

Hydroclimatic zonation of the Congo basin based on altimetric series distributed throughout the basin

M. Becker ^{1*}, J. Santos da Silva², S. Calmant³ and F. Seyler¹

**contact: melanie.becker@ird.fr*

1. *ESPACE-DEV, Cayenne, French Guiana.*
2. *UEA, Manaus, Brazil.*
3. *LEGOS, Toulouse, France.*



Ocean Surface Topography Science Team meeting - 28 - 31 October 2014

Contemporary river dynamics in the Congo Basin ?

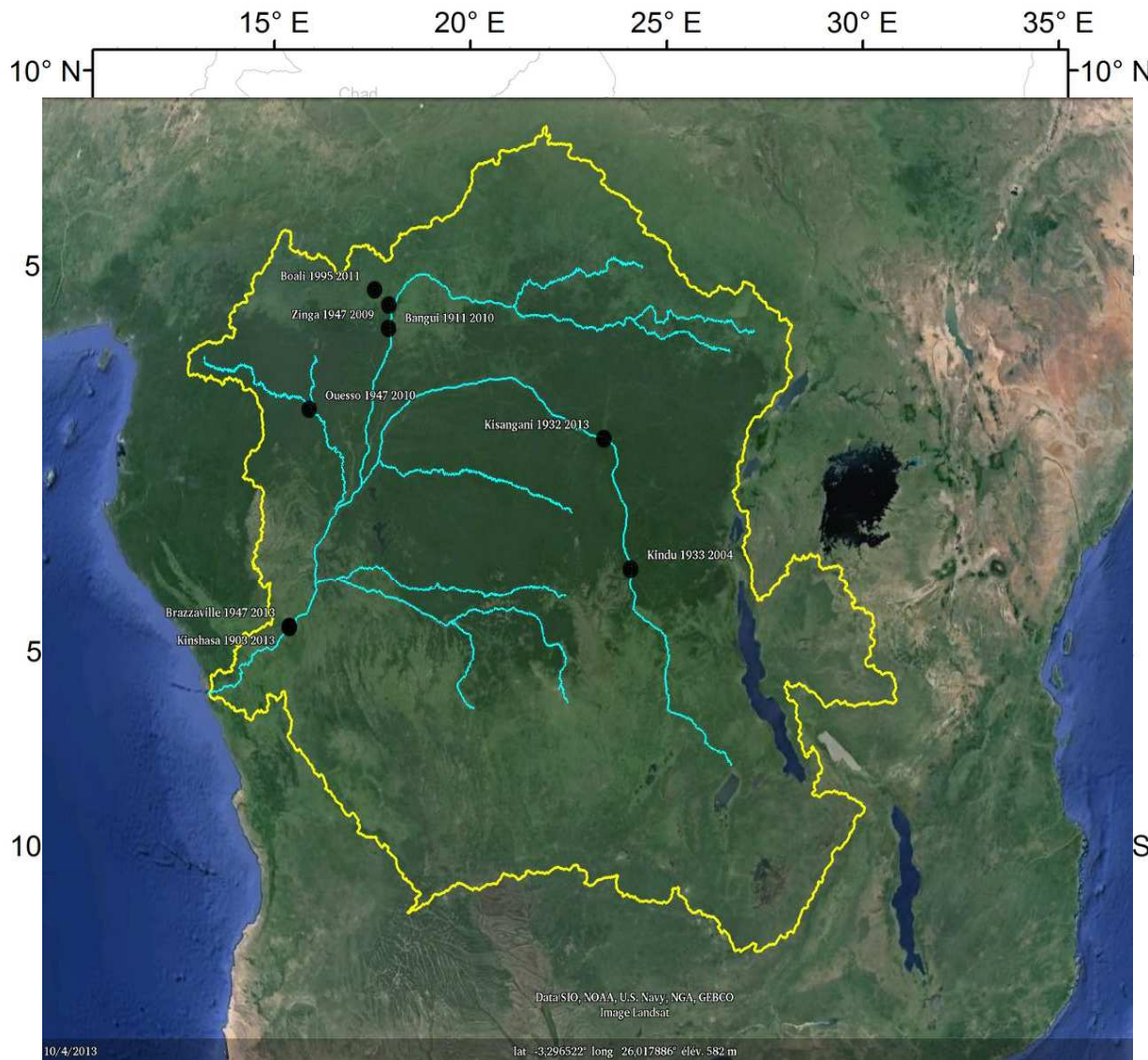


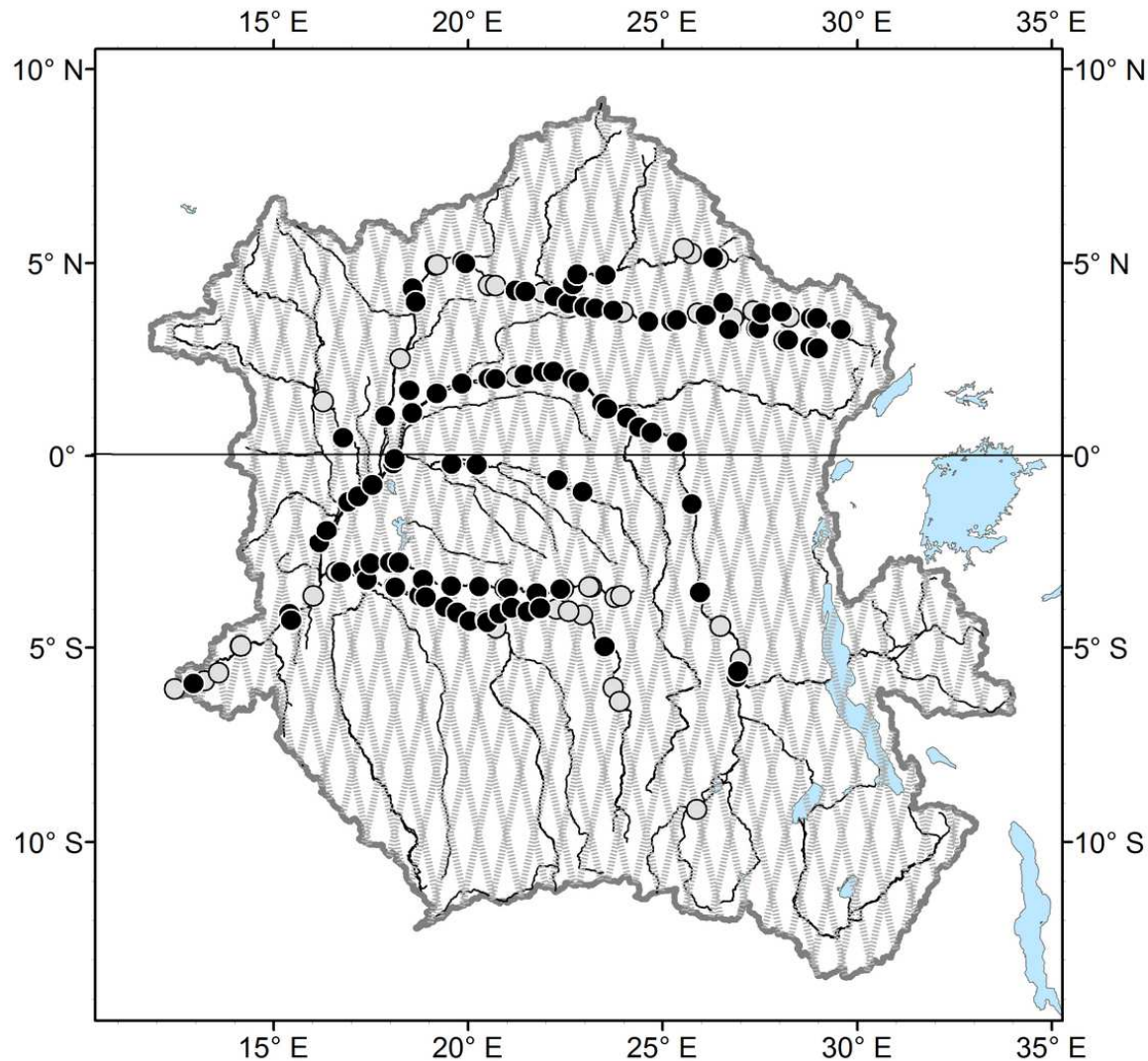
Figure. The principal tributaries and lakes in the Congo Basin.

- second largest river basin in the world (~ 3.7 million km^2)
 - small number of studies
 - lack of the in situ data
 - transboundary basin
 - difficulty of performing fieldwork in the Congo swamps
- large gap in understanding hydro-climate processes.

Remote sensing observations provide the only viable approach to understanding the variability of the basin's hydrological patterns.

→ **Altimetry ?**

Investigation of the ENVISAT altimetry data to analyze contemporary river dynamics in the Congo Basin

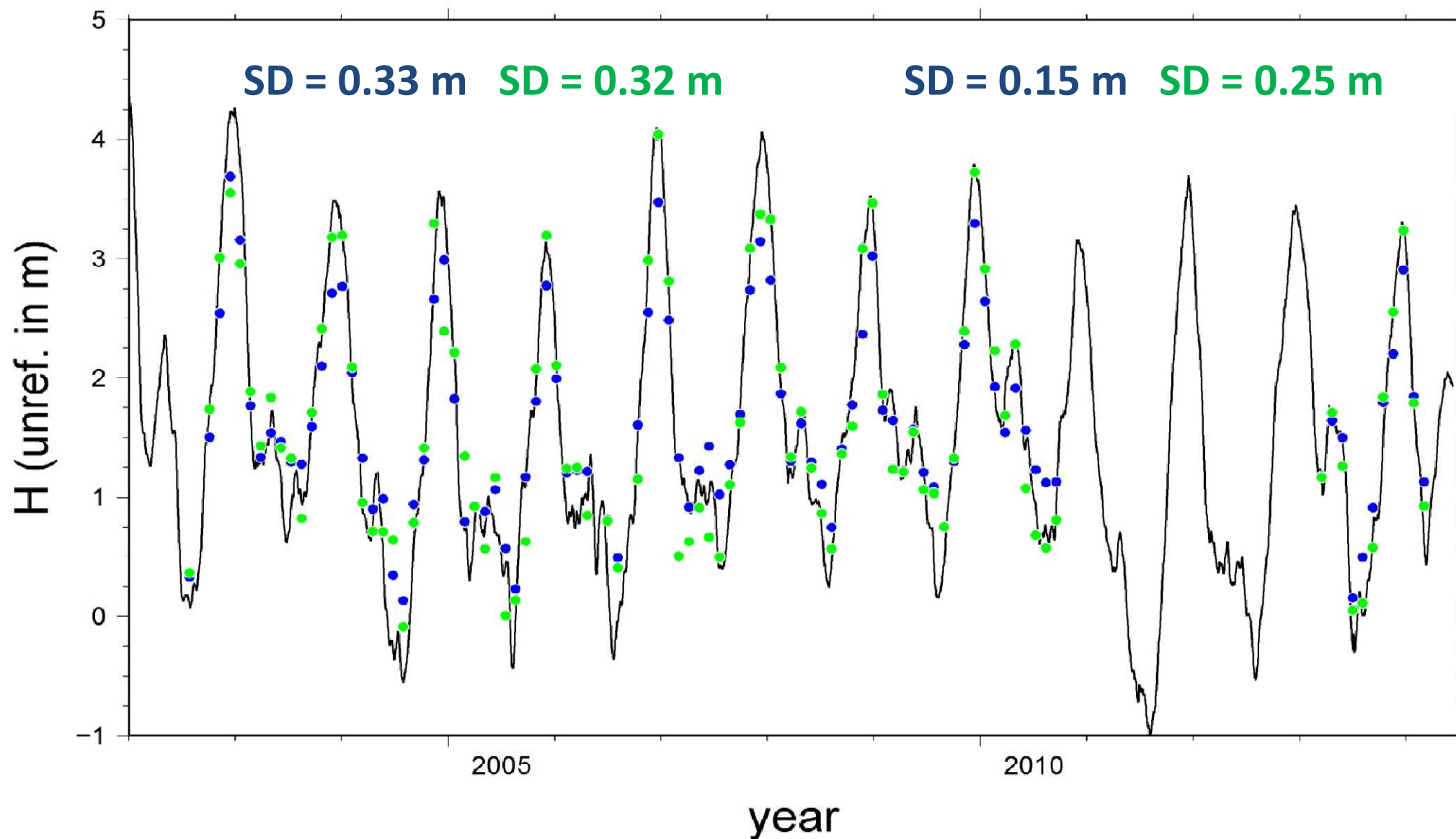


- satellite track intersects a water body = monthly water level time series (virtual stations)
- 140 river water level series
- **99 time series** satisfied the requirements (length, outliers, gaps...)
- Over **2003-2009** (complete years)

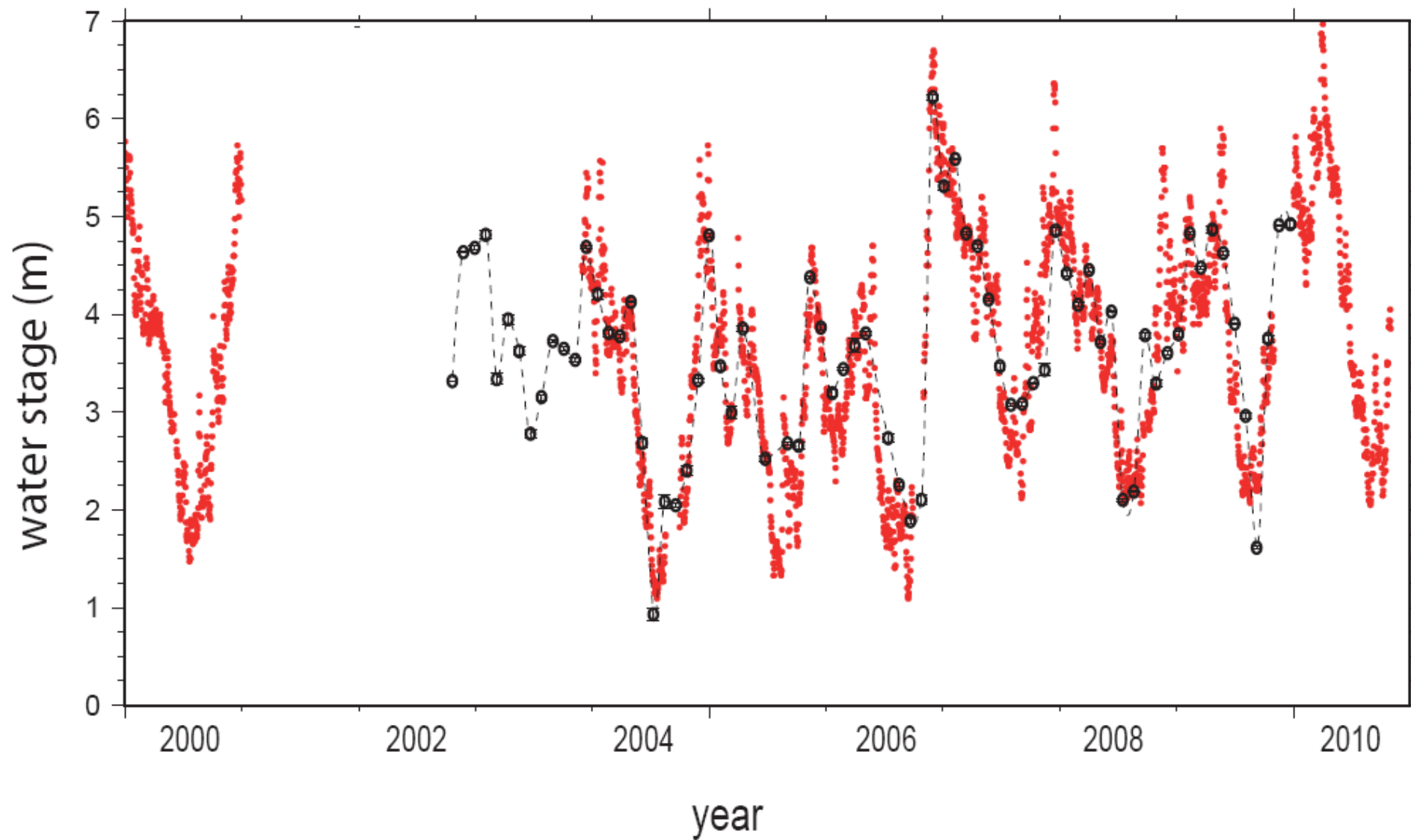
Figure. Location of ENVISAT tracks. Points represent the 140 virtual stations, with the 99 selected stations shown in black.



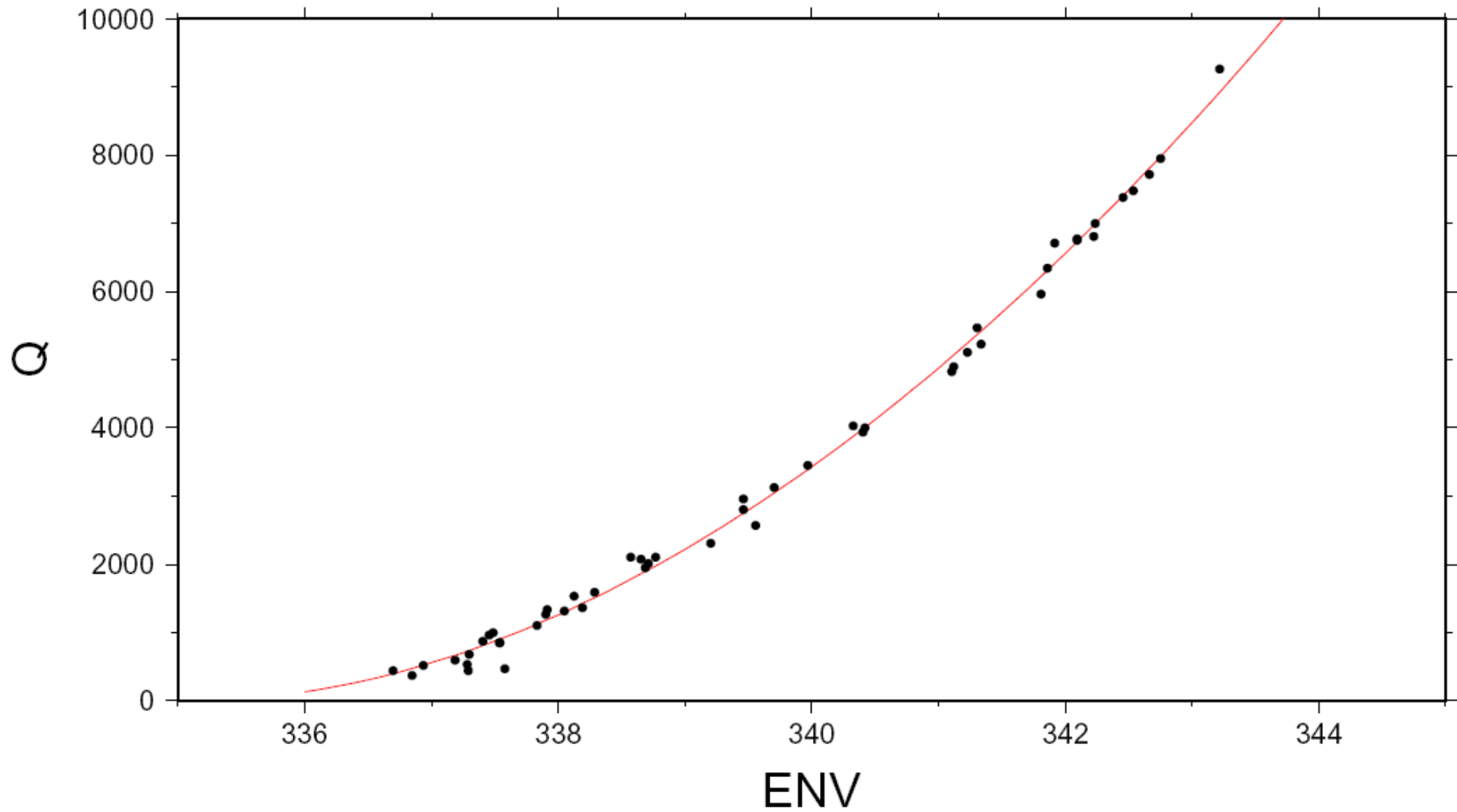
Congo at BRAZAVILLE



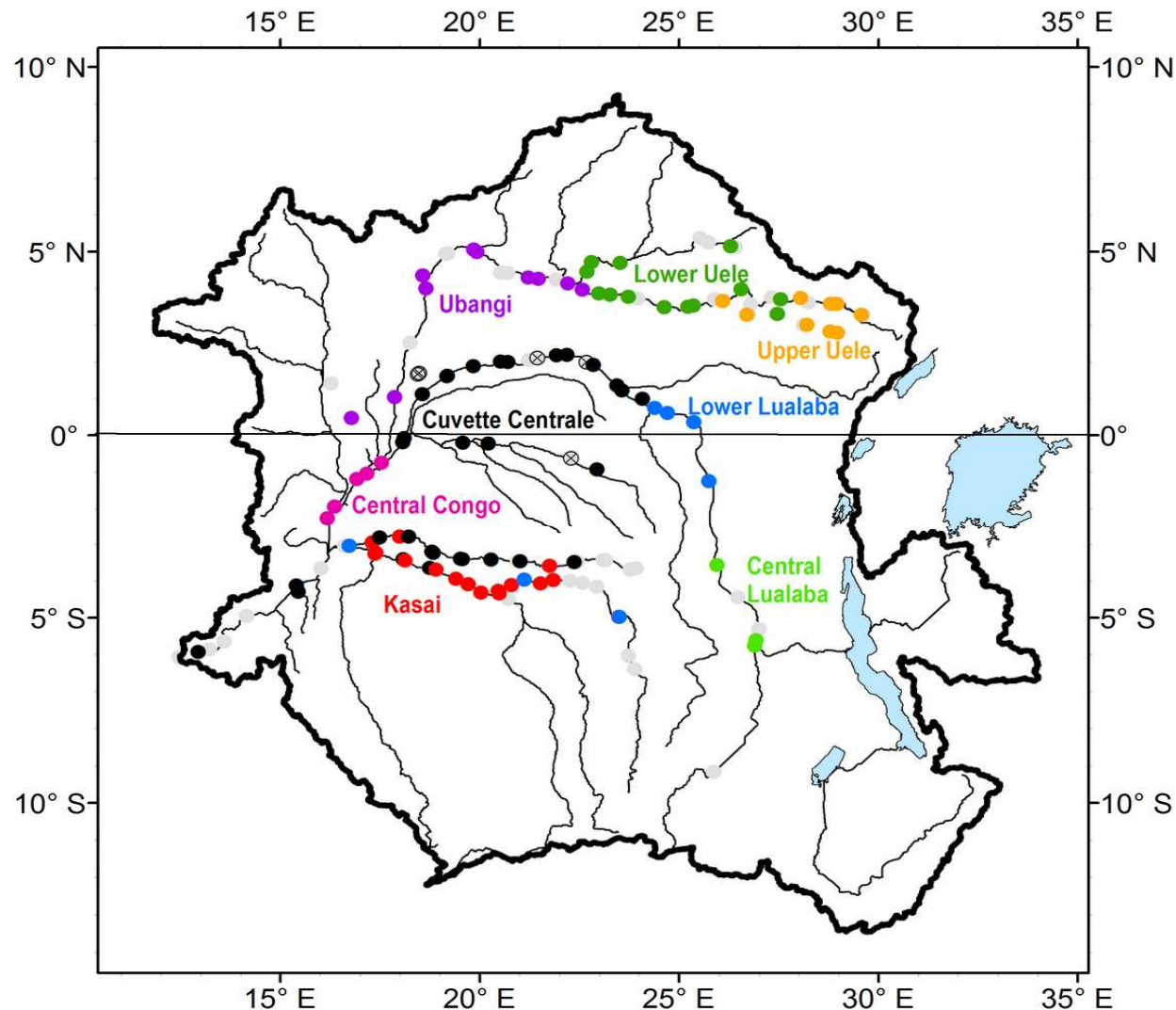
Kisangani



Stage – Discharge relationship at Bangui (Ubangui River)



A scheme for hydrological regionalization



- K-means clustering
- Parameters : elevation, amplitude, dates of low and high stages and interannual correlation structure.
- 10,000 replicates
- Convergence = 8 clusters (+ bin)

Figure. Optimal locations of the clusters. Each circle represents the location of a virtual station and is color-coded to indicate its affiliation to a particular cluster.

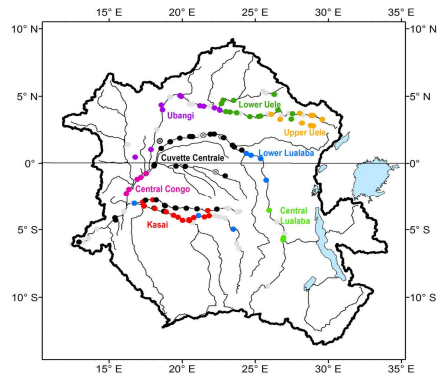
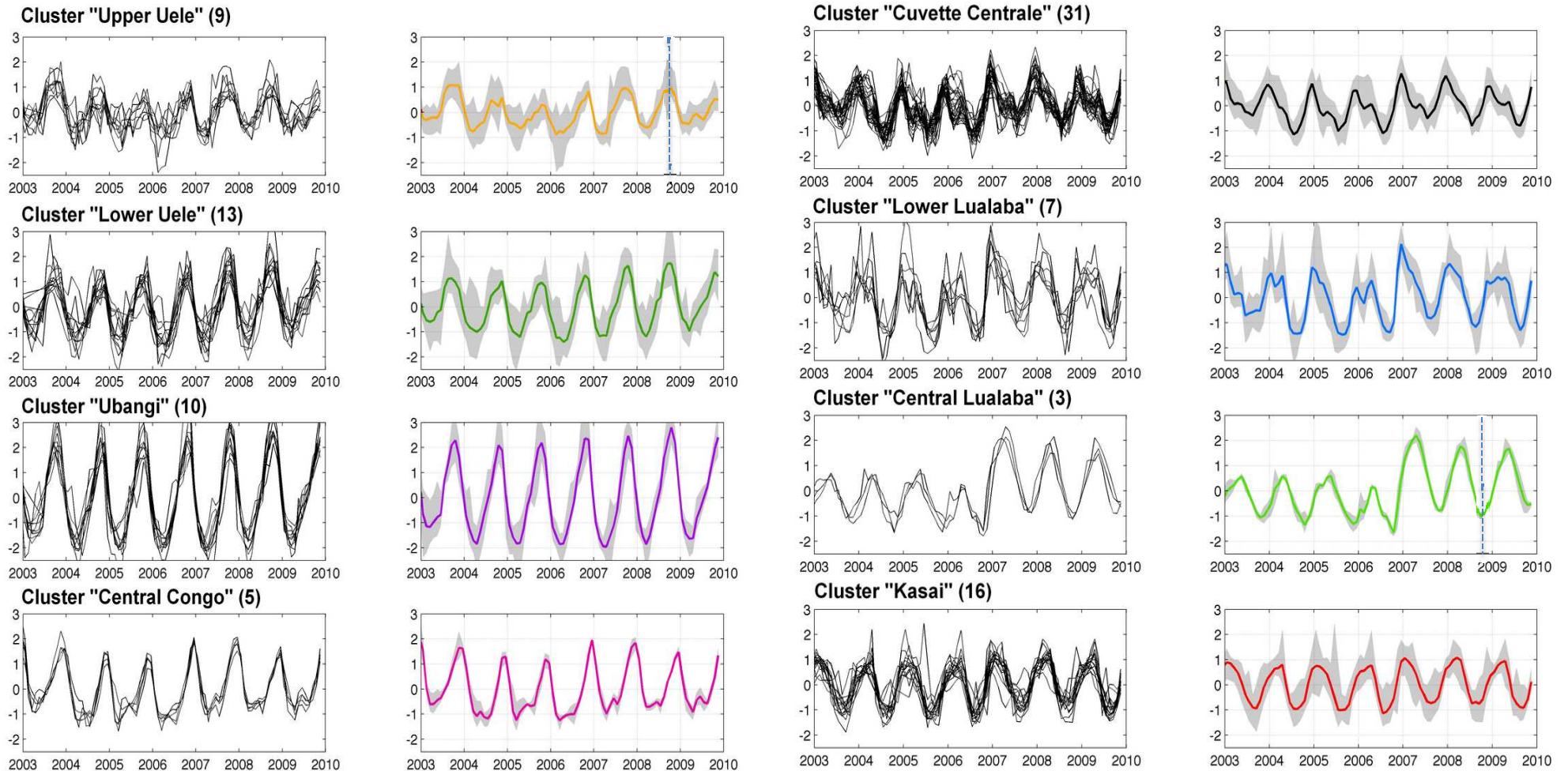
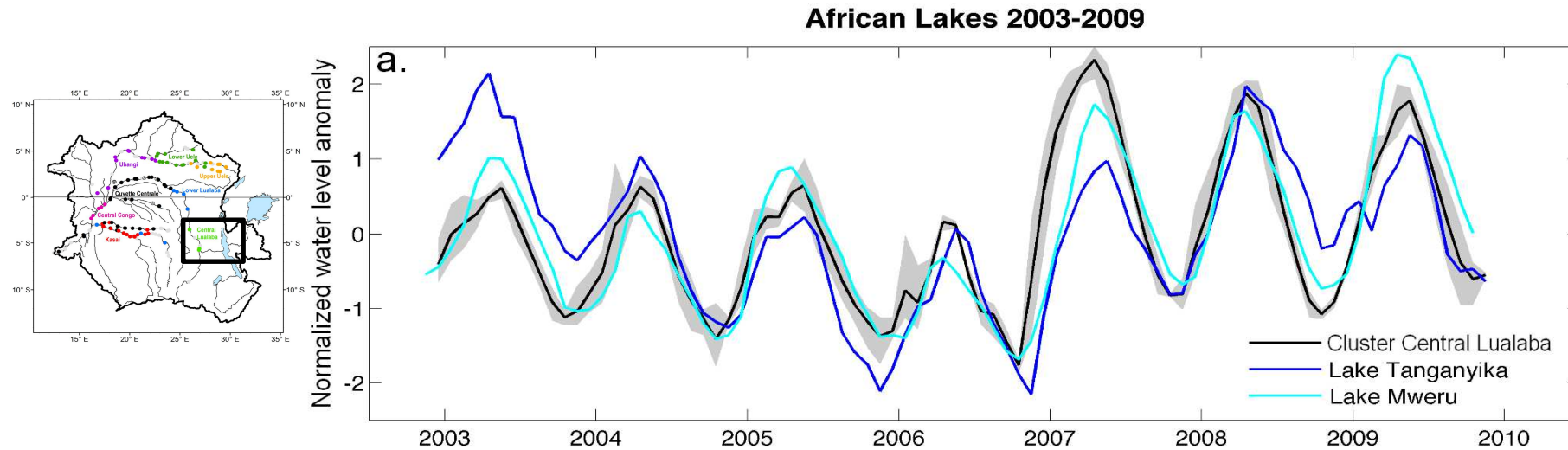


Figure. Left panel: The 8 groups found by using K-means (black lines). Right panel: The bold line represents the mean of the river water level anomaly for each cluster, and the envelope (gray) shows the dispersion.

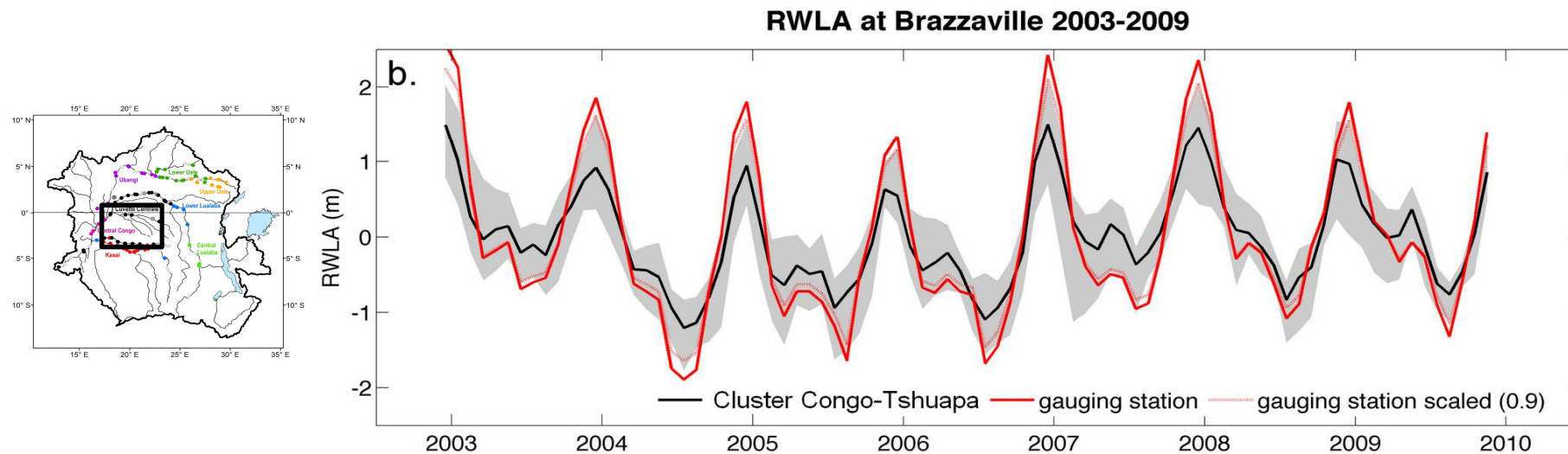


Validation of the regionalization

Comparison of Cluster Central Lualaba with Lake Tanganyika and Lake Mweru water level time series obtained from ***HYDROWEB*** [Crétaux et al. 2011]



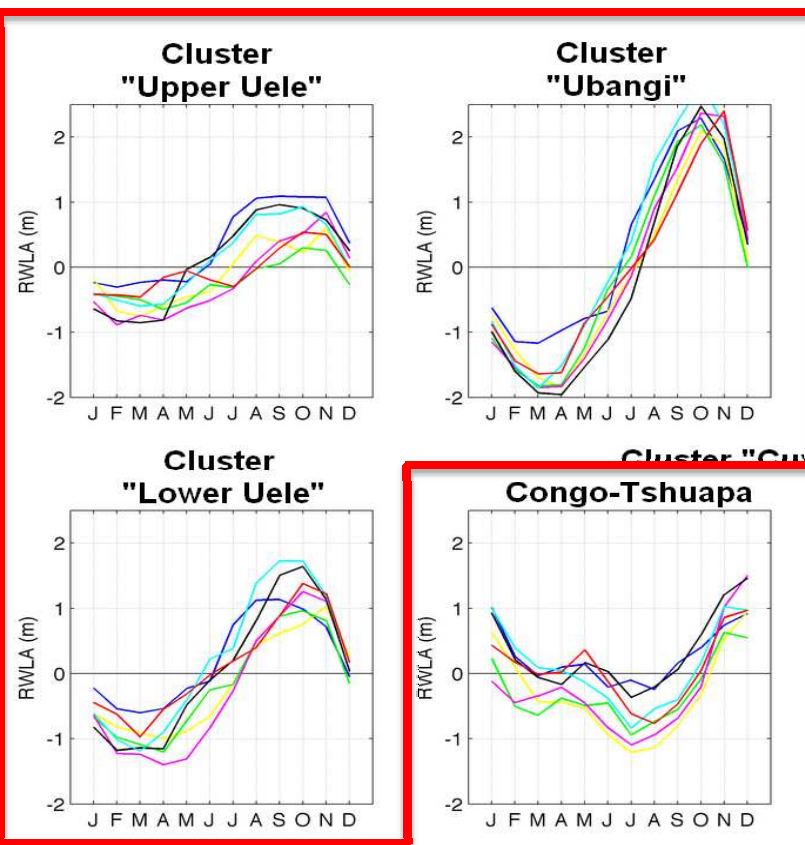
Comparison of Cluster Congo-Tshuapa with RWLA at Brazzaville gauging station ***ORE-HYBAM***



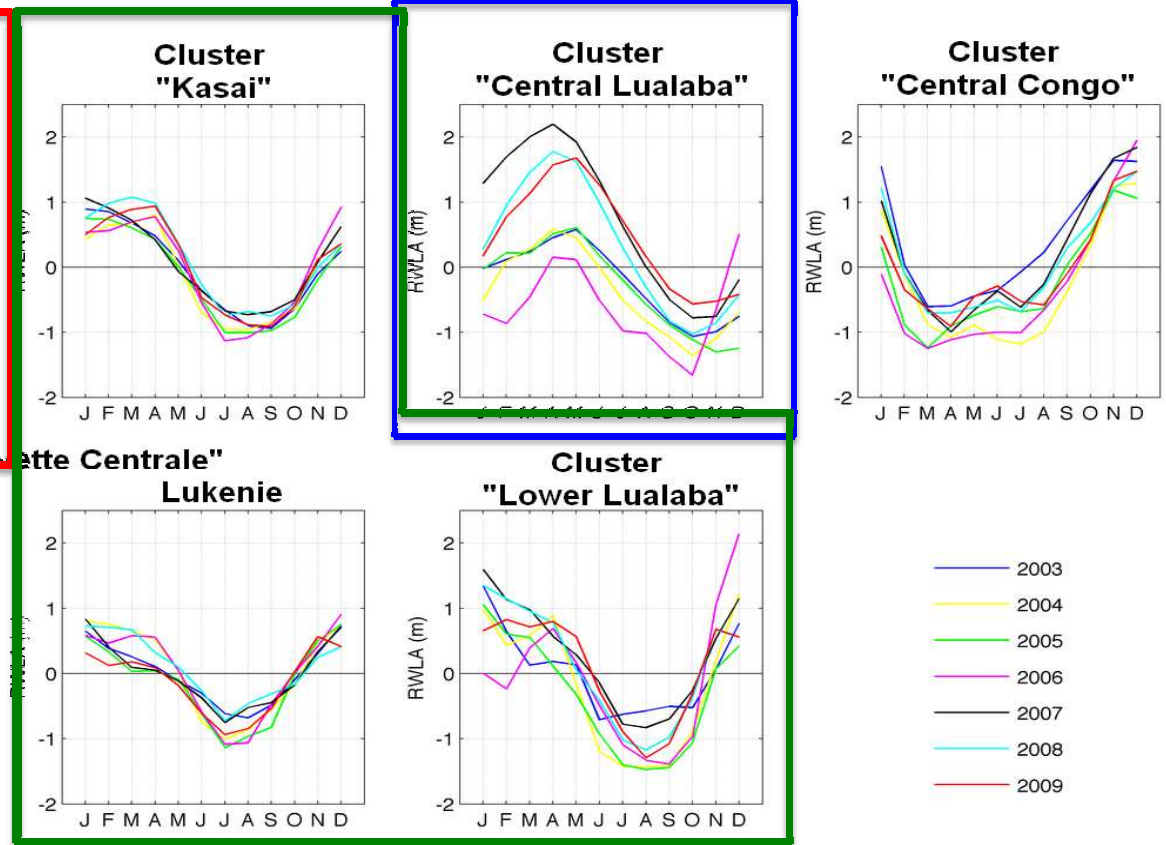
Validation of the regionalization

Comparison of Hydrograph of the river water level anomaly mean for each cluster with historical data, hydrological literature, great climatic zones and climatic events.

North

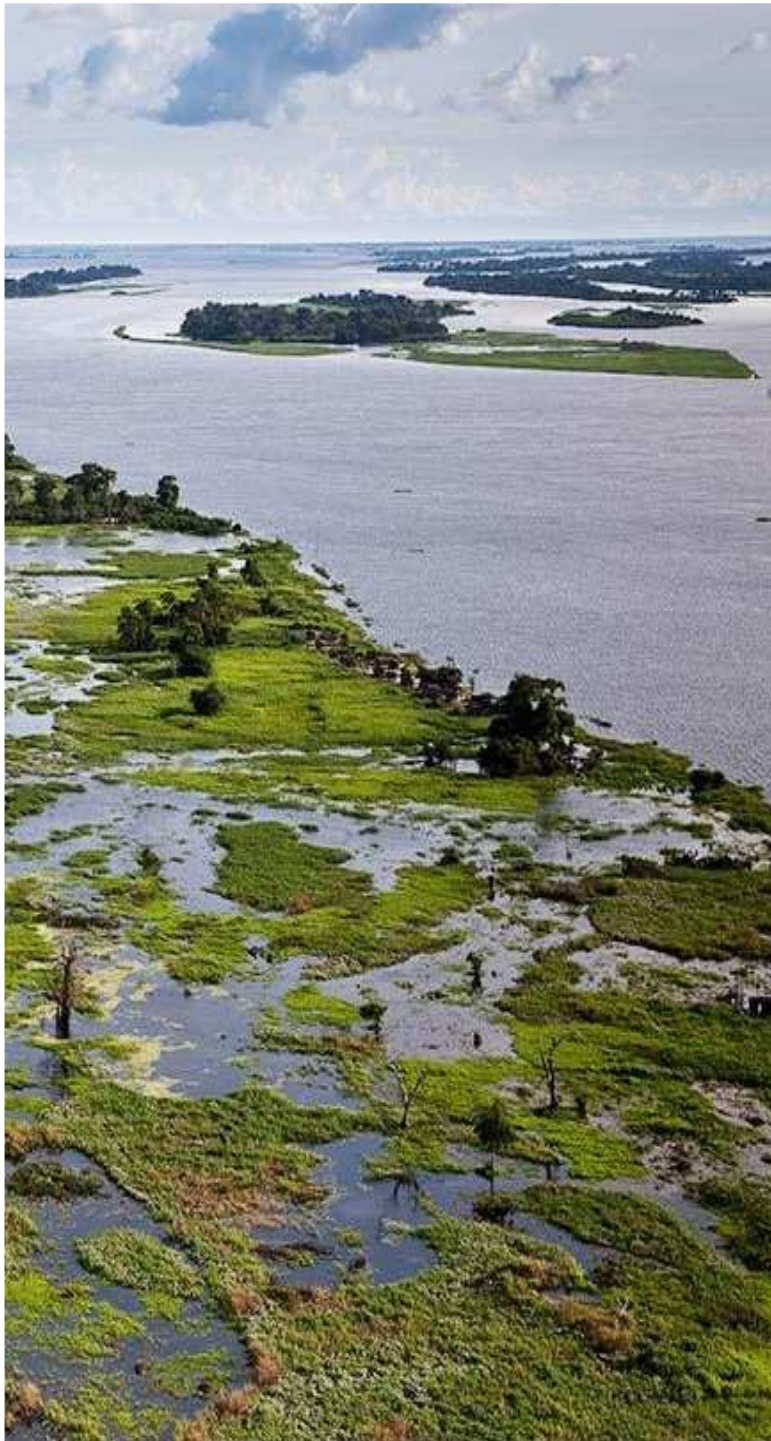


Southeast



East/Soutwest

- Congo Central → divided into 2 sub-clusters
- east-west gradient.
- The central western region is limited to a small region near the Congo swamp and represents the only bimodal regime



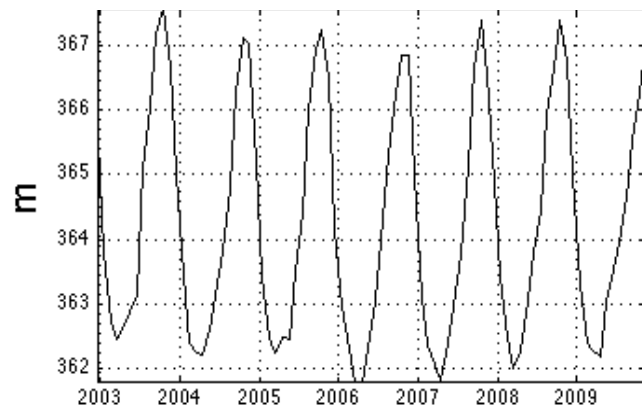
Conclusions

- Very large number of virtual stations across the Congo Basin
- Information on the regional variability of surface water level in places where no in situ data are available
- Interesting insights into the regionalization of the hydrological regime of the Congo Basin
- Potential of satellite altimetry in monitoring spatio-temporal water level for improved representation of the hydrologic characteristics in large ungauged river basins.

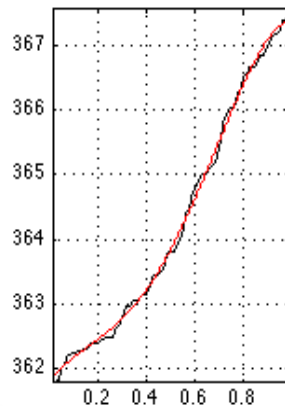
Further Research : estimating nowadays discharge from altimetry-derived stage (AltiKa, Jason-2) and non-synchronous discharge datasets (historical data)

BANGUI : Method by Tourian *et al.* (2013)

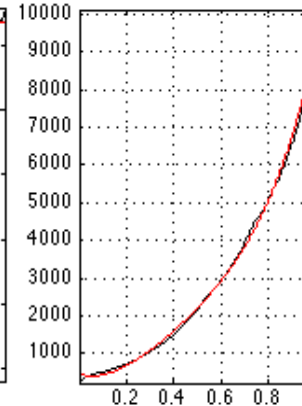
**Altimetry water level ENVISAT
SV 2003-2009**



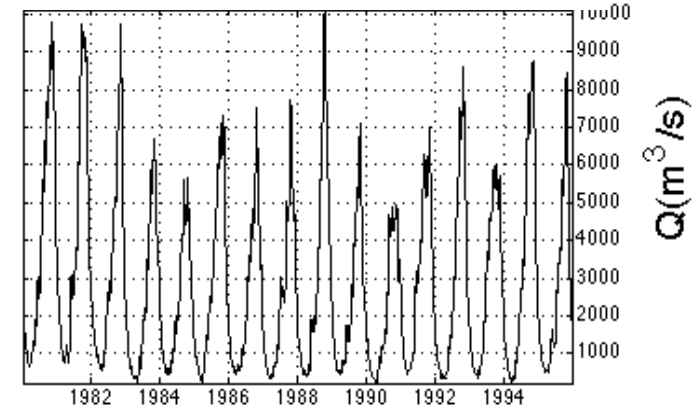
WL-Quantile Function



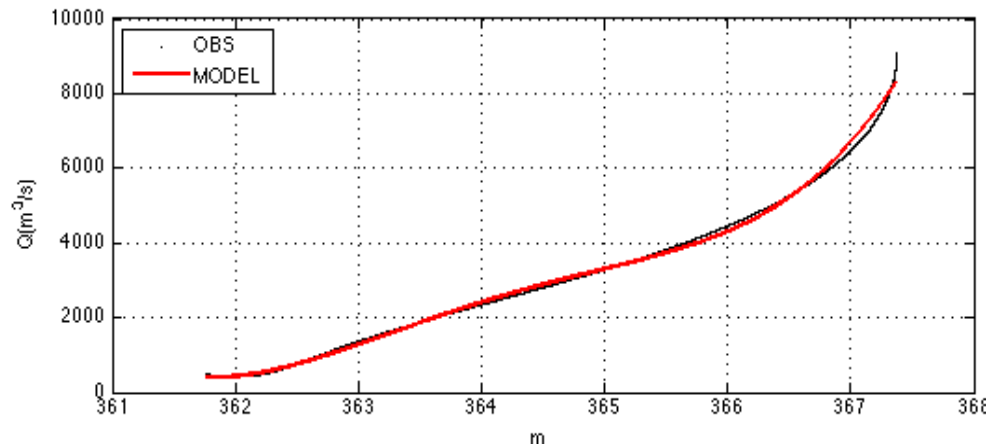
Q-Quantile Function



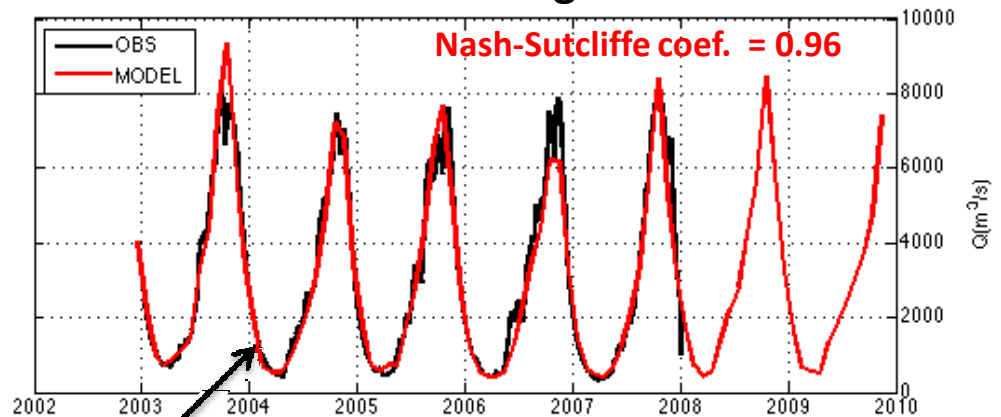
**In situ discharge data
1980-1996 (GRDC)**



Rating Curve



Reonstruted discharge 2003-2009



In situ discharge 2003-2008 (GRDC)

Thank you for your attention!

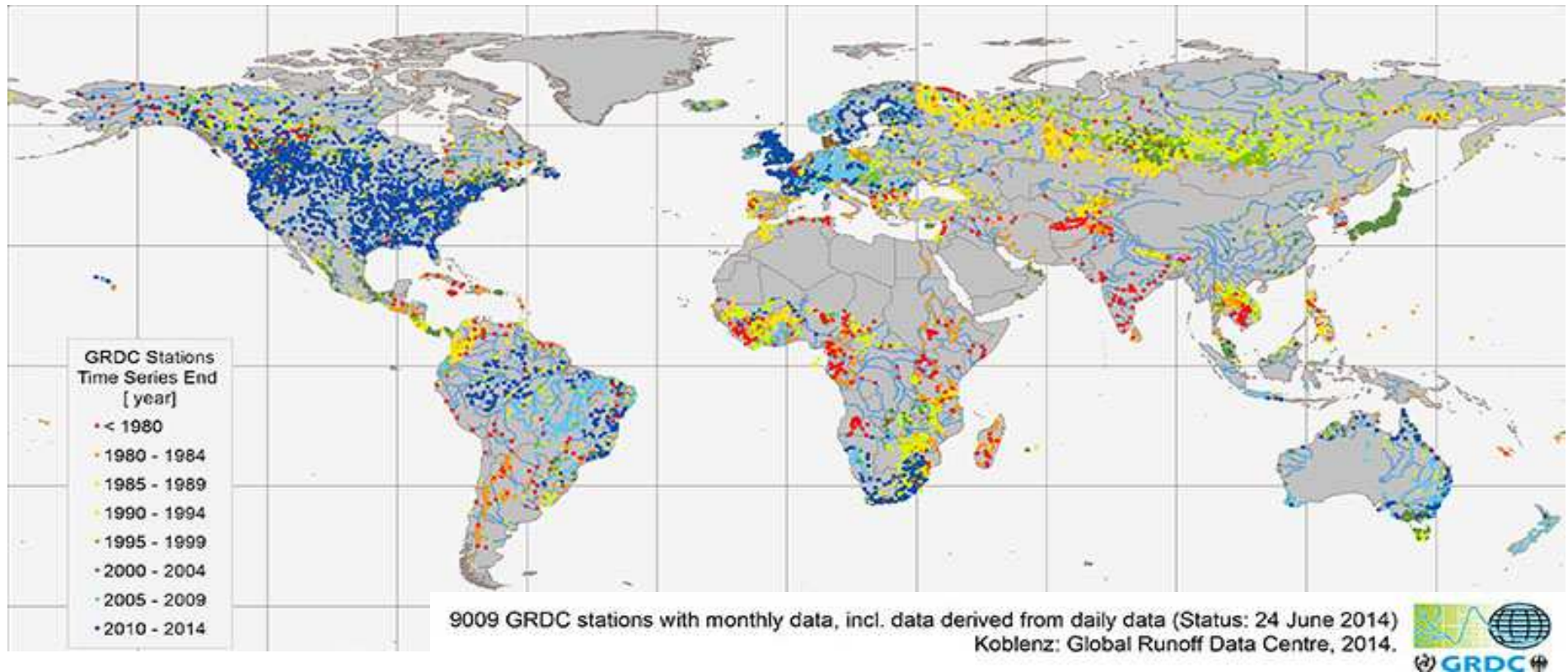
Becker, M.; da Silva, J.S.; Calmant, S.; Robinet, V.; Linguet, L.; Seyler, F. Water Level Fluctuations in the Congo Basin Derived from ENVISAT Satellite Altimetry. *Remote Sens.* 2014, 6, 9340-9358.

All these altimetry data are already freely available, send me an email at : stephane.calmant@ird.fr !



Village sur le fleuve Congo près de Bounda, République du Congo (Congo - Brazzaville) (1°37' S - 16°39' E).
www.yannarthusbertrand2.org

The term “ ungauged basins ” ?



There are different grades of being “ ungauged ” [Kundzewicz, 2007]

- Genuinely ungauged
- Poorly gauged
- Previously gauged
- Monitoring discontinued
- Gauges overtopped or/and destroyed
- Notoriously ungauged due to high flood...



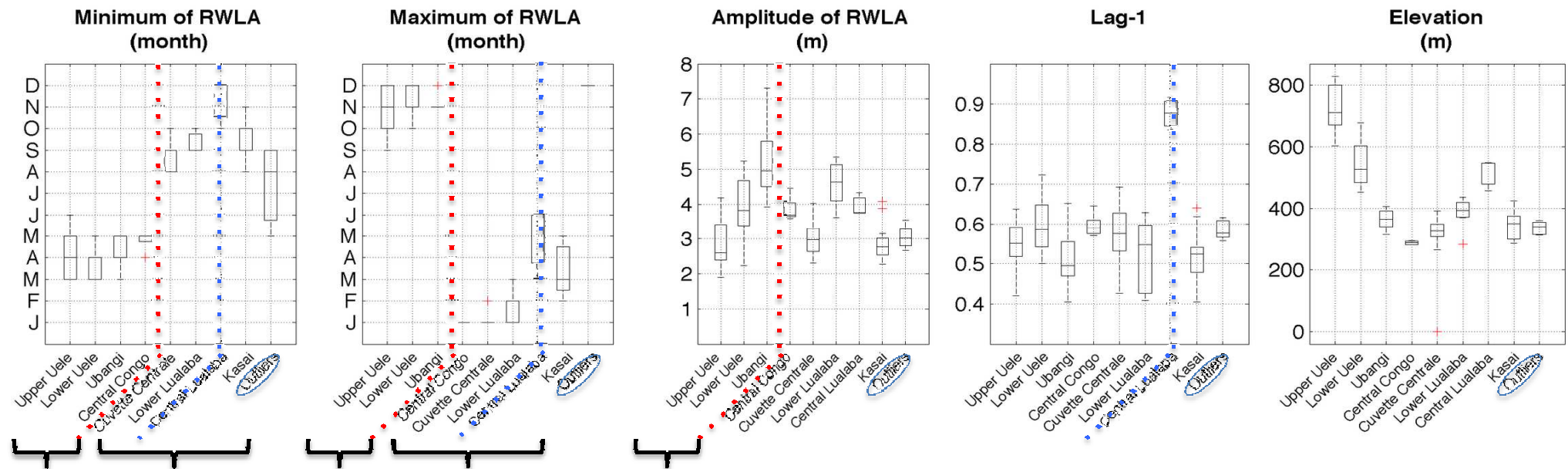
Another problem → **data accessibility**

- limited access to data mostly for confidentiality, national security
- Water data collection: ministries, territorial or regional institutions, farmers cooperatives and energy supply firms...

= the greatest problem in ungauged basins

- Recent improvements in remote sensing technology provide more observations than ever, that can advance our hydrological knowledge of ungauged basins.
- Satellite altimetry can be used to retrieve some hydrological variables.

Optimal cluster topology of river water level anomaly (RWLA) signature vectors.



Further Research : extended time series

2002 → 2010

ENVISAT

2008 →

JASON 2

2013 →

SARAL

Today :

160 SV ENVISAT

60 SV JASON-2

240 SV SARAL

