Hurricane Rapid Intensification Convolutional Neural Network: A Novel Deep Learning Model for Predicting Tropical Cyclone Rapid Intensification Using 20 Years of Satellite Rainfall Data

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The rapid intensification (RI) of tropical cyclones (TCs) is one of the greatest challenges for forecasters. Improving the skill for RI forecasts has been a top priority of the National Hurricane Center (NHC). The Statistical Hurricane Intensity Prediction Scheme RI Index (SHIPS RII) is one of the most accurate models used operationally at NHC. The SHIPS RII uses predictors including climatology and persistence, environmental conditions, and infrared satellite information. One critical piece of information that is missing from SHIPS RII is the rainfall and structural features of TCs. In this study, I developed a novel Hurricane Rapid Intensification Convolutional Neural Network (HRICNN) model to predict the probability of future 24-h RI by using satellite rainfall images and SHIPS predictors. I designed the HRICNN model to detect specific TC structures such as the symmetry of the rainfall pattern associated with RI. A 20-year satellite rainfall dataset was obtained from the NASA Integrated Multi-satellite Retrievals for the Global Precipitation Measurement (GPM) mission (IMERG) product for TCs from the Atlantic basin. The HRICNN model was tested for 4 different radii of the IMERG data from the TC center and 300-km was selected. The model was trained using satellite images for TCs from 2000-2017 and tested using TCs from 2018-2019. My HRICNN model outperforms the SHIPS RII in terms of the Peirce Skill Score by 73% and Brier Skill Score by 13%. The HRICNN model's probability of detection is 7% higher than the SHIPS RII, while the false alarm ratio is 3% lower.

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