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# Lake Tarfala, N-Sweden – first results from a natural observatory mimicking future changes in glacier-fed Arctic lakes

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Lake Tarfala is an up to 50 m deep glacier-proximal Arctic lake in the Kebnekaise Mountains, northern Sweden (~67°55' N, ~18°35' E, 1162 m asl) in direct vicinity to the Tarfala Research Station run by Stockholm University, and to the glacier Storglaciären for which the world's longest glacier mass balance record is kept since 1946. The neighboring Kebnepakte Glacier drains directly into Lake Tarfala. The site provides a unique an easily accessible natural observatory to study the impacts of climate and environmental change in an Arctic lake linked to a melting glacier.

As other Arctic lakes, Lake Tarfala is exposed to accelerated atmospheric warming in recent decades leading to increasingly shorter periods of lake freeze-over. Recent warming has also led to a widespread mass loss from glaciers with so for unclear implications for glacier-fed lakes which may receive larger amounts of meltwater and sediments from shrinking glaciers.

General atmospheric warming on the one hand and in response an increased influx of cold glacial meltwater to glacier-fed lakes on the other hand thus cause two competing processes determining the thermal state of a lake. Understanding (changing) lake thermal states and associated lake mixing dynamics is important because it has ramifications for a multitude of lake ecological, biological, and geochemical processes.

Here, we present the first continuous 3-year water temperature record from the deepest part of Lake Tarfala, acquired between 2016 and 2019. The record shows that Lake Tarfala is dimictic with overturning during spring and fall with substantial interannual variability concerning the timing, duration and intensity of mixing processes, as well as of summer and winter stratification. Particularly cold lake winter states appear to be related to elevated influx of cold glacial meltwater.

The projected high mass loss of Scandinavian glaciers with up to more than 80% of their volume

under RCP8.5 until 2100 AD relative to 2015 renders Lake Tarfala a natural observatory where changes in processes, inherent timescales and impacts in response to competing drivers can be studied before they occur at other glacial lake sites where glaciers melt at a slower place.