Title: A generalized linear modeling approach to stochastic weather generators

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Abstract:

Improved statistical methods are needed to link the statistical behavior of weather variables to climate states. Such methods are used, for instance, in the context of disaggregating seasonal climate forecasts or of constructing climate change scenarios. One popular modeling approach involves the use of stochastic weather generators, either based on parametric models or on resampling. In the parametric modeling approach, the statistical behavior of the weather variables is linked to climate states through conditioning of the parameters of the weather generator. However, generally this conditioning is done in an ad hoc manner not amenable to either straightforward tests of whether the incorporation of the climate change state into the model improves the fit or to performing uncertainty analysis.

We demonstrate how an approach based on generalized linear models (GLMs) can provide a general modeling framework for incorporating climate states into parametric stochastic weather generators. One advantage of the GLM approach is that software is readily available for fitting such models (e.g., the function glm in the open source statistical programming software R, available at www.r-project.org). Long ago, GLMs were advocated by Stern and Coe (1984) for the stochastic modeling of daily precipitation, and more recently by Chandler (2005) for stochastic modeling of individual daily weather variables more generally. This past work has demonstrated how temporal dependence and annual cycles, as well as climate states, can be incorporated into a stochastic model for a single weather variable. Here we extend this approach to treat several daily weather variables simultaneously, as required to construct a stochastic weather generator.

As an application, we apply the GLM technique to daily time series of weather variables (i.e., precipitation amount as well as minimum and maximum temperature) at Pergamino, Argentina. Based on likelihood ratio tests, the fit is significantly improved by permitting both transition probabilities of the first-order Markov chain model for daily precipitation occurrence, as well as the means of both daily minimum and maximum temperature (but not necessarily the scale parameter of the gamma distribution for daily precipitation intensity), to depend on the ENSO state. The performance of the fitted model is evaluated, with particular emphasis on extremes. How the GLM approach is amenable to uncertainty analysis is also described.

REFERENCES

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