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The application of recurrent neural network in nowcasting

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Radar extrapolation is an important means in nowcasting. The main methods in radar extrapolation in China are COTREC and Optical Flow. Two consecutive echo are used to diagnose the advection velocity within rain analyses, which involove the solution of Lagrangian persistence equation. In this paper, RNN(Recurrent Neural Network) is applied in nowcasting. Using PredRNN(Predictive RNN), by modeling historical radar data, the prediction of radar echo in the next 1 hour is given. PredRNN consisted of ST-LSTM unit, which is an improved of LSTM. One of the advantages of using PredRNN is the operation of the state accumulation and the hidden layer output is replaced by convolution. So the neurons not only can get timing relationships, but also extract spatial features like convolutional layers. Another one of the advantages of using PredRNN is the addition of a new spatial memory, which can enhance the transportation of the spatial feature information in different layers. Beijing Daxing and Guangzhou radar are used in this paper to test model performance in different areas in China. Before nowcasing, radar echo is quality controlled to remove isolated echo, abnormal echo, invalid radial, echo below 15dBZ and ground echo, and then combined reflectivity(CR) is made by 0-5 layers of data. To examine the applicability of the PredRNN, a contrast experiment has been designed between PredRNN and COTREC, including an independent verification over months of each radar and two severe convective cases analysis. The test is carried out by point by point in three different reflectivity factor threshold,20dBZ,30dBZ and 50dBZ. The indexes of verification are CSI, POD, FAR. The time range of the test is 0-1h by 6min. The results show that: 1) PredRNN has better forecast performance in all the verification items. Especially, in 20dBZ and 30dBZ, CSI can be raised by 0.15-0.3, POD can be raised by 0.15-0.25, FAR can be reduced by 0.15-0.2. 2) The effect of improvement in 1) increases with time. Although, the forecast performance of both PredRNN and COTREC falls with time, but the PredRNN method descends more slowly. 3) The forecast performance of both PredRNN and COTREC falls with the increase of the combined reflectivity factor strength, which shows the insufficient of prediction ability for the region with intensity over 50dBZ. 4) Two cases show that the PredRNN method has predictive ability for the change of reflectivity factor intensity. In summary, PredRNN is suitable for nowcasting, and its forecast performance is much better than COTREC.