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Modeling Extreme Wave Development in Adverse Current Gradients

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We present results of an ongoing effort to accurately quantify the effects of adverse current gradients on deep water ocean waves, focusing on their role in instigating the Benjamin-Feir instability and produce freak waves in numbers that exceed the probability given by Gaussian statistics. Theory as well as numerical studies both indicate that adverse current gradients induce an increase in the Benjamin-Feir Index (BFI). Recent field experiments implicate wave- current interactions as mechanisms that can give rise to rogue waves in sub-mesoscales in deep water, occurring more commonly than previously theorized. The presentation will describe the latest results from a study utilizing a high-resolution Computational Fluid Dynamics (CFD) model to simulate random waves traveling against adverse current gradients in deep water. Wave characteristics and the BFI were monitored along the full 2D domain, and results were compared with existing theory. Based on our findings we propose an empirical formula that estimates changes in the BFI for ocean waves in deep water traveling against currents of varying strength.