

Influence of the turbulent wake downstream offshore wind turbines on larval dispersal: development of a new Lagrangian-Eulerian model

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Key Words: *Environmental Fluid Mechanics, Marine Renewable Energy, Larval dispersal, Eulerian-Lagrangian coupling*

ABSTRACT

In the context of future offshore wind farms along the French coasts of English Channel, the impacts of foundations on larval dispersal from benthic-pelagic species colonizing the hard substratum of artificial structures are studied in order to assess how the species connectivity could be modified by the farms. In particular, the effects of turbulent wake and horseshoe vortices are investigated. To this end, a new numerical approach is developed that combines the Eulerian model, OpenFoam, solving the 3D Navier-Stokes equations to compute the hydrodynamics, and the Lagrangian model, Ichthyop, based on an advection-diffusion equation to compute the larval trajectories. Firstly, some simple test cases are performed to validate the numerical coupling between OpenFoam and Ichthyop, such as the dispersion of larvae downstream a 2D cylinder in water. Secondly, the ability of OpenFoam turbulence models to simulate turbulent structures around monopile and gravity type foundations is evaluated. The RANS (Reynolds Averaged Navier-Stokes) k- ω SST turbulence model is chosen for the realistic application because it can reproduce the horseshoe vortices and turbulent wake with less computing time than the Smagorinsky's LES (Large Eddy Simulation) model. Lastly, larval dispersal simulations for four benthic species and for a set of monopile and gravity foundations are performed. The main findings are: i) the larval material is transported onto the water column by 3D turbulence near the foundations and for gravity foundation this transport is modulated by the vertical geometry, with few larvae trapped behind the foundation (Fig. 1), ii) the larval material follows the turbulent wake and few larvae are ejected outside the wake.

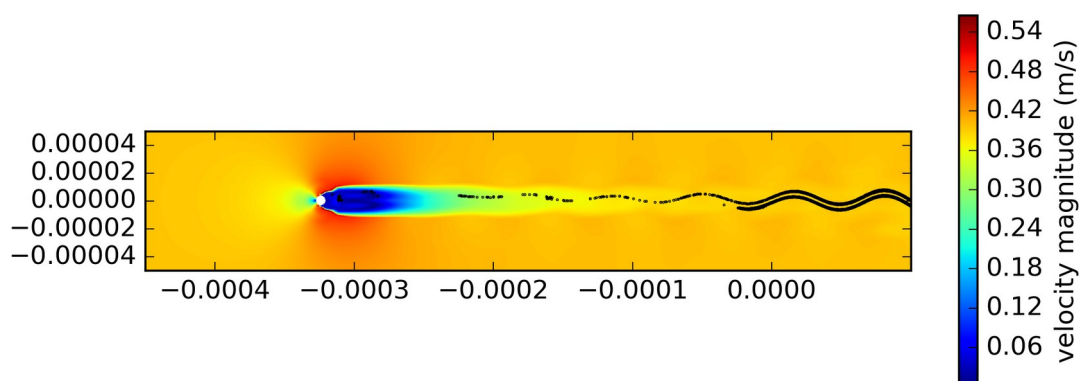


Fig. 1: Flow velocity magnitude (colored contours) during the larvae dispersion around the gravity foundation. Black dots are the larvae positions. The larvae are injected at mid-depth.