Eco-Navigator: Novel Routing Software Optimized to Reduce Greenhouse Gas Emissions and Generate Fuel Savings for Wind-Assisted Ships

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Eco-Navigator, novel software, designs routes for ships to navigate to favorable wind and minimize fuel consumption. Wind-assisted shipping has the potential to reduce greenhouse gas emissions while generating fuel savings for ship operators. Ship engines lose up to 70% of fossil fuel energy as heat and other losses, leaving only 30% for propulsion. By contrast, Flettner rotors and sails deliver 100% of harnessed wind-power to the hull of the ship, equivalent to effective power generated by an engine. Optimizing a route to maximize propulsion from wind-power presents two challenges: modeling complex aerodynamic and hydrodynamic forces and quantifying the potential fuel savings and emissions reductions. Eco-Navigator, a navigation tool, addresses this problem by providing shipowners with software that 1) predicts wind optimized routes for cargo ships with Flettner rotors based on NOAA weather forecasts and 2) quantifies fuel savings and emissions reductions so that ship owners can see the environmental and economic value of Flettner rotors. Eco-Navigator uses Dijkstra's algorithm to select the path that minimizes total work (physics definition) based on the voyage and ship specifications. The code determines total work by calculating the forces acting on the ship and rotors and optimizing the spin of the Flettner rotors using gradient descent. Eco-Navigator's simulations predicted an average of 30.8% fuel and CO_2 emissions savings per trip. The potential impact of Eco-Navigator is the reduction of emissions leading to improvements in human health, protection of ocean ecosystems and property, fuel savings, and consideration and uptake of wind-assisted technology.