Wave-induced transport and vertical mixing of pelagic eggs and larvae

Johannes Röhrs, Kai Håkon Christensen, Frode Vikebø, Svein Sundby, Øyvind Saetra and Göran Broström

Limnol. Oceanogr., 59(4), 2014, 1213-1227 | DOI: 10.4319/lo.2014.59.4.1213

ABSTRACT: The transport of pelagic plankton by wind-driven ocean currents and surface gravity waves is investigated for the example of Northeast Arctic cod eggs and larvae on the coast of northern Norway. Previous studies indicate that the wave-induced drift (i.e., Stokes drift) is relevant for the transport of particles in the upper ocean. We use an ocean general circulation model together with a numerical wave prediction model and a Lagrangian particle tracking model to calculate trajectories of fish eggs and larvae. Waves are considered not only for particle drift but also for the air – sea momentum flux, its contribution to the Coriolis force, and vertical mixing. The sample species provides the advantage that many of its physical and behavioral properties are well known (e.g., egg buoyancy), allowing investigation of vertical particle displacement by turbulent mixing in response to wind forcing and wave breaking. The approach accounting for particle mixing by breaking waves enhances agreement between observed and modeled egg profiles. Results also show a general shoreward transport of particles by the Stokes drift. This wave drift exhibits a more constant direction than the Eulerian current and hence stabilizes particle diffusion to favor a dominant direction. For the case of Northeast Arctic cod, waves concentrated model eggs and larvae on average 1.5 km closer to shore, which is 20% of their total distance to the coast. This increases the residence time of first-feeding larvae close to the spawning areas compared to earlier models.