Combining Generative Adversarial Networks with Multifractals for Urban Precipitation Nowcasting

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Precipitation nowcasting, referring to short-term forecasting ahead for 0 to 6 hours, is an important aspect of many urban meteorological and hydrological studies. This is due to the fact that reliable nowcasting can serve as an early warning of massive flooding and a guide for water-related risk management, making it highly significant in urban areas from a socio-economic perspective. Precipitation exhibits extreme variability over a wide range of space-time scales, so nowcasting is essentially a spatiotemporal sequence forecasting. Convolutional long short-term memory (ConvLSTM) models are frequently used to capture the spatiotemporal correlation, but they often struggle with an issue that produces blurry predictions. Therefore, generative adversarial network (GAN) architecture is employed to achieve more detailed and realistic predictions. The framework of universal multifractal (UM) with only three scale-independent parameters ($\alpha, C_1, H$) is also introduced in the deep learning model to characterize the extreme variability of precipitation. The developed hybrid approach using stochastic models physically based on the cascade paradigm ensures that intermittency is directly taken into account, including in the generation of uncertainty. In addition to the common evaluating metrics, like mean absolute error (MAE), root mean squared error (RMSE), critical success index (CSI), probability of detection (POD), power spectral density (PSD) and UM are also introduced to evaluate nowcasting performance in the spectrum space. This ongoing work is based on the previous research about combining recurrent neural networks with variational mode decomposition and multifractals to predict rainfall time series in Paris area.