves).

October 2013 UK wind speeds of 31.1 m/sec (70 mph) and gusts 44.0 m/sec (99 mph)
Denmark 52.8 m/sec (190 km/hr)
October 1987 UK wind speeds of 51.1 m/sec (115 mph)
Top wind speeds Hurricanes: Katrina 2005 sustained 77.8 m/sec, gusts 95.6 m/sec
Sandy 2012 sustained 41.7 m/sec, gusts 62.1 m/sec

Ships often meet such weather conditions and must survive.

Any powering requirements to meet lesser weather conditions would result in the ship grounding in an upright position in bad weather!

MEPC 64 and MSF Dec 2012 decided on: 19m/sec (8 Beaufort and 6 m waves
MEPC 64 May 2013 reduced the above to: 15.7m/sec and 4 m waves for ships <200m and
19.0m/sec and 5.5 waves for ships >250m !!

In view of the above does this represent safe thinking? NO

Underpowered ships are dangerous

Greece has submitted to IMO MSC 93/inf.13 the paper "Minimum Power Requirements for Ship's Safe Operation in Adverse Weather Conditions", a study prepared by the National Technical University of Athens (NTUA) suggesting that the proposed powering criteria were inappropriate for the weather likely to be encountered. The study proposes that the minimum power should be increased by 20%.

Greece's views at IMO were supported by:

1. **The Royal Institution of Naval Architects (RINA)**
2. **The International Federation of Shipmasters' Associations (IFSMA)**

Press comments:

"….**mariners and marine engineers alike ought to welcome the important intervention of Greece at this month's International Maritime Organization's maritime safety committee**, raising the subject of the safety evaluation of the interim guidelines for determining minimum propulsion power to maintain the maneuverability of ships in bad weather."

Michael Grey "The need for speed" – Lloyd's List May 2nd, 2014:

Underpowered ships have to travel longer distances

Distances as per OCEAN PASSAGES OF THE WORLD, Hydrographic Department, Admiralty, (London 1950)

San Francisco to Yokohama		Rio De Janeiro to Cape Town	
MODERATE POWERED STEAMERS		MODERATE POWERED STEAMERS	
June to September	4535 miles	All seasons	3310 miles
October to May	4840 miles		
LOW POWERED STEAMERS		LOW POWERED STEAMERS	
All seasons	4840 miles	All seasons	3510 miles
Increase in voyage length	**6.70%**	**Increase in voyage length**	**6.04%**
Sunda Strait to Aden		**New York to Gibraltar**	
MODERATE POWERED STEAMERS		MODERATE POWERED STEAMERS	
May to September	3820 miles	July 1st to April 10th	3.180 miles
		April 11th to June 30th	3.185 miles
LOW POWERED STEAMERS		LOW POWERED STEAMERS	
April to June	4145 miles	October to April	3.645 miles
September to October	4145 miles	May to September	3.360 miles
July to August	4000 miles		
Increase in voyage length	**8.51%**	**Increase in voyage length**	**14.60%**
Rio de La Plata to Cape Town			
MODERATE POWERED STEAMERS		LOW POWERED STEAMERS	
All season	3590 miles	All seasons	3650 miles
Increase in voyage length	**1.67%**		

Over the last 60 years weather patterns have deteriorated. The necessary deviations for the Low Powered Steamers, in all probability, have increased causing higher CO_2 emissions.

Example 7:
M.R.V.-An exercise in futility

Trade expands in line with the world economy therefore ship emissions will always increase *ceteris paribus.*

Ships operate in an environment producing many variables most of which are not controlled by the shipowner. All affect speed, resistance and consumption. These are:

-**Condition of load**: full load, part load, light ballast, heavy ballast , trim etc., which create greater or lesser resistance and powering requirements.
-**Consumption and emissions vary with speed**. The speed at which profit is maximized varies with the ratio of freight rate to bunker price if there are no other constrains. It also varies with weather conditions.

-**Water surface currents:** Over the year they may vary from **1kn to 3 kn on the prevalent axis.**
-**Wind speed and direction**
-**Hull and propeller fouling**
-**Hull deformation/damages/groundings**

No amount of data analysis can be meaningful when trying to assess the recorded speed and consumption of about 50.000 ships, operating with the above variables, particularly if one tries to take averages over extended periods. Even identical sister ships in different trades and trading areas have recorded different consumptions.

A practical suggestion for rating ship efficiency

"Columbus's egg"

All owners create **warranted time charter speed and consumption descriptions** for their ships **at various speeds and conditions of load** which they update from time to time based on the ship's observed performance.

Charterers monitor a ship's speed/consumption performance daily using routing companies. This way they calculate overconsumption or underperformance, if any.

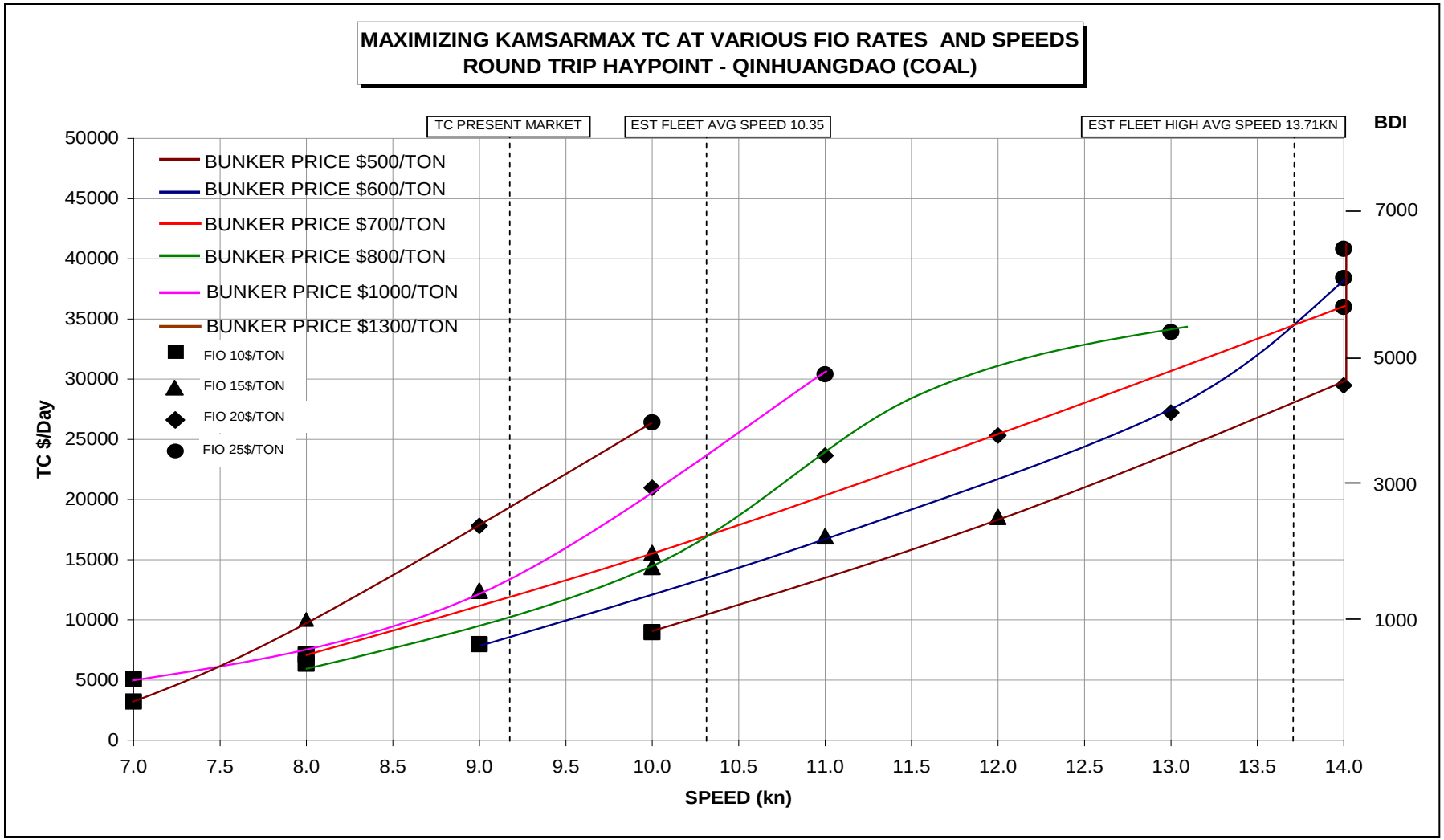
Since these speed and consumption descriptions are legally binding there is no reason to ask for third party verifications. A ship's recent speed and consumption warranties **are known on the market and verified by the fact that both owners and charterers accept them**.

This is (and has been) how ships are rated on a daily basis.

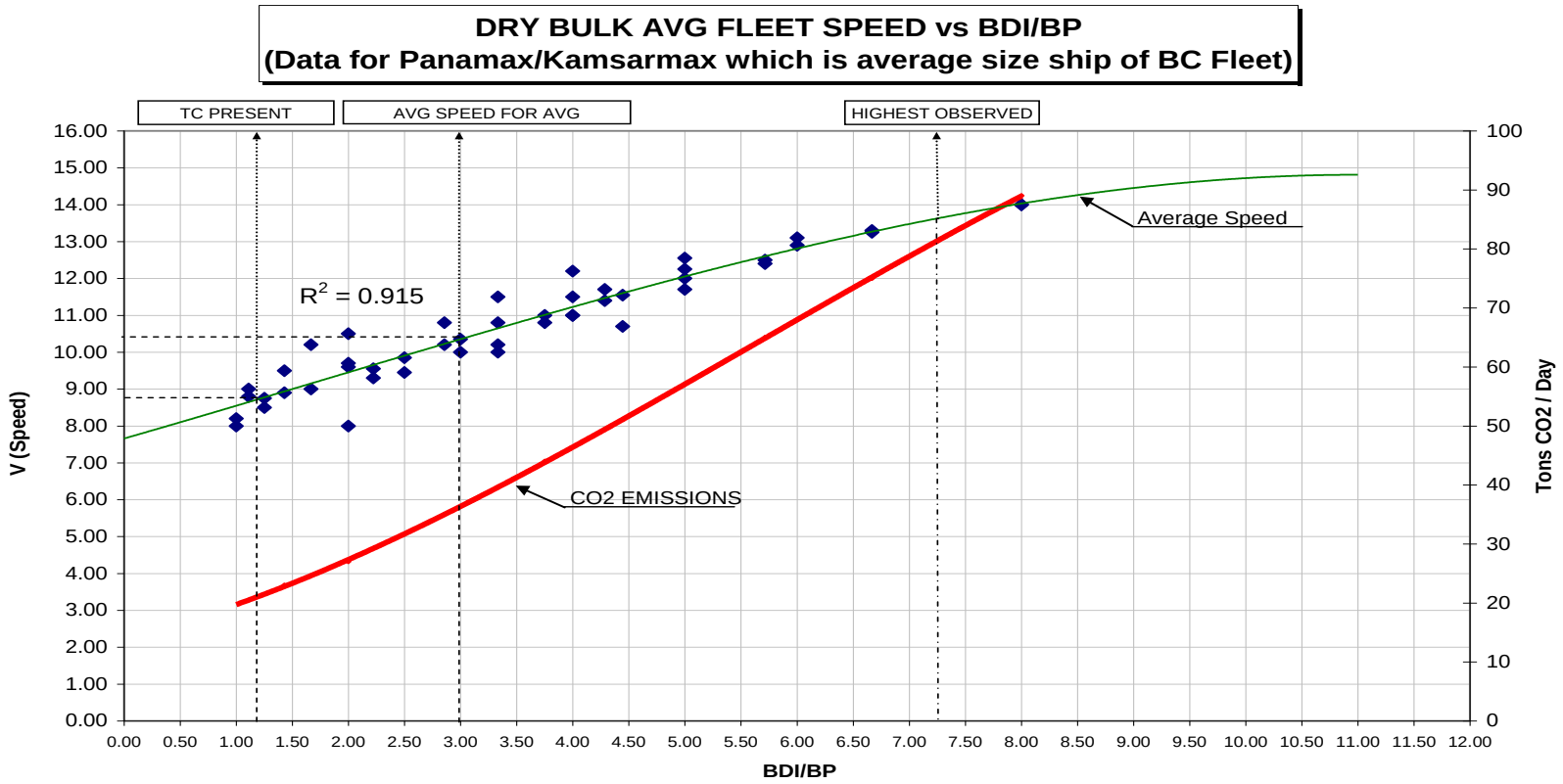
Shipping reacts to cost inputs and profitability criteria

To improve shipping's already **very good environmental performance** we must think clearly, **free of ideological constraints** and **avoid meaningless, unnecessary complications**.

Ships trade at the speed at which they maximize earnings for any given freight rate and bunker price. Ship emissions vary with the cube (or more) of the speed. **Ships operate in an environment producing many variables most of which are not controlled by the shipowner. All affect speed, resistance and consumption.**



Simulation for other trips show similar results



Ships will proceed at the speed at which they maximize earnings. This speed is a function of the ratio of the freight market to the bunker price.

The above shows that increasing the bunker price will predictably reduce the fleet's profitable operating speed, therefore its emissions.

The only practical solution for reducing emission is a fixed bunker levy

A bunker Levy alone could act as both:

- A ship design improvement mechanism, and
- An automatic speed regulating mechanism

It would do this while reducing emissions, increasing ship profitability, eliminating unnecessary complexities and uncertainty.

A bunker Levy will not create underpowered ships.

Because of its simplicity the Levy is also **2 to 5 times more cost efficient from ETS** (USA CBO) thus increasing environmental benefits at a lower overall cost to society.

Concluding remarks

- **An EEDI pegged to a certain speed** for different ship types (dry bulk, tanker, container) is a better guide to designers to produce a real eco ship which is safe and has enough power to **prosecute the shortest possible voyages**. Longer voyages will invariably consume more fuel.

- **Ship speed and consumption descriptions clearly identify a ship's energy efficiency.**

- **IEA data and/or bunker delivery notes give a clear indication of shipping's bunker consumption and emissions** which may be higher than the actual consumption because of "leakage".

- **Low sulfur fuel for worldwide trading is unnecessary**, it increases transport cost, it induces global warming and as presently refined is unsuitable for ship engines with dangerous safety implications.

- If an MBM is considered necessary the **Carbon Levy is the most appropriate and most cost efficient method** to reduce CO_2 emissions from shipping because it induces a bias for slower steaming without improving safety.

Too much time and taxpayer money have been spent – no measurable benefit has been achieved

Both emissions and the world transport system are very complex. Their interaction is obviously even more complicated.

Governments should carefully study the repercussions of their regulations before they inflict irreversible damage to society through inappropriate legislation. Our society has developed substantial analytical capabilities to help guide us.

Regulations should be supported by facts not feelings

ATTEMPTS TO DATE ARE NOT IMPRESSIVE

THE ENVIRONMENT CAN'T WAIT

Thank you

G.A.Gratsos