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Hydrology and Earth System Sciences Discussions

Interactive comment on "Utility of daily vs. monthly large-scale climate data: an intercomparison of two statistical downscaling methods" *by* E. P. Maurer and H. G. Hidalgo

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We are grateful to the reviewer for the thoughtful and careful reading of the manuscript, and the helpful comments. Our responses to each comment are listed below, following the reviewer's numbering.

1) The reviewer raises an important point also raised by reviewer #1, namely the need for greater description and contrasting of the CA and BCSD methods. While this is addressed to some degree in the responses to reviewer #1 (see especially responses to reviewer #1 comments 1-3), additional detail has been added. In particular, Section 2.3, paragraph 2 has had the following text added: "As discussed by Wood et al.

(2002), while in principle daily GCM output could be used directly, the BCSD method was developed to streamline the translation of GCM output into fine-scale land surface meteorological forcing, and the assumption of climatological daily variability has proven reasonable for hydrological applications."

Additionally, the second paragraph of Section 2.4 in the revised manuscript now includes: "Just as BCSD in principle could be applied on daily scales, CA could theoretically be applied at a monthly scale. However, CA was developed to enable to direct downscaling of daily large-scale model output to capture the evolution of daily precipitation and temperature statistics as simulated by a model. Furthermore, since constructing analogues requires a large library from which to draw similar patterns, as discussed below, an observational record longer than the 1950-1999 period used in this study would be needed to support a robust monthly application of CA."

2) The reviewer is correct in identifying the problem with the statement, which would only apply to daily statistics. It has been corrected to read (last paragraph of Section 1): "Thus, for daily statistics, the two methods will be expected to distinguish themselves only inasmuch as the large-scale climate exhibits skill at the daily time scale."

3) The reviewer correctly points out that temperatures are also adjusted for elevation in the interpolation process (as described by the referenced Maurer et al, 2002). The first paragraph of Section 2.1 has been modified to include this point: "The data are daily station observations interpolated onto a regular grid, with temperature lapsed to grid cell center elevations and with precipitation adjusted..."

4) This is an excellent point raised by the reviewer, regarding the ability to capture large-scale circulation links to local precipitation. While the reviewer mentions this point in regard to Figure 4, we have added this point following the discussion of Figure 8, which also demonstrates the point quite well. This distinction is in the revised paper as the fifth paragraph of Section 3.2, which reads: "Many others have identified the connection of precipitation patterns to large-scale circulation patterns (e.g., Leung et al., 2003;

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Robertson and Ghil, 1999; Widmann et al., 2003); CA, because it utilizes domain-wide patterns can capture these relationships, while BCSD, defining only the spatial relationship between one large-scale grid box and the fine-scale grid boxes within it, is less able to. Reanalysis, due to its assimilation of observed atmospheric state variables, is known to represent better the large-scale atmospheric variables than derived quantities such as grid-cell precipitation (Widmann et al., 2003). Thus, the higher correlations exhibited by the CA method for dry- and wet-day sequencing in some locations may be a manifestation of the ability to relate these domain-wide patterns to local precipitation, at least to the extent that these effects are reflected accurately in the reanalysis."

5) The reviewer requests a stronger statement of the differences (or lack of differences) between the methods at the monthly and daily level. For the monthly level of intercomparison, a fourth paragraph has been added to Section 3.1, stating: "The overall similarity of skills between the CA and BCSD techniques for downscaled monthly precipitation and temperature should be interpreted in light of the distinctive properties of the methods. As noted above, the "perfect prog" CA approach makes no adjustment for biases in the large-scale spatial and temporal variability of reanalysis precipitation and temperature, while the "MOS" BCSD explicitly corrects any biases at the monthly level. Thus, the similarity in skills for downscaling monthly temperature and precipitation, where daily variability is not yet considered, indicates that the biases in reanalysis at this scale are not large enough to affect in a substantial way the downscaling skill."

Further, the following paragraph has been added to Section 3.2: "As discussed in Section 2.1, since temperature observations are assimilated into reanalysis, there is much lower bias in reanalysis temperature than in reanalysis precipitation, a model-derived variable. Thus, downscaled daily temperature extremes, specifically high extremes in summer and low extremes in winter and fall, show improved skill with CA as compared to BCSD, while correlation at the monthly level was comparable (or even higher for BCSD) (Figures 1 & 2), reflecting the translation of reanalysis daily skill to the fine-scale. In contrast, similarly to the monthly level, daily downscaled precipitation is gen-

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erally indistinguishable between the two downscaling techniques, with the exception of some statistics related to sequencing of daily precipitation, showing that as large-scale daily simulations become less skillful, the downscaling based on daily model output will be less distinguishable from a random daily distribution."

Likewise, these statements are reiterated in the revised Conclusions section of the manuscript.

6) No comment 6 in reviewer's comment.

7) The contrast between using as predictors of local precipitation either large-scale circulation or GCM precipitation is elaborated by including the following sentence in the last paragraph of the conclusions section: "While these fields may be depicted less accurately than other potential predictor variables in the GCM (for example atmospheric circulation fields), using GCM precipitation has the advantage of capturing the complexity of physical processes (as represented in the GCM) producing precipitation in a way that using only large-scale circulation indices may not."

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 4, 3413, 2007.