

# **Assessment of Emission Reduction and Fuel Savings using Ship Speed Optimization in Realistic Weather Conditions**

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## **ABSTRACT**

Rising global temperatures due to climate change is the most pressing problem of our time. Shipping industry is facing a challenge of moving towards zero emissions. Multiple solutions ranging from short term to long-term requiring various levels of additional infrastructure are being proposed. The measures range from design improvements, operational measures to usage of clean fuels. Operational measures like speed optimization require relatively low additional infrastructure even though the emission reductions are also supposed to be low.

In this work, our objective is to quantify emission reductions using speed optimization considering a realistic ship route and a broad range of weather conditions. Two representative bulk carriers have been selected for the analysis. An optimization algorithm has been used to minimize voyage fuel consumption while completing the voyage on or before the expected arrival time. A constraint on engine power has been used for realistic estimates of achievable ship speeds in different weather conditions considering the available engine power. Multiple voyages at different ship speeds and in different seasons have been simulated with and without speed optimization to observe the effect of these factors on emission reduction. The effect of wind and waves on engine power has been considered by calculating wind and wave resistance along with propeller efficiency as a function of advance coefficients.

Up to 11% reduction in fuel consumption was obtained by optimizing speed as compared to the constant speed profile. It was observed that a significant amount of fuel could be saved especially in seasons with a higher likelihood of heavy weather. Variation in fuel savings in different seasons has been discussed in the context of Metocean conditions experienced in the selected months. Additionally, higher fuel savings were obtained for lower average ship speed which means speed reduction combined with speed optimization has greater potential to reduce emissions. Realistic estimates of fuel savings in a range of operating conditions presented in this paper would help ship owners, operators, and policymakers to assess the benefits of speed optimization among other technologies to decarbonize the shipping industry.