Qeios

Peer Review

Review of: "Spatiotemporal Forecasting in Climate Data Using EOFs and Machine Learning Models: A Case Study in Chile"

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The prediction of precipitation using multivariate climatic variables through Empirical Orthogonal Function (EOF) analysis is indeed an attractive and cost-effective technique. This study aims to predict the major EOF modes using various machine learning methods over Chile and conducts an inter-comparison, concluding that the MODWT method outperforms others. The findings offer valuable insights for planning and water resource management.

However, several critical issues need to be addressed in greater detail, as they warrant further explanation:

Operational Forecasting and Border Distortion

EOF-based predictions, when integrated into operational forecasting, often suffer from border distortions. These distortions can significantly degrade the accuracy of forecasts during the operational phase compared to the testing phase. Unfortunately, the manuscript does not discuss any such issues or outline how they were tracked or mitigated in the context of operational forecasting.

EOF Analysis Period and Methodological Caveat

The issue mentioned above typically arises when EOF analysis is conducted jointly over the training and testing periods. Best practices recommend performing EOF decomposition separately for training and testing datasets to avoid data leakage and unrealistic performance estimates. The authors are encouraged to clarify the time periods used for EOF analysis and include a discussion on this methodological caveat.

Underestimation of Extreme Events in LSTM Predictions

Figure 5 illustrates that LSTM models significantly underestimate the EOF mode amplitudes, particularly for extreme events. While the WNN model somewhat addresses this underestimation, it still fails to

 doi.org/10.32388/LJOWXZ

capture the magnitude of such events accurately. Given that extremes are particularly critical from a planning and risk management perspective, model performance under such conditions should be evaluated and reported separately.

Cluster Predictions and Border Effects (Figure 6)

In Figure 6, predictions for clusters C2–C7 are presented. However, it is unclear whether the predicted EOF modes were recombined to generate these cluster-level forecasts. If so, the manuscript should explain how border distortions—commonly observed in such reconstructions—were addressed or mitigated.

Seasonal Context of Predictions (Figure 6)

The figure shows predicted and observed values, but it is not specified whether these correspond to a specific season (e.g., the rainy season) in each year. Clarifying the temporal context of the data shown in Figure 6 would greatly enhance interpretability.

Update of Spatial Coefficients (Figure 4)

Figure 4 could be enhanced by analyzing how the inclusion of 2022 data affects the spatial coefficients of the EOF modes. Including an additional figure or panel to highlight changes in spatial patterns due to the updated dataset would provide further insight into the model's adaptability and robustness.

Border Distortion Reference

Quilty, J., & Adamowski, J. (2018). Addressing the incorrect usage of wavelet-based hydrological and water resources forecasting models for real-world applications with best practices and a new forecasting framework. *Journal of Hydrology*, *563*, 336-353.

Pacola, E. R., Quandt, V. I., Liberalesso, P. B. N., Pichorim, S. F., Gamba, H. R., & Sovierzoski, M. A. (2016). Influences of the signal border extension in the discrete wavelet transform in EEG spike detection. *Research on Biomedical Engineering*, *32*, 253-262.

Pacola, E. R., Quandt, V. I., Liberalesso, P. B. N., Pichorim, S. F., Gamba, H. R., & Sovierzoski, M. A. (2016). Influences of the signal border extension in the discrete wavelet transform in EEG spike detection. *Research on Biomedical Engineering*, *32*, 253-262.

Extreme Event Analysis

Herman, G. R., & Schumacher, R. S. (2016). Extreme precipitation in models: An evaluation. *Weather and Forecasting*, *31*(6), 1853-1879.

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Declarations

Potential competing interests: No potential competing interests to declare.