A Novel Approach for Tropical Cyclone Track Forecast Across the Atlantic Basin

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Over the period from 2008 to 2022, the United States experienced 263 tropical cyclones in the Atlantic basin. The ability to accurately predict the track of tropical cyclones is essential for saving human lives and minimizing property damage. The Global Ensemble Forecast System (GEFS) is a sophisticated physics-based model with 21 ensemble members for tropical cyclone track predictions. To derive a consensus tropical cyclone track forecast from the 21 ensemble members, an average is calculated, herein referred to as GEFS Mean. However, the GEFS Mean has a large 5-day track prediction error when compared against the Best Track, which is the actual tropical cyclone track. To generate the tropical cyclone predicted track with minimal error, a CNN model was developed. Tropical cyclone storm data from 2008 to 2022 were processed to create multiple 5-day forecast sequences of the 21 GEFS predictions and corresponding Best Track. K-fold cross-validation was used to determine a more reliable accuracy score. The relative improvement percentage was evaluated for assessing the enhancement achieved by the CNN Model over the GEFS Mean. The CNN Model improved the GEFS Mean for tropical cyclones such as Hurricane Danielle (2010), Hurricane Ernesto (2012), Hurricane Harvey (2017), Hurricane Maria (2017), Hurricane Larry (2021), and Hurricane Ian (2022). The CNN Model generally outperforms the GEFS Mean and offers a more reliable and accurate prediction performance compared to the GEFS Mean. Future research will include incorporating other ensemble forecasting systems such as European Centre for Medium-Range Weather Forecasts (ECMWF) for better tropical cyclone track prediction.

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