Contributions of Water Storage Compartments to TWS in the East African Rift Region

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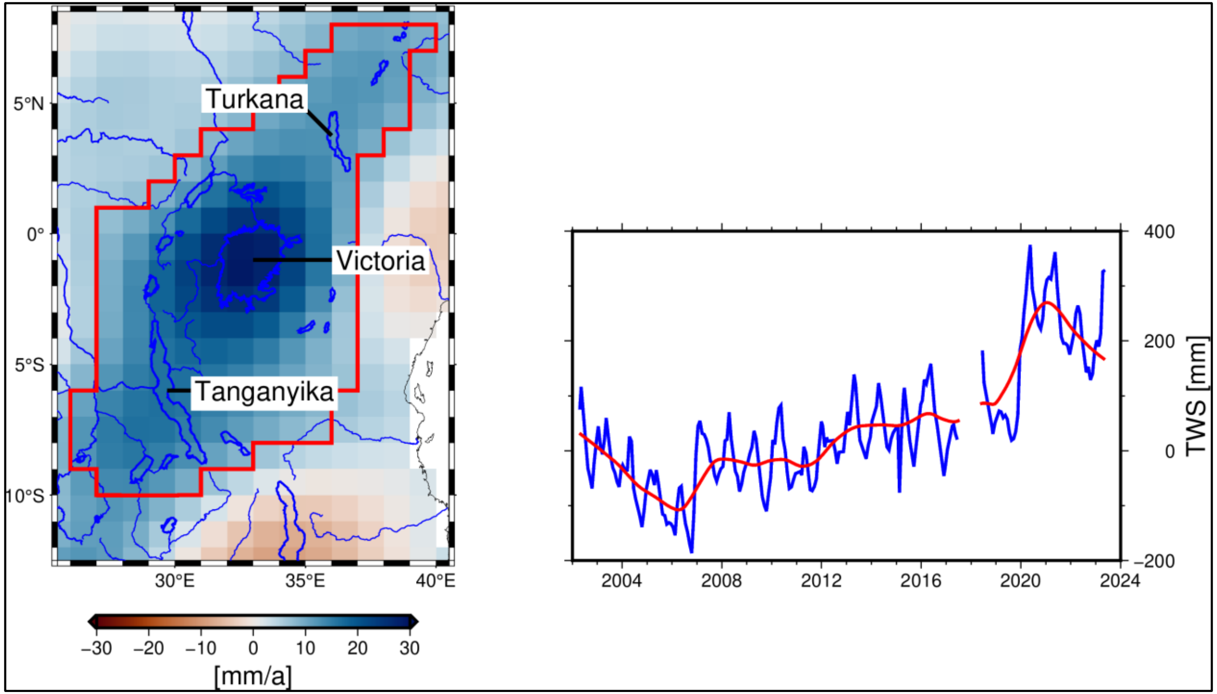
What happens in the hydrology of the East African Rift?



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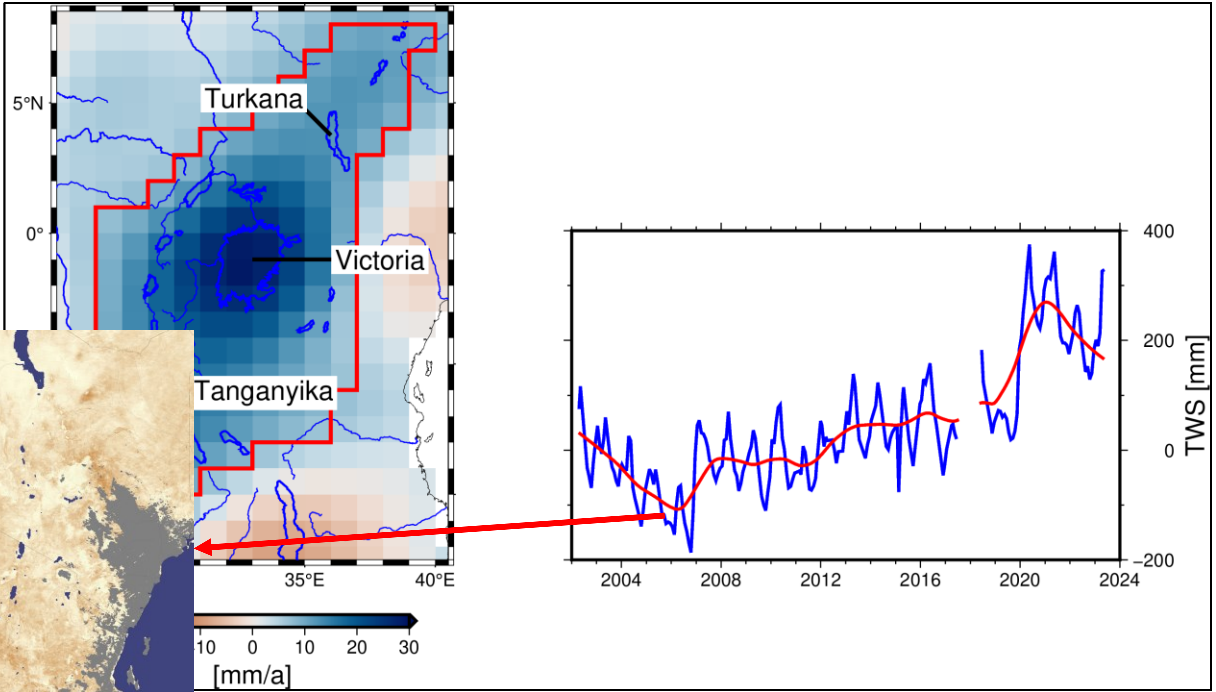

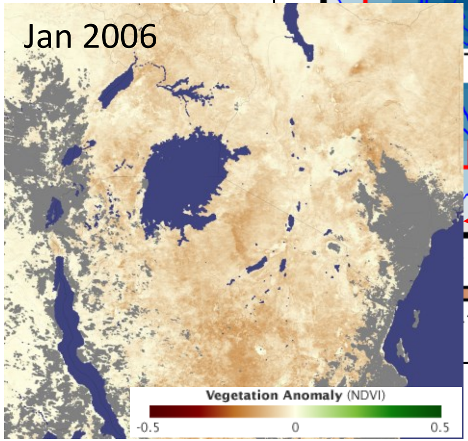

Images from NASA Earth Observatory

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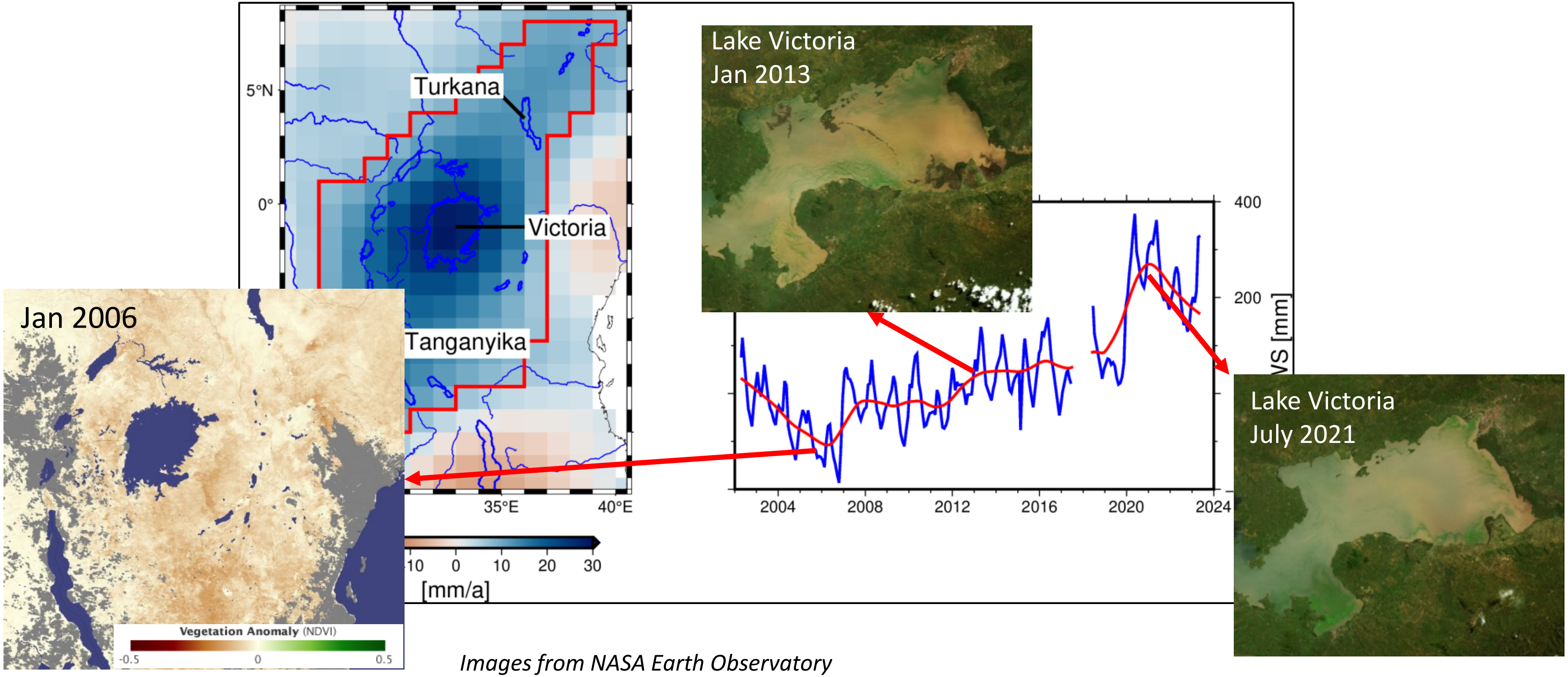

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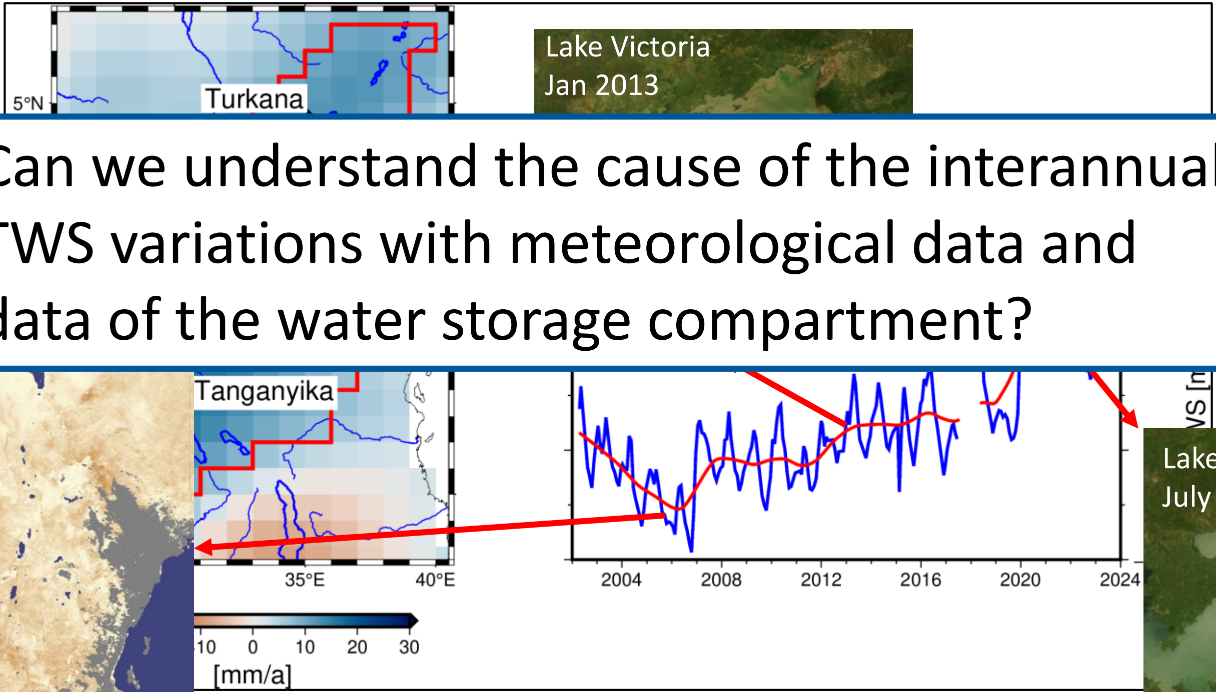
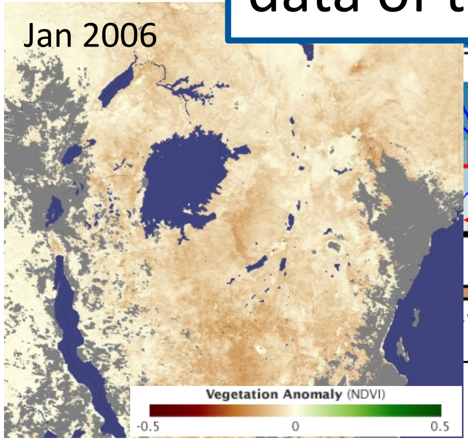


Can we understand the cause of the interannual TWS variations with meteorological data and data of the water storage compartment?



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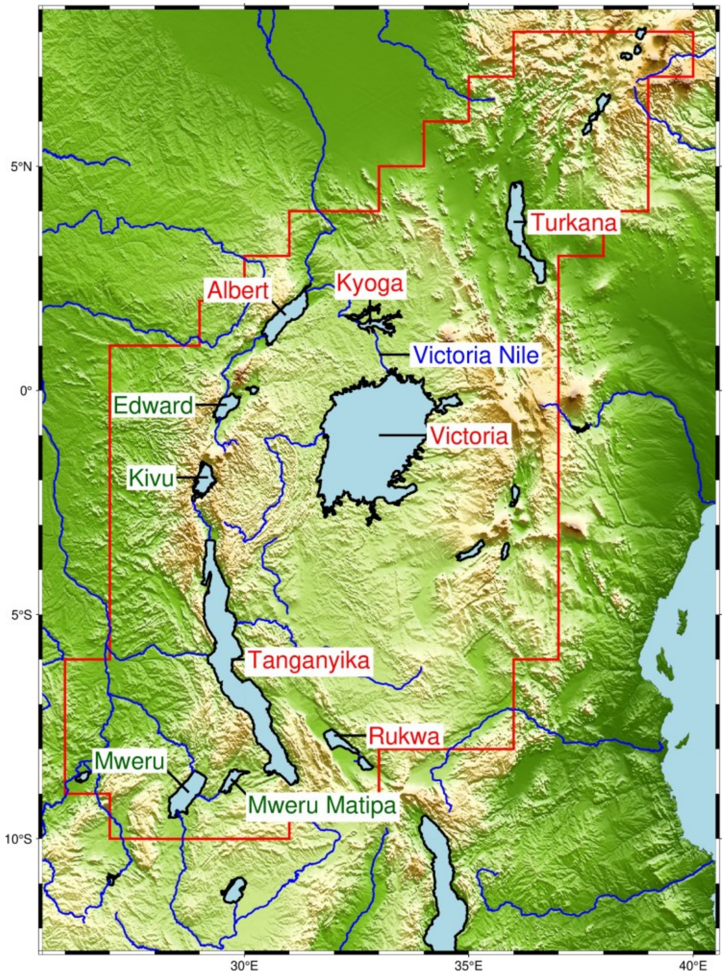
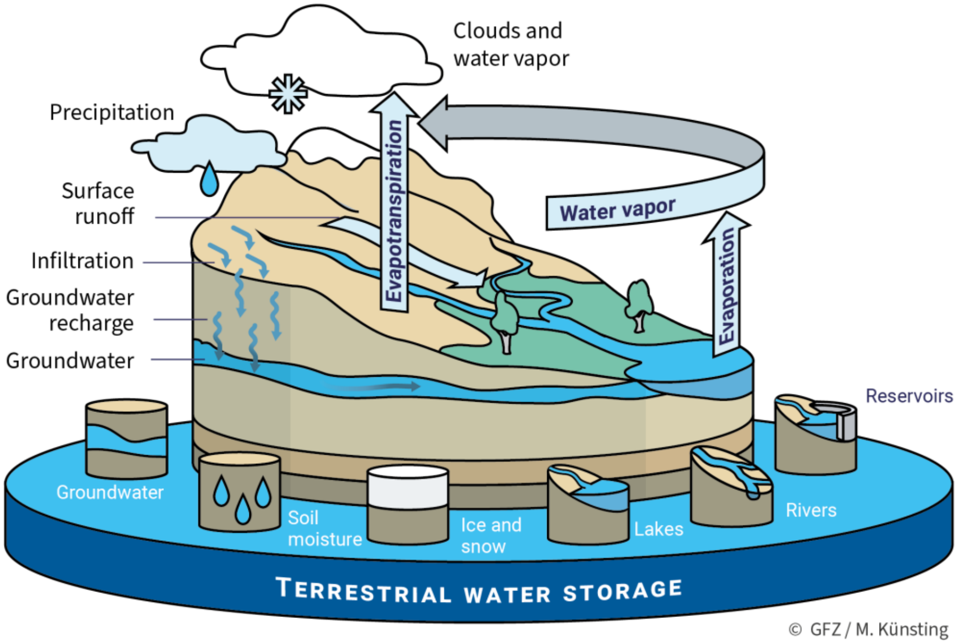


Study Region

- Focus on the northern part of the East African Rift
- Hydrology dominated by some of the largest lakes globally and substantial interannual precipitation variations
- Densely populated along the lake shores
- Lake Victoria dammed by the Nalubaale Dam (formerly Owen Falls Dam)

Data


Clouds and water vapor
Precipitation
Surface runoff
Infiltration
Groundwater recharge
Groundwater
Evapotranspiration
Water vapor
Evaporation
Reservoirs
Groundwater
Soil moisture
Ice and snow
Lakes
Rivers
TERRESTRIAL WATER STORAGE
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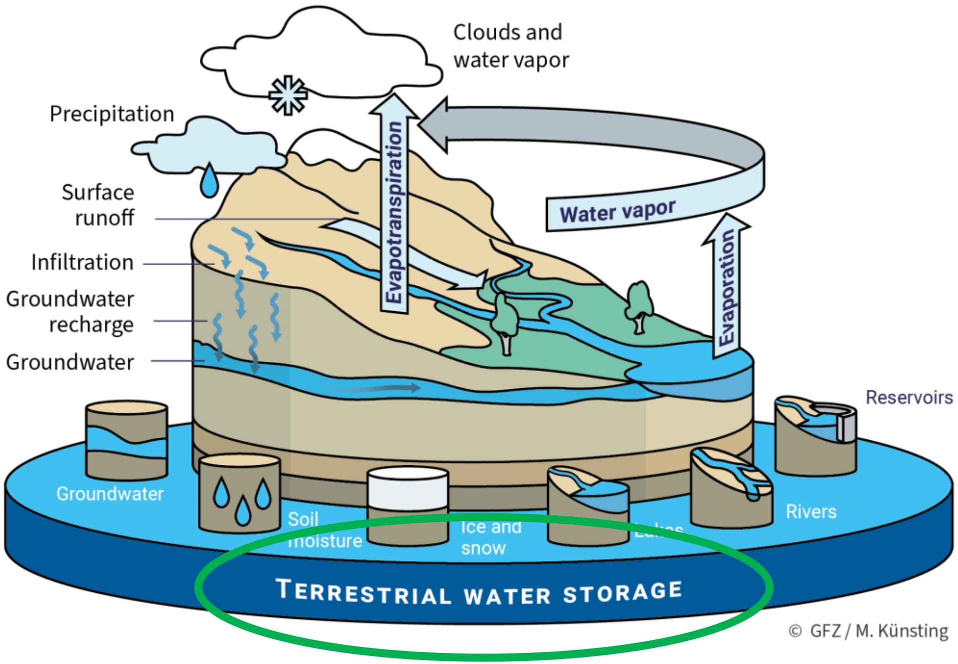
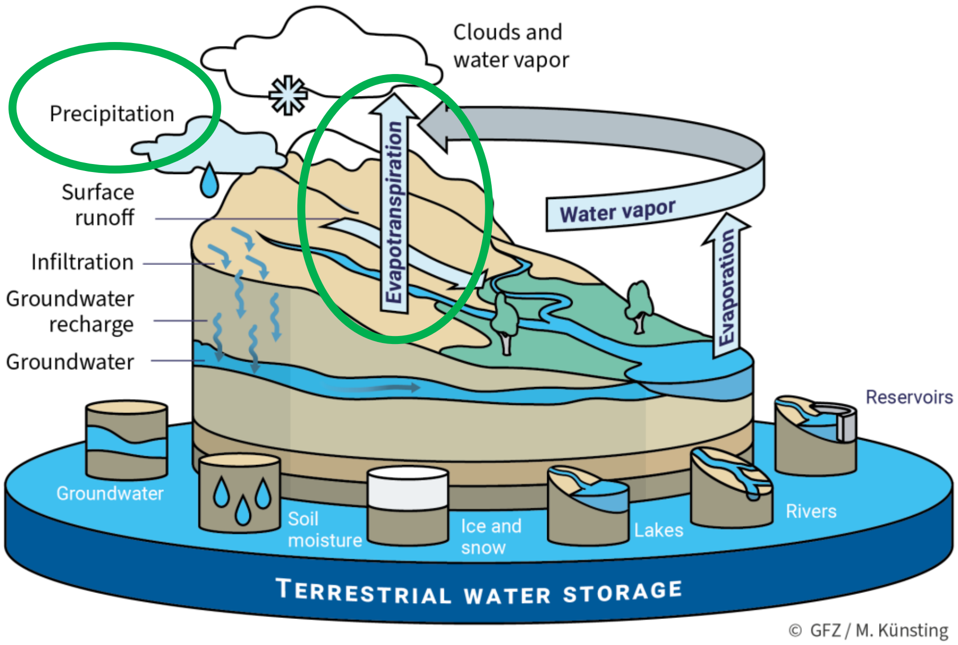
Data



TWS: COST-G GravIS RL01(GRACE)/RL02(GRACE-FO)

Data

P: Global Precipitation Climatology Centre (GPCC) monthly data
P-ET: Standardised Precipitation-Evapotranspiration Index – SPEI (Instituto Pirenaico de Ecología)



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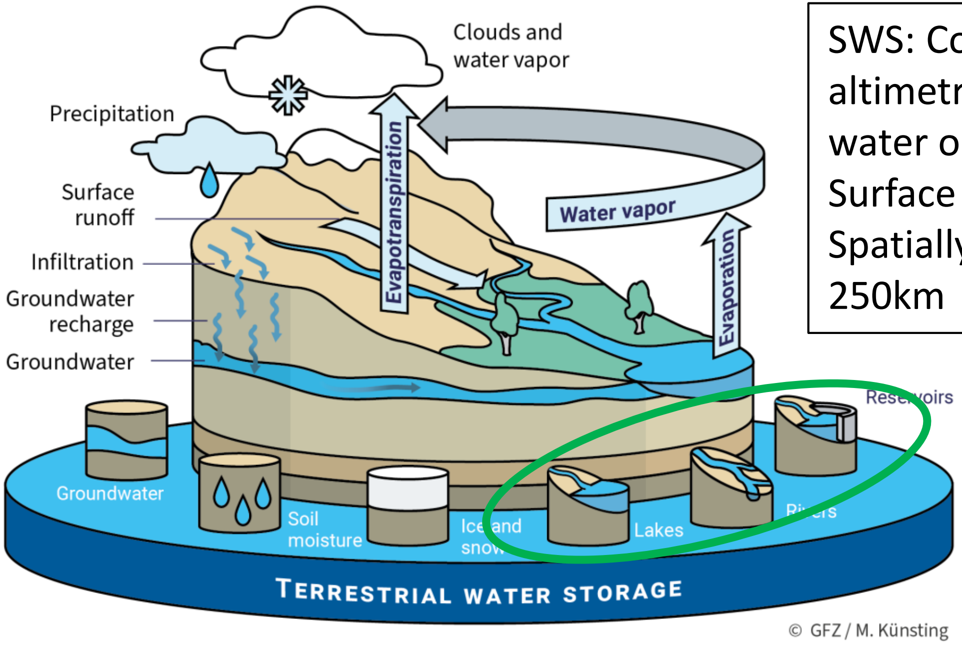

SWS: Combination of satellite altimetry (DAHITI) and surface water occurrence maps (Global Surface Water Explorer). Spatially filtered with Gauss 250km

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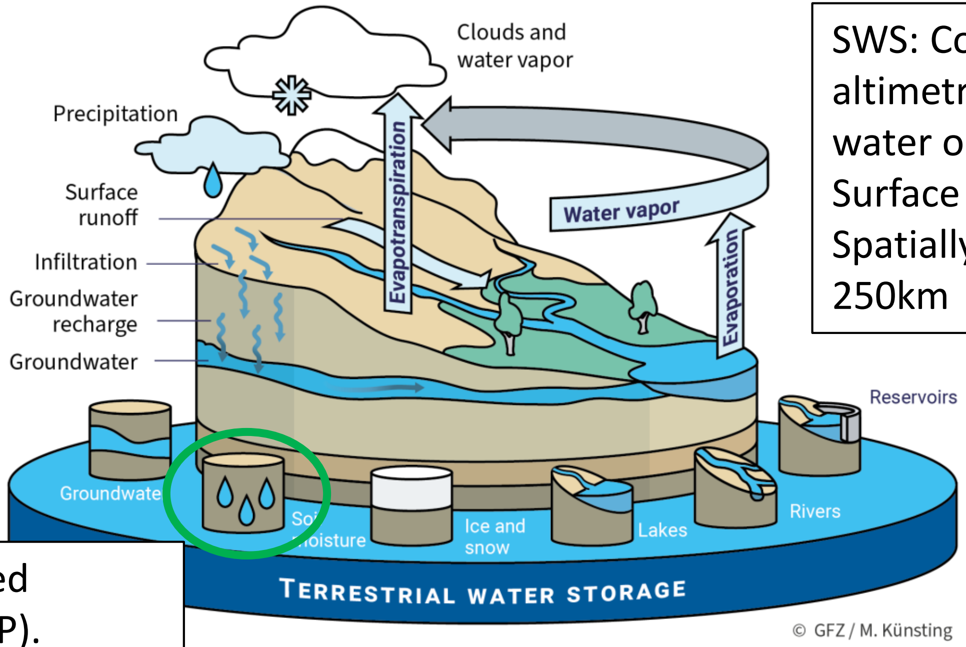

RZSM: Global Gravity-based Groundwater Product (G3P). Spatially filtered with Gauss 250km

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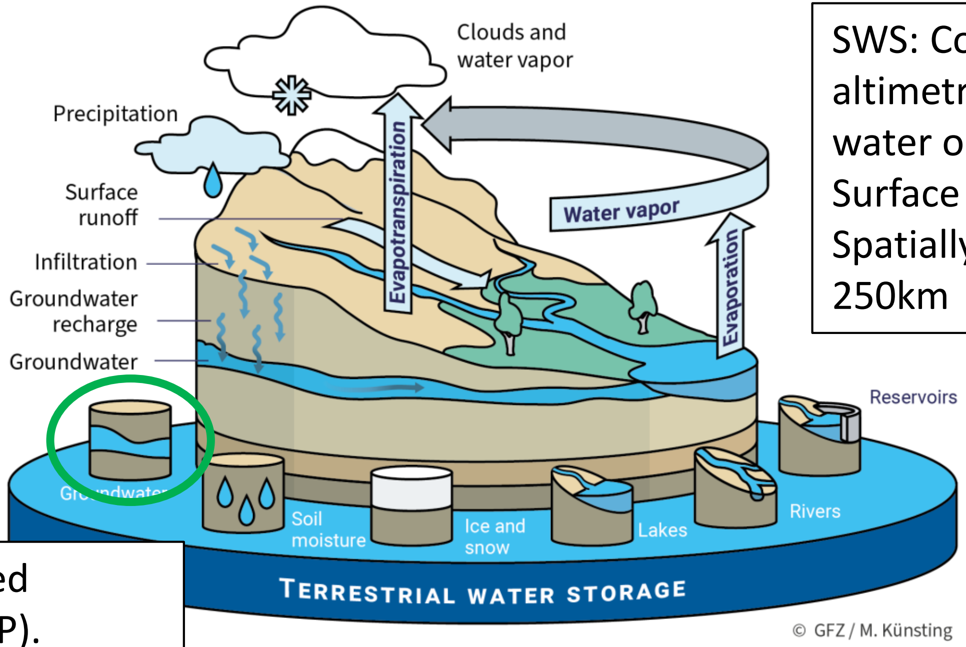
GWS: TWS-SWS-RZSM



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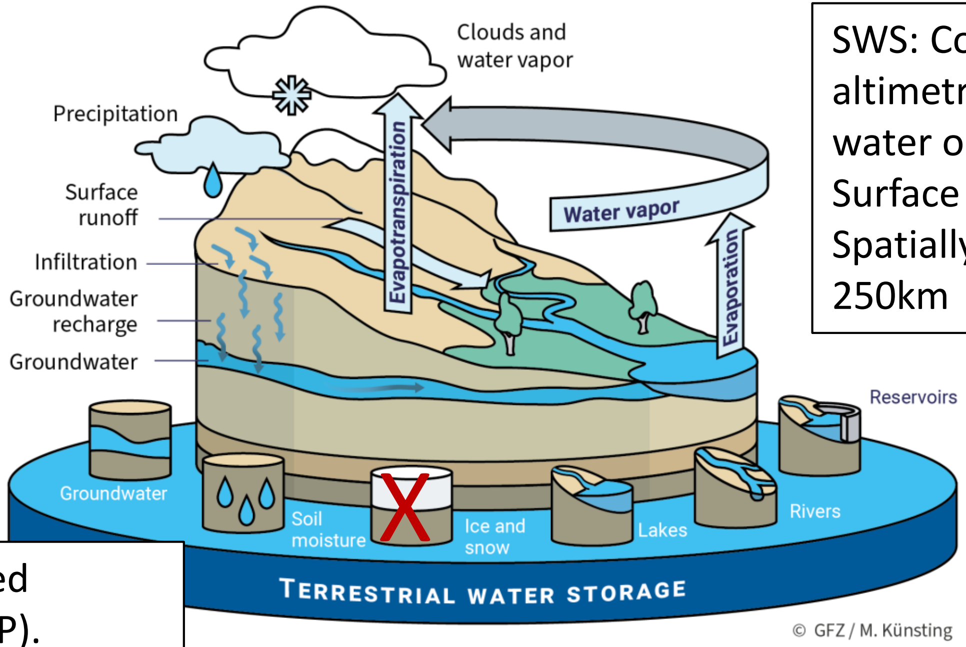

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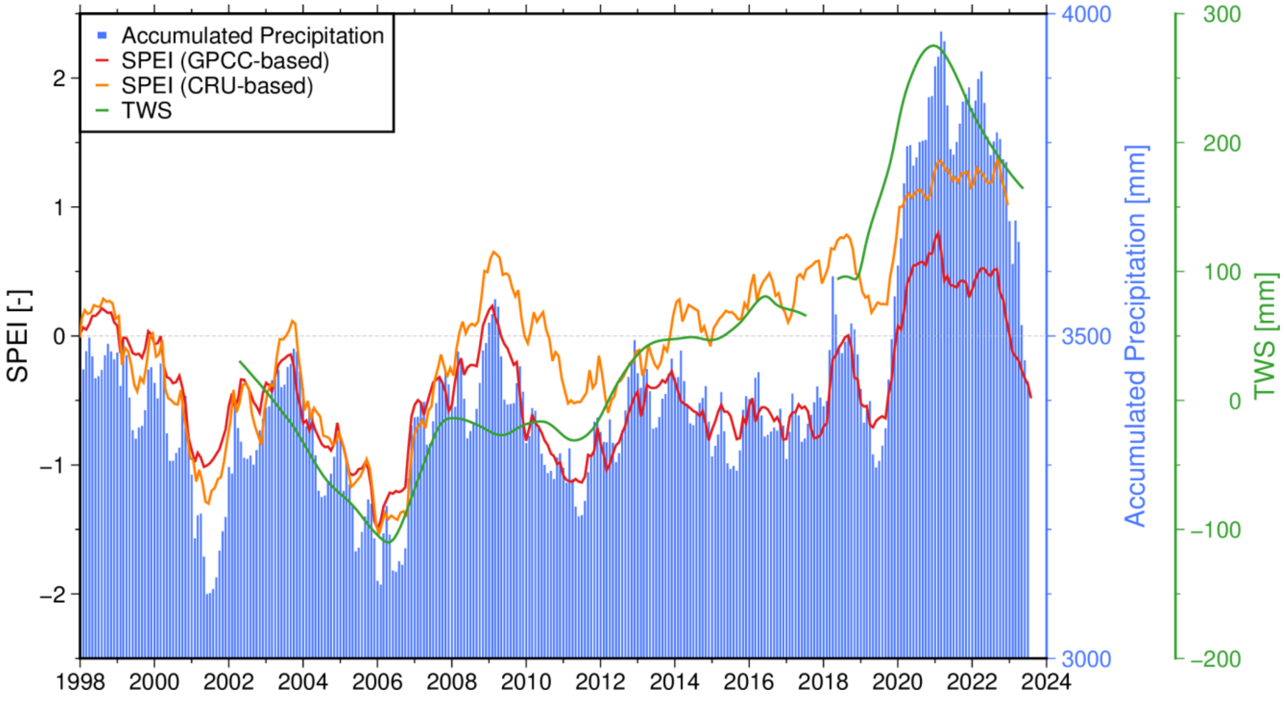
TWS: COST-G GravIS RL01(GRACE)/RL02(GRACE-FO)

TWS and Meteorological Data

TWS:
- Interannual signal of STL

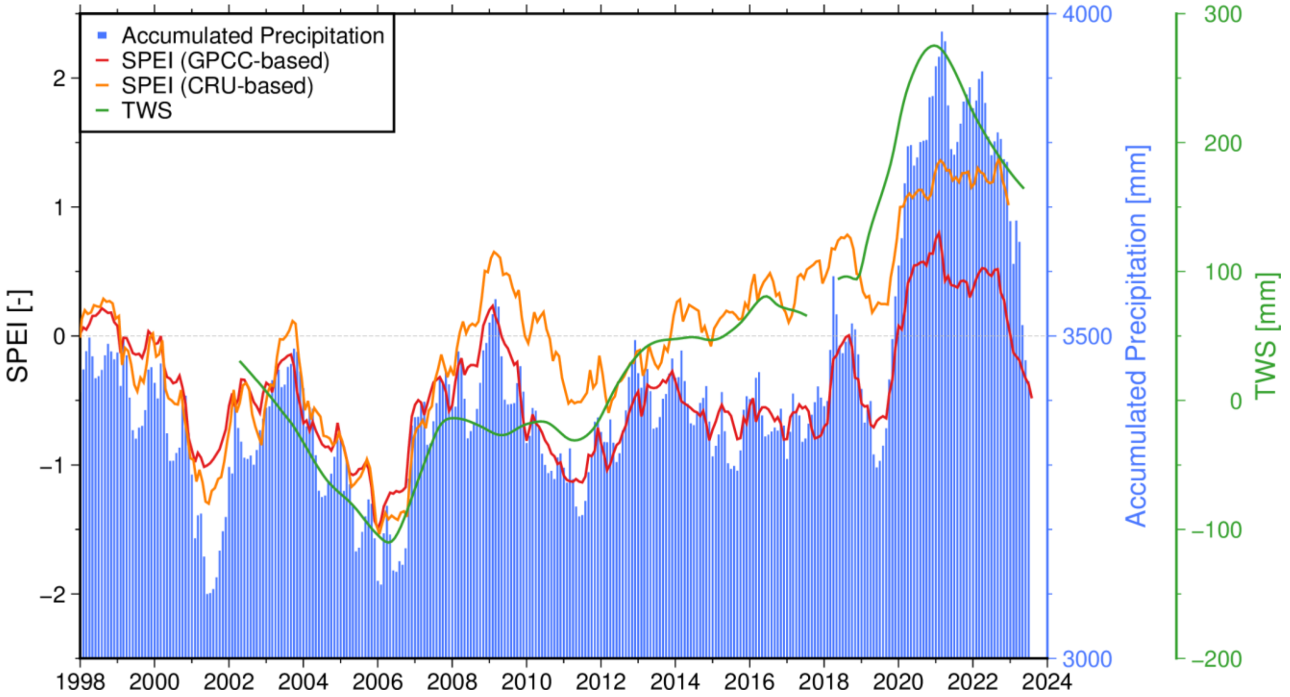
Accumulated precipitation:
- To reduce short-term variability, each monthly value is the sum of the previous 36 months

SPEI:
- Two variants provided, GPCC and CRU precipitation data set
- Different PET algorithms
- P-ET accumulated over 36 months, too



TWS and Meteorological Data

Two extremes, drought prior to 2006 and flooding 2020ff, can in general be explained by meteorological variability



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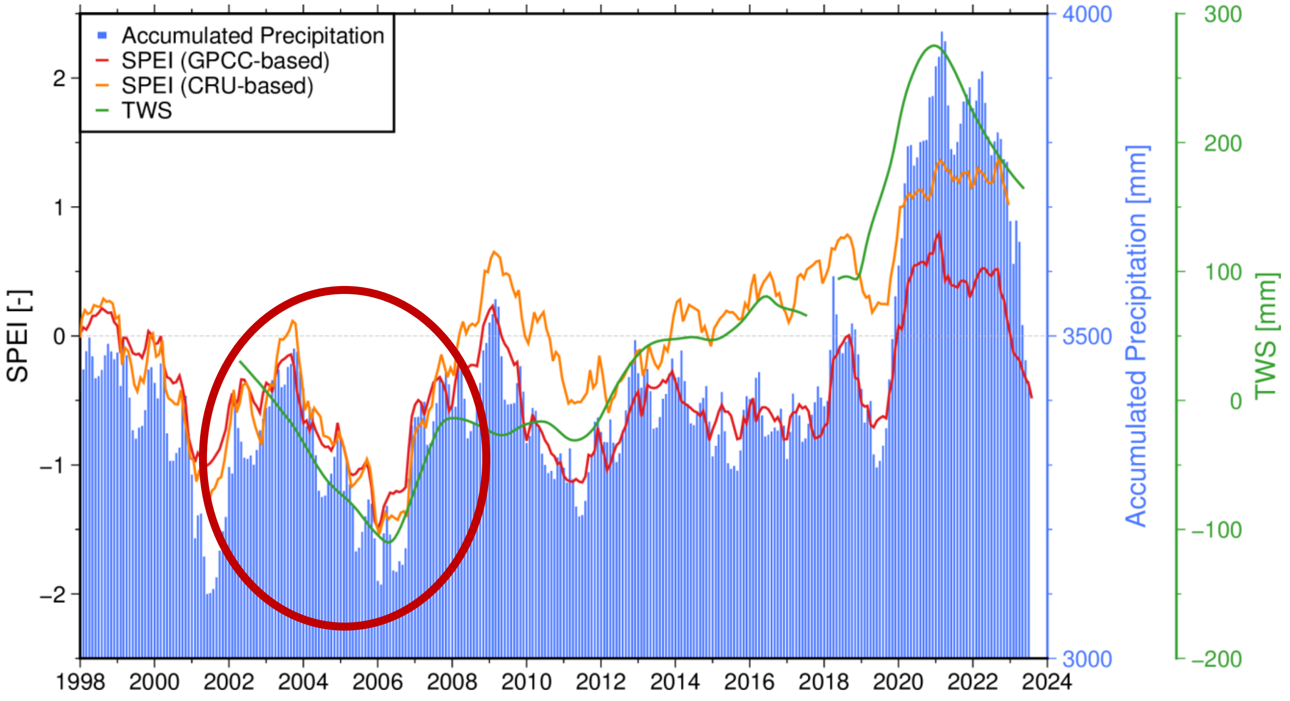

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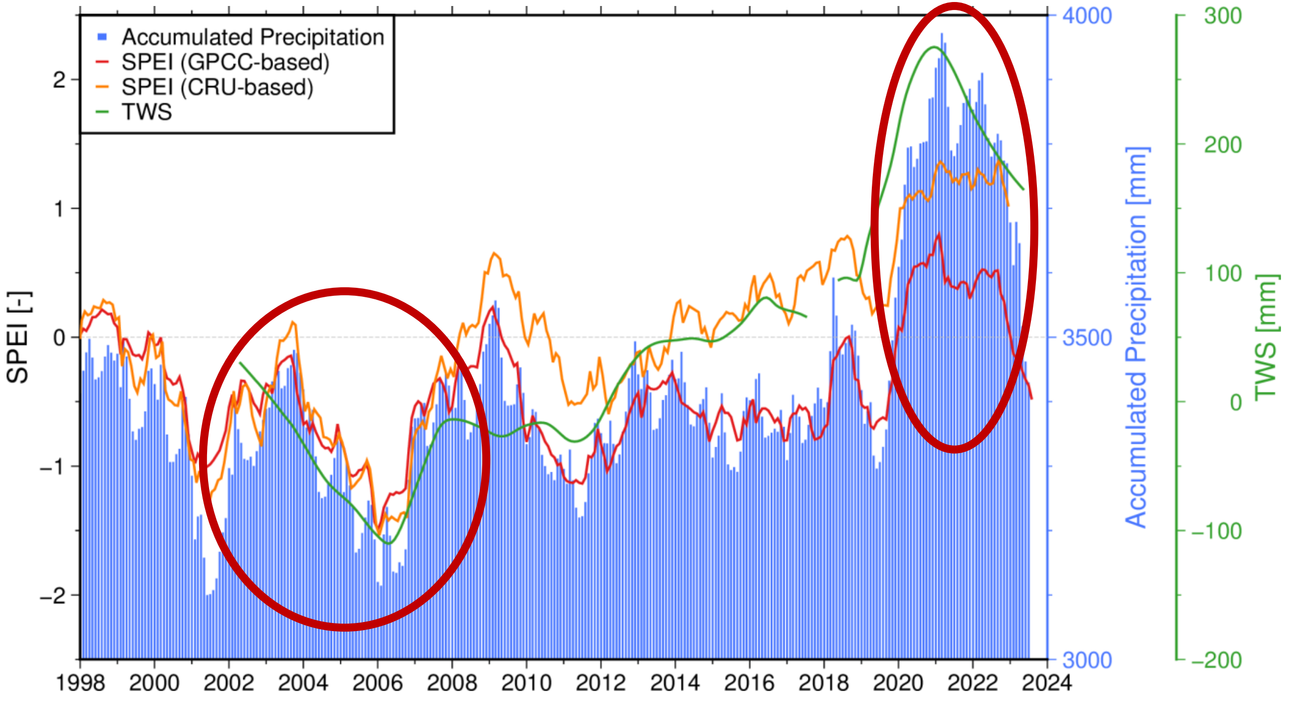

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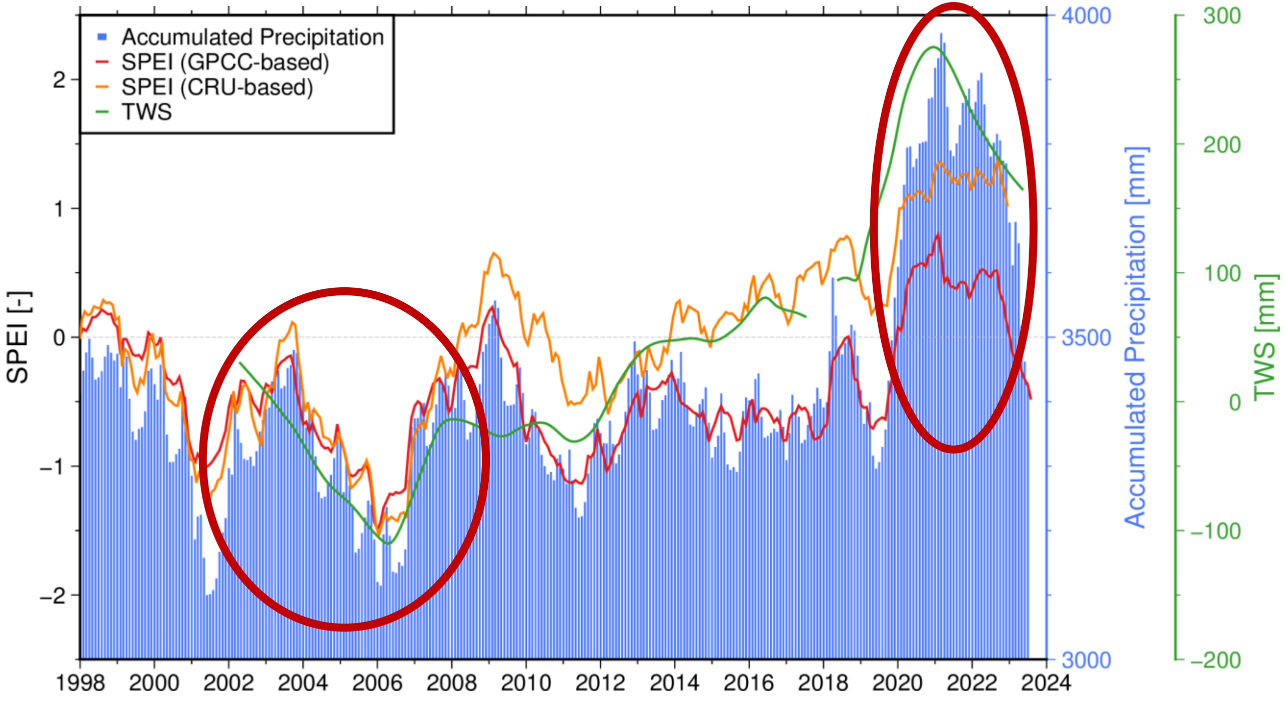
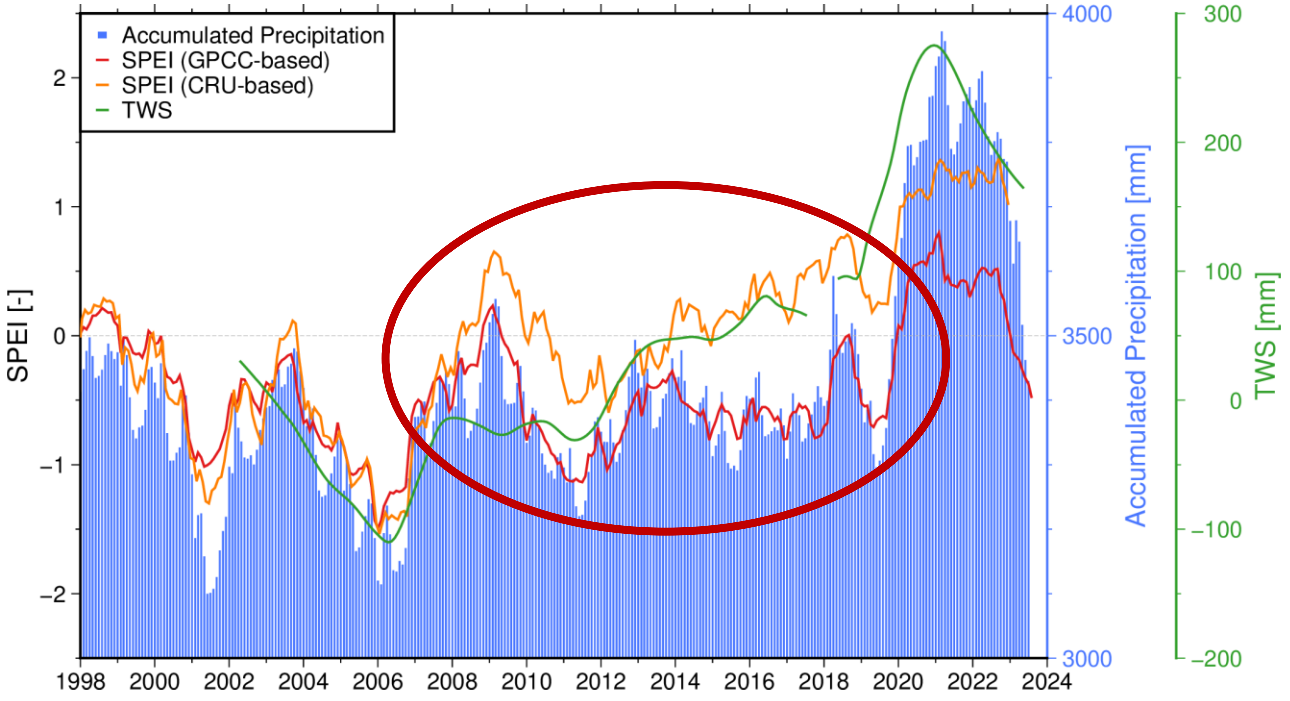
	Accum. Precip.	SPEI (GPCC)	SPEI (CRU)
ρ	0.87	0.79	0.88

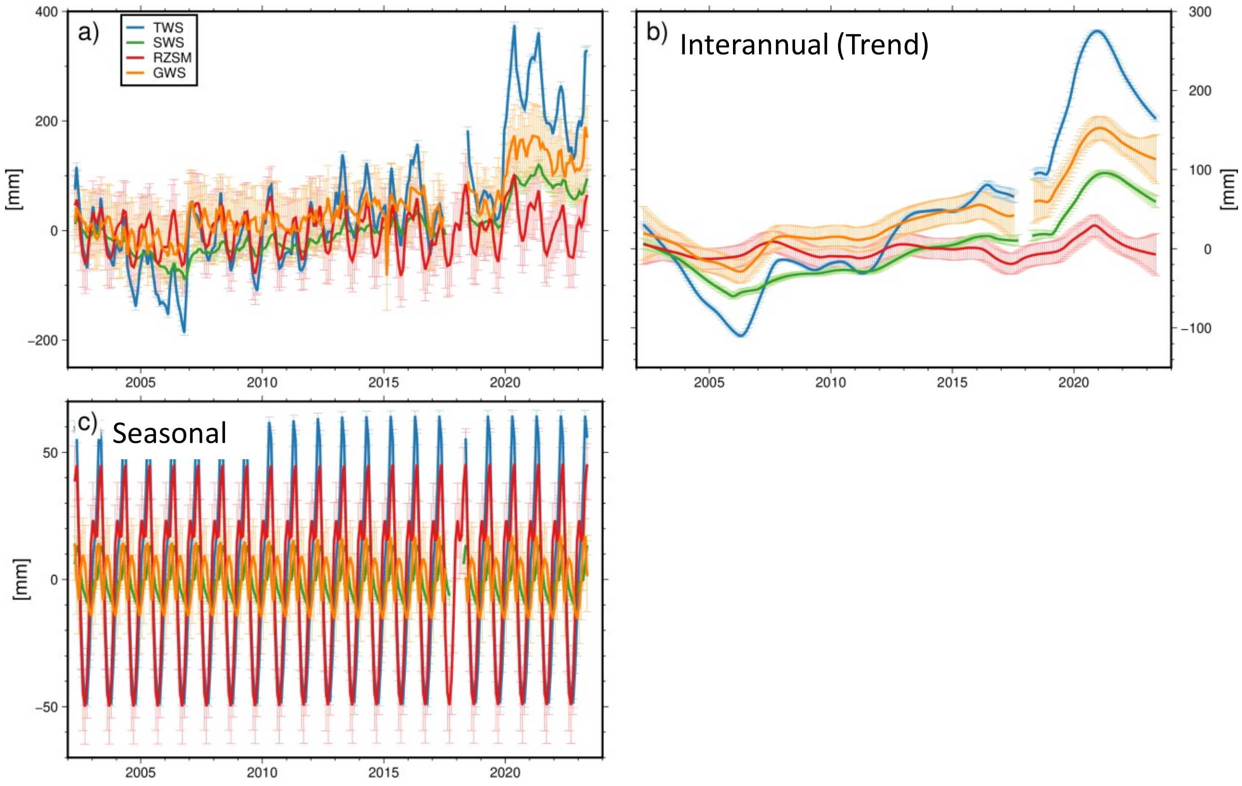


TWS and Meteorological Data

- P and SPEI (GPCC-based) cannot explain TWS rise between 2010 and 2018
- P and P-ET are essential drivers of TWS but cannot explain variability alone, esp. with the uncertainty regarding SPEI

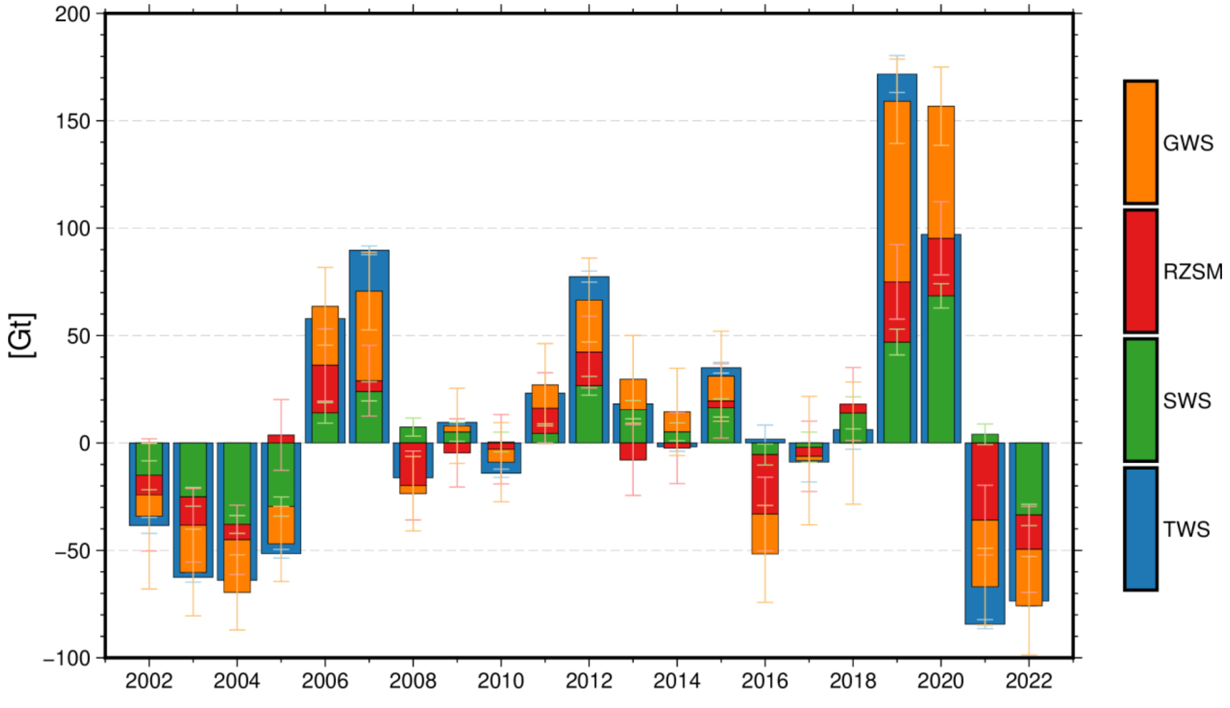


TWS and Water Storage Compartments



- Signal separation with STL
- RZSM explains the majority of annual signal but little interannual variability
- Drought more pronounced in SWS
- Minimum around 2006 time-shifted between SWS, TWS, and GWS
- Flooding similarly in GWS and SWS
- Large uncertainties of RZSM propagate to GWS

TWS and WSC - Yearly Storage Change



- Based on STL trend signal
- Uncertainty of RZSM larger than storage change
- In median, both GWS and SWS explain 35% of TWS storage change
- 2002-2005 storage loss govern by SWS
- 2019-2020 storage gain equally in SWS and GWS
- No correlation between the sign and magnitude of TWS storage variation and governing WSC

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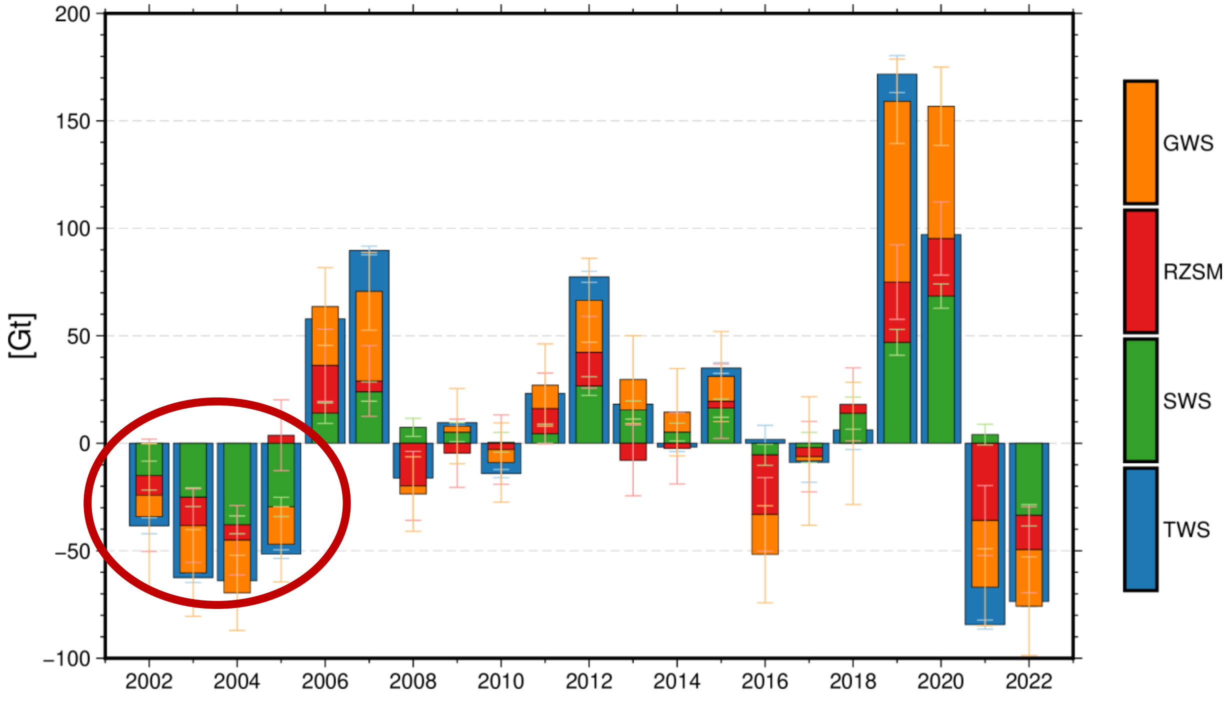

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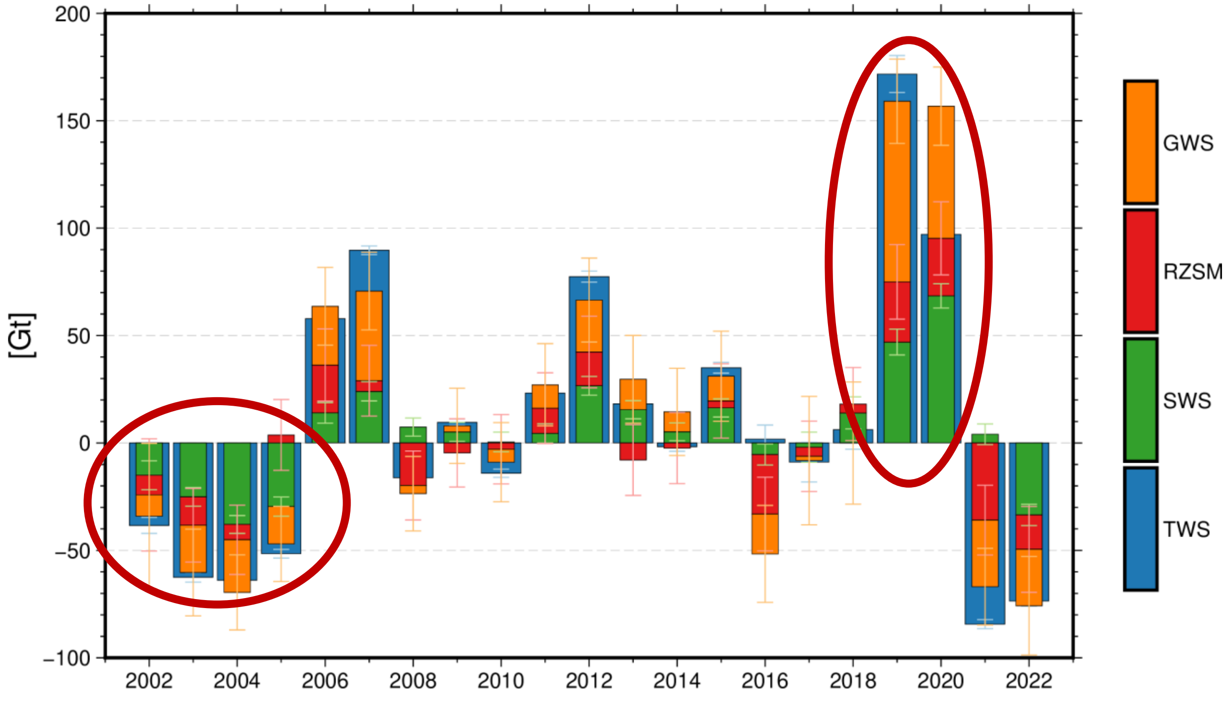

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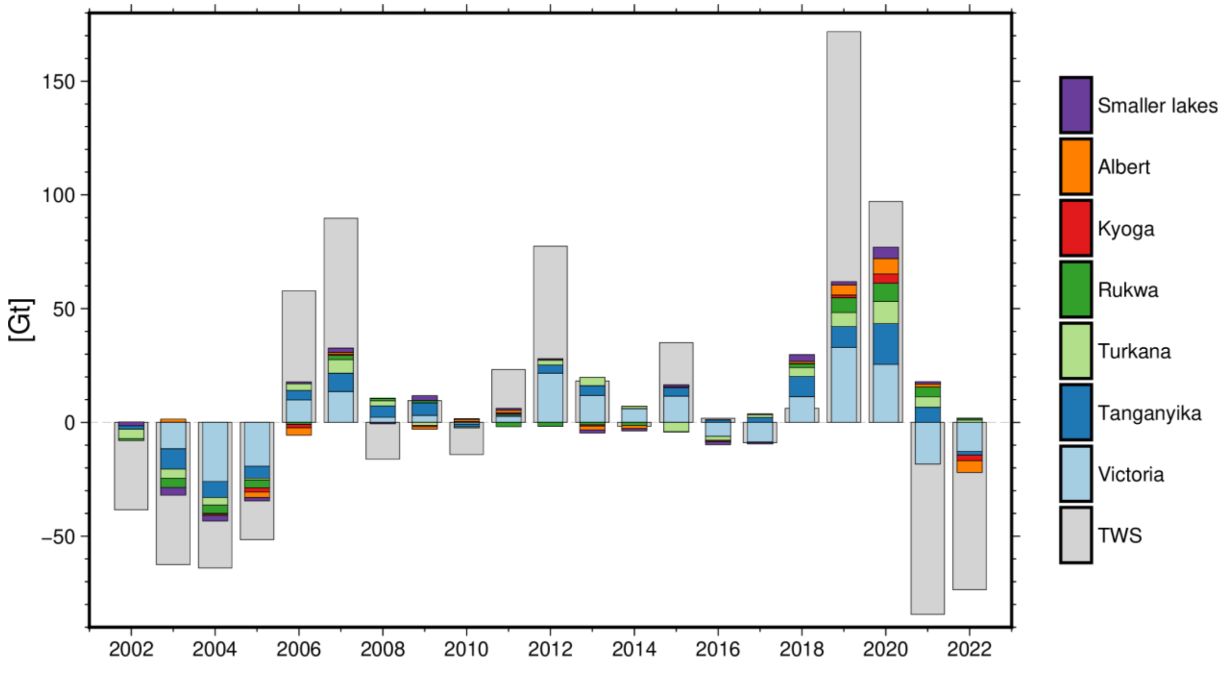
TWS and SWS - Contributions of lakes



- Lake Victoria over most substantial influence on SWS
- However, before 2006, SWS was governed by this lake with only minor contributions of Lake Turkana and Lake Tanganyika
- After 2019, all three lakes contribute more equally to SWS

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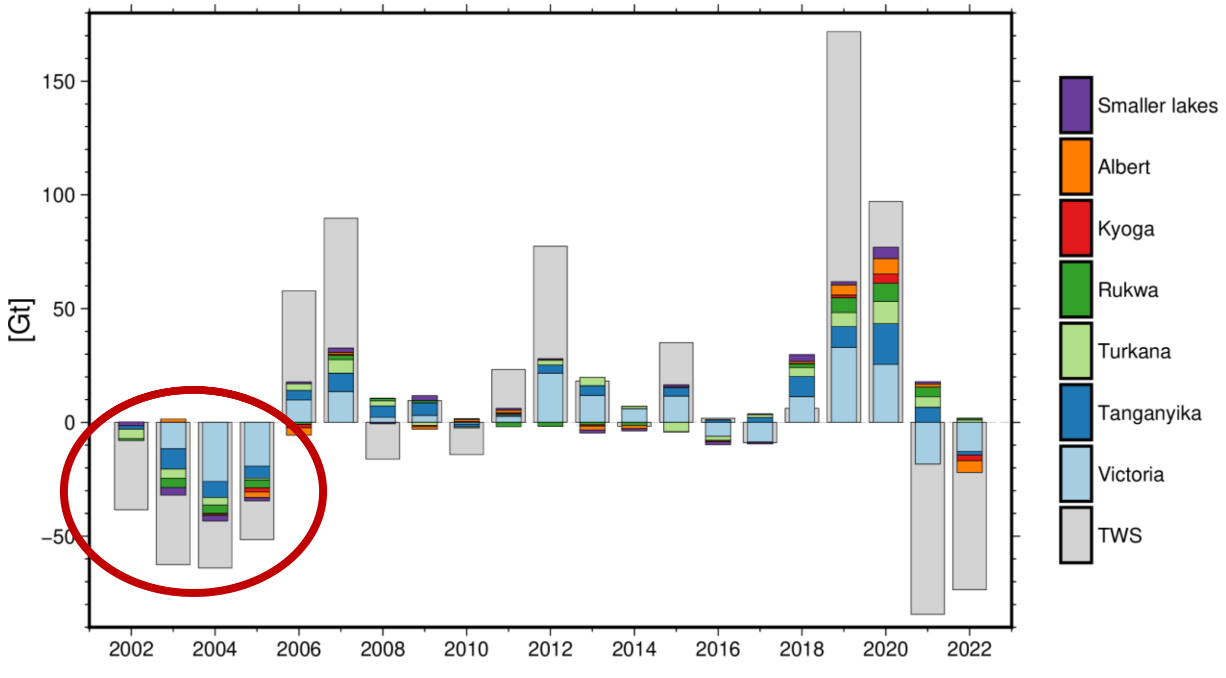

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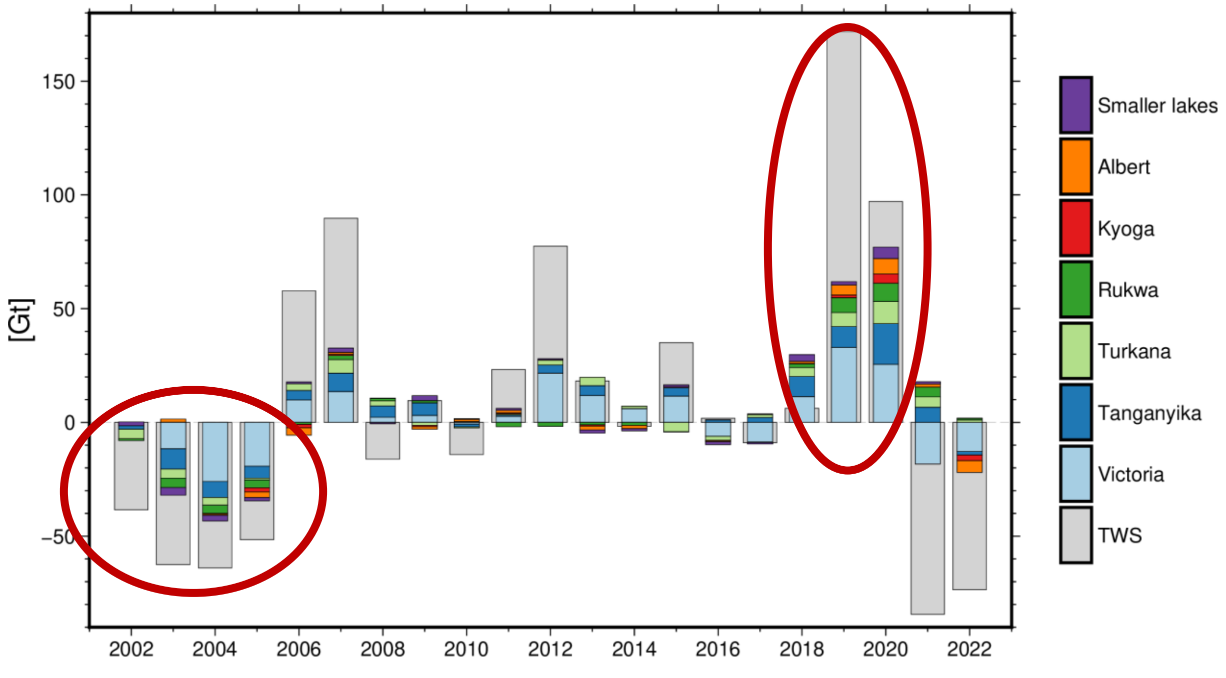

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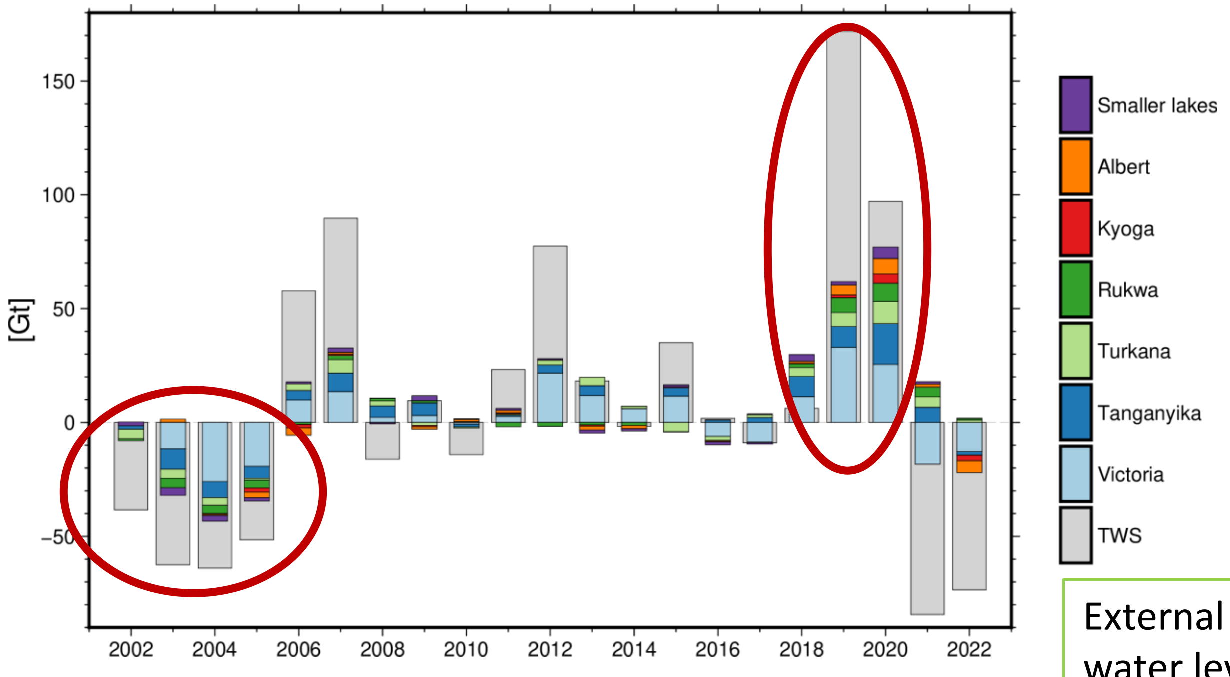

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External data showed that before 2006, the water levels of Lake Victoria had been lowered to inaugurate a new hydroelectric power plant.

Conclusion

- With different meteorological data sets, both the drought before 2006 and floodings in 2019-2020 can be (partly) explained
- Further investigations into WSCs reveal different compositions of the WSCs during drought and flooding events
- We showed that the interannual variations of TWS in the region were both caused by natural precipitation variations and anthropogenic decisions
- A combination of different meteorological and WSCs observations helps to understand the complex interannual TWS variations

Thank you for your attention!

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