환경 및 응용기상 분과 [P-056]

Deep Learning Prediction of Rapidly Developing Convective Storms and Their Rain Rates Using MTG Satellite Data Over West Africa

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Convective storms in West Africa develop quickly and often produce severe rainfall, flooding, and lightning. Their rapid evolution poses a major challenge for early warning and disaster preparedness, especially in a region with sparse ground-based observations. Geostationary satellites now provide high-resolution, frequent observations of storm clouds and lightning, creating new opportunities for timely storm detection. In this study, we apply a hybrid Causal Masked Video Prediction–ConvLSTM (CMVP-ConvLSTM) framework to Meteosat Third Generation (MTG) brightness temperature and lightning observations, with supporting IMERG rainfall estimates. The analysis focuses on storm cases from September to December 2024. The model was trained on calibrated satellite brightness temperature sequences and storm masks defined by convective thresholds (<235 K). The framework generates forecasts of brightness temperature and storm probability maps up to 1–2 hours ahead. Preliminary findings show that it improves the early detection of convective initiation compared with baseline ConvLSTM models. The model produces clearer forecasts of cloud-top cooling, identifies developing convection earlier, and shows stronger consistency with observed lightning activity. While rainfall estimation remains a secondary benefit, the main value lies in improving early warning through better storm detection. This study demonstrates how deep learning combined with high-resolution satellite data can effectively enhance nowcasting capabilities in data-sparse regions. This approach provides a foundation for strengthening early warning systems in West Africa, where timely detection of developing storms is critical for disaster risk reduction.

Keywords: Convective storms, Early detection, Deep learning, Brightness temperature, West Africa