Statistical downscaling of the FSUGSM temperature over the southeast United States

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The recent studies require the simulation of regional climate change scenarios with finer spatial and temporal resolution. Smaller scale prediction is very important in that the local climate significantly determines the consequences for many natural systems and human activities such as vegetation, ecology, hydrology, agriculture, economy, and urban development. Downscaling techniques have emerged as a means of providing this local climate change scenarios from coarsely resolved simulations that the current climate models are able to provide (Wilby and Wigley 1997; Huth and Kysely 2000). In addition, biases unveiled from the model result can be significantly reduced by the application of ideal downscaling technique. The present study has been motivated by this request. This study has focused on downscaling temperature of FSUGSM (Florida State University Global Spectral Model) (T63) seasonal forecasts, along with their bias-correction.

Five-day averaged maximum and minimum temperature data obtained from FSUGSM (~1.8° lon.-lat.) have been statistically downscaled to local spatial scale of 0.2°×0.2° (~20 km) for the southeast US region, covering Florida, Georgia, and Alabama. About 90 grid points are created by downscaling per FSUGSM grid box. Downscaling technique in this study comprises 1) CSFOF analysis (Kim and North 1997) between observation and FSUGSM output for the training period, 2) Regression between the dominant lower modes of each dataset. Observation is specified as predictand whereas the model result the predictor. 3) Generation of CSEOF principal component time series for forecast period on the basis of relationship identified from the first two steps. 4) Reconstruction of local scale data for the forecast domain from the generated principal component time series and the eigenfunctions obtained from training. 5) Repetition of this procedure by withholding a particular year as a forecast period in order to conduct this downscaling under the cross-validation framework. Figure 1 illustrates the basic downscaling procedure applied in the present study.

Downscaled results, FSUGSM simulations, and bias-corrected FSURSM (regional spectral model) are compared together with observations. 10 years from 1994 through 2003 have been used to compare those datasets and the time series of the last two years (2002 & 2003) are shown in Figs. 2 and 3. Time series show that statistically downscaled results are generally closer to observation than FSUGSM results are. This downscaling technique also corrects the bias which is included in FSUGSM. (e.g., Figs. 2c,d,e, Figs. 3a,b). However, statistically downscaled results look comparable to the dynamically downscaled RSM results, as their temporal fluctuations are shown in Figs. 2 and 3.

RMSE maps are provided here to compare the downscaling performance with RSM (Fig. 4). RMSE reveals that statistically downscaled results are moderately better than RSM results over Georgia and Alabama. However, Local climate in Florida is better captured by RSM simulation than statistical downscaling. We expect that the improved forecast skill with higher spatial grids will be very helpful for the near-surface local climate forecasts associated with anthropogenic urban impacts, agriculture and hydrology, and the geographical vegetation characteristics.

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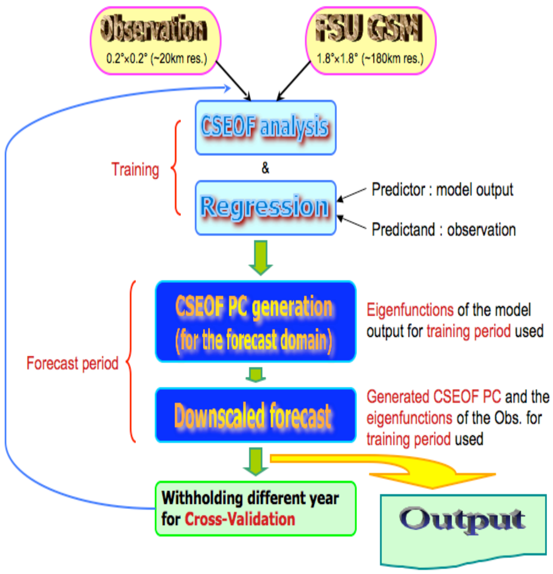

Fig. 1. Schematic diagram of the downscaling procedure in the present study

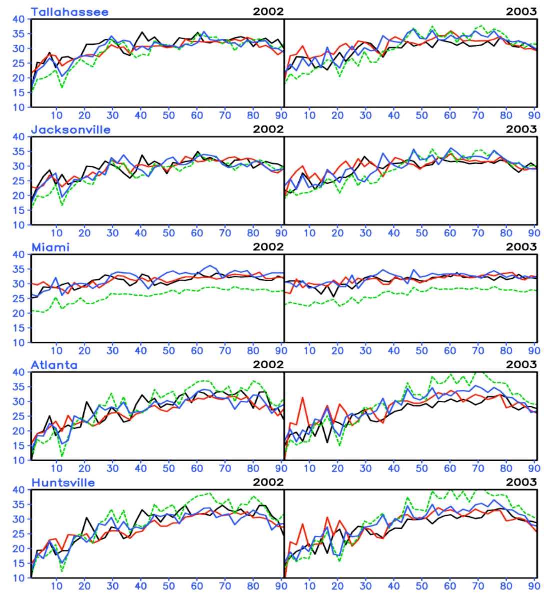

Fig. 2. 5-day mean surface T_{max} time series from downscaling (red), bias-corrected FSURSM (blue), FSUGSM (green-dashed), and observation (black).

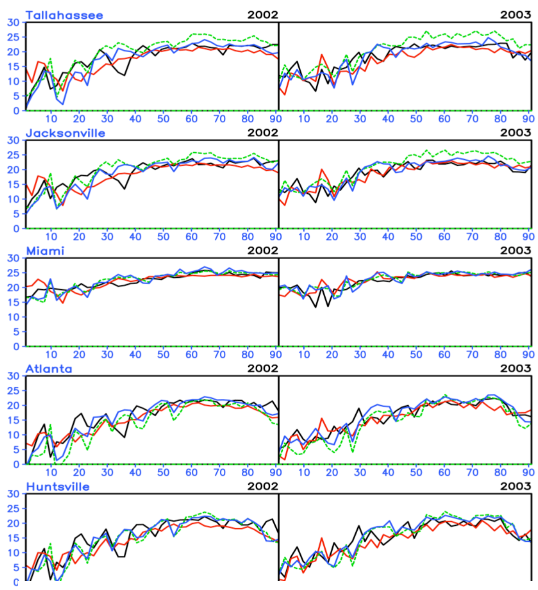

Fig. 3. Same as Fig. 2 but for T_{min}.

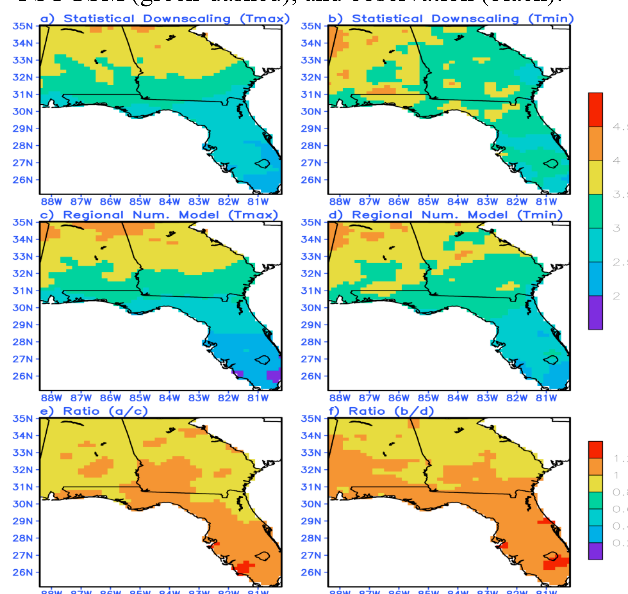

Fig. 4. RMSE maps for statistical downscaling (top) and RSM (middle). Bottom panel represents their RMSE ratio (downscaling/RSM). Left and right panels, respectively, indicate the map for T_{max} and T_{min}.

References

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