대기물리 분과 [P-055]

Estimation of atmospheric profiles using a deep neural network with Geostationary Interferometric Infrared Sounder (GIIRS)

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Vertical profiles of atmospheric temperature and humidity (T/q) are the fundamental meteorological parameters used in monitoring atmospheric instability and other related weather phenomenon. Atmospheric T/q profiles are usually measured from the global radiosonde network and ground- and satellite-based sounding instruments. However, methods for obtaining atmospheric T/q profiles present a trade-off between vertical accuracy and spatiotemporal resolution. Although the global radiosonde network offers high accuracy, its data is limited by coarse spatiotemporal sampling. Conversely, satellite remote sensing provides excellent spatial coverage but suffers from uncertainties in vertical layers near the surface due to ground-contaminated signals on satellite-measured radiances. Besides, processing physical algorithms (e.g., One-dimensional variational method, 1DVAR) used for retrieving atmospheric T/q profiles requires background information served as a short-term prior prediction, usually obtained from Numerical Weather Predictions. As such, the accuracy of retrieval algorithms is driven by the quality of background information; therefore, the 1DVAR retrieval algorithms might face significant uncertainty if errors remain in the background information and this is not adequately addressed in background error covariance matrix. On the other hand, machine learning techniques are reported to have comparable performance with numerical simplicity and efficiency but without the need for background information.

Accordingly, this study attempts to overcome these difficulties by applying a deep residual neural network to retrieve atmospheric T/q profile with infrared sounder of Geostationary Interferometric Infrared Sounder (GIIRS) onboard FengYun-4B satellite. The main objective of this research is to enhance a technique that might provide high accuracy of the vertical atmospheric profiles to benefit weather forecasting under all sky conditions (i.e., clear or cloudy skies). This research is conducted using 1-year GIIRS dataset of 2023 that covers East Asia area where it is highly vulnerable to extreme precipitation every year. The introduced machine learning-based model in this research might bring a versatile and effective tool for atmospheric sounding, which introduces a new pathway toward more accurate weather forecasting for future climate research.

Keywords: GIIRS, ResNET, machine learning, temperature, humidity

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