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Mitigating Local Environmental Extremes with Artificial Ocean Upwelling

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Artificial upwelling using the energy of surface waves can potentially help to mitigate local environmental extremes. Here we investigate the oceanographic, air-sea interaction, and environmental aspects of artificial upwelling for the sample location of the Israel shore of the Mediterranean Sea. Long-term observations show a correlation between the heat content in autumn off the coastline of Haifa and precipitation in Jerusalem during wintertime (Tzvetkov and Assaf, 1982). Artificial upwelling on the Israel shore of the Mediterranean Sea will increase the heat content of the coastal waters during summertime by increasing vertical mixing, which is expected to increase precipitation in the Levant during wintertime and reduce air temperature in summer. We have implemented computational fluid dynamics (CFD) methods to study the dynamics of cold water in the stratified environment with vertical shear. Physical oceanographic and meteorological conditions in the Southeastern Mediterranean are obtained from the Israel Marine Data Center at Israel Oceanographic & Limnological Research Ltd (IOLR). These data are used to initialize the computational fluid dynamics model. In the long-term, the artificial upwelling system on the Israel shore of the Mediterranean Sea is expected to advance agriculture in the Levant by increasing rain rates during winter. The system will also produce a mild climate on the Israel coast during summertime, which will establish a healthier environment and aid in further development of tourism. There are engineering, oceanographic, and environmental issues to be addressed before the system can be implemented. Numerical experiments and field tests are expected to help in the development of a prototype system. Other potential applications of artificial upwelling, in other marine environments around the world, include developing offshore maricultural farming, preserving coral reefs from bleaching, and mitigating hurricane impacts.