

Introduction

- The lake Silbersee in Cuxhaven is distinguished by a rare plant community.
- In this lake, the last existence of the *Isoëtes lacustris* in Niedersachsen is found. *Isoëtes lacustris* is nationwide, and in Niedersachsen as well, registered as "threatened with extinction - Category I" (Buchwald & Schabelreiter 2010).
- Recently, the lake appears to be increasingly *eutrophic* as evidenced by the increase of hydrogen sulfide concentrations in deep water during summer stagnation.

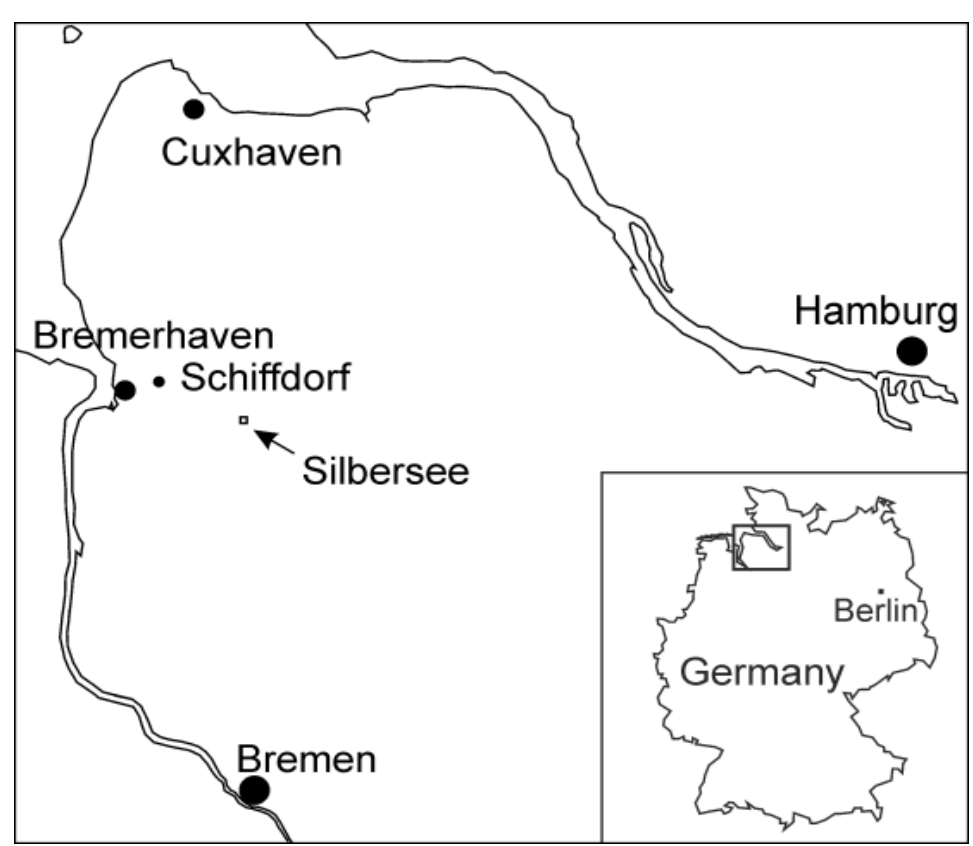


Fig 1: Study area

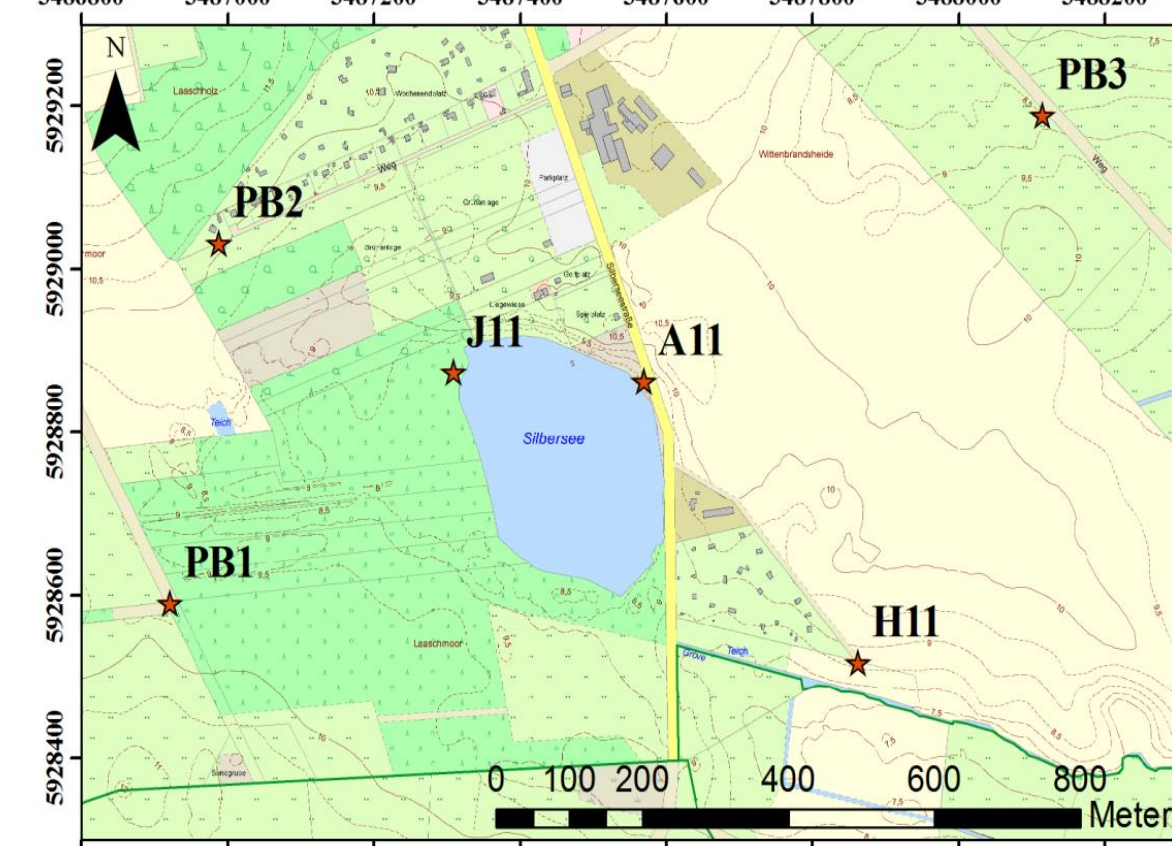


Fig 2: Groundwater wells in the study area



Fig 3: *Isoëtes lacustris*
Fig 4: Algal bloom

Objectives

- To clarify the origin of the lake water using stable isotopes
- To examine the hydraulic connection between surface water and groundwater in order to ultimately
- Determine the source of nutrients

Methods



Fig 5a: Construction of a monitoring well



Fig 5b: Groundwater sampling

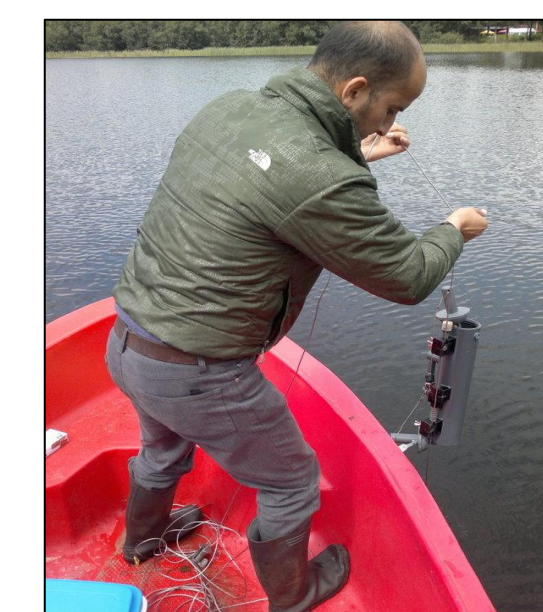


Fig 6a - 6b: Surface water sampling with water sampler (Niskin Type) – Analysis of lake water

Results

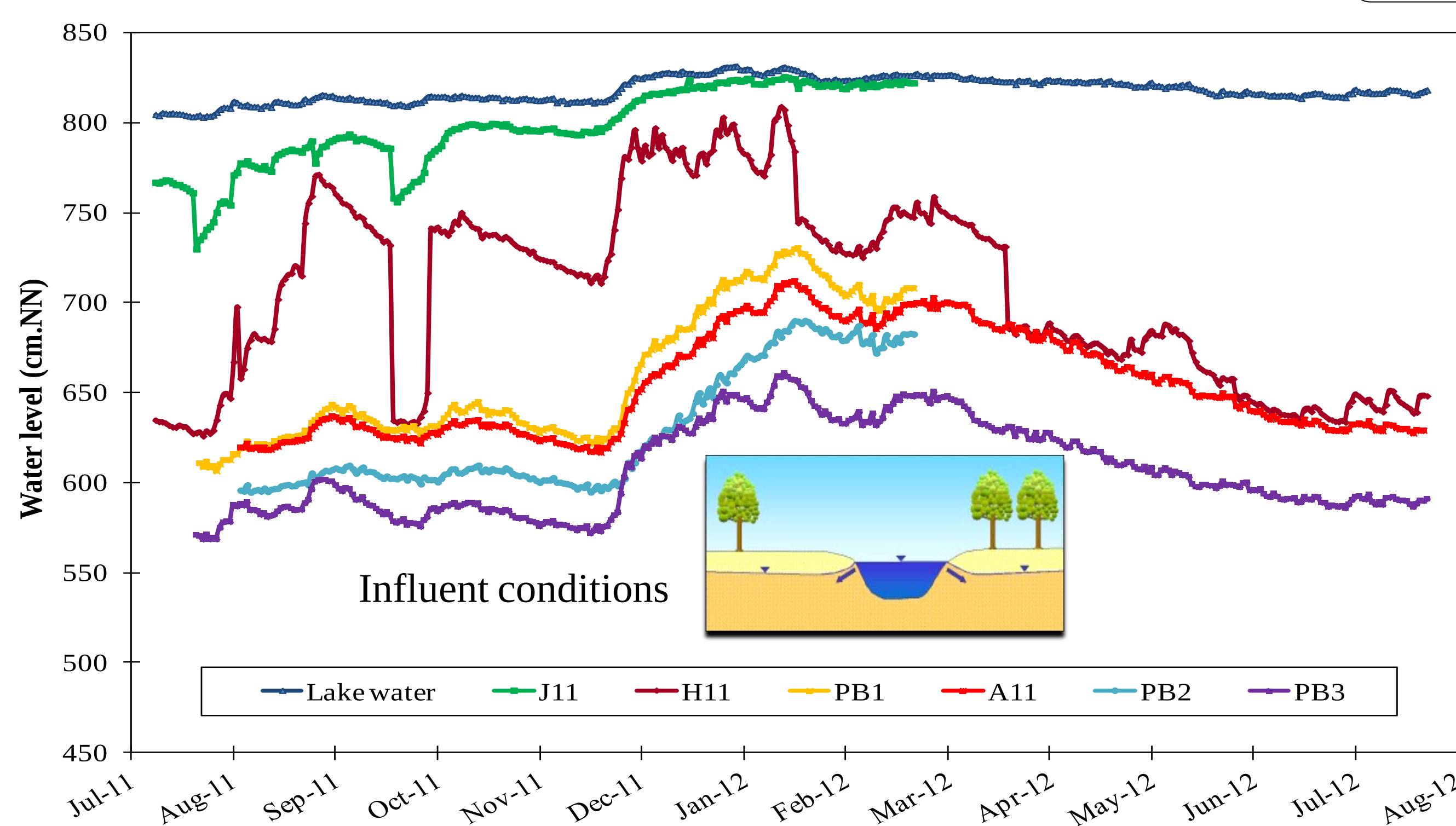


Fig 7: Water level in lake and groundwater

- The lake water level is always higher than the groundwater levels for all monitoring wells
- Groundwater is not the water source of the lake, hydraulic conditions are influent

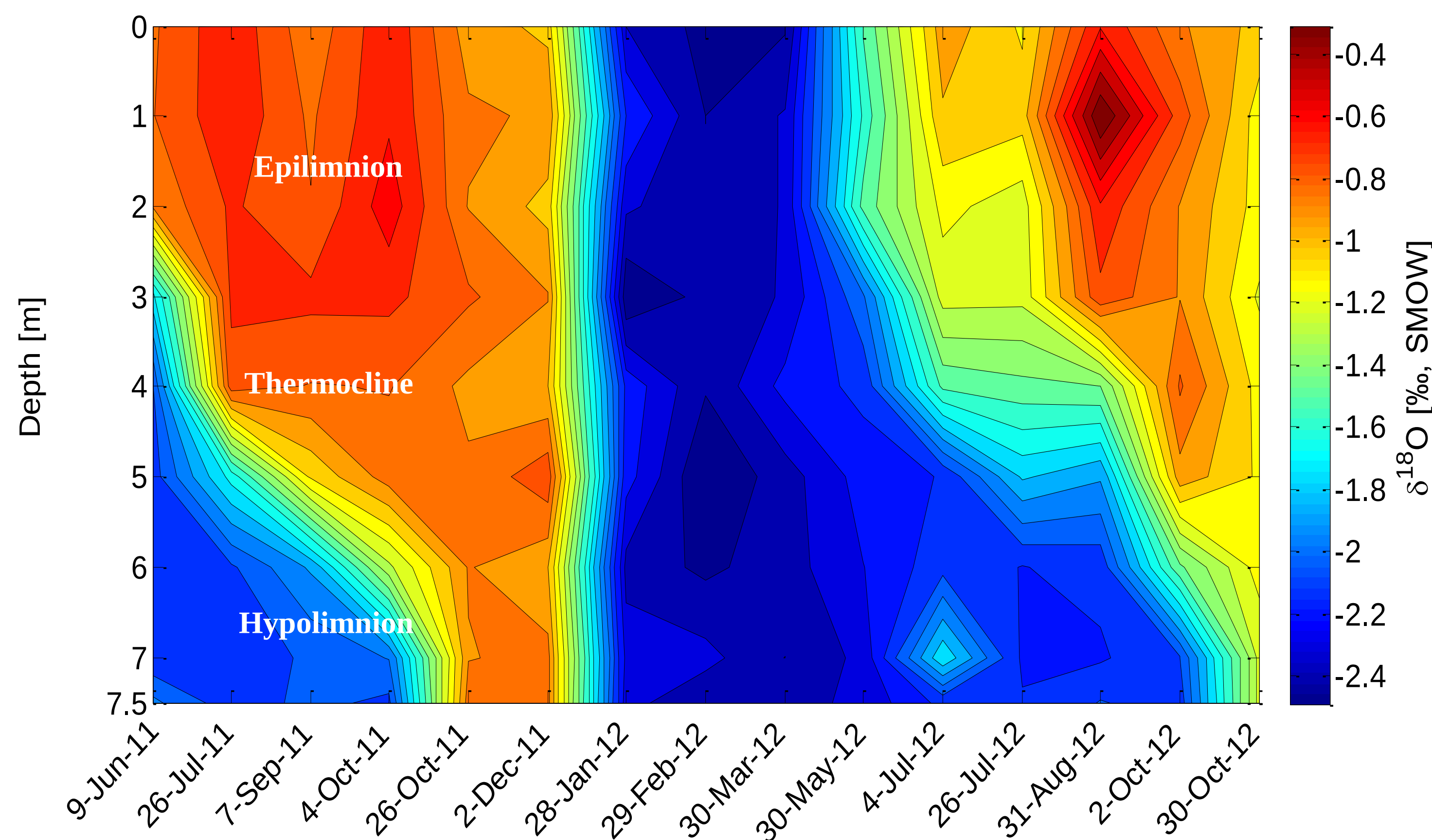


Fig 9: Interpolated depth profiles of $\delta^{18}\text{O}$ signatures in the lake over time

- $\delta^{18}\text{O}$ signatures display a seasonal pattern with enriched values in the epilimnion during summer stagnation
- In autumn and spring, the water column circulates and the isotopes values are homogeneously distributed

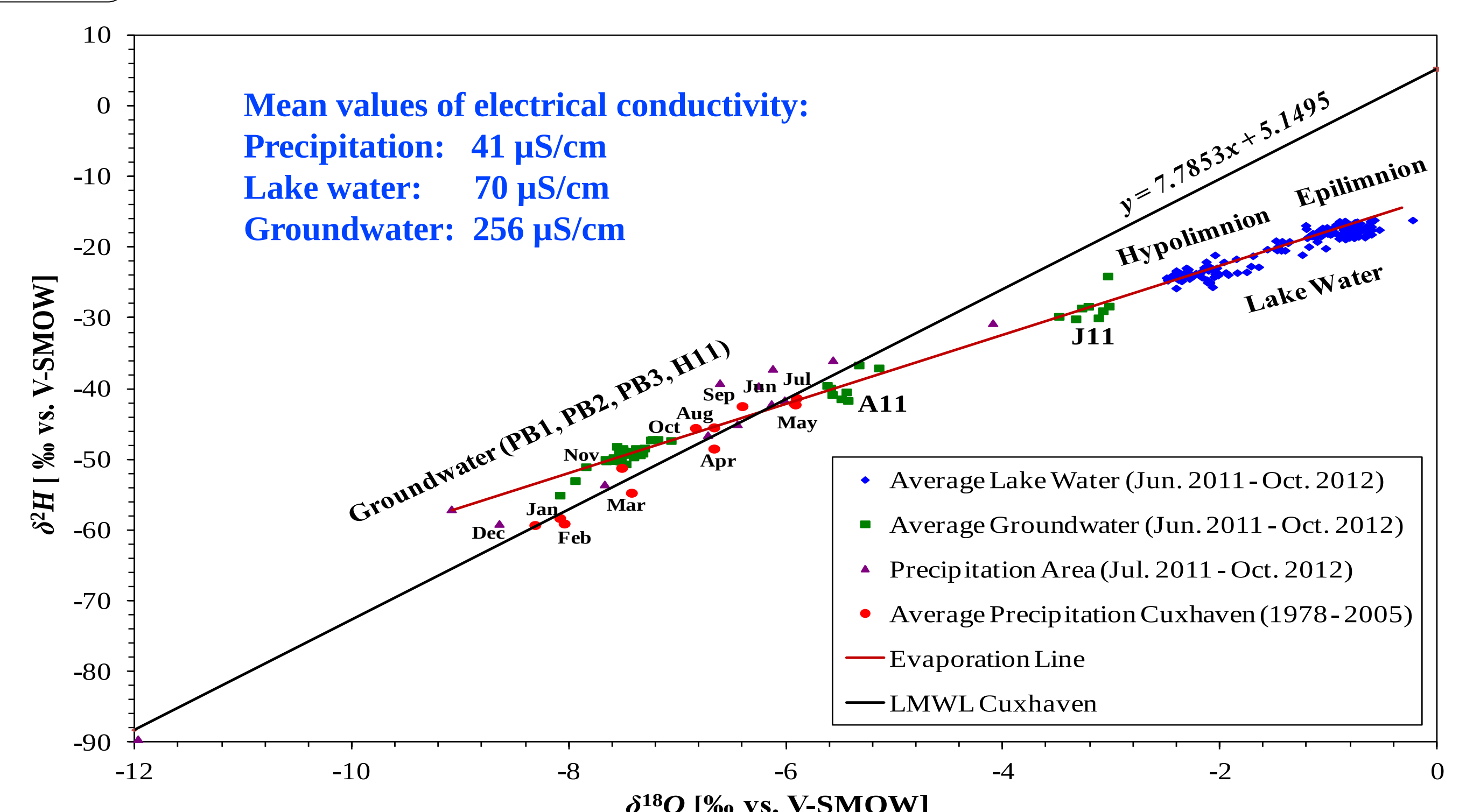


Fig 8: $\delta^2\text{H}$ versus $\delta^{18}\text{O}$ signatures of lake, groundwater and precipitation

- The lake water is enriched in heavy isotopes but less mineralized than groundwater
- Groundwater wells A11 and J11 contain 33% and 65% lake water respectively

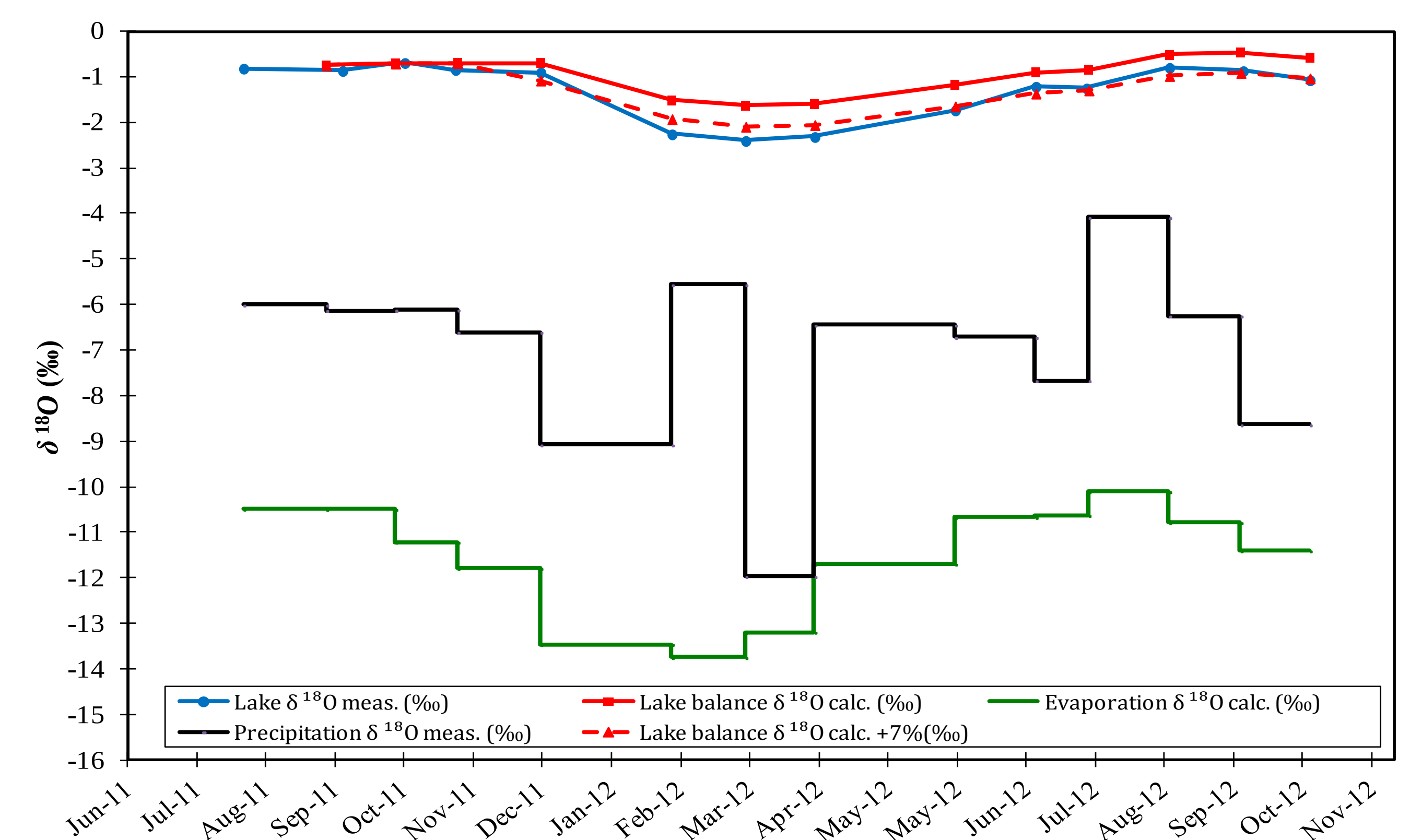


Fig 10: Measured $\delta^{18}\text{O}$ in precipitation and lake, calculated $\delta^{18}\text{O}$ in evaporation (Richter, D. 1984) and modelled $\delta^{18}\text{O}$ in the lake using the percentage of surface run-off as fitting parameter

- An isotope balance was used to estimate the extent of surface run-off throughout the year.
- Results show that isotope signatures of the lake can be fitted well assuming that precipitation is the only source and evaporation the only sink of the lake water except in Dec11/Jan12, when strong rainfall initiated surface run-off (equivalent to 7% of the total lake volume)

Conclusions

- Groundwater is not flowing into the lake, hydraulic conditions are influent
- The water in the lake originates from precipitation only
- Exceptions are periods of heavy rainfall, when surface run-off occurs (December-January 2011/2012)

References

- Buchwald & Schabelreiter (2010): Monitoring 2010 von Kennarten oligotropher Stillgewässer (*Isoëtes lacustris*, *Littorella uniflora*) im Silbersee (Lkr.Cuxhaven)
- Richter, D. (1984): Klimadaten der Deutschen Demokratischen Republik, Ein Handbuch für die Praxi, Reihe B, Band 6 „Verdunstung“, Hauptamt für Klimatologie des MD der DDR, Potsdam

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