Long-term potential for increased shipping efficiency through the adoption of industry-leading practices
Outline

- Background
  - Carbon intensity, shipping activity, and climate impacts of international shipping

- Global in-use ship efficiency assessment
  - Method and data
  - Findings: Factors that influence operational efficiency

- Conclusions and next steps
Background
Carbon intensity and transport activity of international shipping

- Ocean-going vessels are the most carbon efficient freight mode
- They also account for over half of global freight activity
Climate Impacts of International Shipping

- International shipping accounts for 11% of GHG emissions and oil consumption in the transportation sector.
Climate Impacts of International Shipping

- Propelled by the growth of international commerce, CO\textsubscript{2} emissions will continue to grow between now and 2050.


Note: A1T, A1F, A1B, A1, B1, and B2 are scenarios based on which IPCC used to project future CO2 emissions.
The Energy Efficiency Design Index (EEDI) for new ships

- The EEDI will slow but not reverse the CO₂ growth from international shipping
- On-time implementation would maximize benefits

Substantial technical and operational potential to increase energy efficiency

**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%
Significant portions of these opportunities are cost effective.

Global in-use ship efficiency assessment

- The large remaining opportunity for reducing CO$_2$ emissions in-sector lies in the improvement of energy efficiency for in-use ships

- Overarching questions
  - What are factors that influence ship efficiency?
  - Are there data available to assess these factors?
  - If the fleet achieves higher efficiency on par with its leading shipping companies, what are the energy and climate implications for the industry?
Global in-use ship efficiency assessment: Data and Methods
Data and Methods

### Data
- 2011 Satellite Automatic Identification System (S-AIS)
- Clarkson Ship Intelligence (2013)
- UNCTAD “Review of Maritime Transportation”, various years

### Method
- Global shipping fleet turnover model
The S-AIS is installed on every ship larger than 300 gross tonnage for safety reasons.

Signals are transmitted from ships to satellites every few seconds:
- Message 1: vessel location and speed over ground
  - Real time ship speed and shipping routes are two critical improvement from previous studies
- Message 5: Vessel destination, IMO number, and draught (often input manually)
2011 Satellite Automatic Identification System

- Very Large Crude Carrier (VLCC) movement in August 2011
- Containership movement in August 2011

Courtesy of Dr Martin Austwick at CASA in University of College London
2011 Satellite Automatic Identification System (2)

Global Shipping Fleet Turnover Model

- Global Shipping Fleet Turnover Model: use data on ship population, overall ship efficiency, ship activity, and overall CO$_2$ emissions to backcast and forecast the fleet profile and emissions.
Global in-use ship efficiency assessment: Findings
Findings: Technical efficiency and operational efficiency

- Ships with higher technical efficiency (energy efficiency as designed) typically have higher operational efficiency.
Findings: Ship age and operational efficiency

- Newer ships typically have higher operational efficiency
Findings: Ship size, speed, and operational efficiency

- Larger ships typically operate at reduced speed and have higher operational efficiency
Findings: Top performers

- Top performers of each ship type have much higher operational efficiency than the industry average.
Projection scenarios

- Baseline with EEDI standard
- Incorporation of adopted efficiency standard that increases new ship efficiency
- Additional technology
  - Additional new ship efficiency technology at higher penetration levels than required by EEDI, achieving 1.5% annual reduction
- Additional measures
  - On top of technologies, operational measures achieve another annual efficiency improvement rate of 1.1%
- Top 5% industry leaders
  - Incorporates fleet shifts in age, design efficiency, operations, and composition, achieving 3.8% annual efficiency improvement
Fleet wide CO₂ intensity average will decline between 20% and 54% by 2040.
CO$_2$ emissions until 2040

- Fleet wide CO$_2$ emissions will be reduced by between 100 million metric tonnes (mmt) and 400 mmt by 2040.
Marine fuel consumption until 2040

- Oil consumption from international shipping will be cut by between 0.9 million b/d and 3.2 million b/d in 2040
Discussion

- Which measures do you think should be used to increase energy efficiency?
- What are the implications of shipping carbon footprint on global supply chain?
- What are major opportunities for improving energy efficiency over the next three decades in international shipping?
Conclusion

- Shipping offers enormous potential to increase efficiency and reduce CO$_2$ emissions cost effectively.
- Significant differences in operational efficiency can be observed across varying ship types, ages, and sizes.
- Combining S-AIS data with existing data are critical to understanding how ships operate and why they differ in operational efficiency.
Future Work

- Identify differences in operational efficiency within each ship type, age, and size combination
- Collaborate with shipping companies and organizations to examine other factors that influence ship operational efficiency not captured by this methodology
- Integrate satellite data with on-shore AIS to improve data quality
Thank You

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