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# Stochastic Climate Change Scenario Generator: its Use in Probabilistic Climate Change Impact Assessments and in Estimating Missing Climatic Elements

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The volume of GCM simulations available for climate change impact studies continually increases. This allows for better representation of uncertainties (between GCMs, between emission scenarios, between parameterizations, etc.), but, simultaneously, the volume of available GCM output data has become so large such that it poses a strong requirement for more effective organization of climate change impact analyses. In implementing the multi-model information for a given impact analysis, only scenarios from a subset of all available GCMs are mostly employed. Less frequently, the impact analysis is based on scenarios processed from all of the GCMs. However, this is not applicable in cases where an ensemble of GCM simulations is too large (for example, when dealing with the perturbed-physics ensemble available from climateprediction.net project). In such cases, one may use scenario emulators/generators, which may produce a large set of climate change scenarios representing the whole multivariate probability distribution function of the scenarios. The contribution has three parts.

In the first par, the underlying model of the scenario generator is introduced. The generator is based on a multivariate parametric model whose parameters are derived from a set of GCM based scenarios (no limit on the size of the set, the model may also be calibrated with a very large perturbed-physics ensemble). Once calibrated, the generator may produce an arbitrarily large set of climate change scenarios. These scenarios consist of changes in monthly means and variabilities, and are easily linked with the stochastic weather generator M&Rfi, which produces daily weather series to be used as an input to the impact models.

The second part is focused on validation of the scenario generator. It is used to make a probabilistic assessment of climate change impacts on annual averages and extremes of temperature, precipitation and two Palmer drought indices (Z, PDSI) in 10 European and 11 US stations. The monthly weather series, from which the characteristics are derived, are generated by M&Rfi weather generator, whose parameters are derived from observed weather series and then modified according to climate change scenarios coming from two sets: (i) scenarios derived from individual GCMs (IPCC-AR4 database), and (ii) scenarios generated by the stochastic climate change scenario generator. The scenario generator validation is then based on comparison of results obtained with the two sets of scenarios. The probabilistic distribution functions (in individual stations) of impacts based on using the scenario generator are compared with those obtained with a "classical" approach, which consists of pooling the results obtained with a set of single GCM based climate change scenarios (using the same set of GCMs coming from the IPCC-AR4 database, which was used to calibrate the scenario generator).

In the third part, the scenario generator is used to estimate changes in humidity and wind speed, which are the climatic characteristics required as an input to some models used in climate change impact analysis (e.g. some crop models) but they miss in many GCM outputs included in the IPCC-AR4 database. In the present experiment, the scenario generator is calibrated with scenarios from the GCMs, for which the changes in humidity and wind speed are available. In the second step, the generator is used to estimate the missing values of humidity and wind speed changes in scenarios from those GCMs, where these climatic characteristics are not available.

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