Using a Neural Network Model Coupled to a Real-Time Ocean Forecast System for Short-Term Ocean Color Predictions

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In this paper, a Neural Network (NN) model using vertical profiles (0-200m) of temperature, salinity, and zonal velocity and sea surface height fields from the operational Real-Time Ocean Forecast System (ROTFS; Mehra, *et al*, 2011) is used to produce short-term global ocean color (OC: chlorophyll-a and KdPar) forecasts. The underlying scientific premise of this NN model is that ocean color fields — signatures of ocean biological processes — can be statistically correlated to upper ocean physical states. The NN model is trained over many months (July 2013 to December 2015) using NOAA Visible Infrared Imaging Radiometer Suite (VIIRS) science-quality ocean color fields and RTOFS inputs. Then the trained NN model is used for ocean color predictions for an independent data set from 2016. The purpose of this preliminary study is to test the suitability of this coarse-resolution NN model: (a) for initiating global ocean color predictions, (b) as a proof-of-concept for the NN model configuration, and (c) as a test case for embedding the NN ocean color model in future versions of the coupled seasonal forecasting system. As shown in Figures 1 and 2, the coarse-resolution NN model is able to successfully predict the OC fields over most of the tropical oceans, but there are many regions in the global oceans where the NN model has significant issues.

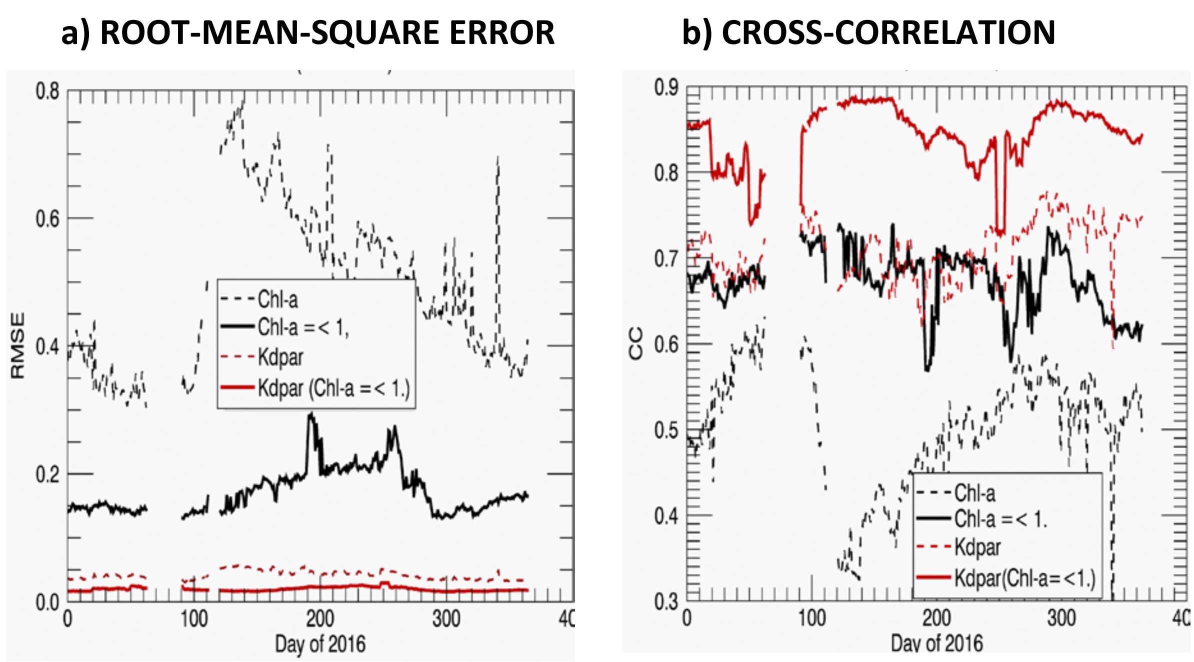

Figure 1: Time-Series plots of: (a) global root-mean-square error, and (b) global cross-correlation for Neural Network daily chlorophyll-a and kdpar predictions for 2016.

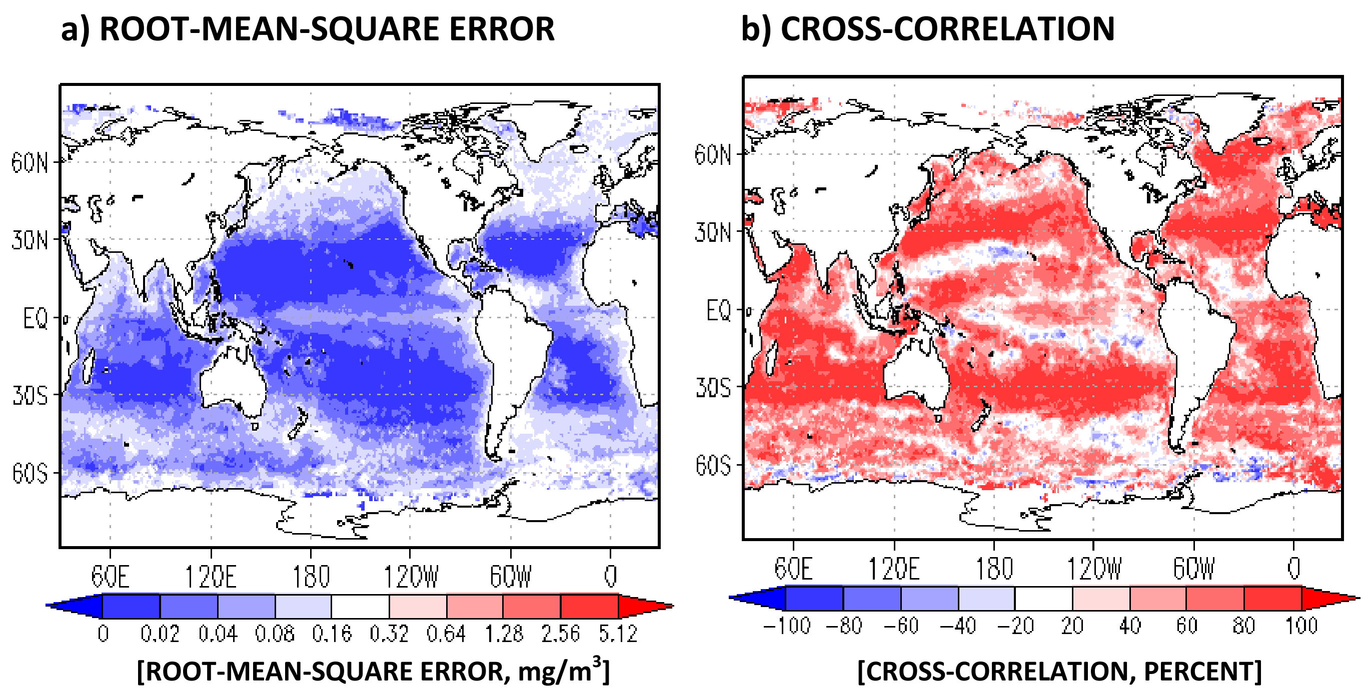

Figure 2: Spatial plots of: (a) root-mean-square error (mg/m^3), and (b) cross-correlation (percent) for Neural Network daily chlorophyll-a predictions for 2016.

In this coarse-resolution proof-of-concept, the 1/12-degree RTOFS inputs and 4-Km VIIRS ocean color fields were collocated into $1^o x1^o$ resolution for July 2013-December, 2016. The test set spans 07/5/2013 to 12/31/2015; and the validation set is from 1/1/2016 to 12/30/2016. While the NN provides excellent results over many oceanic domains, there are significant errors over the continental shelves and the oligotropic subtropical gyres, where the signal-to-noise ratio is low with low potential predictability. Also, the NN performs significantly better for kdpar than for chlorophyll-a and for low values of chlorophyll-a. These results are similar to that shown in Nadiga, *et al.* (2015) and Krasnopolsky, *et al.*, (2017). The expected NOAA users of this new potential capability are NCEP, for improved ocean and coupled modeling (incorporating 2-way coupling to account for biological variability in weather/climate system), NMFS, for gap-filled ocean color predictions in fisheries monitoring, and NOS, for ocean color boundary conditions for coastal /estuarine modeling.

References:

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- Krasnopolsky, V., Nadiga, S., Mehra, A., Bayler, E., and Kim, H.-C., Optimization of a Neural Network-Based Biological Model for Chlorophyll-a Concentrations in the Upper Ocean, NCEP Office Note, 487, 2017.