Validation of Narccap climate products for forest resource applications in the southeast United States

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Abstract

A validation study of North American Regional Climate Change Assessment Program (NARCCARP) climate simulations is conducted for selected Unites States Forest Service (USFS) sites in the southeastern USA. Preliminary results focus on qualitative comparisons of seasonal and monthly data from NARCCAP simulations and the NCEP North American Regional Reanalysis (NARR). Additional analyses extend current validation efforts to more quantitative methods incorporating seasonal and monthly time-series plots of variables (e.g., low-level humidity, temperature, precipitation) applicable to forest resource diagnostics and prediction. The validation studies are precursors to current research to assess the vulnerability of southeastern forest cover and fire loads to climate change. Anticipated outcomes from this research will be useful for decision support and policy development by national, state, and local stakeholders.

Introduction.

The predicted global temperature increase(IPPCC, 2007) due to the increasing concentration of atmospheric carbon dioxide has prompted the US government via the USDA to initiate assessments of the possible impact of such climate changes on US Forests. This paper is based on preliminary work undertaken in the initial stages of such assessment for selected United States Forest Service (USFS) sites in the southeastern USA.

The aim of this study is to perform dynamical downscaling of climate simulations from General Circulation Models (GCMs) from the current relatively coarse resolutions of over 2.0 X 2.0 degrees to finer resolutions of approximately 0.2X0.2 degrees for the southeastern US. The most effective way to achieve this is via a stepwise downscaling to approximately 0.5X0.5 before further downscaling to to the required resolution. It is in this regard that the North American Regional Climate Change Assessment Program (NARCCAP) comes in handy because it is geared to generate high resolution climate change simulations in order to investigate uncertainties in regional scale projections of future climate and generate climate change scenarios for use in impacts research. Instead of re-inventing the wheel by starting from scratch this study opted to to use the NARCCAP results as a first step in performing further downscaling experiments via higher resolution RCM simulations..

NARCCAP modelers are in the process of producing climate simulations from a set of regional climate models (RCMs) driven by a set of atmosphere-ocean general circulation models (AOGCMs) over a domain covering the conterminous United States and most of Canada (fig 1). The RCMs are nested within the AOGCMs for simulations of the current period 1971-2000 and for the future period 2041-2070. The projected simulations are based on the SRES A2 emissions scenario. The first stage of our study consists of rudimentary validation of the Narccap products via spatial and temporal comparison of the current period (1971-2000) simulations with observed data from the University of Delaware program.

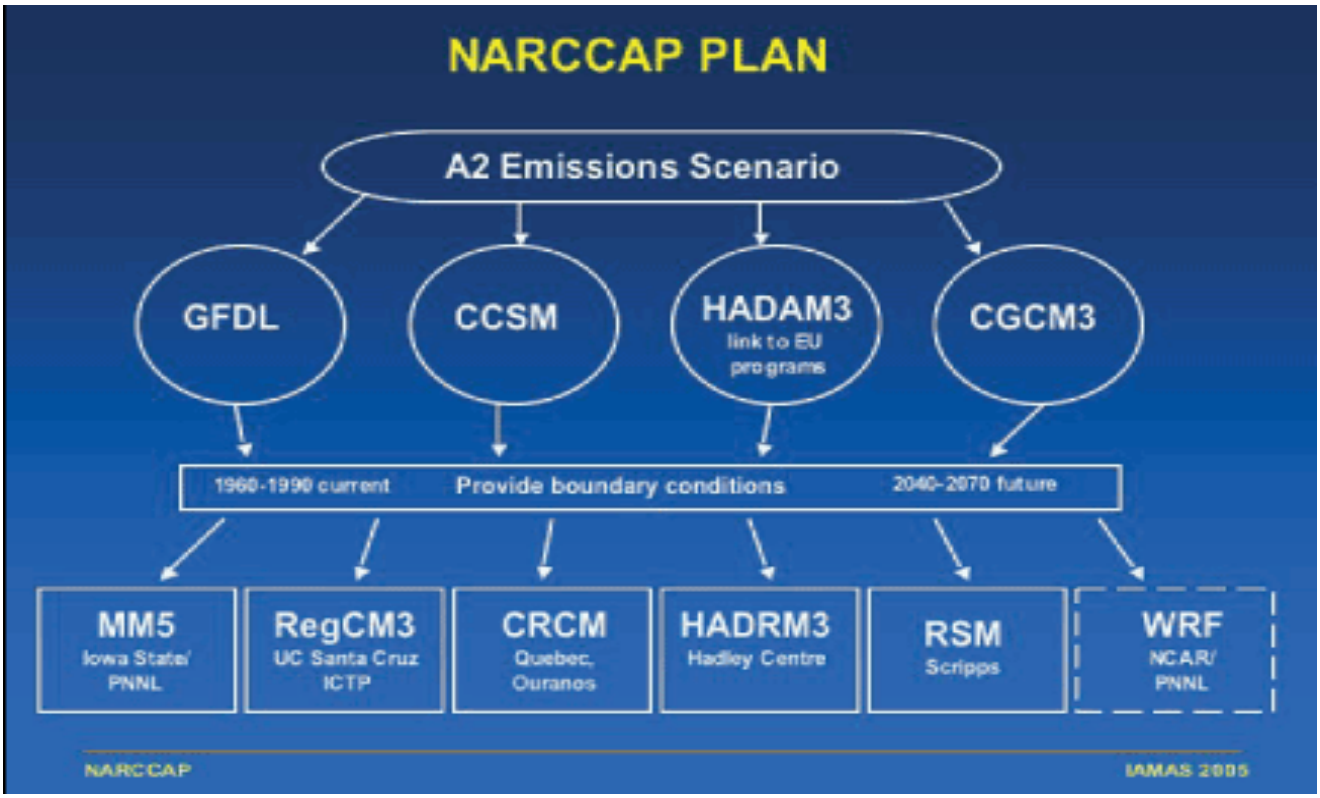

Figure 1. (Adapted from Linda O. Mearns – Narccap Plans – Phase II)

1. Spatial comparison of simulated versus observed data

The surface temperature field for selected simulations based mostly on availability of the finished products from NARCCAP are compared to observations obtained from the University of

Delaware database . Though various model configurations are considered in these comparisons the major focus is on the GFDL-RegCM3 simulations because we were intending to do further downscaling based on RegCM3. Qualitative validation of the the seasonal (DJF, MAM,JJA,mean of surface temperatures from the simulations was facilitated by comparing the spatial plots of the variable side by side as shown in figures 1.1, 1.2, 1.3 and 1.4.

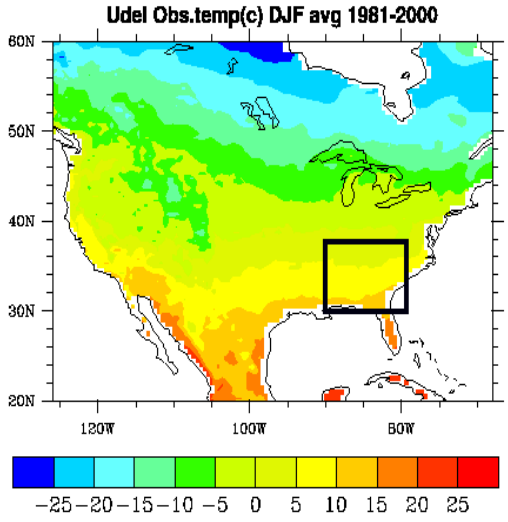

Figure 1.1

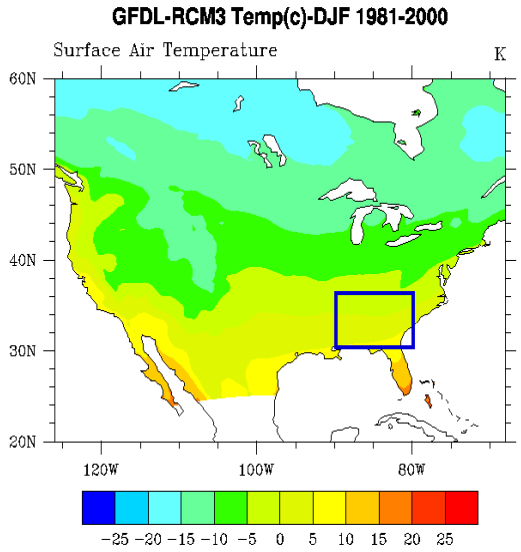

Figure 1.2

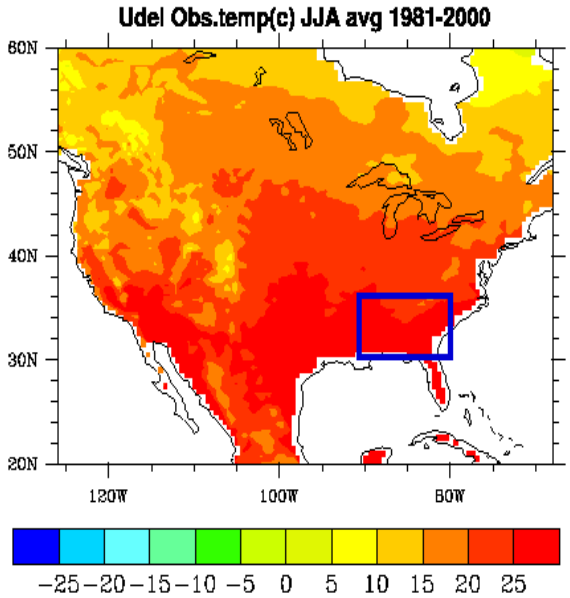

Figure 1.3

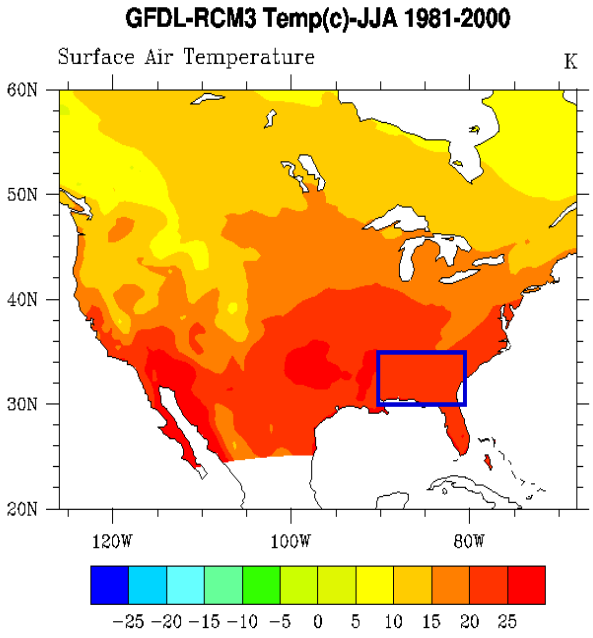

Figure 1.4

Difference plots were obtained by re-griding the simulated product to coincide with the observation grids for the University of Delaware data. The DJF and JJA difference plots are shown in figure 1.5 and figure 1.6

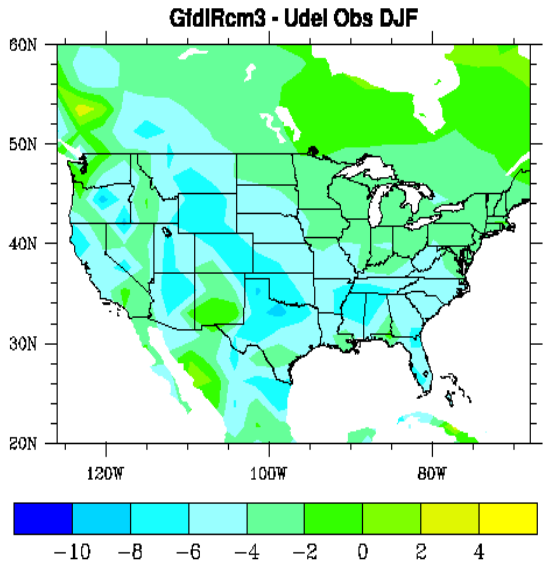

Figure 1.5

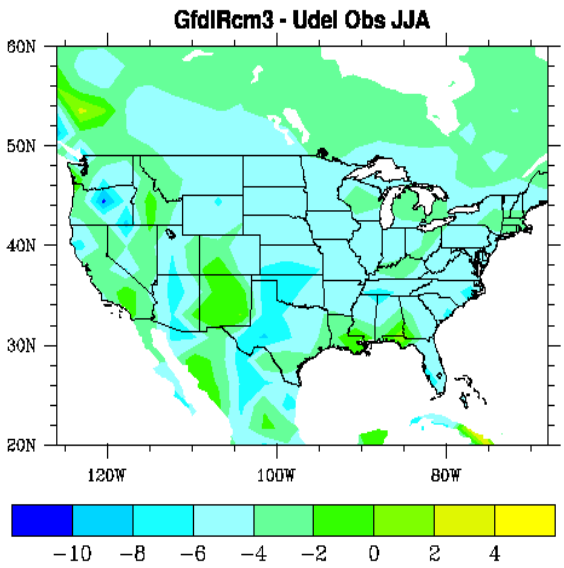

Figure 1.6

2. Time-series plots of simulated versus observed data

Time-series plots of observed and simulated monthly mean surface temperatures for specific forest sites in the southeast US for the current period (1981-2000) are shown with a view to highlighting any trend or diagnostic difference between the simulated and observed data. The sites chosen for these comparisons were Desoto in Southern Mississippi and Nantahala at the border between Georgia and North Carolina. The period 1981- 2000 was considered due to availability of both observed and simulated data. The plots are shown in figures 2.1 and 2.2.

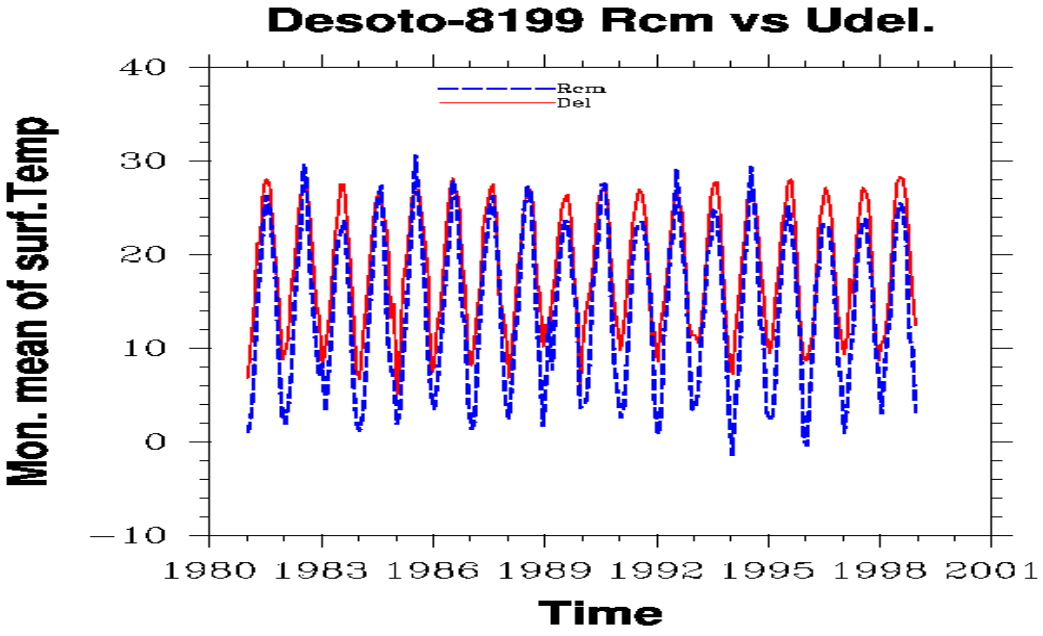

Figure 2. 1

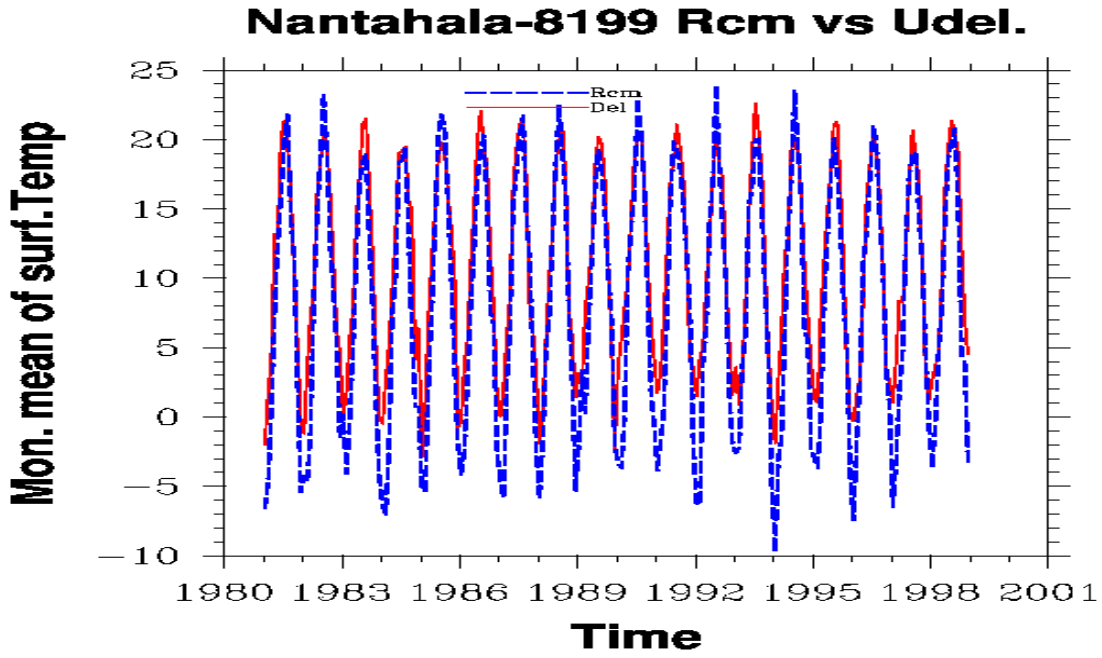

Figure 2. 2

A time-series plot of the observed and simulated monthly mean surface temperatures from other regional climate models nested in different GCM's for Nantahala forest at the same period (1981-2000) is shown in figure 2.3. A similar plot of observations of the same variable versus the ensemble mean from the various model combinations is shown in figure 2.4.

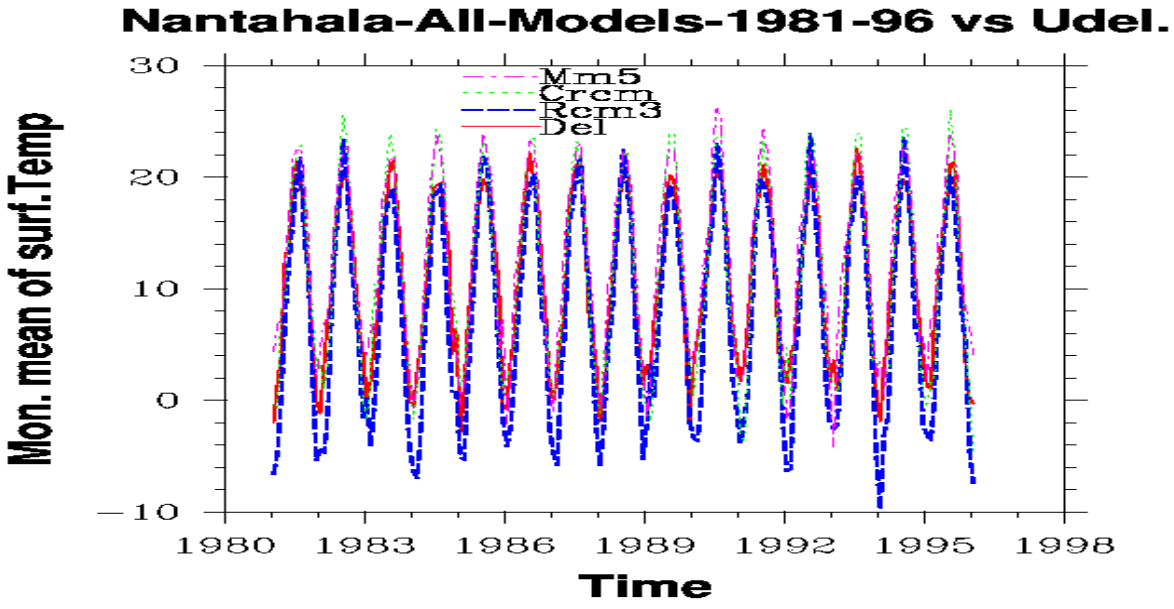

Figure 2.3

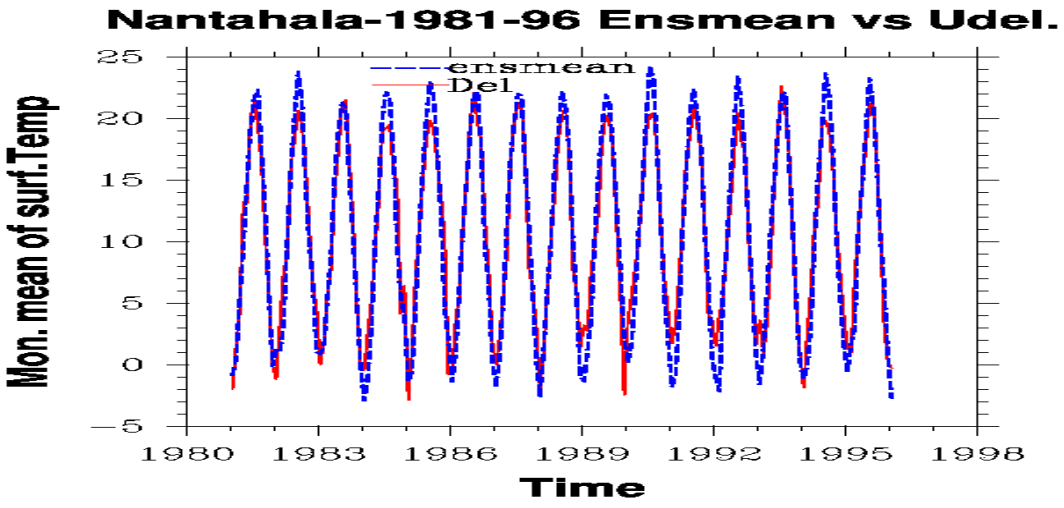

Figure 2.4

A time-series plot for the year 1988 is shown in figure 2.5 highlighting the various tracks of the ensemble.

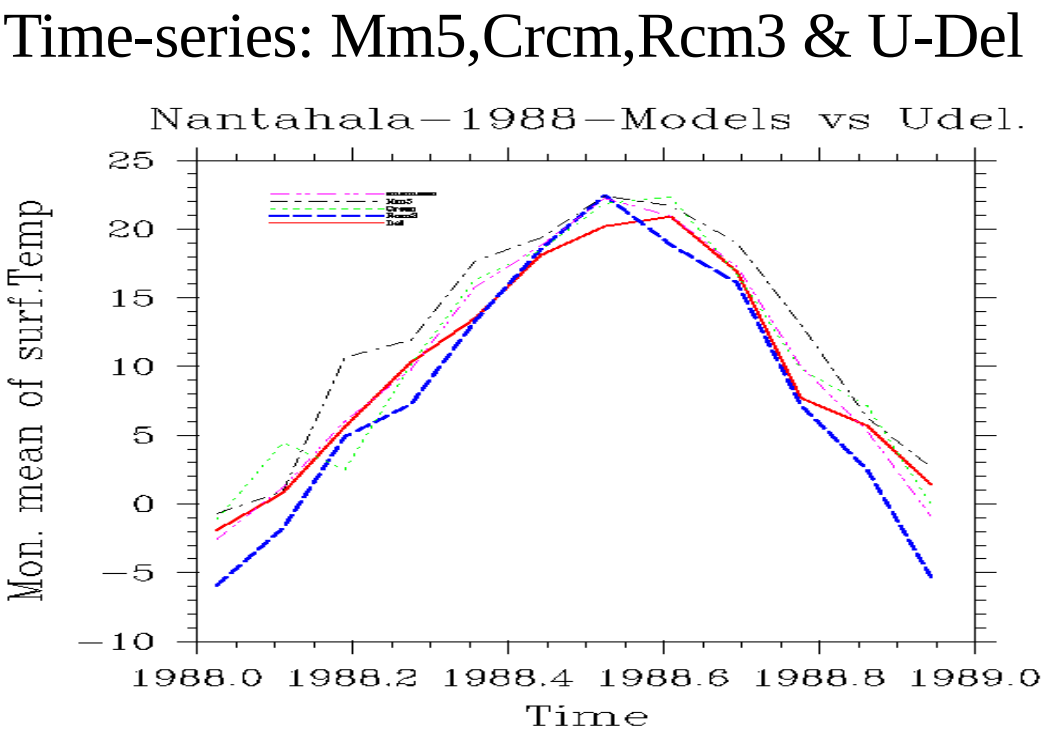

Figure 2.5

3. Statistics

The mean absolute bias and the correlation coefficient between the various simulation results and the observations for the selected forest sites are shown in tables 3.1 and 3.2. These basic statistical indicators are based on the long term mean values for the current period (1981-1996).

Mean Absolute Bias:1981-96(Model - Udel)

Location	RCM(Gfdl)	MM5(Ccsm)	CRCM(Cgcm)	ENS
Desoto	-4.11	0.36	-0.59	-1.44
Nantahala	-2.67	1.91	0.56	-0.07
GWashington	-4.15	-0.18	-1.85	-2.06

Table 3.1

Correlation Coefficient(Model vs Udel)

Location	RCM(Gfdl) (Tslice)	MM5(Ccsm)	CRCM(Cgcm)	ENS
Desoto	0.74 (0.73)	0.83	0.81	0.82
Nantahala	0.76 (0.74)	0.89	0.82	0.85
GWashington	0.84 (0.79)	0.92	0.85	0.90

Table 3.2

4. Summary

The spatial and temporal display of the Gfdl-Rcm3 simulations exhibited a cold bias during winter (DJF) in the southeast US in comparison to observations (University of Delaware data). All of the other models combinations indicated relatively lower warm biases during summer. This rudimentary validation procedure was not capable of determining whether the significant cold bias produced by the Gfdl-Rcm3 simulation was mostly contributed by the driving (Global) model or by the nested regional climate model.

More studies are needed to highlight the influence of the driving global model on the regional simulations. The study however, does indicate that the use of ensemble means might reduce some uncertainties from specific Global-regional model matrices. Even though these preliminary results might be useful in identifying cold/warm biases from the different simulations, they are not necessarily sufficient indicators of the long term predictive capabilities of the various model combinations.

Acknowledgements:
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