Deep learning based Tropical cyclone intensity monitoring and forecasting

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Abstract: Tropical cyclone (TC) is a typical phenomenon of the interaction between the atmosphere and ocean. Depending on the condition of the ocean and atmosphere, TCs can develop, disappear, or reinforce their intensity. However, their behavior has been changed unpredictably due to climate change (Seneviratne et al., 2012). It is the reason that empirical analysis of TC is considered more, recently. The geostationary satellite is one of the most reliable means for observing TCs and it has been used for getting significant information about TCs such as intensity. Furthermore, numerical model based products provides the theoretical analysis products which cannot be obtained using satellite based data.

In this study, we proposed the deep learning based empirical model using satellite based infrared images and numerical model results. The data employed in this study are infrared (IR) channels, U wind (U), V wind (V), Vertical Wind Shear (VWS). IR channels were obtained from Communicate, Ocean and Meteorological Satellite (COMS) Meteorological Imager (MI) of the Korea Meteorological Administration (KMA). The COMS is one of the geostationary satellites which monitoring east side of the earth with 15 minute interval and 0.5 to 4 km spatial resolution. The U, V and VWS wind component were acquired from European Centre for Medium-Range Weather Forecasts Era-interim (ECMWF ERA Interim) with a 6 hour interval and 0.7˚ spatial resolution. The TC location and intensity data are obtained from the Best track data of Joint Typhoon Warning Center (JTWC). The observed and theoretically analysed data are employed for monitoring and forecasting TC intensity using Multi-task learning approach (MTL). While most of deep learning approaches take the inputs as independent variables, MTL considers the relationships between input variables. MTL contains two parts; Task-specific layers and sharing layers. In our model, the significant feature vectors are extracted from IR images of TC using Convolutional neural networks (CNNs) in former one and the numerical model based wind components (U, V and VWS) were aggregated in sharing layer. Our model preliminary shows 15.75 kts of monitoring Root Mean Squared Error (RMSE), 14.40 kts of 6-hrs forecasting RMSE and 15.6 kts of 12-hrs forecasting RMSE.

Keywords: Tropical cyclone intensity, disaster monitoring and forecasting, multi-task deep learning, Convolutional neural networks