COMMENTARY:

Shipping charts a high carbon course

Alice Bows-Larkin, Kevin Anderson, Sarah Mander, Michael Traut and Conor Walsh

The shipping industry expects ongoing growth in CO_2 emissions to 2050, despite an apparent recent decline. Opportunities for decarbonizing the sector in line with international commitments on climate change need to be re-evaluated.

In November 2014, the International Maritime Organization (IMO) released a study estimating greenhouse-gas (GHG) emissions from the shipping sector globally between 2007 and 2012[1]. The report shows how the shipping sector responded to the recent global economic downturn and considers drivers of GHG emissions. It breaks the sector into categories (for example, domestic, international) and ship types, looking back to 2007 and forwards to 2050 to develop future emissions scenarios for the sector. In addition, the report produces historical 'top-down' and 'bottom-up' GHG estimates for the global fleet, and by ship category. The top-down estimates use global marine bunker fuel sales data, whereas the bottom-up figures combine Automatic Identification System (AIS) observation data with technical data on the global fleet. Given the scale and urgency of the global climate change challenge, such detailed studies are essential for improving and prioritizing mitigation policies and efforts.

Headline figures from the report show that the CO_2 emissions from shipping were 949 $MtCO_2$ in 2012 (972 Mt of CO_2 equivalent), with international shipping contributing 84% of this. It also identifies very large changes from year to year — from a drop of 10% in 2009–2010 to an increase of 10% between 2010 and 2011 (Table 1). Despite this variability, the data suggest that between 2007 and 2012 CO_2 emissions from international shipping fell by 10% (14% for all shipping). The IMO study[1] compares bottom-up results (from which the headline figures are gleaned) with top-down estimates. The annual variability in the latter is smaller and shows a nearly constant trend. However, these two data sets are converging over time, as data coverage improves.

Taking both estimates together with the interannual variability in the data illustrates how drawing conclusions to construct any short- or potentially longer-term trend is premature. On the other hand, unpacking the principal GHG drivers provides insights into some of the key contributions and constraints to mitigation of climate change in the sector.

Slow steaming

One of the most significant factors leading to the observed changes in emissions is the widespread adoption of slow steaming (that is, steaming below design speed) in response to economic pressures[2]. The theoretical cubic relationship between ship speed and main engine power demand means that CO_2 emissions from shipping are particularly sensitive to changes in speed[3]. According to the IMO study[1], slow steaming was particularly prevalent in ships designed to operate at the highest speeds. Similarly, the increase in CO_2 from 2010 to 2011 was principally driven by rises in CO_2 emissions from the bulk and container sectors as speeds increased, although still operating within a slow steaming regime.

Between 2007 and 2012, the average speed of container ships reduced by between 6% (for the smallest ship size band) and 24% (for the size band between 8,000 and 12,000 twenty-foot equivalent units (a measure of a standard container)), according to the IMO report[1]. Significant speed reductions were observed in the oil tanker markets (up to 16%) while in the dry bulk category average speed was variable. Market differences influence the levels and likelihood of the uptake of slow steaming. Container vessels operating on regular routes provide a regime more suitable to plan for slower speeds, unlike bulk carriers, where goods are often traded on a voyage-by-voyage basis with no fixed timetable, or 'tramp basis'. In general, between 2007 and 2012, slow steaming has been more

Table 1 | Bottom-up estimates for annual CO_2 emissions from the shipping sector

Year	All shipping CO_2 ($MtCO_2$)	International shipping CO_2 ($MtCO_2$)	Change for all shipping CO_2	Change for international shipping CO_2
2007	1100	885	–	–
2008	1135	921	+3.2%	+4.1%
2009	978	855	–13.8%	-7.2%
2010	915	771	–6.4%	–9.8%
2011	1022	850	+11.7%	+10.2%
2012	949	796	-7.1%	–6.4%
2007–2012 change	-151	-89	–13.7%	–10.1%

Emissions are shown in absolute terms and rates of change. Data from ref. 1.

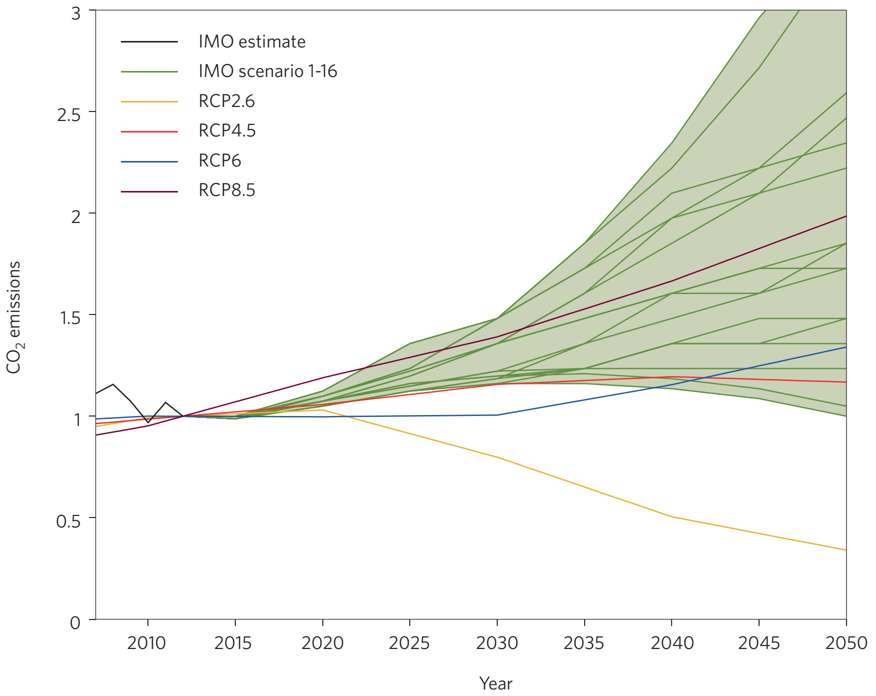

Figure 1 | Comparison of 16 GHG scenarios from the IMO and the RCP marker scenarios for a range of climate outcomes. All scenarios are indexed to 2012 emissions. Data from refs 1,14,15.

prevalent in larger vessels or those designed with more power. Nevertheless, the observed change illustrates that emissions savings could be made if such operational practices were strengthened (that is, greater cuts in speed) and applied more widely (across more ship types).

Slow steaming was, and remains, a response of an industry with overcapacity and operating with low levels of productivity (transport work per unit of capacity), following the global economic downturn. It was not driven by existing, or potential future, mitigation policy. Recent economic conditions led to an oversupply of available ships in some markets, incentivizing slow steaming. However, if ships were to become increasingly optimized for much slower speeds, either through retrofitting existing ships, or new ship designs, this could provide significant savings and improvements in carbon intensity[4]. On the other hand, an upturn in economic conditions could lead to 'latent emissions' being released as the available capacity is taken advantage of and ships revert to quicker speeds.

False interpretation

The IMO study was received favourably by the international shipping industry, with the cuts in CO_2 hailed as 'impressive' given a growth in demand in the sector over the same period[5]. However, the information in the report was both inappropriately communicated and contextualized by some key stakeholders with a quoted claim of "a 20% cut in GHG emissions between 2007 and 2012" expressed in a press release[5] by the International Chamber of Shipping, which is not what the data show. The 20% figure comes from comparing shipping CO_2 emissions as a proportion of the total global CO_2 emissions in 2007 with the new share in 2012. This reflects not only how shipping emissions have changed over time, but also how global CO_2 emissions have grown (~12%[6]). Instead, data in the study show that total international shipping CO_2 has fallen by 10% (14% for all shipping). Taking these estimates as read, this still suggests that the shipping sector has, largely through slow steaming, been able to do more with less fuel, and hence less CO_2.

Comparing emissions from shipping with global emissions, and how that proportion may change over time, is misleading, and gives no indication of how well the shipping sector is doing in mitigating its emissions[7]. Within many industries, comparing sectoral-scale emissions with a global total amount of GHGs both now and in future is used to illustrate how their particular sector is making little contribution to the global climate change problem. Statements such as: "The global shipping industry, which transports by sea around 90% of all world trade, is thought to have produced only about 2.2% of the world's total GHG emissions during 2012…"[5], are commonly repeated in public and industry forums. However, Germany's share of global emissions are around 2%, as are those of Shanghai and California combined[6,8,9], yet few would argue that such high-emitting places do not need to cut their CO_2 emissions. Focusing instead on shipping emissions without recourse to the global total, what does the IMO study[1] tell us about the sector in light of the global commitment to avoiding a 2 °C temperature rise?

Context

International leaders came together in 2009 to make a global commitment to avoiding global warming of 2 °C[10]. Against this backdrop, the shipping industry has made supportive statements, for example the IMO affirmed that the sector "…will make its fair and proportionate contribution towards realizing the objectives that this Conference [Durban 2011] and the global community pursue"[11].

Although international shipping is not covered in the Kyoto Protocol's national targets, the IMO is charged with mitigating its emissions in line with global objectives. To this end, the IMO has developed a range of indices, including the Energy Efficiency Design Index, to incentivize better efficiency. However, if the sector is to make a 'fair and proportionate' contribution to a 50:50 chance of avoiding the 2 °C temperature rise, much more stringent mitigation measures than these are needed across the fleet: a 15% reduction in absolute terms by 2020, up to 85% by 2050 from 2010 levels, according to one study that considers shipping in the context of 2 °C carbon budgets[12].

Comparing the report's estimated 10% cut in CO_2 from international shipping between 2007 and 2012 with a 2 °C framing of climate change[12] illustrates that this is the scale of sustained cut needed over each five-year period until 2050. Whilst it can be argued that international shipping is unlike most other sectors, as nations without climate change targets are as important in terms of international trade as those with, even a relatively conservative interpretation of avoiding 2 °C of warming (that is, a 50:50 chance) is extremely challenging for all. Therefore, if any sector makes less headway than the average in terms of cuts to GHG emissions, other sectors will need to do even more to compensate and remain within the appropriate carbon budget[13]. As yet, no sector has openly discussed cuts over and above the scale necessary for a reasonable chance of avoiding the 2 °C rise.

Maintaining emission cuts over time

How to sustain the GHG cuts estimated for 2007–2012 in the long term is a fundamental question. In contrast, the 'possibility space' for the scenarios exploring future levels of CO_2 from the shipping sector in the IMO study presents no evidence to suggest that such reductions will be maintained. Out of 16 scenarios, only two have emissions falling back to close to 2012 levels by 2050, with the rest anticipating growth (Fig. 1). Superimposed on the shipping scenarios in Fig. 1 are the four representative concentration pathways (RCPs) for comparison[14,15]. The RCP pathways are for total global CO_2 and indexed to 2012. Each delivers a different climate outcome, from RCP2.6 which has an estimated 0.9–2.3 °C of warming by 2100 above pre-industrial levels, to RCP8.5 with 3.2–5.4 °C. As it stands, none of the anticipated shipping scenarios even approach what is necessary for the sector to make its 'fair and proportionate' contribution to avoiding 2 °C of warming (RCP2.6). Instead, they typically cluster below and above RCP8.5 — the scenario with the highest projected temperature increases. If the sector is to bridge the gap between the necessary average sectoral effort to avoid breaching the 2 °C threshold — and current industry expectations for future emissions — measures that go far beyond even widespread slow steaming will be needed[16]. Fortunately, the shipping sector does have options offering step-changes as opposed to incremental efficiency improvements, ranging from Flettner rotors to sails, and biofuels to electric drives[17,18]. The challenges lie in demonstrating the value of new technologies as well as incentivizing long-term investment to rapidly roll-out new measures and reap the benefits of avoiding stranded assets[19,20].

The IMO study[1] highlights that cuts in CO_2 have been made over the period between 2007 and 2012. Given the cumulative nature of long-lived GHGs, this is an important start[21]. However, the sector cannot afford any complacency. Slow steaming is emphasized as playing a significant role in cutting the CO_2 from shipping over the period studied, but conditions that have made slow steaming economically feasible in recent years stem from a range of drivers, many of which are beyond the capacity of the industry to control. Shipping markets have a tendency to be cyclical[22]. If the economy reverts back to one of substantial growth, then recent levels of low productivity could reverse, delivering incentives to revert to faster speeds. This brings with it a significant risk that emissions will rise again as the economy improves and surplus capacity returns to use — and while mitigation policy targeting the sector remains weak.

If the shipping industry is to make its reasonable contribution to carbon mitigation, decarbonization options well beyond incremental efficiency gains must be sought and implemented urgently. If slow-steaming practices were adopted widely across service types, with greater cuts in speed, there is the potential for large emissions savings. Moreover, if they were to be coupled with a more extensive uptake of all feasible efficiency measures, and more serious consideration given to non-fossil fuel modes of propulsion and assisted propulsion, savings could be even greater. Only by opening out the possibility space to consider a step-change in technology and operations, as well as demand-side measures, can the sector sustain the level of cuts associated with making its fair and proportionate contribution to avoiding dangerous climate change. ❐

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