Advances in estimating the climate sensibility of a large lake using scenario simulations

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The vertical mixing behaviour of large deep lakes as e.g. Lake Constance is reflecting the long-term meteorological conditions and therefore is likely to be sensible to climate change.

Today, Lake Constance does not mix completely every year, but only once in 2-3 years, which leads to the typical saw-tooth pattern in the deep water temperature. Whether complete mixing does occur is not only depending on the meteorological conditions in the respective winter period, but also on the thermal conditions in the lake and hence on the meteorological conditions in the preceding years. The lake's response to climate change thus depends on the temperature increase itself as well as on its gradient and on the inter-annual variability of the meteorological variables.

Last year we showed first steps towards a model system to evaluate possible effects of climate change on Lake Constance: The Vector-Autoregressive Weathergenerator VG produces time series of meteorological data, which are used as boundary conditions for the 3D hydrodynamic lake model ELCOM (Centre of Water Research, University of Western Australia). As VG gives the opportunity to change mean and variability of selected variables, "What if?" – scenarios for process understanding can be performed.

The time scales of variability turned out to be a critical point in the artificial time series for modelling the hydrodynamics of Lake Constance, as the big water body integrates over time and thus the hydrodynamics overlook the variability of air temperature on short time scales. Therefore, VG was developed further, especially with respect to the time scales of variability. While for heat input, the time scale of several days to weeks seems to be more important, wind and, when biology is modelled, short-wave radiation should be given at a sub-daily timestep.

Besides producing user-defined scenario time-series, VG can also be used to stochastical downscale output of global climate model IPCC scenarios for lake modelling.

The poster " Simulating the effect of meteorological variability on a lake ecosystem" by Marieke Anna Frassl in this session "Lakes and Inland Seas" shows lake model runs focusing on water quality and ecosystem behavior under different climate change scenarios.

For further information on VG see "Stochastic Downscaling for Hydrodynamic and Ecological Modeling of Lakes" by Dirk Schlabing in Session "Hydroclimatic stochastics" (HS7.5 / NP8.3).