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Abstract

The maritime industry is undergoing significant transformation as it grapples with the need for more sustainable shipping practices. This transition involves a shift in fuel preferences, with traditional high-polluting fuels being phased out in favour of cleaner, more sustainable alternatives. The sector is also contending with increasingly stringent environmental regulations, particularly regarding the reduction of greenhouse gas (GHG) emissions. These regulatory demands, coupled with the already complex techno-economic considerations for optimizing shipping operations, present a set of multifaceted challenges that require comprehensive and integrated solutions. In response to these challenges, the Global Climate Hub (GCH) — an initiative under the United Nations Sustainable Development Solutions Network (UN SDSN) — has been actively developing models that offer sustainable pathways for all economic sectors, including the shipping industry. This paper presents such a model: MaritimeGCH, a free, open-source, and comprehensive tool (optimization model) designed to tackle the diverse challenges associated with maritime fleet management. It has been developed in Python, and there can be different variations, depending on the problem being studied and its scale. MaritimeGCH integrates a range of factors, including techno-economic, fuels, environmental, and operational elements, into a single, unified model. It also incorporates recent European environmental policies and penalties, offering a tool that is detailed, flexible, and adaptable to various scales. The model's optimization

framework is tailored specifically for maritime challenges, balancing the need for economic efficiencystriving for environmental sustainability. The paper first describes the optimization logic applied to maritime problems, followed by a detailed mathematical breakdown of the MaritimeGCH model. Finally, the model's utility for policy-relevant scenario analysis is discussed. By making MaritimeGCH publicly available, the GCH aims to encourage the broader application of the model while fostering continuous improvements. The model offers significant potential for helping the maritime industry navigate its path toward sustainability while balancing economic and environmental goals in an increasingly complex regulatory landscape.

Keywords: MaritimeGCH; Global Climate Hub; Fleet Optimization; Shipping; Sustainable maritime operations; Environmental regulations; Techno-economic analysis.

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