

Hydroclimate and Water Level Variations

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Motivation

Lake Victoria is the world's largest tropical freshwater lake and delivers ecosystem services to more than 40 million people (Downing et al., 2014). The lake's level variation is controlled by precipitation on the lake, evaporation from the lake, inflow from the catchment area, and lake outflow to the Nile River. Almost 80% of the Lake Victoria's water budget is from precipitation over the lake (Awange et al. 2008). It is crucial to disentangle the factors driving Lake Victoria's hydroclimate and lake level variations in light of future climate change projections.

Research Questions

What drivers and mechanisms are involved in the changes in seasonal, interannual, and decadal variation of Lake Victoria's water budget and level?

Research synthesis

Hydroclimate processes in the Lake Victoria basin (LVB) are dominated by regional circulations associated with a complex interaction between lake-land breeze circulation and complex orographic forcing.

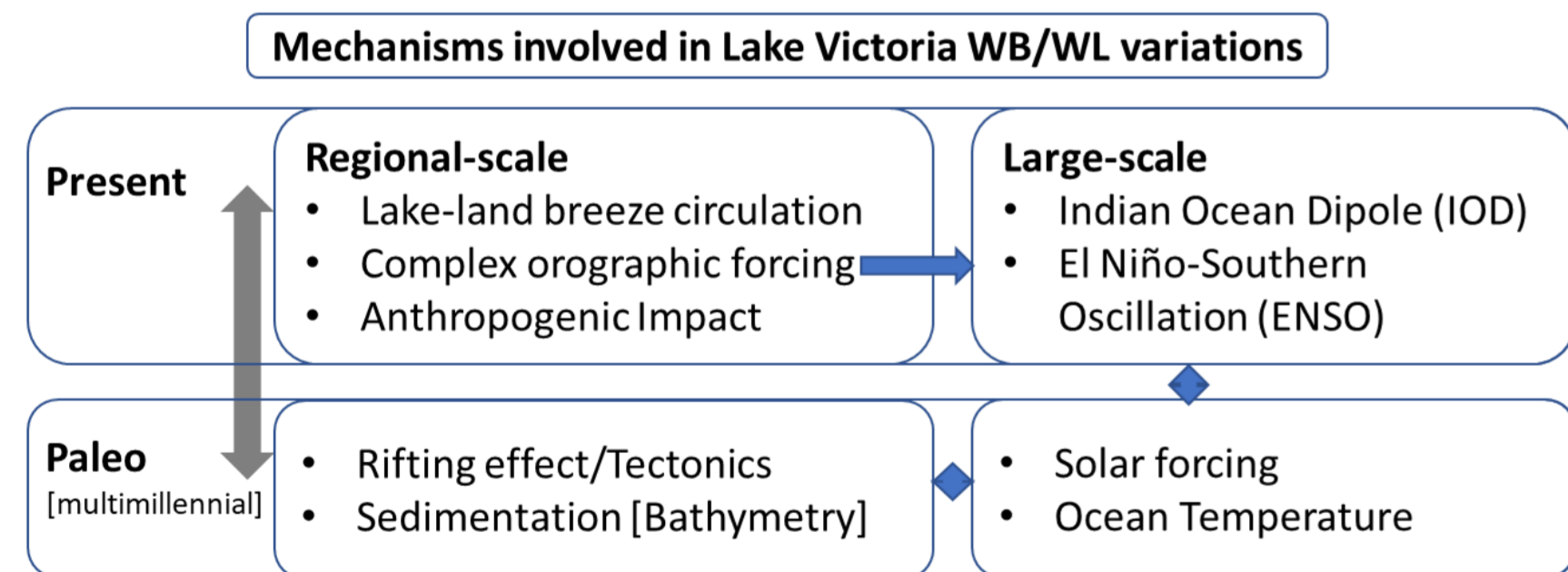


Figure 1: a) Drivers and mechanisms involved in Lake Victoria water balance [level] variations over present and paleo period.

Lake Victoria WB components

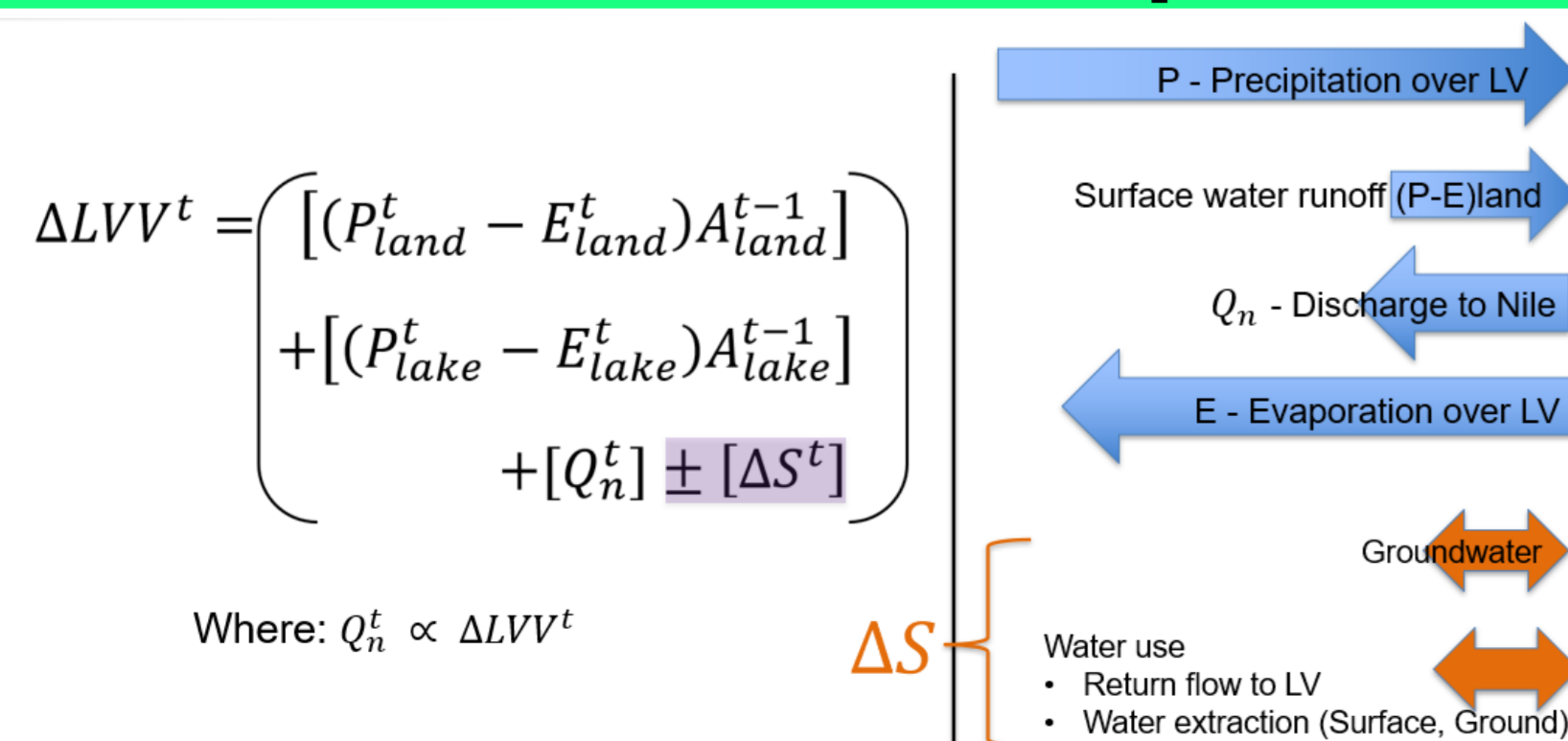


Figure 2: Conceptual Lake Victoria water balance model

Results

Seasonal

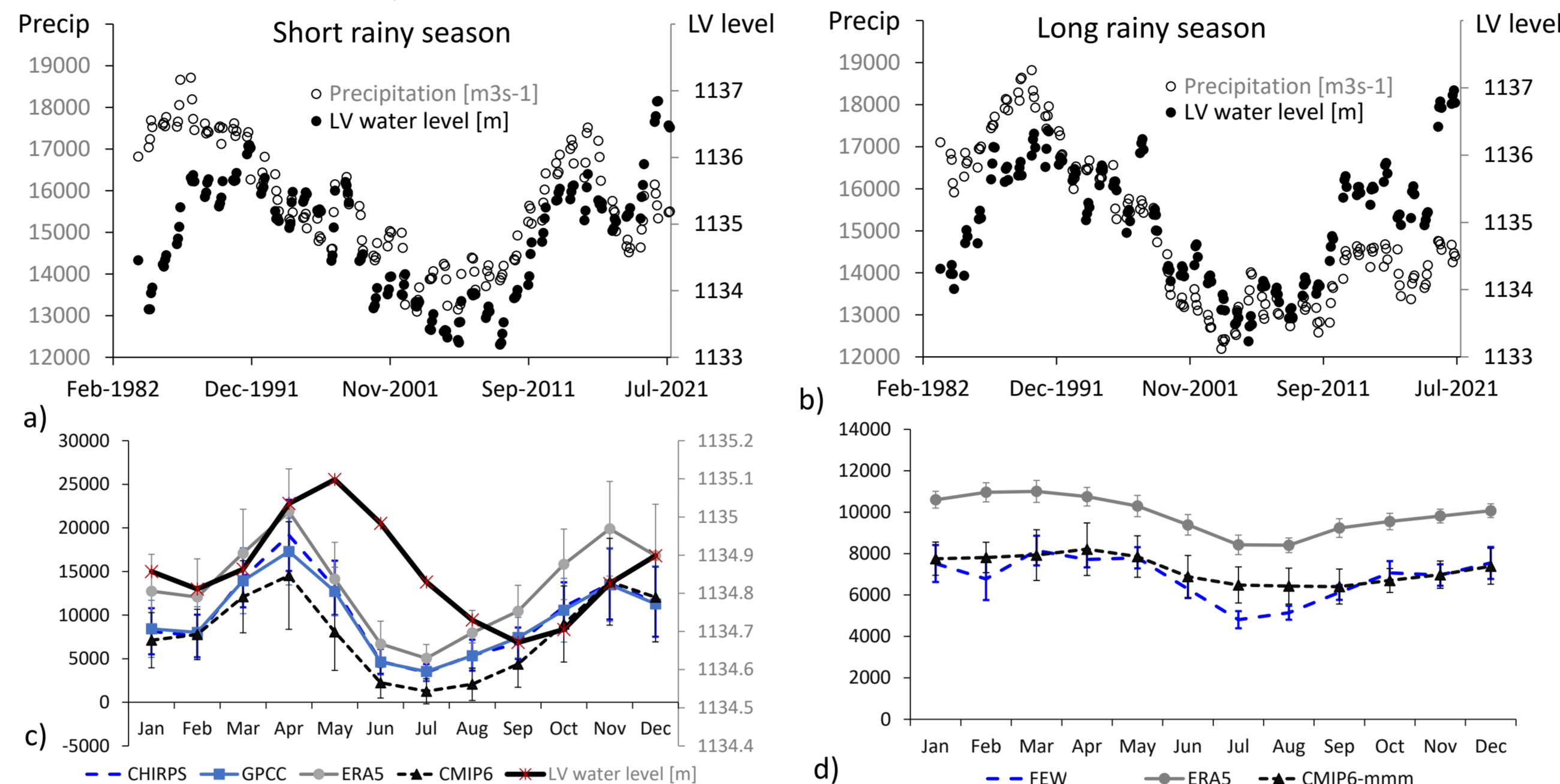


Figure 3: Comparison between short (a) and long (b) rainy season LVB precipitation and Lake Victoria water level; (c) LVB precipitation from observed, reanalysis, and climate model compared to mean Lake Victoria water level; (d) evaporation over Lake Victoria from FEWS-NET (penman-monteith and remote sensing based), reanalysis (ERA5) and climate model (CMIP6).

Interannual and decadal

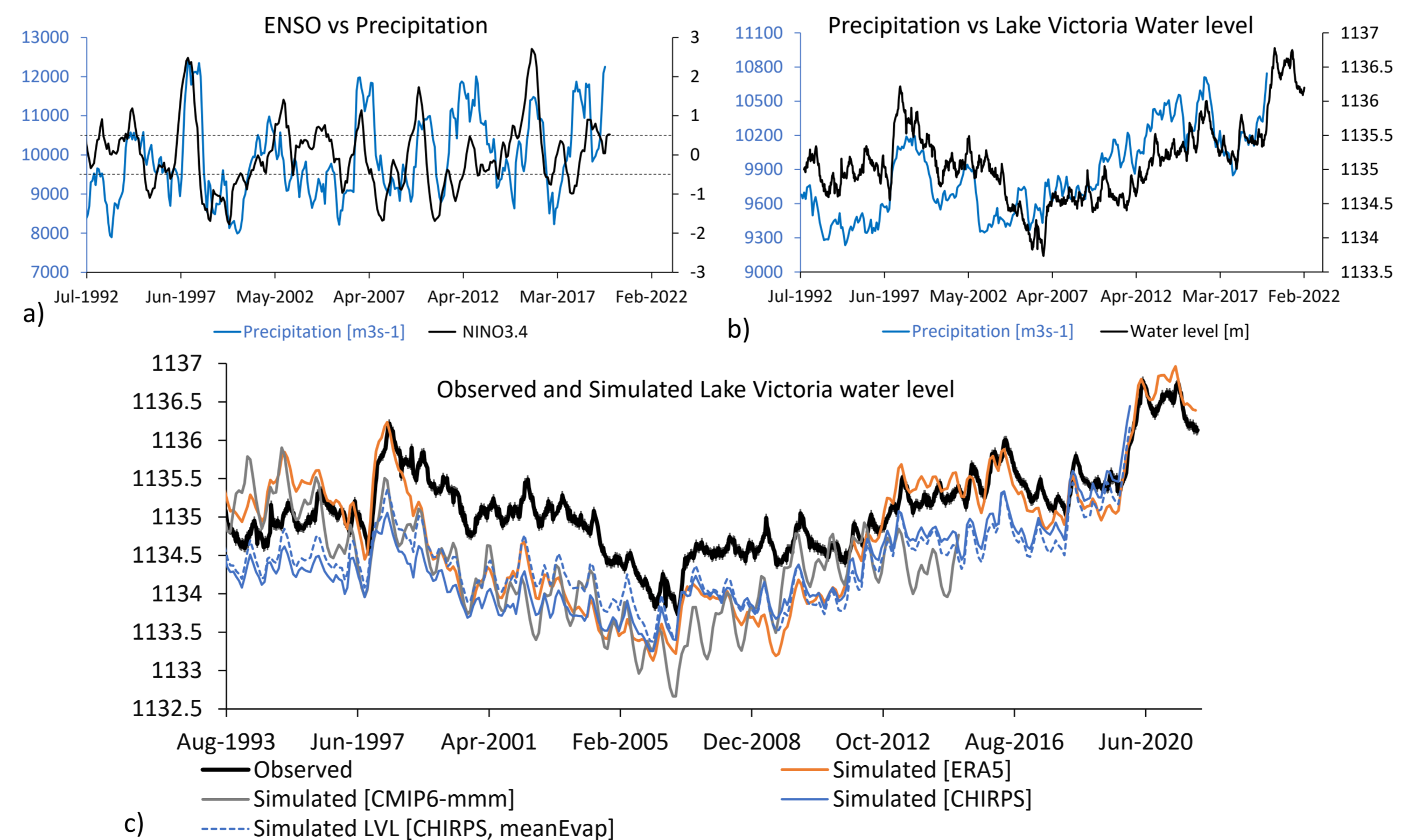


Figure 4: a) ENSO vs LVB precipitation; b) LVB precipitation vs Lake Victoria water level; and c) Lake Victoria water level. Moving average is used to smooth the precipitation over a one-year period for 'a' and five-year period for 'b'. (Keys: CHIRPS: Rainfall Estimates from Rain Gauge and Satellite Observations; CIMP6: Coupled Model Intercomparison Project Phase 6; ERA5: fifth generation ECMWF atmospheric reanalysis of the global climate.)

Discussion and Conclusions

The diurnal, seasonal, inter-annual and decadal variability of Lake Victoria's hydroclimate results from a complex interaction between different processes.

- Lake-land breeze circulation and complex orographic forcing dominates the diurnal cycle and convection.
- The surrounding topography has potential to redirect/block large-scale inflow from the Indian Ocean and impacts the regional rainfall pattern.
- Evaporation does not control precipitation – while evaporation contributes to the low-level moisture in the atmosphere, its variations do not control precipitation variations on seasonal or diurnal time scales.
- El Niño/Southern Oscillation (ENSO) affects decadal rainfall variation and seasonal rainfall patterns
- Indian Ocean monsoon flow (large-scale monsoonal winds) initiates Large-scale precipitation over the Lake Victoria basin.
- Regional and or large-scale processes that affect the precipitation would likely control the water budget and level variations of Lake Victoria.

Acknowledgements

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References

- Awange et al. Falling Lake Victoria water levels: Is climate a contributing factor? Climatic Change 89, 281-297 (2008).
- Downing et al. "Coupled human and natural system dynamics as key to the sustainability of Lake Victoria's ecosystem services." Ecology and Society 19(4) (2014).

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