A Novel Deep Learning Model for Estimating Tropical Cyclone Intensity from Satellite Images

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Estimating the intensity of tropical cyclones (TCs) is one of the most important aspects in TC forecasts. Currently, the operational method of TC intensity estimation is the Dvorak Technique. In this study, a novel Convolutional Neural Network (CNN) model was developed to estimate the current TC intensity by using rainfall images from satellite observations. CNNs have been shown to be able to identify specific patterns in images. In this case, the CNN model was designed to identify circular arcs within the TC rainfall structure. The satellite rainfall data used in this study were collected by the NASA Tropical Rainfall Measuring Mission (TRMM) and the Global Precipitation Measurement (GPM) satellite missions during 1998-2016. This study utilized a total of 6350 rainfall rate images of TCs derived from the TRMM/GPM 3B42 multi-satellite product for a total of 299 TCs from the North Atlantic basin. TC center locations and current intensities were obtained from the Hurricane Best Track dataset. The model was trained using 24x24 pixel images of the TCs, with the rain rate of each pixel represented as a grayscale value. Multiple different CNN architectures were tested for accuracy to select the best model for estimating TC intensity. The final model was trained using all TCs from 1998-2015 and tested using TCs from 2016. Results showed that this model outperformed all previous TC intensity estimation algorithms including the Dvorak Technique. It had a large improvement on major hurricanes, therefore can be used to dramatically improve disaster response.

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