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# Downscaling transient climate change scenarios for water resource management

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The management of hydrological systems in response to climate change requires reliable projections at relevant time horizons and at appropriate spatial scales. Furthermore the robustness of decisions is dependent on both the uncertainty of future climate scenarios and climatic variability. The current generation of climate models do not adequately meet these requirements for hydrological impacts assessments and so new techniques are required to meet the needs of hydrologists and water resource managers.

Here, a new methodology is described and implemented which addresses these issues by adopting a hybrid dynamical and stochastic downscaling approach to produce a multi-model ensemble of transient scenarios of daily weather variables. These scenarios will be used to drive hydrological simulations for two groundwater systems in north-west Europe, the Brévilles and the Geer, studied as part of the EU FP6 AQUATERRA project. In so doing, the impact of climate change on the challenges facing these aquifers can be assessed on relevant timescales and provide the means to answer wide-ranging questions relating to water quality and flow.

The framework described here integrates two components which use projections of future change derived from regional climate models (RCMs) to generate stochastic climate series. Firstly, a new, transient version of the Neyman Scott Rectangular Pulses (NSRP) stochastic rainfall model is implemented to produce transient rainfall scenarios for the 21st century. Secondly, a novel, transient implementation of the Climatic Research Unit (CRU) daily weather generator is adopted, conditioned with daily rainfall series simulated by the NSRP model. This two-stage process is thus able to produce consistent transient series of rainfall, temperature and other variables.

Both of these stages apply monthly change factors (CFs) derived from 13 RCM experiments from the PRUDENCE ensemble to current rainfall and temperature statistics respectively to project future change for the end of the 21st century. These CFs are then scaled to produce monthly CFs for each year throughout the transient period up to 2085, and are used to generate perturbed transient climate series by the stochastic rainfall model and weather generator.

Results of the validation process are summarised for both aquifers for the current climate and for the perturbed transient scenarios for a range of variables including rainfall, temperature and potential evapotranspiration indicating that this framework is able to simulate the main features of the current climate and also of the projected future changes indicated by RCMs. Furthermore, to generate its wide applicability a selection of simple climate indices are examined and for example, demonstrate that climate models project a lengthening of the growing season in this region. By generating a large multi-model ensemble the range of uncertainty in future projections is demonstrated, and by using the transient scenarios to determine the projected timescale of pre-defined impacts it is also shown that this method provides more relevant and informative tools for climate change impacts assessments for hydrological systems.