# Fast-Slow Streamflow Model Using Mass-Conserving LSTM

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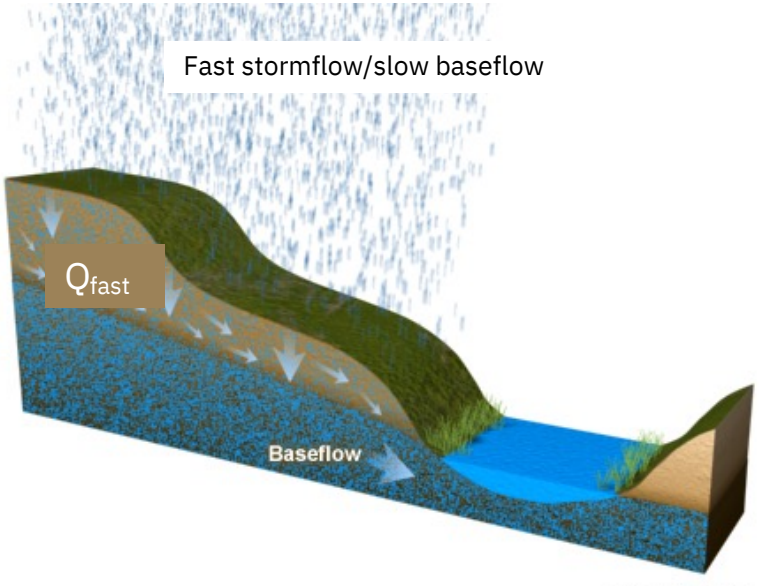
# Streamflow estimation considerations




"Estimating Basin-Scale Water Budgets With SMAP Soil Moisture Data"
Randal D. Koster, Wade T. Crow, Rolf H. Reichle, and Sarith P. Mahanama

**Fast stormflow runoff**

$$Q_{fast}/P \sim W$$

**Slow baseflow runoff**

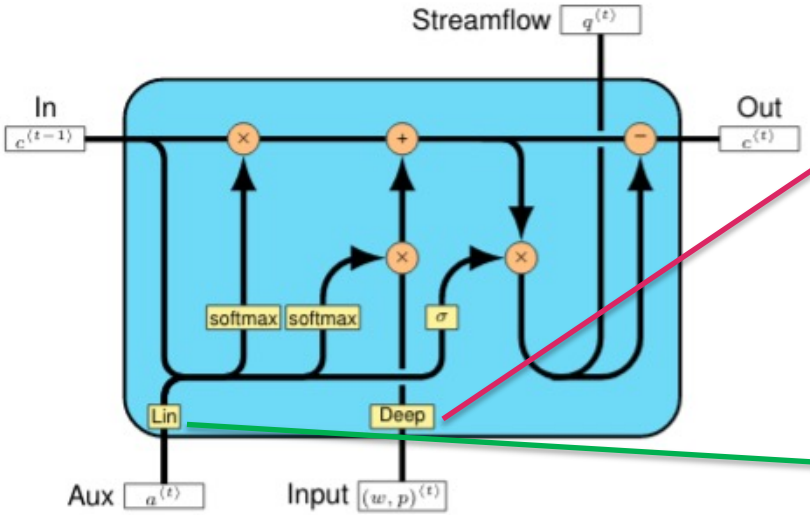
$$Q_{slow} \sim W$$

$$Q = Q_{fast} + Q_{slow} = \alpha \cdot w \cdot p + \beta \cdot w + \gamma$$

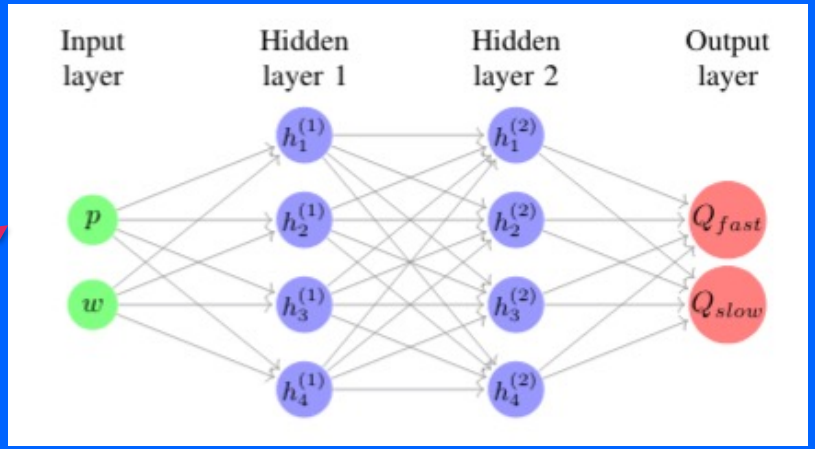
## Proposed architecture:

## FS-LSTM (Fast-Slow streamflow LSTM)

This streamflow forecast LSTM cell consider the fast and slow streamflow contributions, regulated by auxiliary atmospheric variables




## Fas-Slow NN

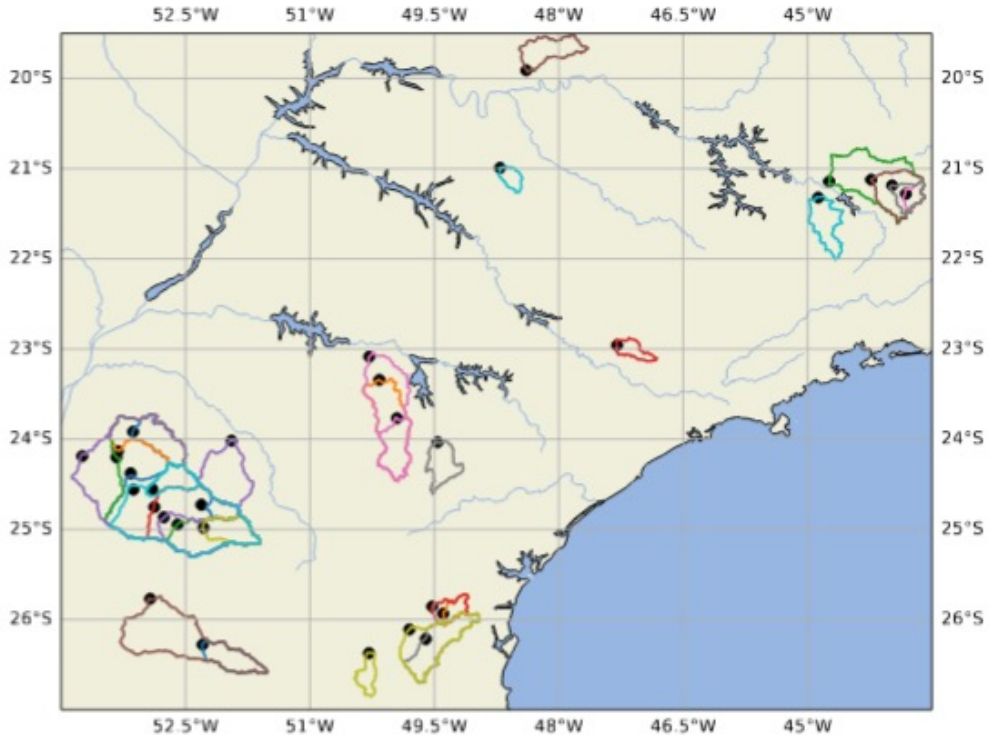



$$\mathbf{r}^t = \mathbf{W}_r \cdot \mathbf{a}_t$$

$$n_r \leq n_a \cdot \frac{(n_c^2 + 2 \cdot n_c)}{(n_c^2 + 2 \cdot n_c) + n_a}$$

# Dataset

The dataset correspond to 32 stations at eastern sub-basins of the Parana river in Brazil colected from CAMELS-BR.

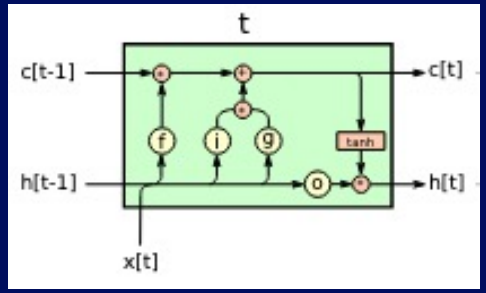


# Model comparison

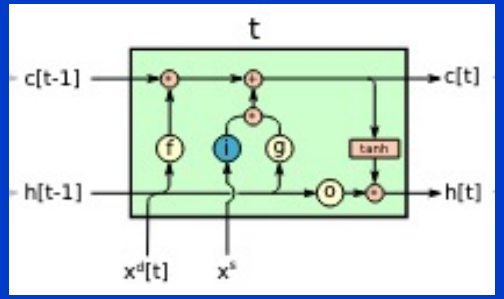
| # Cells | # Epochs | Batch | Input | Output |
|---|---|---|---|---|
| 64 | 30 | 256 | 365 | 1 |

Common setup for LSTM architectures.

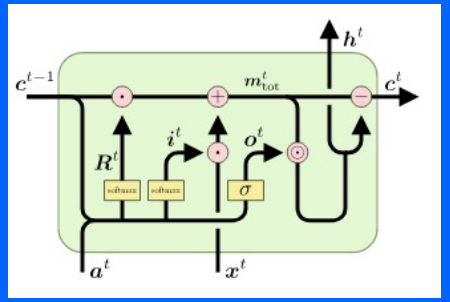
**Vanilla LSTM**



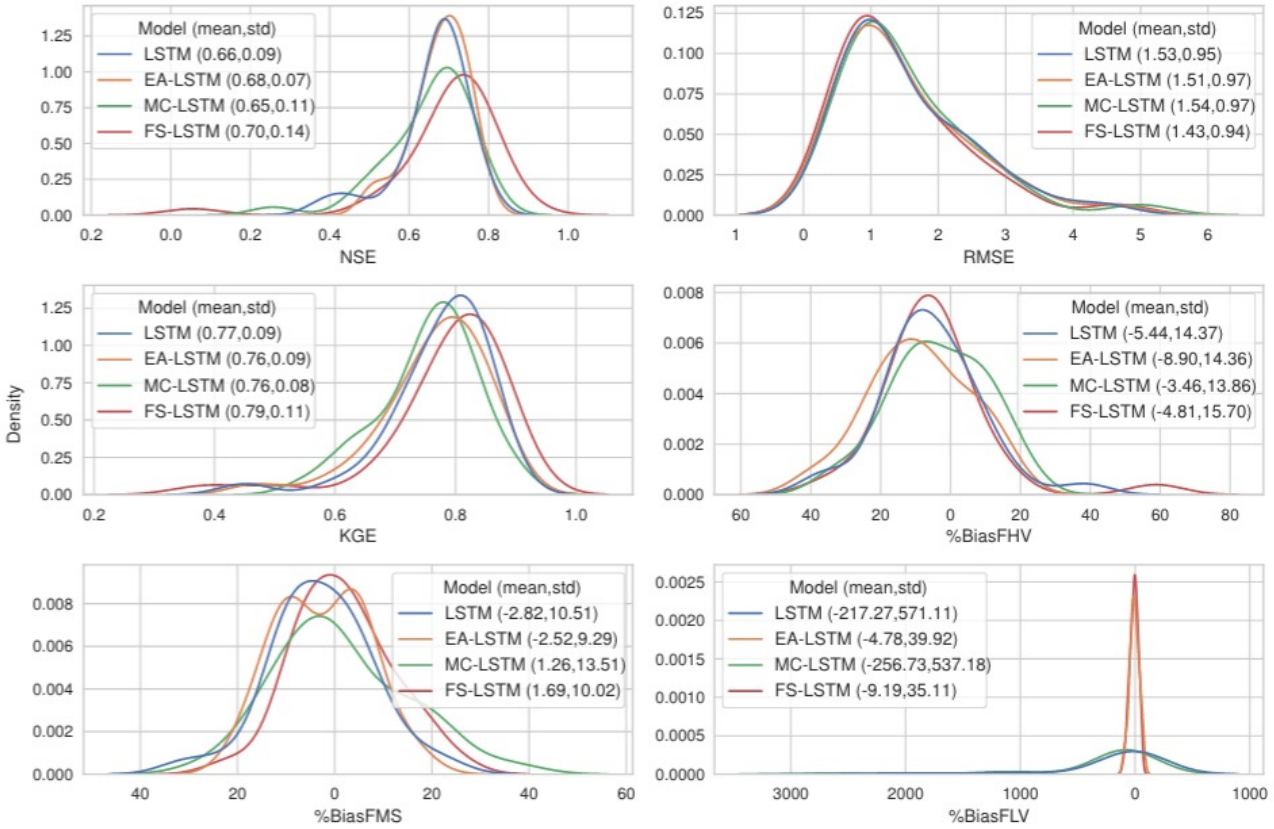

**EA-LSTM** (Entity aware LSTM)




**MC-LSTM**



# Benchmarks: LSTM vs EA-LSTM vs MC-LSTM vs FS-LSTM



# Conclussions and next steps

- We demonstrate that the proposed FS-LSTM achieves high prediction skill for gauges located in southern Brazil.
- Improvements in the high streamflow volumes remain a challenge
- The investigation of strategies to transfer these models to other geographies with less retraining effort.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