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A modeling perspective on hydro-climate variability in dryland lakes : What is the impact of low- to high-frequency and intensity hydro-climate variability on the rise, development, persistence and demise of Lake Eyre - Kati Thanda ?

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Shallow, temporary salt lakes, known as ephemeral playas, are considered among the hydrogeological most sensitive systems to climatic extreme perturbations and flood extent. With a drainage basin exceeding 1,000,000 km² and a lake depth of less than 6.5 m, Kati Thanda-Lake Eyre (KT-LE), in Southern Australia, is characterized by a highly variable water balance and large water level fluctuations. It has reached its maximum level only once in the past 150 years, during the 1974-1977 “Great Filling”, emphasizing its status as one of the most unpredictable systems.

During the project, we aim to understand how hydro-climate variability across event magnitudes drives episodic lake filling and drying, and which basin-scale processes (inflow generation, transmission losses, evaporation, and potential groundwater interactions) control the water-level dynamics of KT-LE.

We use the one-dimensional General Lake Model (GLM), forced with hourly ERA5 meteorological and hydrological reanalysis inputs over the 1974–2022 period to simulate daily lake level variations through time.

Initially, in this study, our model, calibrated in terms of surface energy balance and driven by a basin-averaged surface runoff, produces overestimated lake levels compared to satellite measurements. This suggests that basin-scale precipitation signals, largely driven by the northern catchment, do not necessarily reflect hydrological conditions farther south near the lake.

To quantify water losses and the processes controlling them, we first define the fraction of inflow reaching the lake that reproduces the observed lake-level. We find that losses are strongly non-linear through time, exceeding 70–90% during minor floods, when precipitation affects only limited portions of the Lake Eyre Basin, and decreasing toward 0% during major floods, indicating a saturated and fully interconnected basin state. A river-focused analysis using GLOFAS v4.0 suggests that transmission losses derived from spatially averaged ERA5 runoff may be overestimated in years when sub-basin contributions are asynchronous.

Given the large surface area of the basin and the limited in-situ monitoring, these multi-scale results underline the importance of assessing and continuously evaluating the limitations of reanalysis-based climatic and hydrological forcing when applied to arid environments.

Speaker information

PhD 2nd year

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