Response to Reviewer 2 Comments

General reply to the reviewer*: We would like to express our gratitude to the reviewer for their invaluable suggestions and comments. These comments have indicated to be very important for strengthening our manuscript draft. It gave us an opportunity to look at our work in a different way.*

This manuscript presents a promising and methodologically innovative approach to drought modeling, particularly with its integration SG-CEEMDAN-ARIMA-LSTM. However, to meet the rigor expected by journal, the following revisions would strengthen its statistical grounding and reproducibility:

1- It is recommended incorporating the most recent literature (particularly studies published in 2024-2025) on hybrid drought forecasting methods to ensure the methodology reflects current advances in the field

Reply: *We would like to thank the reviewer for this comment. This was done. we have included the latest studies.*

2- The upper bound of the cumulative probability function $H(x)$ in Equation 21 is incorrectly defined to include the value 1. This leads to an undefined expression:

$$ln\left(\left(\frac{1}{1-H(x)}\right)^2\right)$$

when $H(x) = 1$, which evaluates to $ln(\infty)$. This is mathematically invalid and computationally dangerous, as it can cause overflow or undefined behavior in implementation. The formula must be constrained to $H(x) \in (0,1)$, not $[0,1]$. This critical issue must be addressed and corrected in the manuscript before further consideration.

Reply: *We would like to thank the reviewer for this comment. We replaced "≤" by "<".*

3- Even though MMK (Modified Mann-Kendall) is applied, the paper doesn't explain how the lag selection was determined for autocorrelation adjustments. Additionally, there are no ACF or PACF plots provided to support the chosen ARIMA model order.

Reply: *We would like to thank the reviewer for this comment. This was included and explained under the results section. The study utilised auto_arima() function instead of ACF or PACF.*

4- Before using ARIMA, the study should have checked for stationarity using tests like ADF, but this step isn't mentioned. Also, it's unclear whether the data was normalized or scaled before being fed into the LSTM model or not.

Reply: *We would like to thank the reviewer for this comment. This was included and explained under the results section. The study utilised Box-Jenkins methodology to check the stationarity as the first step. On fitting the LSTM, the data normalization was applied and explained in the process of the hybrid model (see Figure 5).*

5- While the baseline models (ARIMA, LSTM, and CEEMDAN-LSTM) provide useful predictions, the study lacks a formal statistical comparison such as ANOVA to objectively assess their accuracy differences.

Reply: *We thank the reviewer for this important comment. We have noticed the following with the idea to use ANOVA:*

Assumptions of ANOVA do not hold for time series Independence*: ANOVA assumes that observations are independent. In time series, values are autocorrelated (today's value depends on yesterday's), which violates this assumption.*

Normality of residuals: Forecast errors in models like ARIMA or LSTM are not always normally distributed, especially in nonlinear settings.

Equal variance (homoscedasticity): Time series errors often have changing variance (heteroscedasticity).

Thus, because of these violations, the classical ANOVA test can give misleading results.

ANOVA is typically used to test if mean differences between groups are statistically significant.

In forecasting, the focus is not usually on comparing means but on predictive accuracy — how close forecasts are to observed values.

Metrics like RMSE, MAE, MAPE, NSE, R^2 are more informative than ANOVA F-tests.

We should mention that we did try it though, and it was apparent that Running an ANOVA on forecast errors assume residual independence, which is not valid because errors are serially correlated.

We also invite the reviewer to view any paper that does time series forecasting. All of them avoid using ANOVA, but rather use Metrics like RMSE, MAE, MAPE, NSE, R^2. In this paper we go one step further by using directional symmetry as well.

See example paper in this link:
https://scholar.google.com/scholar?hl=en&as_sdt=0%2C5&q=time+series+forecasting+using+ARIMA%2C+LSTM+...&btnG=