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Estimating Land Surface Temperature from AMSR-E and AMSR2 Data with Convolutional Neural Network

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Land surface temperature (LST) is a key factor in earth–atmosphere interactions and an important indicator for monitoring environmental changes and energy balance on Earth's surface. Thermal infrared (TIR) remote sensing can only obtain valid observations under clear-sky conditions, which results in the discontinuities of the LST time series. In contrast, passive microwave (PMW) remote sensing can help estimate the LST under cloudy conditions and the LST generated by PMW observations is an important input parameter for generating medium-resolution (e.g., 1km) all-weather LST. Neural networks, especially the latest deep learning, have exhibited good ability in estimating surface parameters from satellite remote sensing. However, thorough examinations of neural networks in the estimation of LST from satellite PMW observations are still lacking. In this study, we examined the performances of the traditional neural network (NN), deep belief network (DBN), and convolutional neural network (CNN) in estimating LST from the Advanced Microwave Scanning Radiometer for EOS (AMSR-E) and Advanced Microwave Scanning Radiometer 2 (AMSR2) data over the Chinese landmass. The examination results show that CNN is better than NN and DBN by 0.1–0.4 K. Different combinations of input parameters were examined to get the best combinations for the daytime and nighttime conditions. The best combinations are the brightness temperatures (BTs), NDVI, air temperature, and day of the year (DOY) for the daytime and BTs and air temperature for the nighttime. Compared with the MODIS LST, the CNN LST estimates yielded root-mean-square differences (RMSDs) of 2.19–3.58 K for the daytime and 1.43–2.14 K for the nighttime for diverse land cover types for AMSR-E. Validation based on the in-situ LST demonstrates that the CNN LST yielded root-mean-square errors of 2.10–5.34 K and the error analysis confirms that the main reason for the errors is the scale mismatching between the ground stations and the MW pixels. This study helps better the understanding of the use of neural networks for estimating LST from satellite MW observations.