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Artificial ocean upwelling utilizing the energy of surface waves

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Artificial upwelling can bring cold water from below the thermocline to the sea surface. Vershinsky, Pshenichnyy, and Soloviev (1987) developed a prototype device, utilizing the energy of surface waves to create an upward flow of water in the tube. This is a wave-inertia pump consisting of a vertical tube, a valve, and a buoy to keep the device afloat. An outlet valve at the top of the unit synchronizes the operation of the device with surface waves and prevents back-splashing. A single device with a 100 m long and 1.2 m diameter tube is able to produce up to 1 m^3s^{-1} flow of deep water to the surface. With a 10 ^{o}C temperature difference over 100 m depth, the negative heat supply rate to the sea surface is 42 MW, which is equivalent to a 42 Wm^{-2} heat flux, if distributed over 1 km^2 area. Such flux is comparable to the average net air-sea flux. A system of artificial upwelling devices can cool down the sea surface, modify climate on a regional scale and possibly help mitigate hurricanes. The cold water brought from a deeper layer, however, has a larger density than the surface water and therefore has a tendency to sink back down. In this work, the efficiency of wave-inertia pumps and climatic consequences are estimated for different environmental conditions using a computational fluid dynamics model.