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Bio-inspired flows in unsteady environments. Part I: highly unsteady ambient flows MEILIN YU, NARESH POUDEL, University of Maryland, Baltimore County, JOHN HRYNUK, U.S. Army Research Laboratory — Autonomous underwater vehicles (AUVs) and unmanned aerial vehicles (UAVs) usually need to carry out tasks in unstructured and dynamic flow environments. This poses a number of challenges that cannot easily be addressed by approaches developed for highly controlled environments, such as uniform flows frequently used in experiments and numerical simulation This work studies the impact of highly unsteady ambient flows on the performance of flapping wings/fins at relatively high Reynolds numbers (i.e., 12,000 based on the foil chord length). The unsteady flow environment is generated by an array of incline small cylinders or three arrays of staggered ones placed upstream of the flapping wing/fin. A high-order accurate flux reconstruction flow solver with moving/deforming body-fitted unstructured meshes is used to perform the numerical simulation. We find that highly unsteady flow environments dominated by small eddies can always enhance time-averaged thrust generation, no matter how the foil location is changed within the ambient chaotic flows; the effect of environmental unsteadiness on lift production seems to be random. The effects of wing/fin kinematics and the size of cylinders are also studied.

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