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Evaluation of ERA5 Reanalysis Precipitation Data in Pearl River Basin in South China

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ABSTRACT

With global warming, the frequency of extreme precipitation events is continuously increasing. The Pearl River Basin is an important region for agricultural production and population concentration in China. Extreme precipitation events have significant impacts on various aspects such as agriculture, transportation, and water resources in this region. The ERA5 reanalysis dataset is a global atmospheric reanalysis product with high spatial and temporal resolution, as well as diverse meteorological information, offering substantial research value for basin weather forecasting and climate change studies. Based on daily precipitation data from 71 meteorological stations in the Pearl River Basin from 1961 to 2018 and ERA5 reanalysis precipitation data, this study evaluates ERA5's detection capability for rainy days, analyzes its accuracy in simulating precipitation, and assesses its ability to characterize extreme precipitation indices using six selected statistical metrics and five extreme precipitation indices. The main conclusions are as follows:

(1) The ERA5 reanalysis precipitation data demonstrates good detection capability for rainy days. Its performance at the annual scale is better than at the seasonal scale, and the seasonal scale outperforms the monthly scale. On the monthly scale, the Probability of Detection (POD) is highest in July and August, while the False Alarm Ratio (FAR) is highest in July. On the seasonal scale, POD is highest in summer and autumn, while FAR is highest in autumn and winter. Across all scales, the Equitable Threat Score (ETS) is greater than 0, indicating that ERA5 successfully forecasts rainy days.

(2) The ERA5 reanalysis precipitation data can reproduce precipitation at monthly, seasonal, and annual scales. On the monthly scale, the Root Mean Square Error (RMSE) is highest in June. On the seasonal scale, RMSE is highest in autumn and lowest in winter. Across all scales, cases with Relative Bias (RB) > 0 (overestimation) are more frequent than those with RB < 0 (underestimation). Additionally, the Correlation Coefficient (CC) is relatively high at all scales, indicating a strong linear relationship between ground station-observed precipitation data and ERA5 reanalysis precipitation data.

(3) Extreme precipitation indices based on station-observed precipitation data show an increasing trend, while those based on ERA5 exhibit relatively stable changes. For ERA5 reanalysis precipitation data, the extreme precipitation indices PRCPTOT, RX5d, R95p, and P99p initially showed an overestimation trend before 2000, which gradually shifted to an underestimation trend with increasingly larger deviations afterward. Notably, PRCPTOT experienced an abrupt change around 2000, showing a significant decreasing trend. In contrast, RX1d consistently exhibited an underestimation trend, with the deviation growing larger over time.

KEYWORDS

ERA5; extreme precipitation; performance evaluation indicators; pearl river basin

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