Predicting precipitation isotope values (δ2H and δ18O) in tropical regions using a discontinuous exponential model.

Abstract

The stable isotopic composition of precipitation ($\delta^{18}O$ and $\delta^{2}H$) is an important tool for hydrological research, with applications ranging from water resource assessment and groundwater modelling to forensics and ecological studies. While global and tropical-scale studies have highlighted the influence of climatic (e.g., convective intensity, moisture source) and geographic (e.g., altitude, distance from coast) drivers on $\delta^{18}O$ and $\delta^{2}H$ variability, data from northern Australia remain sparse. This study addresses that gap by compiling a high frequency $\delta^{18}O$ and $\delta^{2}H$ dataset from seven sites, four or which are previously unsampled, across this under-studied region. Using a discontinuous exponential model enhanced with machine learning, the study will identify convective patterns linked to monsoonal activity and predict $\delta^{18}O$ and $\delta^{2}H$ values at unobserved locations. Isoscapes and local meteoric water lines will be developed to characterise spatial and temporal variation in isotopic composition. Additionally, climate projections will be integrated to assess potential future shifts. The findings will contribute to improved isotope-based modelling in tropical regions and support hydrogeological investigations across northern Australia.