21e Édition JC² | 6, 7 et 8 Octobre 2021
"Journées CNES JEUNES CHERCHEURS"
Tenue à la cité de l'Espace, Toulouse

Combined use of in-situ and satellite-derived observations to characterize surface hydrology and its variability in the Congo River Basin

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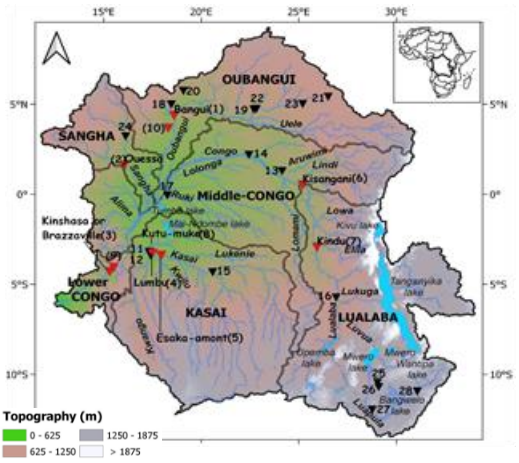
Co-funded thesis by CNES-AFD-IRD and in international co-direction UPS-University of Kinshasa

Study area : the Congo River Basin (CRB)



General context of the CRB

- Highly dependence of the CRB population to the water resources availability,
- CRB is subject to anthropic pressure and climate change,
- Limited understanding of the large-scale variability of the hydrologic components and their link with climate,
- Less and less in-situ records to understand and monitor water availability in the CRB (Laraque et al., 2020),
- Yet an increasing quantity of long term earth observation from space datasets to complement and extend in-situ records (Alsdorf et al., 2016),
- More hydrology-oriented observations will be soon available with the SWOT mission.

Scientific question

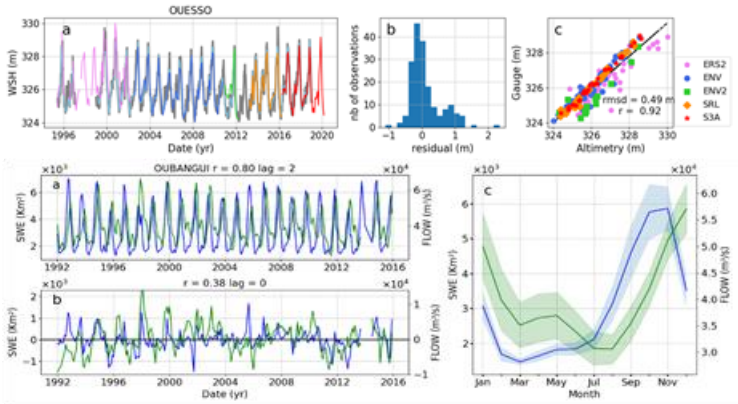
What is the time of water transfer from upstream to downstream, according to different locations in the basin and during the different phases of the hydrological cycle of the Congo River at the Brazzaville station?

Datasets

- Spatial altimetry dataset (~2,311 VSs from multi-satellite missions. > 550 combined VSs covering more than 12 years)
- Global Inundation Extent from Multi-Satellite (GIEMS-2) dataset (1992-2015)
- In-situ database (see map for locations of network)

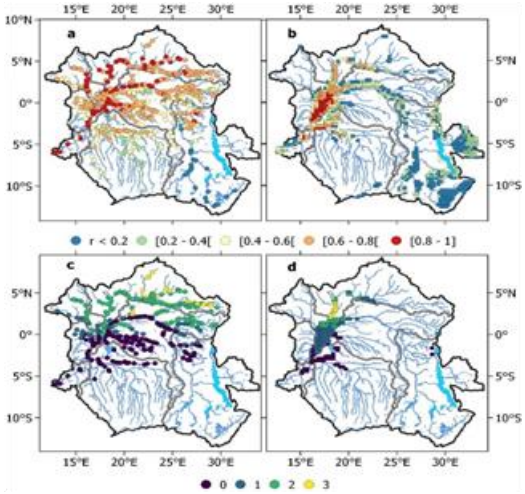
Spatio-temporal variability of SW flows from satellite-derived products

Validation and Evaluation of remote sensing products with in situ data

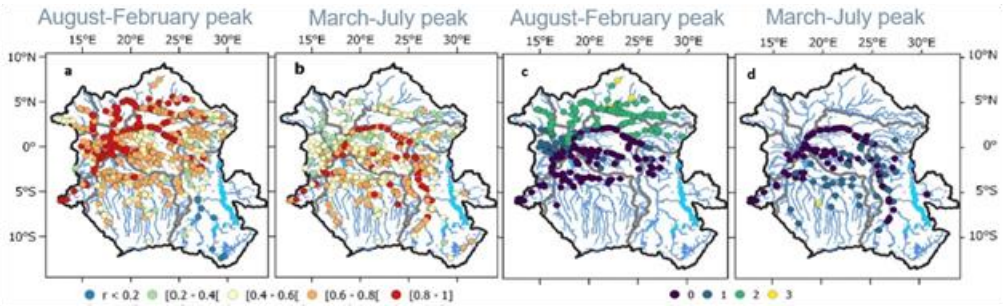


Comparison of in-situ water levels/river discharge and altimeter-derived $SWH_{(upper\ panel)}$/GIEMS-2$_{(bottom\ panel)}$

Maximum correlation between $SWH_{(a)}$/$SWE_{(b)}$ versus height/river discharge at Brazzaville/Kinshasa station (outlet) and the associated lag (in month, $SWH_{(c)}$ and $SWE_{(d)}$)



Contribution to the annual bimodal pattern at the outlet



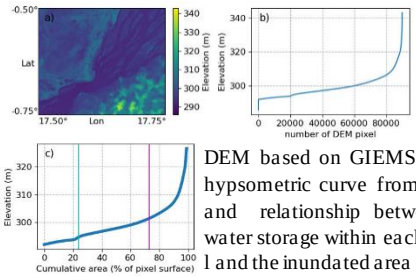
Maximum correlation$_{(SWH(a,b);Brazzaville/Kinshasa\ station)}$ at each peaks and the associated lag (in month, $SWH_{(c,d)}$)

Validation with in situ dataset

Station	Global annual cycle		Pic1 (August-February)		Pic2 (March-July)	
	Daily/Monthly		Daily/Monthly		Daily/Monthly	
	r	lag	r	lag	R	lag
Lower-Congo sub-basin						
Maluku	0.96/0.97	0/0	0.97/0.97	0/0	0.92/0.92	0/0
Con_KM0548	0.97	0	0.97	0	0.9	0
Cell_305637	0.85	0	0.9	0	0.6	1

validation of the results obtained with remote sensing products with in situ data by repeating the same analysis.

Surface volume profile using DEM



DEM based on GIEMS-2 cell (a), hypsometric curve from DEM (b) and relationship between surface water storage within each grid cel l and the inundated area (c).

Conclusions

- High correlation of SWH in the Middle-Congo and northern sub-basins
- Traveltime ranges from 0-1month (Kasaï) to 2-3 months
- Northern sub-basins contributes to only August-February peak
- Southern sub-basins contributes to both peaks

Perspectives

- Use of long-term SWH variations and SWE from GIEMS-2 to generate estimates of Surface Water Storage (SWS) over the CRB.
- Use of SWS in combination with GRACE/GRACE-FO to estimate long-term variations of subsurface and groundwater storage.
- Our datasets are benchmark products for SWOT

References

- Alsdorf, D., Beighley, E., Laraque, A., Lee, H., Tshimanga, R., O'Loughlin, F., Mahé, G., Dinga, B., Moukandi, G., & Spencer, R. G. M. (2016). *Reviews of Geophysics*, *54*(2), 378–409.
- Laraque, A., N'kaya, G. D. M., Orange, D., Tshimanga, R., Tshitenge, J. M., Mahé, G., Nguimalet, C. R., Trigg, M. A., Yepez, S., & Gulemvuga, G. (2020). Water, 12(9).

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The preprint is accessible at : https://hess.copernicus.org/preprints/hess-2021-315/