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The Dynamics of Cold Water Upwelled by a Wave-inertia Pump in the Stratified Ocean Environment with Vertical Shear

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The wave-inertia pumps driven by surface waves are capable of producing flow of cold water to the surface. The cold water brought from a deeper layer has higher density than the surface water and tends to sink back down. In this work, the dynamics of the cold water in the stratified environment with vertical shear is estimated using computational fluid dynamics software ANSYS Fluent. A 3D large eddy simulation model is initialized with observational vertical temperature, salinity, and current velocity data from sample locations in the Straits of Florida. A periodic boundary condition is set along the direction of the current, which allows us to simulate infinite fetch. The results of the simulation indicate that the cold water brought to the sea surface by a wave-inertia pump forms a convective jet. This jet plunges into the upper ocean mixed layer and penetrates below the thermocline. On the way down, the jet partially mixes with the surrounding water reducing the temperature of the upper ocean layer. The cold jet is also slightly warmed; as a result, when the jet reaches the density equilibrium depth below the thermocline, it has accumulated some additional heat. The mixing of the cold water produced by the artificial upwelling depends on stratification, regional ocean circulation, vertical shear, and other environmental parameters. One potential application of the artificial upwelling system is the mitigation of hurricane intensity. The ocean heat content (OHC) is the "fuel" for hurricanes. The surface layer mixing with the upwelled cold water produced by wave-inertia pumps reduces the OHC accessible to hurricanes. At the same time, the results of the simulation indicate that some additional heat is accumulated below the thermocline.