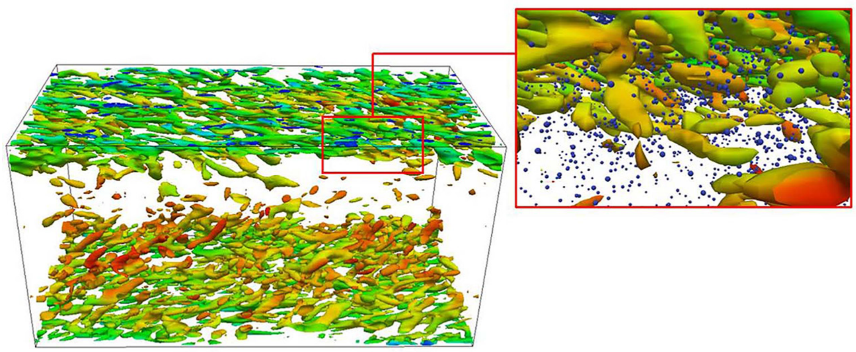
Scilight

3 February 2020

Euler-Lagrange method extends research on how bubbles reduce ship drag

Savannah Mandel

In a numerical study, the Euler-Lagrange method and a two-way coupled algorithm overcome previous challenges in bubble drag reduction study.



Drag reduction on ships and tankers can help curb the enormous carbon footprint of shipping. The Bubble Drag Reduction (BDR) method injects bubbles into the turbulent boundary layer around the vessel hull to reduce drag, which works by reducing frictional resistance through changing the flow medium around the ship.

Zhang et al. explored the underlying phenomena behind this tactic of drag reduction with a two-way coupled Euler-Lagrange code, and performed simulations using Large Eddy simulations.

"One important characteristic of the bubble drag reduction problem is that in water there are a large number of discrete bubbles. Since the bubble size is very small, it is reasonable to assume the bubbles are non-deformable spheres under the action of surface tension," said author Decheng Wan. "The Euler-Lagrange method can accurately solve the water flow and the motion of each bubble at the same time."

Unlike previous numerical simulations, which didn't consider the effects of bubble-bubble collision and bubble-wall collision, the authors simulated such interactions using a nonlinear collision model. This allowed them to study the bubble attachment to the hull more accurately. A Gaussian distributed two-way coupled algorithm was adopted to overcome numerical instabilities demonstrated in previous research.

Their model found that bubble migration induced by turbulent flow and fluid acceleration force generated significant drag reduction, but only over a limited distance.

"In practical application, multiple rows of air injectors should be arranged to improve drag reduction," said Wan.

Source: "Euler-lagrange study of bubble drag reduction in turbulent channel flow and boundary layer flow," by Xiaosong Zhang, Jianhua Wang, and Decheng Wan, *Physics of Fluids* (2020). The article can be accessed at https://doi.org/10.1063/1.5141608.

AIP Scilight. 2020, 061103-1; https://doi.org/10.1063/10.0000732