

Investigation of ship motions and fuel consumption with respect to Charter Party agreements

Dominic Hudson

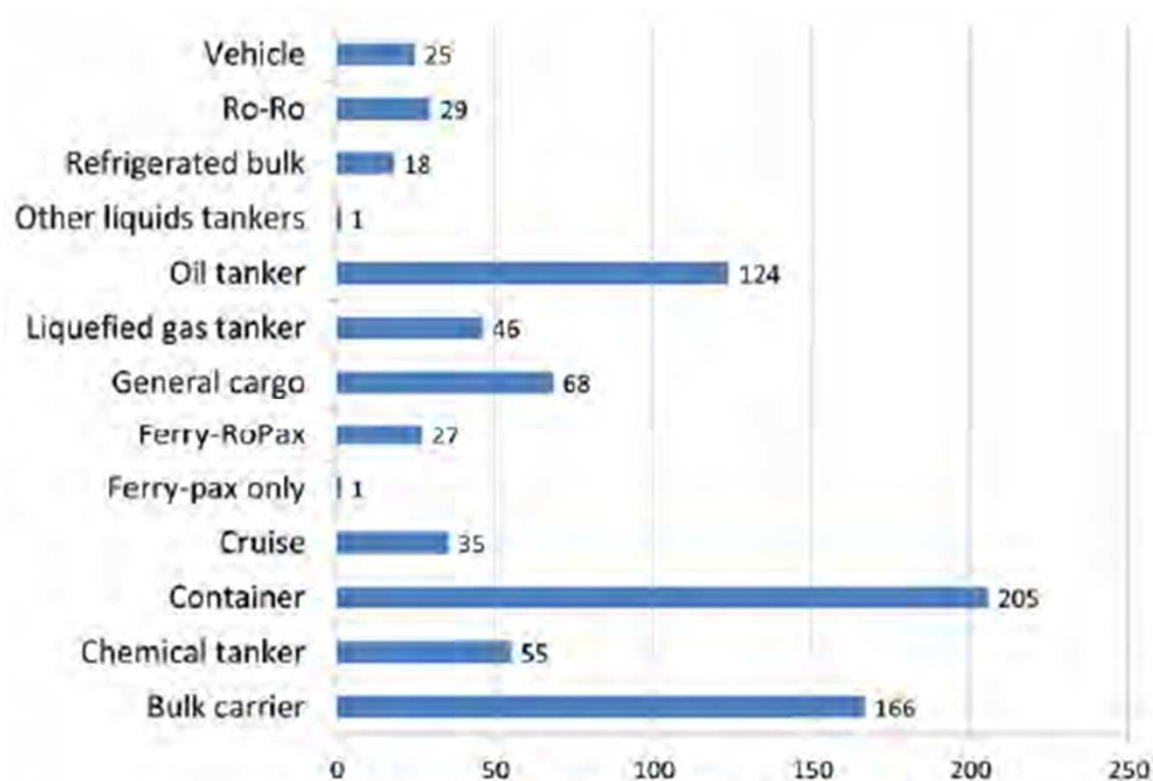
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Shipping in a Changing Climate 2017, UCL, London, 04-05/09/2017

Context – shipping emissions

- All shipping estimated to account for (IMO, 2014):
 - ~1.02 billion tonnes CO₂/annum (average 2007-2012)
 - ~3.1% of global CO₂ emissions

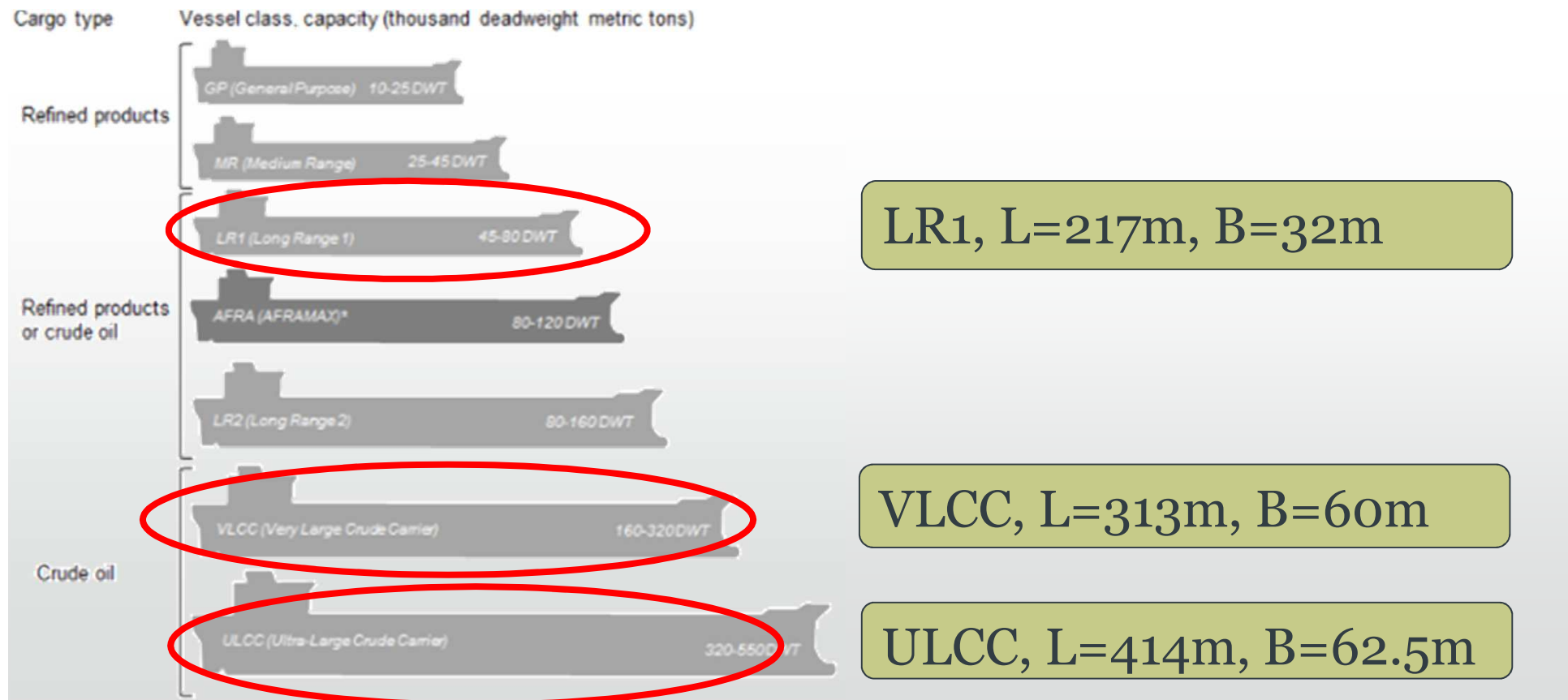


Motivation

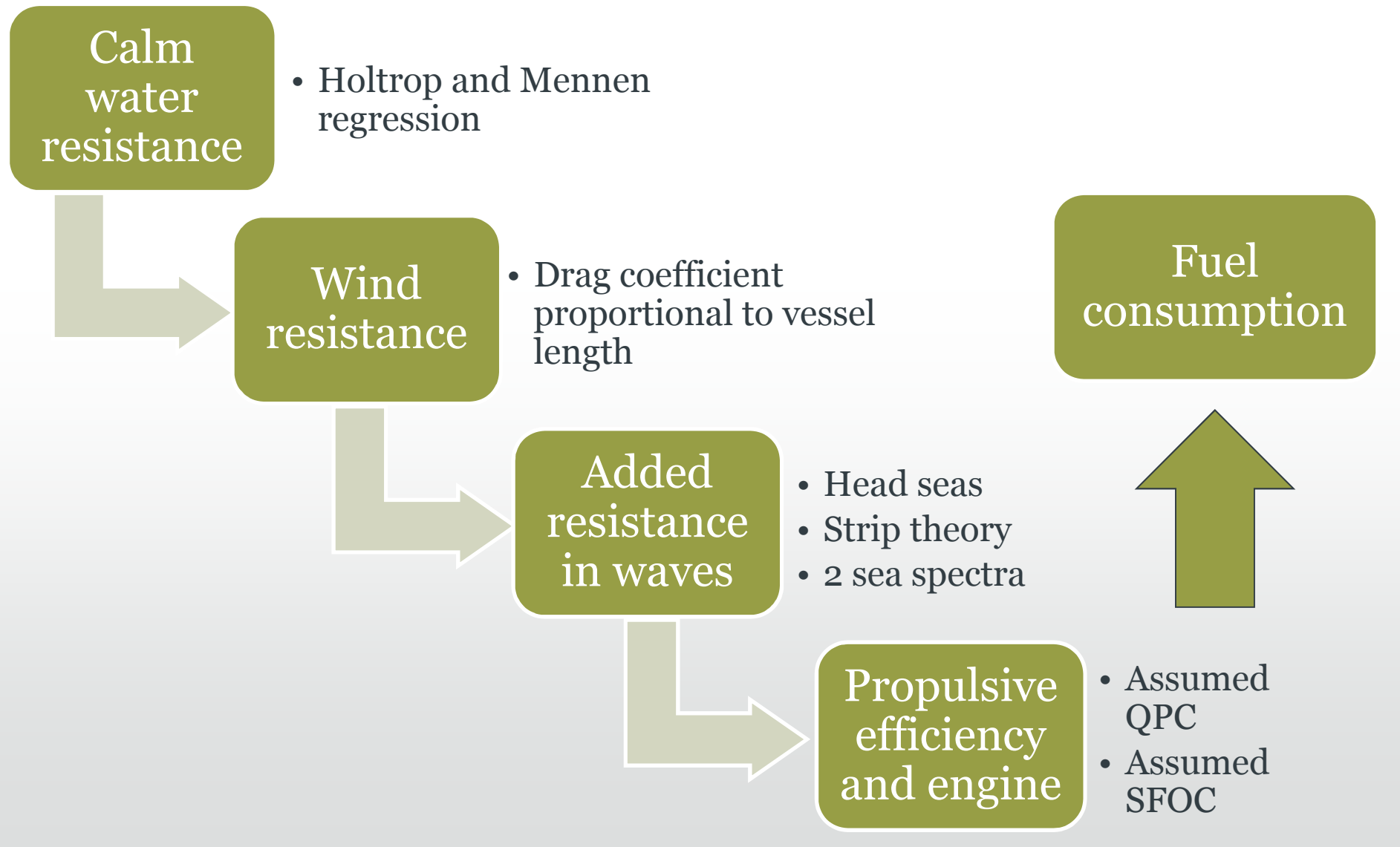
- Oil tankers and bulk carriers responsible for 36% shipping CO₂ emissions (IMO, 2014)
- All operational reductions important – ‘marginal gains’, particularly if applicable to existing fleets
- Commercial structures can hinder efficiency measures
- Charter Party agreements contain performance warranty clauses
 - Origin not always transparent to both parties
 - Likely to contain ‘margins’ on operation?
 - Prevent fuel consumption reductions?

Scope of investigation

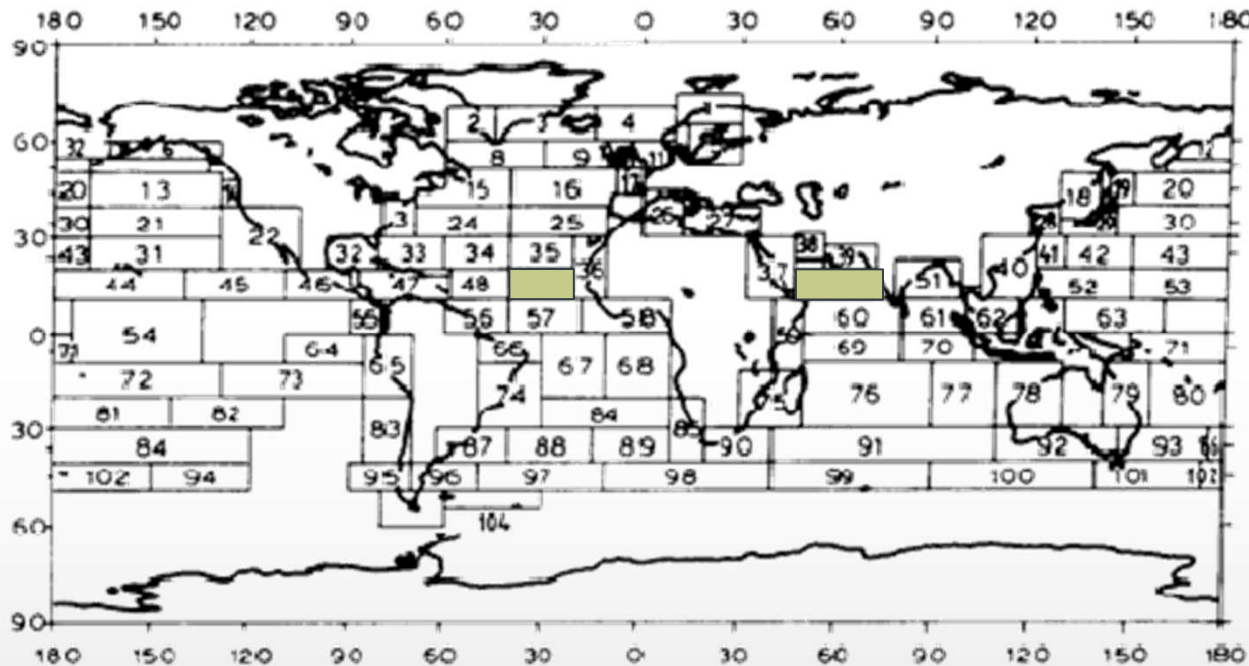
- Ship design tools used to predict fuel consumption
- Range of vessel sizes and sea conditions



Estimation of fuel consumption



Added resistance in waves



Parameters:

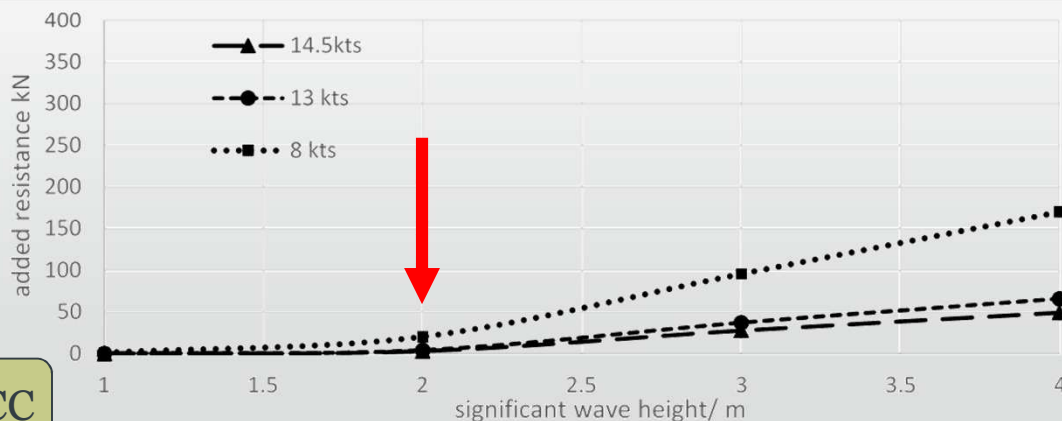
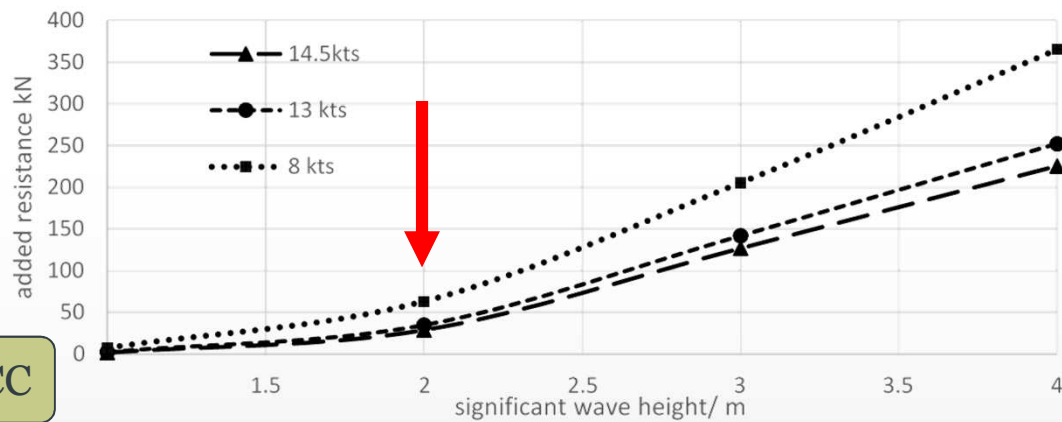
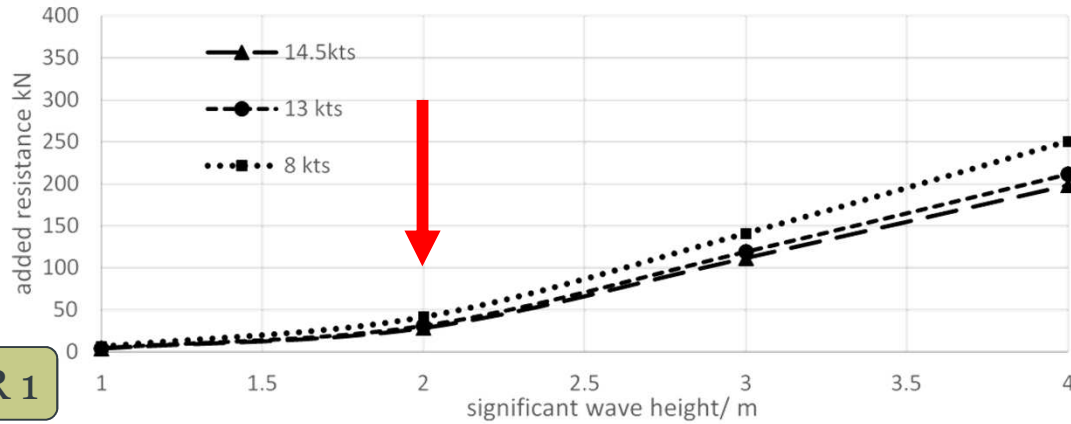
- Sea areas - 49, 50
- Wave heights – 0-4m
- Sea spectra – ITTC, JONSWAP

- Calculated using strip theory for motions and Gerritsma and Beukelman (1972) for added resistance
- As implemented in Bentley Systems, *Maxsurf* suite

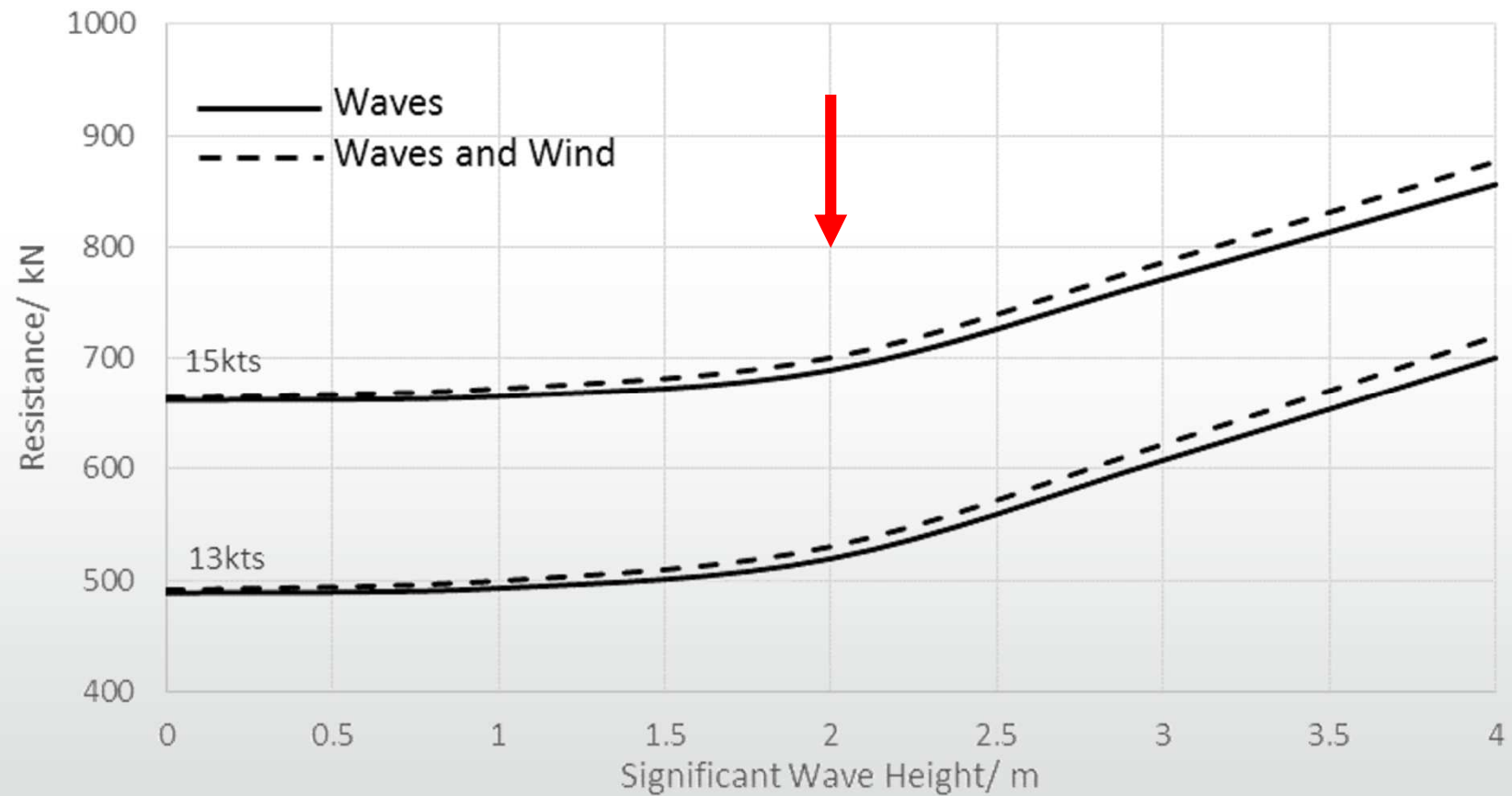
Added Resistance

- Vessel size
- Wave height

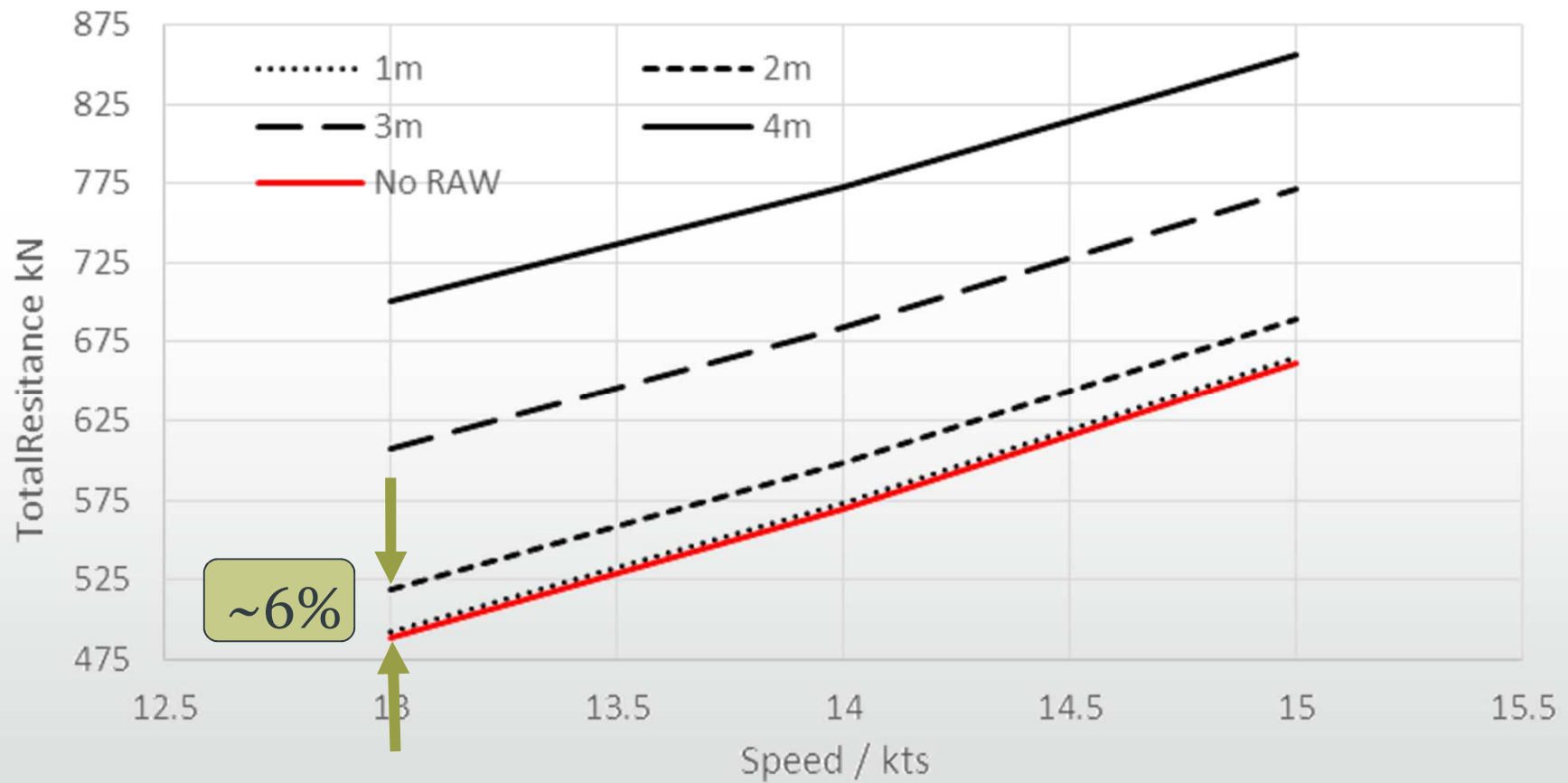
Approximately
Beaufort Force 5



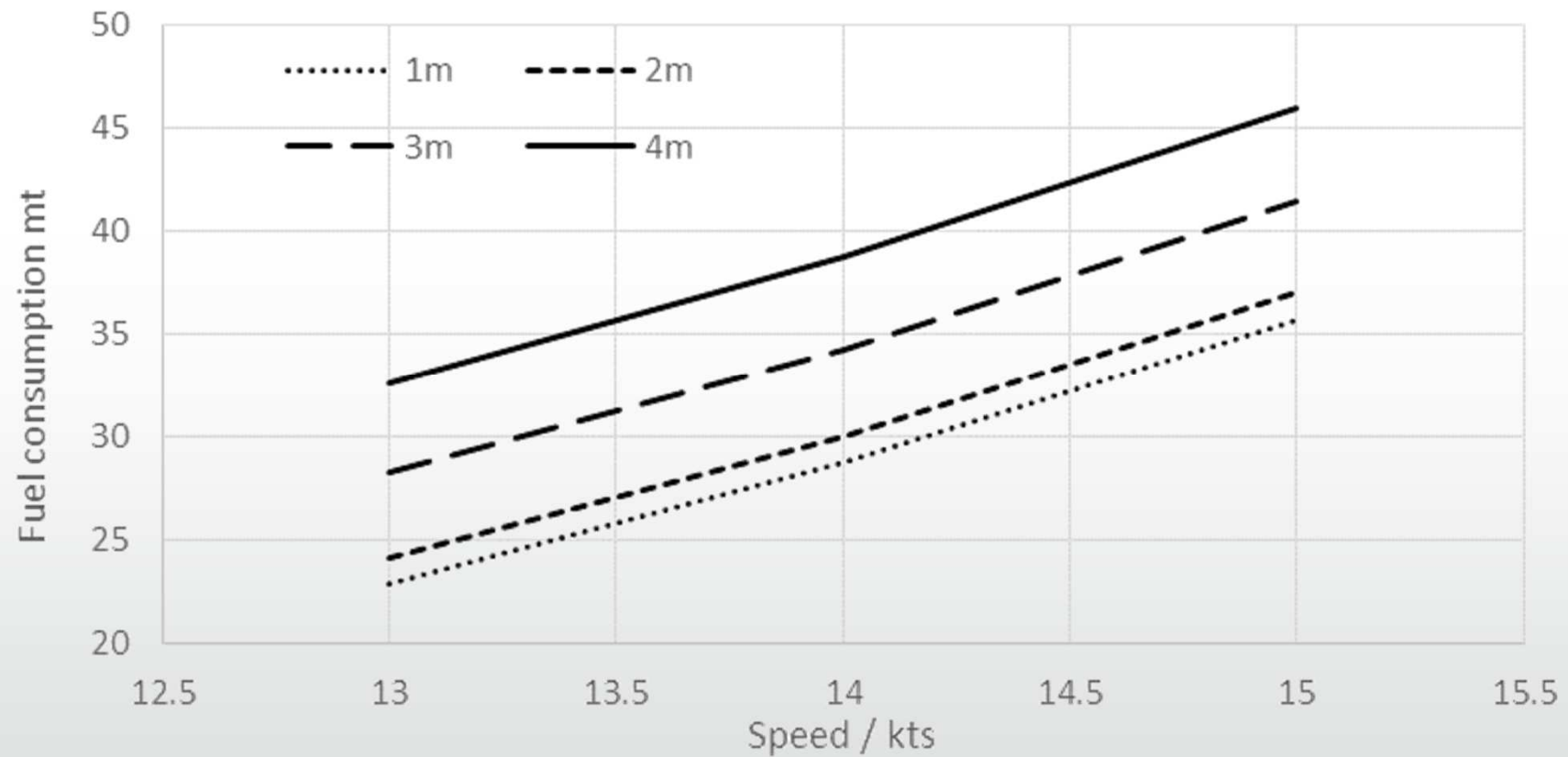
Total resistance – LR 1



Total Resistance – LR 1



Fuel consumption – LR 1



Summary

- Total resistance and fuel consumption calculated in range of head sea conditions for 3 tanker sizes.
- Vessel size makes little difference to magnitude of added resistance.
- For these vessels, **increased** speed results in **decreased** added resistance.
- Added resistance is <6% up to wave height of 2m, then increases more rapidly.
- Methods employed to calculate installed power margins in ship design may be adapted for calculation of expected fuel consumption in weather.

Thankyou