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ResConvLSTM-GAN: a new deep learning nowcast model for radar and satellite imagery

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ResConvLSTM-GAN: 用于雷达及卫星图像的全新深度学习临近预报模型

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摘要

深度学习或机器学习算法近年迅速发展，在不同时间尺度的气象预测中展示鼓舞的成果。对于雷达反射率图像的临近预报，机器学习比利用基于光流法演算的回波移动来进行外推更具优势。不过，机器学习模型面对着一个问题，它们产生的一两小时之后的临近预报图像会变得模糊，未能有效捕捉大雨及强对流。本文提出一个全新的机器学习框架，名为 ResConvLSTM-GAN，利用对抗生成网络(GAN)的架构及特征转换技巧来改进卷积长短期记忆模型(ConvLSTM)。透过比对轨迹门控循环单元(TrajGRU)的临近预报，显示 ResConvLSTM-GAN 能有效保留和产生小尺度特征。本文亦阐述 ResConvLSTM-GAN 于卫星图像的应用，以加强覆盖更大范围的降雨及强对流临近预报。

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Abstract

Deep learning or machine learning (ML) algorithms have been evolving rapidly in recent years, demonstrating promising performance in different time scales of meteorological predictions. In nowcasting radar reflectivity imagery, ML clearly shows an edge over extrapolation using motion field of echoes based on optical flow method. However, ML models have a problem that blurrier images are generated beyond one or two hours of nowcasts, making them ineffective in capturing heavy rain and significant convection. This paper proposes a new ML framework, namely ResConvLSTM-GAN, to enhance the convolutional long short-term memory (ConvLSTM) model using the generative adversarial network (GAN) pipeline and style transfer technique. It is shown that ResConvLSTM-GAN can maintain or generate small-scale features effectively when compared with the ML nowcast based on Trajectory Gated Recurrence Unit (TrajGRU). Application of ResConvLSTM-GAN to satellite imagery to enhance rainfall or significant convection nowcasts over a larger geographical coverage will also be illustrated in this paper.