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Climate sensibility of a large lake - a scenario study using a 3D hydrodynamic model and a statistical weather generator

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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.
To evaluate possible effects of climate change on Lake Constance, the three dimensional hydrodynamic model ELCOM (Centre of Water Research, University of Western Australia) is run with a quite coarse discretization of the lake for long-term simulations. The meteorological boundary conditions for the hydrodynamic model, which are air temperature, humidity, long- and shortwave radiation and wind, are provided by the vector-autoregressive statistical weather generator VG. VG gives the opportunity either to produce time series with the statistical properties of the measured data, or to change the mean or the variability of selected variables, maintaining the dependency structures between the meteorological variables. For further information on VG see "A Vector-Autoregressive "co-shiftable" Weathergenerator for Hydrodynamic Modeling of Lakes" by Dirk Schlabing in Session "Hydroclimatic stochastics" (HS7.5 / NP6.7).
In this study the effects of increasing mean temperature and changed meteorological variability on the lake's mixing behaviour are analysed separately. Using artificial time series, the simulations are not producing predictions, but "What if?" – scenarios for process understanding, and are a tool to detect for example critical gradients in temperature increase and tipping points within the lake system.