Bias Correction of Global Ensemble Forecast System (GEFS) Precipitation Forecasts using AI/ML

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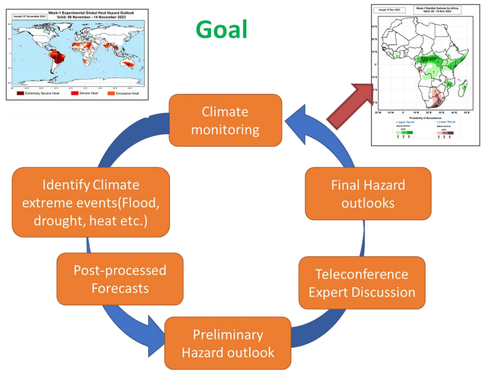
Introduction

Accurate estimation of extreme hydrological events, such as flood at ungaged locations, is a significant hydrological challenge for water resource management.

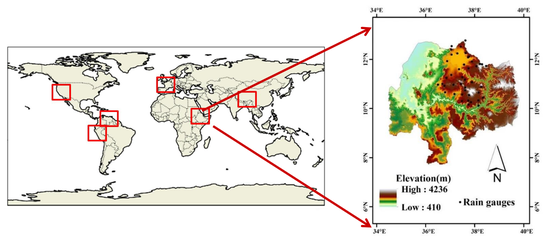
- The process-based models require time-consuming calibration using large number of parameters to increase the accuracy of the model predictions.
- The data-driven Artificial Intelligence (AI) models have appeared as promising tools which offer efficient alternatives without considering the physical processes.
- Evaluation of a deep learning (DL) based time series model, namely the Long Short-Term Memory network (LSTM) Recurrent Neural Networks (RNN) model, to predict climate variables.
- Transferability of the model.

Research Framework



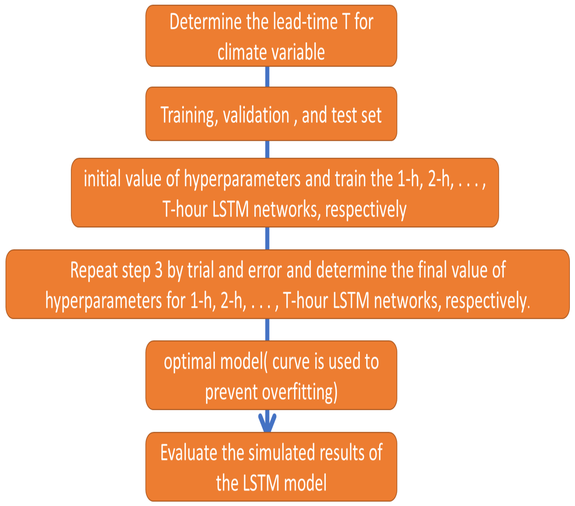
Calibration regions

- The upper Blue Nile basin is in the mountain range of the Great Horn of Africa.
- The elevation ranges from approximately 1000 to 3000 m MSL.
- The climate varies from cool highlands to hot deserts with most of the precipitation falling from June to September
- CPC Global Unified Gauge-Based Analysis of Daily Precipitation is used as reference data



Map of terrain elevation for the study area

Model Setup

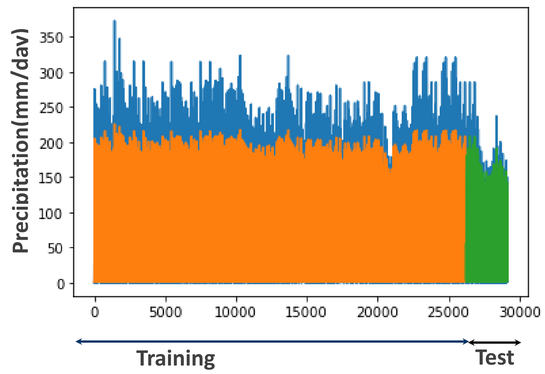


Major Hyper-parameters

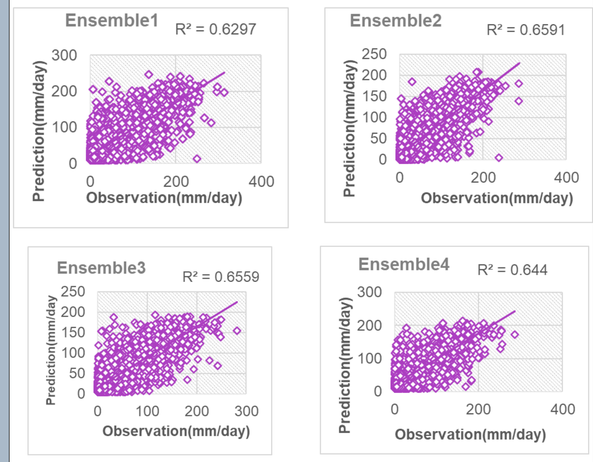
- Activation function
- Epoch
- Loss function
- Batch Size
- Momentum
- Decay rate
- Learning rate

Optimization

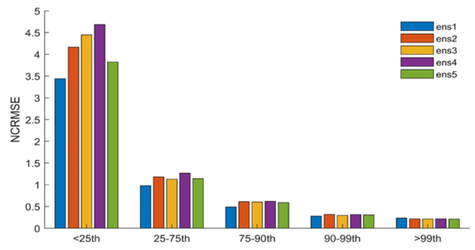
- Trial and Error
- Random Grid Search
- Bayesian
- Randomized search cross validation



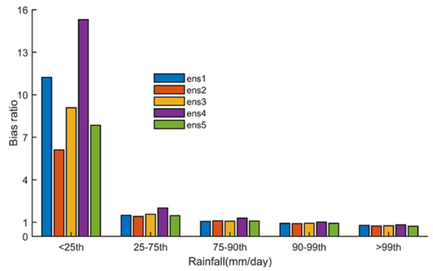
Model Evaluation



Error Metrics

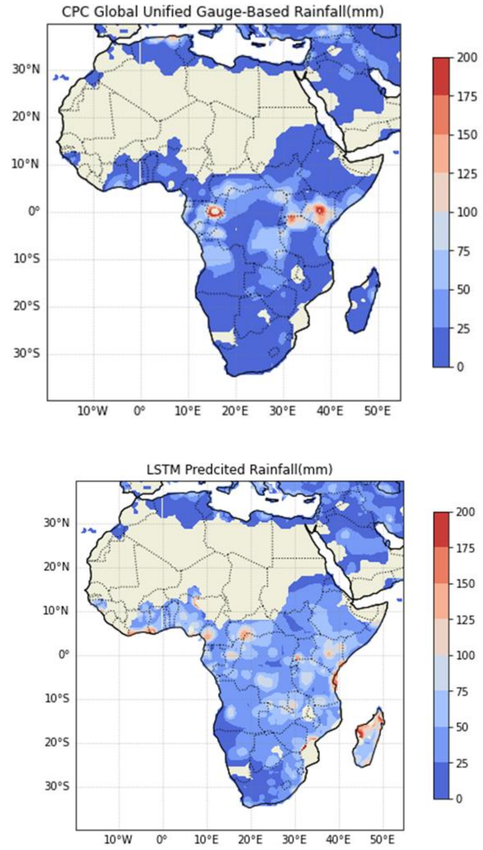


NCRMSE value of 0 indicates no random error, while 1 indicates that the random error is equal to 100 % of the mean reference rainfall.



- For an unbiased model, the BR ~ 1
- Overall, bias ratio values were closer to 1 for moderate to high rain rates for the corrected ensemble member which indicated that DL was able to reduce the systematic error in moderate to high rain rates

Error Analysis Results



Conclusions

- LSTM provided an improved precipitations estimates over Africa
- The proposed framework can be applied in any regions over the globe, where there is missing data(ungauged location) to estimate accurate climate variable.
- Finally, LSTM has the potential to climate variable for improving the predictability of extreme events.
- Explore the use of latest AI/ML to improve hazards forecasts at sub-seasonal to seasonal time scales.