Supplementary Materials for

Current availability and distribution of Congo basin's freshwater resources

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April 17, 2023

Supplementary Notes 1, Sub-basins in Congo River Basin

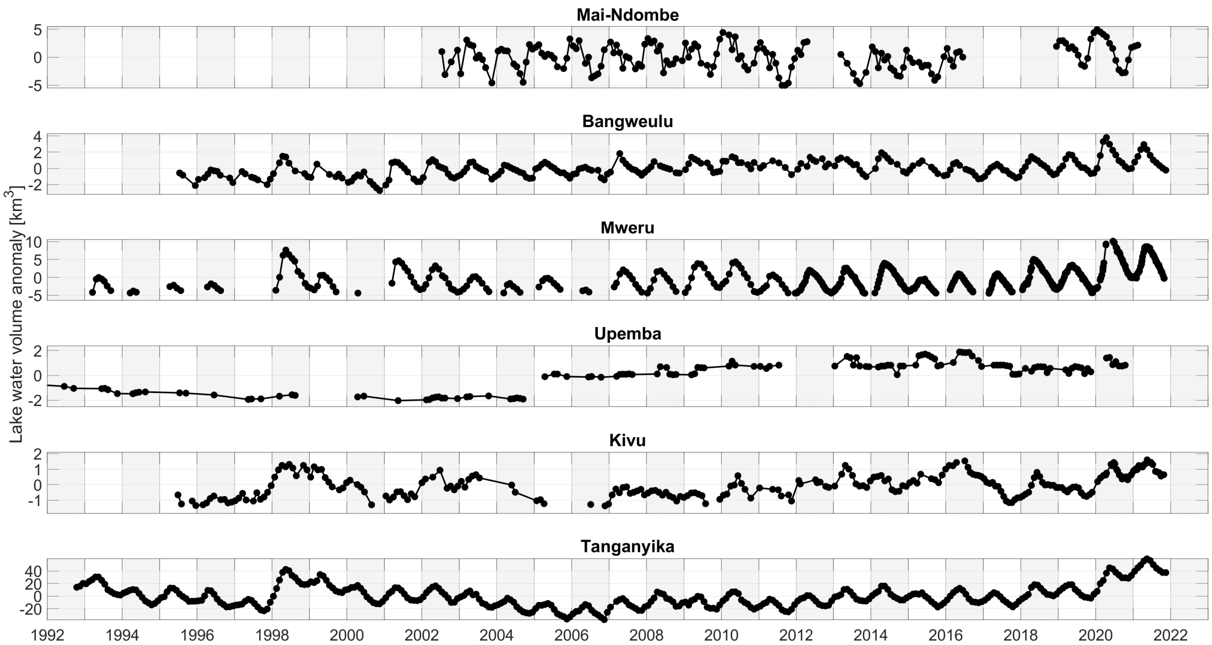
We study the Congo Basin and its sub-basins: Kasaï, Middle-Congo, Ubangui, Sangha, Lualaba-North, Lualaba-South and Lualaba-Lukuga covering an area of 3 610 012 km^2. Table S1 lists these sub-basins with their mean annual precipitation, discharge, evapotranspiration and dominant climate of each subbasin.

Table S1: Subbasins of Congo Basin with their mean annual precipitation, discharge, evapotranspiration, and dominant climate of each subbasin. Precipitation estimates are from GPCC data and evapotranspiration from ERA5 for the period 2002-2018. Discharge values were obtained from discharge data within the period specified in Table S2.

Basin	Area [km^2]	precipitation [mm/yr]	discharge [mm/yr]	evapotranspiration [mm/yr]	Climate classification
Kasaï	895 633	1406±56	282±11	1077±27	Tropical savanna climate
Middle Congo	879 050	1509±48	498±20	1168±28	Tropical rainforest climate
Ubangui	649 495	1352±54	142±09	1051±29	Tropical savanna climate
Sangha	213 654	1291±78	204±13	1001±25	Tropical rainforest and monsoon climate
Lualaba-North	250 975	1400±67	535±38	1133±27	Tropical savanna and monsoon climate
Lualaba-South	454 093	1053±68	148±16	900±28	Tropical savanna and humid subtropical climate
Lualaba-Lukuga	267 108	896±79	9±01	866±25	Tropical savanna climate
Congo	3 615 546	1454±37	335±09	1157±27	all above

Supplementary Notes 2, Lake water storage anomaly

Figure S1 shows the time series of lake volume anomaly of Mai-Ndombe, Bangwelu, Upemba, Mweru, Kivu, and Tanganyika. The time series of Lake Tanganyika and Lake Mai-Ndombe are obtained by combining the time series of lake surface water extent and lake water levels provided by the HydroSat database and accessible at `http://hydrosat.gis.uni-stuttgart.de/`. Time series of water volume anomaly of Lake Mweru, Lake Kivu, and Lake Bangwelu are provided by the Hydroweb database [1] and accessible at `http://hydroweb.theia-land.fr/`.



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Supplementary Notes 3, Surface Water Storage Anomaly

Figure S2 shows the time series of Surface Water Storage Anomaly (SWSA) of five wetlands of Mai-Ndombe, Bangwelu, Mweru, Mweru Wantipa and Upemba derived from the combination of Surface Water Extent (SWE) estimates from the Global Inundation Extent from Multi-Satellite (GIEMS-2) with topographic data from the Forest And Buildings removed Copernicus 30m Digital Elevation Model (FABDEM) following a hypsometric approach.

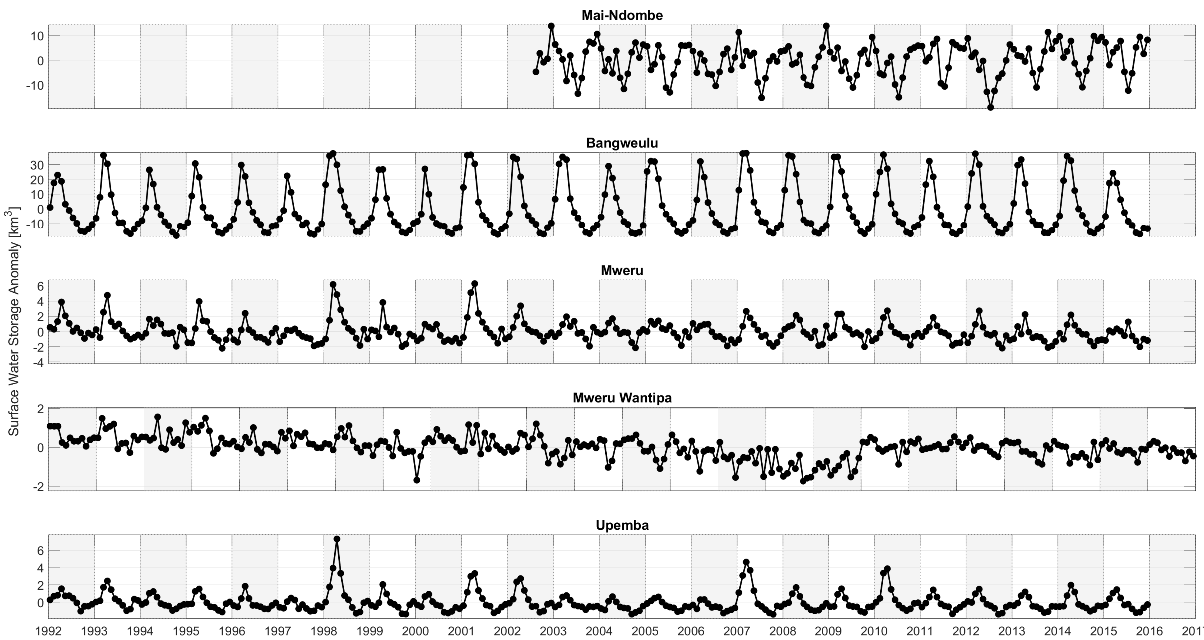

Figure S2: Time series for the period 1992–2015 of Surface Water Storage Anomaly (SWSA) of five wetlands of Mai-Ndombe, Bangwelu, Mweru, Mweru Wantipa and Upemba derived from the combination of Surface Water Extent (SWE) estimates from the Global Inundation Extent from Multi-Satellite (GIEMS-2) with topographic data from the Forest And Buildings removed Copernicus 30m Digital Elevation Model (FABDEM) following a hypsometric approach

Supplementary Notes 4, River discharge from altimetry

For discharge data, we use gauge stations represented by black dots in Figure 1 of the manuscript. Since only legacy discharge data (up to 1959) are available at the outlet of the Kasaï, the Lualaba-North, the Lualaba-South and the Lualaba-Lukuga subbasins, we estimate discharge using water level from satellite altimetry through the quantile function approach proposed by [2]. Figure 1 of the manuscript shows the selected virtual stations in yellow dots. Rating curves are obtained by matching the quantile functions of in situ discharge and altimetry water level measurements. Figure S3 shows the obtained rating curve and Figure S4 represents estimated altimetric discharge for these 4 basins. Table S2 lists the used discharge data of the outlet of each basin. For the Kasaï, the Lualaba-North, the Lualaba-South and the Lualaba-Lukuga discharge data are available only up to 1959 (shaded gray).

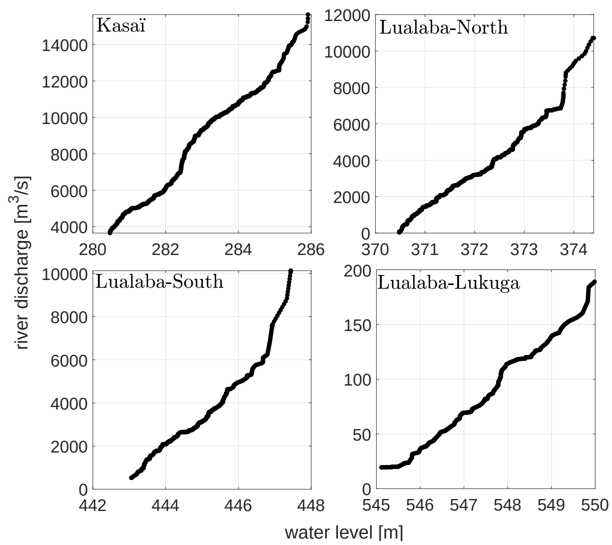

Figure S3: Rating curves obtained by the quantile function matching of legacy discharge and satellite altimetric water level time series for the Kasaï, the Lualaba-North, the Lualaba-South and the Lualaba-Lukuga. The time period of discharge and altimetric water level time series are indicated in Table S2.

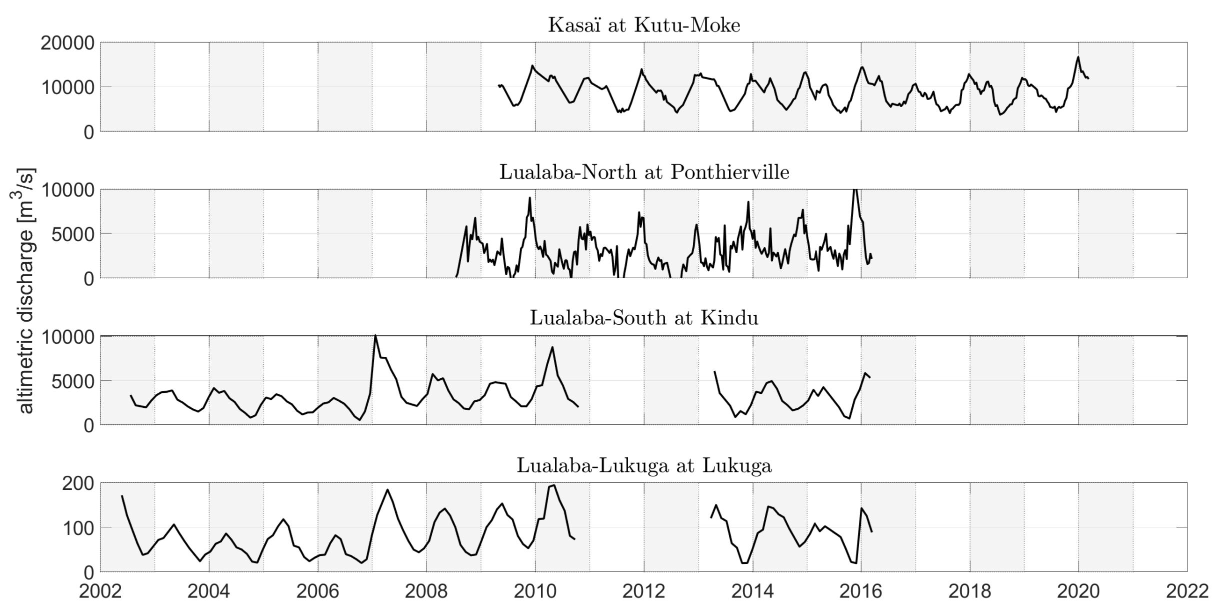

Figure S4: Altimetric discharge obtained by the quantile function matching of legacy discharge and satellite altimetric water level time series for the Kasaï, the Lualaba-North, the Lualaba-South and the Lualaba-Lukuga

Table S2: Discharge data source for the Congo Basin and its sub-basins. Water level from satellite altimetry is used to update discharge for the basins highlighted in gray using the quantile function approach [2]. J2, J3, Env and SRL in the table refer to Jason-2, Jason-3, Envisat, and Saral/AltiKa missions, respectively.

Basin	in situ discharge				water level from altimetry			
	station	Lat [°]	Lon [°]	time period	Mission	Lat [°]	Lon [°]	time period
Kasaï	Kutu-Moke	−3.18	17.38	1932–1991	J2&J3	−3.06	16.62	2009–2020
Middle Congo*	Brazzaville	−4.27	15.32	1990–2020				
Ubangui	Ubangui	4.37	18.61	1990–2020				
Sangha	Quesso	1.62	16.05	1990–2020				
Lualaba-North*	Ponthierville	−0.35	25.45	1932–1959	J2&J3	0.72	24.56	2009–2016
Lualaba-South	Kindu	−2.95	25.92	1933–1989	Env&SRL	−2.96	25.93	2002–2016
Lualaba-Lukuga	Lukuga	−5.91	29.19	1950–1959	Env&SRL	−5.74	26.91	2002–2016
Congo	Brazzaville	−4.27	15.32	1990–2020				

*: incremental basin

Supplementary Notes 5, Water storage-discharge relationship

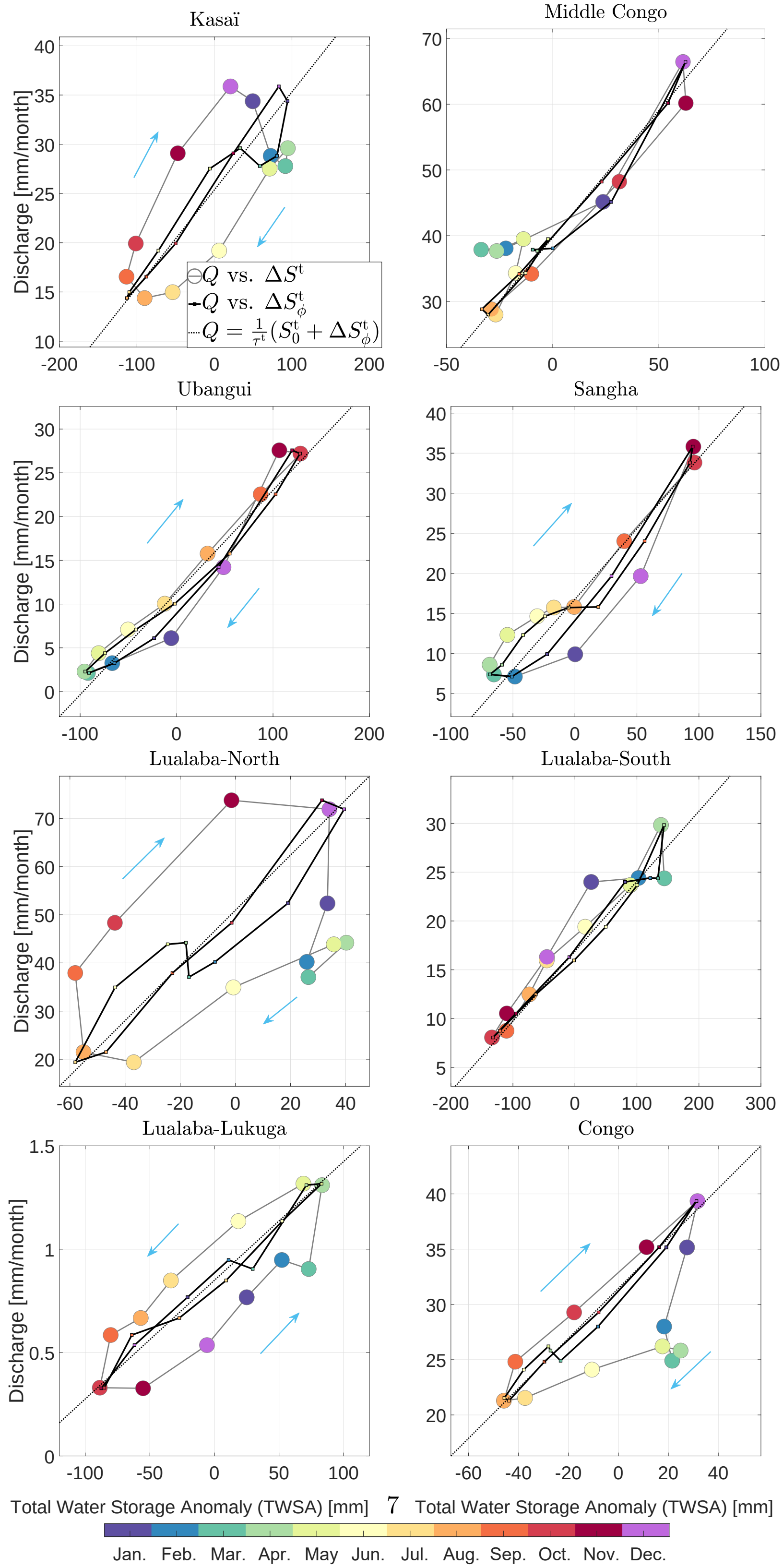

Figure S5: Mean monthly river discharge Q against mean monthly Total Water Storage Anomaly (TWSA) ΔS^t and time-shifted total water storage anomaly ΔS^t_ϕ

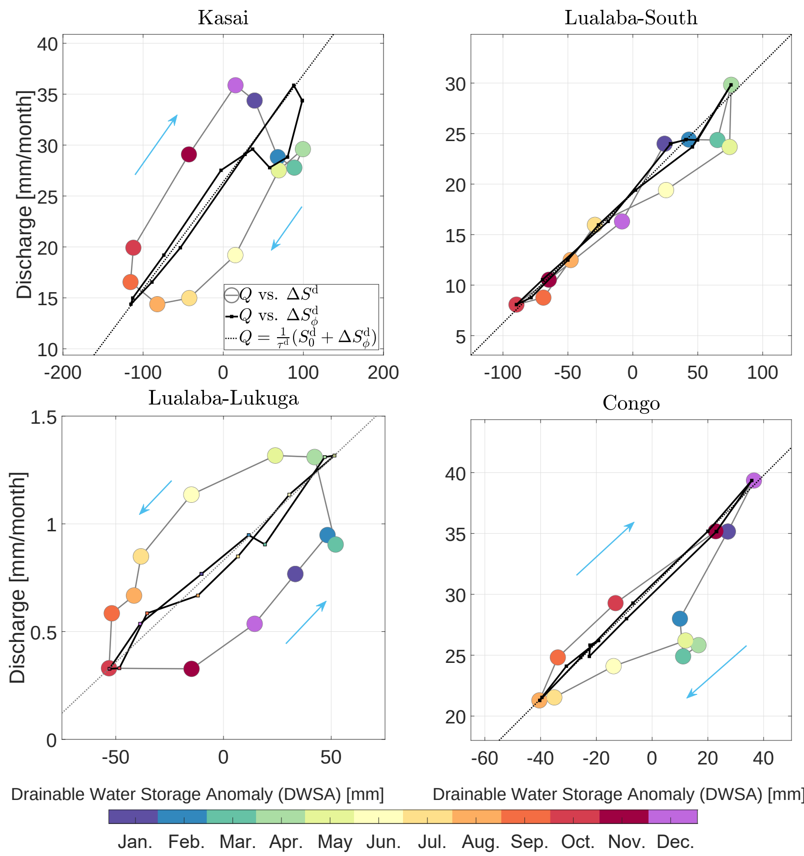

Figure S6: Mean monthly river discharge Q against mean monthly Drainable Water Storage Anomaly (TWSA − LWSA) ΔS^d and time-shifted drainable water storage anomaly ΔS^d_ϕ

Supplementary Notes 6, Precipitation pattern over the Congo River Basin

Precipitation data are obtained from the Global Precipitation Climatology Centre (GPCC) [3]. Figure S7 shows the distribution of monthly mean precipitation (climatology) over the Congo River Basin and its subbasins.

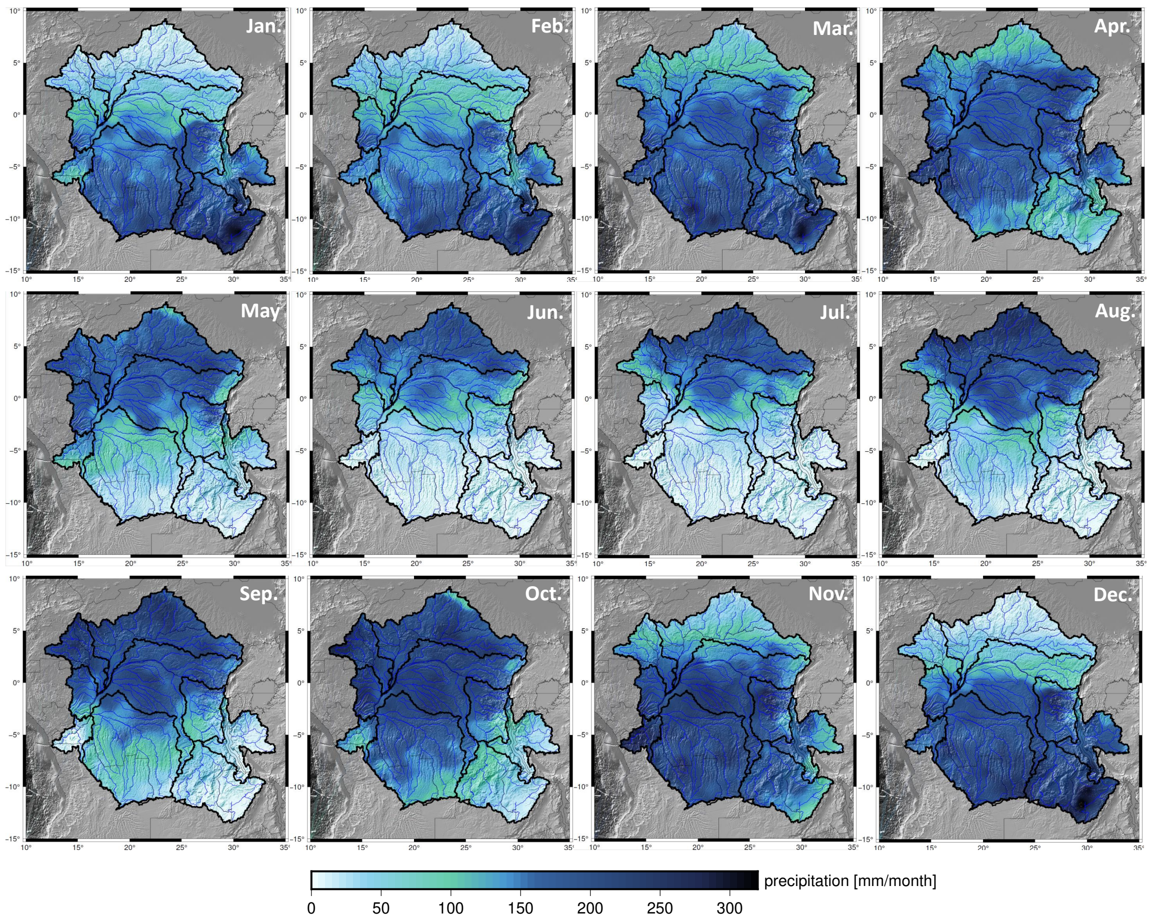

Figure S7: Mean monthly precipitation pattern over Congo and its sub-basins from GPCC dataset averaged over 1990–2019

Supplementary References

[1] J-F Crétaux, W. Jelinski, Stéphane Calmant, A. Kouraev, V. Vuglinski, M. Bergé-Nguyen, M.-C. Gennero, F. Nino, R. Abarca Del Rio, A. Cazenave, and P. Maisongrande. Sols: A lake database to monitor in the near real time water level and storage variations from remote sensing data. *Advances in Space Research*, 47(9):1497–1507, 2011.

[2] M. J. Tourian, N. Sneeuw, and A. Bárdossy. A quantile function approach to discharge estimation from satellite altimetry (ENVISAT). *Water Resources Research*, 49:1–13, 2013.

[3] U Schneider, A Becker, P Finger, A Meyer-Christoffer, B Rudolf, and M Ziese. GPCC full data reanalysis, version 7.0: Monthly land-surface precipitation from rain gauges built on gts based and historic data. research data archive at the national center for atmospheric research, computational and information systems laboratory, 2016.