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Rearranging the Past for future Climate Scenarios

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We present a new down-scaling approach for the derivation of future climate scenarios for climatologically heterogeneous regions with an application to the Elbe catchment. It uses daily data from meteorological stations and a given linear trend in temperatures, which represents long term climate change and can be calculated e.g. from a GCM run.

Our heuristic method is based on the assumption, that the set of daily tuples measured at any station (temperature, precipitation, pressure, ...) in the past is complete in the sense that every future day at this station can be sufficiently well approximated by an unaltered tuple from the past. This transforms the problem into finding a permutation of unaltered daily tuples from the past for each station. Thereby, realistic interdependencies between variables are ensured.

The decision, which day (i.e., which tuple) from the past is used as an approximation for any given future day, is founded on criteria, which are intended to make the scenarios comply with a number of requirements: From what is known from the past, annual cycles, persistence, intra and inter annual variability for each measured variable must be realistic. Mutual correlations between different variables at a single location as well as correlations between those at different locations are to be reproduced reasonably. The linear trend in temperatures representing climate change must be present in the scenarios.

In order to evaluate the power of our approach, we show results from a cross-validation experiment using daily data from stations in the Elbe river catchment. These cover the years 1951 through 2003, which are divided into two subsets, the first one being used as “past”, the second as “future”. With temperature trends calculated directly from the second subset and using the first subset as training data, a scenario for the second subset is derived. The comparison between scenario and second subset shows a very convincing agreement with respect to the requirements given above.