Hydrol. Earth Syst. Sci. Discuss., 7, C1445–C1448, 2010
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Hydrology and Earth System Sciences Discussions

Interactive comment on "A stochastic design rainfall generator based on copulas and mass curves" *by* S. Vandenberghe et al.

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Received and published: 15 July 2010

We acknowledge the input of dr. Ferdinand Beck with respect to the interpretation of the statistical significance of hypothesis testing. We believe that a decent goodness-of-fit test should be considered in all practical applications of copulas. However, with regard to the performance and more specifically to the outcome (p-values) of such tests, the following considerations are relevant.

First of all, a goodness-of-fit test only focuses on one specific aspect of the fit and several goodness-of-fit tests for copulas are available on which Genest et al. (2009) provide a review. The S_n and T_n statistics as used in our paper are denoted as $S_n^{(K)}$ and

$T_n^{(K)}$ in the paper of Genest et al. (2009) and are respectively based on the Cramér-von Mises and Kolmogorov-Smirnov distance taken on the Kendall process, i.e. the difference between the theoretical and empirical Kendall function. Based on their analysis, they find that 'the Cramér-von Mises functionals of a process tend to be more powerful than those based on the Kolmogorov-Smirnov distance taken on the same process'. In the case of our study, this means that the results based on S_n are more important than the ones obtained with T_n. Furthermore, Genest et al. (2009) recommend the use of $S_n^{(K)}$ specifically for Archimedean copulas. The A12 copula is an Archimedean copula, so we conclude that the test based on the S_n-statistic is very powerful.

Secondly, it is clear that the more data one has, the better one can discriminate between different models. In our case, a very large sample was used (almost 2000 data points). This means that finding an appropriate model for our data is a very difficult task compared to other copula-applications in which a sample size of around 100 to 200 is much more common. Taking a random subset of our data set would make the test less severe. Table 1 gives the p-values when a subset of 200 data points is used to fit the A12 copula considering the different seasons. These p-values indicate an appropriate fit in all cases: no significant rejection of the null-hypothesis can be made at a significance level of 5%. Table 2 gives the p-values considering the Frank copula family. The most powerful test (based on S_n) indicates a significant rejection of the null-hypothesis at a significance level of 1%: the fitted Frank copula is therefore not an appropriate model for the data. It should also be noted that the differences in estimated parameters of the fitted copulas, whether using the whole dataset or just a small subset, were negligible.

Thirdly, besides the evaluation of the fit in terms of a p-value, also several other (visual) aspects of the fits were considered (not included in the paper). From a practical point of view, we believe that the consideration whether a fitted copula is appropriate or not should not merely rely on one number, i.e. the p-value. More details can be found in Vandenberghe et al. (2010).

Table 1. Goodness-of-fit statistics and p-values for the fitted A12 copula on a random subset ($n = 200$) of the (W, D) data.

	Winter	Spring	Summer	Autumn
S_n	0.0525	0.0455	0.0581	0.0443
p-value	0.3010	0.4450	0.2570	0.4930
T_n	0.6851	0.5102	0.6341	0.6226
p-value	0.1800	0.7150	0.2980	0.3430

Table 2. Goodness-of-fit statistics and p-values for the fitted Frank copula on a random subset ($n = 200$) of the (W, D) data.

	Winter	Spring	Summer	Autumn
S_n	0.1066	0.1503	0.2311	0.1556
p-value	0.0190	0.0040	0.0000	0.0030
T_n	0.7405	0.9899	1.1014	0.8396
p-value	0.0800	0.0020	0.0000	0.0200

Thus as a conclusion, the p-values in combination with the above considerations indicate that the fitted A12 copulas are appropriate for modelling the dependence between W and D.

With respect to the Huff curves, we did not provide a test for the fits of the Huff curves. What we provided is a non-parametrical test to compare Huff curves (or more specifically, the distribution of cumulative rainfall depths at different time intervals) with each other. The same considerations with respect to the data size are valid here with respect to the p-values.

In the revised version of our paper, we will correct some of the statistically incorrect terminologies such as e.g. 'a significant fit'.

References

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Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 7, 3613, 2010.