Seasonal and Hydroclimatic Dynamics Revealed by δD_{wax} and $\delta^{13}C_{wax}$ in a Tropical Lake Core for the Past 18 000 years

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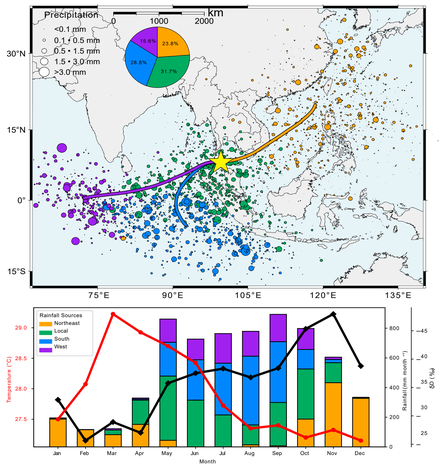
Introduction

The Indo-Pacific Warm Pool (IPWP) region has a large influence on the Asian-Australian monsoon systems and the El Niño Southern Oscillation (ENSO), the most important driver of global interannual climate variability. This study contributes to establishing the region's past hydrological changes in response to the last deglaciation and Holocene ENSO shifts **by reconstructing the hydroclimate in Thailand over the past 18,000 years.**

We also explore the **isotopic effects** from **sea level rise, source and seasonality.**

Methods

- Leaf wax isotopes: δD_{wax} and $\delta^{13}C_{wax}$
- $\Delta\delta D_{terr-aq}$ evaporation proxy
- Climate model simuilations (TraCE21ka[6] and the isotope enabled iTraCE[7])
- Moisture trajectory modelling (HYSPLIT)
- High resolution radiocarbon dating (n = 65)



The study site is a small lake in southern Thailand. Climatology, precipitation sources and water isotopes from HYSPLIT and a nearby meteorological station.

Main results

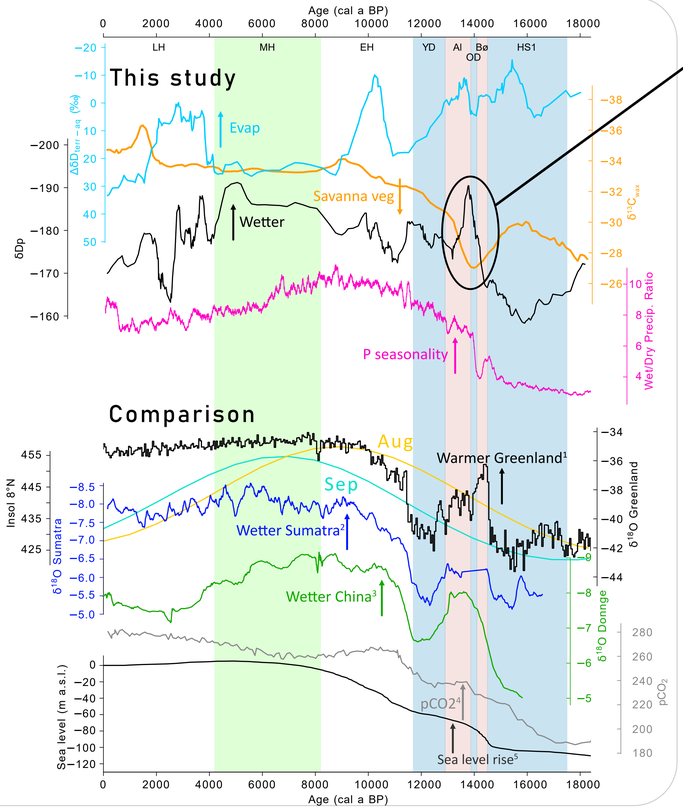
The reconstructed Thai hydroclimate shows a clear deglacial sequence with an important influence from high latitude ice dynamics. However, the Late Glacial (~11.7-15 ka BP) was comparably wet as the Holocene, and the most negative δD_{wax} occured at 13.7 ka BP. This is at odds with other reconstructions in Asia. The Holocene was characterized by a wet Mid-Holocene and drastic drying occuring at approximately 4.2 ka BP, concurrent with a major reorganization of tropical hydroclimate and intensification of ENSO variability.

Deglacial sequence:

- HS1 driest and high evaporation
- Bölling/Alleröd interstadial- wetting and expansion of C4 savanna vegetation
- Younger Dryas- no clear rapid response, drier than the B/A, shift to C3 plants and decreased evaporation.

Holocene:

- Early Holocene- similar to Younger Dryas. Increased evaporation.
- Mid Holocene- wet, low evaporation.
- Late Holocene- drastic drying and high evaporation.

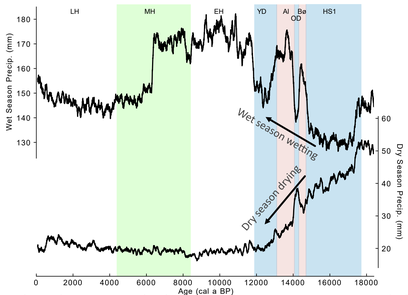


Savanna expansion during wetting

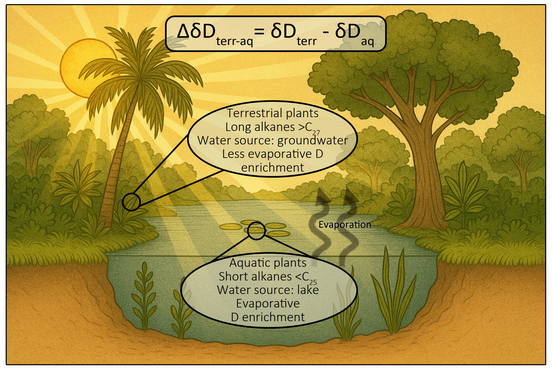
- δD_{wax} indicates drasticly wetter climate during the Bölling/Alleröd periods.
- $\delta^{13}C_{wax}$ indicates concurrent expansion of savanna type vegetation, which usually would be interpreted as drier conditions

This discrepancy suggests a drier dry season, and a wetter wet season.

iTRACE and TRACE model results support seasonality as a driver of savanna expansion despite wetting, driven both by orbital forcing (millenial timescales) and AMOC shifts (rapid shifts).



Simulated wet and dry season precipitation, defined as MJJASO and NDJFMA, respectively.



Evaporation proxy. Negative excursions indicate lower lakewater δD than groundwater δD, interpreted as increased lake evaporation.

Assumption: lake water is subjected to higher rates of evaporative D enrichment than ground water during dry periods.

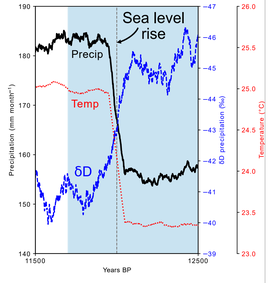
δD affected by sea level rise

The 120m sea level rise during the deglaciation had a large effect on rainfall and it's hydrogen isotopic composition.

A **sensitivity experiment** for **sea level rise** and glacial melt caused:

- 1.6°C warming
- ~17% more precipitation
- ~4.5‰ increase in dDp

Enriched D in paleorecords is usually interpreted as drying, but is here tied to a more proximal moisture source. The effect of SLR needs to be considered in glacial-interglacial reconstructions.



Conclusions

- **Extremely seasonal climate during the deglaciation caused savanna expansion despite an intensified wet season monsoon.**
- **$\Delta\delta D_{terr-aq}$, a proxy for lake evaporation, indicates large shifts in hydroclimate over the deglacial and Holocene.**
- **Sea level rise had a significant effect on δD_{wax}, highlighting that sea level needs to be considered in glacial-interglacial isotopic reconstructions.**

References

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