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Interactive comment on "Retrieving monthly and interannual pH_T on the East China Sea shelf using an artificial neural network: ANN-pH_T-v1" *by* Xiaoshuang Li et al.

Anonymous Referee #2

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Manuscript by Li et. al. presents a Artificial Neural Network (ANN) approach for modeling pH in East China Sea using observations collected from cruises. They have also applied their trained model to prognostic outputs from FVCOM model simulation.

Study is well designed and described and manuscript is easy to read and follow. Below are few questions/comments on the article that would help improve the clarity of the paper. A number of my questions were already captured by Reviewer 1 and addressed well by Author's response, so I will skip some of those in my review.

Choice of inputs: A total of nine variables were used as inputs to the ANN, six of which were direct measurements (T, S, DO, N, P, and Si). Lines 105-107 notes "We found

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geographical information to be a powerful addition in improving the skill of the method (see Table 2), allowing the network to learn spatio-temporal patterns that could not be explained by other input variables (Sasse et al., 2013)."

Adding geographical information does appear to improve the performance for the initial model training (Table 2). However, the cruise tracks are only sampling certain latitudes lead to a biased sampling. BUT can this lead to a geographically biased training? This bias may not be apparent even in the validation using data from three cruises, since they too are in same bands as before. But when applied to data from FVCOM, there are biases reported in Figure 5. Is it possible that the model is not generalized enough for other regions?

Lines 100-109 explains the choice of variables for all but one variable "month". I assume the variable was added to capture the seasonality. However, a significant bias was still reported in August 2013, and July 2016. These biases are being attributed to sudden increase in the river discharge, but did that not affect July 2014, 2015, 2017? What is the role "month" is playing in the ANN model? Once trained is the expectation for the model to be able to interpolate between the month when the samples were not taken?

ANN application to FVCOM: Inputs to the ANN models training, based on cruise observations, were instantaneous measurements. What was the spatial resolution, time step and temporal output frequency from FVCOM model to provide comparable outputs. If monthly averages were used, please comment on applicability and validity of applying model trained based on instantaneous measurements to monthly averages?

Application to FVCOM, scales the model to extended space and time, which I think is a key strength and contribution of this work. Spatial bias has been discussed and reported in the manuscript, but it would be important to discuss the model performance in time. Cruise observations were only from select few months, but is the model able to fill in between the seasons reasonably? And if yes, why? If no, why not?

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Final output of ANN applied to FVCOM data would be a time series of full spatial data i.e. pixel-wise pH estimate for ECS. That product is a key contribution that should be included in the manuscript, and spatial and temporal patterns of the outputs should be discussed.

Variable importance in the ANN model: The methodology here is not clear to me. What does adding 5% to environmental variable separately means? Is this a perturbation to the data to test its sensitivity? In either case, I am not at all convinced that this can be quantified as variable importance. There also is mention of "variable with greatest weight was DO, followed by S and T". What weights are looking at here, is this from the final trained model? From first layer, from second layer, or both? This section need additional detail and discussion to convey and convince the interpretation of variable importance.

Please improve the quality of figures 1 and 6, as they are difficult to read and follow.

In Figures 9 and 11, I am unable to understand what "ANN Model - RMSE" and "ANN Model + RMSE", and thus the related discussions.

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