Multi-task learning based tropical cyclone intensity forecasting through the synergistic fusion of geostationary satellite data and numerical forecasting model output

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The accurate monitoring and forecasting of the intensity of tropical cyclones (TCs) are able to effectively reduce the overall costs of disaster management. In this study, we proposed a multi-task learning (MTL) based deep learning model for real-time TC intensity forecasting with the lead time of 6-48 hours following the event, based on the synergistic fusion of geostationary satellite images and numerical forecast model output. The Communications system, the Ocean and Meteorological Satellite (COMS) Meteorological Imager (MI) data were used to extract the images of typhoons, and the Climate Forecast System version 2 (CFSv2) provided by the National Center of Environmental Prediction (NCEP) was employed to extract air and ocean forecasting data. This study suggested two schemes with different input variables to the MTL models. Scheme 1 used only satellite-based input data while scheme 2 used both satellite images and numerical forecast modeling. For TC intensity forecasting with the lead time of 6 and 48 hours, scheme 2 improved the performance by 13% and 16%, respectively, in terms of the root mean squared error (RMSE) when compared to scheme 1. Relative root mean squared errors (rRMSE) for most intensity levels were less than 30%. The lower mean absolute error (MAE) and RMSE were found for the lower intensity levels of TCs. The MTL models reduced the computational cost about 300% when compared to the single-tasking model, which suggested the feasibility of the rapid production of TC intensity forecasts.

Key words: Tropical cyclone, Intensity forecasting, Multi-task learning, Geostationary satellite, Numerical forecasting model

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