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Using a weather generator and GCM realizations to produce an ensemble of hourly future climate time series

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This study presents a stochastic downscaling methodology to generate an ensemble of hourly time series of several meteorological variables that use information on projected future climates. The stochastic downscaling makes use of General Circulation Model (GCM) realizations and of an hourly weather generator (AWE-GEN). Using a Bayesian approach, the downscaling procedure derives distributions of factors of change for several climate statistics from a multi-model ensemble of GCMs realizations. The factors of change are represented by ratios or "delta" differences of climate statistics between a specific control scenario climate and a specific future scenario. A Monte Carlo technique is used to sample the factors of change from their respective distributions. The methodology allows one to entirely account for the probabilistic information obtained weighting an ensemble of GCMs through the Bayesian approach. In each Monte Carlo iteration the factors of change are applied to the climate statistics derived from observations. This allows one to produce modified statistics of meteorological variables and to re-evaluate the parameters of the weather generator. The generator can reproduce a wide set of climate variables (air temperature, precipitation, vapor pressure, solar radiation, etc.) and statistics over a range of temporal scales, from extremes, to the low-frequency inter-annual variability. Once re-parameterized AWE-GEN generates multiple hourly time series of meteorological variables that can be regarded as representative of a distribution of predicted future climates, as inferred from GCMs. In the procedure, the hourly time series are generated in ensemble mode to reflect the uncertainty of GCM projections as well as the downscaling procedure. Applications of the stochastic downscaling in reproducing future climates are discussed for different locations world-wide: Tucson (AZ), Detroit (MI), and Firenze (Italy). The stochastic downscaling is carried out with eight GCMs from the CMIP3 multi-model dataset (IPCC 4AR, A1B scenario).