Statistical Downscaling of the Warm Season Precipitation in the Core North America Monsoon Region

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ABSTRACT

The North American Monsoon System (NAMS) is the principal feature of summer climate of Mexico and the Southwest U.S., and this study explores the development of statistically downscaled estimates of warm season precipitation over the core region of the North American Monsoon Experiment (NAME). Normalized accumulated daily-total summer precipitation anomalies for northwestern Mexico for the period 1950 to 1998 are manipulated through a triated empirical orthogonal function procedure in which three contiguous precipitation regions were realized. Hence, each of these sub-regions is studied separately. Using output variables from a 1998 version of the National Centers for Environmental Predictions medium-range forecast (MRF) model, we sought to determine which variables are important predictors of the first-mode and boundary layer features responsible for NAMS rainfall. Choice of MRF predictors is important. The k-Nearest Neighbor algorithm (KNN), in an auto-type statistical downscaling technique, is applied to derive local-scale predictions of precipitation from specified MRF model variables. We evaluate the quality of downscaled product in terms of a standard suite of verification metric.

PARTIAL RESULTS

On average, the months of JAS are characterized by high frequency of convective events where studies have proven that meso-convection plays significant role in the warm-season precipitation. Firstly, candidate input fields from MRF model for statistical downscaling model (the KNN) were determined. Subsequently, a reformatted data matrix from these ensembles of daily MRF predictor fields over a large domain encompassing all sub-watersheds was created. To enhance in-depth understanding of the structure of the precipitation regime we examined the seasonal average precipitation amounts for the July-September (JAS) period. Daily precipitation amounts are taken from a gridded, 1ºx1º data set for the period 1948-2002, distributed by the Climate Prediction Center (CPC). Principal component analysis, followed by variance rotation, identified four regions. Region 4 is outside of the basin study area (the Baja peninsula). The first four leading factors explained 83% of the total variance in the JAS series. Regions are identified in maps in which a loading factor is a particular principal component value greater than 0.5. This finding forms a basis for developing separate precipitation disaggregation models for the three regions identified in Figure 1.

RESULTS

The North American Monsoon Experiment (NAME) rain gauge network covers a topographically complex multi-watershed area between 22º and 30º N and 104º and 112º W (see Figure 1). This semi-arid region receives mainly convective precipitation during the warm monsoon season. To enhance in-depth understanding of the structure of the precipitation regime we examined the seasonal average precipitation amounts for the July-September (JAS) period. Daily precipitation amounts are taken from a gridded, 1ºx1º data set for the period 1948-2002, distributed by the Climate Prediction Center (CPC). Principal component analysis, followed by variance rotation, identified four regions. Region 4 is outside of the basin study area (the Baja peninsula). The first four leading factors explained 83% of the total variance in the JAS series. Regions are identified in maps in which a loading factor is a particular principal component value greater than 0.5. This finding forms a basis for developing separate precipitation disaggregation models for the three regions identified in Figure 1.

Figure 1. Basin reliability for the warm season (JAS) precipitation in the PC-2 basin. Insert is a histogram indicating frequency of use of the forecasts (refinement plot).

Figure 2. The (Relative Operating Characteristic) ROC curve for the warm season months (JAS).

Figure 3. Box plots of total monthly rainfall for 105 ensemble members for selected gaging stations (sharpen show the 25th & 75th interquartile range), 1st lead time at day 3.

Figure 4. Box plots of spatial autocorrelation for 105 ensemble members between 25078 & 18001 for the 14-day first lead times.

Figure 5. Rank histograms for JAS months (JAS) at 2-day first lead time with 105 ensemble members for the PC-2 basin (stations pooled).

The following questions will be expanded and clarified over time:

1. How can the KNN ensemble forecasts be used reliably? What adaptation requirements are needed for the spatial and temporal characteristics of the monsoon system to be integrated into a hydrological ensemble system?