Investigation on convolutional neural network models for the improvement of rainfall nowcasting from the Multi Parameter Phased Array Weather Radar observations

*DONGKYUN KIM[1], Taku Suezawa[2], Tomoo Ushio[1]

1. Osaka University, 2. Tokyo Metropolitan University

Nowcasting convective rainfall with accuracy has long been a significant challenge in meteorological societies to prevent hazardous weather phenomena. Compared to conventional one, its technique combined with artificial neural networks (ANN) which capture spatiotemporal features for sequences of measurements has rapidly been advanced in recent years. The main purpose of this research is to develop ANN nowcasting models and make better prediction of radar reflectivity (or rain intensity) images for precipitation systems in different type (isolated or organized band, etc.) occurred in urban areas over a short period of time (<1 h) by using the ANN models and related schemes.

For mesoscale convective systems occurred around the Tokyo metropolitan area on 1 June, 2019 and 24 July, 2018, we create nowcasting prediction models comprised of ANNs for datasets observed by the X-band Multi Parameter Phased Array Weather Radar (MP-PAWR) at Saitama city and test their performance in each event. The MP-PAWR can observe three-dimensional structure of convective systems with a range of 60 km at every 30 sec. In order to detect the characteristics of 2-D radar image sequences, we applied an optical flow method to obtain echo motion vectors of the precipitation systems and made datasets of parameters such as Constant Altitude Plan Position Indicator (CAPPI) reflectivities at 2 km AGL, reflectivity gradients, motion vectors, and maximum heights with a threshold of 15 dBZ at each pixel as input to the neural network models. The x and y pixel resolution is 250 m.

First, we trained time-sequence radar image data at consecutive times and simulated the neural network models also for the remaining test data with the same time sequence in order to predict radar echo fields at one output time (i.e., many to one forecast). For time-dependent data, the sequence of data is important. We simulated these models with varying the time sequence from 5 to 9 and other conditions. In this research, we created the several ANN models by using various architectures and fully-connected layers such as Long Short Term Memory (LSTM), 1-D and 2-D Convolutional Neural Network (CNN), combined CNN-LSTM, and convolutional LSTM (ConvLSTM) to improve the short-term precipitation nowcasting and evaluate the performance of each ANN model for these events. In this presentation, we present results on comparisons with lead time of forecast and evaluations of these from using threat score values based on metrics such as probability of detection (POD) and false alarm ratio (FAR), which are commonly used for rainfall nowcasting.

Keywords: Phased array weather radar, Precipitation nowcasting, Convolutional neural network

