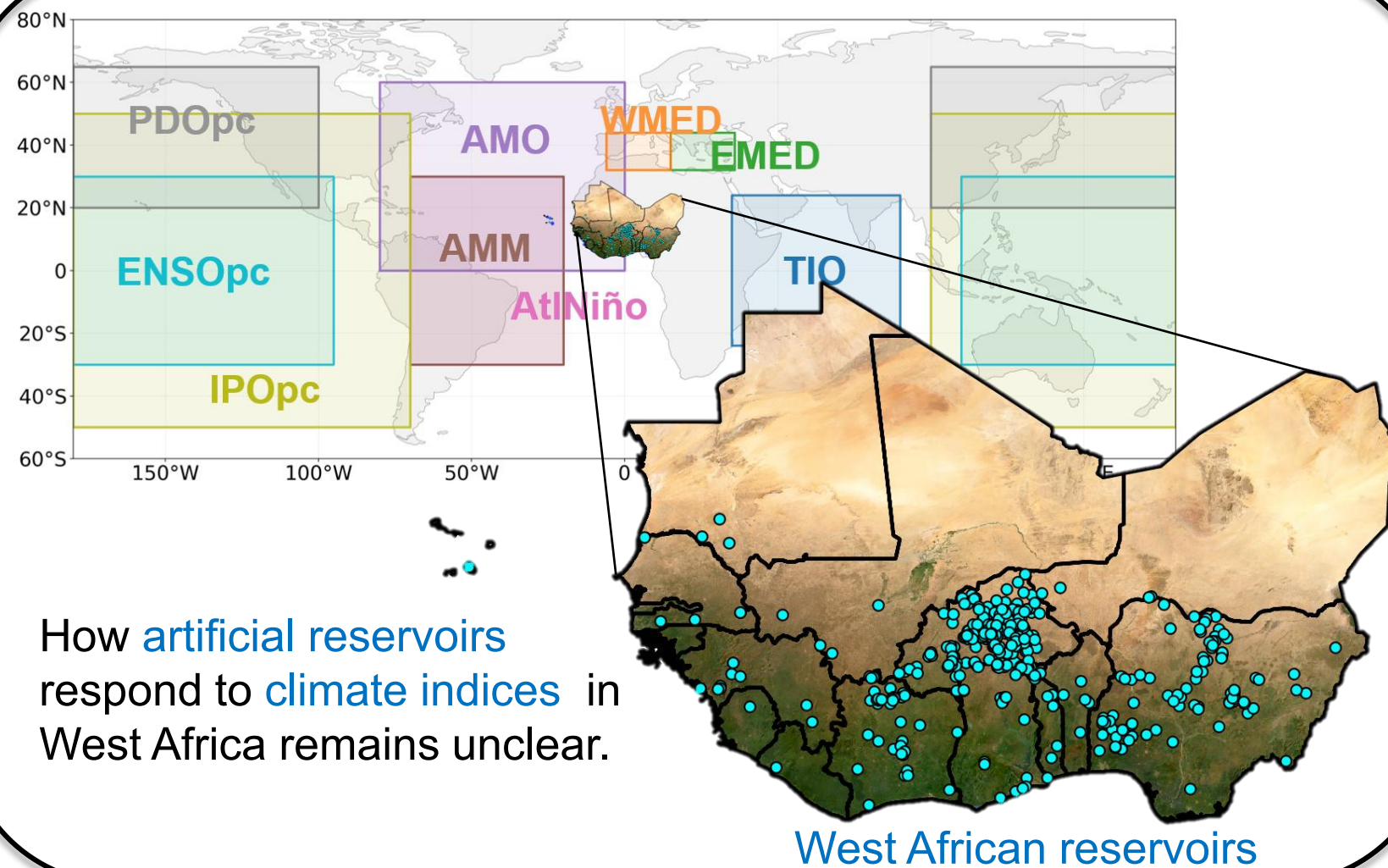


Influence of Large-Scale Climate Indices on Reservoir Surface Extent (RSE) Variability in West Africa



How artificial reservoirs respond to climate indices in West Africa remains unclear.

West African reservoirs

Methods

Sea Surface Temperature Anomalies (SSTAs)

+

Reservoir Surface Extent (RSE)



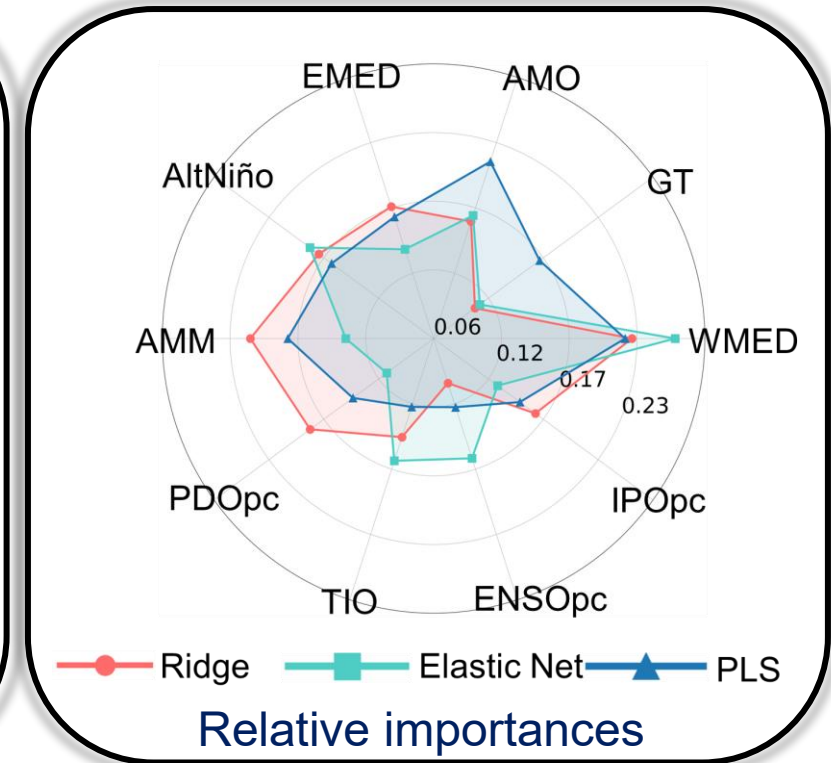
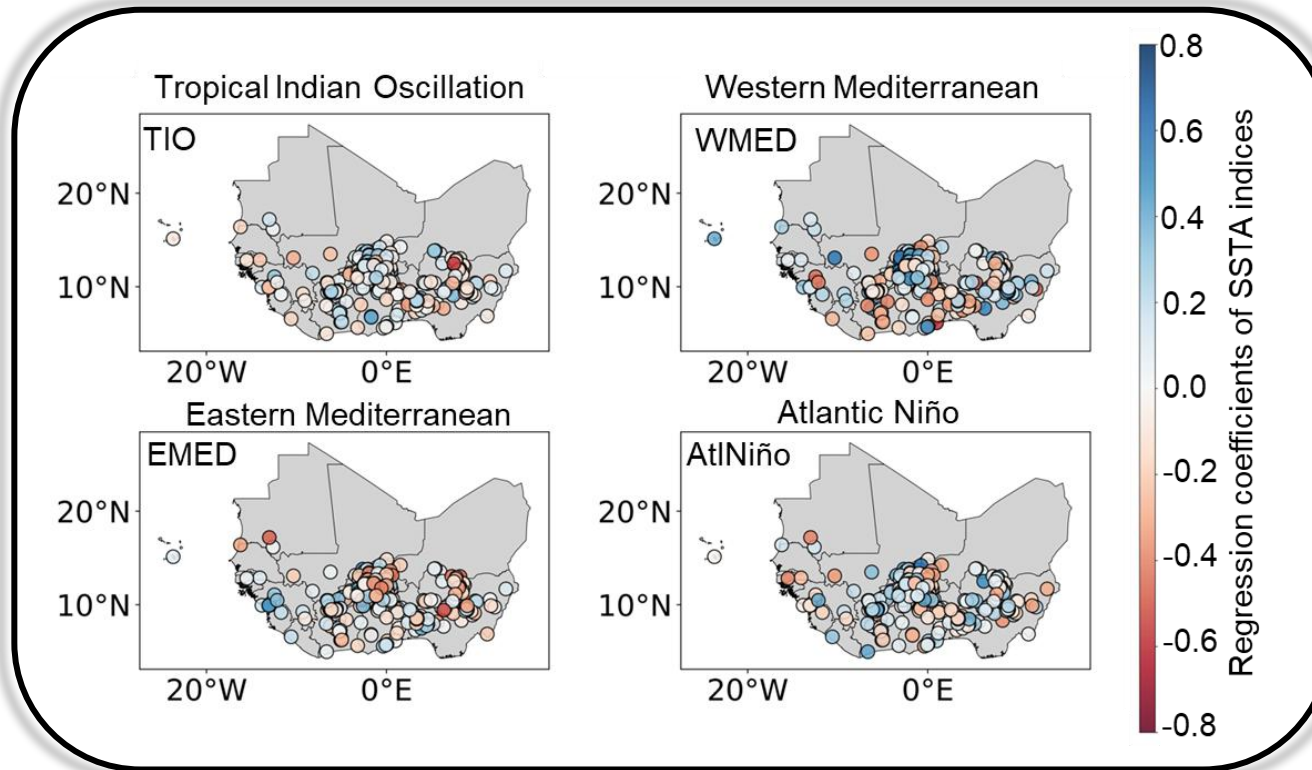
Machine Learning Models



Predicted RSE anomalies

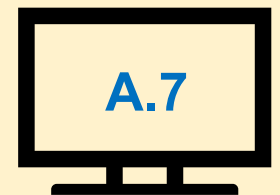
Influence of Large-Scale Climate Indices on Reservoir Surface Extent (RSE) Variability in West Africa

Results & Take home



- ✓ Reservoirs are **unevenly** sensitive to climate indices.
- ✓ Reservoirs respond to **combined** teleconnection signals.
- ✓ **WMED** is the most influential mode.
- ✓ **Partial Least Square + PCA** is the best approach.

Screen



Influence of Large-Scale Climate Indices on Reservoir Surface Extent (RSE) Variability in West Africa



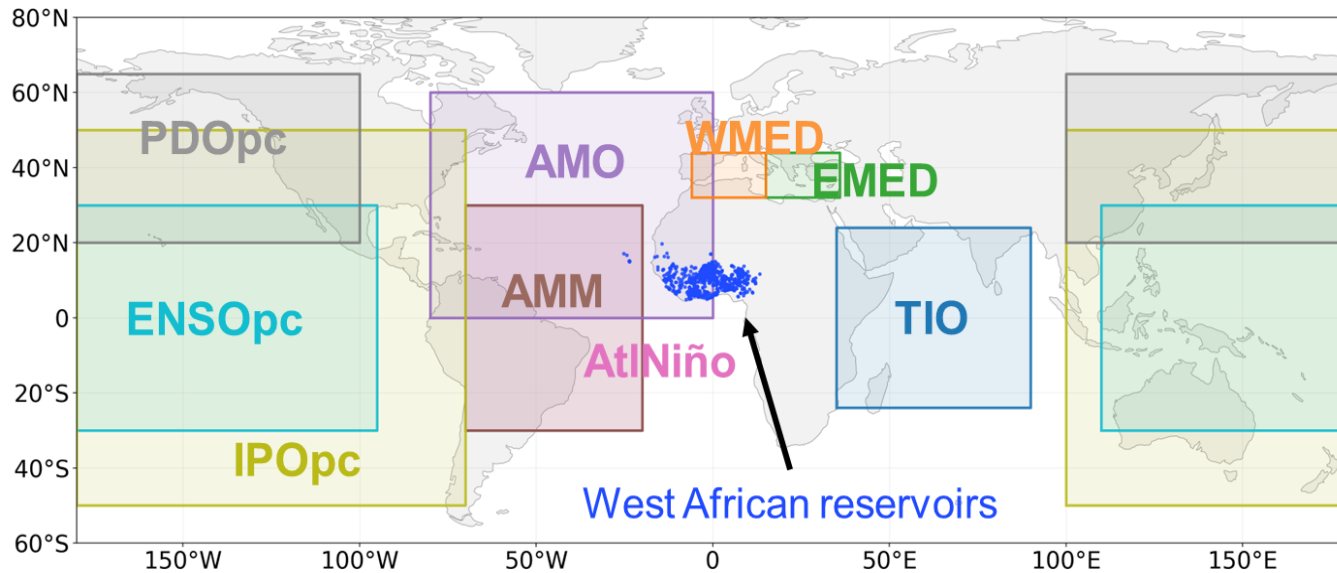
Valery Kouassi



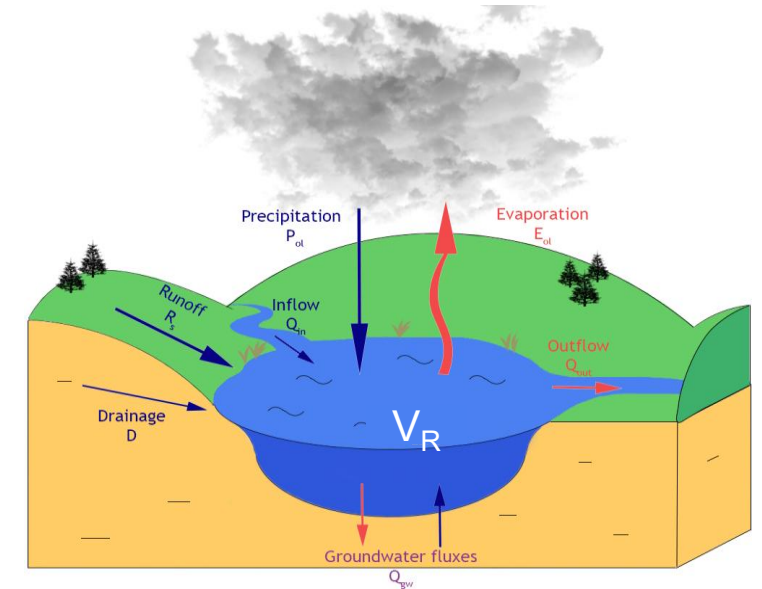
Influence of Large-Scale Climate Indices on RSE Variability in West Africa

1. Background

+1000 artificial reservoirs in West Africa



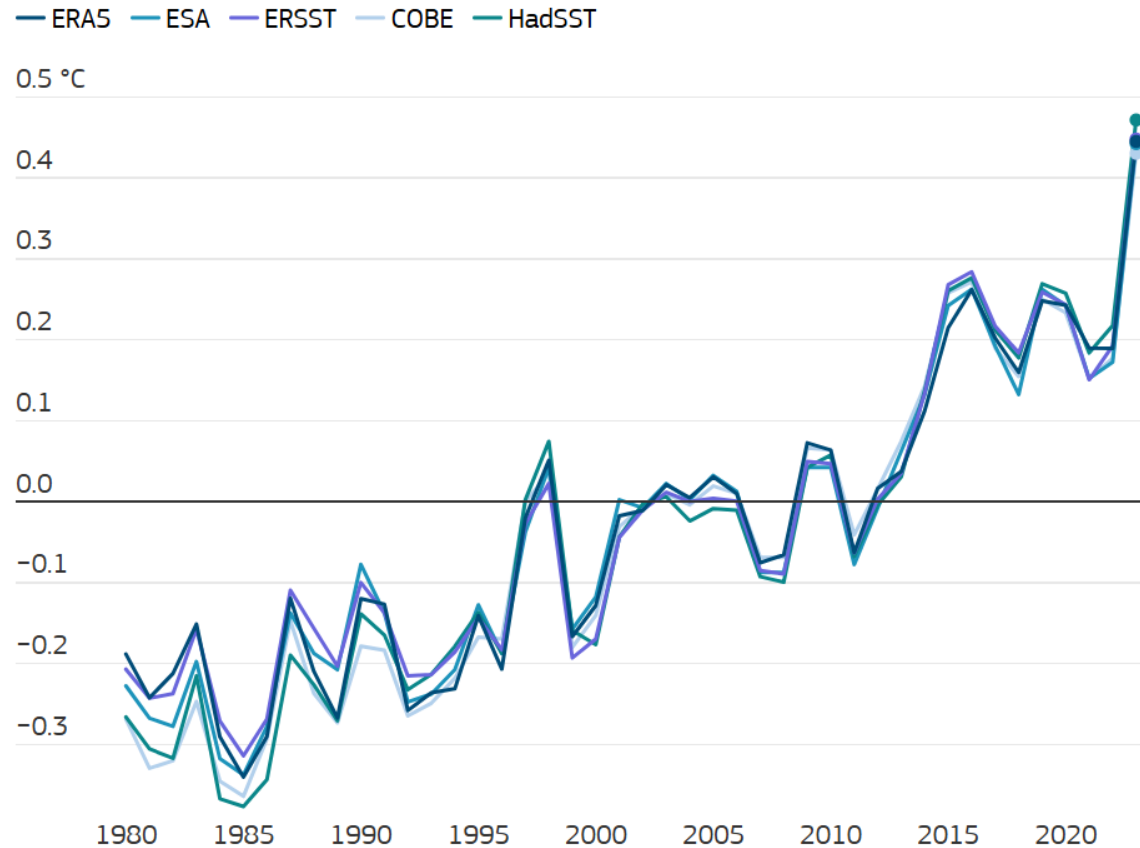
Hydroclimatic variability controls **Storage**



By shaping moisture and rainfall distribution, **climate indices** affect hydrological processes.

(Wang et al., 2004; Owusu et al., 2022; Chun et al., 2021; Hounkpè et al., 2025; Zhang et al., 2026)

1. Background

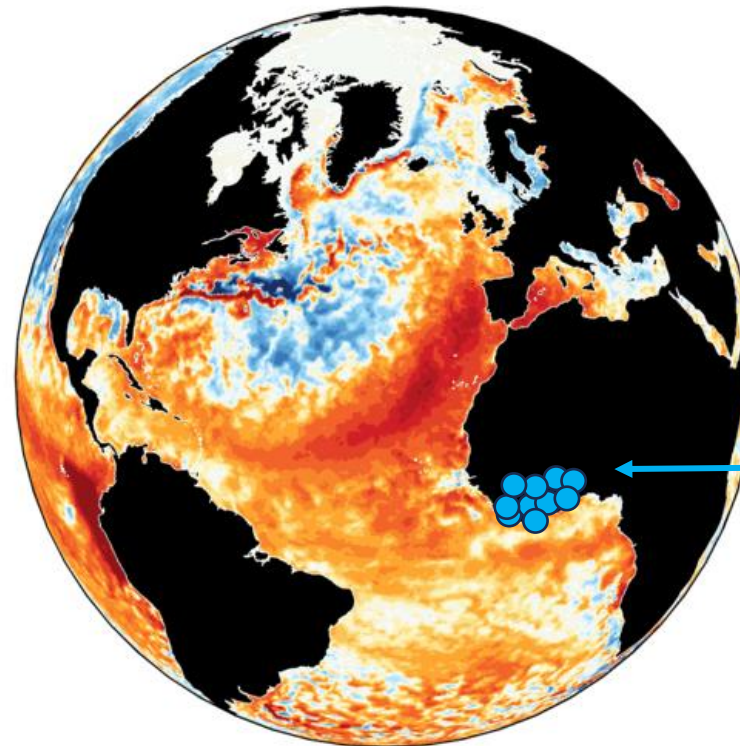


Annual mean SSTA for 60°S-60°N for the 1991-2020
(Copernicus, 2024)

- Warming of SST (Copernicus, 2024)
- Impacts on hydrology is established.
- Different and pronounced effects of SSTAs on West African Monsoon (Chun et al., 2021; Mampo et al., 2025).
- Yet, how reservoirs respond to climate indices (SSTAs) in West Africa remains unclear.

2. Research question

Do climate indices produce consistent or heterogenous effects on reservoirs across West Africa?

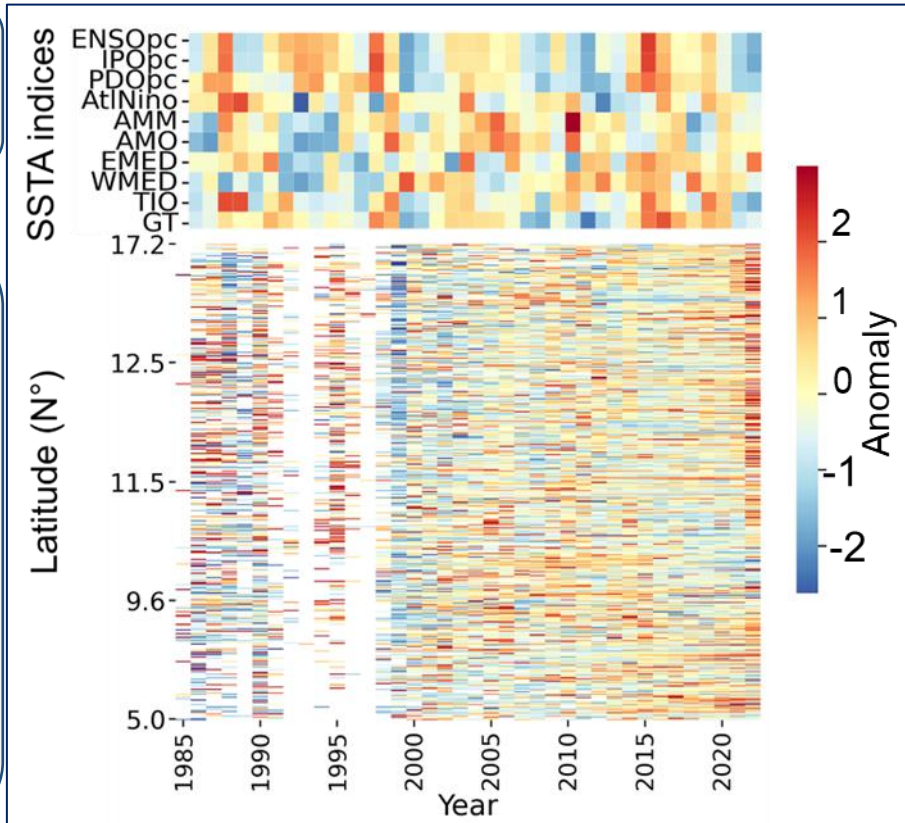


Sea Surface Temperature Anomaly

3. Data and methods

SSTA indices
(ERSSTv5)

Reservoir
Surface
Extent (RSE)
of 412
reservoirs
from Global
Water Watch



Principal Component-Filtered (PCA)

Without

With

Ridge

Elastic Net

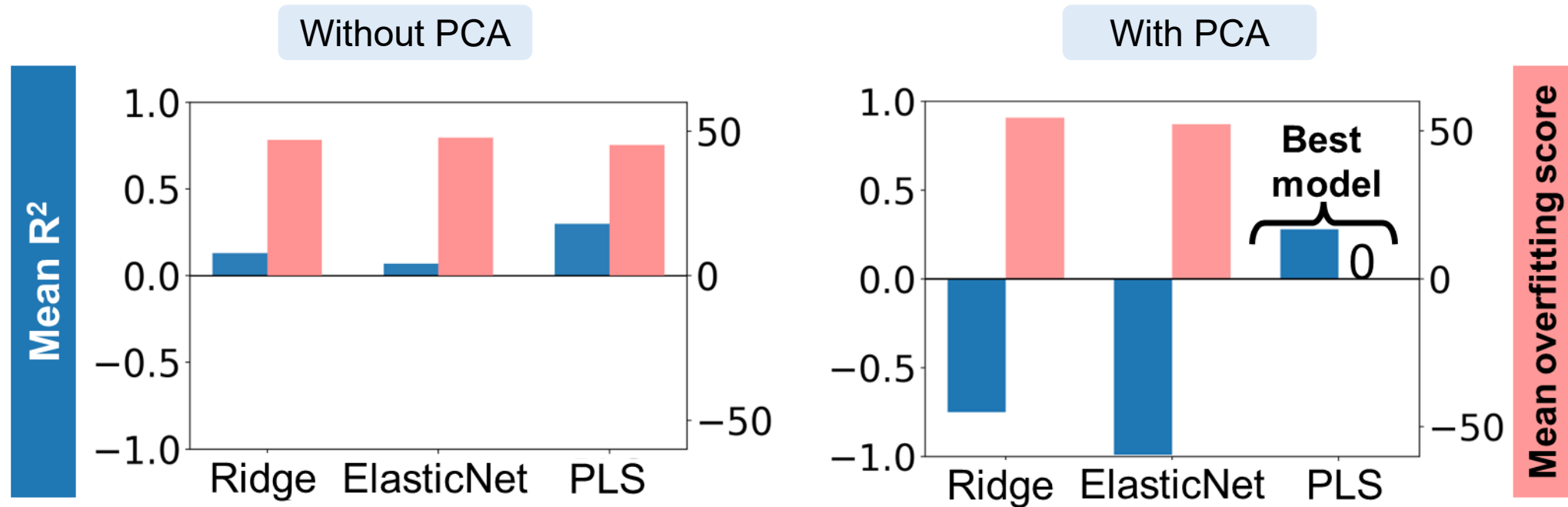
Partial Least Square (PLS)

- Performance metrics
- Relative importance of SSTA
- Regression coefficients

Global and
Local Moran's I

Clustering detection in reservoir responses

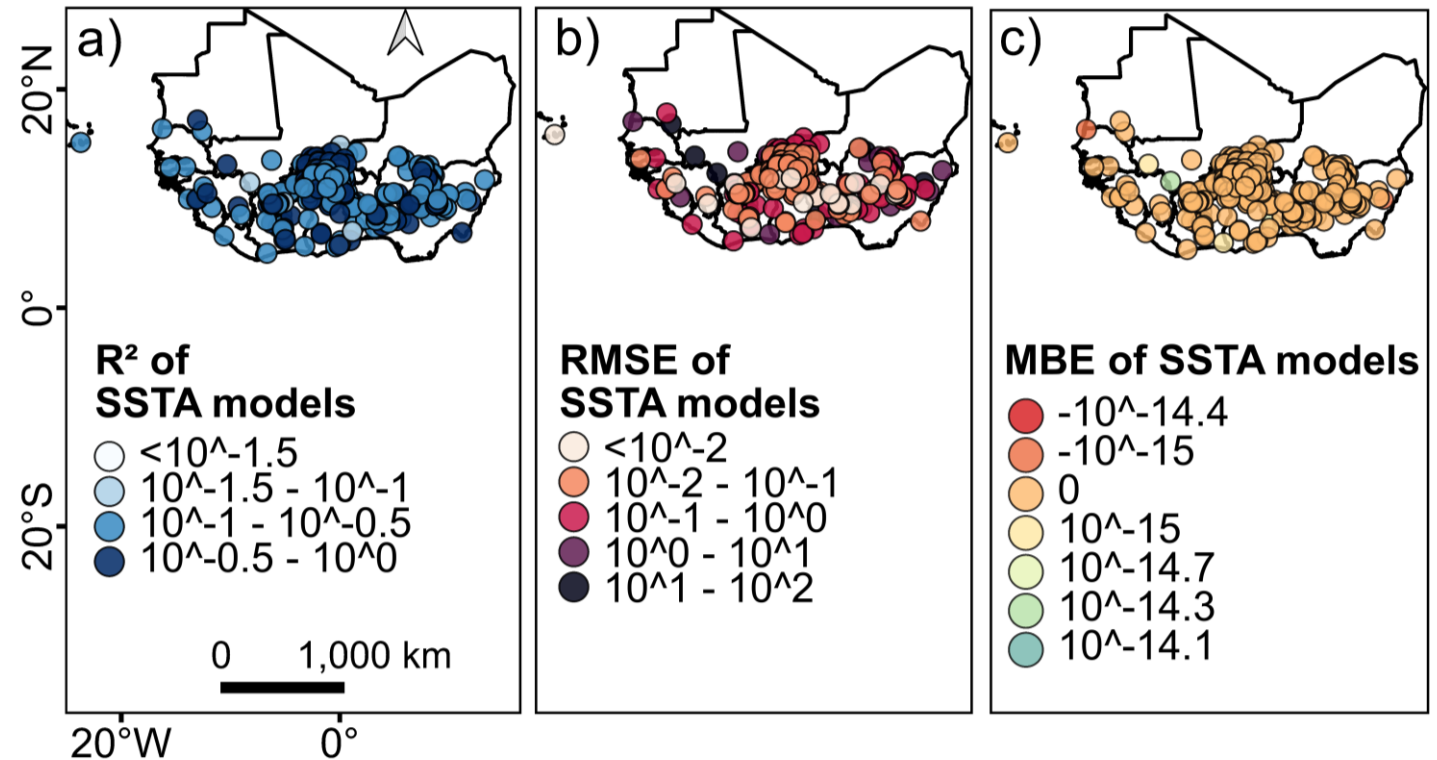
4. Results: Model's performance



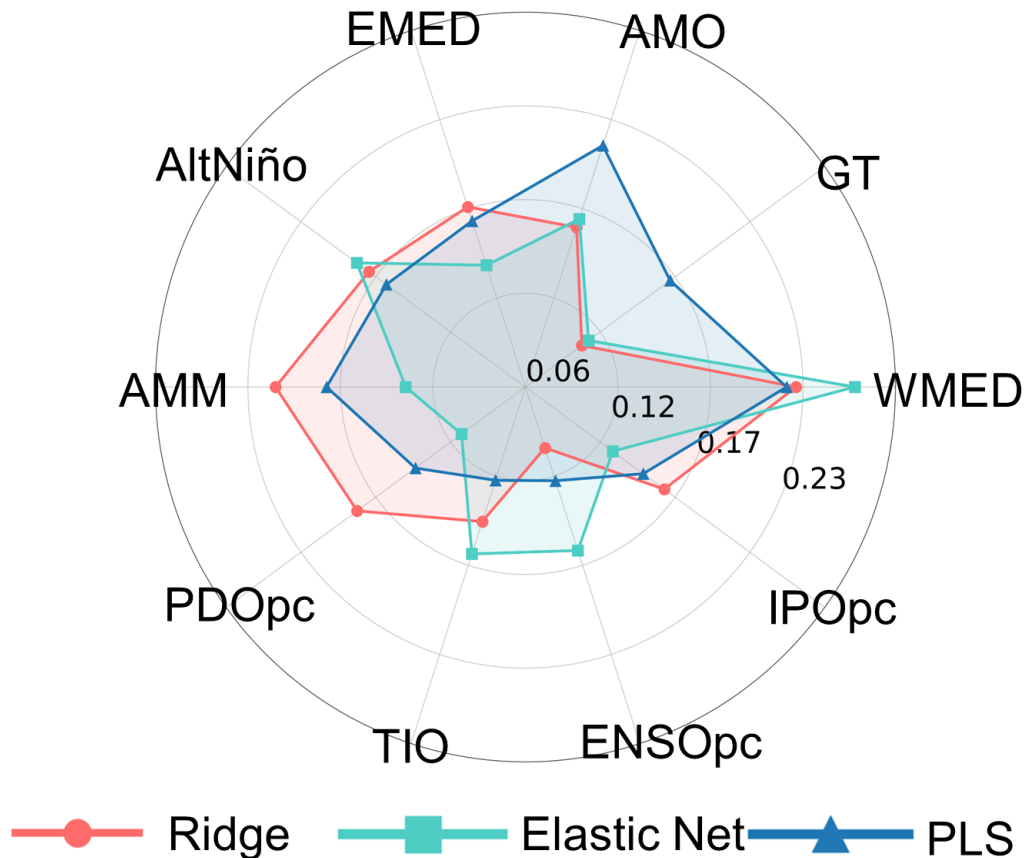
- **PLS + PCA + Low collinearity** is the most robust approach.
- This is due to dimensionality reduction (Angel and McCabe, 2022).

4. Results: Model's performance

- The **predictive** skill of the SSTA-based models is spatially **heterogeneous**.
- The models show negligible bias (**MBE ≈ 0**).
- **SSTA** forcing alone accounts for a **modest** to **moderate** portion of the RSE variability.



5. Results: The dominant climate index

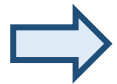


Relative importances

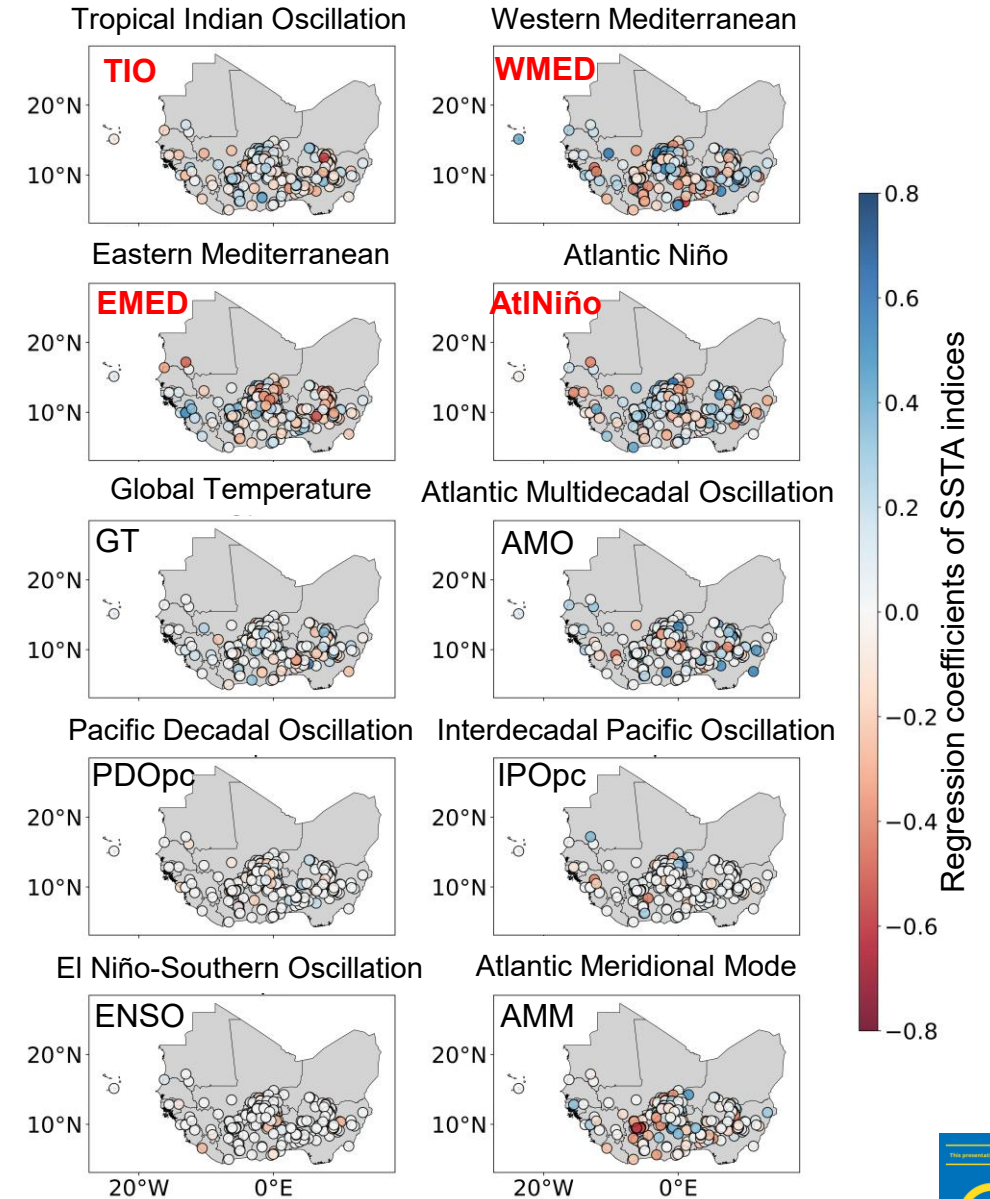
- **WMED** is the most influential mode.
- **ENSOpc** shows the lowest average relative importance.

5. Results: Reservoir sensitivity

- Heterogeneous influence of SSTA indices.
- Mediterranean modes (WMED and EMED) have opposite impact direction.
- The Indo-Mediterranean-Atlantic modes emerge as the most pervasive influences.



Chun et al., 2021; He et al., 2021; Mampo et al., 2025

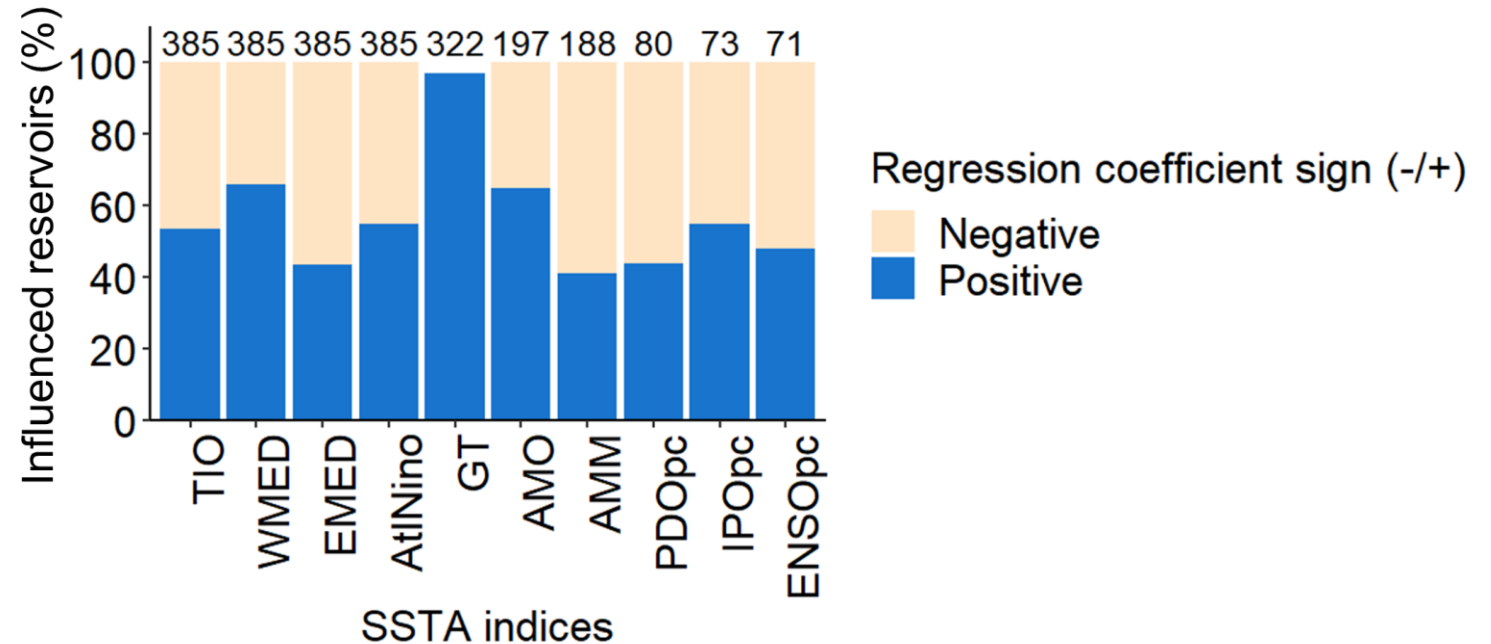


5. Results: Individual effects of SSTA indices

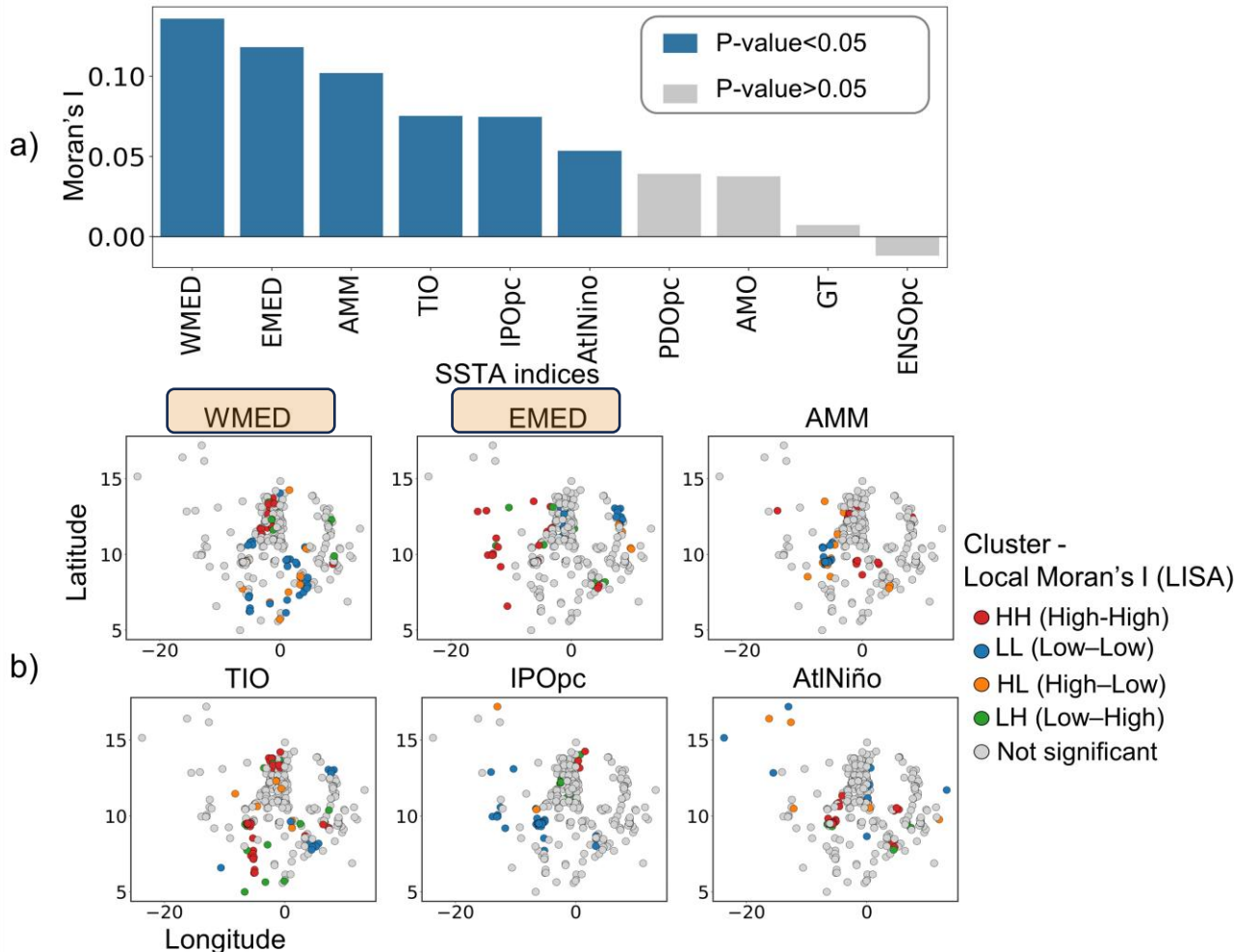
■ 3 categories of SSTA:

- Positive effects
- Negative effects
- Mixed effects

- The **mixed effects** imply more spatially heterogeneous influence and indirect transmission through global-scale atmospheric circulation (He et al., 2025).



5. Results: Any regional clustering in reservoir responses?



- Identifiable cold and hot spot clusters.

- South-north gradient → **WMED**
 - West-east gradient → **EMED**
- (Fontaine et al., 2010)

- Non-uniformity in SSTA influences suggests a potential control of **local factors**.

6. Conclusion

Do climate indices produce consistent or heterogeneous effects on reservoirs across West Africa?

- ✓ Influence of climate indices on reservoirs is **mode-specific** and **spatially heterogeneous**.
- ✓ Coupled **Indo-Mediterranean-Atlantic** has widespread influence.
- ✓ **WMED** is the **dominant** influential mode and associated with **positive effects**.
- ✓ Mediterranean modes (**WMED** and **EMED**) have **contrasting** influences on RSE dynamics.

**Thank you for
your attention**



Valery Kouassi

Valerykouassi.vk@gmail.com

