Stokes drift should not be added to ocean general circulation model velocities

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May 4, 2023

Abstract

Studies of ocean surface transport often invoke the "Eulerian-mean hypothesis": that wave-agnostic general circulation models neglecting explicit surface waves effects simulate the Eulerian-mean ocean velocity time-averaged over surface wave oscillations. Acceptance of the Eulerian-mean hypothesis motivates reconstructing the total, Lagrangian-mean surface velocity by adding Stokes drift to model output. Here, we show that the Eulerian-mean hypothesis is inconsistent, because wave-agnostic models cannot accurately simulate the Eulerian-mean velocity if Stokes drift is significant compared to the Eulerian-mean or Lagrangian-mean velocity. We conclude that Stokes drift should not be added to ocean general circulation model output. We additionally show the viability of the alternative "Lagrangian-mean hypothesis" using a theoretical argument and by comparing a wave-agnostic global ocean simulation with an explicitly wave-averaged simulation. We find that our wave-agnostic model accurately simulates the Lagrangian-mean velocity even though the Stokes drift is significant.