A Deep Learning Driven Improved Ensemble Approach for Hurricane Forecasting

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INTRODUCTION and MOTIVATION

• Tracking the path and forecasting the intensity of hurricanes are challenging. Dynamical models produce a significant model-measurement error. Accurate forecasting is very difficult to achieve after landfall.
• For track forecasting (where the storm is going to go), dynamical models are generally the best. For intensity forecasting, statistical models generally perform better. We can combine the advantages of both models using an machine learning ensemble approach.
• Machine learning models are computationally efficient and are currently used widely for forecasting and ensemble purposes. Deep Neural network (DNN) techniques comprise a popular and powerful class of machine learning methods.
• Here, we used a deep learning-based approach to ensemble eight global and regional dynamical models for forecasting hurricane track and intensity.

MATERIALS and METHODS

Deep Learning Algorithm

• A deep convolutional neural networks (CNN) was implemented for predicting hourly ozone concentration. Inspired by biological processes, CNN is a class of deep, feed-forward artificial neural networks.
• CNN uses relatively little pre-processing compared to other machine learning techniques. This means that the network learns the features that in traditional algorithms would be engineered.
• In CNN (Figure 1), the convolutional layer applies a convolution operation to the input, passing the result to the next layer. The fully connected layer connects every neuron in the last convolutional layer to every neuron in the output layer, similar to the traditional multi-layer perceptron neural network (MLP).

Figure 1: Schematic for the regressive 1D convolutional neural networks (ConvNet-ID).

Figure 2: Schematic for the UH ML Ensemble Hurricane Forecasting System.

Table 1: Summary of global and regional dynamical models for track and intensity used in this study.

RESULTS (Tropical Cyclones, 2017)

• All tropical cyclone of the North Atlantic in 2017 were selected as the case study for the UH ML Ensemble (UH MLE) Hurricane Forecasting System.
• Root mean square error (RMSE) were calculated for position and intensity for each cyclones individually (Figure 4).

Figure 3: Historical tropical cyclone archive collected by International Best Track Archive for Climate Stewardship (IBTrACS) at https://www.ncdc.noaa.gov/ibtracs/.

Figure 4: Box plots comparing UH Machine Learning Ensemble (UH MLE) Hurricane Modeling System and NHC-official forecast (OFDF).