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Derivation of Tidal Elevations in South Asian Waters with Neural Network

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Tidal forcing is one of the important factors in ocean model. Boundary conditions of ocean models require information such as current velocities, tidal elevations. With these boundary conditions and other information in the simulation domain of interest, e.g. bathymetry, temperature profiles, salinity, the governing equations of the ocean model then simulate current velocity, tidal elevation, salinity, temperature etc at points of interest in the computational domain.

Tidal data used in this study stem from the Total Tide tables published by UK Hydrographic Office. The tidal height is based on the full harmonic constants algorithm. The studied domain of South Asian waters ranges from 99E – 121E and from 9S – 24N.There are a total of about 600 Total Tide Stations spread all over the study region. However, only about 100 Total Tide stations scattered around the boundaries. There is a need to derive the tidal elevations at the model's boundary grid points from the vicinity Total Tide stations. Tide elevations data extracted from the Total Tide are in hourly format. Since the area is quite huge (22^0 x 33^0) the boundary is divided into 6 regions.

The study period considered is from 00:00hrs of 6th July, 2004 to 00:00hrs of 9th August, 2004 -- a total of 5 weeks. There are a total of 840 records from each station. Tide elevation at time t of a particular position, H(t), is expressed in terms of its position (x, y) and elevation of the vicinity Total Tide stations of time(t) and time (t-1) as follows:

$$H(t) = f(x, y, H_1(t), H_1(t-1), H_2(t), H_2(t-1), ..., H_n(t), H_n(t-1)) \quad (1)$$

An Artificial Neural Network (ANN) is applied to perform the above relationship. The software used in this study is Neuroshell-2. ANN is first trained and its performance is judged by the goodness-of-fit measures resulting from the training and the cross validation data sets. Upon achieving satisfactory performance, the trained ANN is then used to generate tide elevation data at desired boundary grid points. A recurrent neural network with hidden layer damped feedback is used. The Nash index, R^2, of the validation set is around 0.92 for all boundary regions with the exception of one region. The reason for the comparatively low R^2 (0.85) is that in this region the number of Total Tide stations is quite sparse.

The study also considers generating tide elevation data outside the time period at which ANN was trained. The results show that a high degree of accuracy. With the high prediction accuracy of the trained model one has the option to generate tidal elevations at ocean model's boundary grid points for forecasting purposes.