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Retrieval of total precipitable water under all-weather conditions from Himawari-8/AHI observations using the generative diffusion model

Abstract

Accurate and high spatiotemporal resolution total precipitable water (TPW) under all-weather conditions is a key factor in understanding meteorological and hydrological processes; however, it has not been successfully retrieved before. Therefore, this study introduces a novel machine learning framework based on a generative diffusion model, further improved by a categorical boosting algorithm, called the TPWDiff-CB, to retrieve TPW from the thermal infrared (TIR) bands of the Advanced Himawari Imager (AHI) aboard Himawari-8. The model was trained with ERA5 and radiosonde data in East Asia and Australia. Compared with the radiosonde TPW, TPWDiff-CB achieves a correlation coefficient (R) of 0.98 and a root mean square error of 4.51 mm under all weather conditions. The model performs well in both clear-sky and cloudy-sky, outperforming a random forest (RF) baseline, particularly under cloudy cases. This result suggests that TPWDiff-CB's ability to capture TPW distribution is crucial. This study highlights the potential of the generative diffusion model for all-weather TPW retrieval.

Keyword

Total precipitable water (TPW), diffusion model

Reference

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