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Simulating climate change impacts on lake stratification on a continental scale

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Lake stratification is to a large extent determined by regional climatic conditions. Changes in climate patterns like increasing air temperature or wind speed will lead to a shift in lake characteristics, thus changing the physical basis for live in the aquatic system.
A vertical one-dimensional hydrodynamic model supported by a simple ice cover model is used to simulate abiotic lake characteristics like thermocline depth, timings of the start and end of stratification, ice break-up dates, as well as biological characteristics linked to the physical environment like the timing of maximum Daphnia abundance. To account for hydrodynamic differences due to lake morphometry and trophic state, we use several model lakes differing in depth (from 5 m to 100 m) and light absorption coefficients (0.3 1/m for oligotrophic lakes to 2.4 1/m for eutrophic lakes), respectively. The model lakes are forced by mean meteorological data for the years 1961-1990 as well as for future climate scenarios prescribed on a 0.5 degree grid over Europe. This results in several tens of thousands of simulations of lake temperatures and turbulent diffusivities over several annual cycles, from which we extract cardinal events and values such as the onset of stratification, length of stratification period, thermocline depth or ice cover duration. Using the reference meteorological conditions our simulations describe differences in lake hydrodynamics and ecology, e.g. start of the algal spring bloom, length of the algal growing period, across latitudinal, longitudinal and altitudinal gradients. It also allows for the quantification of changes in lake characteristics due to climate change, e.g. increasing periods of stratification or earlier ice break up.
This large scale simulation approach reveals physical and biological lake characteristics over a wide geographic range in Western Europe. It serves as a baseline for a comparative plankton ecology by setting up a physical frame to allow for cross regional comparison of plankton succession.