

DeepSTRMM: Deep Learning-based Streamflow Monitor



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INTRODUCTION

- Streamflow monitoring is essential for climate adaptation efforts. It provides valuable input for designing early warning systems against floods and droughts, informing resilient infrastructure design against extreme weather events, ensuring sustainable water availability, optimizing irrigation practices and safeguarding hydropower production.
- The African continent faces significant obstacles in this context, including a limited network of gauging stations, issues related to data accessibility, quality and reliability. These challenges have resulted in knowledge gaps concerning water availability, flood and drought prediction, and the repercussions of climate change in the region.

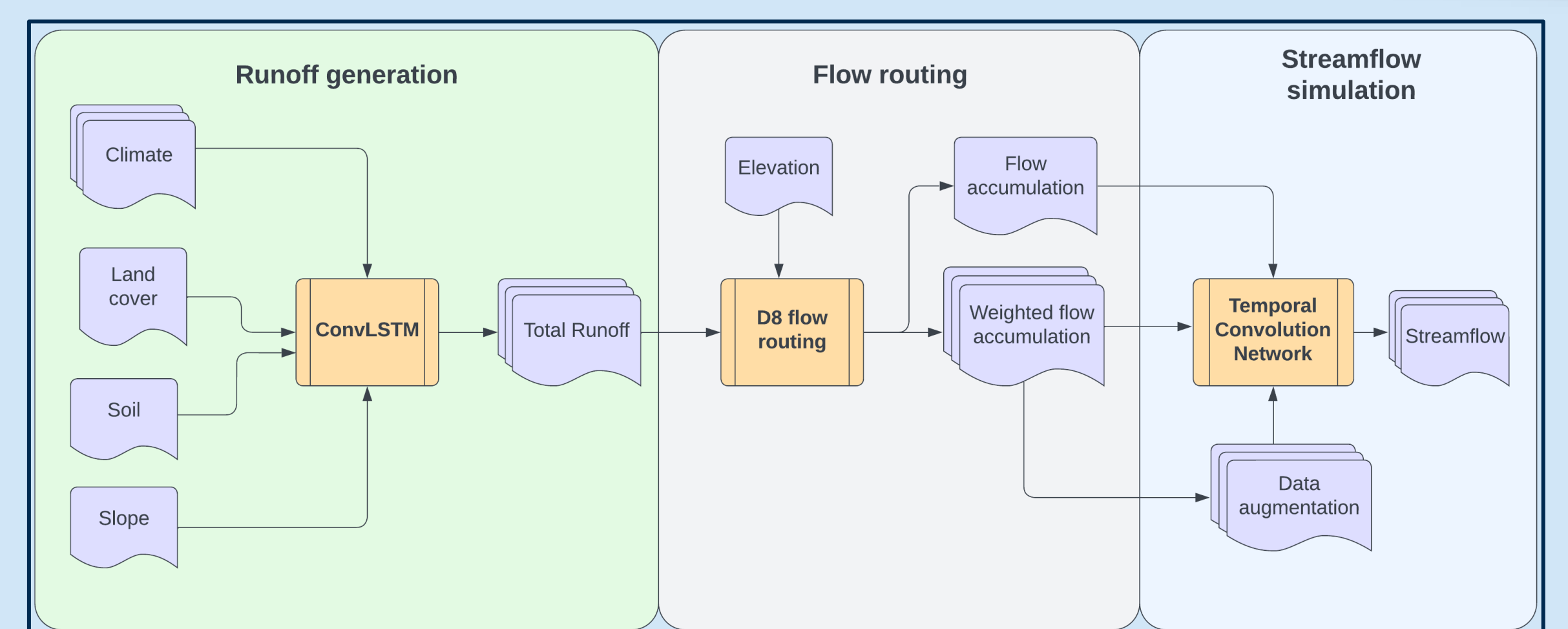
METHODS

The developed model called, **DeepSTRMM**, consists of three modules

1. Runoff generator – this generates daily total runoff as a function of climate, land cover, terrain and soil characteristics. It is based on Convolutional Long Short Term Memory neural network
2. Runoff router - this routes simulated runoff into river networks
3. Streamflow simulator – this module simulates daily streamflow as a function of routed runoff. It is based on Temporal Convolution Network

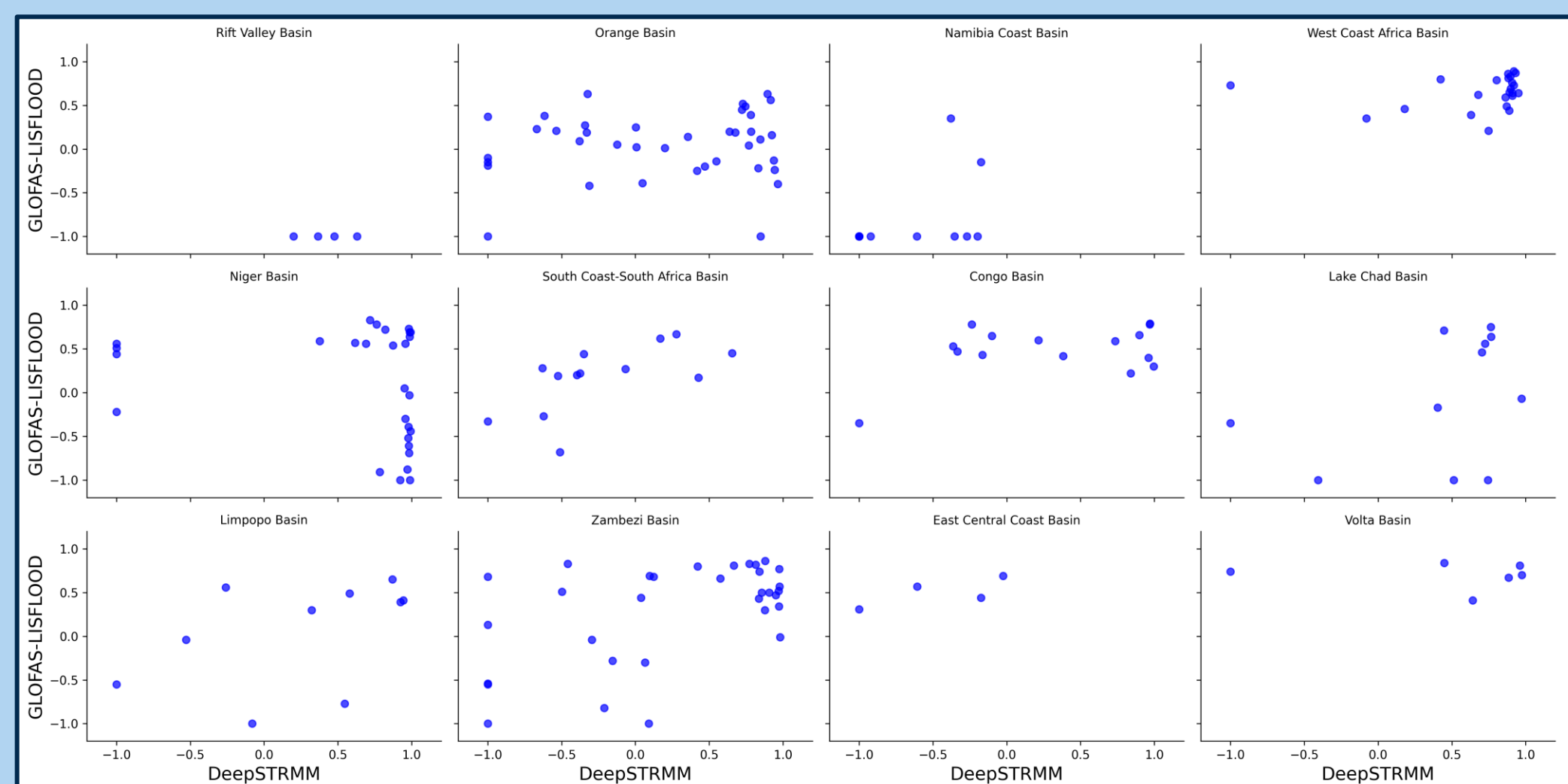
OBJECTIVE

The aim of this project is to develop the first ever data-driven, fully distributed streamflow model at a continental scale. This model is designed to improve streamflow prediction across the continent, democratize access to streamflow data, and offer a user-friendly, readily deployable solution for operational river basin monitoring and early warning systems.



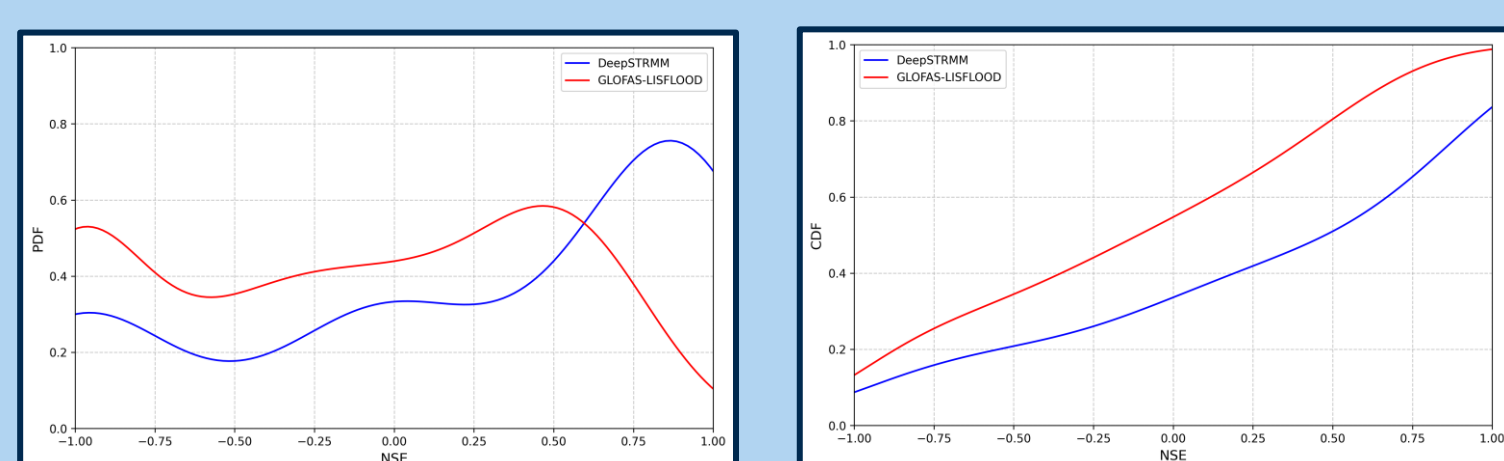
RESULTS

The predictive accuracy of DeepSTRMM was benchmarked against LISFLOOD model that underpins ECMWF's operational flood forecasting service, GLOFAS. DeepSTRMM demonstrates superior predictive accuracy over GLOFAS-LISFLOOD at roughly 70% of the stations using Nash-Sutcliffe Efficiency NSE and 60% using Kling-Gupta Efficiency out of the over 200 monitored stations throughout Africa, as evidenced by the graphs provided. DeepSTRMM outperforms GLOFAS-LISFLOOD in all major river basins in Africa including, Niger, Congo, Volta, Orange and Zambezi.



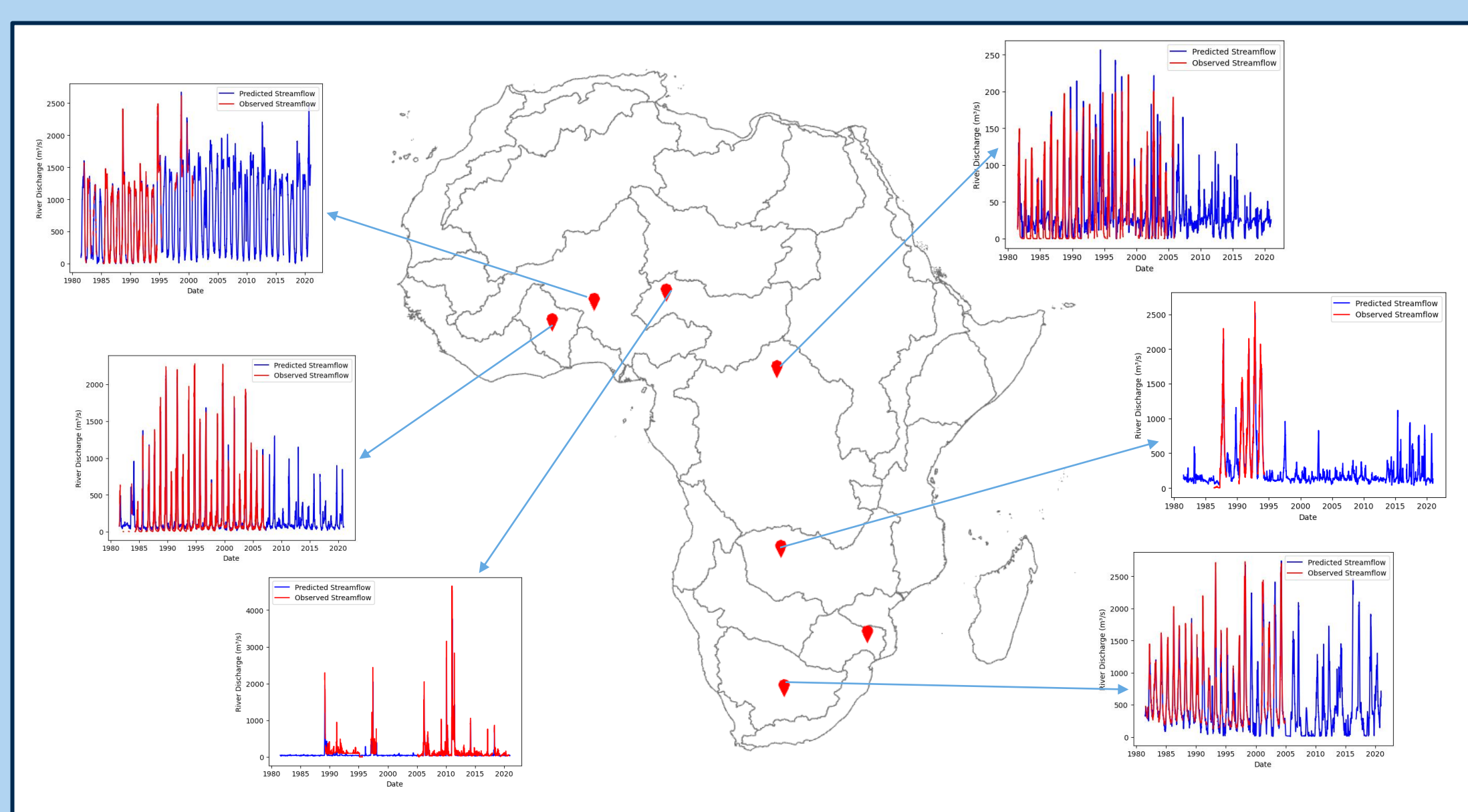
DeepSTRMM is fully distributed meaning that potentially it can predict streamflow for any point on any river across Africa as shown for the mean annual streamflow in the Congo river basin in the map below

The Runoff generation module also allows DeepSTRMM to be used to assess the impact of climate change, land use change and nature-based solutions on flood, drought and water availability in general.



Graphical analysis via PDF and CDF plots confirm that DeepSTRMM model demonstrates enhanced predictive accuracy over GLOFAS-LISFLOOD

The comparison of streamflow hydrographs between DeepSTRMM and in-situ data for selected stations highlights the accuracy of DeepSTRMM's hydrological modeling against actual observed data, crucial for validating its forecasting reliability.



CONCLUSION

- DeepSTRMM represent significant advancement in streamflow monitoring in ungauged basins and data gap-filling in gauged basins.
- DeepSTRMM can enhance the reliability of early warning systems aimed at flood preparedness
- DeepSTRMM substantially advances the state-of-the art in AI for streamflow prediction

NEXT STEPS

- Develop python package to enhance user-friendliness
- Provide open access gap-filled 40-year daily streamflow datasets for over 1000 gauging stations across Africa to stimulate research
- Draft two manuscripts about
- Analyze and compare forecast skill with GLOFAS and Google Forecasts