Geosci. Model Dev. Discuss.,
https://doi.org/10.5194/gmd-2018-97-AC2, 2018

Geoscientific Model Development Discussions

Interactive comment on "A simple weather generator for applications with limited data availability: TEmpotRain 1.0 for temperatures, extraterrestrial radiation, and potential evapotranspiration" *by* Gerrit Huibert de Rooij

G.H. de Rooij

gerrit.derooij@ufz.de

Received and published: 5 July 2018

Initial reply to Prof. Kilsby

I thank Prof. Kilsby for his review. In my reply, all references can be found in the discussion paper, unless stated otherwise.

Prof. Kilsby finds no problems in the presentation of the weather generator but points out that a similar weather generator (UKCP09) is not mentioned, and provides several references to that weather generator.

I carried out a web-search for weather generators and discussed the most pertinent ones in the Introduction. Why the search results did not include UKCP09 I do not know, but I thank Prof. Kilsby for bringing this to my attention. I concur with him that not discussing UKCP09 is an omission, and in the case the Editor allows me to revise the paper I will rectify this. The references included in the review serve as a valuable starting point for this. In the meantime I have also found a useful review paper comparing Bartlett-Lewis and Neyman-Scott processes.

Prof. Kilsby points to similarities in the structure of UKCP09 and TEmpotRain. I agree there are some similarities but submit that there are significant differences as well. Referee # 2 gives an astute description of these. In summary, the models for rainfall in UKCP09 and TEmpotRain are somewhat different, the models for temperature are quite different, and the models for potential evapotranspiration are completely different. The sequence in which the sub–models comprising the weather generators are executed is similar, but I believe that is a necessity when one chooses to use Poisson-process to generate rain storms (1st constraint). One has to start with the rainfall record and 'build' the rest of the weather around that. Because the daily temperature extremes feed into the evapotranspiration model (2nd constraint), the temperature record must be generated before the evapotranspiration record. These two constraints fix the order in which the model cascade has to be executed.

The Bartlett Lewis (BL) and the Neyman Scott (NS) approach to generate rain storms and rain cells within storms are too similar to justify a strong preference for either. For TEmpotRain, BL is slightly more advantageous because unlike NS, the BL process generates cell starting times that are in chronological order within a storm, thereby making the array sorting process that I implemented in the code in order to establish the continuous rainfall record more efficient. The citation analysis presented in Prof. Kilsby's review confirms the lack of a clear preference for either BL or NS, with a more or less even split in number of papers and citations. Referee 2 supports my choice of not reviewing theoretical work on rainfall generation, since GMD is not the outlet for such work. Indeed, referee 2 provides a review in her/his publically available report of such quality that I wonder what I could add to it.

It should be noted that the model to generate potential evapotranspiration in TEmpotRain is much simpler than that in UKCP09. This was a deliberate choice in view of the applicability of the model in data-scarce areas. Droogers and Allen (2002) demonstrated that their modified Hargreaves equation outperformed the much more data-hungry Penman-Monteith equation if the underlying weather data had errors in them.

Apart from the differences in the submodels of TEmpotRain and UKCP09, there are marked differences in the operation of both weather generators. UKCP09 is trained for the UK, where impressive weather records are available. Application to other climate zones is possible but not straightforward. Kilsby et al. (2007; see reference in Prof. Kilsby's review report) indicate that the weather generator relies on regression relations between daily climatic variables and daily rainfall. They also point out that applying the model to other geographic locations requires suitable data to develop these regression relationships. Application to future climates would additionally require data from a regional climate model for the desired location. Kilsby et al. (2007) are aware of the heavy data requirement and mention poor data availability as a factor that prohibits the application of UKCP09. TEmpotRain is much more flexible in this respect. In response to referee 2 I intend to expand on the guidelines to select parameter values in case calibration data sets are not available to improve that flexibility even further.

The currently available web-based version of UKCP09 is an impressive feat. From the website and the manual I gained the impression that this version of the model has been exclusively designed for the UK, and I can easily imagine it has many users there. The web-based version generates multiple records of 100 years at most (30 years for hourly data), whereas TEmpotRain generates a single record of essentially arbitrary duration (I am currently generating 1000-year records). We are studying groundwater recharge in semi-arid regions and found that 100 years is not enough to capture rare catastrophic rainfall events or equally rare sequences of multiple wet years. We believe

that especially the latter phenomenon has the potential to provide recharge to deep aquifers, but we need to model the unsaturated flow process for several centuries to be able to capture this. For applications of this nature, the flexibility to generate records of arbitrary duration is very valuable. For this reason I included leap years in TEmpotRain. If one does not take into account February 29, summer and winter will have changed place after 730 years.

TEmpotRain was developed with the needs of soil and crop modelers in mind. For this group of potential users I expect it is more convenient to run a single longer simulation with a sequence of crops than it would to run a set of parallel 100-year simulations.

Given these operational differences between UKCP09 and TEmpotRain I believe both models have their own sets of users that do not overlap very much.

Gerrit H. de Rooij

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