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Stochastic Downscaling for Hydrodynamic and Ecological Modeling of Lakes

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Weather generators are of interest in climate impact studies, because they allow different modi operandi: (1) More realizations of the past, (2) possible futures as defined by the modeler and (3) possible futures according to the combination of greenhouse gas emission scenarios and their Global Circulation Model (GCM) consequences.

Climate modeling has huge inherently unquantifiable uncertainties, yet the results present themselves as single point values without any measure of uncertainty. Given this reduction of risk-relevant information, stochastic downscaling offers itself as a tool to recover the variability present in local measurements. One should bear in mind that the lake models that are fed with downscaling results are themselves deterministic and single runs may prove to be misleading. Especially population dynamics simulated by ecological models are sensitive to very particular events in the input data. A way to handle this sensitivity is to perform Monte Carlo studies with varying meteorological driving forces using a weather generator.

For these studies, the Vector-Autoregressive Weather generator (VG), which was first presented at the EGU 2011, was developed further. VG generates daily air temperature, humidity, long- and shortwave radiance and wind. Wind and shortwave radiation is subsequently disaggregated to hourly values, because their short term variability has proven important for the application. Changes relative to the long-term values are modeled as disturbances that act during the autoregressive generation of the synthetic time series. The method preserves the dependence structure between the variables, as changes in the disturbed variable, say temperature, are propagated to the other variables. The approach is flexible because the disturbances can be chosen freely. Changes in mean can be represented as constant disturbance, changes in variability as episodes of certain length and amplitude. The disturbances can also be extracted from GCMs with the help of QQ-downscaled time series.

Results of water-quality and ecological modeling using data from VG is contributed by Marieke Anna Frassl under the title “Simulating the effect of meteorological variability on a lake ecosystem”. Maria Magdalena Eder contributes three dimensional hydrodynamic lake simulations using VG data in a poster entitled “Advances in estimating the climate sensibility of a large lake using scenario simulations”. Both posters can be found in the Session “Lakes and Inland Seas” (HS10.1).