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Data-driven models for projecting ocean temperature profile from sea surface temperature

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Data-driven models have been widely used in water resources related field especially in hydrology where it plays an important role in flood forecasting, rainfall-runoff prediction, water quality simulation, etc. However, the applications of data-driven model are relatively still less explored in oceanography field which heavily relies on physically-based mathematical models. Ocean depth varying temperature profiles, for example, are required by many ocean models since temperature is one of the driving mechanisms in ocean circulation. Ocean models simulate temperature profiles at any desired grid points within the domain of interest; however, the accuracy of simulated temperature profiles depends very much of the model accuracy, initial and boundary conditions, bathymetry, etc. This paper demonstrates how data-driven models (neural network and genetic programming), each a simpler and more accurate approach, provides ocean depth varying temperature profiles from sea surface temperature information only.

While the in-situ temperature profiles are difficult and very costly to obtain, sea surface temperatures (SST) can be transmitted from satellite circling the region of interest. Two sets of data are used. The first set stems from Levitus98 database while the second are measured data taken densely at a 60km x 60km site near Kaohsiung (Taiwan) in the period of April-May 2001. The results from the neural network show that the depth varying temperature profiles, simulated with SST information only, have very high prediction accuracy, $R^2$of 0.98. Similarly, the prediction accuracy resulting from genetic programming is very high as well (R^2= 0.95), although not as high as that of the neural network. Genetic programming, however, has the advantage of yielding a simple and explicit relationship between the temperature at desired depth

and SST and their spatial coordinates; this explicit equation may reveal the underlying physics of the process. The high degree of agreement between the simulated and the observed temperature profiles lends the confidence in using satellite observed sea surface temperatures to project depth varying sea temperature profiles.