# LABORATORY AND NUMERICAL EXPERIMENTS ON STARTING VORTEX FORMATION IN A TIDAL INLET

SCOTT A. SOCOLOFSKY*, FRANCISCO NICOLAU DEL ROURE †, KUANG-AN CHANG†, AND PATRICK LYNETT†

* Division of Ocean Engineering
Department of Civil Engineering
Texas A&M University
College Station, TX 77843-3136, USA
socolofs@tamu.edu

† Division of Ocean Engineering
Department of Civil Engineering
Texas A&M University
College Station, TX 77843-3136, USA

Constituent transport by fluids affects the health and welfare of the nation's coastal waters by moving mass and momentum in an out of ecosystem niches in estuaries, bays, and the open coast. In the Gulf of Mexico, estuarine niches provide critical habitat for over 98% of the commercial fisheries catch [1]. Among the important processes influencing fisheries recruitment are transport of nutrients, sediments, pollutants, temperature, salinity, fish larvae, and a host of other important parameters. Transport in coastal waters is largely due to advection, and is dominated by the presence of large, two-dimensional coherent vortical structures (2DLCS) [2,3]. These 2DLCS are much broader than the water depth and exist due to the inherent instability of shallow flows. One class of 2DLCS in coastal waters are formed by the starting jet driven by tides through estuary inlets. These starting jet vortices are critical to the estuary mixing and flushing time and may not be accurately represented in numerical models. Here, we present laboratory and numerical experiments on the tidal starting jets through inlets to study the formation of the starting jet vortices. Accuracy in numerical models is important to predict changes in flow transport due to engineered or natural coastal morphology changes.

The laboratory experiments are conducted at large scale (order meters) in a flat-bottomed shallow water basin. Initial experiments investigate the starting vortices formed by a sudden input of a constant velocity flow. More detailed experiments involve tidal-like oscillating flows through a narrow tidal inlet. The experiments are visualized using food coloring dye tracer. Quantitative measurements of the shallow-water velocity field are obtained from large-scale surface particle image velocimetry (PIV) measurements. The PIV data provide detailed time-evolution of the starting vortex flows.

Numerical experiments are also presented with a goal toward evaluating the performance of the coastal hydrodynamic model ADCIRC, maintained by the U.S. Army Corps of Engineers. ADCIRC solves the depth-averaged shallow water flow equations with a free surface using a finite element numerical scheme. From the numerical simulations, good agreement is reached with the laboratory data, but important limitations are identified for grid resolution and domain size. These comparisons to laboratory data lend confidence to ADCIRC model predictions of tidal vortices at the field scale.

**References**

[1] C.A. Brown, G.A. Jackson, and D.A. Brooks, "Particle transport through a narrow tidal inlet due to tidal forcing and implications for larval transport," *Journal of Geophysical Research* **105**(C10), 24141-24156, 2000.

[2] M.E. Negretti, S.A. Socolofsky, A.C. Rummel, and G.H. Jirka, "Stabilization of cylinder wakes in shallow water flows by means of roughness elements: An experimental study," *Exp. Fluids* **38**, 403-414, 2005.

[3] A.C. Rummel, S.A. Socolofsky, C.F. von Carmer, G.H. Jirka, "Enhanced diffusion from a continuous point source in shallow free-surface flow with grid turbulence," *Physics of Fluids* **17**, Paper 074105, 12 pages, 2005.

**Keywords**: inlets, mixing, tidal exchange