Hydrol. Earth Syst. Sci. Discuss., 10, C599–C604, 2013
www.hydrol-earth-syst-sci-discuss.net/10/C599/2013/

Hydrology and Earth System Sciences Discussions

Interactive comment on "Development and comparative evaluation of a stochastic analog method to downscale daily GCM precipitation" *by* S. Hwang and W. D. Graham

Anonymous Referee #1

Received and published: 2 April 2013

GENERAL COMMENTS

The paper is well written and the different steps and methodologies are, in general, cleary commented and explained. The Authors present a new statistical downscaling method bias-correction and stochastic analog (BCSA) and discussed its capability in reproducing daily spatial and temporal variability of precipitation in Florida. The method is applied to four GCMs with spatial resolution ranging from 1.4° to 2.8° and its performances are compared with those of three different statistical downscaling method. The comparisons are carried one using statistical indices and variograms for spatial variability while temporal variability is discussed in terms of transition probabilities and

length of wet and dry spells. A point where the paper could be clearer is in describing how the proposed methodology combines the pro's of the three methods it is compared with, and why it improves them. This point is not clearly addressed in the paper.

SPECIFIC COMMENTS

Introduction

Page 2143 Lines 21-25 Authors wrote "To overcome this limitation of GCMs, a number of downscaling methods have been developed. It has been shown that fine-scale downscaled results provide better skill for hydrologic modeling (Andr′easson et al., 2004; Graham et al., 2007; Wood et al., 2004) and agricultural crop modeling (Mearns et al., 1999, 2001) than using the coarse resolution GCM output directly. Often downscaling techniques". I expected that Authors provides an overview of downscaling techniques other than statistical, i.e. dynamical downscaling or RCM, before writing on statistical downscaling methods. It would be of interest to know the reasons the Authors prefer statistical downscaling to dynamical downscaling for this case of application, and when, eventually, dynamical downscaling could perform better than statistical downscaling.

Page 2144 Lines 4-5 Authors wrote "Additionally statistical downscaling has been shown to provide climate information at any specific resolution of interests so that is the outcome may be directly used for many climate change impact studies (Fowler et al., 2007; Murphy, 1999; Wilby et al., 2004)." This is partially true, the validity of the statistical relationships on which statistical downscaling methods are based is limited by the spatial resolution of the dataset they are derived from, at any different spatial scale the results are affected by the interpolating scheme used.

Page 2145 Lines 10-14 "However realistic spatial variability of daily precipitation events may not be reproduced by this method because it is designed to preserve only the observed temporal statistics at the time scale chosen for downscaling and the spatial disaggregation process is essentially a simple interpolation scheme." and Page 2146 Lines 1-3 "However the SDBC method does little to improve skill in reproducing spatial

variability because the same approach (interpolation) as used in BCSD is employed for spatial disaggregation." The main disadvantege of using BCSD or SDBC method seems to be the spatialization method (inverse of the distance weighted), there is any attempt to improve these methodologies by using a different spatial disaggregation method, e.g. kriging?

Section 3 General comment

(1)The Authors compares the results of 4 downscaling methods, three of them (BCSD_daily, BCCA, and SDBA) are already available in Litereature while the fourth is proposed by them. I would like to ask the Authors to explain why they choose BCSD_daily, BCCA, and SDBA to be compared with BCSA. Additionally, if the choice is motivated by the fact that BCSA combines the best of these three methods, this should be clearly expressed in the text as motivation of the choice of implementing BCSA method.

(2) The performances of the 4 downscaling methods are compared by applying them to 4 different GCMs, but only two (Table 2) are really used for all the four methods: GFDL-CM2.0 and CGCM3.1. BCCR-BCM2.0 and CCSM3 are statistically downscaled using BCSD_daily, SDBC, and BCSA, and BCCA only is used for CNRM-CM3 and MIROC3.2. It is clear that BCCR-BCM2.0 and CCSM3 were not available for BCCA, but why do Authors not applied the other methods to CNRM-CM3 and MIROC3.2 instead of BCCR-BCM2.0 and CCSM3? By doing so the Authors would have perfomed a comparison among the statistical downscaling methods based on the same initial and boundary conditions and affected by the same GCM error.

- Bias correction and spatial downscaling at daily scale (BCSD_daily) method paragraph. In the paragraph the Authors presents firs the methology in general and in a second time in more details, however it is not immediate to link the concept in the first part with those in the second one. I will suggest the Authors to rephrase it. Additionally, I will suggest to move the comment on the bias correction at the end of the paragraph

(first lines of page 2148) at the end of the explanation of the bias correction procedure instead of at the end of the paragraph.

- Bias correction and stochastic analog (BCSA) method paragraph Page 2149 Line 24 I would suggest the Authors to add "and each grid cell" at the end of the sentence "Because the spatiotemporal features (e.g. frequency, spatial patterns, and correlation) of precipitation events may change monthly or seasonally, the BCSA process was performed using temporal and spatial statistics calculated separately for each month." This to be more coherent with Equation 2, otherwise it seems that all points are represented by the same CDF.

Page 2151 point iv If for each day values are generated using independent Gaussian distribution how can this approach preserve the temporal distribuiton of precipitation? More specifically how it can reproduce the lenght of dry and wet spells, if each day is indipendently generated form the previous one?

Page 2151 equation (7) since in equation (2) G-1 has been defined as "the inverse transform function of the standard Gaussian CDF", here Fnorm should be defined as G.

CONCLUSIONS I think that Authors should indicate that this method is computationally more expensive than the other investigated, since an ensemble of 3000 replicates of spatially distributed precipitation fields for each month is generated and within these replicates the realization with the appropriate monthly ensemble with spatial mean of the generated precipitation fields equal to the GCM prediction is selected. Thus, the BCSA method performs better than the others also because it allows to choose the best realization of the GCM.

TECHNICAL CORRECTIONS Page 2146 line 18 "US. without missing data." probably is "US without missing data." Page 2146 line 18 "this data was" probably is "These data are"

****

TABLES

Table 1 I would suggest to revised it, in particular it is not clear to me why the GCM GFDL-CM2.0 is both in bold (used for all the GCM) and with the textnote b (used only for BCCA method), this not congrunet with what shown in Table 2. Probably the readability of Table 1 could be improved by adding one column with the list of statistical downsscaling ethod applied to each GCM; a further colmun could be added with the spatial resolution of the GCM, by doing so the full name of the GCM can be reported in the legend of Figure 1.

****

FIGURES

I will suggest to carefully check legend and caption of all the figures to uniform the GCMs and downscaling method names, e.g. Gobs is indicated with Gobs., Gobs or G_obs.

Figure 1 Legend: The last two voice are indicated as (only for BCCR) I guess is a mistyping and the right sentence is "only for BCCA" Axis ticks: would it be possible to change the axis tick symbology? In the top x axis the symbol is quite similar to the lower part of symbols used for GFDL and CNRM-CM3 and this can confuse the reader. Would it be possible to draw also the grid of observed data?

Figure 2 Caption The sentence "indicating ... over Florida" does not add any informtion to interpret the figure content it could probably be removed. It is not clear to me the meaning of the sentence "Mean and standard deviation of annual preciptiation predictions are represented in the panel". The only mean and standard value I see is the one of Gobs but Gobs are not predictions. Please clarify it

Figure 6 The title at the top of each panel is not needed.

Figures 9 and 10 on the y-axis the label is written in latex code TP_{11} please verify if it is a compilator problem or if it intentional, anyway check the corrispondence between y-axis label and the caption text (P_{11})

Figures 11 to 14 would it be possible to use the same symbology along these figures?

Figure 11 there is a misspelling "lenth" instead of "length" in the text below each panel

Figure 13 remove the "/" in the caption

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 10, 2141, 2013.